PRE-APPLICATION DOCUMENT

Lower Mokelumne River Hydroelectric Project

FERC Project No. 2916

October 2025

East Bay Municipal Utility District
375 11th Street
Oakland, California 94607

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	micrograms per liter
µS/cm	microSiemens per centimeter
A	
ACGP	Amador County General Plan
ACRA	Amador County Recreation Agency
ADA	Americans with Disabilities Act
AF	actual flow
AFRP	Anadromous Fish Restoration Program
APE	area of potential effects
AWA	Amador Water Agency
B	
BCC	Bird of Conservation Concern (ESA)
BGA	blue green algae
BMAS	below maximum allowable storage
BRM	bedrock milling
C	
CAISO	California Independent System Operator
cal BP	calibrated years before present
Cal-IPC	California Invasive Plant Council
Caltrans	California Department of Transportation
CALVEG	Classification and Assessment with Landsat of Visible Ecological Groupings
CAMC	Camanche Valve House
CAMD	Camanche Dam
CANS WTP	Camanche North Shore Water Treatment Plant
CANS WWTP	Camanche North Shore Wastewater Treatment Plant
CANS	Camanche North Shore Recreation Area
CASS WTP	Camanche South Shore Water Treatment Plant
CASS WWTP	Camanche South Shore Wastewater Treatment Plant
CASS	Camanche South Shore Recreation Area
CBR	considered but rejected
CCE	candidate for listing as endangered (CESA)
CCT	candidate for listing as threatened (CESA)
CCWD	Calaveras County Water District
CDEC	California Data Exchange Center
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CDPR	California Department of Parks and Recreation

CE	California endangered (CESA)
CEII	Critical Energy Infrastructure Information
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFM	constant fractional marking
CFP	California Fully Protected (CESA)
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGS	California Geological Survey
CHHP	Camanche Hills Hunting Preserve
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
COG	Council of Governments
Commission	Federal Energy Regulatory Commission
CPUD	Calaveras Public Utility District
CR	California listed as rare (CESA)
CRMP	Cultural Resources Management Plan
CRPR	California Rare Plant Rank
CT	California threatened (CESA)
CUI	Controlled Unclassified Information
CVPIA	Central Valley Project Improvement Act
CVRWQCB	Central Valley Region Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CWA	Clean Water Act
CWHR	California Wildlife Habitat Relationships

D

Delta	Sacramento-San Joaquin Delta
DLA	Draft License Application
DO	dissolved oxygen
DPS	Distinct Population Segment
DSOD	Division of Safety of Dams
DSSMP	Dam Safety Surveillance and Monitoring Plan
DSSMR	Dam Safety Surveillance and Monitoring Report
DWR	Department of Water Resources (California)

E

Eagle Act	Bald and Golden Eagle Protection Act
EAP	Emergency Action Plan
East Bay	San Francisco Bay Area
EAT	Enhanced Acoustic Telemetry
EBMUD	East Bay Municipal Utility District
EDD	(California) Employment Development Department
EFH	essential fish habitat

EJ	environmental justice
El.	Elevation
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit

F

FC	candidate to be federally listed (ESA)
FE	federally listed endangered (ESA)
FERC	Federal Energy Regulatory Commission
FLA	Final License Application
FOIA	Freedom of Information Act
FPD	Listed, proposed for delisting (ESA)
FPE	federally proposed endangered (ESA)
FPT	federally proposed threatened (ESA)
FR	Federal Register
FT	federally listed threatened (ESA)

G

GIS	Geographic Information System
GPS	Global Positioning System

H

H	historic
HAB	harmful algal bloom
HCG	HDR Engineering, Christensen Associates, and GEI Consultants
HDR	HDR Engineering, Inc.
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HID	hazard input document
HLO	high-level outlet
HOS	Hypolimnetic Oxygenation System
hp	horsepower
HPMP	Historic Properties Management Plan
HR	human remains
HSG	hydrologic soil group
HUC 10	10-digit HUC
HUC 12	12-digit HUC
HUC	USGS Hydrologic Unit Code

I

IHN	infectious hematopoietic necrosis virus
ILP	Integrated Licensing Process
INSTAAR	Institute of Arctic and Alpine Research
IPaC	Information for Planning and Consultation
ISR	Initial Study Report

ITAG	Interagency Acoustic Telemetry Advisory Group
ITP	incidental take permit
J	
JSA	Joint Settlement Agreement
JSATS	Juvenile Salmon Acoustic Telemetry System
JVID	Jackson Valley Irrigation District
K	
kV	kilovolt(s)
kW	kilowatt(s)
L	
LCI	Lettis Consultants International
LLO	low-level outlet
LMID	(California Employment Development Department's) Labor Market Information Division
LMRWSSC	Lower Mokelumne River Watershed Stewardship Steering Committee
Lower Mokelumne River Project	Lower Mokelumne River Hydroelectric Project (FERC Project No. 2916)
M	
M	multi-component
m/sec	meters per second
MCCT	Mokelumne Coast to Crest Trail
MCE	Marin Clean Energy
MCL	maximum contaminant level
M_d	duration magnitude
mg/L	milligrams per liter
MGD	million gallons per day
MRDS	Mineral Resources Data System
MRDUA	Mokelumne River Day Use Area
MRFH	Mokelumne River Fish Hatchery
MRLC	Multi-Resolution Land Characteristics
MRTAC	Mokelumne River Technical Advisory Committee
MRWSS	Mokelumne River Watershed Sanitary Survey
MRZ	mineral resource zones
msl	above mean sea level
MW	megawatt(s)
MWh	megawatt-hour(s)
N	
NAHC	Native American Heritage Commission

National Register	National Register of Historic Places
NAVD 88	North American Vertical Datum of 1988
NGO	non-governmental organization
NGVD 29	National Geodetic Vertical Datum of 1929
NHPA	National Historic Preservation Act of 1966
NLCD	National Land Cover Database
NMFS	National Marine Fisheries Service
NNIP	non-native invasive plants
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NRCS	National Resource Conservation Service
NTU	Formazin Nephelometric Units
NWI	National Wetlands Inventory
NZMS	New Zealand mud snail

P

P	precontact
PACT WTP	Pardee Center Water Treatment Plant
PACT WWTP	Pardee Center Wastewater Treatment Plant
PAD	Pre-Application Document
PARA WTP	Pardee Recreation Area Water Treatment Plant
PARA WWTP	Pardee Recreation Wastewater Treatment Plant
PARA	Pardee Recreation Area .
Partnership	Lower Mokelumne River Partnership
PC	phycocyanin concentration
PCC	Partnership Coordinating Committee
PG&E	Pacific Gas and Electric Company
PH	powerhouse
PIT	passive integrated transponder
PLSS	Public Land Survey System
PME	protection, mitigation, and enhancement
PMF	probable maximum flood
POA	Principles of Agreement
POR	period of record
PRISM	Parameter-Elevation Regressions on Independent Slopes Model
PRIV	Privileged
Project	Lower Mokelumne River Hydroelectric Project (FERC Project No. 2916)
PSC	Partnership Steering Committee
PSP	Public Safety Plan
PURPA	Public Utility Regulatory Policies Act of 1978
PV	photovoltaic

R

REC	Renewable Energy Certificates
RM	river mile
RMC	RMC Water and Environment
RPR	Rare Plant Rank
RS	rock shelter/cave
RSP	Revised Study Plan
RV	recreational vehicle

S

SCADA	Supervisory Control and Data Acquisition
SCORP	Statewide Comprehensive Outdoor Recreation Plan (California)
SD1	Scoping Document 1
SD2	Scoping Document 2
SEWD	Stockton East Water District
SHA	Safe Harbor Agreement
SHIRA	Spawning Habitat Integrated Rehabilitation Approach
SHPO	State Historic Preservation Office
SJCGP	San Joaquin County General Plan
SJCRCD	San Joaquin County Resource Conservation District
SNFMB	Sierra Nevada Foothills Metamorphic Belt
SPD	Study Plan Determination
SRKW	southern resident killer whale
SRT	Salmonid Restoration Team
SSC	California Species of Special Concern (CESA)
SSMP	Sanitary Sewer Management Plan
STID	Supporting Technical Information Document
Study Plan	Proposed Technical Study Plan
SWE	snow water equivalent
SWRCB	(California) State Water Resources Control Board

T

TAF	thousand acre-feet
TCP	Traditional Cultural Property
TDC	thiamine deficiency complex
TNF	true natural flow
TSS	total soluble solids
TWG	Technical Working Group

U

U	Unknown
U.S. Census	United States Census Bureau
UC Davis	University of California, Davis
USACE	United States Army Corps of Engineers

USC	United States Code
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USR	Updated Study Report

W

WCC	Woodward Clyde Consultants
WID	Woodbridge Irrigation District
WIDD	Woodbridge Irrigation District Dam
WL	Watch List (CESA)
WQRMP	Water Quality and Resource Management Program
WSOM	Water Supply Operations Model

1.0 INTRODUCTION

The East Bay Municipal Utility District (EBMUD) is the licensee, owner, and operator of the Federal Energy Regulatory Commission (FERC)-licensed Lower Mokelumne River Hydroelectric Project (FERC Project No. 2916; Lower Mokelumne River Project or Project). The Project is located on the mainstem of the Mokelumne River in Amador, Calaveras, and San Joaquin counties within the state of California. The Project has a total authorized installed capacity of approximately 38 megawatts (MW). Figure 1.1-1 shows the Project location.

EBMUD currently operates the Project under a 50-year license that was issued by FERC on March 10, 1981. The license will expire on March 31, 2031. EBMUD is seeking a license renewal to continue to operate and maintain the Project and intends to file an application for a new license with FERC on or before March 31, 2029. EBMUD is using FERC's Integrated Licensing Process (ILP) as found in Title 18 of the U.S. Code of Federal Regulations (CFR), Part 5. The Pre-Application Document (PAD) provides FERC and interested parties with a summary of existing, relevant, and reasonably available information related to the Project as supplemented by a due diligence search. The PAD also includes draft study plans to facilitate the development of study planning earlier in the FERC relicensing process and to take advantage of a longer timeline to implement studies. The information required in the PAD is specified in 18 CFR 5.6 § (c) and (d).

Accompanying this PAD (Volume I) are additional volumes that will form the basis of the relicensing process: Volume II (Appendices), which provides all of the supporting information for the various sections of the PAD; Volume III (Proposed Technical Study Plans [Study Plans]), which will form the basis of the proposed Study Plans; and Volumes IV and V (CEII/CUI/PRIV Confidential Information), which contain information on the electrical power system at Pardee and Camanche powerhouses, and the location(s) of sensitive wildlife, botanical, and rare/threatened/endangered species. Disclosure of the information in Volumes IV and V could be harmful to these resources, and, pursuant to 18 CFR §388.113(d) and 112(b), EBMUD requests confidential treatment of this information.

1.1 LOWER MOKELUMNE RIVER PROJECT OVERVIEW

The Lower Mokelumne River Project is made up of two developments: Pardee Reservoir and Dam, located at river mile (RM) 76.4, and Camanche Reservoir and Dam, located at RM 63.9. Pardee and Camanche reservoirs are operated in tandem to accomplish the Project objectives, and at times when Camanche Reservoir is full, the waters from Camanche Reservoir back up within 1,500 feet of the downstream toe of Pardee Dam.

A portion of the water diverted at Pardee Reservoir is conveyed to the EBMUD service area in the eastern region of the San Francisco Bay Area (East Bay) via the Mokelumne Aqueducts and used for drinking water. A portion of the stored water in Pardee and Camanche reservoirs is released to meet downstream flow obligations. The FERC Project boundary encompasses 19,022 acres, all of which is owned and maintained by EBMUD. There are no federal lands within the FERC Project boundary.

2.0 PROCESS PLAN AND SCHEDULE

2.1 PROCESS PLAN

EBMUD has elected to use FERC's default ILP for the relicensing of the Lower Mokelumne River Hydroelectric Project (FERC Project No. 2916, Lower Mokelumne River Project or Project). Table 2.1-1 outlines the FERC ILP activities, responsible parties, applicable regulations, and proposed dates specific to this relicensing as required by 18 CFR § 5.6(d)(1), based upon filing the NOI and PAD on October 17, 2025. Additionally, in developing the Process Plan and Schedule, EBMUD has included timeframes for formal dispute resolution (18 CFR § 5.14) while noting that any study disputes may also be resolved through informal dispute resolution. The Process Plan and Schedule is subject to change throughout the relicensing proceeding.

Table 2.1-1. Process plan and schedule.

Activity[a,e,f]	Responsible Party	Regulation	Proposed Dates[b,c,d]
Issue Public Notice for NOI/PAD	EBMUD	18 CFR § 5.3(d)(2)	10/17/2025
File NOI/PAD	EBMUD	18 CFR § 5.5, 5.6	10/17/2025
Initial Tribal Consultation	FERC	18 CFR § 5.7	11/17/2025
Issue Notice of Commencement of Proceeding and SD1	FERC	18 CFR § 5.8(a)(c)	12/16/2025
Conduct Scoping Meetings and Site Visit	FERC	18 CFR § 5.8(b)(viii)	01/28/2026 & 01/29/2026
Comments on PAD, SD1, and Study Requests Due	Interested Parties	18 CFR § 5.9(a)	02/14/2026
File PSP	EBMUD	18 CFR § 5.11(a)	03/31/2026
Issuance of SD2 (if necessary)	FERC	18 CFR § 5.10	03/31/2026
Study Plan Meeting	EBMUD	18 CFR § 5.11(e)	04/30/2026
Comments on PSP Due	Interested Parties	18 CFR § 5.12	06/29/2026
File RSP	EBMUD	18 CFR § 5.13(a)	07/29/2026
Comments on RSP Due	Interested Parties	18 CFR § 5.13(b)	08/13/2026
Issuance of SPD	FERC	18 CFR § 5.13(c)	08/28/2026

Activity[a,e,f]	Responsible Party	Regulation	Proposed Dates[b,c,d]
Initiate Formal Study Dispute Resolution Process (if necessary)	Mandatory Conditioning Agencies	18 CFR § 5.14(a)	09/17/2026
Dispute Resolution Panel Convenes	Dispute Panel	18 CFR § 5.14(d)	10/07/2026
File Comments on Study Dispute	Dispute Panel	18 CFR § 5.14(i)	11/01/2026
Dispute Resolution Panel Technical Conference	Dispute Panel	18 CFR § 5.14(j)	11/08/2026
Dispute Resolution Panel Issues Findings	Dispute Panel	18 CFR § 5.14(k)	12/28/2026
FERC Issues Study Dispute Determination	FERC	18 CFR § 5.14(l)	03/08/2026
First Season of Studies	EBMUD	18 CFR § 5.15(a)	08/2026–08/2027
File ISR	EBMUD	18 CFR § 5.15(c)(1)	08/28/2027
ISR Meeting	Interested Parties	18 CFR § 5.15(c)(2)	09/12/2027
File ISR Meeting Summary	EBMUD	18 CFR § 5.15(c)(3)	09/27/2027
Second Season of Studies	EBMUD	18 CFR § 5.15(a)	08/2027–08/2028
File USR	EBMUD	18 CFR § 5.15(c)(1)	08/27/2028
USR Meeting	Interested Parties	18 CFR § 5.15(c)(2)	09/11/2028
File USR Meeting Summary	EBMUD	18 CFR § 5.15(c)(3)	09/26/2028
File DLA	EBMUD	18 CFR § 5.16(a)-(c)	10/31/2028
Comments on DLA Due	Interested Parties	18 CFR § 5.16(e)	01/30/2029
File FLA	EBMUD	18 CFR § 5.17, 5.18	03/30/2029

NOI = Notice of Intent, PAD = Pre-Application Document, CFR = Code of Federal Regulations, SD1 = Scoping Document 1, PSP = Proposed Study Plan, SD2 = Scoping Document 2, RSP = Revised Study Plan, SPD = Study Plan Determination, ISR = Initial Study Report, USR = Updated Study Report, DLA = Draft License Application, FLA = Final License Application

Notes:

[a] This Process Plan and Schedule provides estimated due dates for the Project's relicensing activities. FERC will issue the Project's official Process Plan and Schedule via SD1 and SD2 (if necessary).

[b] If the due date falls on a weekend or holiday, the deadline is the following business day.

[c] Early filings or issuances will not result in changes to the estimated due dates.

[d] The schedule is subject to change throughout the relicensing proceeding.

[e] All Director's determinations are subject to request for rehearing to the Commission pursuant to 18 CFR § 375.301(a) and 385.713. Any request for rehearing must be filed within 30 days of determination.

[f] Activities shaded in gray are related to study dispute resolution and are not necessary if there are no study disputes.

2.2 SCOPING MEETING AND SITE VISIT

As set forth in the ILP regulations, FERC will issue Scoping Document 1 (SD1) within 60 days of the filing date of the NOI and PAD. In addition, pursuant to 18 CFR § 5.8(b)(3)(viii), FERC will provide public notice and schedule a public scoping meeting, and a Project site visit to be held within 30 days of issuing SD1. FERC will notice the dates, times, and location of the scoping meetings and publish that information in local papers after the filing of the NOI and PAD. Based on the October 2025 filing date for the NOI and PAD, EBMUD anticipates the FERC scoping meeting and site visit occurring in January 2026. EBMUD, in accordance with 18 CFR § 5.6 (d)(1), proposes that FERC host public scoping meetings in Lodi, California, on January 28, 2026, and the associated site visit for the Lower Mokelumne River Project on January 29, 2026.

2.3 PARTICIPATION IN THE INTEGRATED LICENSING PROCESS

Relicensing documents are available to the public through FERC's eLibrary, an online records information system that contains documents submitted to and issued by FERC. The eLibrary can be accessed through FERC's homepage at http://www.ferc.gov or directly at https://elibrary.ferc.gov/idmws/search/fercgensearch.asp. There is no registration or login required to use the eLibrary. The eLibrary contains most of FERC's documents, including microfilm records from 1981 forward. Documents filed with FERC as part of the Project's relicensing process are available for viewing and printing via the eLibrary by searching under the Project's docket number, P-2916. Interested parties can subscribe to the docket (P-2916) for the Lower Mokelumne River Project under eSubscription on the Commission's website at https://ferconline.ferc.gov/ to receive notices by email of filings and FERC issuances.

To facilitate communication and provide access during the relicensing process to all relevant documents, meeting materials, and key references, EBMUD has established a publicly accessible website, https://www.ebmud.com/mokrelicense.

EBMUD has provided this PAD to representatives of federal and state resource agencies, local governments, Native American Tribes, NGOs, members of the public, and other parties potentially interested in the relicensing proceedings (Volume II – Appendix A). Any party that would like to be added to or removed from the distribution list should send a written request to MokRelicense@ebmud.com.

2.4 COMMUNICATION AND DOCUMENT DISTRIBUTION

EBMUD will maintain a list of contacts for all Project relicensing participants who express an interest in the Project relicensing and who have provided an email and/or mailing address for contact. In addition to an email address, EBMUD requests that each agency,

Tribe, and NGO provide appropriate information (i.e., name, title, affiliation, mailing address, and telephone and fax numbers) for its designated contact. EBMUD will assume that those designated contacts will keep the appropriate members of their agency, Tribe, or NGO advised of Project relicensing activities. Also, EBMUD expects each agency, Tribe, and NGO will notify EBMUD if contact information for its designated contact changes. This list will be used to distribute electronic copies of major relicensing documents and will be updated with additions and modifications upon request.

EBMUD's goal is to maintain open communication during the relicensing process and to provide public access to relevant Project relicensing information. EBMUD anticipates distribution of relevant documents, submittal of comments, and correspondence will be largely conducted electronically, either by posting on the Project website, electronic filing of documents with FERC, and/or via email distribution. EBMUD will maintain documentation of all electronic correspondence as part of its formal agency consultation record.

As noted above, EBMUD has established, and plans to maintain, a publicly accessible website, https://www.ebmud.com/mokrelicense, as a means of making information regarding the Project relicensing readily available. The type of information that will be provided on the website includes the existing FERC license for the Project, relevant FERC orders, and major relicensing documents such as the NOI, PAD, and Proposed Study Plan. A hard copy of each non-confidential major FERC milestone will be maintained and available for public viewing, up on request, at EBMUD's offices in Oakland, Lodi, and Valley Springs, California. All requests for hard copies of relicensing documents should be sent to MokRelicense@ebmud.com and should clearly indicate the document name, publication date, and FERC Project No. 2916. A reproduction charge and postage costs may be assessed for hard copies requested by the public.

2.5 RESTRICTED DOCUMENTS

Certain Project-related documents are restricted from public viewing in accordance with FERC regulations. Controlled Unclassified Information (CUI) is information that requires safeguarding or dissemination controls pursuant to and consistent with applicable law, regulations, and government-wide policies as specified in Executive Order 13556 and 32 CFR Part 2002. CUI information includes Critical Energy Infrastructure Information (CUI/CEII) (defined under 18 CFR § 388.113), which are materials related to the design and safety of dams and appurtenant facilities and that are, as necessary to protect national security and public safety, restricted. Additional restricted materials include Privileged Information (CUI/PRIV) associated with protecting sensitive information, such as the location of rare, threatened, or endangered species, and sensitive archaeological

or other culturally significant properties. Volumes IV and V of this PAD include information considered CUI/CEII/PRIV and are being filed separately.

Anyone seeking CEII or CUI information from FERC must file a Freedom of Information Act (FOIA) request. Instructions for CEII, CUI, and FOIA are available on FERC's website at https://www.ferc.gov/foia.

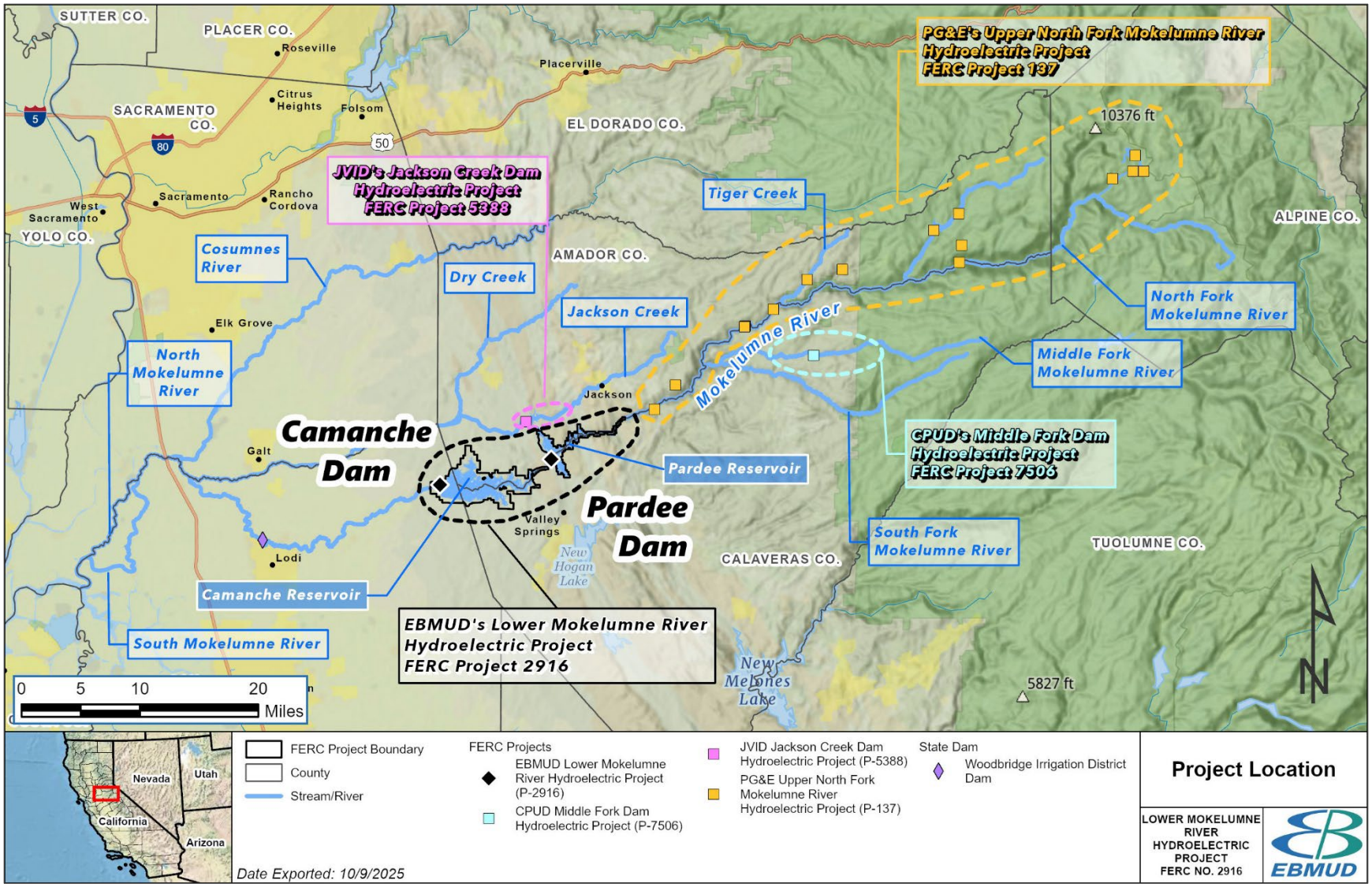


Figure 2.5-1. Lower Mokelumne River Project location.

The Project facilities, organized by development, are listed below.

Pardee Development:

- Pardee Dam and Reservoir
- Pardee South Spillway
- Jackson Creek Spillway and West End Dike
- Pardee Outlet Tower
- Pardee Powerhouse
- Pardee Recreation Area

Camanche Development:

- Camanche Dam and Reservoir
- Camanche Spillway
- Camanche Dike Nos. 1-6
- Camanche Powerhouse
- Camanche South and North Shore Recreation Areas
- Mokelumne Day Use Recreation Area
- Camanche Hills Hunting Preserve

Detailed information regarding Project facilities, features, and operations is included in Section 3.0 of this PAD. Refer to Section 4.1 for a description of the Mokelumne River basin.

2.6 PRE-APPLICATION DOCUMENT CONTENT

EBMUD is distributing the PAD and Notice of Intent (NOI) simultaneously to federal and state resource agencies, local governments, Native American Tribes, non-governmental organizations (NGOs), members of the public, and other parties potentially interested in the relicensing process. The information was assembled based on the requirements set forth in 18 CFR §5.6 and is organized as follows:

VOLUME I:

- Front Matter: Table of Contents; List of Tables; List of Figures; List of Acronyms and Abbreviations
- Section 1.0 – Introduction

- Section 2.0 – Process Plan and Schedule [18 CFR §5.6(d)(1)]
- Section 3.0 – Project Location, Facilities, and Operations [18 CFR §5.6(d)(2)]
- Section 4.0 – Description of Existing Environment and Resource Impacts [18 CFR §5.6(d)(3)]
- Section 5.0 – Preliminary Issues, Project Effects, and Potential Studies List [18 CFR §5.6(d)(4)]
- Section 6.0 – Literature and Information Sources Cited in the Descriptions and Summaries of Existing Resource Data [18 CFR §5.6(c)(2)]

VOLUME II:

- Appendix A – Consultation Log / Proof of Publication
- Appendix B –Joint Settlement Agreement (JSA)
- Appendix C – JSA Non-Flow Partnership Projects
- Appendix D – FERC License Articles 1-32
- Appendix E – Flow Duration Curves
- Appendix F – Water Quality Data
- Appendix G – Supporting Information for Wildlife and Botanical Species

VOLUME III:

- Draft Proposed Technical Study Plans

VOLUME IV (Critical Energy Infrastructure Information [CEII]) (Confidential)

- Supporting Information Energy Transmission – Single Line Diagrams

VOLUME V (Controlled Unclassified Information [CUI]//Privileged [PRIV]) (Confidential)

- Supporting Information for Rare, Threatened, and Endangered and Special Status Species and Sensitive Natural Communities in the Project Vicinity

2.7 PURPOSE OF THE PRE-APPLICATION DOCUMENT

By filing the NOI and this PAD, EBMUD is formally initiating the FERC ILP relicensing process for the Lower Mokelumne River Project. The purpose of this PAD is to: (1) describe the existing facilities and current and proposed operations at the Lower Mokelumne River Project, and (2) summarize existing information that is relevant to the evaluation of the Lower Mokelumne River Project relicensing. In addition, this PAD is

intended to assist resource agencies, municipalities, Native American Tribes, NGOs, and interested parties in identifying potential resource issues and related informational needs and to develop potential study requests (18 CFR §5.6(b)). In accordance with the regulations, the PAD and NOI have been filed with FERC and distributed to interested stakeholders.

EBMUD is also filing preliminary draft Study Plans to identify the studies that EBMUD is proposing to conduct to gather necessary information to evaluate any potential impacts from the Project.

FERC's regulations require that a licensee exercise due diligence in obtaining and including existing relevant and reasonably available information about the Project and related resources. To accomplish this, EBMUD has thoroughly reviewed its files for relevant information regarding the Project. EBMUD has contacted resource agencies, municipalities, Native American Tribes, NGOs, and other potentially interested parties and requested information and data that they may have about the Project or Project resources via a Pre-PAD Questionnaire. Additionally, EBMUD conducted searches of other potential information sources, including peer-reviewed journal articles, reference books, and the internet. All information sources cited in this PAD are appropriately referenced.

3.0 PROJECT LOCATION, FACILITIES, AND OPERATIONS

3.1 APPLICANT CONTACT INFORMATION

The exact name, business address, telephone number, and email address of each person authorized to act as an agent for EBMUD is listed below.

Ms. Priyanka K. Jain
Senior Civil Engineer
375 11th Street, MS 901
Oakland, CA 94607
510-287-1153
priyanka.jain@ebmud.com

Mr. Derek T. McDonald
General Counsel
375 11th Street, MS 904
Oakland, CA 94607
510-287-0168
derek.mcdonald@ebmud.com

3.2 PROJECT LOCATION AND LANDS

The Lower Mokelumne River Hydroelectric Project, FERC Project No. 2916 (Lower Mokelumne River Project or Project) was developed by EBMUD and comprises two existing major dams (Pardee Dam and Camanche Dam), two existing reservoirs (Pardee Reservoir and Camanche Reservoir), an existing powerhouse at an upstream location (Pardee Dam) having three turbine-generating units, an existing powerhouse at a downstream location (Camanche Dam) that contains three turbine-generating units, and various associated facilities at each of the two sites.

The FERC Project boundary includes lands and facilities necessary for operation and maintenance of all Project structures. The Project boundary encompasses approximately 19,022 acres of lands, all owned by EBMUD. Project lands designated for non-Project use exist within the Project boundary. These areas include a photovoltaic project for energy production constructed east of the Camanche Dam downstream right abutment, several cattle grazing leases around the Pardee and Camanche reservoirs, and several limited land use permits for seismic recording equipment and communications infrastructure. Refer to Section 4.8.7.1 for additional information on non-Project use of Project lands. There are no federal lands or Native American reservations within the Project boundary. Figure 3.2-1 provides a general Project location map, while Table 3.2-1 shows the Township, Range, and Section of each major component.

Table 3.2-1. Major Project facility locations.

Project Component	Location	County
Pardee Dam	5N 10E	Calaveras County
Pardee Reservoir	5N 10E, 5N 11E, 4N 10E	Calaveras County
Pardee Powerhouse	5N 10E	Calaveras County
Camanche Dam	4N 9E	San Joaquin County
Camanche Reservoir	4N 9E, 5N 9E, 4N, 10E, 5N 10E	Amador and San Joaquin counties
Camanche Powerhouse	4N, 9E	San Joaquin County

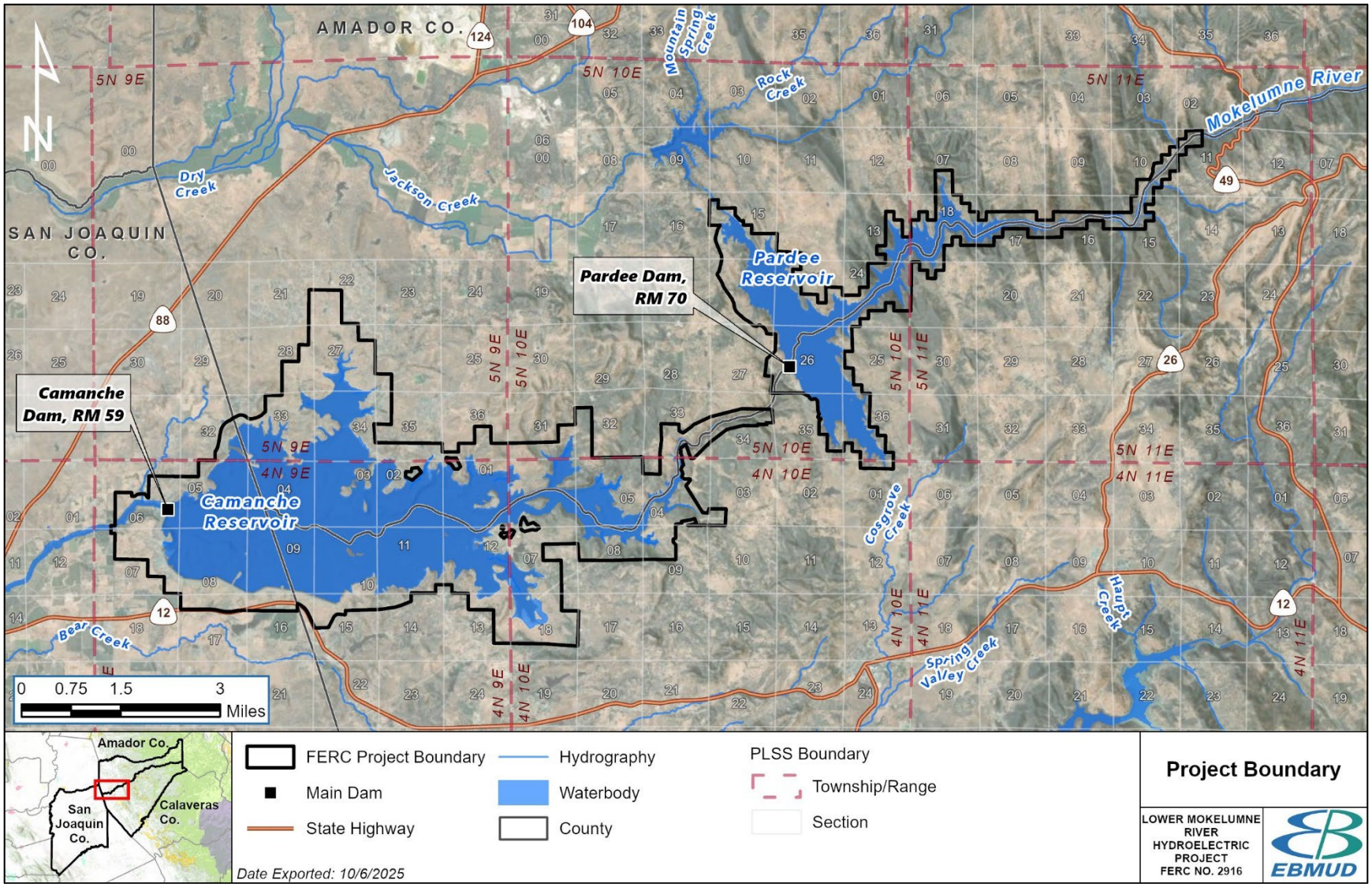


Figure 3.2-1. Project location.

3.3 EXISTING PROJECT FACILITIES

Per 18 CFR § 5.6(d)(2)(iii), the following sections describe the facilities of the Lower Mokelumne River Project. The Project consists of two developments: Pardee Dam Development and Camanche Dam Development. Both developments contribute to a combined FERC-authorized installed capacity of 38.06 megawatts (MW), with 28.61 MW at the Pardee Dam Development and 9.45 MW at the Camanche Dam Development.

Unless otherwise stated, elevations in this PAD are reported in feet and refer to the respective Project Datum. The conversion between the North American Vertical Datum of 1988 (NAVD 88) and the Project Datum at Pardee Dam is as follows: NAVD 88 = Project Datum + 2.0 feet. The conversion between NAVD 88 and the Project Datum at Camanche Dam is as follows: NAVD 88 = Project Datum + 2.2 feet.

Table 3.3-1 includes a detailed list of all major Project components.

Table 3.3-1. Lower Mokelumne River Project components list.

Description	Pardee	Camanche
	Number or Fact	
Powerhouse Capacity		
Capacity	28,608 kW	9,450 kW
Impoundment		
Normal Maximum Surface Area (acres)	2,260	7,800
Normal Dam Crest Elevation (El.) (feet, Project Datum)	575.0	263.0
Operational Storage Capacity[1] (acre-feet)	188,208	416,696
Gross Storage Capacity (acre-feet)	203,795	417,120
Dam		
Year Built	1929	1964
Layout	Curved concrete gravity	Zoned earth-fill roller compacted embankment, with impervious core and located approx. 10 miles downstream from Pardee Dam
Dam Dimensions	345 feet high 1,337 feet long	171 feet high 2,640 feet long

[1] Operational storage capacity is the volume of water stored above the level of the lowest outlet.

Description	Pardee	Camanche
	Number or Fact	
North Dike Dimensions	N/A	Dike 4 Crest El. 263.0 feet (Project Datum) Crest Length 500 feet Height 32.7 feet Dike 5 Crest El. 263.0 feet (Project Datum) Crest Length 1,200 feet Height 41.7 feet Dike 6 Crest El. 263.0 feet (Project Datum) Crest Length 1,200 feet Height 46.2 feet
South Dike Dimensions	N/A	Dike 1 Crest El. 263.0 feet (Project Datum) Crest Length 7,530 feet Height 82.7 feet Dike 2 Crest El. 263.0 feet (Project Datum) Crest Length 5,750 feet Height 86.7 feet Dike 3 Crest El. 263.0 feet (Project Datum) Crest Length 4,500 feet Height 41.2 feet
Spillway Crest Elevation	567.65	235.50

Description	Pardee	Camanche
	Number or Fact	
Water Conduits		
	Six conduits: Two 72-inch-diameter sluiceways w/needle valves, one at the south 244 feet long, and one at the north 299 feet long The north 72-inch sluiceway bifurcates to Unit No. 3 (1983 addition) (66-inch-diameter, 45-foot-long penstock) and to a needle valve Two 42-inch-diameter sluiceways w/needle valves, each 244 feet long Two 72-inch-diameter cast iron penstocks (Unit Nos. 1 & 2), each 213 feet long	10-foot-diameter, 416-foot-long penstock to powerhouse from Conjoined trifurcation that extends to: One 48-inch high-level steel conduit, 699 feet long Two 66-inch branches of North Conduit, each 789 feet long

3.3.1 PARDEE DAM DEVELOPMENT

Since the 1920s, EBMUD's primary source of water has been the Mokelumne River. In 1923, after residents voted to form EBMUD to address the unreliable water supplies for the growing populations in the East Bay, the District began an effort to import water from the Mokelumne River. Construction of the Pardee Dam and Reservoir was completed in 1929. Pardee Dam is located on the Mokelumne River, about 26 miles east-northeast of Lodi, California, in Amador and Calaveras counties. Pardee Reservoir is used primarily for EBMUD's municipal water supply, with three aqueducts transporting water 90 miles across the San Joaquin Valley and Delta to East Bay reservoirs for treatment and delivery to approximately 1.4 million customers. Other uses include power generation, source supplies for Jackson Valley Irrigation District (JVID), recreation for the public, flow releases for downstream diversions/water rights obligations, and flow releases to protect and enhance the Lower Mokelumne River ecosystem and fishery.

Pardee Reservoir is created by three structures: Pardee Dam, the Pardee South Spillway, and the Jackson Creek Spillway and West End Dike. Pardee Dam is a curved concrete gravity structure. A powerhouse at the base of the dam has a total FERC-authorized installed capacity of 28.61 MW and generates an average of approximately 95,000 megawatt-hours (MWh) of electric energy annually based on data from 1983 to 2024. The Pardee South Spillway is a concrete gravity overflow spillway located immediately south of the dam. The Jackson Creek Spillway and West End Dike are concrete and earthen dikes located at the north end of the reservoir. These structures are classified as "High

Hazard Potential" under FERC's dam safety guidelines. The California Division of Safety of Dams also asserts jurisdiction over the Pardee Dam Development.

Releases into the Mokelumne Aqueduct System for domestic water supply are made though an outlet tower south of the left abutment of Pardee South Spillway. The outlet tower houses the operators and controls for the outlet gates. Four levels of outlets with three gates at each level are available for flow releases. This arrangement allows operators to utilize water from different depths in the reservoir. Access to the tower is by a warren truss style foot bridge, which spans approximately 180 feet from the shore.

3.3.2 CAMANCHE DAM DEVELOPMENT

Camanche Dam is located on the Mokelumne River, immediately downstream of Pardee Dam, about 14 miles east-northeast of Lodi, California, in San Joaquin County with the reservoir in portions of Amador, Calaveras, and San Joaquin counties. Camanche Dam and Reservoir were completed in 1964 as part of a regional effort to improve water management and flood control[2] along the Mokelumne River and to enhance EBMUD's water supplies. The Camanche facilities are operated in conjunction with Pardee Reservoir, with the primary purposes to provide flood control, meet downstream water release obligations, and provide additional storage in dry years.

Camanche Reservoir also provides extensive recreational amenities at the North and South shore recreation areas. Camanche Reservoir is created by the Main Dam, spillway, and six earthen dikes, numbered sequentially: three on the north side and three on the south side. The Main Dam is an earth embankment structure on the Mokelumne riverbed. A separate concrete gravity spillway is located south of the Main Dam and through Dike No. 3. These structures are classified as "High Hazard Potential" under FERC's dam safety guidelines. The California Division of Safety of Dams also asserts jurisdiction over the Camanche Dam Development.

EBMUD added a three-unit powerhouse at the base of Camanche Dam in 1983. The hydroelectric powerhouse with a 9.45 MW authorized installed capacity generated an average of approximately 30,000 MWh of electric energy annually based on data from 1983 to 2024.

The Mokelumne River Fish Hatchery (MRFH) is located just below Camanche Dam. The hatchery is operated by the California Department of Fish and Wildlife (CDFW) in

[2] Camanche Dam is a Section 7 dam as defined in the Flood Control Act of 1944 and is subject to United States Army Corps of Engineers (USACE) oversight for flood control regulation purposes.

partnership with EBMUD. The Project features are briefly described in the subsections that follow and are illustrated in Figure 3.3-1 and Figure 3.3-2.

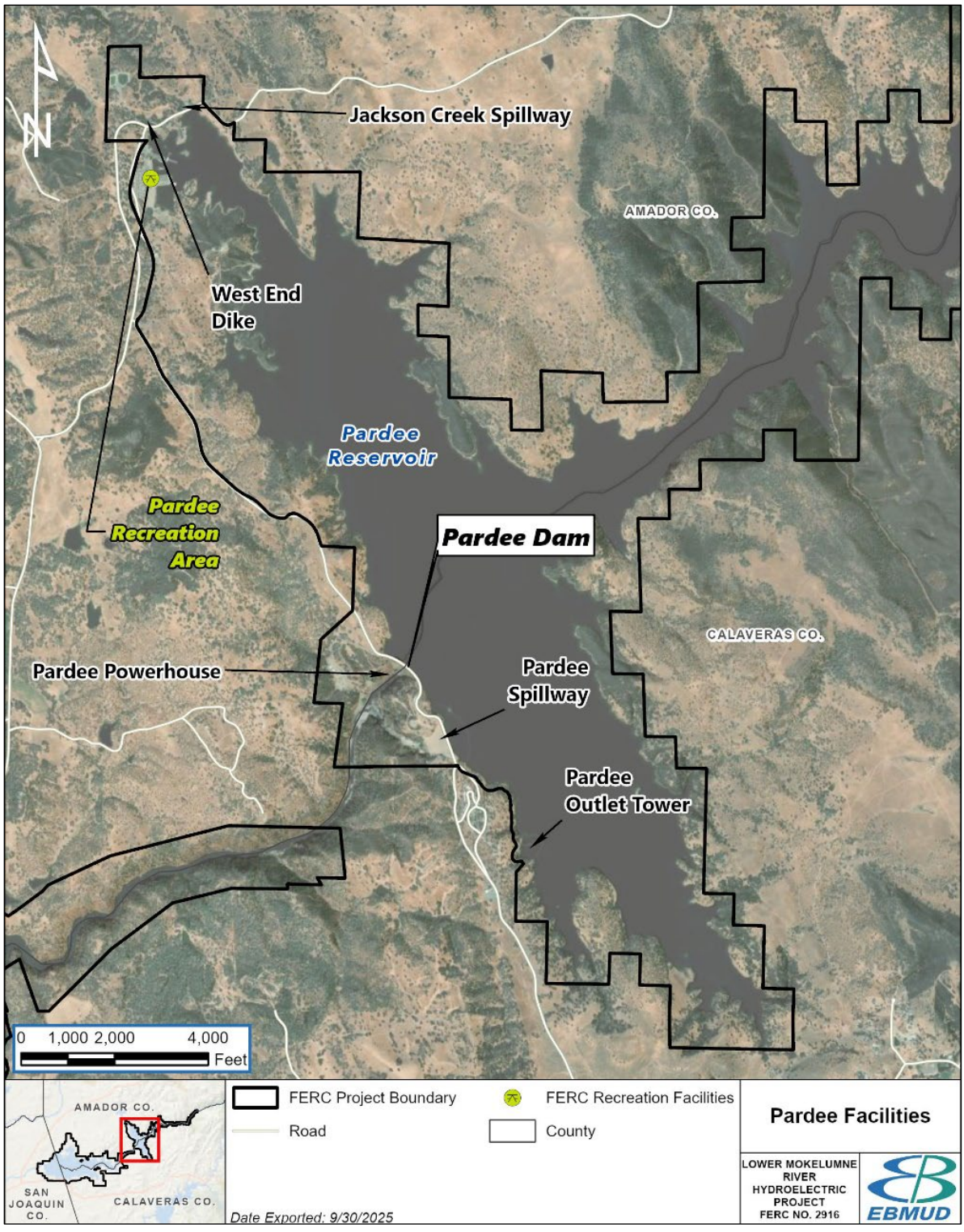


Figure 3.3-1. Lower Mokelumne River Project – Pardee Dam Development.

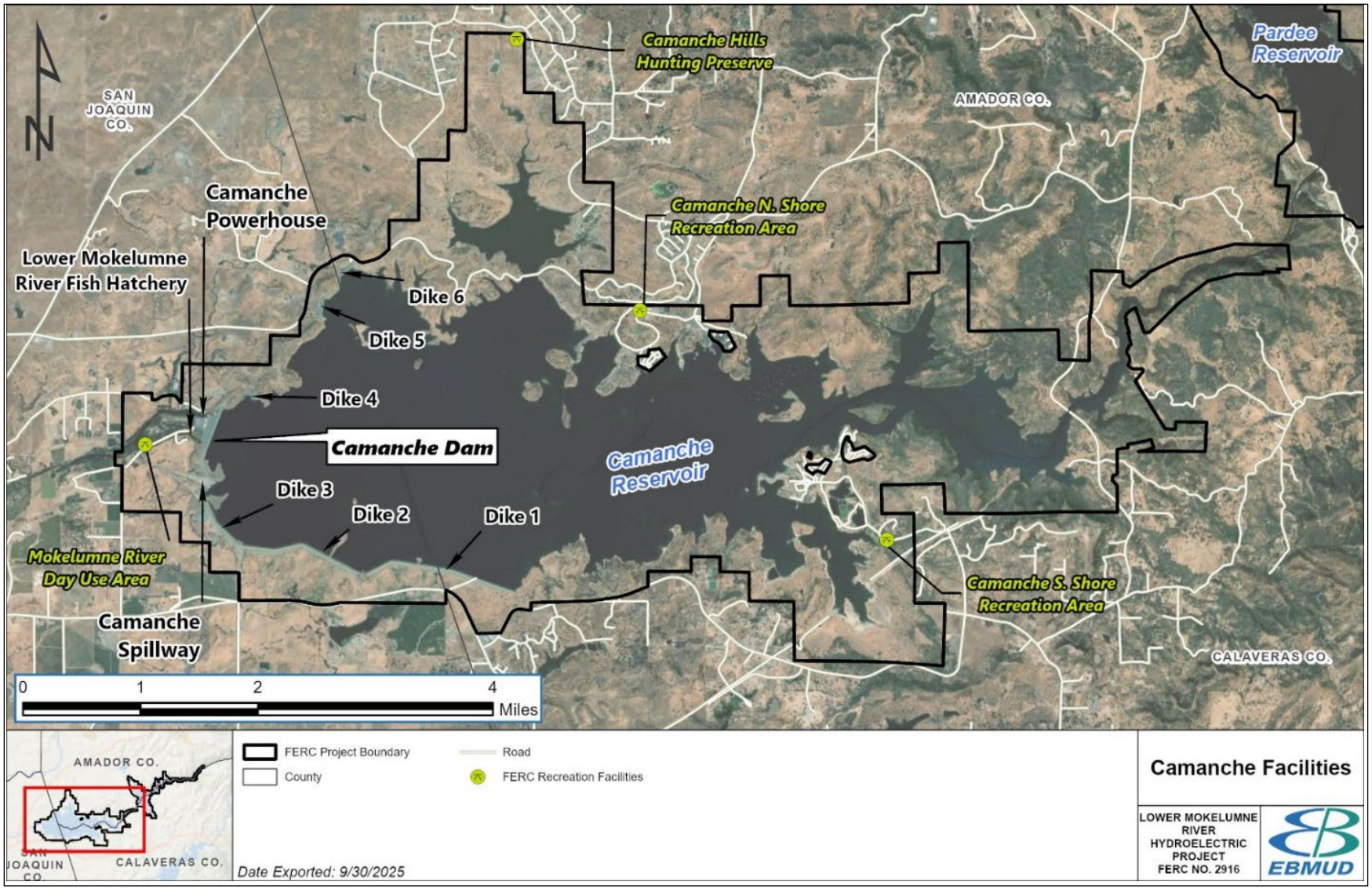


Figure 3.3-2. Lower Mokelumne River Project – Camanche Dam Development.

3.3.3 DAMS, SPILLWAYS, AND ASSOCIATED FACILITIES

3.3.3.1 PARDEE DAM

Pardee Dam (originally known as Lancha Plana Dam) was completed in 1929. It is a concrete gravity structure 345 feet high at its crest, as measured from the lowest elevation of the downstream limit of the dam, excluding the 6.5-foot-tall parapet wall, and is 1,337 feet long. The thickness of the dam is 16 feet at the crest and 239 feet at the base at its maximum section.

Photo 3.3-1. Pardee Dam.

The design elevation of the parapet wall on the top of the dam (upstream side) is Elevation (El.) 581.5 feet, resulting from a modification in 2000 to add a 1.25- to 2-foot raise on the upstream parapet wall across the main Pardee Dam. This was done as a preventive measure against any overtopping during extreme hydrologic conditions.

Flows from Pardee Dam are released directly into the upper reach of Camanche Reservoir.

3.3.3.2 PARDEE SOUTH SPILLWAY

The South Spillway is located approximately 500 feet south of the left abutment of the dam. The spillway consists of an unlined approach channel, an ogee control structure, a converging 360-foot-long concrete chute, and an unlined gulch, referred to as Mexican Gulch. The ungated, mass-concrete, rock anchored, ogee-shaped weir control structure has a crest length of 847.50 feet with the crest at El. 567.65 feet, which is 13.85 feet lower than the design crest elevation of the dam parapet wall. The spillway concrete slab has an average thickness of 2 feet. A bridge above the spillway control section is founded on piers and has a soffit 22 feet above the spillway crest. The chute converges to 425 feet wide at the downstream terminus. Phased structural modifications were made to the spillway in 1996, 2000, and 2002 to ensure the spillway met FERC's safety requirements.

Photo 3.3-2. Pardee South Spillway.

3.3.3.3 JACKSON CREEK SPILLWAY AND APPROACH DIKES

Photo 3.3-3. Jackson Creek Spillway.

The Jackson Creek Spillway and Dike is a concrete structure flanked with earth embankments and one additional earth dike southwest of the Jackson Creek Spillway. These structures were built in a saddle, beyond which Carson Creek flows north to Lake Amador on Jackson Creek. The concrete siphon spillway, with a crest length of 758 feet, was originally constructed by EBMUD to discharge expected flood water into the Jackson Creek drainage basin. The siphon structure has never functioned as a spillway, and the 16 siphon openings were backfilled with concrete to El. 558 feet in 1994. A rockfill buttress was also added downstream of the siphon structure to improve structural stability. A 24-inch discharge pipe through the base of the siphon structure supplies water via Carson Creek to Lake Amador for JVID. The Jackson Creek West End Dike, constructed by EBMUD in 1929, is a 324 feet long saddle dike located a few hundred feet southwest of the Jackson Creek Spillway, and both the spillway's abutments are earthen embankments. They all have two compacted earthfill zones with a curved, reinforced concrete upstream face.

3.3.3.4 CAMANCHE MAIN DAM

Photo 3.3-4. Camanche Dam.

Camanche Main Dam was completed in 1964 and is a zoned compacted earthfill structure. The Main Dam is 171 feet high and 2,640 feet long. The design crest of the Main Dam is El. 263.0 feet with a crest width of 34.5 feet.

The upstream face of the Main Dam is protected by riprap from the crest down to El. 145.0 feet.

Flows from Camanche Dam are released directly into the Mokelumne River.

3.3.3.5 CAMANCHE SPILLWAY

Photo 3.3-5. Camanche Spillway.

The spillway is located through Dike No. 3, about 1,000 feet left of the left abutment of the Main Dam. The spillway consists of an unlined approach channel, an ogee control structure, a 1,550-foot-long concrete chute, and an unlined channel that rejoins the Mokelumne River. The ungated, mass-concrete, rock anchored, ogee-shaped weir control structure has a crest length of 400 feet with the crest at El. 235.5 feet, which is 27.5 feet lower than the design crest elevation of the dam, and a 50-foot-deep grout curtain for seepage control. The concrete chute has approximately 24-foot-tall vertical side walls.

3.3.3.6 CAMANCHE DIKES 1 TO 6

Camanche Dam has six auxiliary dikes, with three on the south side, Dike Nos. 1, 2, and 3, and three on the north side, Dike Nos. 4, 5, and 6. The dikes are sequentially numbered starting with Dike No.1 at the southern upstream end and in a clockwise direction, ending with Dike No. 6 at the northern upstream end.

The dikes range in height from 40 to 90 feet and length from 500 to 7,530 feet (Table 3.3-2). The design crest of the dikes is El. 263.0 feet, and the upstream face of each dike is protected by riprap.

Table 3.3-2. Dimensions of Camanche Dam auxiliary dikes.

Dike No	Height (ft)	Length (ft)	Elevation (ft) (Project Datum)
South Dikes			
Dike No. 1	82.7	7,530	263.0
Dike No. 2	86.7	5,750	263.0
Dike No. 3	41.2	4,500	263.0
North Dikes			
Dike No. 4	500	500	263.0
Dike No. 5	1,200	1,200	263.0
Dike No. 6	1,200	1,200	263.0

3.3.3.7 CAMANCHE OUTLET WORKS

The main outlet works for Camanche Reservoir consist of two low-level outlet (LLO) pipes in cut-and-cover conduits in the right abutment bedrock of the Main Dam on the north

side of the original river channel. These conduits were used during construction for river diversion and valved steel pipes were added to construct the permanent LLO. The north conduit was modified in 1983 at the outlet structure end to divert flows to the Camanche Powerhouse.

The LLO extends from the intake structure to a valve chamber at the upstream side of the central core of the Main Dam, and large concrete cutoff collars surround the concrete conduits within the dam core. Each pipe in the valve chamber is fitted with a 108-inch-diameter butterfly valve, mounted on saddles within two concrete conduits. Immediately downstream from the butterfly valves, two air-relief valves with inlets were provided in the original construction. Two additional 10-inch air-relief valves were added in 1980 with inlets downstream of the two original air-relief valves.

Downstream from the valve chamber, water flows through a pair of 8-foot-diameter steel pipe conduits. Both north and south conduits are protected with asphalt coating. Each of the 8-foot-diameter steel pipes bifurcates into two 66-inch-diameter branches at the outlet structure; these originally terminated with four 66-inch fixed cone valves. The two 66-inch branches from the north conduit conjoin with the high-level outlet (HLO) into a single 120-inch penstock that serves the powerhouse. The flow releases through the two 66-inch branches from the south conduit are also controlled by fixed-cone (Howell-Bunger) dispersion valves at the outlet structure downstream of the dam toe. The dispersion valves discharge into spray chambers, which dissipate the energy of the releases. The absence of mechanical moving parts in the water path, aside from the valve, leads to having minimal fish injury risk. One 18-inch-diameter and one 12-inch-diameter fixed-cone dispersion valves were originally provided for lower releases. However, the 18-inch-diameter valve was removed when the powerhouse was added.

The outlet channel downstream of the discharge valves is protected with grouted riprap for approximately 90 feet downstream of the outlet structure. Controls for the outlets are electrical-hydraulic and are operated either locally from the outlet works structure or by remote control from the Pardee Powerhouse.

To support the operations at the MRFH, a portion of flow is diverted into the hatchery via an intake structure at the downstream toe of Camanche Dam. Steady, regulated flow is provided to support fish raceways, incubation trays, and holding ponds.

3.3.4 INTAKES AND CONVEYANCE SYSTEMS

3.3.4.1 PARDEE DAM

Intakes

Six conduits with two 72-inch penstocks, two 72-inch sluiceways, and two 42-inch sluice ways are located through the bottom of the dam with entrance centerlines at El. 260 feet. Three half-circle intake wells feed the six conduits, each intake well serving two conduits. The center well provides water to the two penstocks to Powerhouse Unit Nos. 1 and 2. A bifurcation on the rightmost sluiceway serves Powerhouse Unit No. 3. Two bulkhead gates, stored and lowered from the gate house on the dam crest, can close the upstream end of the six conduits.

A free-standing outlet tower in the southern arm of Pardee Reservoir supplies water to the Mokelumne Aqueduct System. The gate operation room at the top of the tower is accessed by a truss walkway and contains equipment to operate slide gates. There are two gates at El. 395 feet (not shown), one gate at El. 400 feet (not shown in Figure 3.3-3), and three gates each at El. 460 feet, El. 490 feet, El. 520 feet, and El. 550 feet. See Figure 3.3-3 for an illustrative profile view.

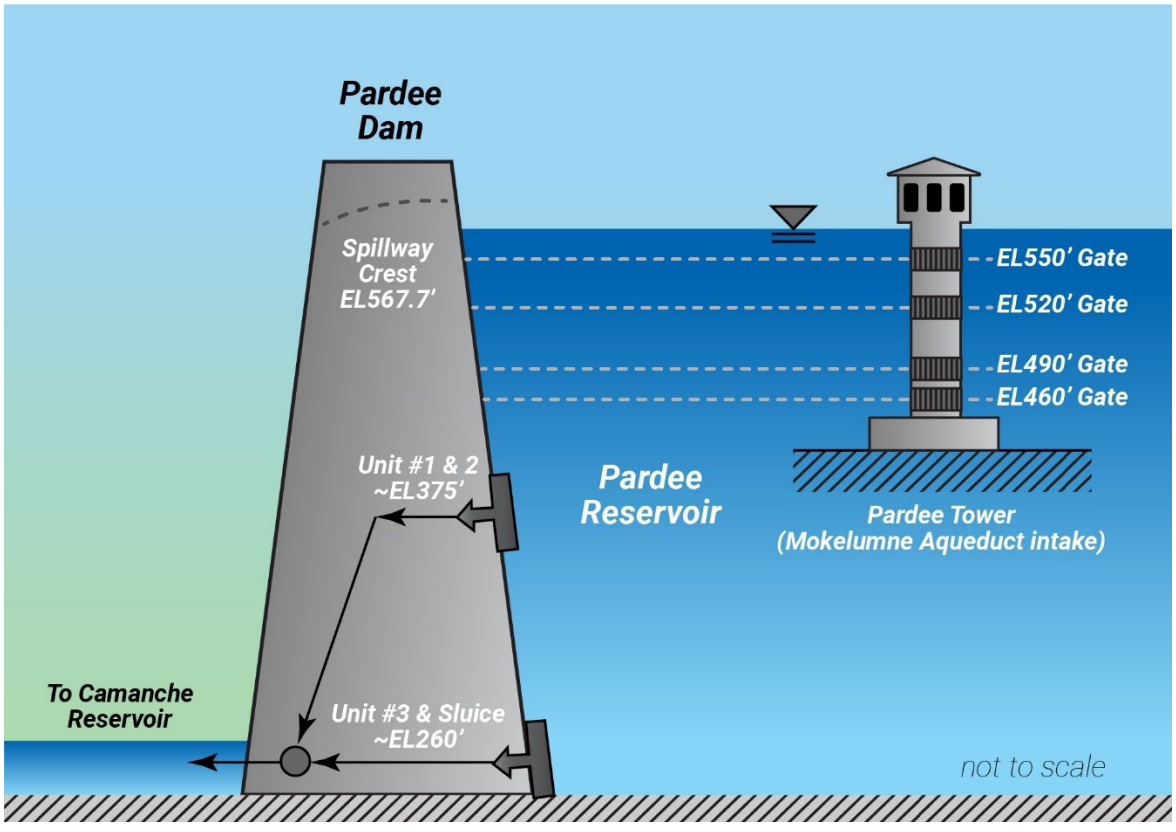


Figure 3.3-3. Pardee Reservoir – Pardee Dam and tower profile view.

Conveyance System

Two 72-inch penstocks supply water to Powerhouse Unit Nos. 1 and 2, and a 66-inch bifurcation from the rightmost 72-inch sluiceway serves Powerhouse Unit No. 3.

Pardee Tunnel, a 2.2-mile-long, 8-foot-tall, horseshoe-shaped tunnel, carries water from Pardee Reservoir to the Mokelumne Aqueduct System at Campo Seco Center. The Mokelumne Aqueduct's three steel pipelines, with diameters of 65 inches, 67 inches, and 87 inches, convey water about 82.2 miles from the Pardee Tunnel at Campo Seco to EBMUD's inline water treatment plants and storage reservoirs in the water service area.

3.3.4.2 CAMANCHE DAM

Intakes

Water is drawn from Camanche Reservoir primarily through the LLO and secondly from the HLO, both located on the right side of the Main Dam, to the outlet works valve house. The intakes of the LLO and HLO are at El. 104 and 203.0 feet, respectively. The LLO intake structure is hydraulically operated, protected with trashracks, and has bulkhead slots. The HLO intake structure has stop log slots and a 66-inch square hydraulically operated slide gate. See Figure 3.3-4 for an illustrative profile view.

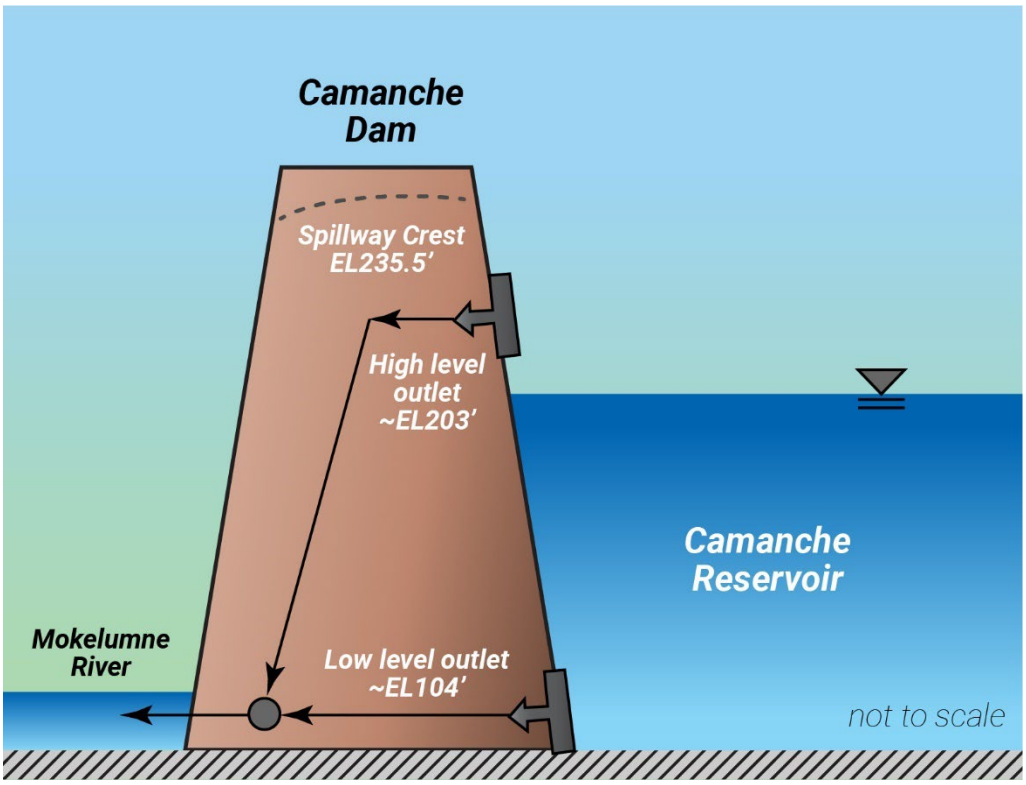


Figure 3.3-4. Camanche Reservoir – Camanche Dam profile view.

Conveyance System

Water is supplied from Camanche Reservoir to the powerhouse via the penstock conjoined to the two 66-inch branches of the north LLO conduit and the HLO. In 1983, two 66-inch branches of the north LLO conduit and the HLO joined via trifurcation to the new 10-foot-diameter penstock. The penstock has three 66-inch branches that lead to Turbine Unit Nos. 1, 2, and 3 and terminates with two discharge lines fitted with 66-inch fixed-cone valves.

3.3.5 POWERHOUSES

3.3.5.1 PARDEE

The original powerhouse structure at the base of the Pardee Dam was completed in 1929. It is constructed of reinforced concrete and has several floors. The original powerhouse housing Unit Nos. 1 and 2 is approximately 30 feet wide by 100 feet long at the generator floor. In 1983, the powerhouse was expanded, and a third turbine-generator unit was installed. The new Unit No. 3 is located at the northwest corner of the original powerhouse structure near the right abutment of the dam. This powerhouse addition is constructed of reinforced concrete, and it is approximately 40 feet wide by 50 feet long.

Photo 3.3-6. Pardee Powerhouse

3.3.5.2 CAMANCHE

The Camanche Powerhouse was added to the dam in July 1983. The powerhouse is located about 250 feet downstream from the Camanche outlet structure on the north bank of the Mokelumne River. The Camanche Powerhouse is a reinforced concrete structure approximately 63 feet wide by 102 feet long.

Photo 3.3-7. Camanche Powerhouse

3.3.6 TURBINES AND GENERATORS

Pardee Powerhouse includes three units for a total installed capacity of 28.61 MW; Camanche Powerhouse includes units for a total installed capacity of 9.45 MW. Details of each powerhouse components are described in Table 3.3-3 and Table 3.3-4.

Table 3.3-3. Pardee Powerhouse components summary.

Pardee Powerhouse Data	Original	1983 Addition
Generators		
Number of Generators	2	1
Manufacturer	General Electric (rewound by GE in 2013)	Fuji Electric Co.
Nameplate Rating	7,500 kilowatts (kW)	8,597.5 kW
Power Factor	1.0	0.95
Revolutions per Minute	450	450
Turbines		
Number of Turbines	2	1
Manufacturer	Pelton	Fuji Electric Co.
Type Wheel	Francis	Francis
Vertical/Horizontal Shaft	Vertical	Vertical
Horsepower (hp)	13,600 hp per unit	14,500 hp per unit
Design Head (ft)	317	320
Design Flow (cubic feet per second [cfs])	480 cfs	432 cfs
Power Transformers		
Number	3	1
Kilovolt-amps	2,500	10,400
Phase	Single	Three

Table 3.3-4. Camanche Powerhouse components summary.

Camanche Powerhouse Data	
Generators	
Number of Units	3
Manufacturer	Dongfeng Electric Machinery Works, People's Republic of China
Nameplate Rating	3,750 kW
Power Factor	0.95
Revolutions per Minute	450
Turbines	
Number of Units	3

Camanche Powerhouse Data	
Manufacturer	Dongfeng Electric Machinery Works
Type Wheel	Kaplan Adjustable Blade
Vertical/Horizontal Shaft	Vertical
Horsepower (hp)	4,200 hp per unit
Design Head (ft)	105
Design Flow (cfs)	400 per unit, 1,200 total
Transformer	
Number of Units	1
Kilovolt-amps	8,000/8,960/11,200
Phase	Three

3.3.7 RESERVOIRS

Photo 3.3-8. Pardee Reservoir.

Pardee Reservoir has a gross storage capacity of 203,795 acre-feet at normal maximum water surface elevation of El. 567.65 feet. The reservoir is formed by Pardee Dam on the Mokelumne River, Pardee South Spillway located approximately 500 feet from the left abutment of the dam, and both Jackson Creek Spillway and Jackson Creek West End Dike located along the northern perimeter of the reservoir. The usable or operational storage capacity of Pardee Reservoir is 188,208 acre-feet based on the elevation of the lowest gate of El. 395 feet. The normal maximum water surface area of the reservoir when full is approximately 2,260 acres.

Photo 3.3-9. Camanche Reservoir.

Camanche Reservoir has a gross storage capacity of 417,120 acre-feet at normal maximum water surface elevation of El. 235.5 feet. The reservoir is formed by the Main Dam on the Mokelumne River, Camanche Spillway, and six auxiliary dikes located along the southern (Dike Nos. 1, 2, and 3) and northern (Dike Nos. 4, 5, and 6) perimeter of the reservoir. The usable or operational storage capacity of Camanche Reservoir is 416,696 acre-feet based on the elevation of the LLO at El. 105 feet. The normal maximum water surface area of the reservoir when full is approximately 7,800 acres.

3.4 GRID INTERCONNECTION

There are no transmission lines associated with the FERC license for the Project. Power generated at the Project connects to the grid via transmission lines owned and operated by PG&E, specifically Pardee Tap No. 2 and Camanche Tap Project, FERC No. 5536. 19 FERC ¶ 62,423 (1982). PG&E's license for Project No. 5536 will terminate on March 31, 2031, the same day as EBMUD's license for the Lower Mokelumne River Project. Pardee Tap No. 1 is owned and operated by PG&E.

3.4.1 PARDEE

PG&E owns two 60 kV transmission lines that connect to the powerhouse and terminate on the roof. The point of interconnection for each line is as follows: Unit Nos. 1 and 3 are connected to the "Valley Springs-Clay 60 kV Line," and Unit No. 2 is connected to the "Valley Springs-Lockeford 60 kV Line." The lengths of PG&E transmission lines at Pardee are unknown to EBMUD. PG&E's transmission lines begin immediately outside of Pardee Powerhouse at Switches 77 and 87, and these transmission lines are non-Project lines. Single line diagrams are included in Volume IV – Section 1.

3.4.2 CAMANCHE

As part of its transmission line Project No. 5536, PG&E owns a single 115 kV transmission line that connects to the powerhouse switchyard adjacent to the Camanche Powerhouse. The point of interconnection is at the "Gold Hill-Bellota-Lockeford 115 kV Line." According to the FERC record for Project No. 5536, the Camanche 115 kV Tap is 6.74 miles long.

PG&E's transmission line begins immediately outside of Camanche Powerhouse at Switch 171. Single line diagrams are included in Volume IV – Section 1.

3.5 CURRENT PROJECT OPERATIONS

EBMUD operates Pardee and Camanche reservoirs in a coordinated manner to meet its water supply needs while concurrently making releases from Camanche Reservoir to satisfy downstream senior water rights, for flood control, and to meet regulatory and environmental obligations. Flow downstream of Camanche Dam is affected by:

- instream flow requirements under the Joint Settlement Agreement (JSA) to protect and enhance conditions for the anadromous fish and ecosystem of the Lower Mokelumne River;
- entitlements held by the North San Joaquin Water Conservation District (NSJWCD) and Woodbridge Irrigation District (WID);
- diversions by other individual water right holders and riparian landowners; and
- carriage losses from evaporation, seepage from the river, and evapotranspiration by riparian vegetation.

Resulting minimum required releases from Camanche Reservoir range from about 135,000 acre-feet in critically dry years to about 315,000 acre-feet in normal and above-normal wet years.

More specifically, streamflow from the Mokelumne River is collected and stored in EBMUD's Pardee and Camanche reservoirs. Raw water from Pardee Reservoir is transported to the East Bay terminal reservoirs and treatment plants through the Pardee Tunnel, Mokelumne Aqueducts, and Lafayette Aqueducts. EBMUD's water system currently serves approximately 1.4 million people in the East Bay. Based on the historical average, approximately 90 percent of the untreated water entering EBMUD's East Bay water system originates from the Lower Mokelumne River Project.

Camanche Dam is located 9.5 miles (by the shortest route) to the west of Pardee Dam. Camanche Reservoir stores water to meet the needs of fisheries, riparian habitat, and downstream water-rights holders, and to provide flood control. Hydropower plants are operated at both Pardee and Camanche reservoirs. Further details on the factors that are taken into account in the existing Project operations are described below.

EBMUD's Operations Committee, which includes representatives from the Operations and Maintenance Department and the Water and Natural Resources Department, meets regularly throughout the year to review and discuss operational issues that may have impacts. This committee meets as frequently as necessary to ensure concerns are addressed while meeting the requirements of the Project license.

3.5.1 WATER RIGHTS, STORAGE REQUIREMENTS, AND OTHER OPERATIONAL GOALS

EBMUD operates its Mokelumne water supply reservoirs in accordance with water right permits and licenses that have been issued by the SWRCB. From August 1 through September 30, water is not diverted to storage in Pardee Reservoir, other than temporary ponding of less than 30 days, consistent with EBMUD's water right and the State Water Resources Control Board 30-day rule. During the season when diversion to storage is not permitted, storage will decline due to evaporative losses. Year-round aqueduct drafting of up to 200 million gallons per day (MGD), equivalent to 310 cubic feet per second (cfs), is allowed under EBMUD's water rights License No. 11109. Aqueduct drafting over 200 MGD must be consistent with EBMUD's water right Permit No. 10478 as described in Section 4.3.3.

3.5.1.1 PARDEE RESERVOIR WATER SUPPLY AND CARRYOVER STORAGE

Unless otherwise coordinated with the United States Army Corps of Engineers (USACE), Pardee and Camanche reservoirs are operated, within practical operating limits, to achieve a combined storage on November 5 that does not encroach on the 10 thousand acre-feet (TAF) flood control space provided for in the USACE Flood Control Diagram (refer to Section 3.5.1.8). Pardee Reservoir is typically operated with the objective of having at least 170 TAF of water in storage (approximately El. 552 feet) by November 5.

3.5.1.2 PARDEE RESERVOIR OPERATING RANGE

From December through June, sufficiently broad operating ranges, usually 3 to 5 feet in depth, will be provided for Pardee Reservoir's operation to allow for fluctuations in inflow and lake level. From July through November, smaller operating ranges will be used to manage water rights and storage requirements in Pardee and Camanche reservoirs.

3.5.1.3 PARDEE SLUICE AND RELEASE

Pardee Reservoir is operated with the objective of not spilling at a rate of more than 10,000 cfs to avoid erosion-induced rock deposition that could create a backwater effect and flood the powerhouse. To prevent such a rate of spill, sluicing is initiated when inflows exceed both full generation and amounts high enough to lead to spills greater than 10,000 cfs. Sluicing may also be initiated to minimize the effect of high turbidity inflows from large storm events.

Within practical operating limits, releases from Pardee Reservoir to Camanche Reservoir will be occasionally scheduled to maintain Camanche water surface sufficiently high to prevent, or at least minimize, vortexing in the vicinity of the HLO. Vortexing occurs when Camanche's water surface elevation falls below approximately El. 205 feet and can lead to cavitation in the turbines and unstable generator load at Camanche Powerhouse.

3.5.1.4 PARDEE POWER GENERATION

Consistent with all other project objectives and obligations, releases from Pardee Reservoir are managed to provide hydropower generation. This is accomplished, whenever possible, by operating at or above El. 550 feet, provided all other criteria can be met. Maximum available capacity of the Pardee generators begins to decline when the water surface drops below El. 550 feet.

Pardee Powerhouse's generation rates vary from the minimum generation from a single unit operating at 5.0 MW to the maximum from all three generation units operating at 10.4 MW each. In optimal operational conditions, this maximum generation rate can exceed the generation units' nameplate capacity, which reflects the as-designed performance assigned by the manufacturer assuming standard operational conditions. The powerhouse may generate under a peaking operation when the generation output is maximized during the higher demand periods and minimized or shut down during the lower demand periods. The objective of peaking the powerhouse is to provide maximum benefit to the energy grid without altering the total quantity of water used for power generation. Pardee is certified by the California Independent System Operator (CAISO) to sell ancillary services into the CAISO-controlled electric grid. Ancillary services are offered when the powerhouse has unused capacity available and the ancillary services market price is favorable.

3.5.1.5 PARDEE RECREATION AREA

A drawdown below El. 547 feet impacts operation of the Pardee Recreation Area boat launch facilities. EBMUD's Mokelumne Recreation and Watershed Division within the Natural Resources Department is notified if drawdown below El. 550 feet is anticipated.

3.5.1.6 CAMANCHE RESERVOIR OPERATING RANGE

The storage target range at Camanche Reservoir is between 290 TAF (El. 217 feet) and 310 TAF (El. 220 feet) on November 5. Releases from Camanche Reservoir are restricted to the extent possible to quantities that will not cause flows in the Lower Mokelumne River below Camanche Dam to exceed the controlling flow rate of 5,000 cfs.

3.5.1.7 CAMANCHE SLUICE AND RELEASES

The total rate of release from Camanche Reservoir is the sum of all sluices, power generation, and releases through the MRFH. This release rate must be kept as close as practical to the intended release rate as operations permit. The reason for gradual reduction in the release rate is to avoid river-bank sloughing, which could occur during rapid drawdown, as the riverbanks and levees become saturated during extended periods of high flows, and to help prevent stranding of fish that may be occupying habitat in flooded areas and near the edges of the river as water drains toward the main channel.

3.5.1.8 FLOOD CONTROL

EBMUD's 1962 agreement with USACE requires that a combined storage reservation of up to a maximum of 200 TAF be maintained in Camanche and Pardee reservoirs between September 15 and July 31 of each year for the control of floods. A portion of the 200 TAF of flood control reservation may be transferable, up to a maximum of 70 TAF, to available space in PG&E's Salt Springs and Lower Bear reservoirs.

At all times, releases from Camanche are restricted to the extent possible to quantities that will not cause flows in the Lower Mokelumne River below Camanche Dam to exceed the controlling flow rate of 5,000 cfs. When space available for flood control is less than required as determined using the USACE Flood Control Diagram, the encroachment and release plan will be coordinated with USACE, with consideration for the USACE release schedule in addition to other hydrologic and operational factors. Releases shall also be made to the extent possible to optimize conditions for the downstream fishery. For more information, see Section 3.5.3, *Flood Control Requirements*.

3.5.1.9 CAMANCHE RESERVOIR WATER QUALITY MANAGEMENT

The Hypolimnetic Oxygenation System (HOS), which feeds pure oxygen into the deeper, colder (hypolimnetic) portion of Camanche Reservoir, is designed to prevent bottom waters from going anoxic, thereby preventing the natural formation of hydrogen sulfide (H_2S). The HOS is typically operated from May through October, or until Camanche Reservoir becomes thermally destratified in the fall, when either: (1) the dissolved oxygen (DO) level in the Camanche Reservoir hypolimnion is *projected* to drop to 2 milligrams per liter (mg/L) as measured near Camanche Dam (CAMD), or (2) when DO *drops* to 2 mg/L as measured at Camanche Valve House (CAMC). For more information, see Section 4.3.5.6.

3.5.1.10 CAMANCHE POWER GENERATION

Consistent with all other flow objectives and obligations, releases from Camanche Reservoir are managed to provide hydropower generation.

3.5.1.11 PARDEE AND CAMANCHE RESERVOIRS' THERMAL STRATIFICATION

Pardee and Camanche reservoirs are managed to maintain thermal stratification in Camanche Reservoir as late in the year as possible. Stratification in Camanche Reservoir through the end of October is supported by releasing cold water from Pardee Reservoir when necessary and when possible. During October, releases are directed through Pardee Powerhouse Unit No. 3 with access to cooler temperature water through the lower elevation intake to optimize cold water transfer. Pardee Reservoir temperatures are monitored and managed through the summer to maximize cold water available for transfer in October. Strategies to maintain cold water in Pardee Reservoir during the

summer months include directing generation releases through Pardee Powerhouse Unit Nos. 1 and 2 with access to warmer temperature water through the upper elevation intake and using higher elevation Pardee Tower Gates to minimize cold water diversions into the Mokelumne Aqueducts when possible. Refer to Section 4.3.4.3 for additional information.

3.5.1.12 LOWER MOKELUMNE RIVER TEMPERATURE MANAGEMENT

The operational goal for temperature management, consistent with the FERC license, is to provide optimum temperatures for the MRFH and to provide the coldest water (less than 16.4 degrees Celsius [°C], or 61.5 degrees Fahrenheit [°F]) possible to the Lower Mokelumne River during October and November when up-migrating salmon return to the river. Typically, the HLO will be kept open from January 1 to August 31 and closed from September 1 to December 31, unless otherwise requested by the MRFH or EBMUD's Water and Natural Resources Department. An additional consideration in operating the Camanche HLO is vortexing in the vicinity of the outlet, which occurs when the water surface falls below approximately El. 205 feet. Re-scheduling releases from Pardee to Camanche Reservoir may be considered if Camanche Reservoir's water surface is projected to drop below El. 205 feet from January 1 to August 31. Refer to Section 4.3.4.3 for additional information.

3.5.2 HYDROLOGIC REQUIREMENTS FOR FISH PROTECTION

Starting in the early 1990s, EBMUD, FERC, the United States Fish and Wildlife Service (USFWS) and California Department of Fish and Game (now CDFW) began negotiating a settlement, including flow and non-flow measures, to resolve issues related to the conservation and development of fish and wildlife resources in the Mokelumne River. The result of these negotiations was the JSA, which is a formal agreement between EBMUD, USFWS, and CDFW (formerly California Department of Fish and Game) that addresses EBMUD's operation of the Project.

The JSA goals are as follows:

- Provide, to the extent feasible, habitat quality and availability in the Lower Mokelumne River to maintain fishery, wildlife, and riparian resources in good condition.
- Contribute toward the state and federal fishery restoration goals as defined in the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act and the Central Valley Project Improvement Act.
- Sustain the long-term viability of the salmon and steelhead fishery while protecting the genetic diversity of naturally producing populations in the Lower Mokelumne River.

The JSA includes non-flow measures and flow measures pertaining directly to flows and reservoir storage based on water year type, Camanche release requirements, and hypolimnion goals. These measures are described in the following sections.

These goals are achieved by the creation of a Partnership Steering Committee (PSC), establishment of a Partnership Fund, creation of a Water Quality and Resource Management Program (WQRMP), and engagement in additional voluntary participation and stakeholder involvement.

The Partnership Steering Committee, composed of one representative each from CDFG, USFWS, and EBMUD, developed the WQRMP to define reasonable goals, measures, performance criteria, and responsive actions associated with the implementation of the JSA. The Partnership has a three-tier structure: the Mokelumne River Technical Advisory Committee (MRTAC) consists of technical staff and conducts data sharing and monitoring responsibilities; the Partnership Coordinating Committee (PCC) consists of mid-manager level staff from the three organizations and implements annual decision-making for monitoring, flow scheduling, and research needs; the top tier is the PSC, composed of Director and Senior Manager level staff from each agency, which provides signatory authority over decisions when needed (e.g., if a decision triggers an SWRCB Action or Approval).

In addition to EBMUD, CDFW, and USFWS, the Partnership includes representation from the National Marine Fisheries Service (NMFS) as non-signatory technical advisors. Other Lower Mokelumne River Tributary stakeholders, including Mokelumne River water rights holders, NGOs, Tribal interests, landowners, local business interests, and public agencies are invited to participate in Partnership proceedings.

The Partnership Fund was established in January 1999 when EBMUD set aside $2 million from its general fund, and the interest from the fund is used to provide operating support for Partnership programs. The principal has been invested in the Local Agency Investment Fund of the state of California, and the interest and expenditures are tracked by EBMUD. The Partnership Fund has been used to support agency and stakeholder efforts to improve the riparian conditions of the Lower Mokelumne River, conduct scientific studies relevant to the anadromous fisheries, and support stewardship and awareness raising activities. Funding requests follow guidelines developed by the Partnership and are reviewed by the PCC, approved by the PSC, and administered by EBMUD. Volume II – Appendix C contains information on the projects that have been awarded funds by the PSC from the Partnership Fund.

EBMUD actively participates in the monthly meetings of the Lower Mokelumne River Watershed Stewardship Steering Committee (LMRWSSC). The Lower Mokelumne River Watershed Stewardship Plan (2002) contains recommendations for water quality, biological resources, agriculture, recreation, education, and more. Refer to additional non-flow measures that are outlined in the JSA: Section G Ecosystem Protection, Section H MRTAC, and Section J Consultation in Volume II – Appendix C.

In 2008, the PSC agreed that mapping of aquatic and terrestrial riparian systems and surveys of invertebrates, amphibian, reptile, mammal, raptor, and neotropical bird communities were complete and that water quality monitoring, including DO, pH, and temperature in the MRFH influent and effluent, as well as concentrations of cadmium, copper, and zinc at PENN20 (located within Camanche Reservoir) and ELLIOTT (at Elliott Road Bridge in the lower Mokelumne River), would continue, with appropriate analytical methods used to be able to detect concentrations of cadmium, copper, and zinc at or below chronic criteria. The remainder of the water quality sampling program would be discontinued, but all the other measures in the WQRMP would continue to be implemented. [EBMUD, USFWS, and CDFG 1998]

SWRCB amended EBMUD's Mokelumne River water rights to require it to provide specified flow requirements at Camanche Dam and made corresponding changes to the water rights of the Woodbridge Irrigation District Dam (WIDD) to ensure a specified portion of the Camanche Dam releases passed below Woodbridge Dam (Revised Water Rights Decision 1641, March 15, 2000 (D-1641), pp. 170-179.) A 10-year review was completed by EBMUD, CDFW, and USFWS as required in the JSA, and the report was published in 2008. The report documents accomplishments achieved in the first 10 years of the JSA. Achievements include meeting or exceeding JSA flow requirements, increases in fall-run Chinook Salmon (*Oncorhynchus tshawytscha*) total escapement and in-river escapement above pre-JSA numbers, refined monitoring and accounting for steelhead (anadromous Rainbow Trout, *O. mykiss*) population parameters in the river and the hatchery, establishment of the Partnership Fund and related projects completed using the Fund, along with a list of performance measures and criteria, the status of achieving those at the time of preparation of the report, and recommendations moving forward. [EBMUD 2008a]

3.5.2.1 WATER YEAR TYPES AND RELEASES

The JSA specifies minimum flow releases from Camanche Dam and expected flow below the Woodbridge Dam developed to support fish life stage needs annually by water year types. For the releases from October through March, water year types are determined based on the projected combined storage in Camanche and Pardee reservoirs on

November 5. For the releases in April through September, water year types are determined based on the unimpaired runoff into Pardee Reservoir as forecasted by the California Department of Water Resources (DWR) in the April 1 Bulletin 120 Report, unless the projected combined storage for November 5 is less than 200 TAF, in which case the water year type would be critically dry. Table 3.5-1 provides a detailed overview of how the JSA water year types are defined.

Table 3.5-1. JSA year types defined.

Period	Criteria	JSA Year Type			
		Normal And Above	Below Normal	Dry	Critically Dry
Oct – Mar	Pardee & Camanche Reservoir Storage[a]	>Max allowable storage[b]	Max allowable to 400 TAF	399 TAF to 270 TAF	269 TAF to 0 TAF
Apr – Sept	Unimpaired Runoff[c,d]	890 TAF	889 TAF to 500 TAF	499 TAF to 300 TAF	269 TAF to 0 TAF

[a] Projected Pardee and Camanche reservoir storage on November 5

[b] Maximum allowable storage on November 5 as determined by USACE's Water Control Manual for Camanche Dam and Reservoir (Sept 1981) – maximum allowable storage is the EBMUD Requirement line

[c] Water year unimpaired runoff into Pardee Reservoir as forecasted by DWF in the April 1 Bulletin 120 report

[d] April-September shall be critically dry when Pardee and Camanche reservoir storage on November 5 is projected to be less than 200 TAF based on the DWR April 1 Bulletin 120 report

3.5.2.2 CAMANCHE RELEASE REQUIREMENTS

The JSA Camanche Dam release requirements vary throughout the year to meet the needs of the life stages of anadromous fish. Minimum release requirements range from 100 to 325 cfs during normal and above normal water years, 100 to 250 cfs during below normal years, 100 to 220 cfs during dry years, and 100 to 130 cfs during critically dry years (Table 3.5-2). Additional releases up to 200 cfs are required in April, May, and June in both normal and above and below normal water year types depending on the combined storage in Camanche and Pardee reservoirs relative to the maximum allowable storage for the end of the prior month.

The JSA also includes requirements to maintain flows below the WIDD. The requirements can also be in Table 3.5-2.

As described above, EBMUD typically releases more than the JSA minimum flow requirements to also meet downstream senior obligations or when regulating flood-control releases. Since implementation of the JSA in 1998 (Water Years 1998 through

2012), annual releases from Camanche Dam have ranged from about 188 TAF in Water Year 2021, to about 1.7 million acre-feet in Water Year 2017.

The JSA stipulates that, except during emergencies or when flood-control releases are being made, decreases in flow should not be more than 50 cfs per day during October 16 through March 31 (the spawning and incubation period for anadromous fish) and not more than 100 cfs per day during the rest of the year except in the case of emergencies. In addition, the gainsharing provision in the JSA provides that EBMUD contribute part of the actual yield from new water supplies to river flow. Under the gainsharing provision, EBMUD agrees to increase instream flows beyond the flow specified in JSA Attachment 1 by an amount equal to 20 percent of the actual yield of additional water supplies developed by EBMUD from new facilities until reaching a maximum quantity of 20 TAF, which will be available at the joint written request of the resource agencies. The water that is available to the resource agencies in any year under the Gainsharing Provision could be added to carryover storage, but it does not affect the subsequent JSA year type determination.

3.5.2.3 HYPOLIMNION GOALS

The *hypolimnion* is the cooler and denser bottom layer of water in a thermally stratified lake or reservoir. Like most deep California reservoirs, Pardee and Camanche reservoirs become de-stratified and lose their hypolimnion during the colder part of the year. The JSA specifies that EBMUD will use its best efforts to maintain Pardee and Camanche reservoir stratification with a minimum of 28 TAF of hypolimnetic volume in Camanche Reservoir through October whenever Pardee Reservoir volume exceeds 100 TAF. The hypolimnetic volume is based on water being less than 16.4°C (61.5°F). Figure 3.5-1 illustrates the operational process used to meet the goal.

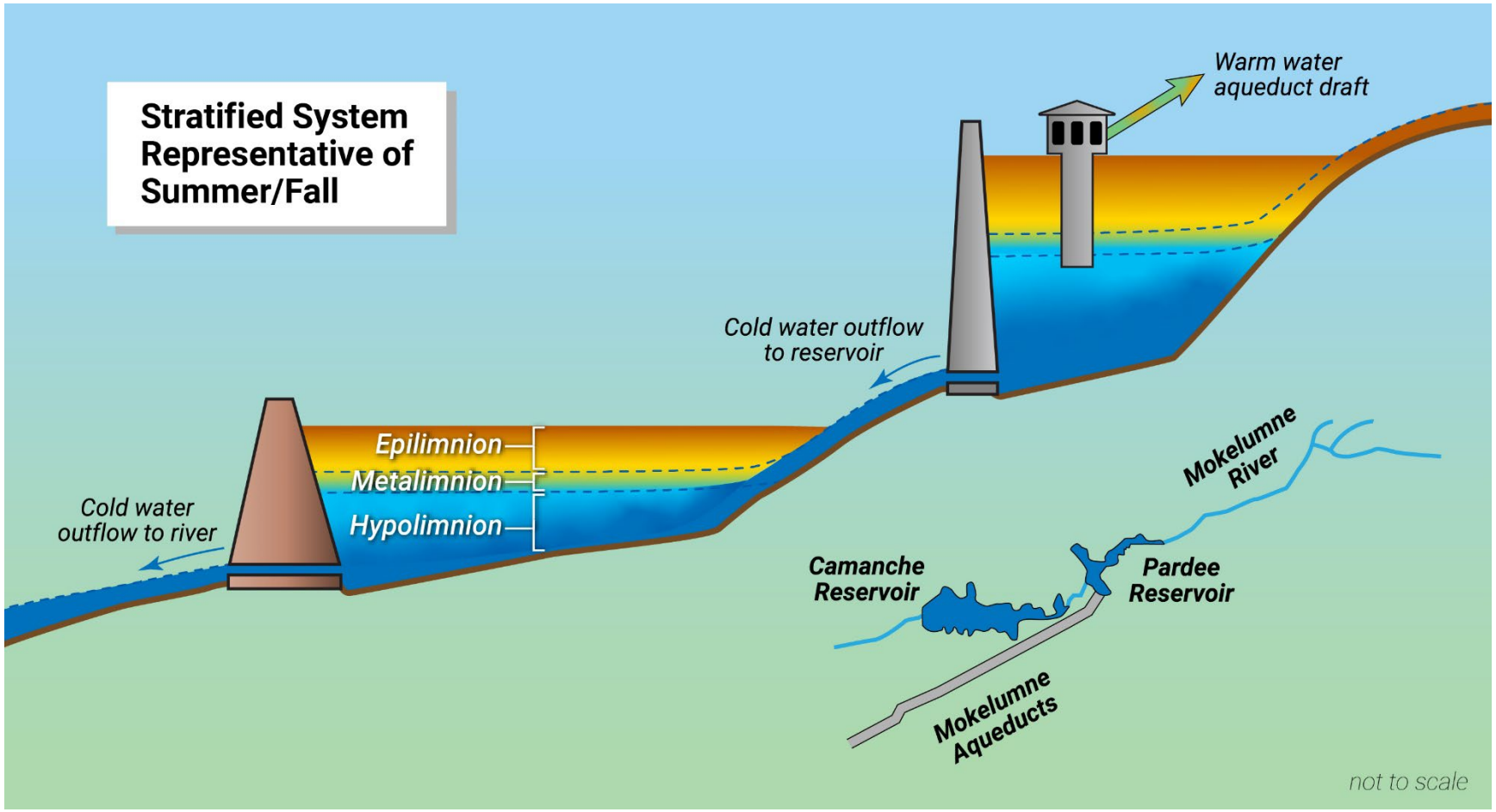


Figure 3.5-1. Illustration of EBMUD's temperature management for fisheries.

Table 3.5-2. Summary of Camanche release requirements specified in the JSA.

Period	Life Stage	Normal and Above Normal		Below Normal		Dry		Critically Dry	
		Camanche Release (cfs)	Below Woodbridge Dam (cfs)	Camanche Release (cfs)	Below Woodbridge Dam (cfs)	Camanche Release (cfs)	Below Woodbridge Dam (cfs)	Camanche Release (cfs)	Below Woodbridge Dam (cfs)
Oct 1–15	Adult migration	325	100	250	100	220	80	100	15
Oct 16–31	Spawning/ incubation	325	100	250	100	220	80	130	75
Nov 1–Mar 31[a]	Spawning—fry rearing	325	100	250	100	220	80	130	75
Apr 1–30	Fry rearing	325[b]	150	250[b]	150	220	150	130	75
May 1–31	Fry and juvenile rearing	325[b]	300	250[b]	200	220	150	100[c]	15
Jun 1–30	Outmigration	325[b]	300	250[b]	200	100[c]	20	100[c]	15
Jul 1–Sep 30	Oversummer	100	25	100	20	100	20	100	15

[a] Approximate period when Woodbridge Dam boards are out and Lodi Lake is empty. When the boards are out, it is expected that flow downstream of Woodbridge Dam would be at least as high as the value shown, but EBMUD would not be required to release more than the specified amount from Camanche Reservoir. During the other periods, Camanche releases must be sufficient to meet the specified flow below Woodbridge Dam.

[b] For normal, above normal, and below normal years, extra flows would be released from Camanche Reservoir during April–June depending on the combined Pardee and Camanche storage for the end of the prior month as follows:

< 10 TAF below maximum allowable storage (BMAS), additional release is 200 cfs for subsequent month.
10 TAF <= BMAS < 20 TAF, additional release is 150 cfs for subsequent month.
20 TAF <= BMAS < 30 TAF, additional release is 100 cfs for subsequent month.
30 TAF <= BMAS < 40 TAF, additional release is 50 cfs for subsequent month.

[c] Outmigrating smolts would be trapped, tagged, and transported around the Delta.

3.5.3 FLOOD CONTROL REQUIREMENTS

Camanche Reservoir is classified as a Section 7 reservoir by USACE; therefore, EBMUD is required to operate Pardee and Camanche reservoirs in accordance with the USACE Flood Control Diagram (Figure 3.5-2). EBMUD is required to begin maintaining flood control space on September 15 annually; the required space increases daily from September 15, when it is zero, until November 5, when a total of 200,000 acre-feet of space must be maintained. EBMUD must maintain 200,000 acre-feet through March 15, when the requirement decreases daily, until May 31, when the storage requirement is again zero. Specific constraints include the following:

- EBMUD is required to release any water encroaching the flood control reservation as rapidly as possible according to the published schedule except that:
    - flood control releases are limited to a maximum of 5,000 cfs;
    - the rate of change of release shall not exceed 1,000 cfs per 2-hour interval; and
    - EBMUD is allowed to “cut the corner” by no more than 10,000 acre-feet (5 percent of reservation) between November 1 and November 12.
- Projected runoff to come after March 15, based on snowpack in the upper watershed, will result in a snowmelt reservation that extends the flood storage reservation requirement until snow is melted or by August 1.
- EBMUD may transfer up to 70,000 acre-feet of the flood reservation storage to PG&E’s Salt Springs and Lower Bear reservoirs based on the available space in these reservoirs below a specified volume.

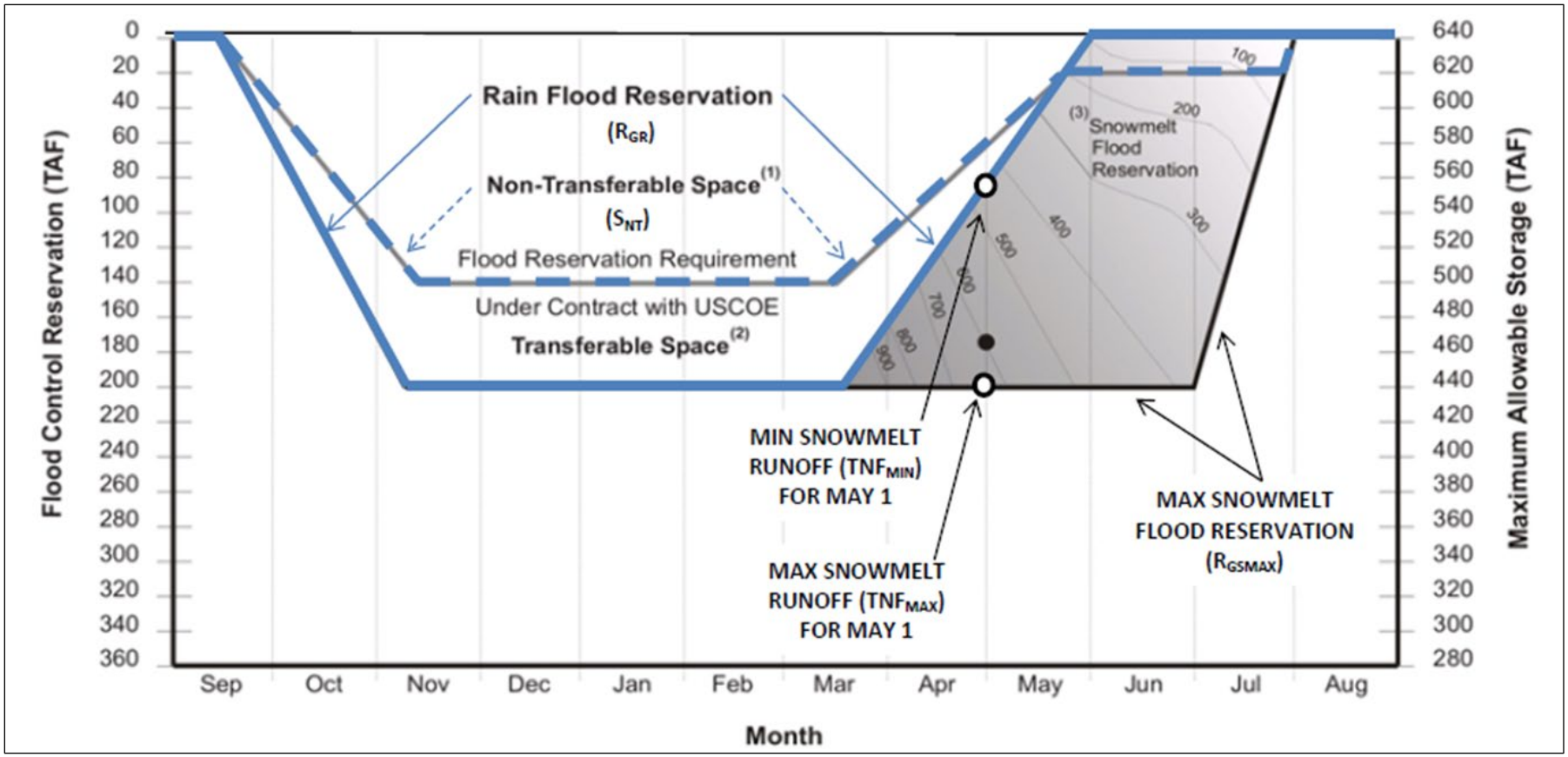


Figure 3.5-2. USACE Flood Control Diagram.

Notes:
(1)Non-transferable Space = minimum flood control space that must be maintained in Pardee and Camanche Reservoirs
(2)Transferbale Space = reduction of flood control space requirement provided by upstream (PG&E) reservoirs
(3)Snowmelt Flood Reservation is dependent on estimated runoff-to-follow in TAF
Example shown by ●: If on May1, 600 TAF or more of runoff is expected through July 31, the portion of the curve above this line is used to estimate the minimum transferable space.
USCOE = US Corps of Engineers (USACE in this document)

3.5.4 HYDROLOGY AND STREAMFLOW

3.5.4.1 UPSTREAM OF PARDEE RESERVOIR

Annual precipitation and streamflow in the Mokelumne River watershed are extremely variable from month to month and from year to year. Most precipitation normally falls between November and May, with very little falling between late spring and late fall. Annual precipitation averages 21 inches at Camanche Reservoir and 92 inches at the higher elevations in the upper Mokelumne watershed. Runoff is generally dominated seasonally by snowmelt, with the highest flows in April through June of wet years.

Figure 3.5-3 shows the distribution of historical monthly inflow to Pardee Reservoir measured at Mokelumne Hill during Water Years 1930 through 2024. The median annual regulated flow into Pardee Reservoir is about 635 TAF, with a range from less than 300 TAF (10th percentile) to about 1,225 TAF (90th percentile).

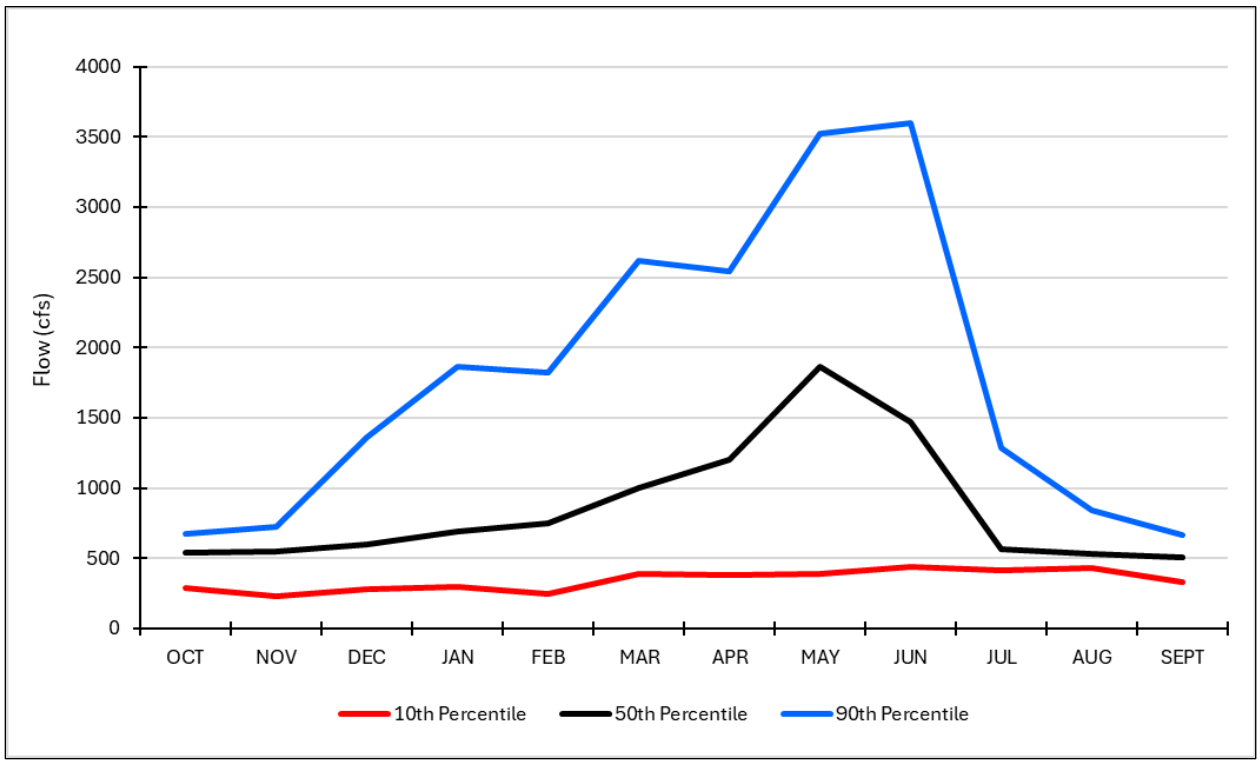


Figure 3.5-3. Distribution of monthly flow measured at Mokelumne Hill for Water Years 1930 through 2024.

3.5.4.2 PARDEE AND CAMANCHE RESERVOIRS

Figure 3.5-4 and Figure 3.5-5 show historical end-of-month storage in Pardee and Camanche reservoirs. Pardee Reservoir typically is operated with a total storage between 170,000 and 200,000 acre-feet, and end-of-month storage has ranged from 48,000 acre-

feet (March 1977) to 212,000 acre-feet (May 1984). Camanche Reservoir typically is operated with a total storage from 270,000 to 340,000 acre-feet and has ranged from approximately 9,200 acre-feet (February 1989) to 423,000 acre-feet (July 1967).

Operations of the two reservoirs are coordinated to achieve multiple objectives. These objectives are to provide municipal water supply, regulate streamflow, meet fishery/public trust interests, provide flood control, meet obligations to downstream diverters, maintain water temperatures suitable for anadromous fish in the Lower Mokelumne River, and generate hydropower. The coordinated operational procedures for maintaining cold-water supply were discussed earlier in Section 3.5.2.3.

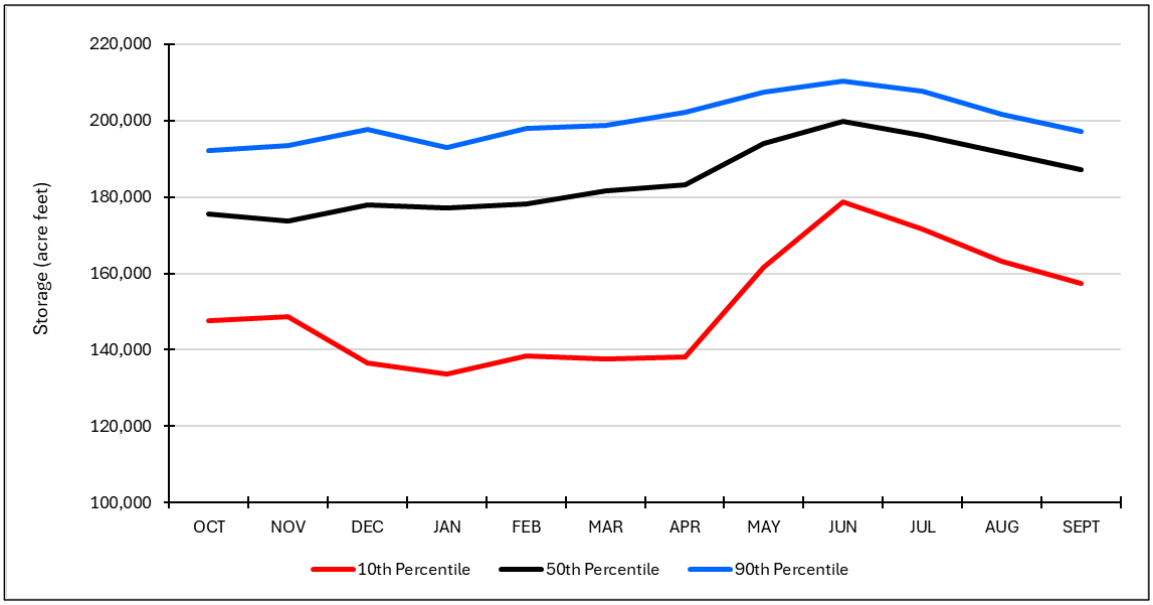


Figure 3.5-4. Distribution of monthly end-of-month storage at Pardee Reservoir for Water Years 1931 through 2024.

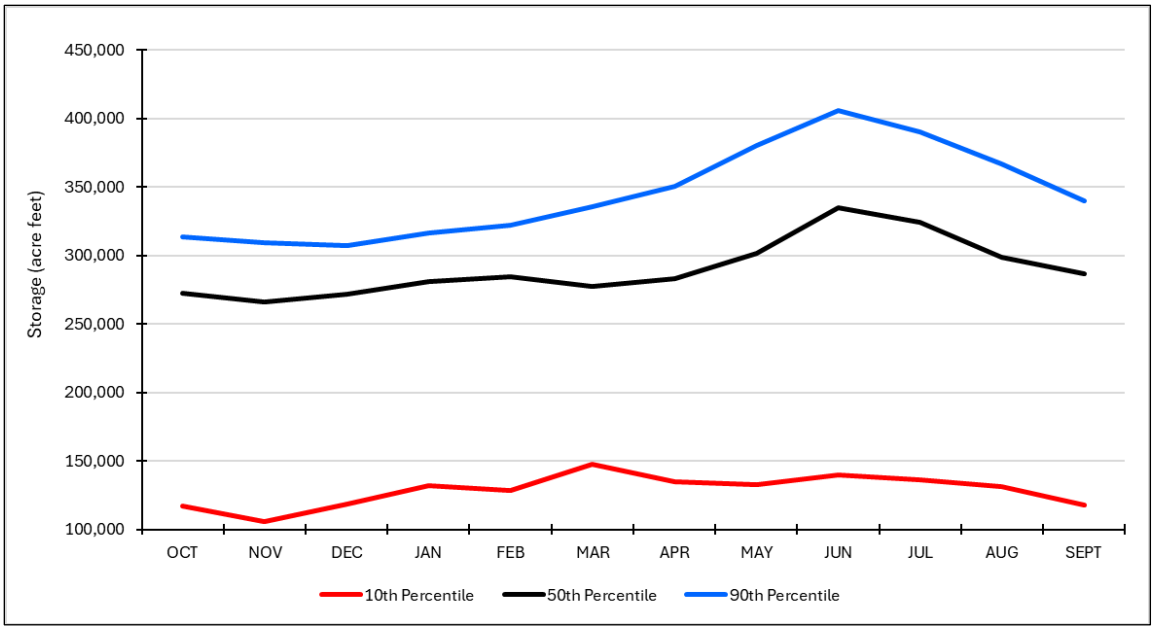


Figure 3.5-5. Distribution of monthly end-of-month storage at Camanche Reservoir for Water Years 1966 through 2024.

3.5.4.3 DOWNSTREAM OF CAMANCHE RESERVOIR

The amount of flow in the Lower Mokelumne River is important to the anadromous fish that use the river downstream of Camanche Dam. Flow in the Mokelumne River is also important for:

- maintaining riparian vegetation,
- providing water supply for downstream users,
- providing recreational opportunities, and
- improving water quality for fisheries.

Historical flow patterns, including the occurrence of high-flow events, are described below.

Flow Patterns

Flow downstream is principally moderated by Camanche Dam. However, there is still variation in Mokelumne River flows as shown in Figure 3.5-6. Based on flow data from Water Years 1966 through 2024, in years with high flows (90th percentile), the Camanche release flows are highest during May. In contrast, during years with average flow, water is stored in the reservoirs, and peak reservoir releases tend to occur in June.

During April, May, and June normal and above and below-normal water year types, the JSA requires additional releases from Camanche Dam of up to 200 cfs based on Pardee and Camanche storage levels. These additional flows are reflective of the seasonal pattern of flows in the Mokelumne River basin (Figure 3.5-6).

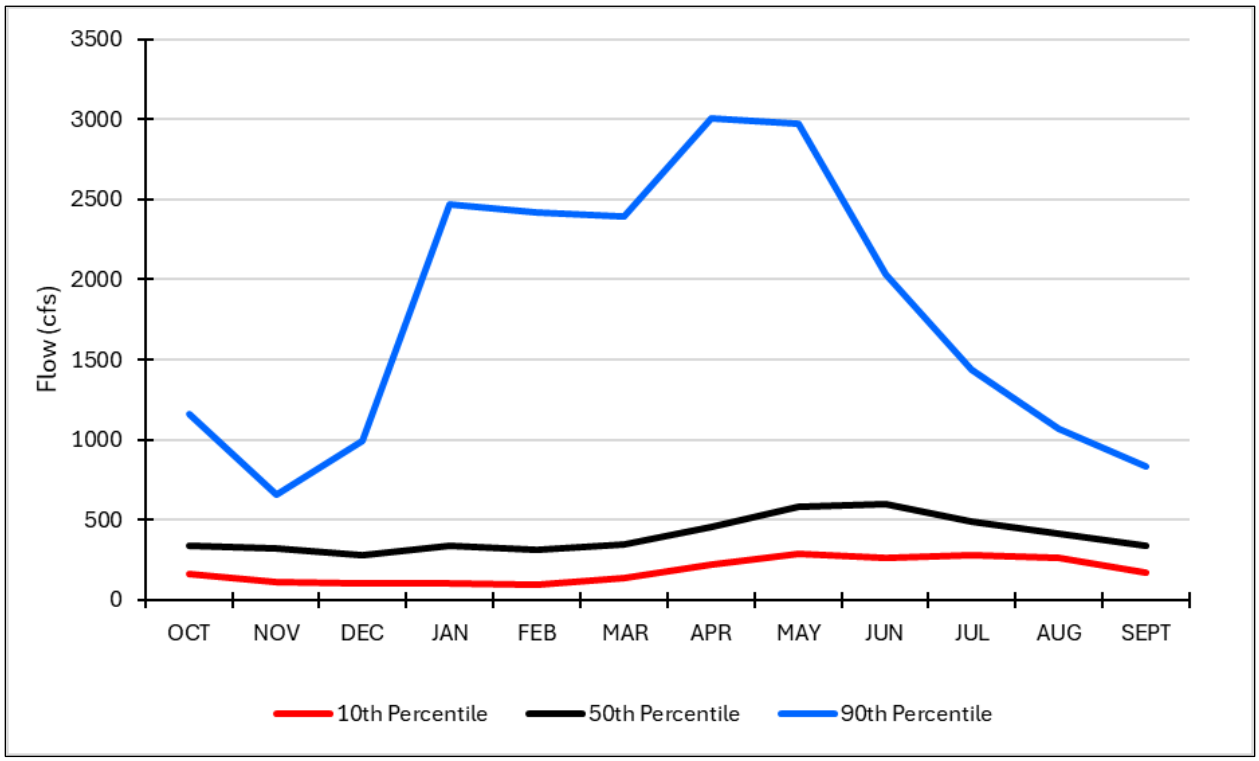


Figure 3.5-6. Distribution of monthly flow releases from Camanche Reservoir for Water Years 1966 through 2024.

Peak flows have been diminished by the presence of the dams and by USACE flood control requirements. Figure 3.5-7 depicts the inflow to Pardee Reservoir and the outflow from Camanche Reservoir where it can be seen that the regulated inflow into Pardee Reservoir is variable, while the outflow from Camanche Reservoir has fewer fluctuations, lower maximum flow values, and higher minimum flow values as compared to the inflow.

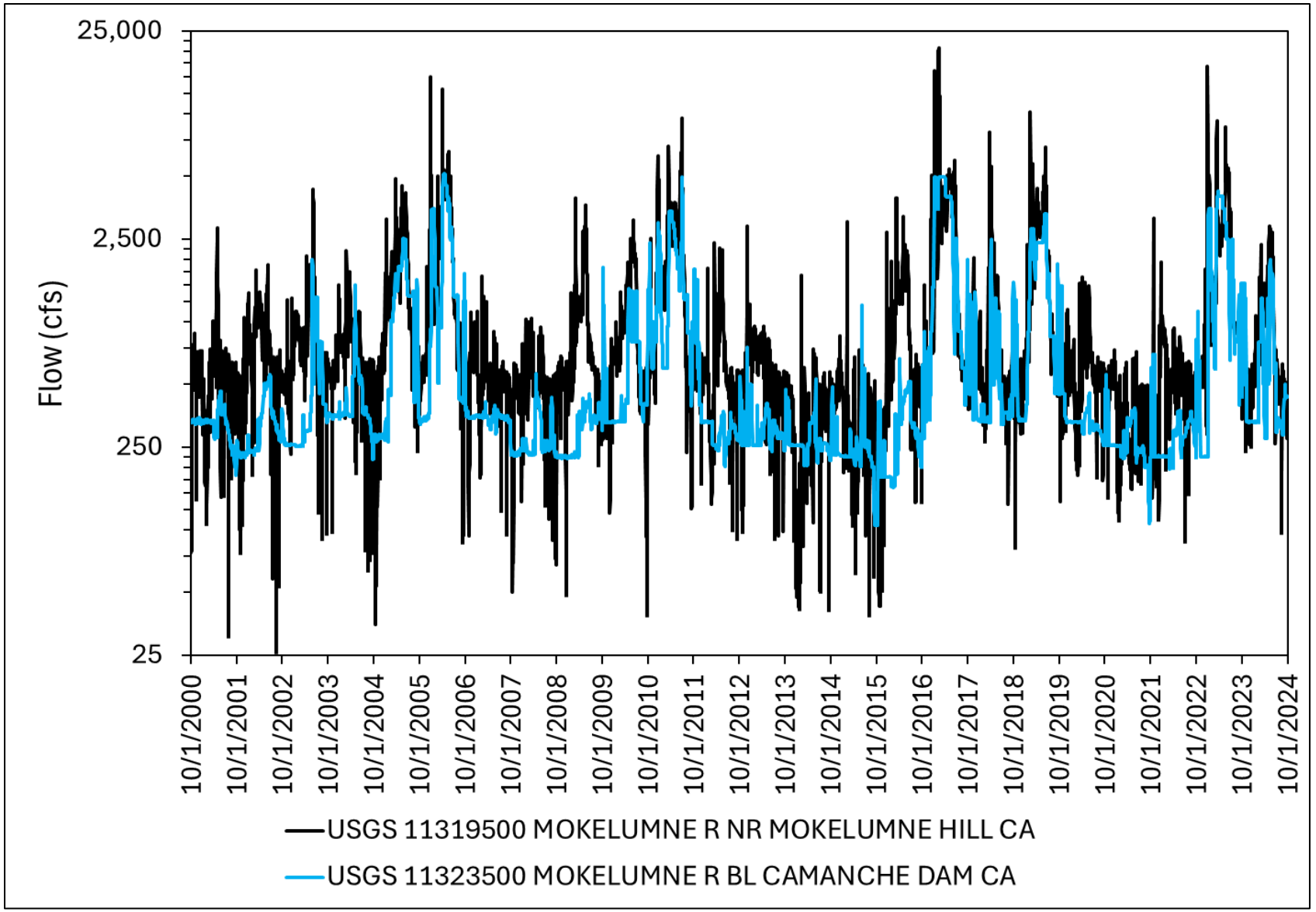


Figure 3.5-7. Pardee Reservoir inflow and Camanche Reservoir outflow.

3.5.5 WATER SUPPLY AND OPERATIONS MODEL

EBMUD's Water Supply Operations Model (WSOM) utilizes a mass balance accounting tool using Microsoft Excel to forecast and manage water operations for the following water year.

The input features of the model include hydrology, demand, and facility operational status assumptions. The model pulls the recent measured hydrology and operations data from EBMUD's database to establish initial conditions, and it then applies forecasted assumptions to manage current year operations. The model includes 17 months, from July of the current year to November of the following year.

The short-term forecast is obtained from California Nevada River Forecast Center, which provides water resources forecasts to support decision-making for flood control and water supply management.

The model applies planned assumptions to control operations based on the user-defined initial conditions, which are in monthly time steps. The monthly forecast assumptions are then used to calculate raw water system operations on a daily time-step basis. The model can be used for a single water year, or models can be "linked" to create a multi-year model run.

3.6 GENERATION AND DEPENDABLE CAPACITY

Other than a small amount of electricity being used at the EBMUD facilities at Pardee and Camanche, EBMUD sells its hydroelectric energy and Renewable Energy Certificates (RECs) (i.e., certificates from the generation of renewable energy) to the Silicon Valley Clean Energy Authority through a power purchase agreement. Separately, EBMUD sells resource adequacy (i.e., capacity) from the hydroelectric facilities to energy service providers and energy marketers. Additionally, the operating capacity at Pardee is occasionally sold as spinning reserve to the grid operator. Prior to July 1, 2025, the electricity and RECs produced by the Lower Mokelumne River Project were sold by EBMUD to Marin Clean Energy, under a 10-year power purchase agreement that expired on June 30, 2025.

Dependable capacity is defined here as the final net qualifying capacity values for Compliance Year 2026 published by CAISO on September 15, 2025. The monthly values are given in Table 3.6-1.

Table 3.6-1. Monthly net qualifying capacities for Compliance Year 2026.

Month	Pardee (MW)	Camanche (MW)	Total (MW)
January	15.76	4.41	20.17
February	14.96	4.40	19.36
March	15.76	5.73	21.49
April	23.60	4.95	28.55
May	20.56	6.43	26.99
June	23.76	5.94	29.70
July	14.96	4.70	19.66
August	14.96	2.51	17.47
September	14.96	1.06	16.02
October	14.96	2.66	17.62
November	10.96	0.81	11.77
December	15.76	2.02	17.78

The Project utilizes storage that is managed year-round; therefore, the critical stream flow for determining critical capacity is not applicable here. Camanche has a minimum generation value of 0.8 MW/175 cfs, and Pardee has a minimum generation value of 5.5 MW/200 cfs. For Pardee and Camanche, the flow is approximate, as it changes with reservoir elevation. Any releases below this value would have to be bypassed through the sluice valves. Project inflow and outflow records are provided in Section 4.3, *Water Resources*, and Project annual and monthly flow duration curves are provided in Appendix E.

The average annual generation for the Lower Mokelumne River from 1983 to 2024 is approximately 125,000 MWh. In 2015, when the Mokelumne River watershed experienced a drought that was the driest since 1977, the Lower Mokelumne River generation was 2,992 MWh in July and 34 MWh in December. Monthly and annual average generation for the Project is provided in Table 3.6-2, and historical annual generation is provided in Table 3.6-3.

Table 3.6-2. Monthly and annual generation (MWh) for the Lower Mokelumne River Project.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2020	6,499	3,902	3,508	14,579	4,988	7,000	4,187	5,584	4,818	6,368	3,576	6,148	71,157
2021	2,514	3,156	2,766	2,372	1,713	743	2,219	2,946	3,904	4,072	1,686	8,107	36,198
2022	14,406	11,602	2,263	2,385	6,286	7,351	4,526	6,215	4,686	10,069	4,178	14,585	88,552
2023	22,262	22,365	29,676	28,424	25,438	28,980	28,716	17,442	14,365	15,605	2,922	3,500	239,695

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2024	11,193	14,193	21,694	20,232	27,834	19,328	4939.7	3944	6384	13597	2272	3857	149,468
Average	11,375	11,044	11,981	13,598	13,252	12,680	8,918	7,226	6,832	9,942	2,927	7,239	117,014

Table 3.6-3. Historical annual generation (MWh) for the Lower Mokelumne River Project.

Calendar Year	Generation (MWh)
2015	39,959
2016	146,583
2017	244,124
2018	125,598
2019	231,463
2020	71,157
2021	36,198
2022	88,552
2023	239,695
2024	149,468

3.7 CURRENT LICENSE REQUIREMENTS AND COMPLIANCE HISTORY

3.7.1 CURRENT LICENSE REQUIREMENTS

Per 18 CFR § 5.6(d)(2)(v), the following text describes information required to be included in the PAD for an existing license.

3.7.1.1 SUMMARY OF STANDARD TERMS AND CONDITIONS

The Lower Mokelumne River Project license is subject to FERC's standard terms and conditions designated Articles 1 through 32 set forth in Form L-2 (revised October 1975), entitled "Terms and Conditions of License for Unconstructed Major Project Affecting Lands of the United States" attached in Volume II – Appendix D.

3.7.1.2 SUMMARY OF SPECIAL TERMS AND CONDITIONS

This license is also subject to the special conditions described in the 1981 Order Issuing License (Major), 14 FERC ¶ 62,237, and in Table 3.7-1.

Table 3.7-1. Summary of license requirements.

Requirement Type	Requirement
Article 33 Submission of Camanche Dam PMF study	Requires licensee to submit to FERC a Probable Maximum Flood (PMF) study for the Camanche Dam to determine the need for additional spillway capacity. The study must be submitted within a year from the license issuance date and include sufficient data for an independent evaluation of all assumptions and parameters.
Article 34 Submission of annual piezometer measurements summary report for Pardee Dam	Requires licensee to submit to FERC an annual report summarizing piezometer measurements of foundation uplift pressure at Pardee Dam.
Article 35 Filing of contract drawings and specifications for important project works	Requires licensee to file contract drawings and specifications for important project works with FERC, 60 days prior to the start of construction.
Article 36 Filing of Exhibits A, F, and G	Requires licensee to file with FERC Exhibits A, F, and G for approval within a year after the project begins operation, describing and showing the constructed project works and facilities.
Article 37 Management of cultural resources for construction activities	Requires licensee to consult with the California SHPO for cultural resource surveys and funding for required work before construction begins. Article addresses procedures on findings of unrecorded archaeological or historical sites during construction and process for developing mitigation plans.
Article 38 Approval requirements of additional recreational facilities at Pardee Development	Requires licensee to file with FERC for approval a facility description, construction schedule, and any necessary revised Exhibit G before starting construction of additional recreational facilities at the Pardee Development.
Article 39 Requirements for the installation and operation of public safety devices	Requires licensee to install and operate necessary safety devices to warn the public about flow fluctuations and ensure public safety during recreational use of project lands and water.
Article 40 Requirements for establishing and updating an emergency action plan for sudden water releases	Requires the licensee to file, implement, and modify an emergency action plan within 1 year to provide early warnings of sudden water releases due to accidents or failures. The plan must be updated as needed.

Requirement Type	Requirement
Article 41(a) Authorized installed capacity annual charges	Requirement to pay the United States authorized installed capacity annual charges as determined by FERC.
Article 41(b) Land acreage based annual charges	Requirement to pay the United States land acreage based annual charges as determined by FERC.
Article 42 Terms governing construction timelines	Requires licensee to start construction of the project within 2 years from the license's effective date, continue the construction diligently, and complete it within 4 years from the license's effective date.
Article 43 Requirements for conveyance of project lands	(a) The licensee may grant permission for certain uses of project lands and waters without FERC approval, provided these uses protect and enhance the project's scenic, recreational, and environmental values and the licensee supervises these uses and correct any violations. (b) The licensee may grant permission for certain uses of project lands and water without FERC approval that includes landscape plantings, certain non-commercial overwater structures, erosion control structures for shoreline protection. The uses must protect and enhance the project's scenic, recreational, and environmental values, be maintained, and comply with health and safety requirements. (c) The licensee may grant easements, rights-of-way, or leases for various uses of project lands, for certain work related to bridges and roads, storm drains and water mains, sewers, minor access roads and utility lines, non-project overhead electric transmission lines, telephone distribution cables or major electric distribution lines, and water intake or pumping facilities. The licensee must file an annual report to FERC by January 31 each year detailing each conveyance made in the prior year. (d) The licensee may convey fee title, easements, rights-of-way, or leases of project lands for certain work related to the following: • New bridge or road construction. • Sewer or effluent lines. • Pipelines crossing project lands or waters. • Non-project overhead electric transmission lines. • Private or public marinas and located at least one-half mile from any other marina. • Recreational development consistent with approved license Exhibits. • Other uses, if the land conveyed is 5 acres or less, located at least 75 feet from the project reservoir, and no more than 50 total acres are conveyed per calendar year. • Before conveying any interest, the Licensee must file a letter with FERC at least 45 days in advance, notifying its intent of

Requirement Type	Requirement
	the conveyance and describing it, the agencies consulted, and required approvals. (e) These additional conditions apply for any intended conveyance that requires filing with FERC under paragraphs (c) or (d): 1) Consultation with relevant federal and state agencies and the State Historic Preservation Officer. 2) Consistency check that the proposed use of the conveyed lands is consistent with approved recreational resources documents or Exhibits or that the lands do not have recreational value. 3) Covenants inclusion in the conveyance instrument to ensure the use of the lands does not endanger health, create a nuisance, or conflict with project recreational use. The grantee must ensure the structure or facilities protect the scenic, recreational, and environmental values of the project. 4) Reservation of FERC's rights to require remedial action to protect and enhance the project's scenic, recreational, and environmental values. (f) Conveyed lands may be excluded from the project boundaries upon approval of revised Exhibit G or K drawings. Land will only be excluded if it is determined unnecessary for project purposes.

3.7.1.3 LICENSE AMENDMENTS

In addition to the numbered License Articles in Table 3.7-1, the following FERC Orders have modified the Project license as summarized below:

- FERC. 1981. 14 FERC ¶ 62,237. Order Issuing License (Major): Lower Mokelumne River Project No. 2916.
- FERC. 1984. 29 FERC ¶ 62,136. Order Amending Major License: Lower Mokelumne River Project No. 2916.
    - Article 41(b) was amended and removed on November 15, 1984, as it pertains to charges for occupancy of United States land, which does not exist for this Project and is therefore not applicable. The order also updated Exhibit F and Exhibit G drawings and revised Exhibit A.
- FERC. 1994. 67 FERC ¶ 62,010. Order Approving Revised Exhibit A and Revising Annual Charges: Lower Mokelumne River Project No. 2916. Errata Notice, Order Approving Revised Exhibit A and Revising Annual Charges: Lower Mokelumne River Project No. 2916, eLibrary No. 19940420-0365 (Apr. 20, 1994).
    - Article 41(a) was amended on April 1, 1994, to reflect changes in the Project's authorized installed capacity. The order also revised Exhibit A,

amended project description, and revised Article 41 pertaining to the payment of annual charges for authorized installed capacity.

- FERC. 1996. 74 FERC ¶ 62,010. Order Approving Revised Exhibit A and Revising Annual Charges: Lower Mokelumne River Project No. 2916.
    - Article 41(a) was amended on January 17, 1996, to reflect changes in the Project's authorized installed capacity. The order also revised Exhibit A, amended project description, and revised Article 41 pertaining to the payment of annual charges for authorized installed capacity.
- FERC. 1997. 79 FERC ¶ 62,073. Order Approving And Modifying Amended Proposed Revised Recreation Plan: Lower Mokelumne River Project No. 2916.
    - Modified and amended on May 1, 1997, Recreation Plan superseding Exhibits G and E of the original license application.
- FERC. 1998. 85 FERC ¶ 61,292. Order Approving Settlement Agreement and Amending License: Lower Mokelumne River Project No. 2916.
    - Amended on November 27, 1998, to approve a JSA that resolves issues among EBMUD, USFWS, and CDFW concerning measures needed to ensure sufficient water quality and quantity to sustain anadromous fish in the Lower Mokelumne River.
- FERC. 1999. 88 FERC ¶ 62,142. Order Amending License: Lower Mokelumne River Project No. 2916.
    - Amended on August 17, 1999, to revise Exhibit G drawings removing Mine Run Dam from the Project boundary.
- FERC. 2001. 96 FERC ¶ 62,180. Order Approving Revised Exhibit G Under Article 43: Lower Mokelumne River Project No. 2916.
    - Amended on August 22, 2001, to revise Exhibit G drawings that change the Project boundary.
- FERC. 2004. 106 FERC ¶ 62,070. Order Approving Revised Exhibits: Lower Mokelumne River Project No. 2916.
    - Amended on January 30, 2004, to revise Exhibit F drawings (Exs. F-4 & F-1) showing as-built conditions for Pardee South Spillway Modifications.
- FERC. 2019. 169 FERC ¶ 62,131. Order Amending Project Boundary: Lower Mokelumne River Project No. 2916.
    - Amended on December 5, 2019, to amend the Project boundary to remove lands not needed for Project purposes.
    - Errata Notice: FERC. 2020. 170 FERC ¶ 62,056. Errata Notice to Order Amending Project Boundary: Lower Mokelumne River Project No. 2916.
        - Revised the last sentence of the first paragraph to specify that the Project does not occupy federal lands.

- FERC. 2020. 170 FERC ¶ 62,074. Order Approving Revised Exhibit A, Revising Project Description, and Revising Annual Charges: Lower Mokelumne River Project No. 2916.
    - Article 41(a) was amended on February 5, 2020, to reflect changes in the Project's authorized installed capacity. The order also revised Exhibit A, amended Project description, and revised Article 41 pertaining to the payment of annual charges for authorized installed capacity.
- FERC. 2020. 171 FERC ¶ 62,039. Order Approving Revised Exhibit G Drawings: Lower Mokelumne River Project No. 2916.
    - Amended on April 14, 2020, to amend the Project boundary with revised Exhibit G drawings removing lands not needed for any Project purpose.

3.7.1.4 SAFETY PROCEDURES

Under FERC guidelines, the Project developments have High Hazard Potential designations. EBMUD has a Dam Safety Surveillance and Monitoring Plan (DSSMP) for each development and its associated structures that are classified as High Hazard. The DSSMPs detail how EBMUD monitors and evaluates performance of the Project. The purpose of the surveillance program is to identify any dam safety concern so it can be addressed in a timely manner. Annually, the Dam Safety Surveillance and Monitoring Report (DSSMR) is prepared and submitted to FERC that summarizes the monitoring data collected that year and provides an analysis of the results and any changes to the instrumentation. EBMUD filed the most recent Public Safety Plan (PSP) for the Project on July 13, 2017. The PSP outlines the public safety measures that are in place for the Project, including signage and safety barriers such as fencing, boat barriers, and gates.

An Emergency Action Plan (EAP) is in place for Pardee and Camanche dams. EBMUD conducts a notification drill as well as an EAP Seminar/Tabletop annually; the Tabletop/Functional Exercise is done every 5 years, the last one occurring on September 20, 2023.

3.7.2 COMPLIANCE SUMMARY

The Project is required to comply with all License Articles contained in the March 10, 1981 License, as amended, and all FERC-approved plans and reports. The Project does not have a Water Quality Certification from the California Regional Water Quality Control Board (Regional Board) because the Regional Board originally waived certification requirements in accordance with Section 401 of the Federal Water Pollution Control Act.[3]

[3] 14 FERC ¶ 62,237 at 63,371 (1981). Order Issuing License (Major): Lower Mokelumne River Project No. 2916.

Based on a review of the Project's compliance history, EBMUD has been and continues to be in compliance with all License Articles, approved plans, and reports. FERC has never made a finding that EBMUD was in violation of its license.

3.7.2.1 PROJECT INSPECTIONS

Over the term of the existing license, EBMUD has participated in FERC environmental inspections, security inspections, public safety inspections, and dam safety inspections. As part of its ongoing commitment to dam safety, EBMUD performs an external audit, every 5 years, of its entire dam safety program, with the most recent one being done in 2021, and no significant dam safety issues or concerns were identified. The most recent environmental/public safety inspection occurred in 2018, and the dam safety inspection occurred in 2024. EBMUD will continue to implement any FERC directives identified during the above safety inspections in a timely manner.

3.7.2.2 COMPLIANCE HISTORY OF THE PROJECT

EBMUD has had no violations over the course of the current Project license.

3.8 CURRENT NET INVESTMENT

As of June 30, 2024, EBMUD has incurred an original cost investment of $444.4 million, accumulated depreciation of $209.5 million, with a net book value of $234.9 million. This should not be interpreted as the fair market value of the Lower Mokelumne River Project.

3.9 POTENTIAL FOR CHANGES IN PROJECT OPERATION

EBMUD is not proposing any new facilities or changes in Project operations at this time.

3.10 PROJECT BOUNDARY

Since the March 10, 1981 issuance of the current license for the Project, changes have occurred through a series of amendment applications and FERC Orders. Table 3.10-1 lists the last approved date of Exhibits G2-G5 and G7.

Table 3.10-1. Approvals for Exhibits G2-G5 and G7 for the Lower Mokelumne River Project.

Exhibit	Current FERC Drawing Number	Order Approving
G-2	2916-43 FERC Project No 2916, Lower Mokelumne River Project, Project Boundary, Sheet 1 of 4	License Application Submittal: Approved by FERC Order of 3/10/1981 Shows as-constructed project works and facilities pursuant to Article 36 of the license: Approved by FERC Order of 11/15/84 Revises Exhibit G maps that were included in a revised recreation plan: Approved by FERC Order of 5/1/1997

Exhibit	Current FERC Drawing Number	Order Approving
G-3	2916-57 FERC Project No 2916, Lower Mokelumne River Project, Project Boundary, Sheet 2 of 4	License Application Submittal: Approved by FERC Order of 3/10/1981 Shows as-constructed project works and facilities pursuant to Article 36 of the license: Approved by FERC Order of 11/15/84 Order approving revised Exhibit G-3 and G-5 for parcel sold to an adjacent landowner who needs access to land-locked property: Approved by FERC Order of 8/22/2001 Order approves revised Exhibit G drawings for removing 64.2 acres of land from the project boundary because it is not needed for any project purpose under the license: Approved by FERC Order of 4/14/2020
G-4	2916-58 FERC Project No. 2916, Lower Mokelumne River Project, Project Boundary, Sheet 3 of 4	License Application Submittal: Approved by FERC Order of 3/10/1981 Shows as-constructed project works and facilities pursuant to Article 36 of the license: Approved by FERC Order of 11/15/84 Revises Exhibit G maps that were included in a revised recreation plan: Approved by FERC Order of 5/1/1997 Order amends license by approving the removal of Mine Run Dam: Approved by FERC Order of 8/17/1999 Order approves revised Exhibit G drawings for removing 64.2 acres of land from the project boundary because it is not needed for any project purpose under the license: Approved by FERC Order of 4/14/2020
G-5	2916-59 FERC Project No. 2916, Lower Mokelumne River Project, Project Boundary, Sheet 4 of 4	License Application Submittal: Approved by FERC Order of 3/10/1981 Shows as-constructed project works and facilities pursuant to Article 36 of the license: Approved by FERC Order of 11/15/84 Order approving and modifying amended proposed revised recreation plan incorporating by reference Exhibit G-2 through G-5 and G-7 that exclude recreation areas with long-term tenants: Approved by FERC Order of 5/1/1997 Order approving revised Exhibit G-3 and G-5 for parcel sold to an adjacent landowner who needs access to land-locked property: Approved by FERC Order of 8/22/2001 Order approves revised Exhibit G drawings for removing 64.2 acres of land from the project boundary because it is not needed for any project purpose under the license: Approved by FERC Order of 4/14/2020

Exhibit	Current FERC Drawing Number	Order Approving
G-7	Drawing 1790-R-25 FERC Project No 2916, Lower Mokelumne River Project, Camanche North & South Shore Recreation Areas	Order approving and modifying amended proposed revised recreation plan incorporating by reference Exhibit G-2 through G-5 and G-7 that exclude recreation areas with long-term tenants: Approved by FERC Order of 5/1/1997

3.11 PURPA BENEFITS

In accordance with 18 CFR §5.6(e), EBMUD is indicating in this document that EBMUD is not seeking rights under Section 210 of the Public Utility Regulatory Policies Act of 1978 (PURPA) for the Project at this time. EBMUD reserves the right to exercise any rights available to EBMUD under PURPA in the future.

4.0 DESCRIPTION OF EXISTING ENVIRONMENT AND RESOURCE IMPACTS

4.1 DESCRIPTION OF THE RIVER BASIN

The Upper Mokelumne River watershed lies on the western slope of the central Sierra Nevada range in Alpine, Amador, Calaveras, and San Joaquin counties in California and covers an area of 621 square miles from Camanche Dam to the headwaters of the basin near Highland Peak (United States Geological Survey [USGS] 2024a). Elevations range from approximately Elevation (El.) 235 feet (Project Datum) at Camanche Dam to over El. 10,000 feet along the crest of the Sierra Nevada. The Mokelumne River is comprised of three main tributaries in the upper watershed consisting of the North, Middle, and South forks of the Mokelumne River with reach lengths of 64 miles, 29 miles, and 27 miles, respectively. Pacific Gas and Electric Company (PG&E) and Amador Water Agency (AWA) operate facilities on the North Fork of the Mokelumne River. Calaveras Public Utility District (CPUD) and Calaveras County Water District operate facilities along the Middle and South forks of the Mokelumne River. Jackson Valley Irrigation District, AWA, and PG&E all operate facilities along the main stem of the Mokelumne River. The sidebar lists the primary and secondary tributaries to the Mokelumne River.

North Fork Mokelumne River
Bear River
Tiger Creek
Deer Creek
Upper Blue Lake
Lower Blue Lake
Twin Lake
Meadow Lake
Middle Fork Mokelumne River
Salt Springs Creek
West Point Creek
Electra Creek
South Fork Mokelumne River
Dry Creek
North Fork Dry Creek
South Fork Dry Creek
Sutter Creek
Jackson Creek
Other Tributaries
Panther Creek
Summit Creek
Cole Creek

The three main tributaries join and become the Mokelumne River in the Upper Watershed approximately 10 miles upstream of Pardee Reservoir and flow in a southwesterly direction for approximately 31 miles through Pardee and Camanche reservoirs. The distance between the dams is approximately 10 miles, with the upper reach of Camanche Reservoir within 0.5 mile of the downstream toe of Pardee Dam under full pool conditions. Figure 4.1-1 shows a map of the approximate 622 square miles drainage area of the Upper Mokelumne River watershed above Camanche Dam.

Water is released from Camanche Dam through the powerhouse or through discharge valves. The Mokelumne River Fish Hatchery is located at the toe of the dam, receives water from Camanche Reservoir, and discharges water into the Mokelumne River (see Section 4.4.5, Mokelumne River Fish Hatchery, for more information).

The lower watershed of the Mokelumne River flows about 35 miles from Camanche Dam westerly across the Central Valley to the point where it enters the Sacramento-San Joaquin Delta at New Hope Landing. Figure 4.1-2 shows a map of the Lower Mokelumne

River below Camanche Dam. Along its route, the river crosses beneath Highways 88 and 99, passes through the city of Lodi and Lake Lodi,[4] before meandering northerly across flatlands, intercepts the Cosumnes River near Thornton, turns south, and enters the Sacramento-San Joaquin Delta. It continues flowing through and around myriad channels, tracts, and islands to its confluence with the San Joaquin River and into San Francisco Bay.

[4] Lake Lodi is a shallow impoundment on the north side of the city of Lodi, formed by the Woodbridge Irrigation District (WID) diversion dam that seasonally raises the water level of the Mokelumne River sufficiently for diversion to WID's canal system.

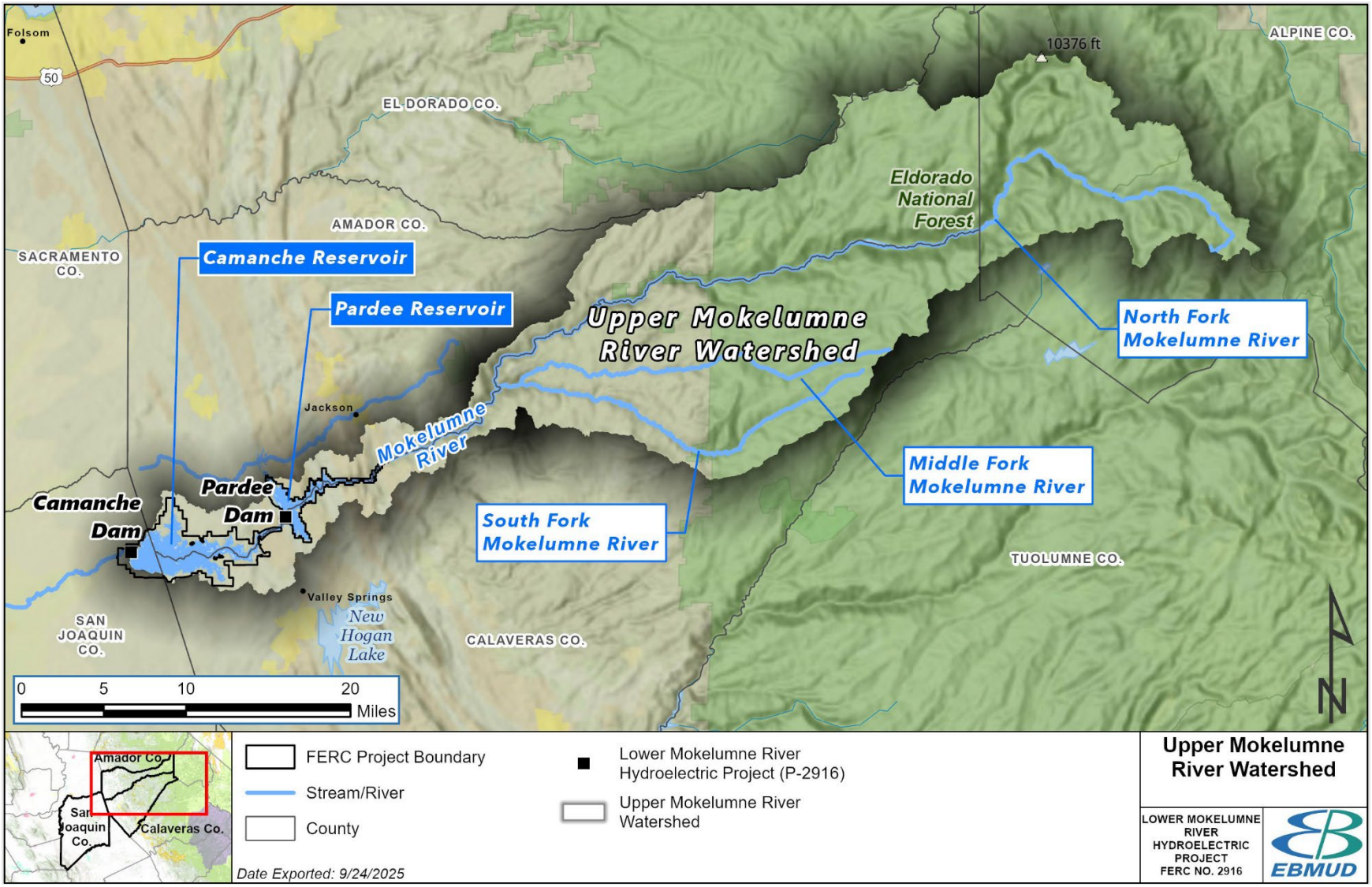


Figure 4.1-1. Upper Mokelumne River watershed.

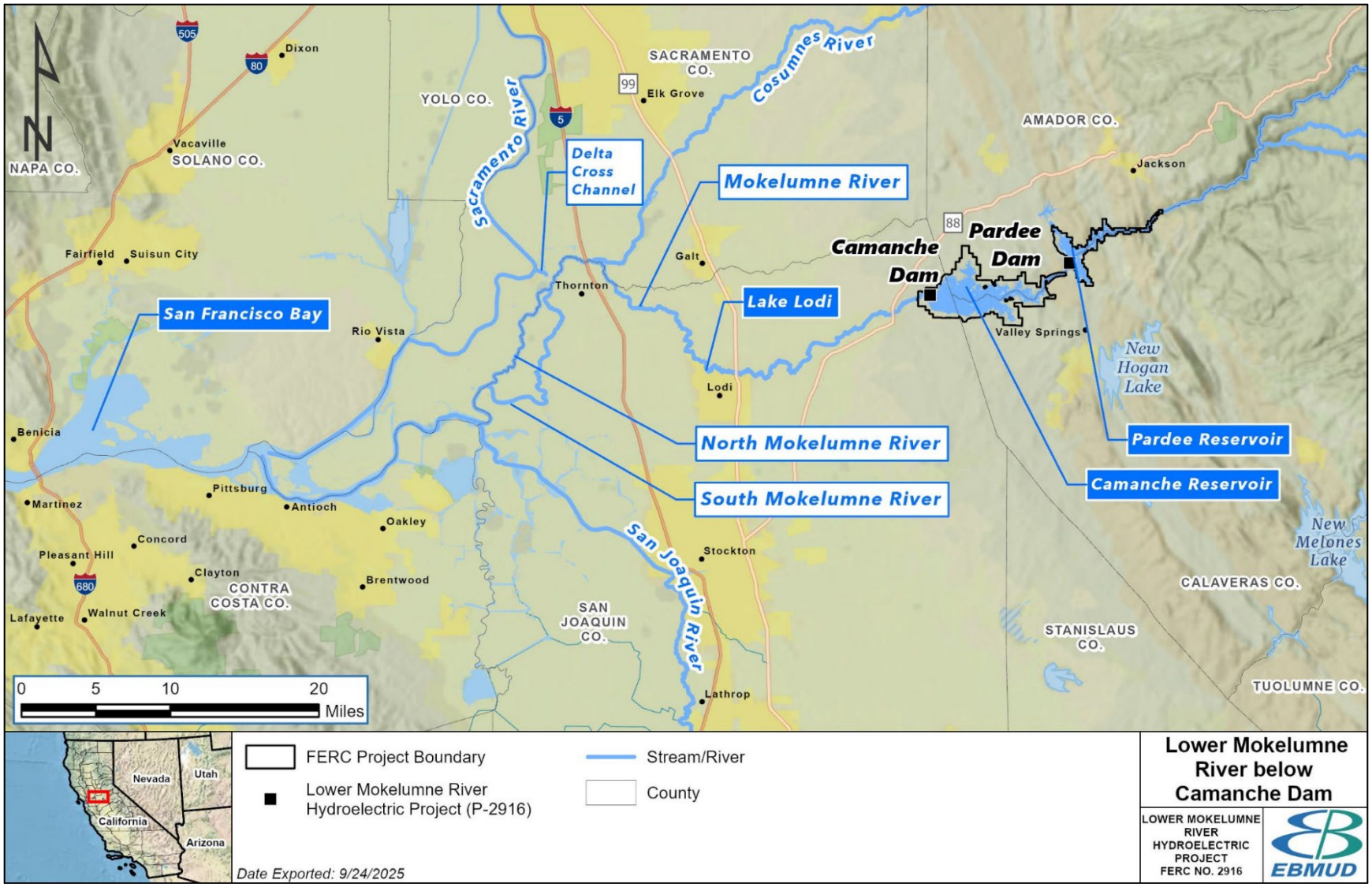


Figure 4.1-2. Lower Mokelumne River below Camanche Dam.

The Lower Mokelumne River Hydroelectric Project (FERC No. 2916) is within the San Joaquin Subregion (USGS Hydrologic Unit Code [HUC] 1804), which is further subdivided into the San Joaquin Basin (HUC 180400) and the Upper Mokelumne Subbasin (HUC 18040012).

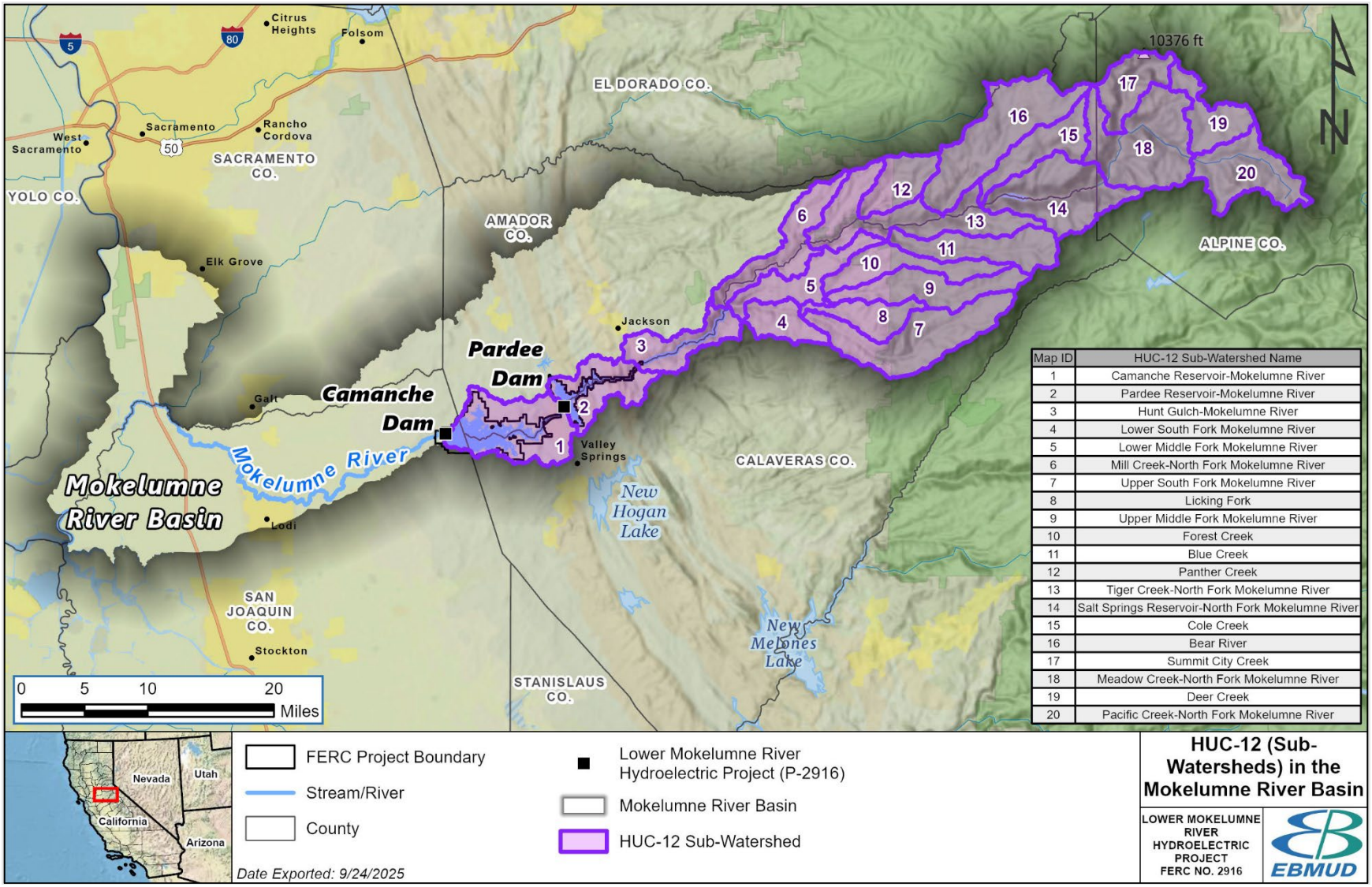
The Mokelumne River watershed has five 10-digit HUC (HUC 10) classifications: Upper North Fork Mokelumne River Watershed (HUC 1804001201), South Fork Mokelumne River Watershed (HUC 1804001202), Middle Fork Mokelumne River Watershed (HUC 1804001203), Lower North Fork Mokelumne River Watershed (HUC 1804001204), and Upper Mokelumne River Watershed (HUC 1804001208).

There are 20 12-digit HUC sub-watersheds that compose the Mokelumne River watershed, as shown in Table 4.1-1 and Figure 4.1-3.

Table 4.1-1. HUC 12 (sub-watersheds) in the Mokelumne River basin.

HUC 12	Name	Drainage Area (sq. miles)
180400120101	Deer Creek	20.8
180400120102	Pacific Creek-North Fork Mokelumne River	33.3
180400120103	Summit City Creek	21.2
180400120104	Meadow Creek-North Fork Mokelumne River	52.9
180400120105	Cole Creek	23.5
180400120106	Salt Springs Reservoir-North Fork Mokelumne River	43.7
180400120201	Upper South Fork Mokelumne River	47.1
180400120202	Licking Fork	16.8
180400120203	Lower South Fork Mokelumne River	14.8
180400120301	Forest Creek	23.8
180400120302	Upper Middle Fork Mokelumne River	29.8
180400120303	Lower Middle Fork Mokelumne River	23.4
180400120401	Bear River	52.6
180400120402	Blue Creek	29.0
180400120403	Panther Creek	18.7
180400120404	Tiger Creek-North Fork Mokelumne River	48.7
180400120405	Mill Creek-North Fork Mokelumne River	28.4
180400120801	Hunt Gulch-Mokelumne River	23.0
180400120802	Pardee Reservoir-Mokelumne River	26.6
180400120803	Camanche Reservoir-Mokelumne River	43.4

HUC 12 = 12-digit HUC.



Map ID	HUC-12 Sub-Watershed Name
1	Camanche Reservoir-Mokelumne River
2	Pardee Reservoir-Mokelumne River
3	Hunt Gulch-Mokelumne River
4	Lower South Fork Mokelumne River
5	Lower Middle Fork Mokelumne River
6	Mill Creek-North Fork Mokelumne River
7	Upper South Fork Mokelumne River
8	Licking Fork
9	Upper Middle Fork Mokelumne River
10	Forest Creek
11	Blue Creek
12	Panther Creek
13	Tiger Creek-North Fork Mokelumne River
14	Salt Springs Reservoir-North Fork Mokelumne River
15	Cole Creek
16	Bear River
17	Summit City Creek
18	Meadow Creek-North Fork Mokelumne River
19	Deer Creek
20	Pacific Creek-North Fork Mokelumne River

Figure 4.1-3. HUC 12 (sub-watersheds) in the Mokelumne River basin.

4.1.1 MAJOR LAND USES AND LAND TYPES

Most of the land in the Mokelumne River watershed, especially in the upper (eastern) part, is undeveloped, consisting of open space and forest land, with small concentrations of residential and commercial development along the major highways, and large tracts of designated wilderness. There are small agricultural areas, mainly orchards and vineyards, and some areas dedicated to recreational developments (including winter sports facilities). There are very few industrial and commercial uses in the watershed, with logging as the major land use activity. Most of the developed areas within the Mokelumne River watershed are residential communities.

Forest land, located chiefly within the Eldorado and Stanislaus national forests, accounts for about 75 percent of the watershed land, with cover ranging from scattered conifers and sub-alpine species with shrubs in the upper elevations to dense fir and cedar trees at intermediate elevations and deciduous trees, chaparral, and grasses at lower elevations, with some urban development, mainly around Camanche Reservoir. Figure 4.1-4 shows the major land classifications in the Mokelumne River watershed from the National Land Cover Database (NLCD) (Multi-Resolution Land Characteristics [MRLC] Consortium 2020). More information regarding land use adjacent to the Project boundary is presented in Section 4.8.6.

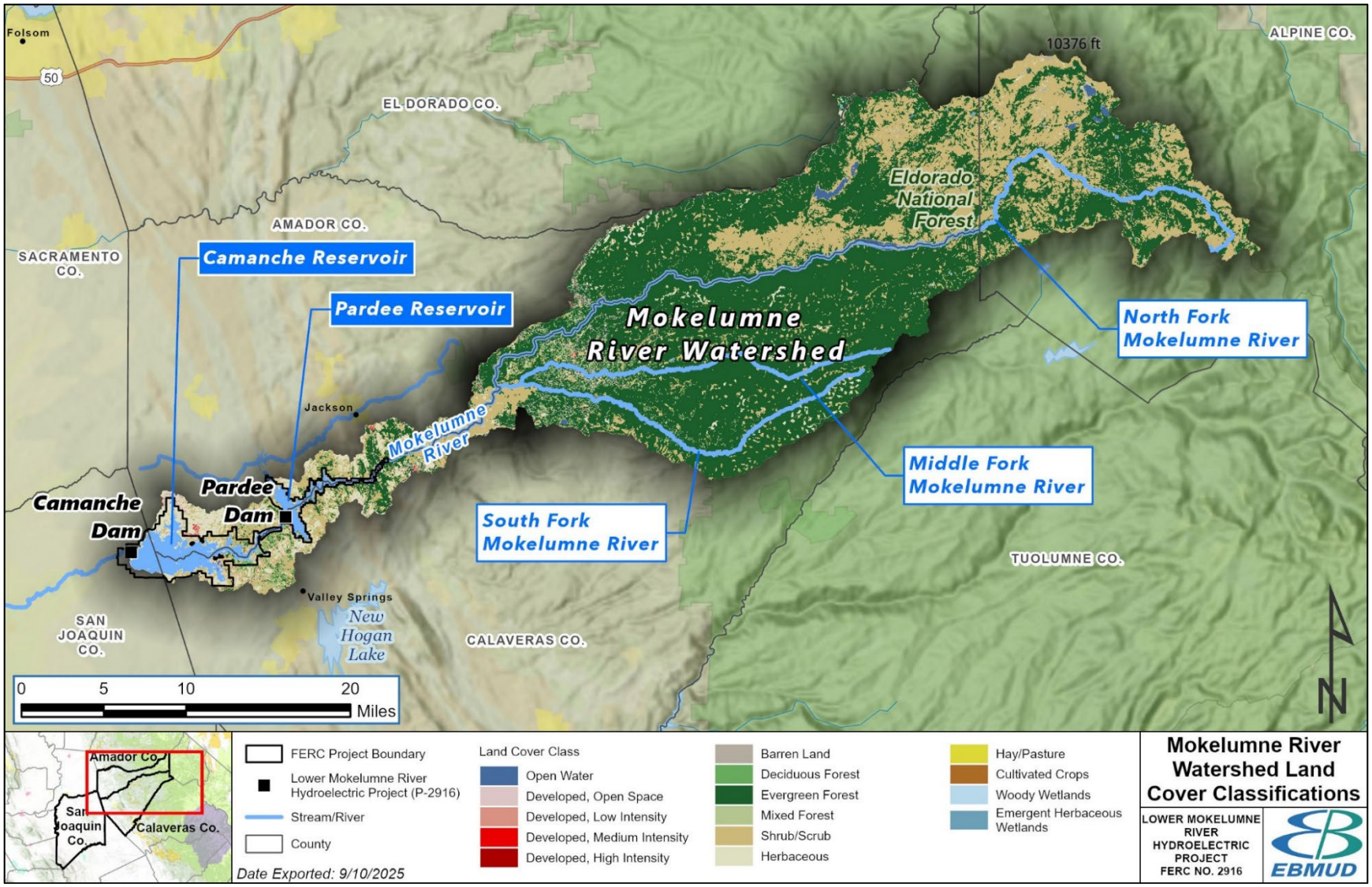


Figure 4.1-4. Mokelumne River watershed land cover classifications.

4.1.2 MAJOR WATER USES

The Mokelumne River serves a variety of uses, including agriculture, fisheries, hydropower, recreation, and municipal and industrial use. EBMUD has water rights that allow delivery of up to a maximum of 325 million gallons per day (MGD) from the Mokelumne River, subject to the availability of Mokelumne River runoff and numerous flow release obligations. EBMUD's Project flow commitments are determined by hydrology, water rights priorities, agreements with state and federal regulatory agencies, California State Water Resources Control Board (SWRCB) orders and decisions, federal directives, court decrees, and numerous agreements between EBMUD and other Mokelumne River users, both upstream and downstream of Project facilities. EBMUD's water rights are discussed in greater detail in Section 4.3.4, Existing and Proposed Uses of Project Waters.

EBMUD supplies drinking water to approximately 1.4 million people in a 326-square-mile area that includes 26 incorporated and 20 unincorporated communities in parts of both Alameda and Contra Costa counties in the San Francisco East Bay Area of California. Based on the historical average, approximately 90 percent of the untreated water entering EBMUD's service area water system originates from the Lower Mokelumne River Project. While EBMUD has adequate stable resources to meet demands in most years, stored water in EBMUD reservoirs is a critical component of EBMUD's annual water supply and year-to-year operations. In the last 10 water years (2015 through 2024), average annual water production to serve EBMUD's customers has been about 180,000 acre-feet. The average distribution system input over this same time period was 157.5 MGD with the maximum day reported as 233.5 MGD.

The median annual runoff from the Mokelumne River, measured at Highway 49, is approximately 593,000 acre-feet. During the 10-year period from 2015 to 2024, the annual Mokelumne River runoff ranged from a low of approximately 222,000 acre-feet in Water Year 2015 to a high of 1.929 million acre-feet in Water Year 2017.

4.1.2.1 DAMS AND DIVERSION STRUCTURES IN THE BASIN

Streamflow in the Mokelumne River basin is modified by various diversions and regulated by reservoir storage operations, including a network of facilities operated by PG&E upstream of the Project. There are 11 dams and reservoirs within the Mokelumne River basin located upstream of the Project, and 1 dam and lake located downstream of the Project (Figure 4.1-5).

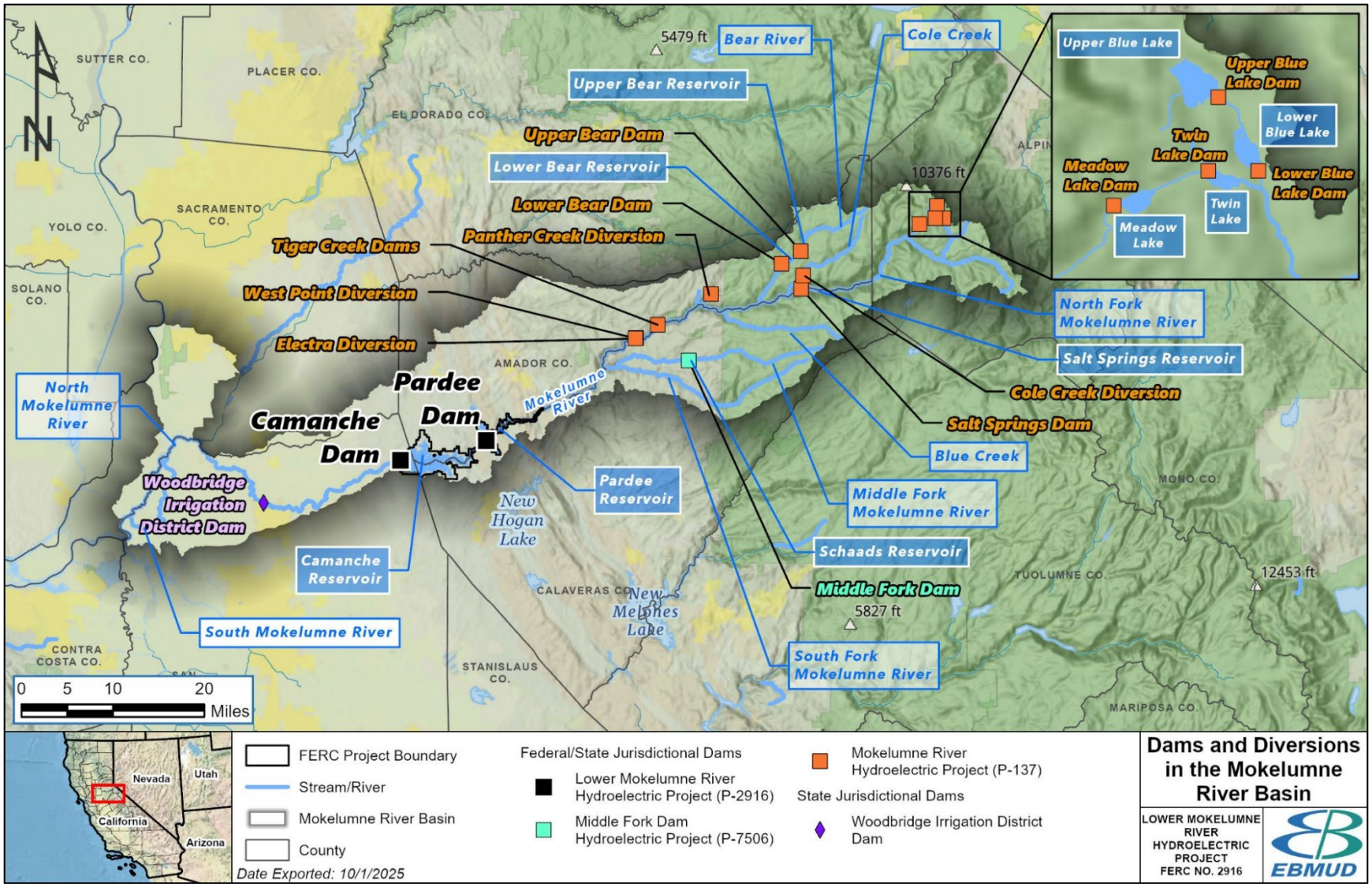


Figure 4.1-5. Dams and diversions on the Mokelumne River in the vicinity of the Project.

From the top of the basin, PG&E's Mokelumne River Hydroelectric Project (P-137) consists primarily of Upper Blue Lake, Lower Blue Lake, Twin Lake, and Meadow Lake dams. These reservoirs discharge into the North Fork Mokelumne River (North Fork) and into Salt Springs Reservoir. Water from Salt Springs Reservoir is either diverted into the North Fork through controlled releases or spills or into the Salt Springs Powerhouse. On the Bear River, Upper Bear Reservoir discharges into Lower Bear Reservoir, whereby water from Lower Bear is diverted into the Bear River or down to the Salt Springs Powerhouse. From Salt Springs Powerhouse, water can be released to the North Fork Mokelumne River or piped into the Tiger Creek conduit, where water enters a complex system of open channels and underground tunnels to the Tiger Creek, West Point, and Electra powerhouses, with releases from Electra flowing into Mokelumne River and into Pardee and Camanche reservoirs. Alternatively, PG&E can also divert water into their system from several other locations in the watershed, including the Cole Creek, Bear River, Panther Creek, West Point, and Electra diversions. For CPUD's Middle Fork Dam Hydroelectric Project (P-7506), water from Schaads Reservoir is either discharged to the Middle Fork Mokelumne River via controlled releases or spills, or through their powerhouse and flows to the Mokelumne River and into Pardee and Camanche reservoirs. Table 4.1-2 provides a summary of the major dams and powerhouses located on the Mokelumne River associated with the FERC projects.

Table 4.1-2. Major dams and diversions located in the Mokelumne River basin.

FERC Project No.	Name	River Mile	Drainage Area[a, b] (sq. miles)	Authorized Capacity[c] (MW)
P-137	Upper Blue Lake Dam	North Fork Mokelumne River	2.7	-
	Lower Blue Lake Dam	North Fork Mokelumne River	4.7	-
	Twin Lake Dam	North Fork Mokelumne River	0.7	-
	Meadow Lake Dam	North Fork Mokelumne River	5.6	-
	Upper Bear Dam	Bear River	28.3	-
	Lower Bear Dam	Bear River	37.3	-
	Salt Springs Dam and PH	North Fork Mokelumne River	169.1	39.965[d]
	Tiger Creek Forebay, Regulator, and Afterbay Dams and PH	North Fork Mokelumne River	7.9 / 357.0	54.400
	West Point PH	North Fork Mokelumne River	-	12.750

FERC Project No.	Name	River Mile	Drainage Area[a, b] (sq. miles)	Authorized Capacity[c] (MW)
	Electra PH	Mokelumne River	-	98.889
P-7506	Middle Fork Dam and PH	Middle Fork Mokelumne River	28.5	0.230
P-2916	Pardee Dam and PH	Mokelumne River	578	28.608
	Camanche Dam and PH	Mokelumne River	621	9.450

PH = Powerhouse; MW = megawatts.

Notes:

[a] Drainage area for P-137 reported by HDR Engineering, Inc. (2019).

[b] Drainage area for P-7506 estimated from USGS (2024b).

[c] *Pacific Gas & Elec. Co.*, 114 FERC ¶ 62.300 (2006); *Calaveras Public Utility District*, 71 FERC ¶ 62,130 (1995); *East Bay Mun. Util. Dist.*, 170 FERC ¶ 62,074 (2020).

[d] Salt Springs Powerhouse 1 (fed by Salt Springs Reservoir) and Powerhouse 2 (fed by Lower Bear Reservoir) combined.

The Project must release sufficient water to meet the needs of senior water users (i.e., entities or individuals with the senior water right priority) and to comply with flow requirements outlined in the Joint Settlement Agreement (JSA), California State Water Resources Control Board Decision 1641, and EBMUD's Camanche Permit 10478. Water diverted by downstream riparian diverters and individual appropriators is not measured by EBMUD directly and is estimated based on historical monthly average losses observed on the river. EBMUD estimates that there are more than 100 such diverters along the Lower Mokelumne River between Camanche Dam and the confluence with the Consumnes River (EBMUD 2013). Water rights in the basin are discussed in greater detail in Section 4.3.4, Existing and Proposed Uses of Project Waters. Figure 4.1-5 shows the location of the Mokelumne River diverters, provides a generalized overview of the Mokelumne River diversions and interagency agreements, and shows the river's flow commitments among the various uses.

4.1.3 CLIMATE

The climate of the basin is characterized by hot, dry summers and cool, wet winters with approximately 80 percent of the annual precipitation falling between the months of November and March (EBMUD 2022). Average annual precipitation for the Mokelumne River basin is approximately 48 inches[5] but varies from about 21 inches at Camanche

[5] EBMUD four-station average (Calaveras Big Trees, Tiger Creek, Salt Springs, and Caples Lake).

Reservoir to 92 inches in the upper watershed (PRISM[6] Climate Group 2024). Winter precipitation events are typically basin-wide with occasional heavy rainfall up to the crest of the Sierra Nevada; however, above El. 5,000 feet, precipitation usually falls as snow, which accumulates until April, when increasing solar radiation and temperatures cause the snowpack to begin melting. Table 4.1-3 shows climate data for the Mokelumne River watershed. Table 4.1-4 shows basin-averaged snow water equivalent (SWE) above El. 5,000 feet from late winter to early spring.

Table 4.1-3. Mokelumne River basin climate statistics.

Month	Average Precipitation[a] (in)	Average Temperature[b] (°F)	
		Mt. Zion Station El. 2,968 feet	Blue Lakes Station El. 7,990 feet
January	8.64	46	27
February	7.75	46	26
March	7.25	48	28
April	4.04	56	37
May	2.22	62	41
June	0.77	72	49
July	0.23	80	59
August	0.25	80	58
September	0.77	73	52
October	2.66	64	43
November	5.35	53	34
December	8.10	46	28

Notes:

[a] EBMUD four-station average (Calaveras Big Trees, Tiger Creek, Salt Springs, and Caples Lake), 1930-2023.

[b] Average temperature, 2019-2023 (California Data Exchange Center [CDEC] 2024).

Table 4.1-4. Mokelumne River basin snow water equivalent.

Month/Date	Average Snow Water Equivalent[a] (in)
February 1	18
March 1	24
April 1	28
May 1	21

Notes:

[a] Basin average SWE above El. 5,000 feet, 2019-2023 (Institute of Arctic and Alpine Research [INSTAAR] 2024).

[6] Parameter-Elevation Regressions on Independent Slopes Model (PRISM).

4.2 GEOLOGY AND SOILS

This section presents descriptions and maps of the existing geology, topography, and soils in the vicinity of Camanche Reservoir and Pardee Reservoir (Lower Mokelumne River Project) and surrounding areas. The descriptions and maps presented in this section are based on readily available information and are meant to comply with 18 CFR §5.6(d)(3)(ii).

4.2.1 REGIONAL GEOLOGY

The Upper Mokelumne River watershed is located in the western foothills of the central Sierra Nevada, a broad north-northwest trending mountain range that extends for more than 400 miles in eastern California. Much of the western flank of the Sierra Nevada is composed of Paleozoic and Mesozoic metamorphic rocks that extend westward beneath the Great Valley and represent the vestiges of island arc terranes that were accreted to the North American continent along ancient subduction zones. Tertiary volcanic flows and volcaniclastic rocks overlie the metamorphic rocks sporadically throughout the western margin of the range front and form broad, accordant divides between the major west-flowing rivers. (Lettis Consultants International [LCI] 2020)

4.2.2 GEOLOGICAL FEATURES

4.2.2.1 PARDEE DAM

The Mokelumne River within the vicinity of Pardee Dam traverses Paleozoic and Mesozoic terranes that are collectively referred to as the western Sierra Nevada Foothills Metamorphic Belt (SNFMB) (Snow and Scherer 2006) (Figure 4.2-1). These terranes were originally described by Clark (1964) and form relatively continuous, northwest-trending blocks of late Paleozoic-Mesozoic metamorphic rocks that are typically bounded by east-dipping Mesozoic faults. These terranes represent fragments of subduction zone complexes, oceanic crust (ophiolites), and island arcs. Primary bedding and foliation within the metamorphic rocks generally strike north-northwest, parallel to the trend of the metamorphic belt, and dip steeply to the east. Pardee Dam is located along the western margin of the SNFMB. The dam and reservoir are primarily underlain by the SNFMB rocks consisting of the Jurassic Salt Springs Slate and Jurassic Gopher Ridge Volcanics (Wagner et al. 1981; Holland et al. 2015; Holland and O'Neal 2019) (Figure 4.2-1). As these rocks are not wholly in fault contact with adjacent rocks, they are not technically considered to be a distinct lithotectonic terrane (Edelman and Sharp 1989; Snow and Scherer 2006). The Jurassic rocks are unconformably overlain by sequences of Tertiary volcanic, volcaniclastic, and sedimentary rocks (Wagner and Saucedo 1990). Downstream of the dam and along the eastern body of the reservoir, northwest-striking faults offset the Tertiary and younger rocks, indicating reactivation of Mesozoic faults in

late Cenozoic time (Bateman and Wahrhaftig 1966; Woodward Clyde Consultants [WCC] 1977, 1978; Page and Sawyer 2004).

The Jurassic Gopher Ridge metavolcanics is the primary rock unit at the Pardee Dam and spillway and is composed mostly of pyroclastic and flow rocks (LCI 2020; AECOM 2024). This formation is exposed nearly continuously along the northern and southern banks of the Mokelumne River canyon from Pardee Dam downstream to near the confluence with Mexican Gulch, a distance of about 185 meters (607 feet). The rock is referred to as "greenstone" in older reports addressing the dam foundation (EBMUD and GEI Consultants, Inc. 2013). The physical characteristics of the rock (i.e., competence) vary at the surface with the degree of weathering. The rock is described as predominantly massive, strong, and hard, and provides a competent foundation for the dam. The rock is jointed at fairly wide spacing (typically several meters). The foundation rock has essentially no primary permeability, and water flow occurs only through joints and fractures (EBMUD and GEI Consultants, Inc. 2013).

HDR Engineering, Christensen Associates, and GEI Consultants, Inc. (HCG) (1997) performed multiple seismic refraction surveys at Pardee Dam and spillway. The compressional wave velocities (V_p) indicate three primary velocity horizons. The upper zone corresponds to residual soils and intensely weathered bedrock to a depth of 3 meters (10 feet). The V_p ranged from 323 to 975 meters per second (m/sec) (1,060 to 3,199 feet per second [ft/sec]). The second horizon is about 6 to 21 meters (20 to 69 feet) thick with V_p ranging from 1,600 to 2204 m/sec (5,249 to 7,231 ft/sec), corresponding to moderately weathered and intensely to moderately fractured bedrock. The third zone was reported to be slightly weathered to fresh, moderately fractured bedrock with V_p ranging from 3,048 to 5,060 m/sec (10,000 to 16,601 ft/sec).

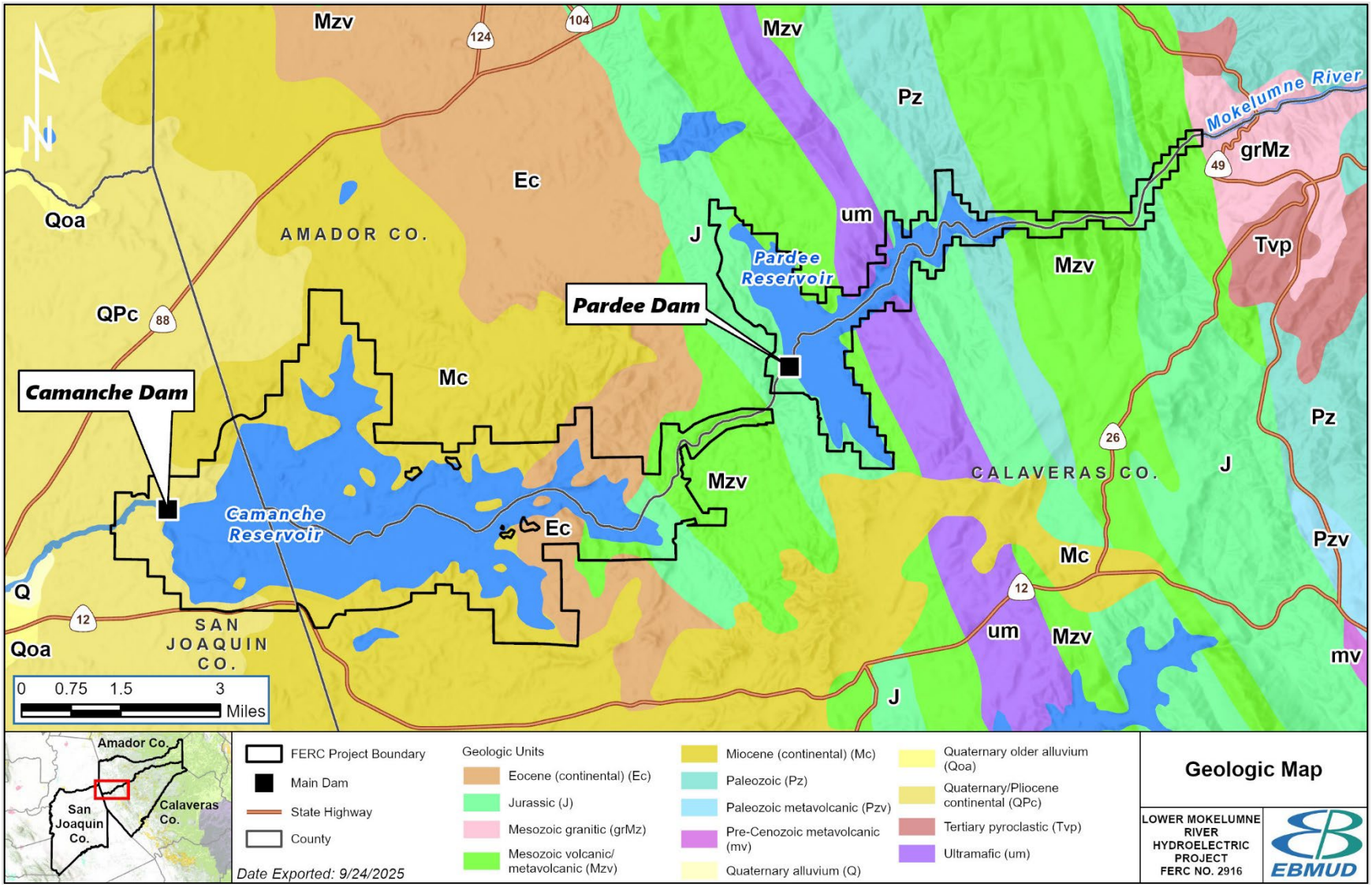


Figure 4.2-1. Lower Mokelumne River Project and surrounding area geologic map.

4.2.2.2 CAMANCHE DAM

Camanche Dam was excavated directly into the Miocene-Pliocene Mehrten and the Oligocene-Miocene Valley Springs formations on the western end of Camanche Reservoir (Figure 4.2-1). The Mehrten Formation varies in rock type from mudflow or agglomerate, to conglomerate, sandstone, siltstone, and claystone. The most widespread sediments in the Mehrten Formation are the sandstones, which comprise over 50 percent of the material. They also occur as lenticular bodies and may be seen grading into siltstones at one extreme and into conglomerates at the other (Bechtel Corporation 1961). The Valley Springs Formation consists of interbedded fluvial deposits (siltstone, sandstone, and conglomerate) and rhyolitic tuffs. Beds within the Valley Springs Formation are relatively continuous laterally. For about 366 meters (1,201 feet) across the floodplain, the upstream and downstream shells of the Main Dam are founded on dredge tailings, specifically reworked river sands, and gravels (Rizzo Associates, Inc.2018).

Downhole seismic velocity measurements were collected from 18 wells at the Main Dam, Dike No. 2, and Dike No. 5 (Terra/GeoPentech 2010). Sixteen of these wells collected data in the Mehrten and Valley Springs formations, which in many cases were overlain with older alluvium or dredge tailings. For most wells, single shear-wave velocity (V_S) values were reported for each formation. The downhole measurements sampled the two formations over thicknesses ranging from about 1 to 27 meters (3 to 89 feet), with an average of 9.5 meters (31 feet). For the purpose of calculating a time-averaged shear-wave velocity in the upper 30 meters (98 feet) (V_{S30}), it was assumed the reported V_S values extend to 30 meters (98 feet). The average V_{S30} of the Mehrten and Valley Springs formations is about 760 m/sec (2,493 ft/sec), and a summary of the approximate shear-wave velocities for each principal material is shown in Table 4.2-1.

Table 4.2-1. Summary of shear-wave velocity layers (Terra/GeoPentech 2010, Volume 2).

Geologic Unit	Approximate Shear-wave Velocity Range (ft/sec)
Dam Embankment (Main Dam and Dike No. 2)	1,160 to 1,420 (660 upper 13-ft of Well DH-8)
Dredge Tailings (Toe Main Dam)	500 to 1,190
Dredge Tailings (Well DH-8 - Main Dam)	1,780
Foundation Alluvium/Fine Tailings (DH-8 - Main Dam)	980
Older Alluvium (Dike No. 2)	690 to 1,330
Mehrten Formation (Main Dam and Dike No. 2)	1,370 to 3,640
Valley Springs Fm (Dike No. 5)	2,370 to 3,810

4.2.3 MINERAL RESOURCES

The California Department of Conservation's Division of Mine Reclamation compiles data on the current status of mines and the commodities produced, and the California Geological Survey (CGS) produces Mineral Land Classification studies that identify areas with potentially important mineral resources that should be considered in local and regional planning (CGS 2025). At least six Mineral Land Classification area studies have been undertaken in and adjacent to the Project area, including O'Neal and Gius (2018), Loyd (1983), Loyd and Kohler (1987), Busch (2001), Smith and Clinkenbeard (2012), and Taylor et al. (1993). The studies identified mineral resource zones (MRZs) in and adjacent to the Project area, MRZ-1 through MRZ-4. Several of the identified areas are considered "regionally significant" mineral resources (MRZ-2) as defined in Sections 2761(a) and (b) and 2790 of the California Surface Mining and Reclamation Act of 1975 (California Department of Conservation 2020). There is history of gold, copper, diamonds, mercury, tungsten, and other minerals mining in the Mokelumne River watershed and surrounding area (O'Neal and Gius 2018; Loyd 1983; Loyd and Kohler 1987; Busch 2001; Smith and Clinkenbeard 2012; Taylor et al. 1993); however, the CGS and USGS Mineral Resources Data System (MRDS) do not provide detailed information about the current status of these historical mines (CGS 2025; USGS 2025).

4.2.4 PROJECT AREA SOIL TYPES

Elevations in the Mokelumne River watershed range from El. 235 feet (Project Datum) at Camanche Dam to over El. 10,000 feet along the crest of the Sierra Nevada. Average basin slopes range from about 20 to 60 percent. The basin is underlain predominately by igneous and metamorphic rock structures with massive granitic outcroppings visible in the upper third of the basin and metamorphic rocks of sedimentary and volcanic origin over the remainder of the area.

Soils found in the Main Stem Mokelumne River sub-watershed (1804001208) consist of generally shallow to moderately deep, medium-textured, and stony soils. Most are weathered from fractured metamorphic rocks and granite. Deep loamy soils have developed on gently rounded ridges underlain by granitic rocks, on occasional gently sloping tabletop ridges underlain by volcanic flow deposits, and on sharp ridges underlain by schists and slates. The three soil associations below are present within the lower watershed. (EBMUD 2020)

> ***Auberrv-Ahwahnee-Sierra Association:*** These soils are well-drained coarse, sandy loams and sandy loams formed in materials weathered from granitic rocks. The Auberry Series is generally found at elevations between El. 700 and 1,800 feet where granite is between 40 and 60 inches deep. The Ahwahnee Series are coarse,

sandy loams to very rocky, coarse, sandy loams located where granite bedrock lies 24 to 40 inches deep, between 500 to 2,500 feet elevations. The Sierra Series are found at elevations between El. 1,000 and 2,000 feet where the underlying granite is from 40 to 60 inches deep.

Auburn-Argonaut Association: These soils consist of well-drained silt loams to gravelly loams, formed in materials weathered from basic and metasedimentary rocks characteristic of this association. The Auburn Series is a heavy subsoil variant consisting of cobbly, clay loam. It has formed 8- to 27-inch soil layers above vertically tilted schists and associated rocks of the Calaveras Formation at elevations between El. 1,000 and 1,700 feet. The Argonaut Series have formed over metabasic or basic rocks.

Boomer-Auburn Association: These soils consist of well-drained silt loams and gravelly loams formed from weathered basic igneous rocks or metasedimentary rocks. The Boomer Series is a very rocky loam ranging from 24 to 52 inches thick above basic schists at El. 1,000 to 3,500 feet. The Auburn Series is a heavy subsoil variant consisting of cobbly, clay loam. It lies in 8- to 27-inch layers above vertically tilted schists and associated rocks of the Calaveras Formation at elevations between El. 1,000 and 1,700 feet.

There is a wide variety of soils in the basin, but drainage characteristics are less variable. Most of the basin soils predominantly fall into the National Resource Conservation Service (NRCS) Hydrologic Soil Groups (HSG) C and D, indicating relatively poor drainage, though there are pockets of more well-drained soils, as shown in the Lower Mokelumne River Project area in Figure 4.2-2 (Esri 2020; NRCS 2020). Table 4.2-2 shows the percentages of each HSG within the Mokelumne River watershed.

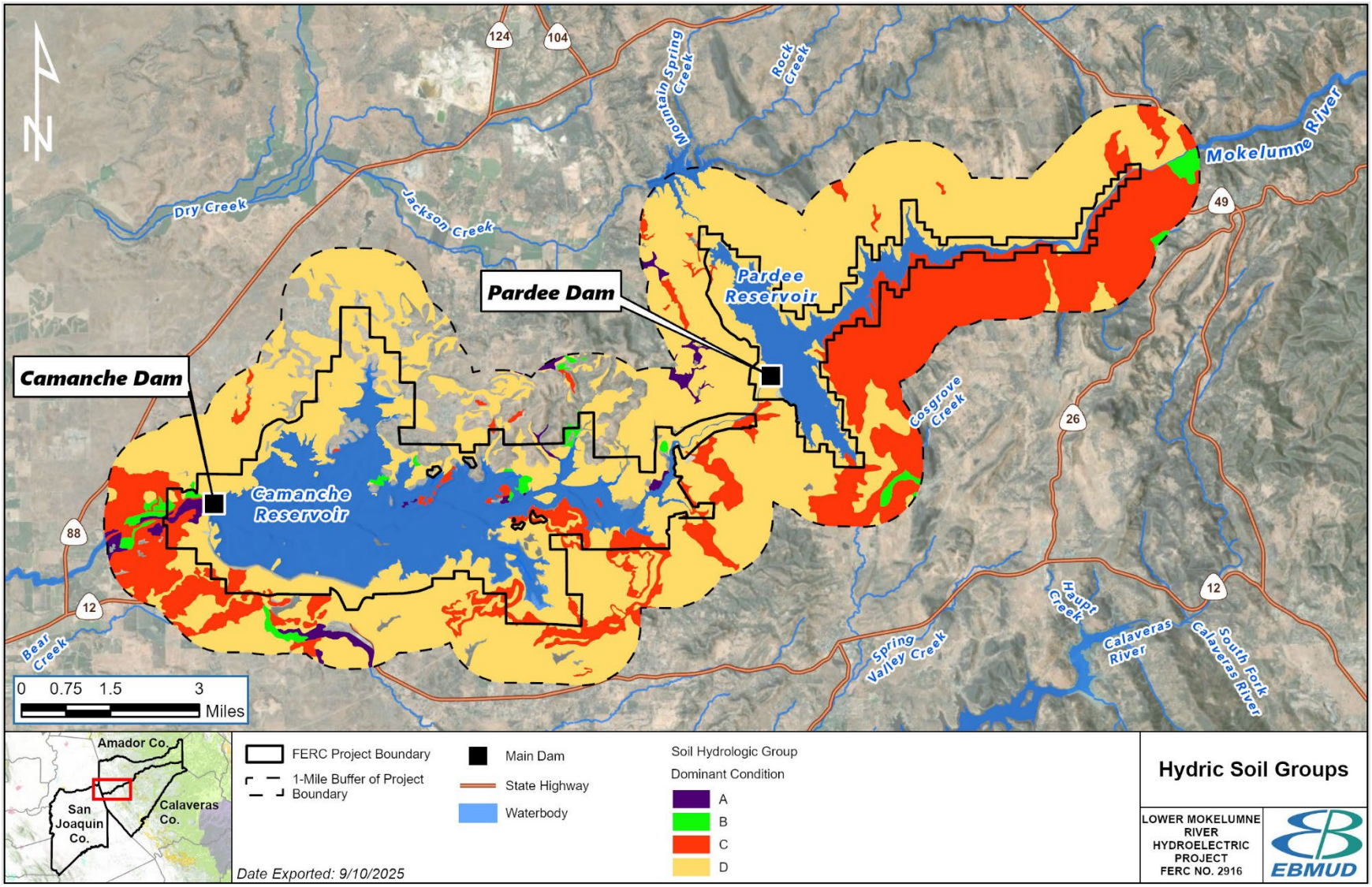


Figure 4.2-2. Lower Mokelumne River Project Hydric Soil Groups.

Table 4.2-2. Hydrologic Soil Group percentages in the Mokelumne River watershed.

Hydrologic Soil Group	Description	Percentage
A	Low runoff potential when thoroughly wet.	19.0
B	Moderately low runoff potential when thoroughly wet.	20.3
C	Moderately high runoff potential when thoroughly wet.	18.2
C/D	Moderately high runoff potential when thoroughly wet, when drained; high runoff potential when thoroughly wet, when undrained.	1.8
D	High runoff potential when thoroughly wet.	40.7

4.2.5 RESERVOIR SHORELINES AND STREAM BANKS

Pardee Reservoir shoreline generally has little vegetation coverage with minimal unconsolidated soil deposits underlain by varying highly weathered bedrock formations and features minimal to imperceptible erosion over its nearly 100 years of operations (see Figure 4.2-3). There is no known shoreline slumping, debris flow, or other mass movement. The shoreline slopes are at a roughly 30- to 50-percent grade (see Figure 4.2-4 and Figure 4.2-5), based on a 2014 bathymetric survey (EBMUD 2014b) and aerial photogrammetry mapping from a 1977 drought year. Within the original Mokelumne River valley upstream of Pardee Dam, the cross-section has side slopes of approximately 210 to 240 percent (see Figure 4.2-6). There have been no known issues around the reservoir shoreline and stream banks in the past nearly 100 years of operations.

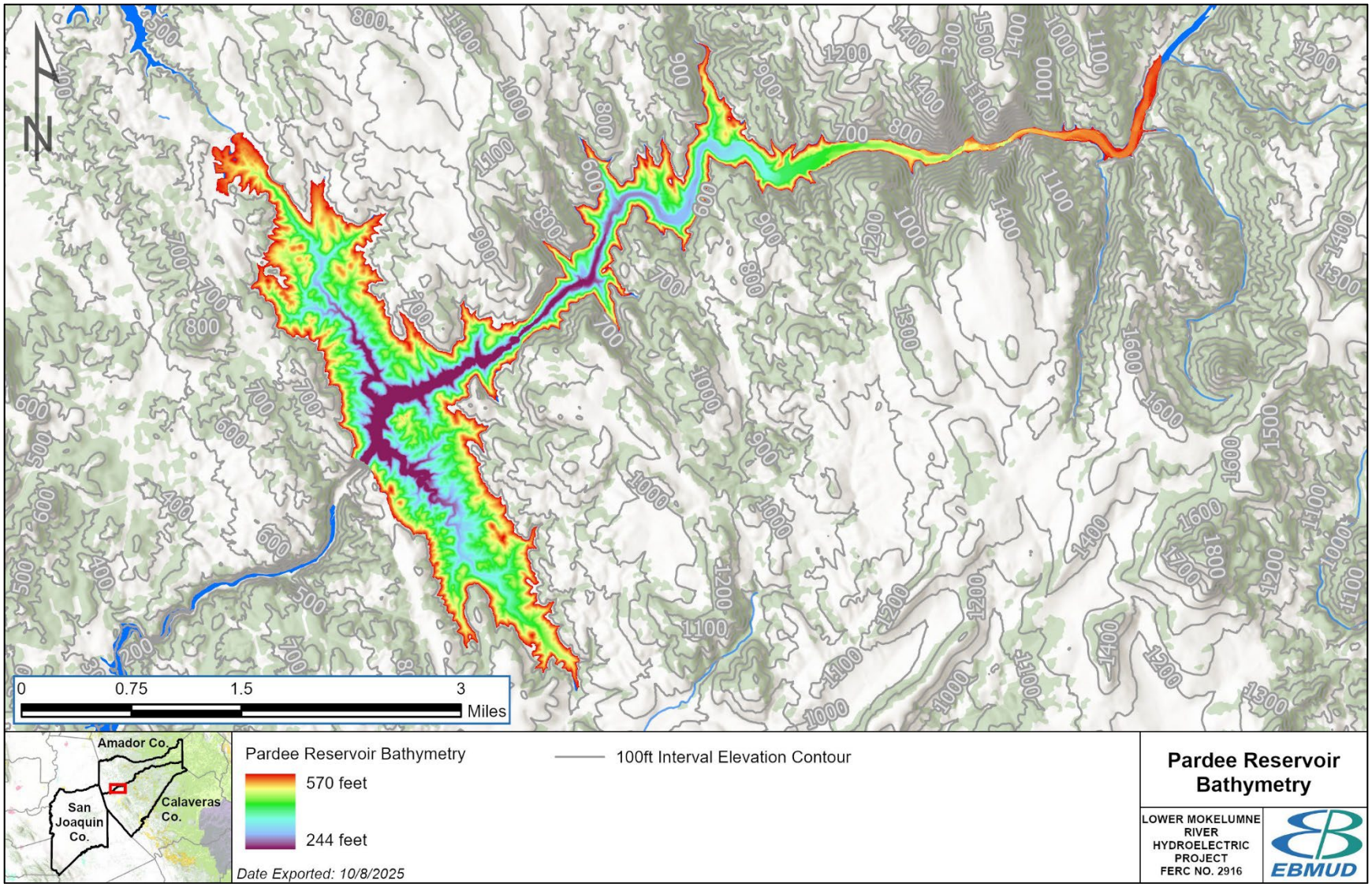


Figure 4.2-3. Pardee Reservoir bathymetry.

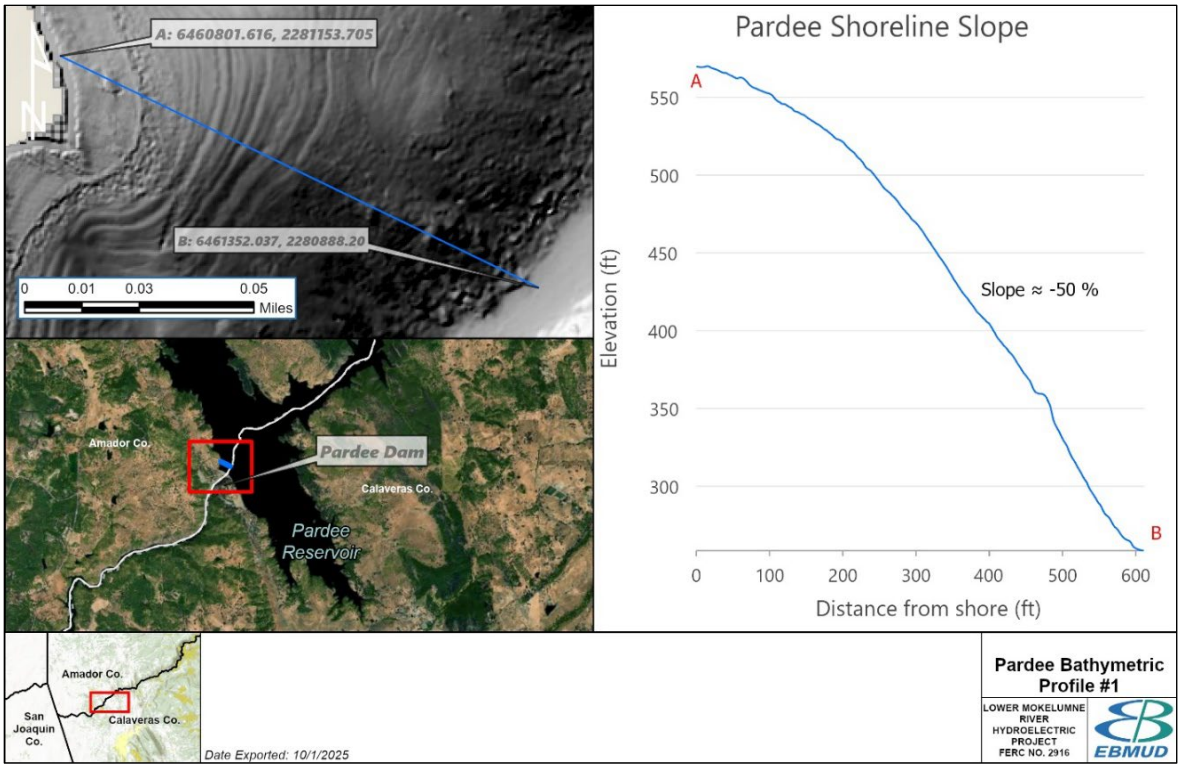


Figure 4.2-4. Pardee Bathymetric Profile 1.

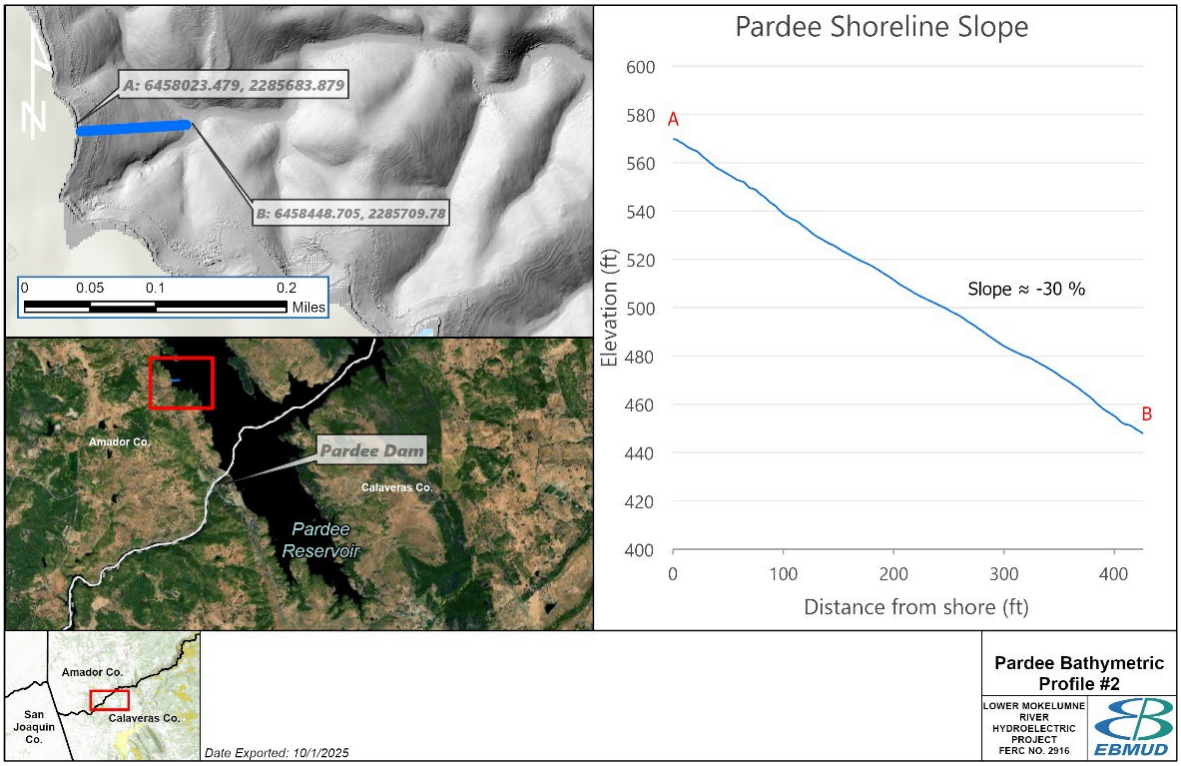


Figure 4.2-5. Pardee Bathymetric Profile 2.

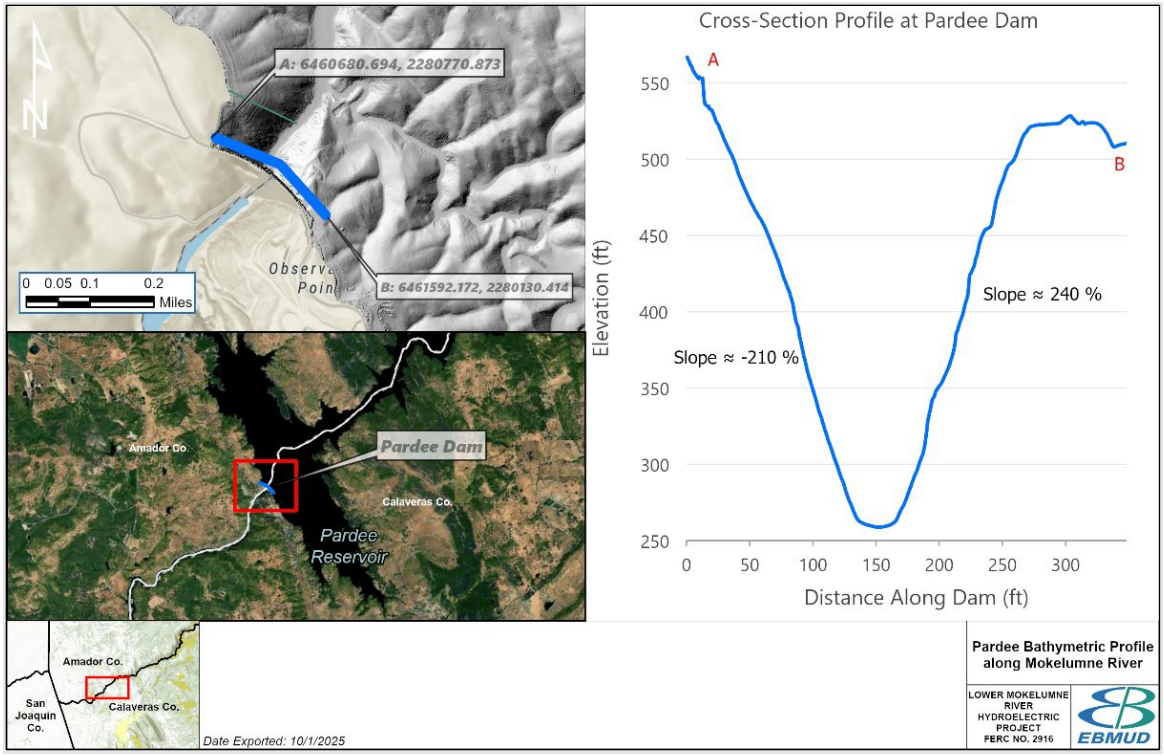


Figure 4.2-6 Pardee bathymetric profile along Mokelumne River.

Camanche Reservoir is located at the margins of the Central Valley and Sierra Foothills and consequentially features alluvial deposits washed down from the Sierra Nevada and erosion of the formational materials in the vicinity (see Figure 4.2-7). The reservoir basin of Camanche is significantly flatter than Pardee. In the area of the Main Dam and Dike Nos. 1 through 6, the crest-level shoreline is generally outcrops of Mehrten Formation. The shoreline has slopes of approximately 5 to 15 percent, with localized steeper banks formed by Mehrten bedrock outcrops at approximately 20 to 25 percent (see Figure 4.2-8). The shoreline generally has little vegetation, in part due to relatively transient reservoir levels. There have been no known issues of instability associated with the shoreline or embankment dam and dikes.

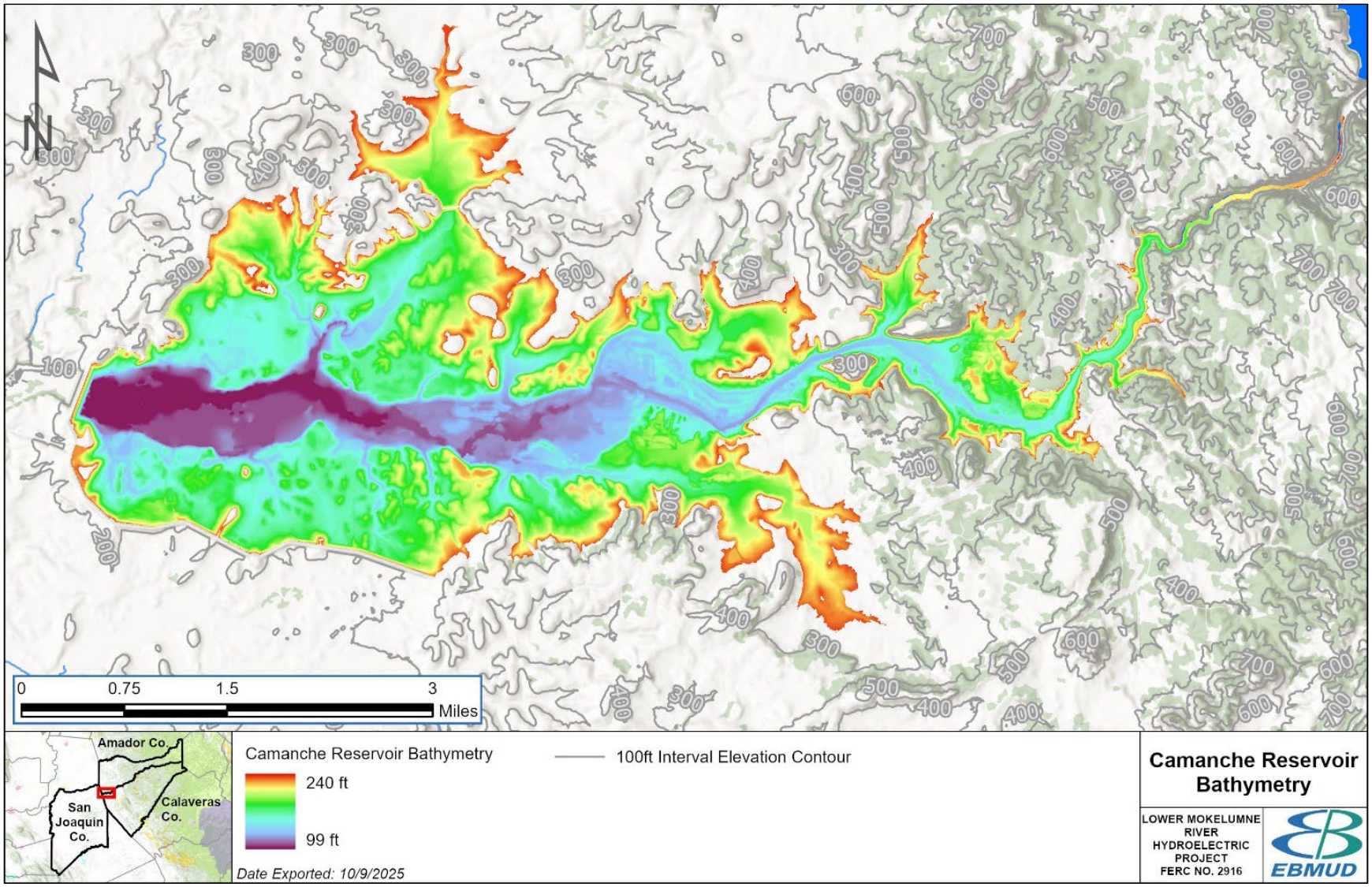


Figure 4.2-7. Camanche Reservoir bathymetry.

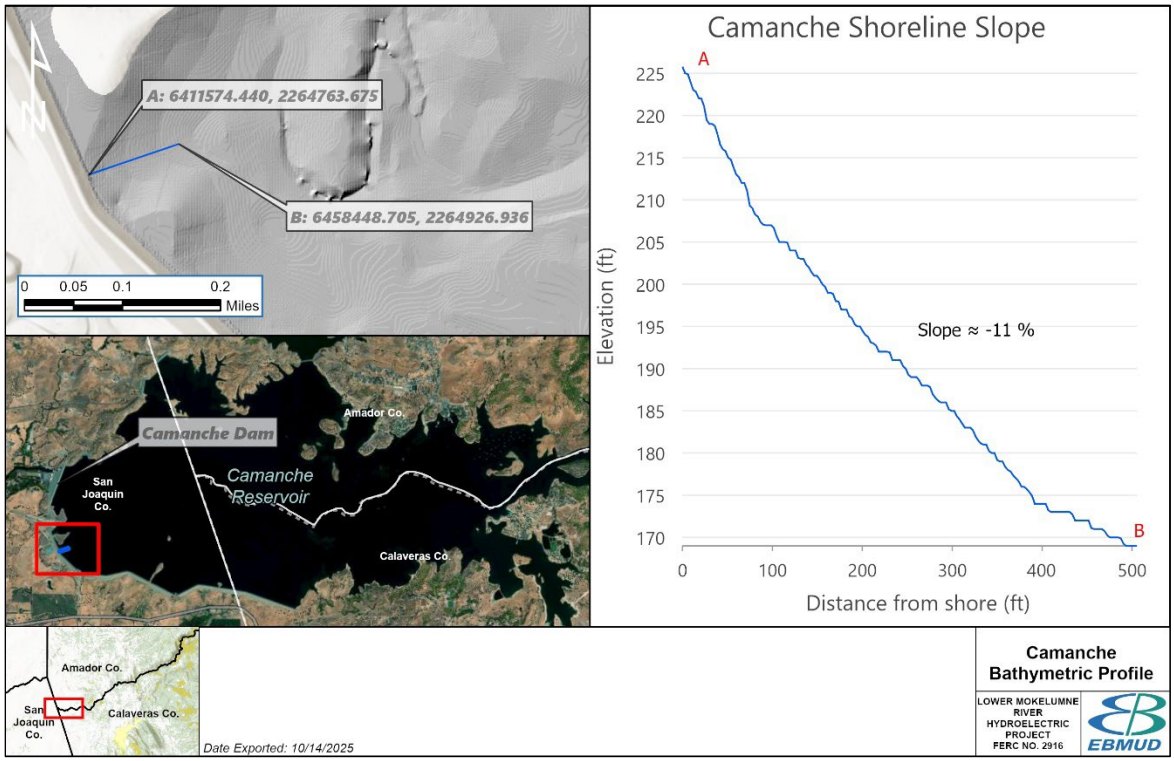


Figure 4.2-8. Camanche Reservoir shoreline slope.

4.2.6 SEISMICITY

The Pardee and Camanche dams are located in a region characterized by a relatively low-level of historical seismicity, though seismographic coverage of the region is far less than in coastal California (AECOM 2024). Seismic events within 50 kilometers (31 miles) of Pardee and Camanche dams have been recorded since 1869 (AECOM 2024). The largest of these was the 1986 duration magnitude (M_d) 3.2 event, which occurred 49 kilometers (30 miles) west of Camanche Dam. The closest recorded event is the 1986 M_d 2.5 event, 9 kilometers (6 miles) east of the dam. Within 100 kilometers (62 miles) of the dam, 8 events with a magnitude (M) ≥ 5.0 and 3 events M ≥ 6.0 have been recorded, all of which have occurred to the west of the dam in the San Francisco Bay Region.

Fourteen events have been recorded since 1869 near the site of Camanche Dam. The largest of these was the 2003 M_d 3.5 event, 47 kilometers (29 miles) northwest of the dam. The closest recorded event is the 1989 M_d 2.7 event, 25 kilometers (16 miles) southeast of the dam. Within 100 kilometers (62 miles) of the dam, 11 events M ≥ 5.0, and 4 events M ≥ 6.0 have been recorded, all of which have occurred to the west of the dam in the San Francisco Bay Region. The largest event recorded within 100 kilometers (62 miles) of either dam was the 1892 M 6.5 event, 96 kilometers (60 miles) west-northwest of Pardee Dam and 88 kilometers (55 miles) west-northwest of Camanche Dam (Figure 4.2-9).

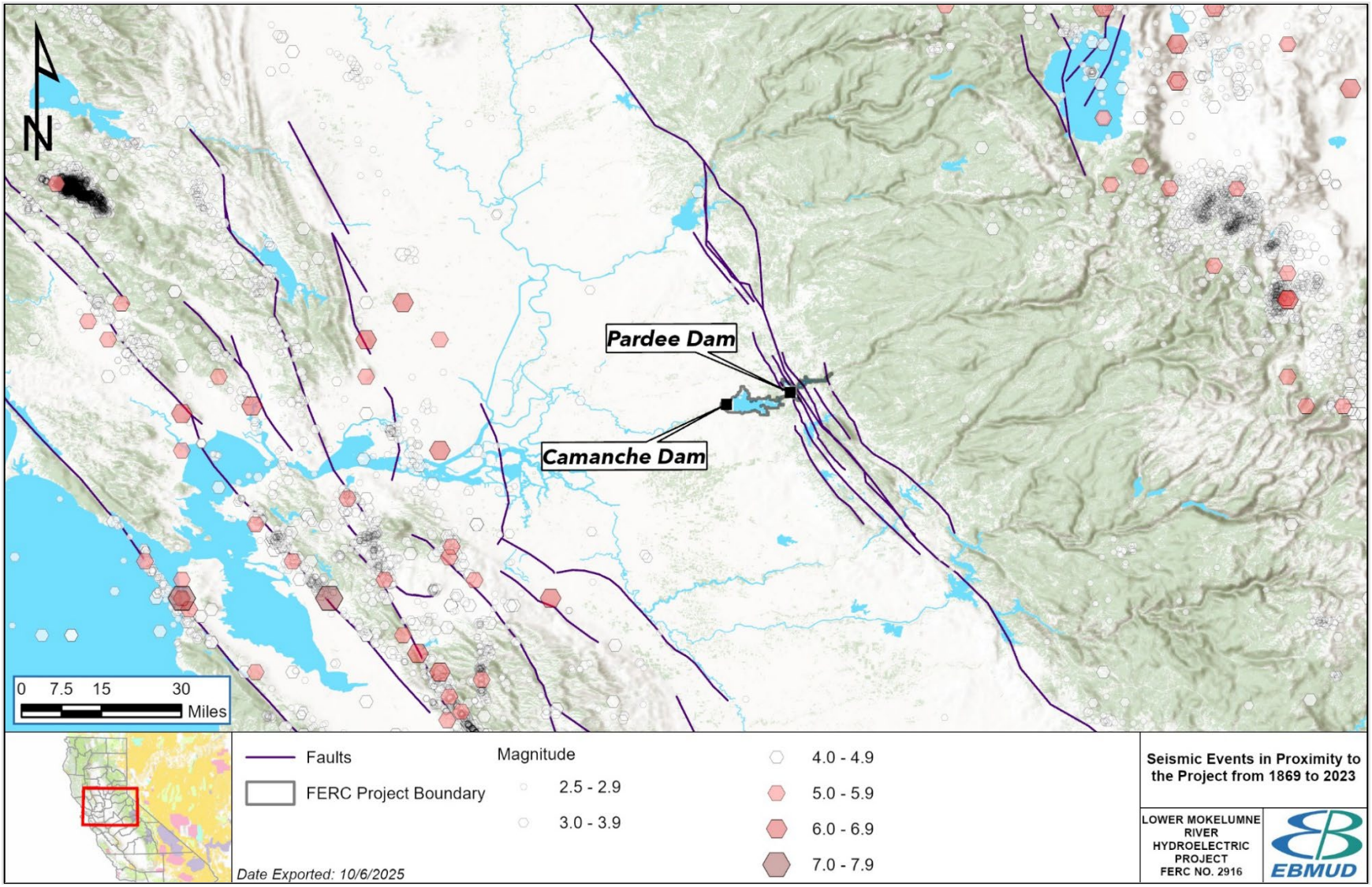


Figure 4.2-9. Seismic events recorded near the Project area from 1869 to 2023.

In the vicinity of Pardee Dam, the Foothills fault system (Figure 4.2-10) consists of the Melones fault zone (Haupt Creek, Devils Gate, and Poorman Gulch faults to the east) and the Bear Mountain fault zone (Ione, Waters Peak, and Youngs Creek faults to the west) (Clark 1960). These fault zones are up to 5 kilometers (3 miles) wide and are developed mainly within rocks of ophiolitic origin. Pardee Dam and Reservoir are intersected by, or are in relative proximity to, multiple fault traces associated with both the Bear Mountain fault and Melones fault zones.

The Foothills fault system formed in response to eastward convergence and subduction during Mesozoic time (Clark 1960). The fault zone is largely composed of Mesozoic structures that have not been active in Cenozoic time. Although originally developed as reverse faults associated with convergence, the late Cenozoic faults exhibit primarily normal dip-slip motion in response to tectonic extension (LaForge and Ake 1999). Earthquake focal mechanisms also indicate extensional stresses along the Sierra Foothills (Lahr et al. 1976). Page and Sawyer (2001) estimated that about 1 to 2 millimeters per year (0.04 to 0.08 inches per year) of dextral shear are also accommodated by faulting within the central Sierra Nevada, and some of the more westerly-striking faults within the Foothills fault system are dextral-oblique.

Segments of the Foothills fault system have been reactivated since the Late Miocene to Pliocene with onset estimated approximately 3 to 7 million years ago, a period temporally coincident with interpreted late-stage uplift and westward tilting of the Sierra Nevada (Unruh 1991; Zandt et al. 2004; Wakabayashi 2013; Wakabayashi and Kemp 2015). The closest reaches of the Mesozoic Melones and Bear Mountain fault zones to Pardee Dam that exhibit clear evidence for late Cenozoic reactivation are based on vertically displaced Miocene to Pliocene volcanic flows and fault trenching (Busby et al. 2008; USACE 1995). Late Cenozoic faults that offset the Miocene-aged Valley Springs and Mehrten formations in the vicinity of Pardee Dam include the Waters Peak, Youngs Creek, Haupt Creek, and Poorman Gulch faults along the Bear Mountains fault zone (WCC 1978; HCG 1998) . These faults vertically offset the surface of these volcanic flows and deposits and are interpreted as steeply east-dipping, down-to-the-east normal faults (WCC 1978) with a possible dextral (right-lateral) slip component (HCG 1998). Extensive paleoseismic investigation by WCC (1978) and USACE (1995) revealed that a soil horizon, referred to as the “paleo B” horizon, is commonly deformed along some of these fault segments. This soil horizon is estimated to have formed approximately during the mid to late Quaternary (likely prior to 100,000 years ago). If this age determination is correct, then some of these fault segments may have been active in late Quaternary time.

Recently, LCI (2020) performed a Foothills fault system study for Pardee Dam. This included three paleoseismic trenches of the Waters Peak fault near Pardee Dam. Based on this study and field investigations of other nearby faults, LCI (2020) developed a hazard input document (HID) for seven segments of the Foothills fault system (Figure 4.2-10). The characterization of these additional segments was adopted from Anderson and Ake (2008). The segments most important to the seismic hazard at Pardee and Camanche dams are summarized below from LCI (2020).

4.2.6.1 WATERS PEAK – GREEN SPRINGS RUN FAULT

The Waters Peak fault represents one of the western-most faults comprising the Bear Mountain fault zone and is defined by a prominent northwest-trending lineament. The fault trace is located 0.2 kilometers (0.1 mile) west of Pardee Dam and 14.5 kilometers (9 miles) east of Camanche Dam. The Waters Peak fault is modeled as a 62-kilometer (39-mile) fault from north of Pardee Reservoir to approximately 5 kilometers (3 miles) south of Table Mountain, based on a connection with the Green Springs Run fault, a similarly active late Cenozoic structure along strike to the southeast without significant steps, bends, or structural complexities. The Waters Peak fault is well expressed in the Mokelumne River gorge and Pardee Dam spillway, where it dips steeply to the east at 64° to 70°. This places Pardee Dam in the hanging wall, while Camanche Dam is in the footwall. The style of faulting across the Waters Peak fault in the current tectonic regime is east-down, strike-slip-normal oblique based on structural and stratigraphic evidence in trenches (LCI 2020).

Trenches across the Waters Peak fault at multiple locations between Pardee Dam and New Hogan Reservoir document offset of Miocene Mehrten Formation and offset of younger alluvium/colluvium interpreted to be middle to late Quaternary age (LCI 2020). However, it should be noted LCI's analysis of the trench exposures, together with a detailed review of earlier USACE (1995) results, indicates the Waters Peak fault is likely inactive per Division of Safety of Dams (DSOD) criteria for active faults in California (LCI 2020), that is, no evidence of rupture in the last 35,000 years. However, there is clear evidence of activity in the Quaternary, such that the fault could be labeled as conditionally active (DSOD 2018).

4.2.6.2 IONE FAULT

The Ione fault is located approximately 1 kilometer (0.6 mile) west of Pardee Dam and 13.9 kilometers (9 miles) east of Camanche Dam. It is recognized by its strong geomorphic expression as a southwest-facing scarp mainly north of the Mokelumne River. The 17-kilometer-long fault (11-mile-long) source extends from north of Dry Creek near Ione to a point directly north of the Mokelumne River. The southwest side down fault

places Pardee Dam in the footwall, while Camanche Dam is in the hanging wall. Estimates of vertical separation of the Ione Formation across the fault vary from about 150 to 250 meters (490 to 820 feet), to about 40 to 120 meters (130 to 390 feet) (LCI 2020). USACE (1995) trenched the Ione fault northwest of the Lake Amador spillway channel, and evidence of late Quaternary (Holocene) activity of the Ione fault could not be confirmed.

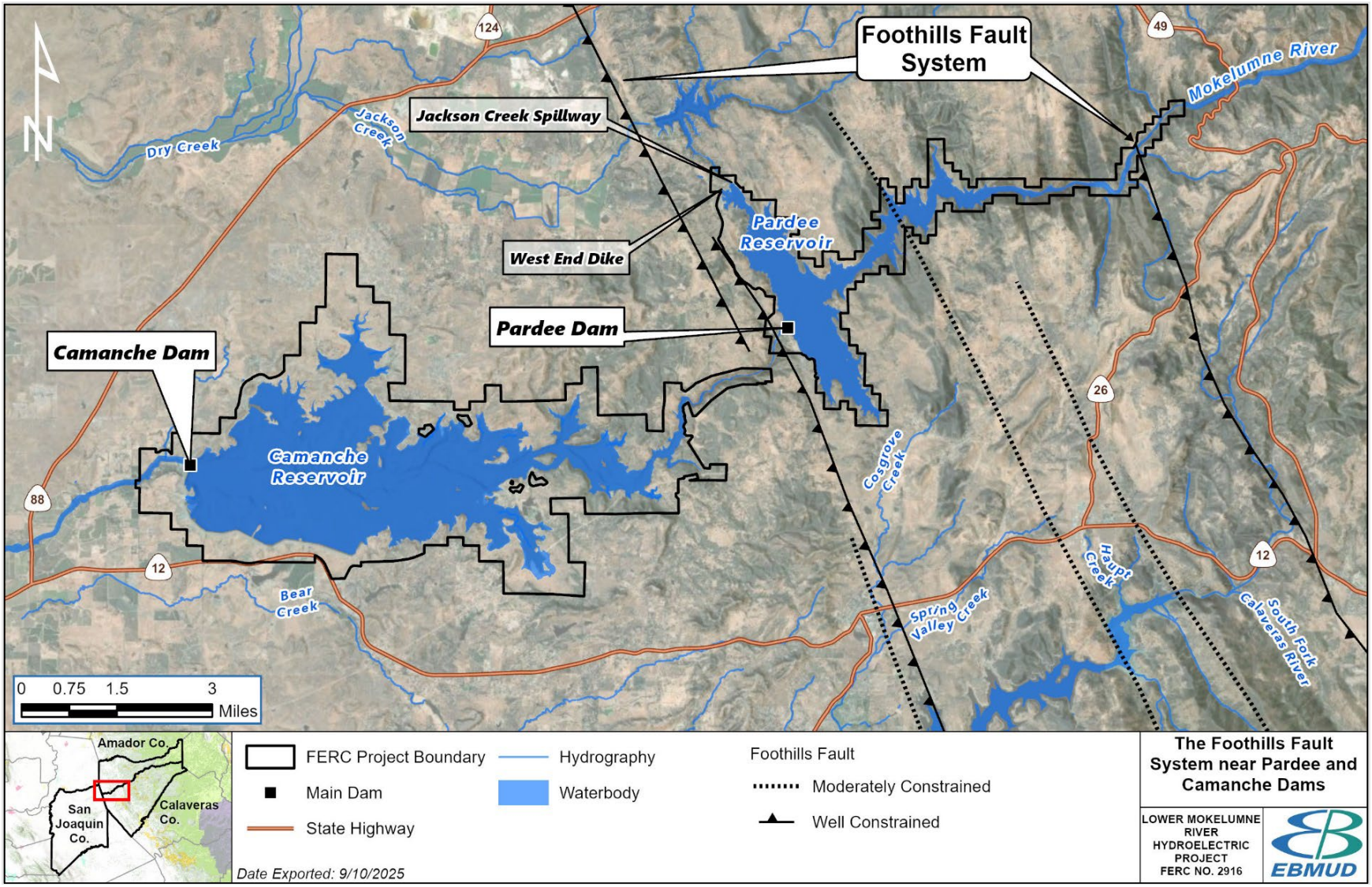


Figure 4.2-10. The Foothills fault system near Pardee and Camanche dams.

4.3 WATER RESOURCES

This section describes water use, hydrology, and water quality in the Mokelumne River, Pardee Reservoir, and Camanche Reservoir, as they relate to EBMUD's Lower Mokelumne River Project. FERC's content requirements for this section are specified in 18 CFR § 5.6(d)(3)(iii). Unless otherwise stated, elevations in this section refer to the respective Project Datum, as noted in Section 3.0.

4.3.1 DRAINAGE AREA

The Mokelumne River watershed lies on the western slope of the Central Sierra Nevada mountain range in Alpine, Amador, Calaveras, and San Joaquin counties in California and covers an area of 621 square miles from Camanche Dam to the headwaters of the basin near Highland Peak (USGS 2024a) (Figure 4.3-1). Elevations range from El. 235 feet at Camanche Dam to over 10,000 feet along the crest of the Sierras (mean = El. 4,963 feet [NAVD 88]; total relief = 10,249 feet; longest flow path = 99 miles). Most of the watershed consists of forested land within the El Dorado and Stanislaus national forests and is underlain predominately by igneous and metamorphic rock structures, with massive granitic outcroppings visible in the upper third of the basin and metamorphic rocks of sedimentary and volcanic origin over the remainder of the area. The North, Middle, and South forks of the Mokelumne River are the three main tributaries to the Mokelumne River, with the North Fork draining more than 60 percent of the basin. The three tributaries join and become the Mokelumne River approximately 10 miles upstream of Pardee Reservoir and flow southwesterly through the lower watershed, including Pardee and Camanche reservoirs, releasing to the basin outlet at Camanche Dam.

Downstream of Camanche Dam, the Lower Mokelumne River combines with Dry Creek, the Consumes River, and eventually the San Joaquin River in the Delta. The area of the Mokelumne River Basin at the Dry Creek confluence is 703 square miles with an average elevation of El. 4,403 feet (NAVD 88), minimum elevation of El. 7 feet (NAVD 88), total relief of 10,362 feet, and 135-mile-long longest flow path.

4.3.2 STREAM AND RESERVOIR GAGE DATA

4.3.2.1 STREAM GAGES

There are several stream gages upstream and downstream of the Project monitored by EBMUD; the stream gages shown in Figure 4.3-1 and summarized in Table 4.3-1 are used for the JSA and other water rights agreements, with the stream data from the gages validated by USGS. Inflows to the Project are measured at the USGS stream gage located a few miles upstream of Pardee Reservoir on the Mokelumne River near Mokelumne Hill (USGS Gage No. 11319500) (USGS 2024b).

Table 4.3-1. Project stream gages.

USGS Gage ID[a]	USGS Gage Name	Agency	Data Type	Period of Record[b]	Latitude	Longitude	Drainage Area (sq mi)	El. (feet, NAVD 88)
11319500 (R)	Mokelumne River Near Mokelumne Hill	USGS/ EBMUD	Flow	1928-2024	38.312778	-120.719167	544	587.8
11323500 (R)	Mokelumne River Below Camanche Dam	USGS/ EBMUD	Flow	1905-2024	38.226111	-121.023333	621	85.4
11325500 (R)	Mokelumne River at Woodbridge	USGS/ EBMUD	Flow	1924-2024	38.158611	-121.302500	661	17.5

[a] R corresponds to gage influenced by regulation.

[b] Period of record corresponds to water years.

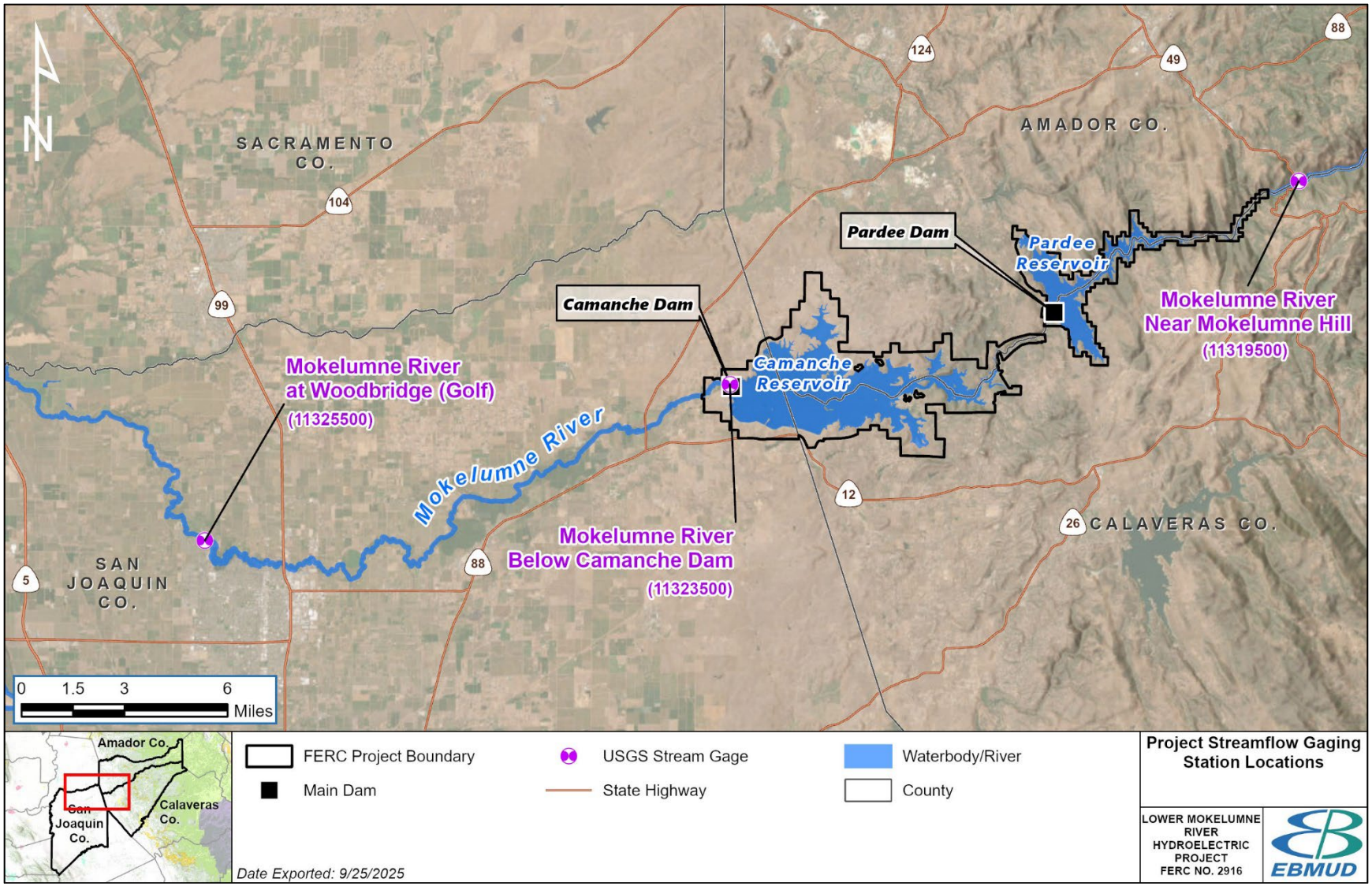


Figure 4.3-1. Project stream gage locations.

4.3.2.2 MONTHLY MINIMUM, MEAN AND MAXIMUM FLOW STATISTICS

Figure 4.3-2 shows the annual unimpaired Mokelumne River runoff computed near Mokelumne Hill (USGS Gage No. 11319500) from the measured regulated flow data, storage change and evaporation in PG&E reservoirs, and upstream diversions in the basin over the period of record (POR) since construction of Pardee Dam (1929–2024). Included are the corresponding April–September JSA year types as an indicator of the hydrologic variability in the Mokelumne watershed. Annual computed unimpaired inflows range from a low of approximately 129,200 acre-feet during the 1976/1977 drought to a high of approximately 1,929,500 acre-feet in 2017, with the long-term average slightly greater than 740,000 acre-feet over the POR. Looking at a 25-year running average, there are several instances where the average yearly unimpaired inflow peaked above and dipped below the long-term average, with the average over the last 25 years (2000–2024) dipping to approximately 723,600 acre-feet.

As described in earlier sections, several upstream dams and diversions from PG&E and other projects in the Mokelumne watershed regulate inflows to the Project. Figure 4.3-3 shows the difference between the computed unimpaired and regulated (observed) daily average inflows near Mokelumne Hill over the last 25 years. Regulated inflows to the Project tend to result in lower maximum flows during the winter rainfall and spring snowmelt seasons, with higher minimum flows in the summer months when the natural unimpaired flow of the river significantly diminishes. Monthly flow statistics summarizing the regulated inflows to the Project over the POR (1929–2024) of the gage near Mokelumne Hill (USGS Gage No. 11319500) are shown in Table 4.3-2. Maximum inflows occur January through June (monthly mean 948 to 1,778 cfs). Minimum inflows occur in August through November (monthly mean 556 to 570 cfs).

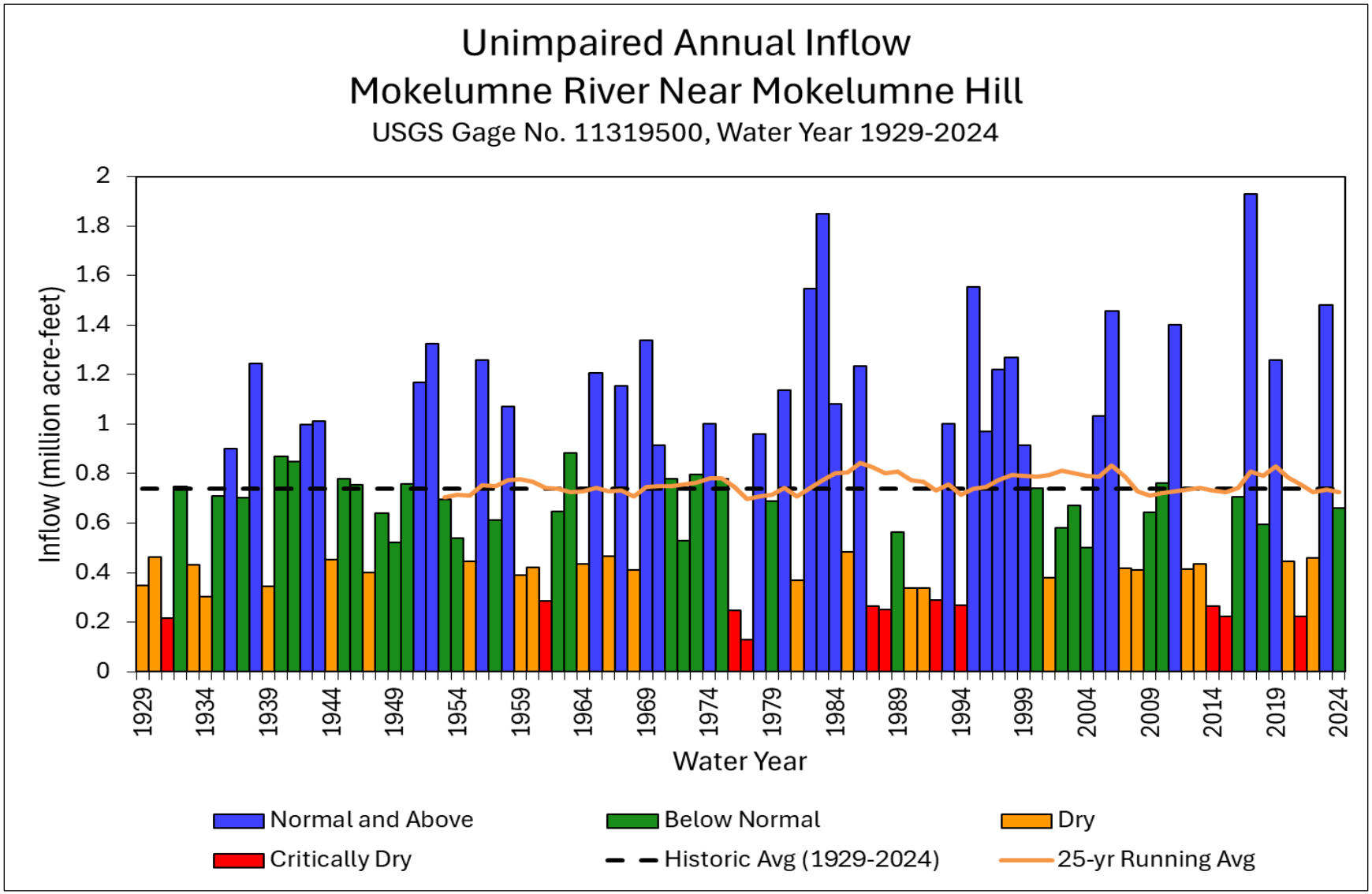


Figure 4.3-2. Computed unimpaired annual inflow near Mokelumne Hill.

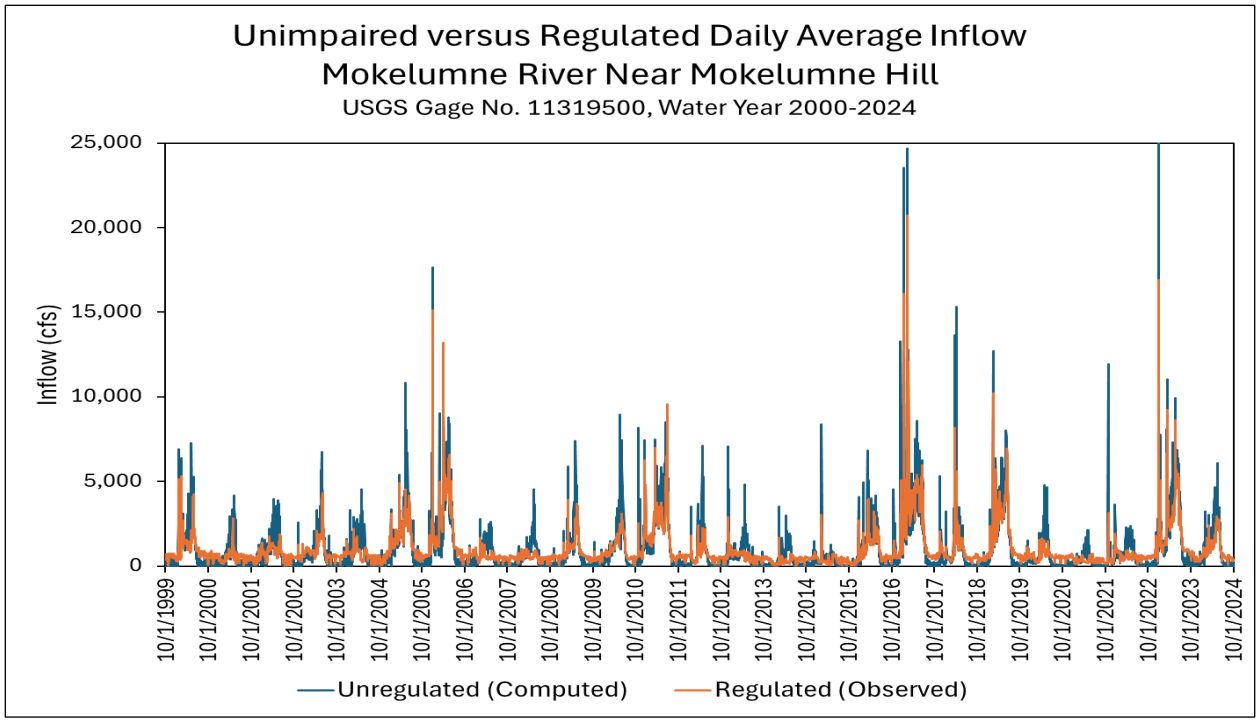


Figure 4.3-3. Unimpaired and regulated daily average inflow near Mokelumne Hill.

Table 4.3-2. Regulated monthly average, median, minimum, and maximum inflow near Mokelumne Hill (USGS Gage No. 11319500, Water Years 1929–2024).

Month	Average (cfs)	Median (cfs)	Minimum (cfs)	Maximum (cfs)
January	948	675	66	5,659
February	1,060	787	100	6,930
March	1,205	971	115	3,950
April	1,399	1,219	221	4,896
May	1,869	1,847	273	5,092
June	1,778	1,431	262	6,243
July	756	553	114	3,384
August	556	525	78	1,117
September	519	515	68	949
October	508	528	9	898
November	570	554	25	3,275
December	770	581	70	4,375

Additional time series plots showing the storage, power plant releases, and total outflows from Pardee and Camanche reservoirs over the last 25 years are shown in Figure 4.3-4 and Figure 4.3-5, respectively. Table 4.3-3 shows the average consumptive diversions from Pardee Reservoir into EBMUD's service area from 2007 to 2024. Table 4.3-4 summarizes the monthly releases from Pardee Reservoir into Camanche Reservoir over the period from 1985-2024 (CDEC 2025). Total outflow from Camanche Reservoir, including power plant and sluice releases measured at the USGS stream gage located on the Lower Mokelumne River below Camanche Dam (USGS Gage No. 11323500) (USGS 2024a), is shown in Figure 4.3-5. Monthly flow statistics summarizing the regulated outflows from the Project discharged from Camanche Reservoir from 1964 (construction of Camanche Dam) to 2024 are provided in Table 4.3-5.

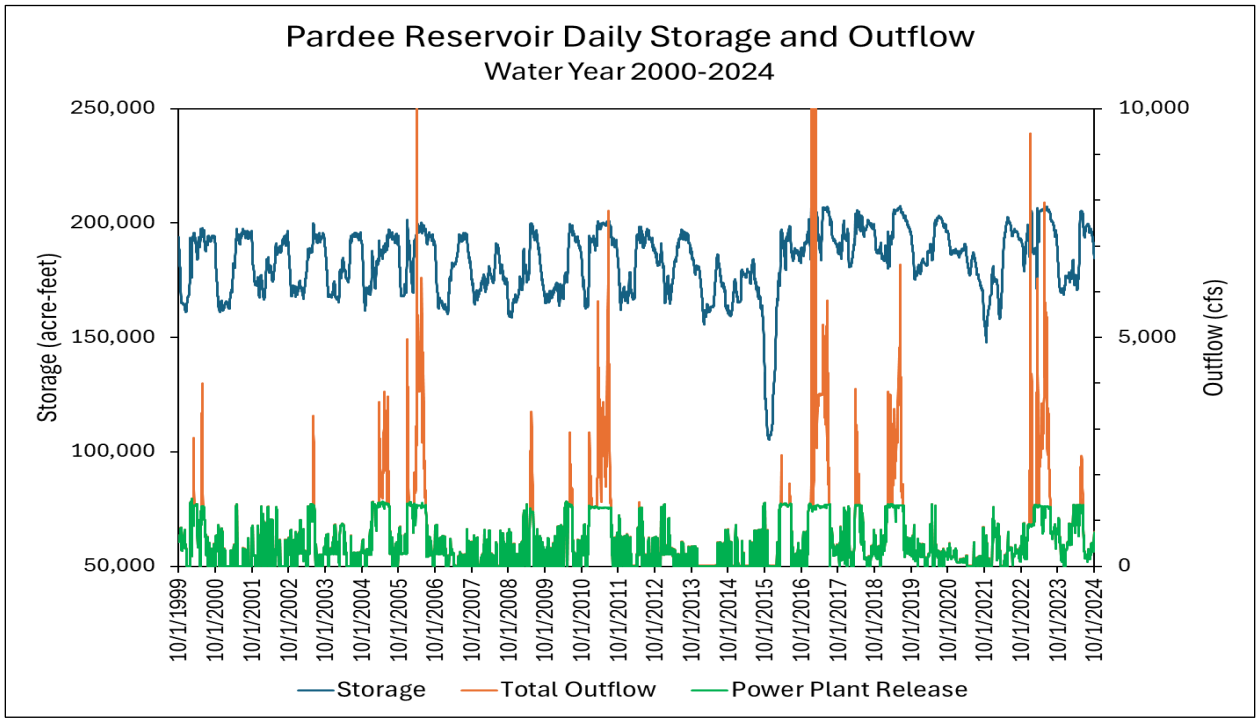


Figure 4.3-4. Pardee Reservoir daily storage and total outflow and power plant release time series.

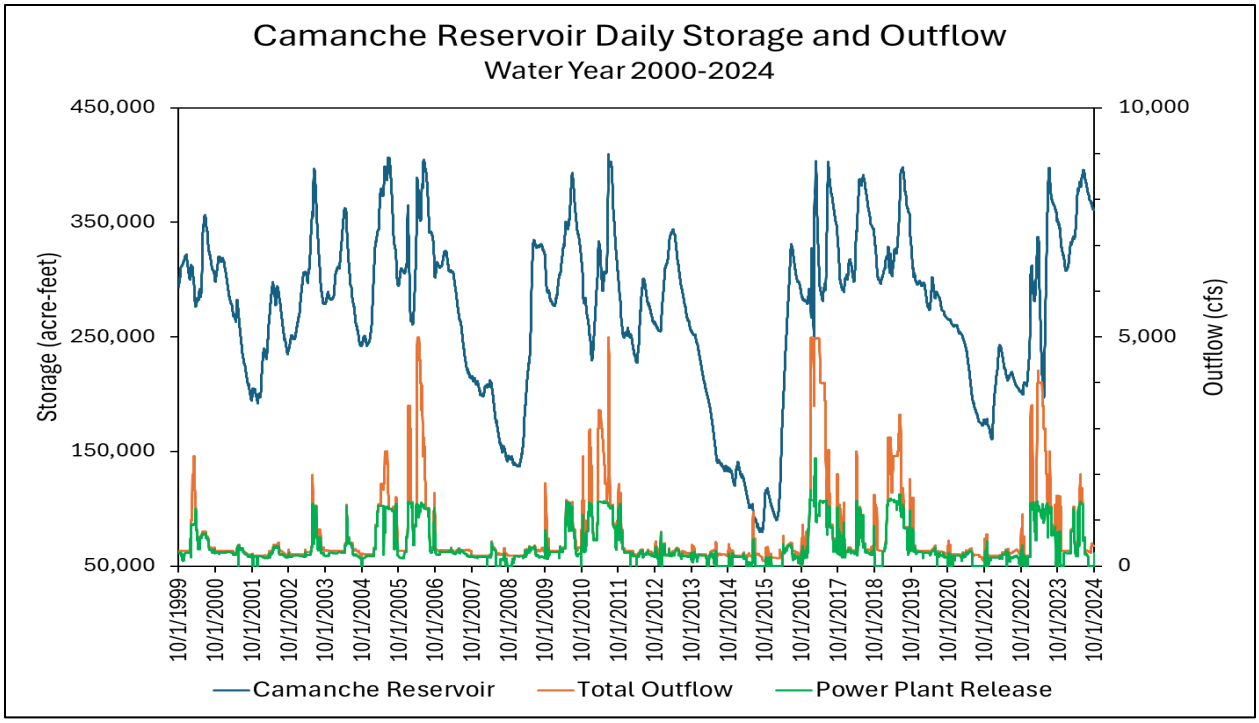


Figure 4.3-5. Camanche Reservoir daily storage and total outflow and power plant release time series.

Table 4.3-3. Monthly average, median, minimum, and maximum consumptive diversions from Pardee Reservoir (EBMUD, Water Years 2007–2024).

Month	Average (cfs)	Median (cfs)	Minimum (cfs)	Maximum (cfs)
January	5,975	6,190	1,647	10,193
February	5,316	5,352	149	8,421
March	6,841	7,415	811	9,074
April	7,135	6,866	4,239	11,480
May	7,453	7,479	4,123	9,217
June	8,034	8,105	4,245	14,409
July	8,498	8,770	4,487	11,855
August	8,043	8,441	4,502	11,800
September	7,881	8,325	4,098	10,933
October	7,509	7,979	4,399	9,461
November	6,503	7,141	2,785	8,647
December	6,603	6,982	2,584	8913

Note: Water Year 2024 data are from October 2023–June 2024.

Table 4.3-4. Regulated monthly mean, median, minimum, and maximum outflow from Pardee Dam (CDEC Station ID: MKM, Water Years 1985–2024).

Month	Mean (cfs)	Median (cfs)	Minimum (cfs)	Maximum (cfs)
January	930	706	80	4,170
February	974	716	259	6,329
March	1,298	910	258	3,535
April	1,435	1,058	107	4,655
May	1,747	1,306	338	4,630
June	1,534	785	317	4,734
July	722	505	280	2,449
August	513	493	210	932
September	468	478	187	860
October	466	491	143	739
November	524	539	163	914
December	738	593	222	2,061

Note: Data are provisional.

Table 4.3-6 and Figure 4.3-6 show the regulated daily flow time series measured at the USGS stream gage located approximately 26 miles downstream of Camanche Dam on the Lower Mokelumne River at Woodbridge (USGS Gage No. 11325500) (USGS 2024c). Outflows from Camanche are typically higher than measured flows at the gage at WIDD to meet expected instream flows as prescribed by the JSA (Section 3.0) after satisfying downstream senior water rights obligations and accounting for channel losses along the lower river between the gages.

Table 4.3-5. Regulated monthly mean, median, minimum, and maximum outflow below Camanche Dam (USGS Gage No. 11323500, Water Years 1964–2024).

Month	Mean (cfs)	Median (cfs)	Minimum (cfs)	Maximum[a] (cfs)
January	795	331	84	4,978
February	888	332	61	4,650
March	980	354	78	5,117
April	1,019	482	125	4,572
May	1,086	541	170	3,935
June	971	606	234	3,847
July	761	511	240	2,932
August	574	427	219	1,770
September	493	349	123	1,447
October	531	331	33	2,061
November	425	328	84	2,157
December	462	283	79	2,938

Notes:

[a] The monthly maximum outflow from Camanche in March occurred in 1986 following a large storm event in February. The stream gage below Camanche Dam at the time was located a short distance below the dam and included some local flows in addition to the outflows from Camanche. The actual maximum outflow from Camanche during this period was closer to 5,000 (5,005) cfs.

Table 4.3-6. Regulated monthly mean, median, minimum, and maximum Mokelumne River flow at Woodbridge (USGS Gage No. 11325500, Water Years 1964–2024).

Month	Mean (cfs)	Median (cfs)	Minimum (cfs)	Maximum (cfs)
January	751	268	33	4,746
February	815	276	20	4,655
March	825	245	9	4,767
April	815	190	9	4,179
May	791	209	9	3,869
June	603	271	8	2,736
July	391	53	9	2,561
August	236	46	7	1,462
September	235	88	5	1,067
October	383	190	2	1,716
November	379	281	23	1,979
December	412	247	39	2,825

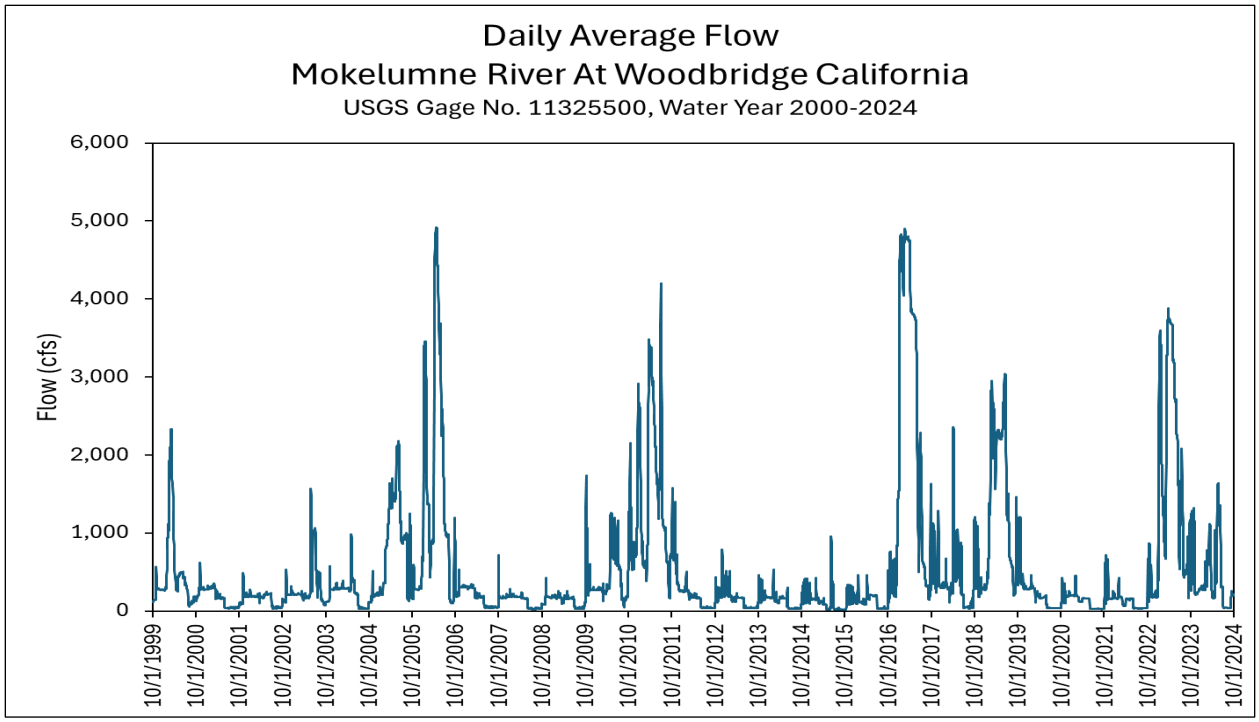


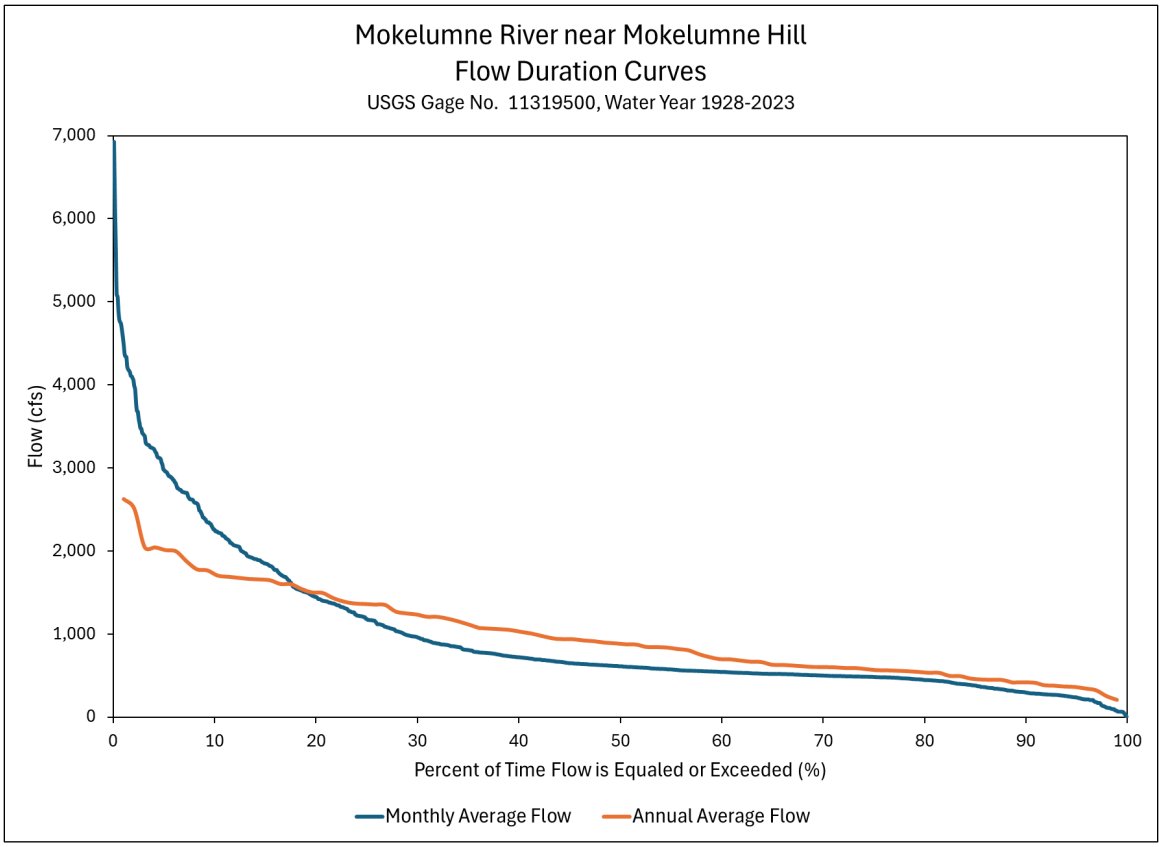
Figure 4.3-6. Daily flow time series Mokelumne River at Woodbridge.

4.3.2.3 FLOW DURATION CURVES AND CRITICAL STREAM FLOW TO DETERMINE DEPENDABLE CAPACITY

Monthly exceedance plots for the Mokelumne River inflow during the 1928–2023 POR and Camanche Reservoir outflow during the 1965–2024 POR for the Project are shown in Volume II – Appendix E. Figure 4.3-7 shows the annual average flow duration curves for the Project summarized from the USGS stream gage at Mokelumne River near Mokelumne Hill (USGS Gage No. 11319500) for Water Years 1928 to 2023 and for the Mokelumne River below Camanche Reservoir (USGS Gage No. 11323500) for Water Years 1965 to 2024.

The Project dependable capacity is discussed in Section 3.6. The Project utilizes storages that are managed year-round; therefore, the critical streamflow for determining critical capacity is not applicable here. Camanche has a minimum generation value of 0.8 MW/175 cfs, and Pardee has a minimum generation value of 5.5 MW/200 cfs. For Pardee and Camanche, the flow is approximate, as it changes with reservoir elevation.

Inflows at the Mokelumne River near the Mokelumne Hill gage (USGS Gage No. 11319500) and storage available in the reservoirs during 2015, as can be seen Figure 4.3-4 and Figure 4.3-5, are the best representation of water available in an adverse hydrologic year.



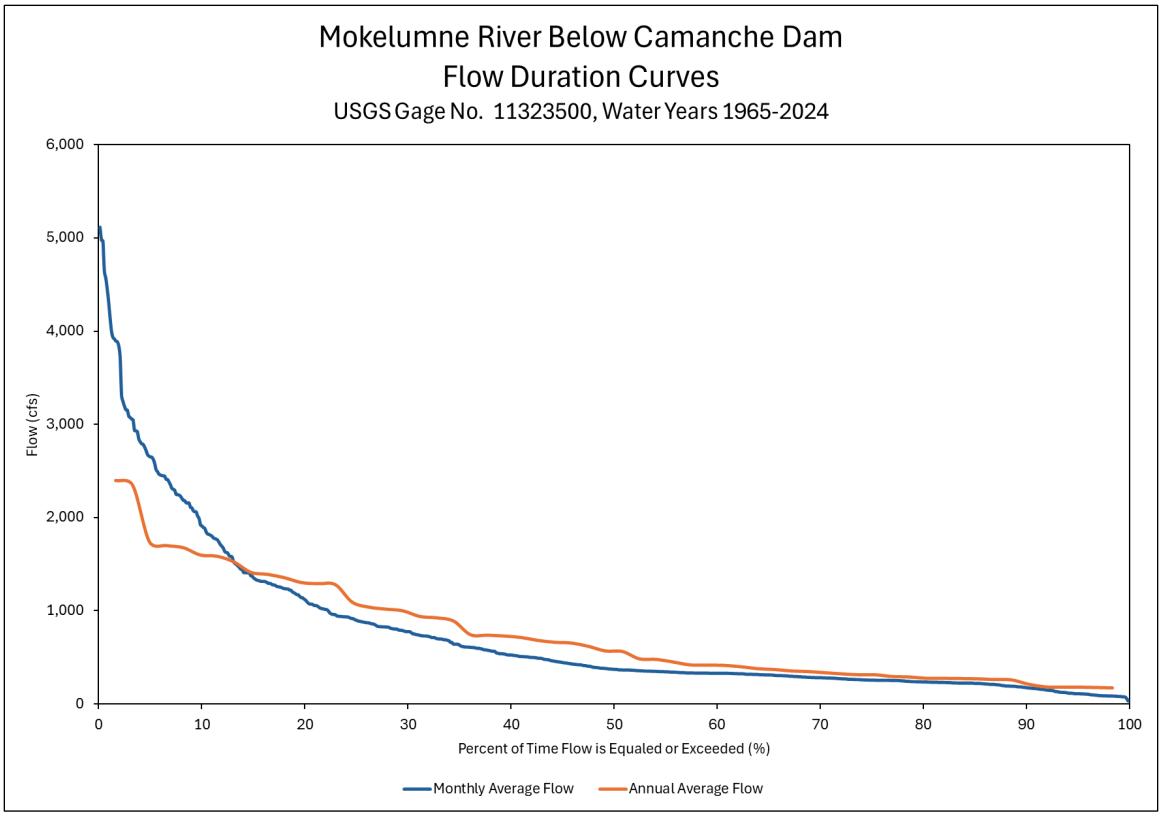


Figure 4.3-7. Mokelumne River flow duration curves.

4.3.3 EXISTING AND PROPOSED USES OF PROJECT WATERS

Existing beneficial uses of water Mokelumne River sources to Pardee Reservoir and the Lower Mokelumne River Project area include municipal and domestic supply, irrigation, stock watering, power, recreation contact and canoeing/rafting, recreation non-contact, warm and cold freshwater habitat, migration, and spawning wildlife habitat (Central Valley Region Water Quality Control Board [CVRWQCB] 2019). EBMUD does not propose to modify the existing uses of Project water.

These uses can be categorized into: consumptive, non-consumptive, and instream flow. They are discussed below. EBMUD maintains water rights for these Project uses as listed in Table 4.3-7, and general locations are shown in Figure 4.3-8.

4.3.3.1 CONSUMPTIVE USES OF PROJECT WATERS

This section discusses (1) existing uses of Project water for domestic water supply, irrigation, and other consumptive purposes, and (2) upstream and downstream requirements or constraints on those uses.

EBMUD Use of Project Water

Since the 1920s, EBMUD's primary source of water has been the Mokelumne River. EBMUD diverts Mokelumne River water for municipal and hydroelectric uses pursuant to a series of water rights. EBMUD also operates Pardee and Camanche reservoirs for other purposes, including fish and wildlife preservation and enhancement (Statement 21241), recreation in the reservoirs, and flood control.

The EBMUD water supply system collects, conveys, treats, and distributes high-quality water from its primary water source, the Mokelumne River, to its customers in the San Francisco East Bay Area. The Mokelumne Aqueducts convey the Mokelumne River supply from Pardee Reservoir across the Sacramento-San Joaquin River Delta to local storage and treatment facilities in the East Bay. After treatment, water is distributed to the incorporated cities and unincorporated communities in Alameda and Contra Costa counties that EBMUD serves.

Table 4.3-7. Summary of EBMUD existing water rights for the Project.

Facility	Water Right	Direct Diversion (DD)	Diversion to Storage (DS)	Total Annual Use (DD + WS)	Face Value
Pardee Dam	L11109	310 cfs (Jan 1–Dec 31)	209,950 AF (Oct 1 – Jul 31)	224,037 AF	316,250 AF
Pardee Dam & Powerhouse	L1388	375 cfs (Jan 1–Dec 31)		N/A	470,457 AF
	L6062	375 cfs (Jan 1–Dec 31)			300,194 AF
	P10479	350 cfs (Jan 1–Dec 31)	50,000 AF (Dec 1–Jul 1)		303,392 AF
	S20477 (Riparian)	TNF[a]	N/A		TNF[a]
Camanche Dam & Pardee Dam	P10478	194 cfs (Dec 1–Jul 1)	353,000 AF (Dec 1–Jul 1)	140,000 AF	434,962 AF
Camanche Dam & Powerhouse	P17378	1,200 cfs (Oct 1–Jul 31)		N/A	853,000 AF
	S24076 (Riparian)	TNF[a]	N/A	TNF[a]	TNF[a]
Mokelumne River Hatchery	S21241 (Riparian)				

AF = acre feet; TNF = true natural flow; N/A = not applicable

Notes:

[a] The maximum direct diversion rates are limited to the TNF of the Mokelumne River available at the point of diversion.

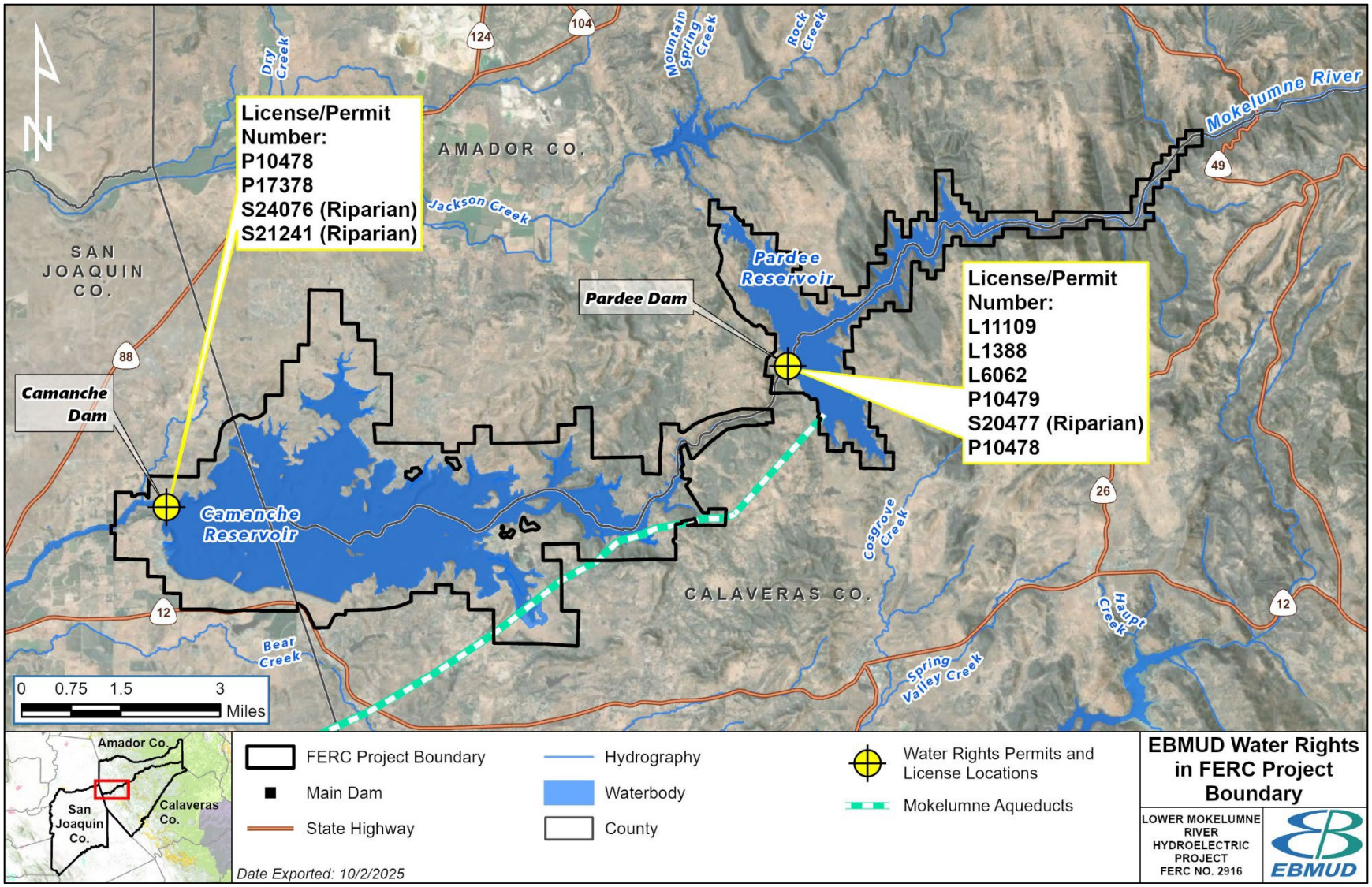


Figure 4.3-8. EBMUD water rights in FERC Project boundary.

Based on 2010 U.S. Census data and Association of Bay Area Government projections for 2040, approximately 1.4 million people are currently served by EBMUD's water system in a 332-square-mile area extending from Crockett on the north, southward to San Lorenzo and portions of Hayward (encompassing the major cities of Oakland and Berkeley), eastward from San Francisco Bay to Walnut Creek, and south through the San Ramon Valley (including Alamo, Danville, and San Ramon). EBMUD water customers include residential, industrial, commercial, institutional, and irrigation water users.

Based on the historical average, approximately 90 percent of the untreated water entering EBMUD's system originates from the Mokelumne River watershed. EBMUD operates the Project facilities (reservoirs, powerhouses, municipal diversions) in a coordinated manner as a single unified Lower Mokelumne River Project. EBMUD diverts its municipal water supply from Pardee Reservoir, while operating Pardee and Camanche reservoirs to generate power and concurrently make releases from Camanche Reservoir to satisfy downstream senior water rights holders, regulatory requirements (e.g., flood control), environmental obligations (instream flow, water temperature), and recreation. No changes are currently planned for existing Project water usage.

Operational Considerations

Factors that affect EBMUD's Mokelumne River use include:

- variability in rainfall and runoff,
- storage and minimum pool constraints,
- flood control requirements,
- water quality requirements,
- changes in timing and quantity of water by PG&E's upstream non-consumptive hydropower use,
- use by other Mokelumne diverters with senior water rights, upstream and downstream of the Pardee and Camanche dams,
- buffer losses, and
- instream flow requirements to protect fish.

The following sections describe these factors in greater detail.

Storage

Pardee Reservoir

As listed in Table 3.3-1, Pardee Reservoir has a gross storage capacity of 203,795 acre-feet at normal pool elevation of El. 567.65 feet and useable or operational storage capacity of 188,208 acre-feet.

From August 1 through September 30, water is not diverted to storage in Pardee Reservoir, other than temporary ponding of less than 30 days, consistent with the SWRCB 30-day rule. During the no-storage season, storage shall decline by at least evaporation.

Camanche Reservoir

As discussed in Section 3.3.7, Camanche Reservoir has a gross storage capacity of 417,120 acre-feet at normal pool elevation of El. 235.5 feet and useable or operational storage capacity of 416,696 acre-feet based on the elevation of the low-level outlet at El. 104 feet.

From July 2 through November 30, water is not diverted to storage in Camanche Reservoir, other than temporary ponding of less than 30 days, consistent with the SWRCB 30-day rule. During the season when storage is not permitted, storage will decline by at least evaporation.

Flood Control Requirements

EBMUD manages Pardee and Camanche reservoirs for flood control purposes per the USACE Flood Control Guidelines as described in detail in Section 3.5.3. EBMUD must begin to create flood control reservation in Camanche and/or Pardee reservoir(s) in mid-September of each year. By November 5, between 130,000 and 200,000 acre-feet of flood control reservation (depending on how full PG&E's upstream reservoirs are at the time) must have been created. The flood control reservation must be maintained, if possible, at least through mid-March, and potentially into July in years of heavy snow accumulation.

The flood control agreement with USACE provides a release schedule from Camanche Reservoir whenever encroachment into the flood control reservation occurs. The schedule specifies that the maximum release from Camanche Reservoir should be limited to 5,000 cfs, insofar as possible, and the rate of change in release shall not exceed 1,000 cfs per 2-hour interval.

Water Quality Management

Pardee and Camanche reservoirs are managed to maintain thermal stratification in Camanche Reservoir as late in the year as possible. The JSA requires EBMUD to “use its

best efforts to maintain Pardee and Camanche Reservoir stratification with a minimum of 28 TAF of hypolimnetic volume in Camanche Reservoir through October whenever Pardee Reservoir exceeds 100 TAF" (§F.5, p. 8). Stratification in Camanche Reservoir through the end of October is typically supported by releasing cold water from Pardee Reservoir when necessary and possible. Pardee Reservoir temperatures are monitored and managed through the summer to maximize cold water available for transfer in September/October.

The Hypolimnetic Oxygenation System (HOS), which feeds pure oxygen into the deeper, colder (hypolimnetic) portion of Camanche Reservoir, is designed to prevent the bottom waters from going anoxic, thereby preventing the natural formation of hydrogen sulfide (H_2S). The HOS is typically operated during the period from May through October, or until Camanche Reservoir becomes thermally destratified in the fall, when either: (1) the DO level in the Camanche Reservoir hypolimnion is *projected* to drop to 2 mg/L as measured near Camanche Dam (CAMD), or (2) when DO *drops* to 2 mg/L as measured at Camanche Valve House (CAMC).

Mokelumne River Water Users

EBMUD must release sufficient water to meet the needs of senior water users (i.e., entities or individuals with the oldest water right priority) and to meet fishery release requirements. Riparian landowners, who have rights that are tied to the river's natural flow, and other individuals and agencies with appropriative water rights that predate EBMUD's rights, have claims on the river that are senior to EBMUD's rights. Figure 4.3-9 provides a generalized overview of the Mokelumne River diversions. EBMUD ensures sufficient flows are available to meet senior downstream water rights.

Upstream Water Use

Streamflow in the Mokelumne River is modified by upstream diversions and regulated by reservoir storage operations for hydroelectric power generation and water supply. PG&E operates a network of storage reservoirs and diversion facilities on the North Fork. Upstream of Pardee Reservoir, water use includes use under senior water rights held by agencies in Amador and Calaveras counties, including AWA, CPUD, Calaveras County Water District (CCWD), and JVID. The rights of upstream diverters constitute a maximum diversion of approximately 47 TAF per year that is senior to the Pardee/Camanche water right permit (Permit 10478).

PG&E Hydroelectric Project

PG&E's Mokelumne Hydroelectric Project consists of seven storage reservoirs having a combined capacity of about 220,000 acre-feet, various canals, tunnels, stream diversions,

conduits, regulating reservoirs, and four powerhouses. Electric power generated from these facilities is used to serve PG&E customers in its Northern California service territory. PG&E's operating rules address the timing and quantity of their discharges into the Mokelumne River, which can have impacts upon EBMUD's exercise of its Pardee and Camanche water rights.

The PG&E project is operated within limits set by the following judgments and decrees:

1. City of Lodi, Plaintiff vs. East Bay Municipal Utility District, et al., Defendants. Judgment and decree No. 22415 of the Superior Court of San Joaquin County, dated March 14, 1938.
2. East Bay Municipal Utility District, Plaintiff vs. Pacific Gas and Electric Company, Defendant. Judgment and decree No. 1950 of the Superior Court of Calaveras County, dated July 25, 1940.
3. City of Lodi, Plaintiff vs. East Bay Municipal Utility District, et al., Defendants. Order modifying Judgment and decree No. 22415, dated October 4, 1950.

Collectively, these decrees are commonly known as the "Lodi Decrees." The Lodi Decrees define the relative rights of Lodi, EBMUD, PG&E, and areas around Jackson and Sutter creeks that received domestic water from PG&E's Mokelumne Hydroelectric Project facilities. Under the Lodi Decrees, PG&E is bound to a strict set of operating rules governed by storage and by precipitation, an example of the complexity of the interrelationships between Mokelumne River basin water users.

Amador Water Agency

AWA is a wholesale and retail water supplier chartered to serve municipal and agricultural needs in all areas of Amador County. Amador County has entitlements to water from the Mokelumne River based upon PG&E's pre-1914 water rights and upon partial assignments of water rights originally issued to the California Department of Finance, based on water right applications made in 1927. AWA's entitlements include up to 2,200 acre-feet annually for use in their Central Amador Water Project (License 13899 and Permit 21462) and a contractual right to use up to 15 thousand acre-feet purchased from PG&E that is diverted through the Amador Water System.

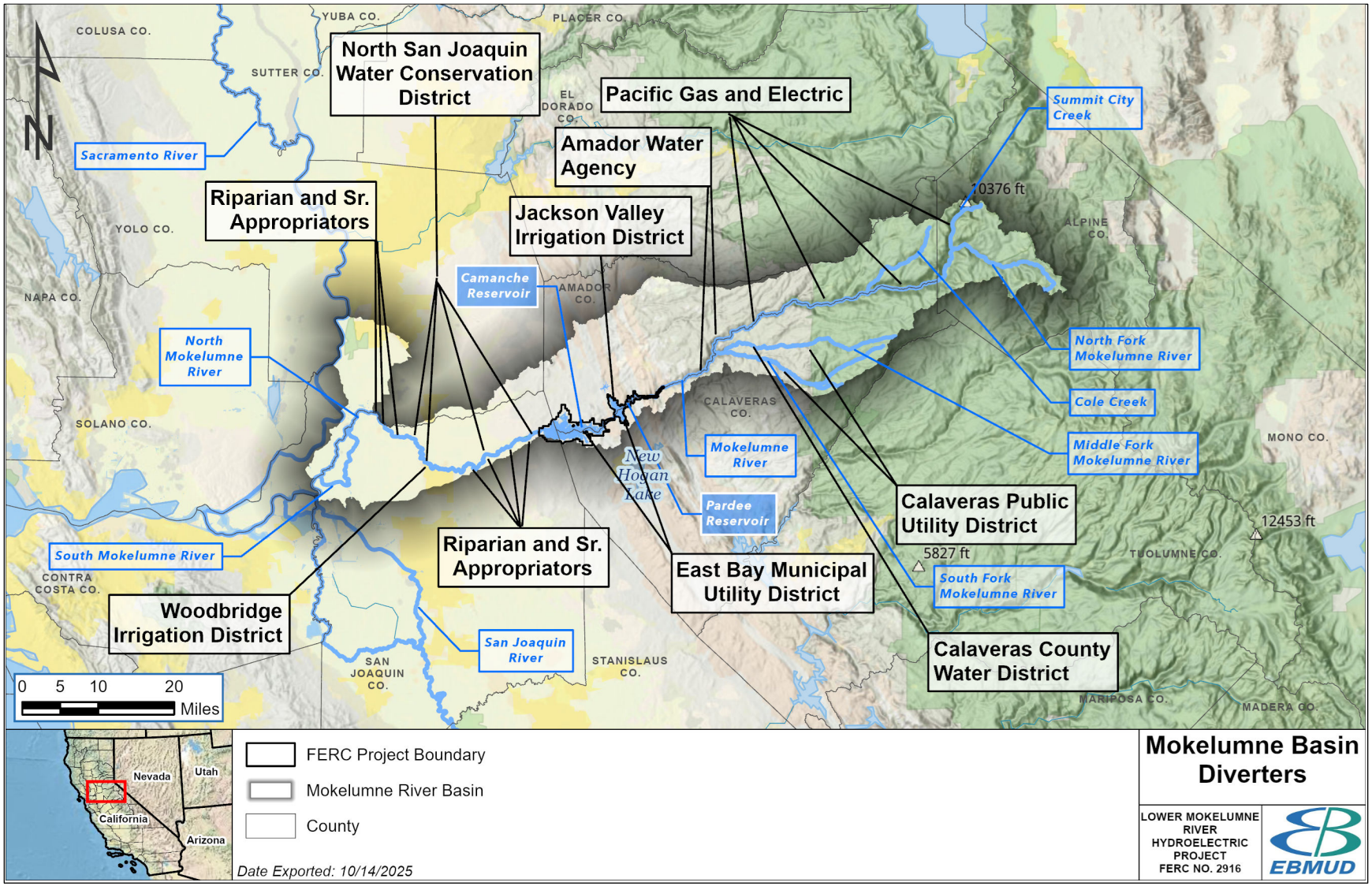


Figure 4.3-9. Mokelumne basin diverters.

Jackson Valley Irrigation District

In addition to diversions from Jackson Creek, JVID has an entitlement to divert up to 2,800 acre-feet annually from the Mokelumne River at the Jackson Creek Spillway structure on the north arm of Pardee Reservoir. These releases flow into Lake Amador. JVID provides irrigation water to farmland in the lower elevations of Amador County. JVID has a water right permit (an assignment of the 1927 California Department of Finance filing) to transfer water from the Mokelumne River to its storage reservoir. Pursuant to an agreement with EBMUD, water is released to JVID by gravity from the north arm of Pardee Reservoir. If the water level at Pardee Reservoir drops below El. 550 feet, then portable pumps are deployed to maintain JVID's access to divert water under its water right permit. However, if there is no water available under this Permit's 1927 seniority date, no water is available to JVID from Pardee.

Calaveras County Water District

CCWD provides water service to about 13,080 municipal, residential, and commercial customers in six service areas throughout the county. CCWD has an entitlement of Mokelumne River water, for up to 400 acre-feet per year, based upon pre-1914 and post-1914 water rights, and has additional contractual rights. CCWD diverts from Bear Creek near West Point, about 6 miles above the confluence with Middle Fork.

Calaveras Public Utility District

CPUD serves treated water to nearly 2,000 households in unincorporated communities of San Andreas and Mokelumne Hill in Calaveras County. CPUD's rights on the Mokelumne include diversion to storage of 2,130 acre-feet, and direct diversion of up to 15 cfs, based upon a combination of pre-1914 and partial assignments of the 1927 state filings. CPUD operates Schaads Reservoir on the Middle Fork and diverts water from the South Fork into off-stream storage at Jeff Davis Reservoir upstream of Pardee Reservoir.

Downstream Water Use

Riparian landowners, WID, and other senior downstream appropriators have priorities that are senior to EBMUD's Camanche water rights. In addition, NSJWCD has a junior water right that is derived from Permit 10478 and provides for temporary use of up to 20 TAF of unused Permit 10478 water.

Riparian and Individual Appropriators

Riparian landowners have rights that are tied to the river's natural flow. Water diverted by downstream riparian diverters and individual appropriators is not measured by EBMUD directly and is estimated based on historical monthly average losses observed on the

river. EBMUD estimates that there are more than 100 such diverters along the Lower Mokelumne River between Camanche Dam to its confluence with the San Joaquin River. Based on information from the California Fish Passage Assessment Database, over 90 percent of the Lower Mokelumne River water diversions lack screens designed to prevent losses of fish. Although riparian water users may operate any time of the year, the highest volume of water is diverted from April through September (EBMUD 2019). These individuals and agencies include ranches, vineyards, and farms that pump water from the Mokelumne River between Camanche Dam and tidewater for irrigation and domestic purposes. Riparian and senior appropriators usually take 20.6 TAF when true natural flow is greater than 250.0 TAF and 16.0 TAF in dry years when natural flow diminishes. The amount of water available in dry years is based on true natural flow and senior appropriators' water rights.

North San Joaquin Water Conservation District

NSJWCD is an irrigation district with diversion pumps located downstream of Camanche Dam. NSJWCD holds Permit 10477, which includes diversion and temporary storage of water derived from the unused portion of EBMUD's Camanche water right. NSJWCD has not constructed a permanent storage facility on the Mokelumne River. Instead, NSJWCD entered into an agreement with EBMUD to store water in Camanche reservoir for later release to NSJWCD's diversion facilities along the river below Camanche Dam. The maximum entitlement under this agreement is 20 TAF per year in wet years. Under this agreement, no water is available in dry years.

A 2014 agreement including NSJWCD, Stockton East Water District (SEWD), and EBMUD allows for more than the previous 20 TAF in wet years. In the agreement, EBMUD would release up to 3 or 6 TAF in certain dry years and up to 8 TAF in wet years. Dry and wet years are specifically defined for this agreement and are different from other versions of dry and wet years throughout this section (JSA, Lodi Decree, etc.). The agreement will be implemented after applicable permits are obtained.

Woodbridge Irrigation District

WID serves irrigation water to about 20,000 acres of agricultural land in San Joaquin County in the vicinity of Lodi and Woodbridge. WID also provides water for municipal uses through water transfer agreements with the cities of Lodi and Stockton. The original WID diversion dam was built in 1891. The current structure located at the northeast side of Woodbridge was constructed in 2006. The dam creates Lake Lodi with a capacity of approximately 1,583 acre-feet. From this lake, WID diverts water into an extensive canal system. WID's entitlements are conditioned by a series of water rights agreements with

EBMUD, which provide WID with firm annual supply of 60 TAF in normal and wet water years and 39 TAF in dry years.

City of Lodi

The City of Lodi, with a population of 68,642 in 2024, draws its water supply from the regional groundwater basin and surface water supplies from the Mokelumne River purchased from WID. The City of Lodi's well field is replenished, in part, by seepage from the Mokelumne River. Under the "Lodi Decrees," EBMUD is required to ensure that up to 3,600 acre-feet per year is available to the city of Lodi. This may require EBMUD to make additional releases, if certain groundwater and pumping conditions cannot be met.

Carriage Water (Losses)

EBMUD also releases carriage water to assure that sufficient water reaches senior downstream users. Water is "lost" from river flows due to several factors such as direct evaporation from the water surface, evapotranspiration from riparian phreatophytes, and seepage from the stream bed into the groundwater basin. The net effect of these losses is generally referred to as channel losses or buffer water loss. The components that make up the losses are not directly measured. Furthermore, the quantity and rate of losses vary with soil properties and geology, groundwater levels, and total seasonal flow in the river. EBMUD estimates the channel losses between Camanche and Woodbridge dams based on all available historical monthly average observed losses, by JSA year type.

4.3.3.2 INSTREAM FLOW USES OF PROJECT WATERS

Project waters serve a variety of instream flow uses, including fish protection and passage, fish hatchery flow, hydropower, and recreation. EBMUD does not propose to modify the existing instream flow uses of Project water.

Instream Flow Requirements for Fish Protection—Joint Settlement Agreement

EBMUD operates Pardee and Camanche reservoirs to maintain minimum instream flow releases for fish protection as required by FERC under the JSA and the SWRCB under Decision 1641 (D-1641). In 1998, EBMUD entered a long-term partnership with CDFW and USFWS by signing the JSA for the Mokelumne River. The SWRCB amended EBMUD's Mokelumne River water rights to require it to provide specified flow requirements at Camanche Dam and made corresponding changes to the water rights of WID to ensure a specified portion of the Camanche Dam releases passed below Woodbridge Dam (Revised Water Rights Decision 1641, March 15, 2000 (D-1641), pp. 170-179). Per the JSA and D-1641, EBMUD must use its best efforts to release cold water from Pardee Reservoir to

Camanche Reservoir in summer and fall to be released from Camanche Reservoir for the benefit of the anadromous fishery in the lower Mokelumne River.

The JSA also has a gainsharing provision that provides that 20 percent of the actual yield from new water supplies is required to be used to augment instream flows, up to a volume of 20 TAF per drought cycle. Examples of these new water supplies include development of additional storage capacity on the Mokelumne River and groundwater from a conjunctive use program. Water from conservation programs, recycled water projects, or the Amador Canal pipeline project are not subject to gainsharing. In essence, gainsharing is a mechanism to allow fishery resources to receive a portion of the yield from new water supply projects, further boosting fishery flows above the base JSA amounts. Allocation of gainshare water is determined through the JSA Partnership Steering Committee (PSC).

Minimum JSA flow releases from Camanche Dam and the expected flows below Woodbridge Dam are designed to protect fish resources in the Lower Mokelumne River (Table 3.5-2). Actual flows from 1998 to date have met or exceeded the required JSA flows below Camanche and Woodbridge dams. For almost 100 years from Water Years 1928 through 2023, annual Mokelumne River flows just upstream of Pardee Reservoir (Mokelumne Hill Station) ranged from 150 TAF to 1.9 million acre-feet. Since implementation of the JSA in 1998, flow releases below Camanche Dam have ranged from 111 TAF to 1.2 million acre-feet.

Water Right Permit 10478 Term 20: Mitigation Measure Fish-1

Mitigation Measure Fish-1 (MMRP Fish-1), which is Term 20 of Permit 10478, was added by SWRCB as a condition to EBMUD's Permit 10478 in its Order WR 2016-0019-EXEC dated August 2, 2016 ("Order Approving A Petition For Extension Of Time Until 2040 And Approving Petitions For Changes In Place Of Use, Purpose Of Use, And Permit Terms And Issuing An Amended Permit"). Term 20 requires that EBMUD release additional fishery flows, over and above the JSA flows, to ensure that flows remain in the Mokelumne River to maintain adequate water depths for salmon passage. EBMUD releases from Camanche Dam up to a total of 2,000 acre-feet of additional water above required releases during the September through February period in below normal and dry JSA water year types to facilitate adult salmonid fish passage below Woodbridge Dam.

The magnitude, frequency, and duration of the additional flows set forth above are to be determined by the JSA PSC based on Camanche cold water storage and water temperatures below Woodbridge Dam. Instream passage improvements are to be determined by the JSA PSC based on EBMUD assessment of potential passage impediments from Woodbridge Dam downstream to tidal influence during July or August

of current (April through September) or anticipated (October through March) *critically dry water years*.

Mokelumne River Fish Hatchery

In 1961, EBMUD entered into an agreement with CDFW (1961 Agreement) that required EBMUD to release 13 TAF annually from Camanche Reservoir to the Lower Mokelumne River for the benefit of fishery production, in addition to the releases for the WID, riparian and senior appropriators, and accounting for channel losses. These flow requirements have since been superseded by the 1998 JSA. The 1961 Agreement also required EBMUD, at CDFW's request, to construct a fish hatchery at Camanche Dam, with the hatchery to be operated by CDFW. Consistent with the 1961 Agreement, EBMUD completed construction of the fish hatchery (MRFH) in 1964. The 1998 JSA contained a provision under which EBMUD was to provide up to $12.5 million to expand and upgrade the hatchery. The expansion and upgrade of the hatchery were completed in 2002. CDFW continues to operate the hatchery. More information can be found in Section 4.4.

Recreation

Various forms of recreation such as camping and water-related activities are allowed at Pardee Reservoir (only non-body-contact activities allowed) and Camanche Reservoir (body-contact activities allowed). More information can be found in Section 4.8.

Pardee Reservoir

Pardee Reservoir hosts recreational activities including fishing, boating, camping, wildlife watching, and hiking. About 90 percent of Pardee Lake anglers fish for trout, both from the shore and from boats. Other available species include Brown Trout (*Salmo trutta*), kokanee (lacustrine Sockeye Salmon, *Oncorhynchus nerka*), black bass (*Micropterus sp.*), and three kinds of catfish. Motorboats, deluxe boats, pontoon boats, and deluxe pontoons are available for rent. Water contact activities (swimming, water skiing, pets) are not allowed at Pardee Reservoir, as it is a municipal water supply reservoir.

Camanche Reservoir

The North Shore and South Shore recreation areas at Camanche Reservoir host access to 12 square miles of lake and 53 miles of shoreline. Popular activities include fishing, swimming, waterskiing, jet skiing, and windsurfing. Visitors can also play tennis and basketball, picnic, bicycle, and hike.

Numerous picnic sites are available at both shores, with tables and barbecues; some include shade canopies. Camanche is known for bass and trout fishing. Each year more

than 50,000 pounds of trout (each more than a pound) are stocked between October and June. Other species include Largemouth Bass (*M. salmoides*), Smallmouth Bass (*M. dolomieu*), catfish, crappie, kokanee salmon, Bluegill (*Lepomis macrochirus*), and sunfish.

Patio boats, deluxe patio boats, fishing boats, kayaks, and paddle boats are available for rent.

Hydropower

In accordance with all other obligations, EBMUD produces hydropower. Additional information on the powerhouses is provided in Section 3.5.5. See Figure 4.3-4 and Figure 4.3-5 for power plant releases for Pardee and Camanche reservoirs, respectively.

4.3.4 WATER QUALITY STANDARDS APPLICABLE TO PROJECT WATERS

4.3.4.1 FEDERAL AND STATE WATER QUALITY STANDARDS

The state of California has responsibility for maintaining water quality standards through implementation of the federal Clean Water Act (CWA). The CVRWQCB has established water quality objectives for specific beneficial water uses. The Project is located in the Central Valley Region. Existing and potential beneficial uses that apply to surface waters within the watershed are identified in the Sacramento River Basin and San Joaquin River Basin Water Quality Control Plan (Basin Plan) (CVRWQCB 2019). Beneficial uses identified in the Basin Plan that pertain to the Project area include: (1) municipal and domestic supply; (2) agricultural supply; (3) hydropower generation; (4) water contact recreation; (5) non-contact water recreation; (6) cold and warm freshwater fish habitat; (7) migration for cold and warm water species; (8) spawning, reproduction, and/or early development habitat for fisheries (warm and cold); and (9) wildlife habitat. The definition of each of these beneficial uses is provided in the Basin Plan (CVRWQCB 2019). The water quality objectives in narrative and numerical form are defined in the Basin Plan.

California Code of Regulations Title 22 is a compilation of rules and regulations that addresses human health and safety issues. As part of Title 22, The California Toxics Rule, officially known as the "Water Quality Standards: Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California," is enforced in California's inland surface waters. These standards establish numeric criteria for toxic pollutants in water bodies to protect human health and the environment. Many drinking water contaminants are regulated with primary standards, which specify a maximum contaminant level (MCL) for the contaminant, while other contaminants are targeted by required treatment techniques in lieu of MCLs. Regulated contaminants include microbial contaminants, inorganic chemicals, synthetic non-volatile organic chemicals, radionuclides, disinfection

byproducts, and volatile organic chemicals. There are also secondary standards, which require monitoring for constituents that impact drinking water aesthetics and consumer acceptance (EBMUD 2020).

EBMUD complies with the aforementioned requirements through applicable permits for all facility discharges and adhering to all terms, conditions, and limits set forth in the permits to ensure water quality is protected.

4.3.4.2 REGULATED WATER QUALITY PROGRAMS

The following provides an overview of the Mokelumne watershed facilities regulated water quality programs through the CVRWQCB in consultation with SWRCB.

Camanche North Shore Recreation Area

- Camanche North Shore Water Treatment Plant

  The Camanche North Shore Water Treatment Plant (CANS WTP) generates backwash water through its treatment process. This backwash water discharges into two on-site storage ponds, equipped with an overflow pipe that discharges into a nearby unnamed creek, a tributary to Camanche Reservoir.

  During April through October, the backwash water is beneficially reused for irrigation of the nearby Blue Oaks Playground and adjacent wooded campground area. The land application also helps control mosquitos in the storage ponds during the spring through summer months.

  The backwash discharge is regulated under the following two permits:

  - SWRCB General Order for Drinking Water Systems, Order No. WQ 2014-0194-DWQ, General Order CAG14000 (Order). The Order allows for planned and unplanned discharges from the backwash storage ponds to the unnamed creek, in addition to reuse of the wastewater discharge. The Order's monitoring and reporting for this type of discharge is minimal, with discharge volume reporting on an annual basis.
  - CVRWQCB Order No. R5-2012-0023 Waste Discharge Requirements. This individual permit requires monthly and quarterly monitoring during April through October, when the backwash water is applied to land for irrigation use. Monitoring includes measuring the untreated water from the CANS WTP source drinking water wells, in addition to the backwash water. Measured constituents of concern include alkalinity, conductivity, pH, standard minerals, and total dissolved solids.

- Camanche North Shore Sanitary Sewer System

Camanche North Shore sanitary sewer system collects wastewater generated at the recreation area for amenities hard plumbed to the collection lines, including recreational vehicle holding tank dump station, mobile home laterals, and restrooms.

The collected sewage is regulated under the SWRCB General Order No. WQ 2022-0103-DWQ (Order). The intent of the Order is to protect public health and waters of the state from sewage spills, with a per gallon penalty. The Order requires development and implementation of a Spill Emergency Response Plan (Plan), allowing for prompt response to sewage spills. The Plan is an element of the Camanche and Pardee recreational areas' Sanitary Sewer Management Plan (SSMP), adopted by EBMUD's Board of Directors. EBMUD has fully implemented the SSMP and Plan for its sewage collection systems within the Camanche and Pardee recreational areas.

- Camanche North Shore Wastewater Treatment Plant

  Wastewater generated at Camanche North Shore Recreation Area is treated at the Camanche North Shore Wastewater Treatment Plant (CANS WWTP). CANS WWTP is regulated under the SWRCB General Order No. WQ 2014-0153-DWQ for small domestic wastewater systems. The wastewater is stored in three ponds for treatment consisting of aeration and settling of solids. For disposal, treated wastewater is discharged through a spray system to a nearby dedicated piece of land. There is also some incidental disposal through evaporation and percolation while the wastewater is stored in the wastewater ponds.

  The Order requires monitoring of both the treated wastewater (prior to land application) as well as the local groundwater aquifer to ensure that the treated wastewater is not impairing the groundwater quality. Measured constituents include pH, nitrates, alkalinity series, conductivity, standard minerals, and total dissolved solids.

  In addition to the Order, CANS WWTP discharge to land is also regulated through the SWRCB General Order No. WQ-2019-0037, where EBMUD is required to annually report the volume of treated wastewater discharge to land through the state's GeoTracker database.

  CANS WWTP is also subject to CVRWQCB's Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) Program, an alternative approach to addressing the Central Valley's groundwater salts contamination. For an annual nominal fee, EBMUD and other permit holders support the subject matter expert's

effort to study the salts in depth and determine the best long-term approach to manage the problem, including the potential to build a brine line from the Central Valley to EBMUD's main wastewater treatment plant in Oakland, for eventual discharge to the San Francisco Bay.

Camanche South Shore Recreation Area:

- Camanche South Shore Water Treatment Plant

  The Camanche South Shore Water Treatment Plant (CASS WTP) generates backwash water through its treatment process. The wastewater discharges into a nearby unnamed creek, and eventually into the recreation area's freshwater ponds that support recreational fishing.

  The backwash discharge is regulated under the SWRCB General Order for Drinking Water Systems, Order No. WQ 2014-0194-DWQ, General Order CAG14000 (Order).

- Camanche South Shore Sanitary Sewer System

  Camanche South Shore sanitary sewer system collects wastewater generated at the recreation area for amenities hard plumbed to the collection lines, including recreational vehicle holding tank dump station, mobile home laterals, and restrooms.

  Similar to Camanche North Shore Recreation Area, the collected sewage is regulated under the SWRCB General Order No. WQ 2022-0103-DWQ.

- Camanche South Shore Wastewater Treatment Plant

  Wastewater generated at Camanche South Shore Recreation Area is treated at the Camanche South Shore Wastewater Treatment Plant (CASS WWTP). CASS WWTP is regulated under CVRWQCB's Order No. R5-2002-0070, an individual Waste Discharge Requirements Permit. The wastewater is stored in two ponds for treatment consisting of aeration and settling of solids. Wastewater is disposed of through evaporation and percolation while stored in the treated wastewater pond.

  The Order requires monitoring of both the treated wastewater and the local groundwater aquifer to ensure that the percolated wastewater is not impairing the groundwater quality. Measured constituents include pH, nitrates, alkalinity series, conductivity, standard minerals, and total dissolved solids.

  In addition to the Order, CASS WWTP discharge to land is also regulated through the SWRCB General Order No. WQ-2019-0037, where EBMUD is required to report

the volume of the percolated treated wastewater through SWRCB's GeoTracker database.

CASS WWTP is also subject to CVRWQCB's CV-SALTS Program, in addition to their parallel Nitrate Control Program. EBMUD has partnered with the Valley Water Collaborative where the nitrate problem is addressed on a regional level rather than individual. This approach has significant cost savings for EBMUD.

Camanche Dam Powerhouse

- Camanche Dam Powerhouse Wastewater Treatment System

  Wastewater generated at Camanche Dam Powerhouse is regulated under CVRWQCB Order No. 2008-007, an individual permit that allows disposal of the treated wastewater through land application. Generated process wastewater is treated for incidental oil and grease through a skimming system prior to storage in a nearby pond, where it is disposed of through evaporation and percolation.

  The Order requires monitoring of the treated wastewater prior to land application. Measured constituents include copper, fixed dissolved solids, oil, and grease.

  Soil monitoring is also required at specific locations in the facility's main and standby storage ponds to ensure that the treated wastewater is not impairing the soil or underlying groundwater quality.

  Camanche Dam Powerhouse is also subject to CVRWQCB's CV-SALTS Program.

Pardee Center Campus:

- Pardee Center Water Treatment Plant

  The Pardee Center Water Treatment Plant (PACT WTP) generates backwash water through its treatment process. Treated wastewater is discharged to land through a local leach field system. The backwash discharge is regulated under the CVRWQCB Waiver of Discharge Requirements, Order No. R5-202-0061 (Order).

  Monitoring of the backwash water is required, including pH, conductivity, and standard minerals. Note that raw water sampling is not controlled by EBMUD, but the water is treated to meet drinking water standards.

- Pardee Center Wastewater Treatment Plant

  The Pardee Center Wastewater Treatment Plant (PACT WWTP) is regulated under the SWRCB General Order No. WQ 2014-0153-DWQ for small domestic wastewater systems, similar to CANS WWTP.

  Wastewater generated at the Pardee Center Campus is piped through its sanitary sewer collection system and then treated at PACT WWTP, an on-site treatment package plant. After treatment, the wastewater is stored in a local wastewater treatment pond, where it is disposed of through evaporation and percolation.

  The Order requires monitoring both the treated wastewater (prior to land application) and the local groundwater aquifer to ensure that the treated wastewater is not impairing the groundwater quality. Measured constituents include pH, nitrates, alkalinity series, hardness, standard minerals, and total dissolved solids.

  PACT WWTP is also subject to CVRWQCB's CV-SALTS Program.

Pardee Recreation Area:

- Pardee Recreation Area Water Treatment Plant

  The Pardee Recreation Area Water Treatment Plant (PARA WTP) generates backwash water through its treatment process. The backwash discharge is regulated under the CVRWQCB General Order for Limited Threat Discharges to Surface Water, Order No. R5-2022-0006-02 (Order). The Order allows for the discharge of the treated backwash water through a spray system on the nearby hillside, where it eventually discharges to Pardee Reservoir.

  Monitoring of the backwash is required, including residual chlorine, conductivity, pH, and temperature.

  PARA WTP is also subject to CVRWQCB's CV-SALTS Program.

- Pardee Recreation Area Sanitary Sewer System

  The Pardee Recreation Area sanitary sewer system collects wastewater generated at the recreation area for amenities hard plumbed to the collection lines, including recreational vehicle holding tank dump station, mobile home laterals, and restrooms.

Similar to Camanche North Shore and South Shore recreation areas, the collected sewage is regulated under the SWRCB General Order No. WQ 2022-0103-DWQ.

- Pardee Recreation Area Wastewater Treatment Plant

  Wastewater generated at Pardee Recreation Area is treated at the Pardee Recreation Wastewater Treatment Plant (PARA WWTP). PARA WWTP is regulated under the SWRCB General Order No. WQ 2014-0153-DWQ for small domestic wastewater systems, similar to CANS WWTP and PACT WWTP. The wastewater is stored in two concrete-lined ponds for treatment that consists of aeration and settling of solids. The treated wastewater is land applied, through a spray system, to a nearby dedicated piece of land.

  The Order requires monitoring both the treated wastewater (prior to land application) and to the local groundwater aquifer to ensure that the treated wastewater is not impairing the groundwater quality. Measured constituents include formaldehyde, phenols, pH, nitrates, alkalinity series, conductivity, standard minerals, and total dissolved solids.

  PARA WWTP is also subject to CVRWQCB's CV-SALTS Program.

4.3.4.3 WATER TEMPERATURE MANAGEMENT

The water temperature of Camanche Reservoir releases to the Lower Mokelumne River and the MRFH depends on the maintenance of thermal stratification in Camanche Reservoir until reservoir turnover in late fall or early winter. When surface waters cool and the difference between the surface and bottom temperatures is about 3°C or less, the reservoir stratification begins to break down. If an inadequate amount of cold water, water less than 16.4°C, is retained in Camanche Reservoir, reservoir turnover could occur early, resulting in elevated release temperatures after the reservoir mixes that could result in negative effects to the aquatic resources. By maintaining an adequate amount of cold water in storage, reservoir release temperatures are otherwise tempered, and reservoir turnover occurs naturally in late fall to early winter as temperatures cool and winter storms begin occurring. The JSA requires EBMUD to "use its best efforts to maintain Pardee and Camanche Reservoir stratification with a minimum of 28 TAF of hypolimnetic volume in Camanche Reservoir through October whenever Pardee Reservoir exceeds 100 TAF" (JSA, p. 8).

4.3.5 EXISTING WATER QUALITY DATA

The water quality information presented in this section provides an overview of the existing physical and chemical water quality conditions in the Project vicinity derived from collected data and from existing published reports and publicly available databases.

EBMUD conducts several water quality monitoring programs on Pardee and Camanche reservoirs for regulatory compliance, water rights, environmental assessment, and water supply objectives. In addition, EBMUD monitors general water quality parameters throughout the reservoirs to assist in managing reservoir operations and water treatment issues. EBMUD has developed a flexible reservoir management strategy under which operating decisions are guided by a combination of real-time monitoring and computer models. The operational guidelines in the reservoir management strategy are designed to provide the lowest fall temperature to the Lower Mokelumne River below Camanche Dam and minimize unnecessary releases from Pardee Reservoir that do not support beneficial uses of the river. Monitoring data collected in the field, including fishery conditions, are evaluated to confirm that the goals of the strategy are being met and to analyze any trends in key performance indicators. This management approach allows a balanced multi-objective use of the water supply in the Mokelumne River for all beneficial uses.

Additional detailed information regarding the Mokelumne River watershed including Pardee and Camanche reservoir monitoring data are available in the Mokelumne River Watershed Sanitary Survey (MRWSS). EBMUD submitted the first MRWSS to the state of California in December 1995, followed by 5-year updates in 2000 (EBMUD 2000), 2005 (EBMUD 2005), 2010 (EBMUD 2011b), 2015 (EBMUD 2016), and 2020 (EBMUD 2020, 2021). The purpose of the MRWSS is to identify potential sources of contaminants in the watersheds, analyze trends, and recommend watershed management practices to protect raw water quality.

4.3.5.1 RESERVOIR WATER TEMPERATURE AND QUALITY PROFILE MONITORING STATIONS

There are approximately 13 established reservoir water quality monitoring stations with long-term records. The station name, brief description, location (latitude and longitude coordinates), and a description of the types of water quality datasets collected are summarized in Table 4.3-8. Manual water quality measurements are acquired at these stations at irregular frequencies throughout the year and can range in frequency from weekly to only a few measurements in any given year. Manual water quality data are generally characterized as water quality profiles collected using a water quality sonde or multi-sensor deployed from a boat. Water quality profile data sets generally include depth

(feet), temperature (°C), pH, DO (mg/L or parts per million), DO percent saturation, and specific conductivity (microSiemens per centimeter [µS/cm]). Starting in 2014, additional sensors were added to the sonde capturing the following additional water quality data sets: chlorophyll (micrograms per liter [µg/L]), blue green algae (BGA) – phycocyanin concentration (PC) (µg/L), and turbidity (recorded in Formazin Nephelometric Units [NTU]). A plan view map of the long-term water quality stations within Pardee and Camanche reservoirs is depicted in Figure 4.3-10.

Table 4.3-8. Long-term reservoir manual water quality monitoring stations.

Station name	Brief description	Period of record
Pardee Reservoir		
LOGBOOM	Upstream reservoir inlet at floating log boom used to block debris flows into the reservoir	1993 to Present
PARI	Reservoir interior water quality station adjacent to small creek inflow.	1990 to Present
PATW	Pardee Reservoir at Intake Tower	1988 to Present
PADA	Pardee Dam	1989 to Present
Camanche Reservoir		
FLEX	Upstream reservoir inlet at location of buoy line, inaccessible in low reservoir elevations during droughts	1990 to Present
CAMA	Upstream station accessible in most years	1990 to Present
PENN	Adjacent to abandoned Penn Mine	1993 to Present
CAMB	Coincident with Buena Vista Rd/ Camanche Parkway S. Bridge Crossing	1990 to Present
CALP	Adjacent to Lancha Plana	1988 to Present
CAMI	Interior reservoir	1990 to Present
CANS	Adjacent to North Shore Recreation Area	1988 to 1999
CASS	Adjacent to South Shore Recreation Area	1988 to Present
CAMD	Camanche Dam	1988 to Present

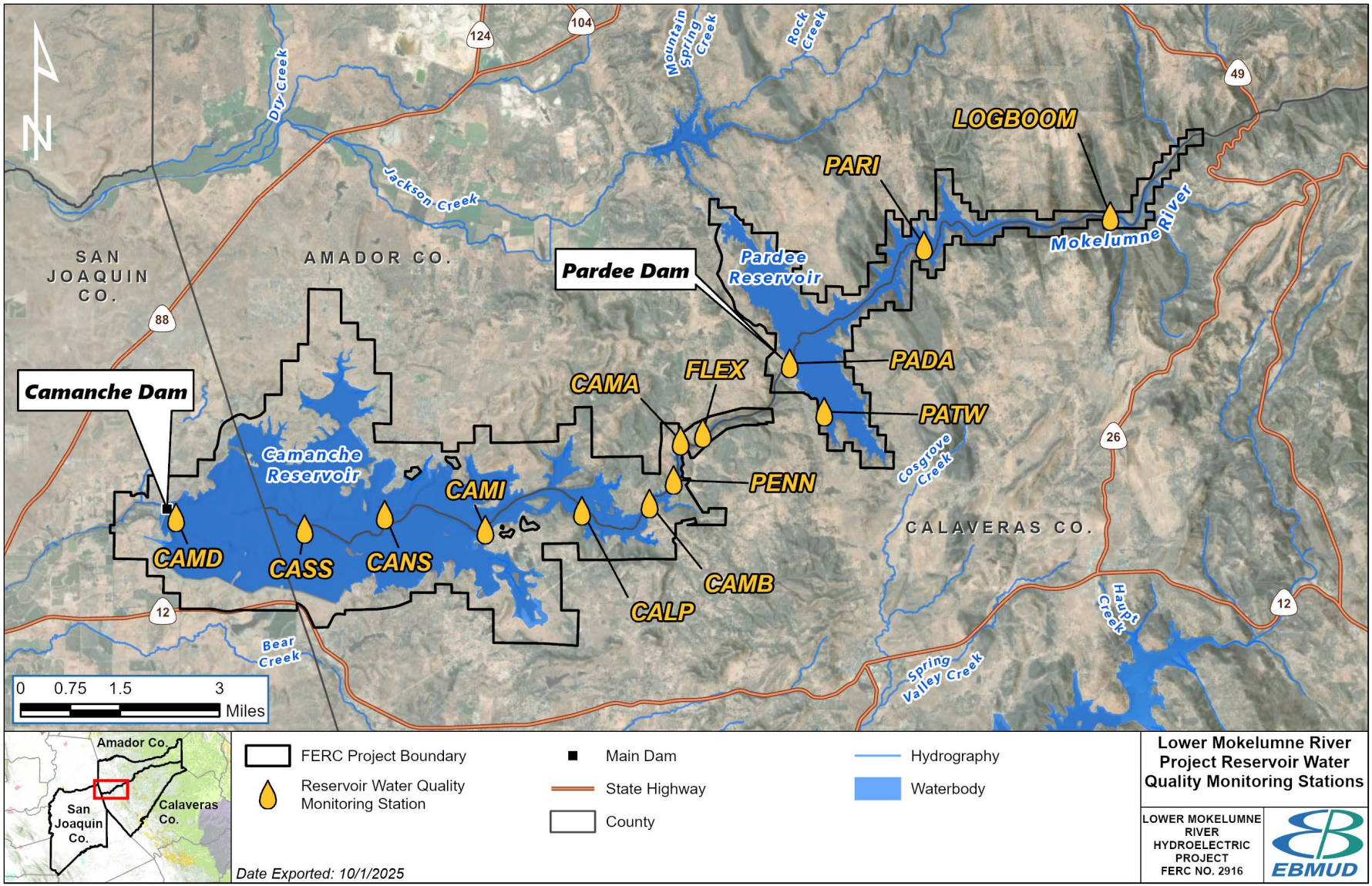
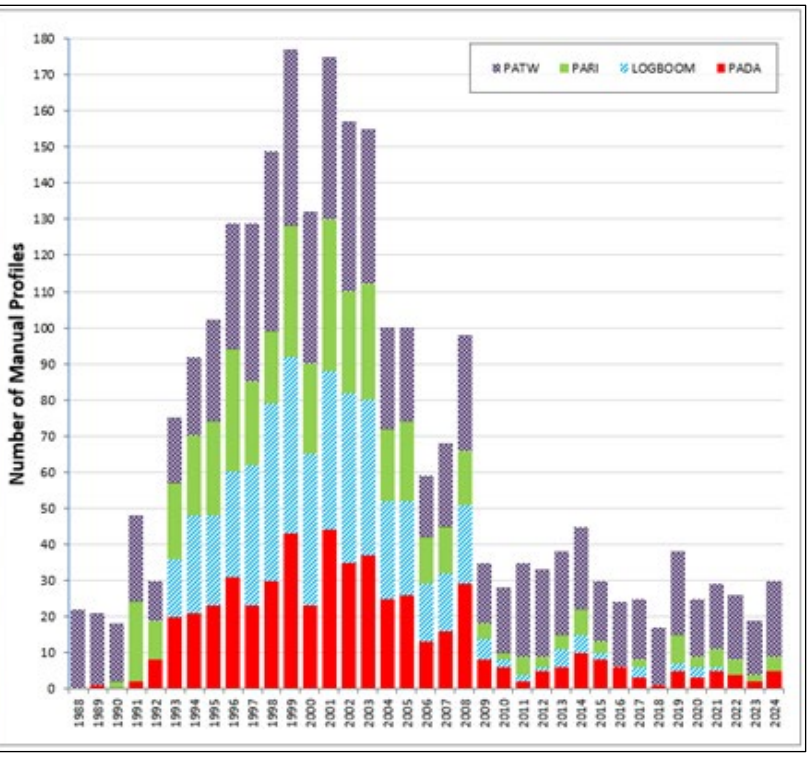


Figure 4.3-10. Pardee and Camanche reservoir water quality monitoring stations.

The frequency of reservoir water quality profile samples collected over time has been inconsistent. In some years, reservoir profiles were collected on a weekly or biweekly basis at most reservoir stations. In other years, only a few profiles were collected for a subset of the reservoir stations. A full accounting of the frequency and number of profiles collected for Pardee and Camanche reservoirs with colored stacked bars for each station is provided in Figure 4.3-11.

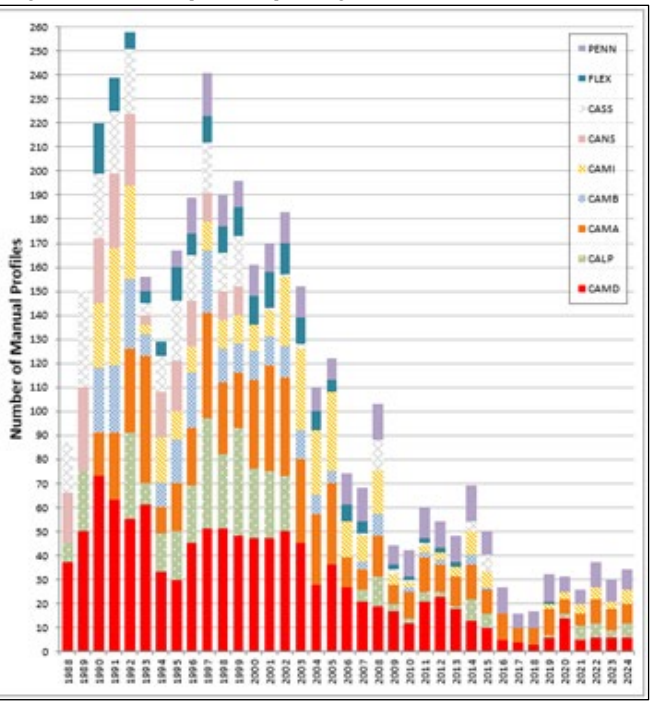
In Volume II – Appendix F, Tables F-1 through F-23 present seasonal summary statistics for the manual profile data sets collected over time. In Volume II – Appendix F, Figures F-1 through F-8 provide some examples of water quality profile data at some select dates and times for Pardee and Camanche reservoirs.

Year	LOGBOOM	PADA	PARI	PATW	Total
1988	0	0	0	22	22
1989	0	1	0	20	21
1990	0	0	2	16	18
1991	0	2	22	24	48
1992	0	8	11	11	30
1993	16	20	21	18	75
1994	27	21	22	22	92
1995	25	23	26	28	102
1996	29	31	34	35	129
1997	39	23	23	44	129
1998	49	30	20	50	149
1999	49	43	36	49	177
2000	42	23	25	42	132
2001	44	44	42	45	175
2002	47	35	28	47	157
2003	43	37	32	43	155
2004	27	25	20	28	100
2005	26	26	22	26	100
2006	16	13	13	17	59
2007	16	16	13	23	68
2008	22	29	15	32	98
2009	6	8	4	17	35
2010	2	6	2	18	28
2011	2	2	5	26	35
2012	1	5	3	24	33
2013	5	6	4	23	38
2014	5	10	7	23	45
2015	2	8	3	17	30
2016	0	6	0	18	24
2017	3	3	2	17	25
2018	0	1	0	16	17
2019	2	5	8	23	38
2020	3	3	3	16	25
2021	1	5	5	18	29
2022	0	4	4	18	26
2023	0	2	2	15	19
2024	0	5	4	21	30



(a) Pardee Reservoir water quality station sample frequency, 1988–2024.

Year	CALP	CAMA	CAMB	CAMD	CAMI	CANS	CASS	FLEX	PENN	Totals
1988	8	0	0	37	0	21	21	0	0	87
1989	25	0	0	50	0	35	40	0	0	150
1990	0	18	27	73	27	27	27	21	0	220
1991	0	28	28	63	49	31	26	14	0	239
1992	36	35	29	55	35	30	27	7	0	258
1993	9	53	9	61	4	4	5	5	6	156
1994	16	11	10	33	19	19	15	6	0	129
1995	20	20	18	30	12	21	25	14	7	167
1996	24	24	23	45	11	19	19	9	15	189
1997	46	44	26	51	12	12	21	11	18	241
1998	31	30	14	51	12	12	16	11	13	190
1999	45	23	12	48	12	12	21	12	11	196
2000	29	37	12	47	11	0	0	12	13	161
2001	28	44	12	47	11	0	1	15	12	170
2002	23	41	13	50	29	0	1	13	13	183
2003	0	35	12	45	34	0	2	11	13	152
2004	0	29	8	28	27	0	0	8	10	110
2005	0	34	5	36	33	0	0	5	9	122
2006	0	12	0	27	15	0	0	7	13	74
2007	5	8	3	21	11	0	1	5	14	68
2008	12	17	9	19	18	0	13	0	15	103
2009	3	8	0	17	4	0	2	2	8	44
2010	2	11	2	12	2	0	1	1	11	42
2011	4	14	2	21	3	0	1	2	13	60
2012	2	11	2	23	3	0	0	2	11	54
2013	1	12	0	18	4	0	0	2	11	48
2014	9	14	4	13	10	0	4	0	15	69
2015	6	10	1	10	6	0	7	0	10	50
2016	0	11	0	5	0	0	0	0	11	27
2017	0	6	0	4	0	0	0	0	6	16
2018	0	7	0	3	0	0	0	0	7	17
2019	1	11	0	6	2	0	0	1	11	32
2020	2	6	0	14	3	0	0	0	6	31
2021	6	5	0	5	4	0	0	0	6	26
2022	6	10	0	6	5	0	0	0	10	37
2023	3	9	0	6	3	0	0	0	9	30
2024	6	8	0	6	6	0	0	0	8	34



(b) Camanche Reservoir water quality sample frequency, 1988–2024.

Figure 4.3-11. Water quality manual profile annual sample collection frequency for (a) Pardee Reservoir stations and (b) Camanche Reservoir stations.

Pardee Reservoir

At Pardee Dam, a set of eight thermocouples are deployed at fixed elevations that provide real-time temperature measurements in degrees Celsius through EBMUD's Supervisory Control and Data Acquisition (SCADA) system. Thermocouple probes are established at the following elevations in feet above mean sea level (msl): 550, 500, 450, 400, 375, 350, 300, and 271. Hourly and daily records are archived for historical data queries. Figure 4.3-12 is a time series of the eight sensors where the probes near the surface clearly depict the annual reservoir stratification cycles. Thermocouple temperature records extend from November 17, 2009, to the current date. Table 4.3-9 through Table 4.3-16 provide the monthly average temperature for each sensor elevation over the period of data available. Figure 4.3-13 shows an example of the thermocouple probes plotted with a profile measurement at Pardee Dam (Station PADA) recorded on August 27, 2014. Note the coarse spacing of the thermocouple probes misses much of the nonlinear change in temperature with depth that occurs in the metalimnion.

In late summer 2023, EBMUD installed an auto-profiler in Pardee Reservoir at Pardee Tower. It is programmed to conduct twice daily profiles, which include measurements at 1-meter depth intervals for temperature (°C), pH, DO (mg/L), conductivity (µs/cm), oxidation-reduction potential (millivolts), chlorophyll (µg/L), BGA – PC (µg/L), turbidity (NTU), and fluorescence.

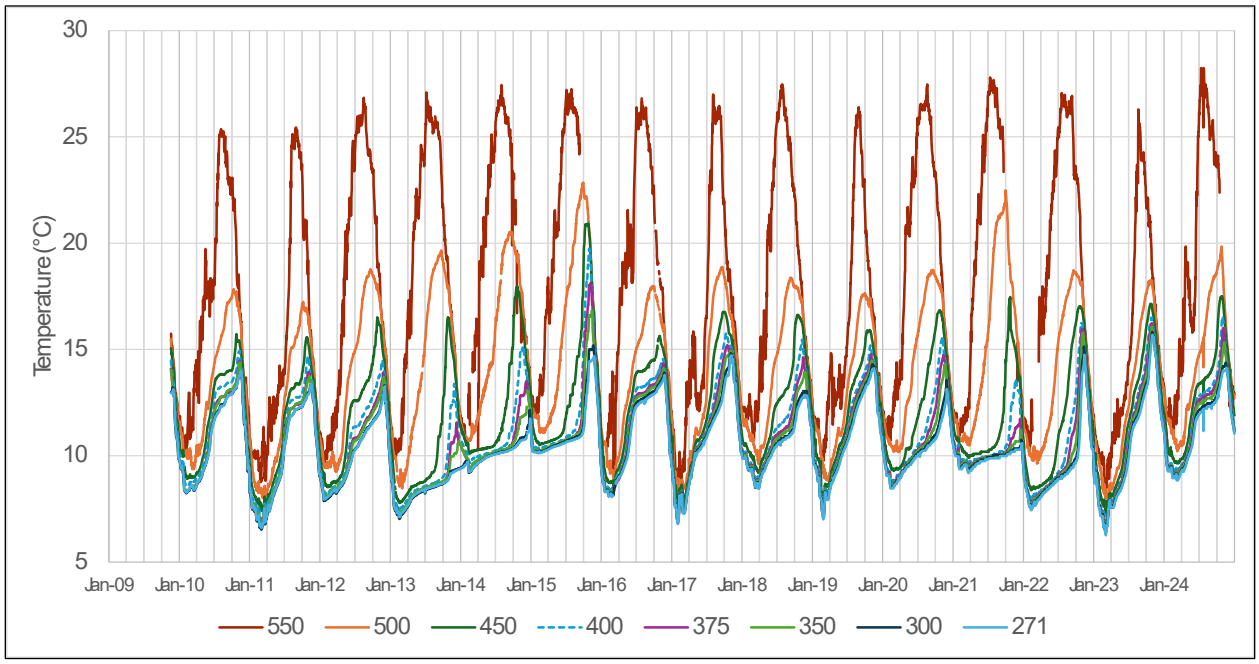


Figure 4.3-12. Pardee Dam temperature sensor time series sensor elevations spanning El. 550-271 feet msl.

Table 4.3-9. Pardee Dam monthly average water temperature at El. 550 feet msl via thermocouple.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	-	-	-	-	-	-	-	-	-	-	15.1	12.8
2010	11.0	11.3	12.6	14.6	17.7	17.7	21.9	24.9	23.1	20.9	16.3	12.8
2011	10.2	9.7	9.8	11.2	12.4	13.6	16.6	24.5	24.4	20.7	15.8	12.3
2012	10.3	10.5	11.5	14.3	19.4	22.9	25.4	26.0	24.1	21.0	17.0	13.7
2013	10.8	10.5	13.8	17.4	21.4	23.8	26.2	25.6	24.2	19.8	16.4	13.0
2014	11.4	12.5	14.8	17.9	21.6	24.2	26.4	26.3	24.5	20.6	16.5	14.6
2015	12.3	12.9	15.7	17.9	21.1	24.7	26.6	26.2	25.0	N/A	N/A	N/A
2016	10.5	11.8	12.4	17.8	19.5	21.3	25.9	25.9	23.7	19.9	17.0	13.4
2017	10.2	9.3	11.5	14.3	12.8	14.5	21.4	26.2	24.5	19.4	16.7	13.6
2018	12.0	11.9	12.0	14.8	18.9	23.7	26.6	25.9	23.6	20.3	16.6	13.8
2019	11.7	10.4	11.6	13.2	12.9	13.9	17.9	25.0	24.0	19.4	16.3	13.3
2020	11.6	11.6	13.3	16.4	21.2	23.8	26.2	26.6	24.4	21.3	16.6	13.4
2021	11.7	11.4	12.4	17.6	21.5	24.8	27.3	26.5	25.0	N/A	13.8	13.6
2022	11.3	11.2	16.3	16.9	20.1	23.6	26.2	26.4	24.9	21.6	16.2	12.9
2023	10.7	9.6	9.2	10.9	11.7	13.1	16.1	23.4	23.6	20.9	17.0	14.1
2024	12.2	11.8	13.5	16.9	17.2	20.6	27.3	26.3	24.6	23.5	N/A	13.2

Table 4.3-10. Pardee Dam monthly average water temperature at El. 500 feet msl via thermocouple.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	-	-	-	-	-	-	-	-	-	-	14.8	12.6
2010	10.8	10.0	9.7	10.3	11.8	13.4	14.8	15.9	17.2	17.6	15.9	12.4
2011	9.6	8.4	8.2	8.7	9.8	11.3	13.6	15.2	16.2	16.9	15.3	12.2
2012	10.1	9.6	9.6	9.9	12.6	14.5	15.5	17.7	18.6	18.1	16.6	13.6
2013	10.5	8.9	9.1	10.6	12.2	14.1	16.9	18.8	19.4	18.4	16.3	12.9
2014	11.1	10.8	11.4	12.4	13.6	14.7	17.3	19.7	20.4	19.5	17.3	14.5
2015	12.1	11.4	11.3	11.9	13.2	15.9	18.1	20.3	22.2	21.8	17.9	13.5
2016	10.6	9.4	9.4	10.9	12.7	14.3	15.4	16.7	17.8	17.4	16.0	13.4
2017	9.8	8.7	8.8	10.2	11.1	12.0	15.4	18.0	18.7	17.5	15.9	13.4
2018	11.6	10.9	10.1	10.4	11.8	14.1	15.4	17.4	18.2	17.8	16.3	13.8
2019	11.5	10.2	9.0	9.9	10.9	11.9	14.0	15.7	17.4	17.3	15.9	13.2
2020	11.3	10.5	10.4	11.0	12.8	14.9	16.5	18.0	18.6	18.1	16.3	13.3
2021	11.5	10.8	10.7	11.3	12.7	14.6	17.7	20.8	21.6	20.0	16.9	13.6
2022	10.8	10.0	10.0	10.5	11.6	13.9	16.2	17.5	18.5	18.3	16.0	12.8
2023	10.3	8.9	8.2	8.8	9.8	11.6	13.3	15.1	17.0	18.0	16.7	13.9
2024	12.0	11.1	10.5	11.2	12.7	14.2	15.2	17.0	18.3	19.2	16.5	13.5

Table 4.3-11. Pardee Dam monthly average water temperature at El. 450 feet msl via thermocouple.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	-	-	-	-	-	-	-	-	-	-	14.6	12.3
2010	10.1	9.0	9.0	9.4	10.6	12.3	13.7	13.8	14.0	14.8	14.8	11.5
2011	8.6	7.8	7.7	8.2	9.1	10.3	12.5	13.2	13.5	14.9	14.3	11.8
2012	9.3	8.6	8.8	9.0	10.4	12.4	12.6	13.2	13.8	15.5	15.5	12.8
2013	9.5	7.9	8.0	8.4	8.6	8.8	9.0	9.4	11.1	14.7	15.2	12.5
2014	10.9	10.3	10.2	10.3	10.4	10.4	10.8	11.9	14.2	17.4	16.5	14.0
2015	11.3	10.6	10.6	10.7	10.8	11.2	12.4	13.7	15.8	20.6	17.9	13.3
2016	9.7	8.8	9.0	9.9	11.7	13.2	14.0	14.1	14.4	15.0	15.0	12.5
2017	9.0	8.2	8.3	9.7	10.7	11.2	12.6	15.1	16.4	16.3	15.0	12.4
2018	10.5	10.0	9.4	9.7	10.6	12.0	12.7	13.1	14.0	16.4	15.7	13.3
2019	10.6	9.0	8.6	9.4	10.3	11.0	12.7	13.7	14.5	15.8	15.0	12.7
2020	10.5	9.5	9.4	9.7	10.4	11.3	12.3	13.6	15.1	16.6	15.6	12.9
2021	10.9	10.4	10.0	10.1	10.1	10.2	10.3	10.7	12.1	16.0	15.1	12.8
2022	9.5	8.5	8.5	8.7	9.0	9.9	11.4	13.0	15.5	16.8	15.6	12.3
2023	9.4	7.9	7.7	8.3	9.1	10.7	12.2	13.5	15.0	16.8	16.0	13.2
2024	10.9	9.9	9.7	10.1	11.5	13.1	13.4	13.8	14.4	16.9	15.9	13.1

Table 4.3-12. Pardee Dam monthly average water temperature at El. 400 feet msl via thermocouple.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	-	-	-	-	-	-	-	-	-	-	14.0	11.8
2010	9.6	8.7	8.8	9.1	10.0	11.7	13.0	13.3	13.4	13.9	14.3	10.9
2011	8.2	7.4	7.3	8.0	8.8	9.8	12.0	12.7	12.8	13.7	13.8	11.1
2012	8.7	8.3	8.5	8.8	9.6	11.1	11.4	12.0	12.5	13.2	14.1	12.0
2013	8.7	7.5	7.7	8.1	8.4	8.5	8.6	8.7	8.9	9.6	12.3	11.6
2014	10.4	9.8	9.9	10.0	10.1	10.2	10.3	10.5	11.1	12.8	14.8	13.2
2015	10.7	10.3	10.4	10.5	10.6	10.8	11.0	11.3	12.7	17.8	17.4	12.7
2016	9.0	8.5	8.8	9.5	11.0	12.6	13.2	13.3	13.6	13.8	14.3	11.7
2017	8.4	7.8	8.0	9.4	10.5	10.9	11.8	13.2	14.7	15.5	14.5	11.7
2018	10.1	9.6	9.0	9.4	10.2	11.0	11.4	11.8	12.5	14.1	14.8	12.5
2019	9.9	8.3	8.3	9.1	9.9	10.7	11.9	13.0	13.6	14.5	14.5	12.1
2020	9.9	9.0	9.0	9.4	9.8	10.2	10.7	11.4	12.5	14.3	14.8	12.2
2021	10.5	9.8	9.7	9.8	9.9	10.0	10.0	10.1	10.3	11.1	13.1	11.9
2022	8.8	8.1	8.2	8.5	8.7	9.0	9.4	10.5	12.1	14.8	15.0	11.6
2023	8.8	7.4	7.3	8.0	8.7	10.0	11.6	12.8	13.9	15.8	15.3	12.5
2024	10.2	9.5	9.4	9.8	10.8	12.5	12.9	13.1	13.5	15.0	15.1	12.5

Table 4.3-13. Pardee Dam monthly average water temperature at El. 375 feet msl via thermocouple.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	-	-	-	-	-	-	-	-	-	-	13.6	11.3
2010	9.3	8.4	8.5	8.9	9.7	11.3	12.5	12.8	13.0	13.3	13.8	10.5
2011	7.8	7.1	7.0	7.7	8.5	9.5	11.6	12.3	12.4	13.1	13.4	10.8
2012	8.5	8.1	8.4	8.6	9.2	10.5	10.9	11.5	11.9	12.5	13.4	11.7
2013	8.3	7.3	7.5	8.0	8.2	8.4	8.5	8.6	8.7	9.0	10.5	10.9
2014	10.2	9.6	9.7	9.8	9.9	10.0	10.1	10.2	10.5	11.5	12.8	12.8
2015	10.4	10.2	10.3	10.4	10.5	10.6	10.8	10.9	11.7	16.2	16.7	12.3
2016	8.8	8.2	8.7	9.3	10.7	12.3	12.9	13.0	13.3	13.5	14.0	11.5
2017	8.2	7.7	7.9	9.4	10.4	10.8	11.6	12.6	14.0	15.0	14.3	11.5
2018	10.0	9.5	8.8	9.3	10.0	10.7	11.1	11.3	12.0	13.4	14.1	12.3
2019	9.7	8.1	8.1	9.0	9.8	10.6	11.7	12.7	13.4	14.1	14.3	11.8
2020	9.7	8.8	8.9	9.3	9.7	10.1	10.4	10.9	11.7	13.2	14.3	12.0
2021	10.3	9.7	9.6	9.7	9.8	9.9	10.0	10.0	10.1	10.4	11.1	11.1
2022	8.6	7.9	8.1	8.4	8.6	8.9	9.2	9.7	11.1	13.7	14.8	11.4
2023	8.7	7.2	7.2	7.9	8.6	9.7	11.5	12.5	13.5	15.4	15.2	12.4
2024	10.0	9.3	9.3	9.7	10.6	12.3	12.7	12.9	13.2	14.3	14.9	12.3

Table 4.3-14. Pardee Dam monthly average water temperature at El. 350 feet msl via thermocouple.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	-	-	-	-	-	-	-	-	-	-	13.6	11.3
2010	9.2	8.4	8.6	8.9	9.7	11.2	12.4	12.8	13.1	13.4	13.8	10.5
2011	7.9	7.1	7.1	7.8	8.6	9.6	11.6	12.3	12.5	13.0	13.4	10.7
2012	8.5	8.2	8.4	8.7	9.2	10.3	10.8	11.3	11.8	12.3	13.1	11.6
2013	8.3	7.3	7.6	8.0	8.3	8.4	8.6	8.6	8.7	8.9	9.9	10.4
2014	10.2	9.6	9.7	9.9	10.0	10.1	10.2	10.3	10.5	10.9	11.8	12.3
2015	10.4	10.3	10.3	10.5	10.6	10.7	10.8	10.9	11.3	15.0	16.0	12.2
2016	8.7	8.3	8.7	9.4	10.5	12.2	12.8	12.9	13.2	13.4	13.8	11.3
2017	8.2	7.7	7.9	9.3	10.3	10.8	11.5	12.2	13.4	14.6	14.2	11.3
2018	9.9	9.4	8.8	9.2	9.9	10.6	10.9	11.1	11.5	12.9	13.7	12.2
2019	9.6	8.0	8.1	8.9	9.7	10.5	11.5	12.5	13.2	13.8	14.2	11.7
2020	9.6	8.7	8.9	9.2	9.7	10.0	10.3	10.6	11.2	12.3	13.8	11.9
2021	10.2	9.6	9.6	9.6	9.8	9.9	10.0	10.0	10.1	10.3	10.6	10.6
2022	8.5	7.8	8.0	8.3	8.6	8.9	9.1	9.4	10.2	12.6	14.6	11.3
2023	8.6	7.1	7.2	7.9	8.5	9.5	11.3	12.2	13.3	15.0	15.0	12.2
2024	9.9	9.3	9.2	9.6	10.5	12.1	12.5	12.7	12.9	13.9	14.6	12.2

Table 4.3-15. Pardee Dam monthly average water temperature at El. 300 feet msl via thermocouple.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	-	-	-	-	-	-	-	-	-	-	13.1	11.2
2010	9.2	8.3	8.5	8.8	9.6	11.0	12.0	12.4	12.8	13.1	13.5	10.4
2011	7.7	7.0	6.9	7.6	8.4	9.4	11.2	12.0	12.2	12.6	13.0	10.6
2012	8.3	8.0	8.3	8.5	9.0	9.9	10.5	11.0	11.4	11.8	12.6	11.5
2013	8.2	7.2	7.4	7.8	8.2	8.3	8.4	8.5	8.6	8.8	9.2	9.4
2014	9.6	9.4	9.5	9.7	9.9	10.0	10.1	10.2	10.3	10.5	10.8	11.4
2015	10.3	10.2	10.3	10.4	10.5	10.6	10.7	10.8	11.0	13.3	14.9	11.9
2016	8.7	8.2	8.7	9.3	10.2	12.0	12.6	12.7	13.0	13.2	13.6	11.3
2017	8.2	7.7	7.9	9.3	10.2	10.7	11.3	12.0	12.8	14.1	14.1	11.3
2018	9.8	9.3	8.7	9.1	9.8	10.4	10.7	10.9	11.2	12.4	13.0	12.0
2019	9.5	8.0	8.0	8.8	9.6	10.4	11.2	12.2	13.0	13.6	14.0	11.6
2020	9.6	8.7	8.8	9.2	9.6	9.9	10.2	10.4	10.8	11.4	12.7	11.8
2021	10.1	9.5	9.5	9.5	9.7	9.8	10.0	10.0	10.0	10.2	10.3	10.4
2022	8.5	7.7	8.0	8.3	8.5	8.8	9.0	9.3	9.7	11.4	14.2	11.2
2023	8.6	7.1	7.2	7.8	8.4	9.3	11.1	11.9	12.9	14.5	14.9	12.2
2024	9.9	9.2	9.1	9.5	10.3	11.8	12.2	12.4	12.6	13.5	14.1	12.1

Table 4.3-16. Pardee Dam monthly average water temperature at El. 271 feet msl via thermocouple.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	-	-	-	-	-	-	-	-	-	-	13.0	11.2
2010	9.2	8.4	8.5	8.9	9.6	10.9	11.9	12.4	12.8	13.1	13.5	10.5
2011	7.8	7.0	7.0	7.6	8.4	9.4	11.2	12.0	12.3	12.6	13.0	10.6
2012	8.4	8.1	8.3	8.6	9.1	9.9	10.5	10.9	11.4	11.8	12.5	11.5
2013	8.3	7.3	7.5	7.9	8.2	8.4	8.5	8.6	8.7	8.8	9.2	9.3
2014	9.5	9.4	9.5	9.7	9.9	10.0	10.1	10.2	10.3	10.5	10.7	11.1
2015	10.3	10.1	10.2	10.4	10.5	10.6	10.7	10.8	10.9	12.7	14.5	11.9
2016	8.6	8.2	8.8	9.2	10.1	11.8	12.4	12.6	12.8	13.1	13.5	11.2
2017	8.1	7.6	7.8	9.3	10.2	10.6	11.2	11.8	12.6	13.8	14.1	11.2
2018	9.8	9.3	8.6	9.1	9.7	10.3	10.6	10.8	11.1	12.1	12.7	12.0
2019	9.5	7.9	7.9	8.8	9.5	10.3	11.1	12.0	12.8	13.4	13.9	11.5
2020	9.5	8.6	8.8	9.2	9.5	9.9	10.1	10.4	10.6	11.1	12.2	11.8
2021	10.1	9.4	9.4	9.4	9.7	9.8	9.9	9.9	10.0	10.1	10.2	10.3
2022	8.4	7.6	7.9	8.2	8.5	8.8	9.0	9.2	9.5	11.0	14.0	11.2
2023	8.5	7.0	7.1	7.7	8.3	9.2	10.9	11.7	12.7	14.2	14.8	12.1
2024	9.8	9.1	9.0	9.4	10.2	11.6	12.1	12.3	12.5	13.3	14.0	12.0

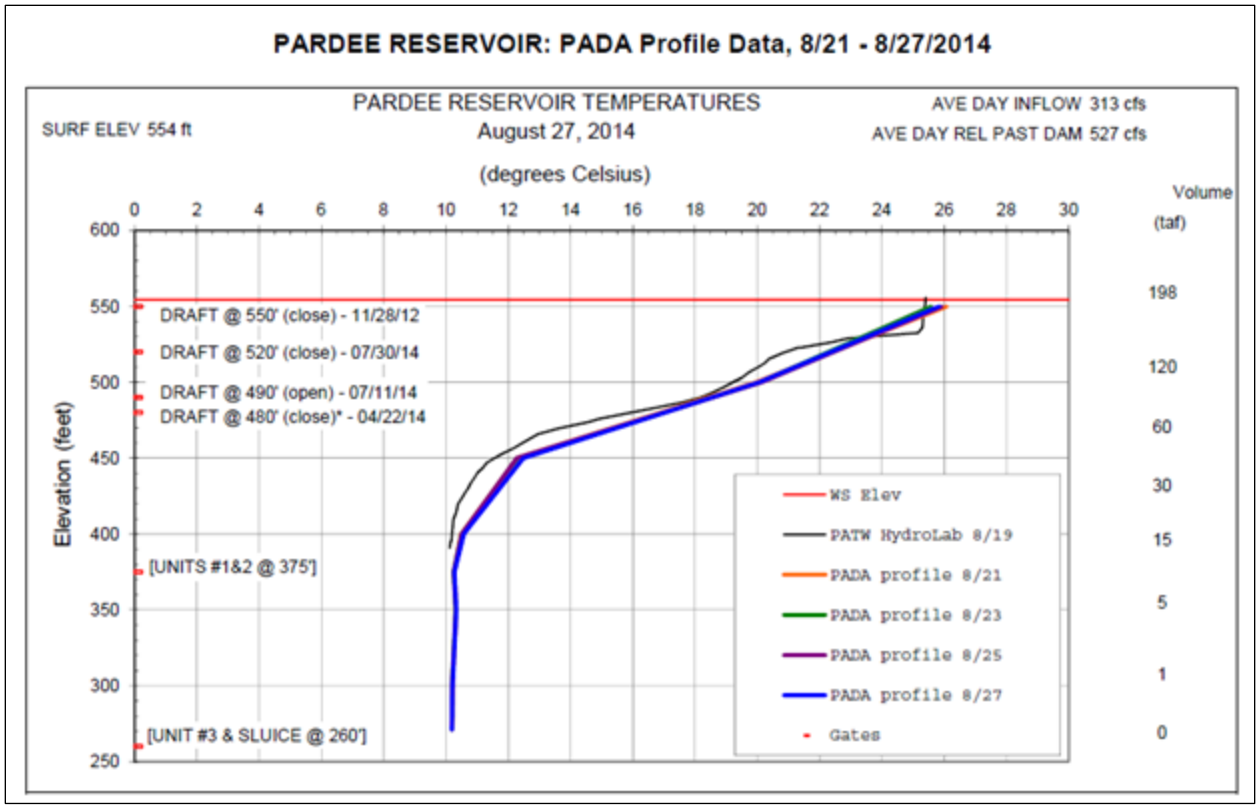


Figure 4.3-13. Pardee Reservoir temperature profile example via thermocouple probes with Station PADA manual profile measurement, August 27, 2014.

Camanche Reservoir

Behind Camanche Dam at Station CAMD, EBMUD has deployed an automatic vertical profiler system anchored by buoy (auto-profiler). The equipment is programmed to take profiles that include depth (meter), temperature (°C), specific conductivity (µS/cm), pH, DO (parts per million), DO percentage saturation, chlorophyll, and battery voltage. When deployed, measurements are generally acquired four times daily every 6 hours and telemetered to operations staff. Profile acquisition generally takes 30 to 40 minutes to collect the profile at CAMD. The auto-profiler is typically deployed in spring after winter storm intensity has subsided and removed after reservoir turnover to prevent equipment damage in winter. A photograph of the auto-profiler is provided in Photo 4.3-1.

Photo 4.3-1. Camanche auto-profiler at Station CAMD.

The Camanche auto-profiler datasets are seasonal, covering spring through late fall of each year (with occasional outages) starting in 2006 to support temperature management (described below). The Camanche auto-profiler provides real-time cold-water tracking in Camanche and supports adaptive operations of the Mokelumne system to balance multiple objectives of water supply, flood control management, water quality, recreation, and hydropower. Manual profiles collected at Station CAMD immediately behind Camanche Dam are used to validate the auto-profiler readings to ensure sensors are providing accurate readings. While a significant portion of 2006 data are missing, contours of water temperature, pH, DO, and specific conductivity for each year from 2007 through 2024 (filtering for the mid-day reading) are plotted in Appendix F, Figures F-9 through F-78.

Figure 4.3-14 provides an example of Camanche auto-profiler temperature profiles (mid-day reading) over several days from July 14 to July 19 plotted alongside a manual profile collected on July 14, 2023. Successive readings from the auto-profiler reveal a short-term warming trend in the epilimnion with stable temperatures in the metalimnion and hypolimnion. This example demonstrates excellent agreement in the temperature readings between the auto-profiler and manual profile readings on July 14. Figure 4.3-15 also plots DO profiles for the same dates and location. Note the increased variability in DO with depth as compared with temperature. The DO increases from 9 mg/L to 10.5 mg/L from the surface water to El. 205 feet before reversing in trend and declining sharply to El. 195 feet where the DO ranges around 8 mg/L before decreasing in trend near the bottom of the reservoir from El. 130 feet to 110 feet. The HOS (described below) was not in service during the period these data were collected. The HOS is used to keep the oxygen from depleting at depth, which can lead to adverse fishery effects downstream. Figure 4.3-16 shows an example of two time series trends starting at the end of June 2007, through the end of October 2007. The blue time series represents the lowest depth temperature reading (i.e., bottom water temperature) from the auto-profiler, and the red time series represents the Camanche hypolimnion or cold-water pool volume.[7] In 2007, the estimated volume of cold water in Camanche on October 31 was 49 TAF with reservoir turnover occurring a few weeks later on about November 22 (not shown).

[7] The volume of water in the reservoir with temperature less than or equal to 16.4°C as defined by the Lower Mokelumne River Project Water Quality and Resource Management Program (EBMUD, USFWS, and CDFG 1998, p. 4).

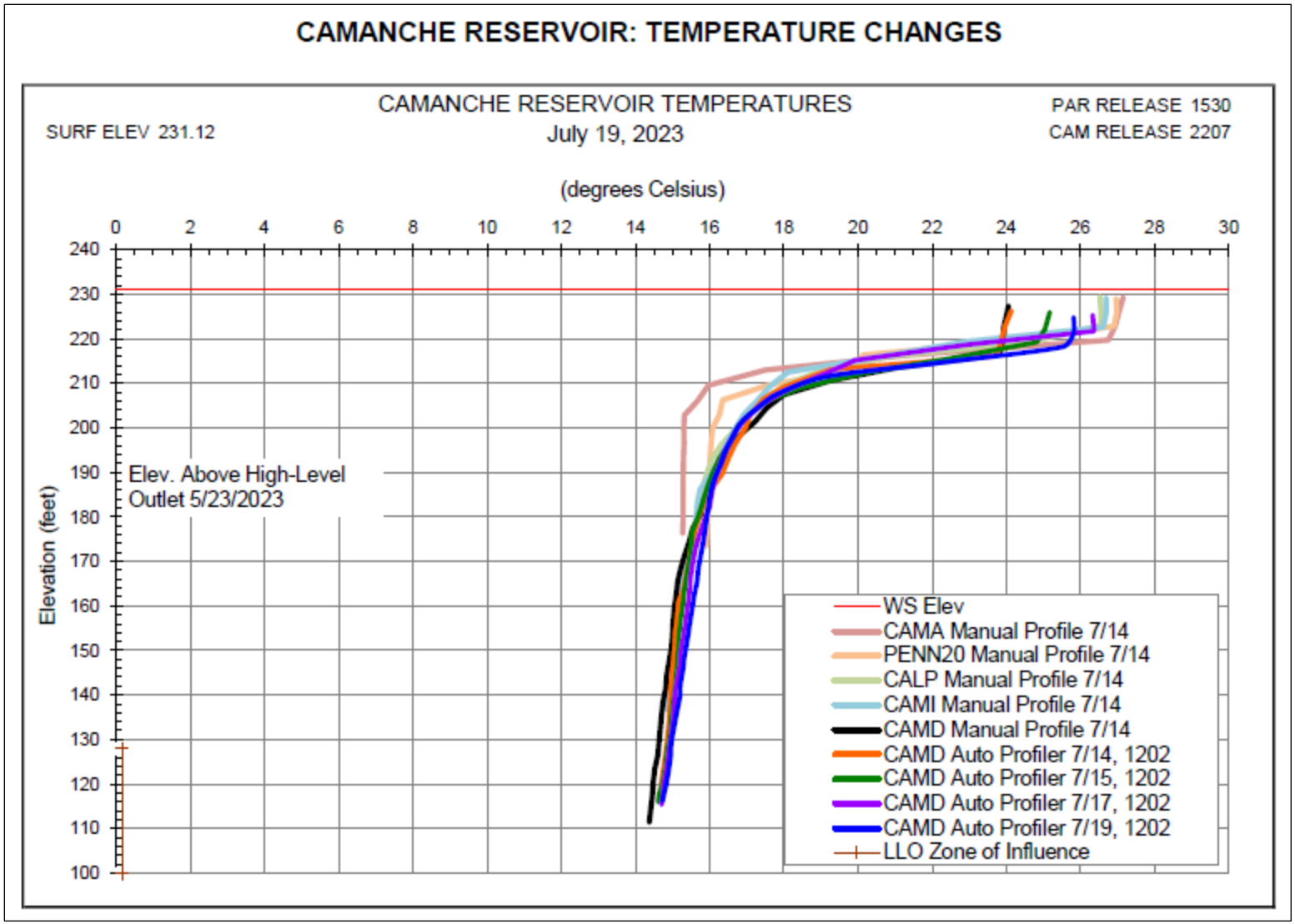


Figure 4.3-14. Example temperature (°C) profile datasets from Camanche Dam (Station CAMD) auto-profiler mid-day reading July 14 through 19 with manual profile on July 14, 2023. (Source: Water Supply Engineering Operations Committee Agenda July 20, 2023, p. 5).

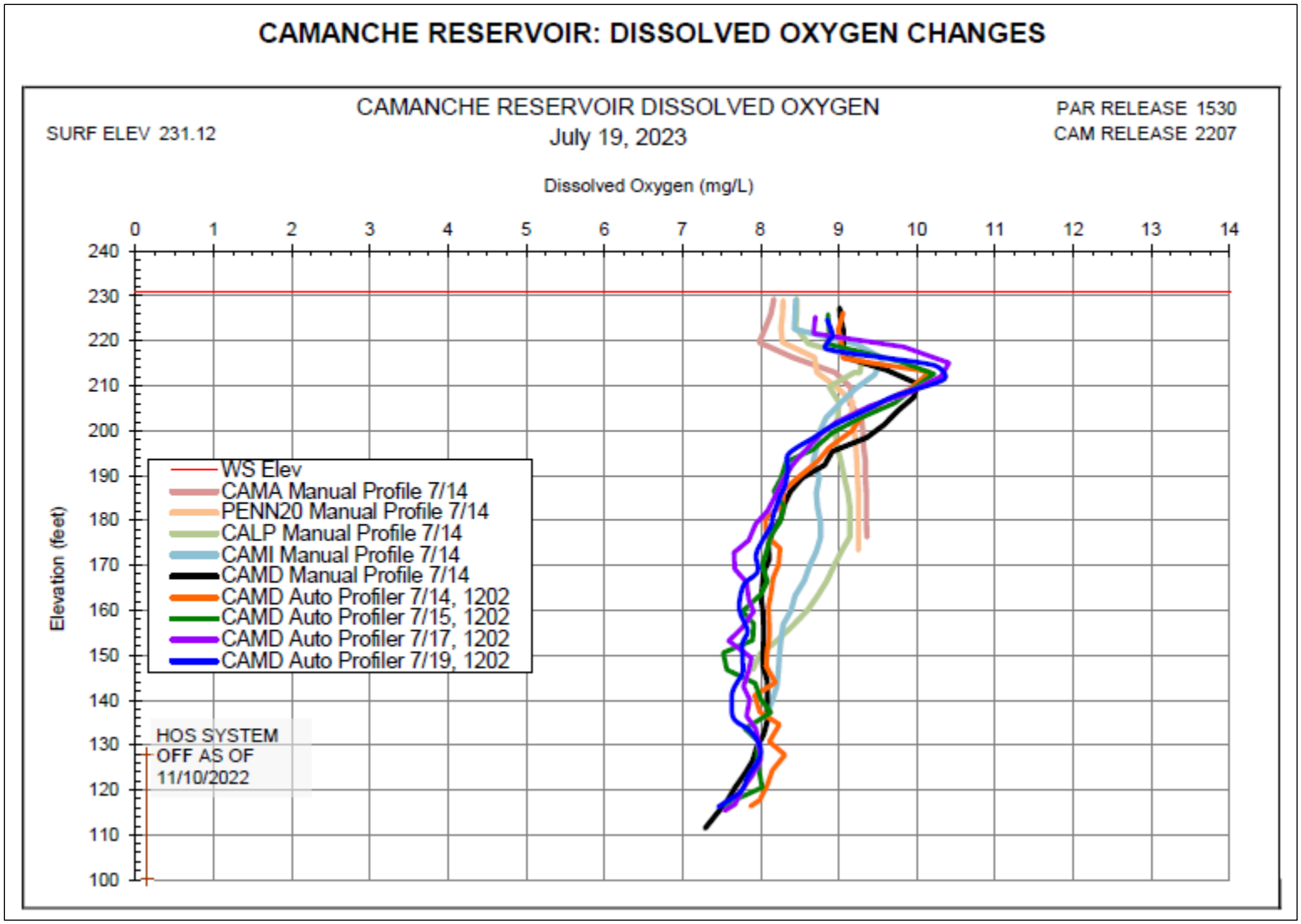


Figure 4.3-15. Example DO (mg/L) profile datasets from Camanche Dam (Station CAMD) auto-profiler mid-day reading July 14 through 19 with manual profile on July 14, 2023. (Source: Water Supply Engineering Operations Committee Agenda July 20, 2023, p. 5).

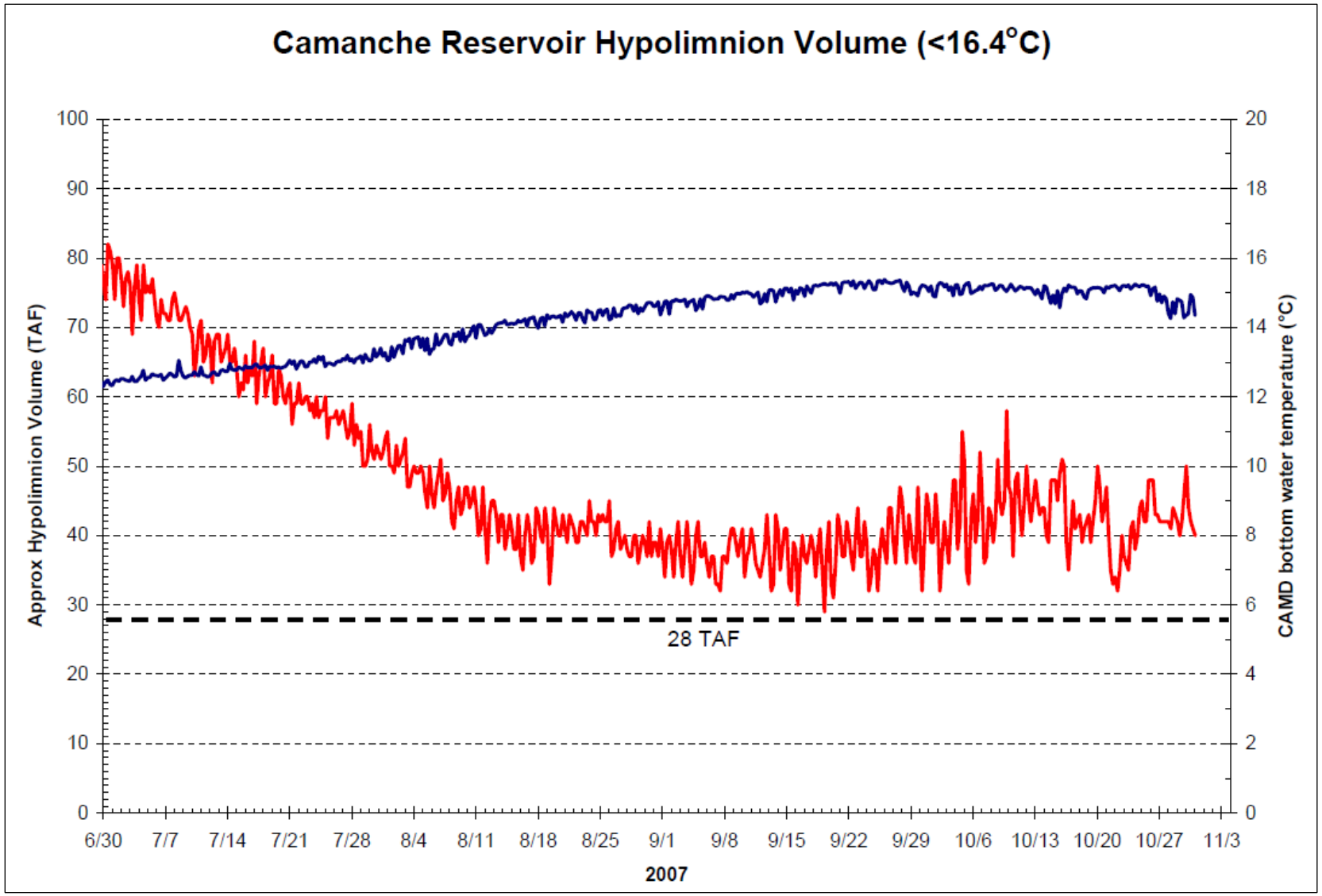


Figure 4.3-16. Camanche Dam (Station CAMD) cold water pool volume time series in red (left axis) and bottom water temperature reading in dark blue (right axis) June 30 through November 8, 2007.

4.3.5.2 RIVER/FACILITY WATER TEMPERATURE AND QUALITY MONITORING STATIONS

Several river or facility in-situ water quality stations are established where water temperature and/or DO data are collected either continuously or at 15-minute intervals. Figure 4.3-17 is a map of the in-situ water temperature and/or DO monitoring stations. Table 4.3-17 provides a list of each in-situ station with a brief description of the POR available, the parameters monitored, and the coordinates for the stations.

Figure 4.3-17. Mokelumne River in-situ water temperature and water quality/temperature sites.

Table 4.3-17. In-situ water temperature and DO stations on Upper and Lower Mokelumne River.

Station Name	Brief Description	Parameters Measured	Frequency	Period of Record	Location
HWY49	Upper Mokelumne River at Highway 49 crossing.	Water Temperature	15-min	1993 to Present	X: 6498509.709 Y: 2300666.712
CAMC	North/South Camanche conduits in valve house (SCADA System)	Water Temperature and DO	Continuous	1994 to Present	X:6411257.417 Y: 2269340.071
Below Camanche USGS station Mokelumne R BL Camanche Dam (11323500).	Lower Mokelumne River Below Camanche Dam.	Water Temperature	15-min	1994 to Present	X: 6407177.656 Y: 2267623.482
Station 11	Downstream of MRFH	DO	Continuous (seasonal[a])	2011 to Present	X: 6408390.585 Y: 2268715.491
Mackville	Lower Mokelumne River at Mackville Road	Water Temperature	15-min	1993 to Present	X: 6391094.632 Y: 2261660.436
Elliott	Lower Mokelumne River at Elliott Road	Water Temperature	15-min	1993 to Present	X: 6370453.319 Y: 2252152.053
Victor	Lower Mokelumne River at Victor Rd	Water Temperature	15-min	1991 to Present	X: 6357886.964 Y: 2245367.177
Below Woodbridge (also known as Golf) USGS station Mokelumne R A Woodbridge CA (11325500).	Lower Mokelumne River downstream of Woodbridge Dam	Water Temperature	15-min	1994 to Present	X: 6331559.733 Y: 2245510.519
Thornton (also known as Frandy)	Lower Mokelumne River above the confluence with the Cosumnes River	Water Temperature	15-min	1991 to Present	X: 6309551.888 Y: 2264727.964

[a] In place typically in late spring/summer through the end of fall; removed during winter, after reservoir turnover.

Daily average, daily maximum, and daily minimum time series plots of water temperature from 1998 through 2024 for each 15-minute station are plotted in Appendix F, Figures F-79 through F-85. The monthly average, monthly maximum, and monthly minimums aggregated from daily records are presented in Appendix F, Tables F-32 through F-52.

DO is monitored continuously at two locations, CAMC and Station 11 immediately downstream of the MRFH. These monitoring locations are used to optimize Camanche releases via sluice and generation to maintain DO levels above 7 mg/L. Figure 4.3-18 is a time series of daily average CAMC water temperatures from 1998 through 2024.

Figure 4.3-19 presents daily average DO levels at Station 11 from 2011 through 2024, during periods when the seasonal sensor was deployed. Typically, these sensors are removed from the river between December and spring to prevent damage from high flows. However, in the 2015–2016 season, the sensor remained in place longer than usual, capturing an extended record that included December 2015 and parts of January 2016. This extended deployment coincided with the fourth consecutive year of drought, resulting in unusually low and steady river flows—ideal conditions for sensor operation. As a result, DO levels rose significantly during this period, reaching the highest values recorded across all seasons. This rise would likely have gone undocumented had the sensor been removed at the usual time.

Table 4.3-18 presents the monthly average temperatures at CAMC from 1998 through 2024, and Table 4.3-19 presents the monthly average DO at Station 11 from 2011 through 2024.

Extensive plots of water quality field data described above are available in EBMUD's weekly operations committee agenda records maintained by EBMUD's Water Operations and Maintenance Department. Examples from EBMUD's operations committee agendas are provided in Figure 4.3-13, Figure 4.3-14, and Figure 4.3-15, and Figure 4.3-16 above.

In October 2022, EBMUD installed an automated water quality monitoring station on the Mokelumne River at Station Highway 49 that measures the same water quality parameters as the Pardee auto-profiler: temperature (°C), pH, DO (mg/L), conductivity (µs/cm), oxidation-reduction potential (millivolts), chlorophyll (µg/L), BGA – PC (µg/L), turbidity (NTU), and fluorescence.

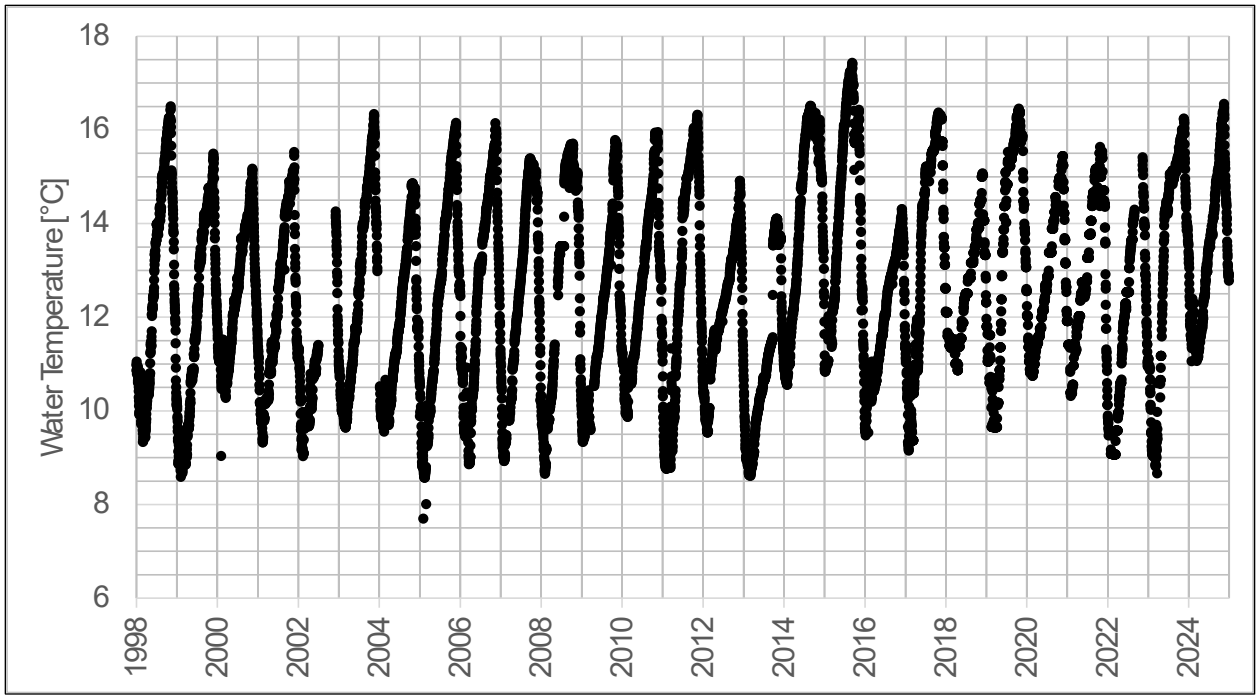


Figure 4.3-18. CAMC water temperature time series, daily average raw data, 1998–2024.

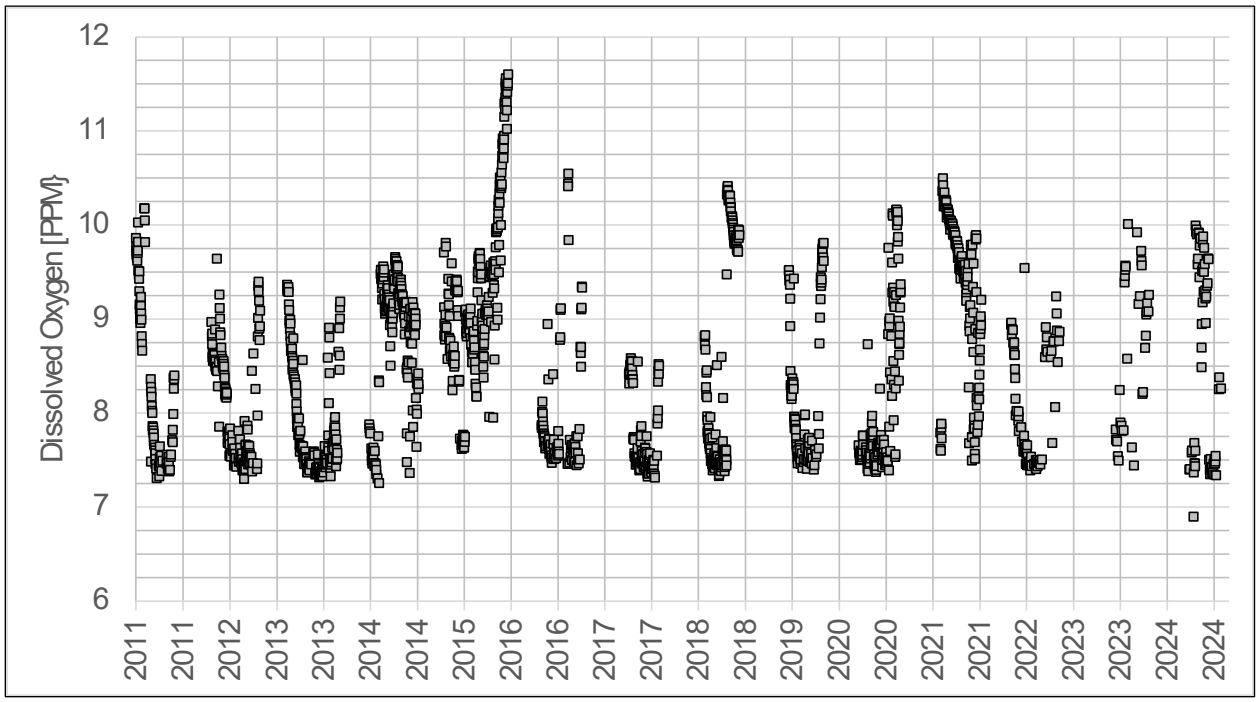


Figure 4.3-19. Station 11 DO time series, daily average raw data, 2011–2024.

Table 4.3-18. Monthly average water temperature (°C), Station CAMC, 1998–2024.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1998	10.6	10.3	9.6	10.4	11.6	13.1	14.0	14.7	15.4	16.1	15.2	11.9	12.7
1999	9.5	9.0	9.0	9.6	10.7	11.5	12.6	13.6	14.1	14.5	14.9	13.3	11.9
2000	11.3	11.0	10.6	11.0	11.8	12.4	12.9	13.6	14.0	14.4	14.6	12.4	12.5
2001	10.6	9.7	10.2	10.6	11.3	11.8	12.8	13.5	14.3	14.7	15.0	12.0	12.2
2002	10.5	9.4	9.9	10.0	10.6	11.1	11.4	N/A	N/A	N/A	N/A	12.8	10.7
2003	10.5	9.9	9.9	10.6	11.3	12.0	13.0	14.1	14.7	15.4	15.7	13.8	12.6
2004	10.0	9.9	9.8	10.3	11.0	11.5	12.2	12.9	13.6	14.5	14.4	11.7	11.8
2005	9.6	8.6	9.6	10.4	11.2	12.3	12.9	13.9	14.6	15.4	15.9	13.5	12.3
2006	11.1	9.6	9.3	10.0	11.3	12.9	13.3	14.1	14.7	15.2	15.7	12.9	12.5
2007	9.8	9.2	9.9	10.6	11.7	12.4	13.2	14.3	15.2	15.2	14.8	12.4	12.4
2008	9.6	9.2	9.9	10.7	11.4	13.2	13.7	15.3	15.5	15.3	14.9	12.2	12.6
2009	9.5	9.9	9.9	10.6	11.1	11.7	12.3	12.9	13.6	14.9	15.3	12.4	12.0
2010	10.8	10.2	10.6	11.1	11.7	12.5	13.1	13.8	14.4	15.3	15.5	12.7	12.6
2011	9.5	9.1	9.5	9.9	11.6	12.9	14.5	15.0	15.4	15.9	15.7	12.2	12.6
2012	10.1	9.8	11.0	11.5	11.7	12.0	12.4	12.7	13.2	13.7	14.2	13.0	12.1
2013	9.6	8.8	8.8	9.5	10.1	10.4	10.7	11.2	11.9	13.9	13.8	12.2	10.9
2014	10.8	10.9	11.9	12.6	13.7	15.0	15.9	16.4	16.2	16.1	15.6	13.9	14.1
2015	11.0	11.7	12.0	13.0	14.4	15.6	16.5	17.1	16.8	15.9	15.2	11.6	14.2
2016	10.0	10.5	10.6	10.7	11.3	11.8	12.3	12.8	13.1	13.4	13.9	13.2	12.0
2017	10.5	10.0	10.1	11.4	12.8	14.5	15.1	15.3	15.6	16.1	16.2	13.8	13.5
2018	11.8	11.4	11.3	11.1	11.6	12.2	12.6	13.0	13.4	13.9	14.6	13.7	12.6
2019	11.4	10.5	9.7	10.1	12.0	14.2	15.1	15.4	15.8	16.3	15.8	13.6	13.3
2020	11.5	10.9	11.2	11.5	12.0	12.5	13.1	13.7	14.3	14.7	15.1	13.1	12.8
2021	11.4	10.5	11.4	12.0	12.6	12.6	13.5	14.4	15.0	15.1	14.9	12.4	13.0
2022	9.6	9.1	9.3	10.2	11.4	12.3	13.0	13.9	N/A	N/A	14.6	12.0	11.5
2023	10.3	9.2	9.3	10.9	13.0	14.4	14.9	15.0	15.3	15.6	15.9	14.1	13.2
2024	12.1	11.7	11.3	11.6	12.2	13.1	13.7	14.3	15.0	15.8	16.0	13.7	13.4

Table 4.3-19. Monthly average DO at Station 11 below Camanche, 2011–2024.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2011	N/A	N/A	N/A	N/A	9.7	9.3	9.7	7.8	7.5	7.5	8.1	N/A	8.5
2012	N/A	N/A	N/A	N/A	8.6	8.6	7.9	7.6	7.5	7.6	8.1	9.1	8.1
2013	N/A	N/A	N/A	9.1	8.3	7.7	7.5	7.5	7.4	7.7	7.7	8.8	8.0
2014	N/A	N/A	N/A	7.8	7.5	9.2	9.1	9.4	9.2	8.6	8.6	N/A	8.7
2015	N/A	N/A	9.0	9.1	9.0	7.9	8.9	8.9	9.1	9.2	9.6	10.7	9.1
2016	11.4	N/A	N/A	N/A	N/A	7.8	7.7	7.6	8.9	8.5	7.6	8.8	8.6
2017	N/A	N/A	N/A	N/A	N/A	N/A	8.5	7.6	7.5	7.5	7.9	N/A	7.8
2018	N/A	N/A	N/A	N/A	N/A	8.6	7.7	7.5	7.6	10.2	9.8	N/A	8.6
2019	N/A	N/A	N/A	N/A	N/A	N/A	8.7	7.8	7.6	7.6	7.8	9.6	8.2
2020	N/A	N/A	N/A	N/A	7.5	7.6	7.7	7.6	7.6	8.7	9.2	N/A	8.0
2021	N/A	N/A	N/A	N/A	7.7	9.9	10.0	9.7	9.5	8.8	8.6	9.2	9.2
2022	N/A	N/A	N/A	8.8	8.1	7.7	7.5	7.5	8.5	8.5	8.8	N/A	8.2
2023	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.8	9.1	7.5	9.5	8.8	8.5
2024	9.3	N/A	N/A	N/A	N/A	N/A	7.4	9.6	9.5	7.4	8.1	N/A	8.5

4.3.5.3 BACTERIAL WATER QUALITY SAMPLING

EBMUD conducts bacteriological sampling at the following locations with the noted frequency:

- PACT WTP – intake pumps off Pardee Reservoir – Monthly
- PARA WTP – intake pumps off Pardee Reservoir – Twice a month
- CASS WTP – intake pumps off Camanche Reservoir – Twice a month
- Upper Mokelumne River – North, Middle, South – Quarterly
- Camanche Shoreline beaches – Twice a month from May to mid-September

Data sampling results for two locations—Camanche South Shore Recreation Area Beach Cove and at Highway 49, upstream of Pardee in the Mokelumne River—are provided in Figure 4.3-20 and Figure 4.3-21, respectively.

For the raw water sampling that is done, although EBMUD cannot control levels, the water is treated to meet drinking water standards.

EBMUD follows California Department of Public Health guidelines for freshwater beaches and works with Calaveras County Public Health Department, which also monitors the sampling results along with beach closures and re-openings. Coliform levels have been high in the past due to geese grazing and deposition of fecal matter in combination with

fluctuating reservoir levels. The threshold levels (Most Probable Number/100 milliliters) for Beach Cove are 10,000 for Total Coliform, 400 for Fecal Coliform, and 235 for *E. coli*. Signs are posted on the beach, and access is closed when these thresholds are surpassed.

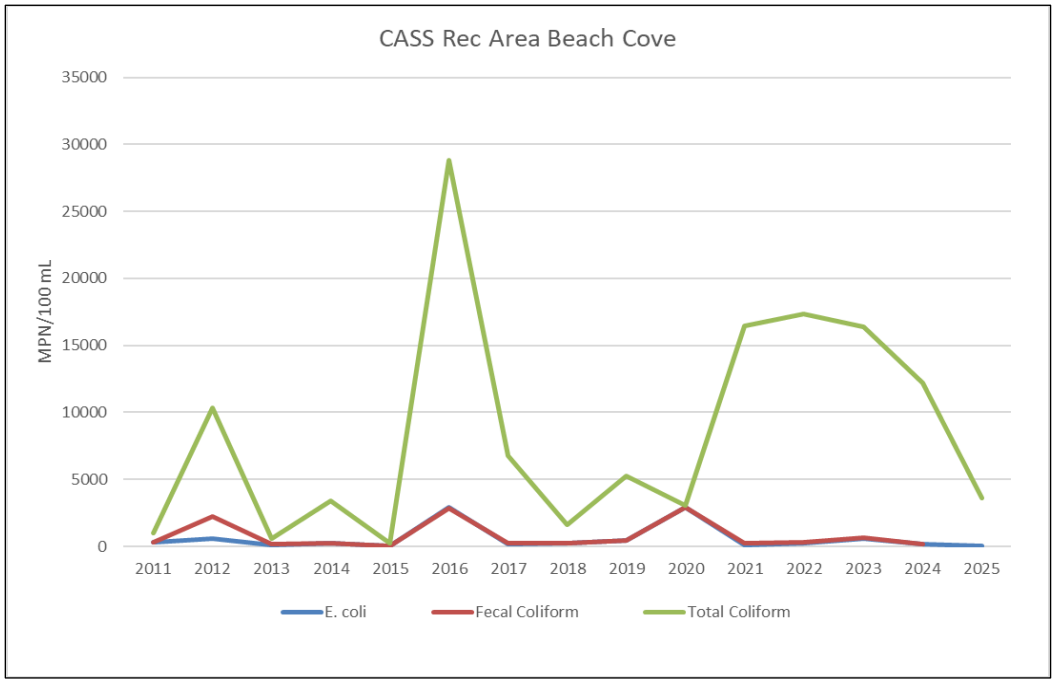


Figure 4.3-20. Camanche South Shore Coliform sampling results 2011-2025.

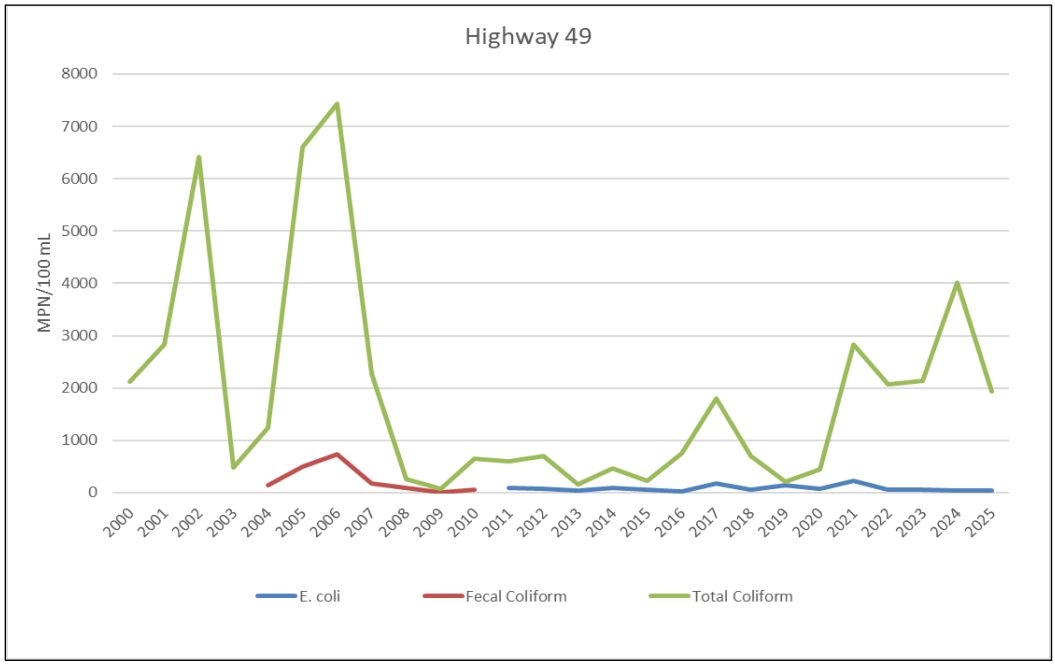


Figure 4.3-21. Highway 49 Coliform sampling results 2000-2025.

4.3.5.4 TOXIC ALGAE SAMPLING

In 2016, EBMUD developed a comprehensive Cyanotoxin Management Plan. Field staff conduct regular visual inspections of all EBMUD source water reservoirs to identify visible algae blooms or odors for signs of algal blooms. When blooms or odors are detected, a semi-quantitative Abraxis "dipstick" test kit is used to quickly determine the presence of cyanotoxins. If the test indicates the presence of toxins, a water sample is collected and submitted for laboratory analysis to identify and quantify the toxin. The EBMUD lab maintains a contract with a commercial lab that can run these samples quickly.

At Pardee Reservoir, plankton samples for harmful algal blooms (HABs) and cyanotoxins are collected from the surface and from the level of the open gates of the outlet towers. This monitoring is usually once a month from November through February, and then twice per month from March/April to September/October. EBMUD's laboratory identifies and counts the plankton in the samples to the genus level. If a significant number of algae with cyanotoxin producing potential were found, cyanotoxin samples would be collected for analysis. Such toxin-producing algae have not been detected in the main body of Pardee Reservoir. If the presence of cyanotoxins was suspected or confirmed, appropriate signage would be placed in the area to warn visitors of the danger. Body contact, whether human or canine, is never allowed in Pardee Reservoir.

At Camanche Reservoir, plankton samples are collected from the surface and from the level of the open gates of the outlet towers at least monthly and more frequently when algal activity is high. EBMUD's laboratory identifies and counts the plankton in the samples to the genus level. If a significant number of algae with cyanotoxin-producing potential were found, cyanotoxin samples would be collected for analysis. Such toxin-producing algae have not been detected in the main body of Camanche Reservoir at sufficient concentrations to trigger additional laboratory sampling. In an abundance of caution, cyanotoxins were collected weekly for 2 months at CASS WTP in 2015 when cyanotoxins were detected in Rabbit Creek, which at the time was not flowing into the reservoir at the surface level due to low water levels. All results at CASS WTP were non-detect.

Cyanotoxins can be harmful, potentially even fatal, to people or animals that come into contact with or drink the water. Additionally, it is possible for fish and waterfowl to accumulate the toxins in their organs, which can in turn present a hazard to humans who may consume the fish or waterfowl. If the presence of cyanotoxins was suspected or confirmed, appropriate signage would be placed in the area to warn visitors of the danger.

If cyanotoxins were suspected near a drinking water intake to the treatment plant(s), EBMUD would take action to protect public health. Various operational options are

available, and the option(s) selected depend on many factors. A water treatment plant may be shut down, or operators may evaluate appropriate gate opening elevations to minimize loading to the treatment plant. If the plant(s) remain in service, testing would be conducted to confirm that treatment plant processes are eliminating toxins in the treated water, and adjustments to processes will be made if necessary. If toxins were present in the treated water, then appropriate notifications would be made to regulatory agencies and the public.

4.3.5.5 HEAVY METAL TESTING

Located near Camanche Reservoir and partially within the Project boundary (Figure 4.3-22) is a historical mine called Penn Mine that operated from the mid-1800s to its closure in 1952. Penn Mine used to produce copper, zinc, gold, and silver and is located approximately 0.5 mile upstream of the Lancha Plana Bridge on the shore of the Mokelumne River in the upper reach of Camanche Reservoir. Mining activities were conducted intermittently at the site from the 1860s until the 1950s. The primary environmental concern associated with the abandoned mine was the generation of acid mine drainage, resulting in discharge of low pH water and elevated concentrations of heavy metals (including copper and zinc) into the Mokelumne River. In the 1960s, Camanche Dam was constructed and the area near this portion of the Mokelumne River, and the former Penn Mine was flooded by Camanche Reservoir.

EBMUD and CVRWQCB jointly conducted two restoration projects at Penn Mine in the 1970s and in the late 1990s in an effort to provide long-term water quality protection. The second restoration project was completed in late 1999 and included removing and encapsulating mine waste into an on-site landfill. Additionally, geochemical amendments were applied to the nearby ground surface and drainage channels to neutralize residual acid mine drainage and the natural acidity of native materials.

EBMUD was required to report to FERC semi-annually from 2000 to 2003 measurements of pH, copper, and zinc from sites on the drainage from the Penn Mine site and within Camanche Reservoir (Order Amending License, August 17, 1999). EBMUD continues to monitor water quality in Camanche Reservoir on a monthly basis at two locations adjacent to the mine site. Figure 4.3-23 shows the monitoring results from 2021-2025. The data collected at the site from January 2000 through June 2022 have been compiled, analyzed, and reported to SWRCB in two separate reports (2012 and 2022). Both Post-Restoration Monitoring Reports documented that the restoration efforts have been successful in consistently reducing the annual dissolved metal loadings to Camanche Reservoir. Ongoing work at the site also involves periodic pumping of low pH leachate from the landfill.

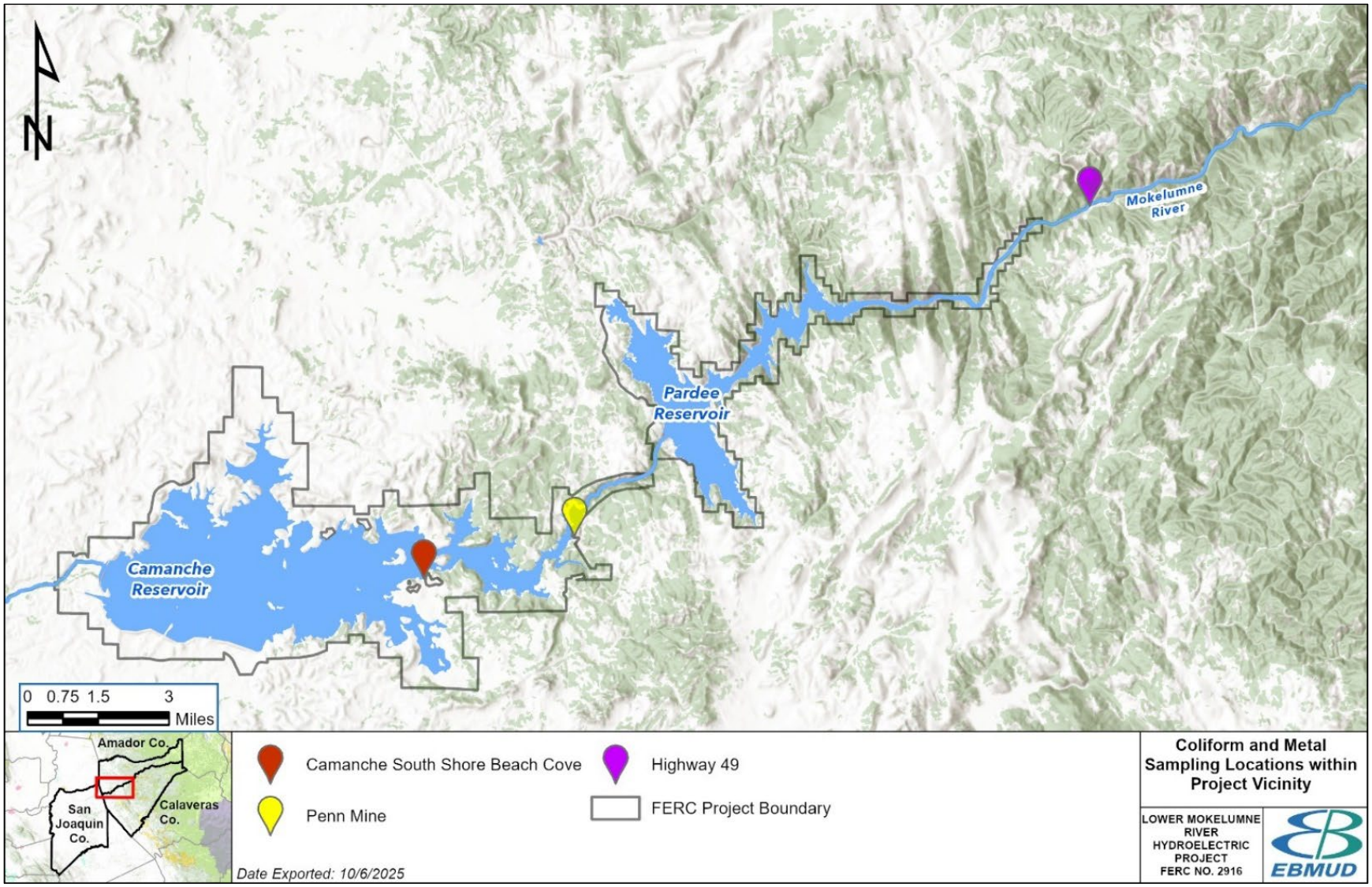


Figure 4.3-22. Coliform and Metal Sampling Locations within Project Vicinity.

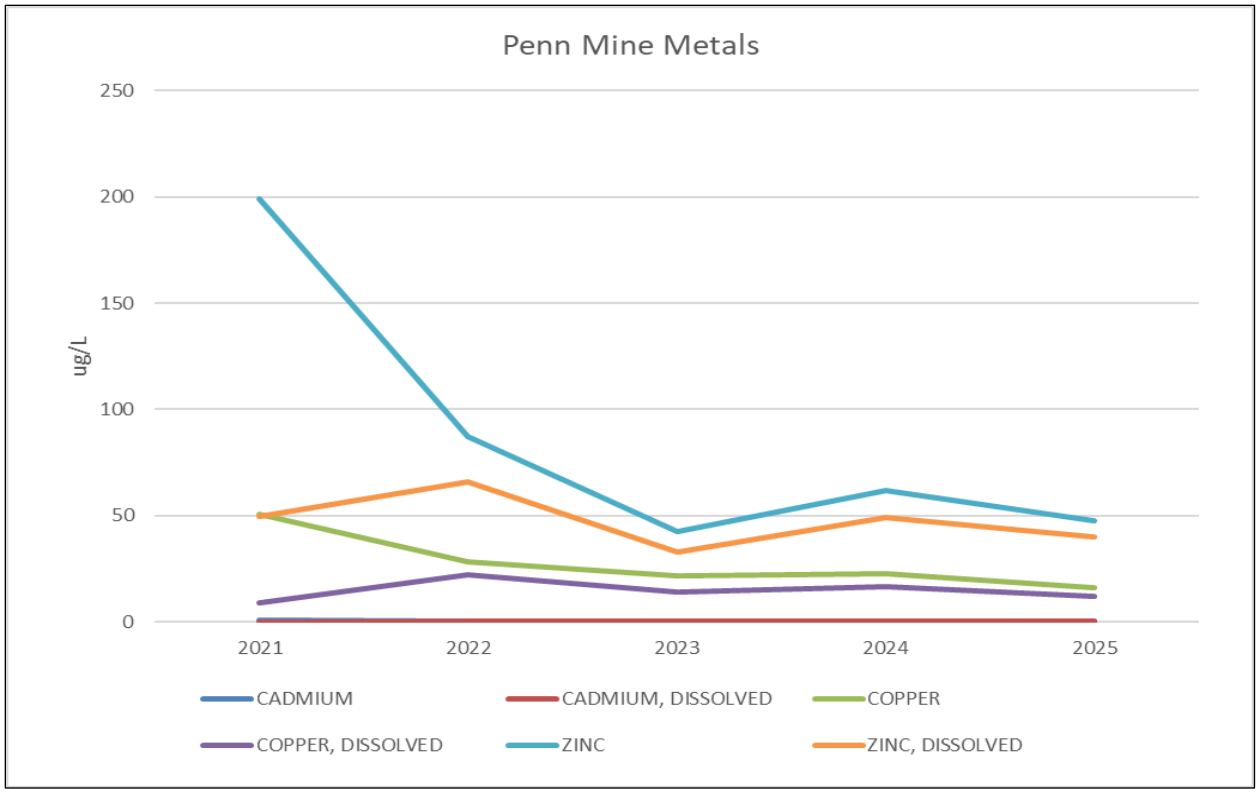
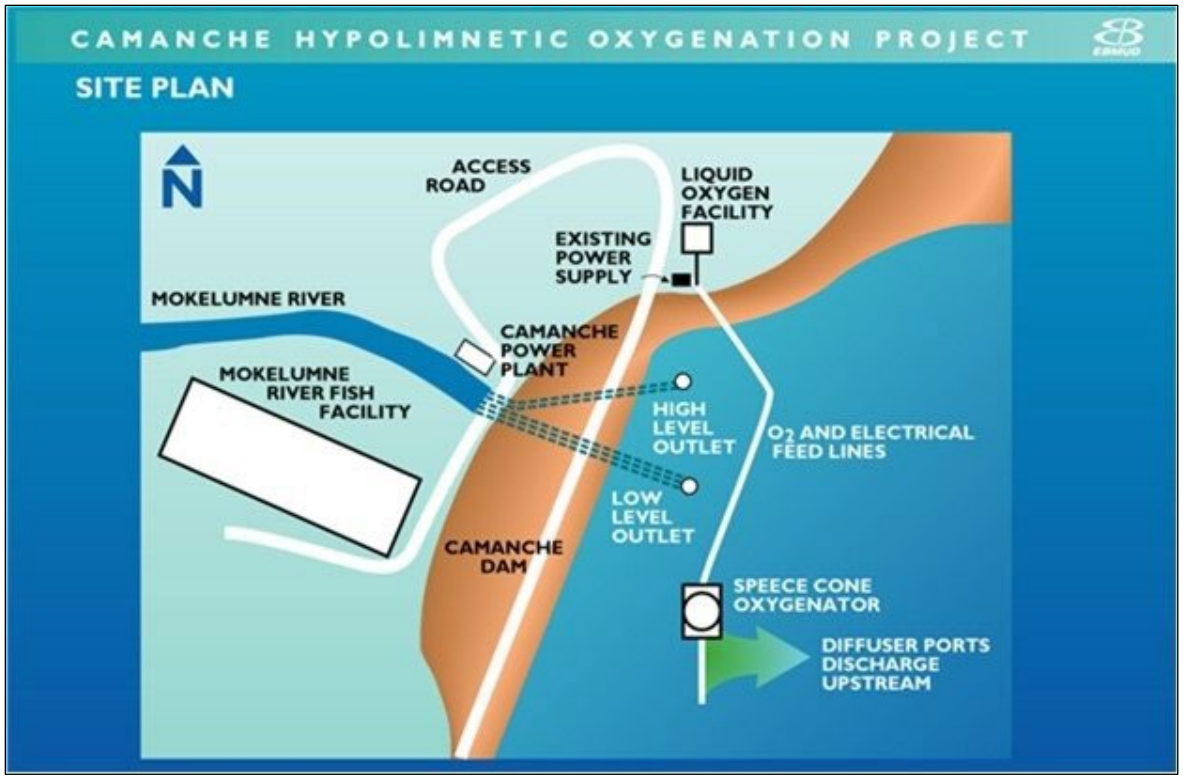


Figure 4.3-23. Penn Mine metals sampling results 2021-2025.

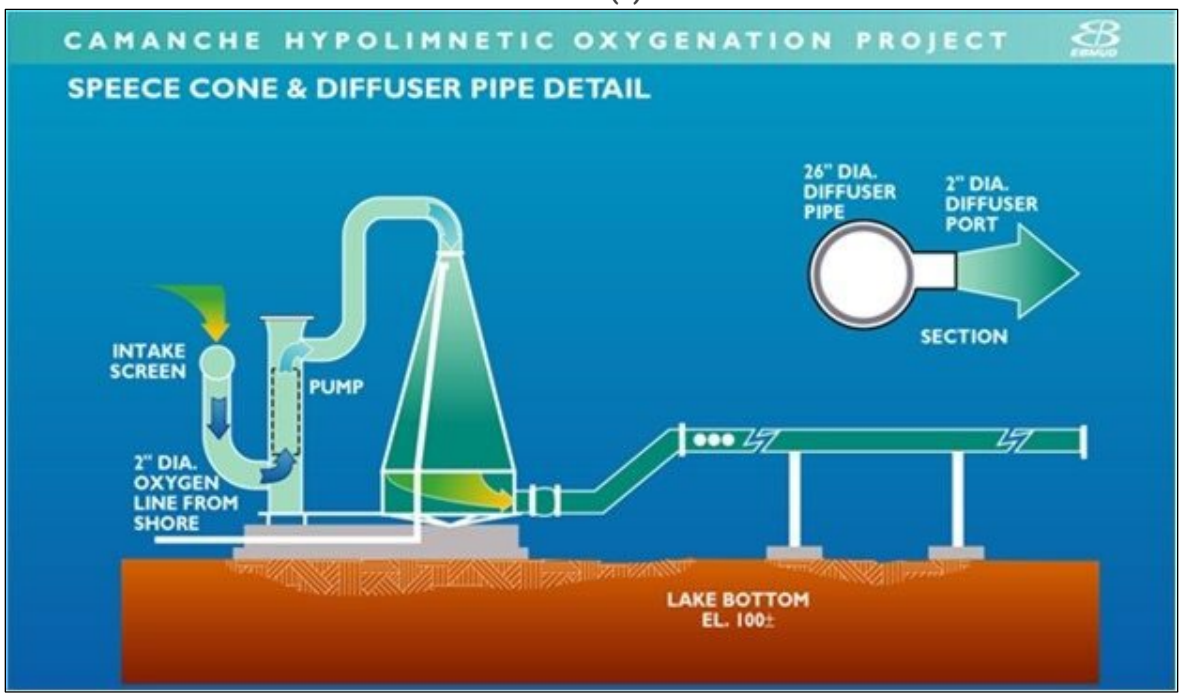
4.3.5.6 CAMANCHE HYPOLIMNETIC OXYGENATION SYSTEM

Poor water quality caused fish losses in the MRFH in the late 1980s. Key causes of the fish losses were identified as high temperatures from early turnover and hypolimnetic anoxia leading to the formation of hydrogen sulfide in the reservoir release water downstream and the MRFH supply water. A study conducted in the early 1990s recommended installation of an HOS in Camanche Reservoir to prevent conditions leading to the presence of hydrogen sulfide in Camanche Reservoir releases. The HOS project objectives were to eliminate hydrogen sulfide, prevent anoxia from occurring in the hypolimnion, and generally increase the DO level in the hypolimnion.

The Camanche HOS was designed and installed in approximately 1993. The HOS construction cost was $1.5 million. Annual costs include up to $50,000 for liquid oxygen and up to $25,000 to operate the Speece cone pump. Figure 4.3-24 shows the location of the HOS in plan view with a longitudinal profile of the system. Photo 4.3-2 is a photograph taken of the Speece cone under construction with crews working to assemble the system.



(a)



(b)

Figure 4.3-24. Camanche HOS (a) plan map and (b) Speece cone and diffuser design in profile view.

The HOS system has been a successful project resulting in the enhancement of water quality. Figure 4.3-25 is a depiction of three water quality variables over an extended period of operation that includes several years before installation and several years after the operation of the HOS. Figure 4.3-25(a) shows suppression of ammonia as nitrogen, with operation of the HOS limiting concentrations to less than 0.2 mg/L where higher concentrations exceeding 1 mg/L were measured before HOS operations. Figure 4.3-25(b) and Figure 4.3-25(c) show how the HOS operation held the concentrations of total phosphate and chlorophyll-a low compared to the period before the HOS was installed.

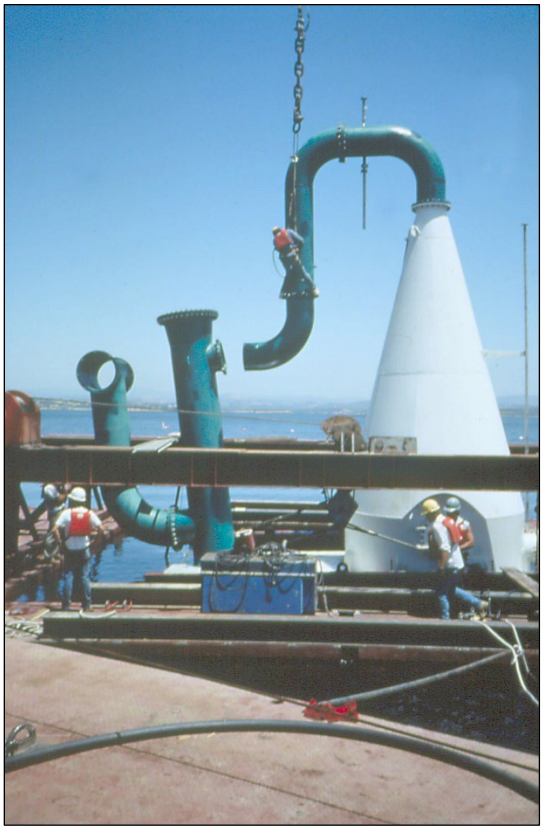
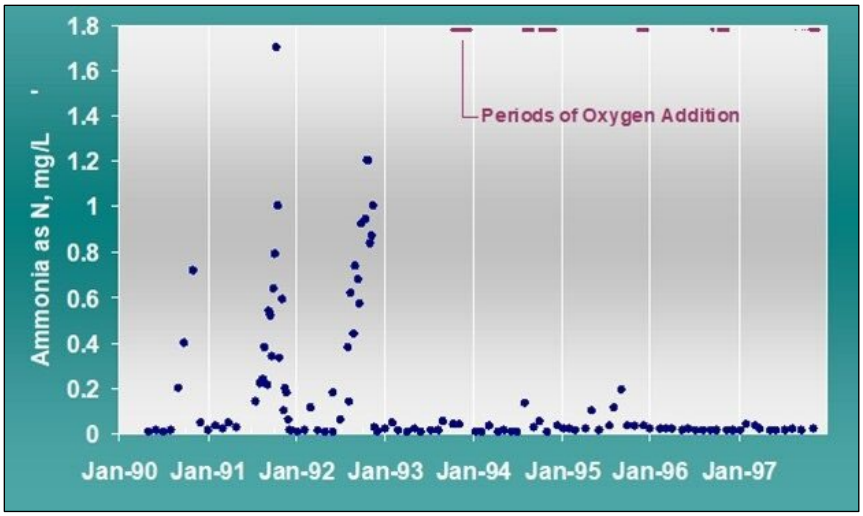


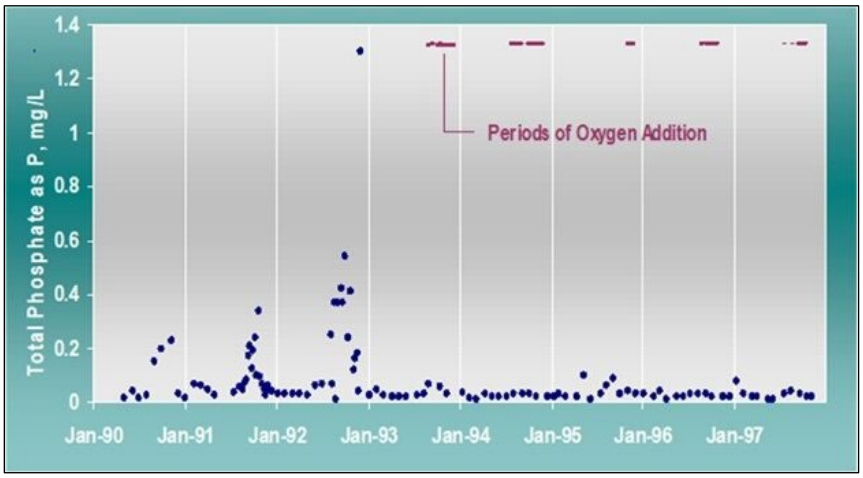
Photo 4.3-2. Speece cone construction. 1992.

Figure 4.3-26 presents a more recent example of the HOS effect using 2024 data. Figure 4.3-26(a) presents the DO profile in early August measured by the auto-profiler at Station CAMD (see description above). Figure 4.3-26(a) shows several DO profiles at CAMD in early August before the HOS is started up. The DO is starting to drop below 6 mg/L below El. 170 feet msl and reading below 5 mg/L near the bottom of the reservoir. The HOS was started on August 20; then, after about a month of operation, the DO continued to decline in the elevation band from El. 180 feet msl to El. 160 feet msl. Then, a higher DO concentration at about 5 mg/L or slightly higher is recorded between El. 150 feet msl to El. 110 feet msl in Figure 4.3-26(b).

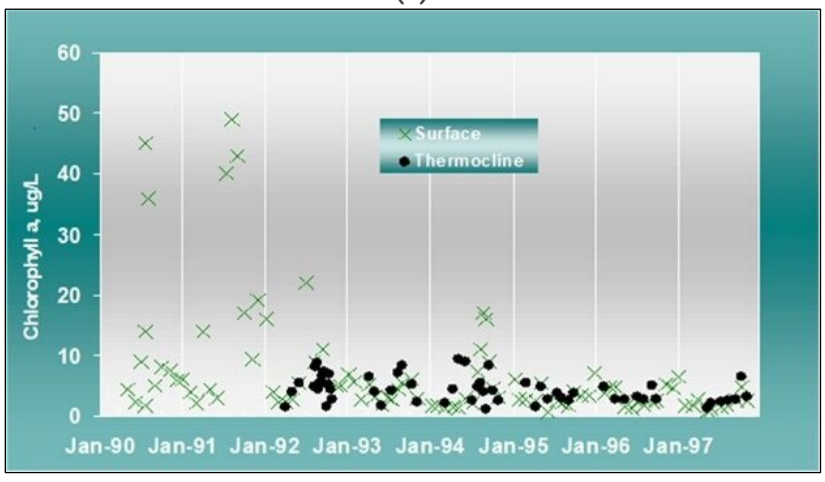
There have been no catastrophic fish losses due to poor water quality since installation of the HOS system.



(a)

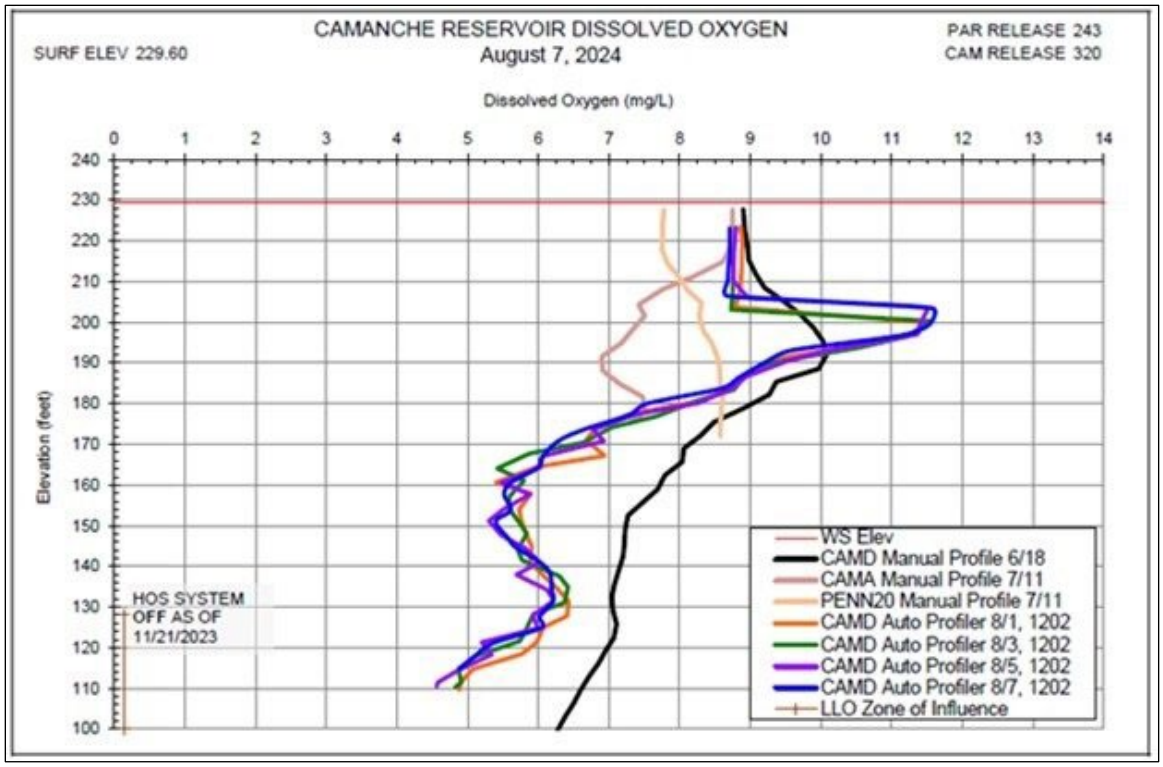


(b)

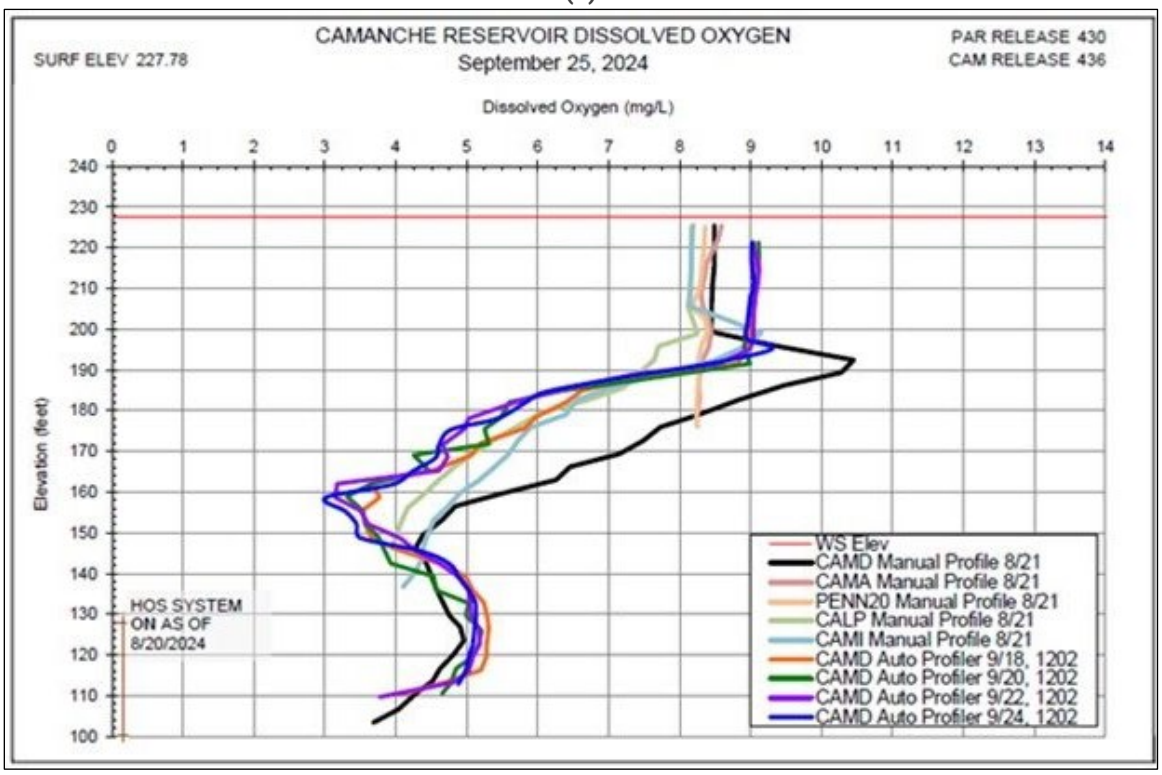


(c)

Figure 4.3-25. Water quality effect before and after HOS operation 1990-1997, (a) hypolimnetic ammonia, (b) hypolimnetic total phosphate, and (c) chlorophyll-a.



(a)



(b)

Figure 4.3-26. Example of elevated DO within the Camanche hypolimnion resulting from the HOS operation on (a) August 7, 2024, and (b) September 25, 2024.

4.3.6 PHYSICAL CHARACTERISTICS OF PROJECT RESERVOIRS AND STREAM REACHES

4.3.6.1 RESERVOIRS

The Project reservoirs are described in Section 3.3.7. Summary data for each reservoir are provided in Table 4.3-20.

Stream Gradients

The gradient of the river reaches directly affected by the Project are provided in Table 4.3-21. Locations of the related stream reaches can be seen in Figure 4.3-27.

Table 4.3-20. Lower Mokelumne River reservoir data.

Reservoir	Surface Area (acres)	Operable Storage Capacity (acre-feet)	Maximum Depth / Mean Depth (ft)	Flushing Rate (days)	Min El. (feet, Project Datum)	Normal Max El. (feet, Project Datum)	Approx. Reservoir Shoreline Length (miles)	Approx. Residence Time (days)	Substrate Composition
Pardee	2,260	188,208	316 / 90	52	395	567.65	44	52	Moderately large subangular monolithic rock cobbles derived from Gopher Ridge and Salt Springs formations
Camanche	7,800	416,696	145 / 51	135	104	235.5	67	135	Predominantly alluvial deposits consisting of silty-sands and gravels with occasional cobbles

Table 4.3-21. Gradients of river reaches in the vicinity of the Project.

Reach	Approx. Length (mi)	Upstream Terminus El. (feet, NAVD 88)	Downstream Terminus El. (feet, NAVD 88)	Average Gradient (feet/mile)	Percent Drop (%)
Mokelumne River inflow to Pardee Reservoir	4.0	Mok R at the Mok R near Mok Hill USGS stream gage El. 587.76 feet	Mok R at Full Pool Water Level in Pardee Reservoir El. 569.65 feet	4.5	0.085
Mokelumne River from Camanche to Woodbridge Dam	24.7	Mok R below Camanche Dam El. 98 feet	Mok R at Woodbridge Dam El. 20 feet	3.2	0.050

Reach	Approx. Length (mi)	Upstream Terminus El. (feet, NAVD 88)	Downstream Terminus El. (feet, NAVD 88)	Average Gradient (feet/mile)	Percent Drop (%)
Mokelumne River from Woodbridge Dam to Consumnes River Confluence	14.9	Mok R below Woodbridge Dam El. 18 feet	Mok R at Consumnes River Confluence El. -1 foot	1.3	0.024

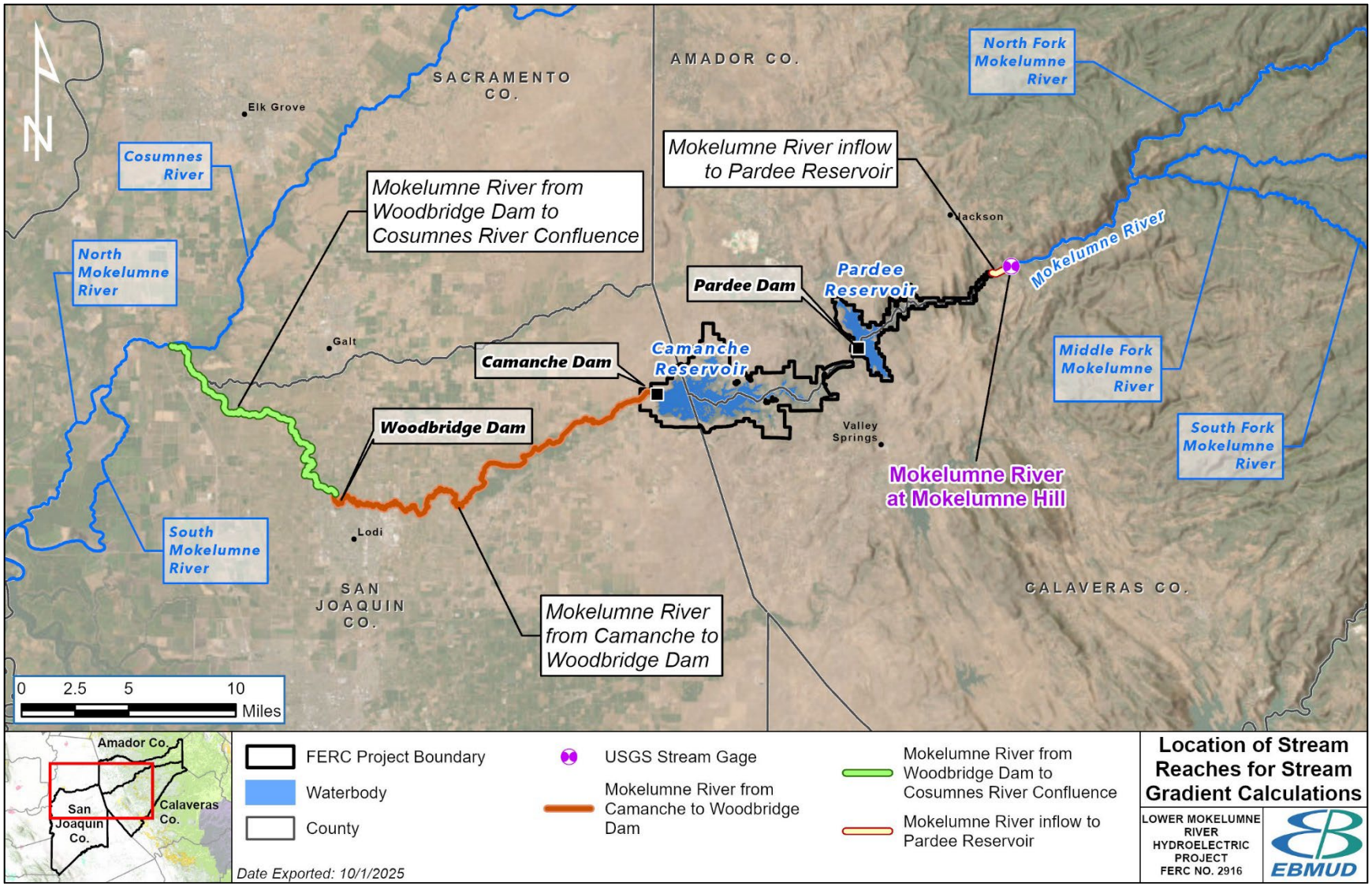


Figure 4.3-27. Stream reaches for stream gradient calculations.

4.4 FISH AND AQUATIC RESOURCES

This section describes aquatic physical habitat and fish and aquatic resources in the Mokelumne River, Pardee Reservoir, and Camanche Reservoir, as they relate to EBMUD's Lower Mokelumne River Project. FERC content requirements for this section are specified in 18 CFR § 5.6(d)(3)(iv).

The fish and aquatic resource information provided in this section is based on the current understanding of existing environmental resources in the Project area. Long-term monitoring programs conducted by EBMUD have documented a wide variety of native and introduced species (Table 4.4-1 and Table 4.4-2). Endangered Species Act (ESA)-listed species are covered in greater detail in Section 4.7.

The Project area is delineated into four sections: (1) Mokelumne River upstream of Pardee Reservoir; (2) Pardee Reservoir; (3) Camanche Reservoir; and (4) Lower Mokelumne River.

4.4.1 MOKELUMNE RIVER UPSTREAM OF PARDEE RESERVOIR

4.4.1.1 EXISTING AQUATIC HABITAT

The Lower Mokelumne River Project does not operate or affect the hydrology in the Mokelumne River upstream of Pardee Reservoir. The Upper Mokelumne River watershed is regulated primarily by PG&E's FERC Project No. 137 and several upstream water users.

4.4.1.2 WATER TEMPERATURE AND WATER QUALITY

Mokelumne River water temperature data are collected upstream of the Project boundary at Station Highway 49 (see Section 4.3.5 for additional site information). Data from 1998 through 2024 indicate that daily average temperatures are lowest in January (on average 5.6°C) and highest in July (on average 16.1°C). See Volume II – Appendix F, Figures F-79 through F-85 for a complete summary of available temperature data from this station.

With water quality there are no known issues with DO, pH, turbidity, or other water quality parameters. For example, at station MR1 in the Mokelumne River above PG&E's Electra Powerhouse where water quality data were collected in 2017 and 2020 by PG&E (PG&E 2022), the range for each parameter measured was as follows: DO 8.0–12.1 mg/L (83–124 percent saturation); specific conductance 22–70 micromhos per centimeter; pH 7.3–8.4, turbidity 0.6–13.3 NTU; total hardness 8–32 mg/L; total soluble solids (TSS) <1.0–14 (mg/L); dissolved copper ranged from 0.14–0.64 µg/L; total alkalinity ranged from 11–35 mg/L; total nitrate as N <0.2; and fecal coliform <1.8–110 Most Probable Number/10 milliliters.

Gradient, Channel Geometry, and Riparian Vegetation

The channel geometry in the North Fork Mokelumne River upstream of the confluence of the Middle/South Fork Mokelumne River near the West Point Powerhouse has a gradient of 0.79 percent with a D_{50} particle size of 140 millimeters (small cobble) sinuosity of 1.26, V* of 2.0, Rosgen class B3c, bankfull width of 72–82 feet; mean bankfull depth of 1.8–2.3 feet; width:depth ratio of 32–46; flood prone width of 102–139 feet; and an entrenchment ratio of 1.2–1.9 and low bank erosion (PG&E 2022). Other reaches upstream and downstream from this location have steeper gradients. The gradient above Pardee Reservoir near the Highway 49 bridge is 2.4 percent, and the typical wetted width from Google Earth is approximately 70–90 feet.

The riparian vegetation in the Mokelumne River upstream of PG&E's Electra Powerhouse includes a mix of seedling, young, and medium-aged/mature shrub and tree species. The tree species are primarily white alder (*Alnus rhombifolia*), red willow (*Salix laevigata*), and Gooding's willow (*Salix gooddingii*) with a few Fremont cottonwood (*Populus fremontii*). Other species across the riparian corridor are sedges, grasses, rushes, horsetail, interior live oak (*Quercus wislizeni*), incense cedar (*Calocedrus decurrens*), and Himalayan blackberry (*Rubus armeniacus*) (PG&E 2022).

Hydrology and Instream Flow Habitat

PG&E's Electra Powerhouse, located on the Mokelumne River upstream of Pardee Reservoir, is typically operated as a peaking unit, responding to system energy needs as determined by the energy market. The Lodi Decree specifies flows at the Electra Diversion Dam on the North Fork Mokelumne River, and there are minimum instream flows required below Electra Diversion Dam that range from 15 cfs to 980 cfs depending on the season and water year type. Tributary inflows below the Electra Diversion Dam include the Middle Fork and South Fork Mokelumne River.

Mokelumne River inflows to Pardee Reservoir are summarized in Section 4.3.2, *Stream and Reservoir Gage Data*. Flows are generally highest from April through June, with median monthly flows for that period averaging 1,499 cfs. The lowest flows occur from August through October with an average median monthly flow for that period of 522 cfs. The monthly minimum and maximum flows for the years 1929 through 2024 range from 9 cfs (October) to 6,930 cfs (February).

Table 4.4-1. Fish species observed during EBMUD monitoring programs within the Project area and Lower Mokelumne River.

Family	Species	Scientific Name	Status	North Fork Mokelumne River Above Pardee Reservoir	Pardee Reservoir	Camanche Reservoir	Camanche Dam to WIDD	WIDD to Cosumnes River	Cosumnes River to San Joaquin River
Atherinopsidae: Silversides Family	Inland Silverside	Menidia beryllina	I					X	X
Catostomidae: Sucker Family	Sacramento Sucker	Catostomus occidentalis	N	X	X		X	X	X
Centrarchidae: Sunfish Family	Black Crappie	Pomoxis nigromaculatus	I		X	X	X	X	X
	Bluegill	Lepomis macrochirus	I		X	X	X	X	X
	Green Sunfish	Lepomis cyanellus	I		X	X	X	X	X
	Largemouth Bass	Micropterus salmoides	I		X	X	X	X	X
	Redear Sunfish	Lepomis microlophus	I		X	X	X	X	X
	Redeye bass	Micropterus coosae	I				X	X	X
	Smallmouth Bass	Micropterus dolomieu	I		X	X	X	X	X
	Spotted Bass	Micropterus punctulatus	I		X	X	X	X	X
	Warmouth	Lepomis gulosus	I				X	X	X
	White Crappie	Pomoxis annularis	I			X	X	X	X
Clupeidae: Herring Family	American Shad	Alosa sapidissima	I					X	X
	Threadfin Shad	Dorosoma pretenense	I		X	X	X	X	X
Cottidae: Sculpin Family	Pacific Staghorn Sculpin	Leptocottus armatus	N				X		X
	Prickly Sculpin	Cottus asper	N		X	X	X	X	X
Cyprinidae: Minnow Family	California Roach	Lavinia symmetricus	N	X	X				
	Common Carp	Cyprinus carpio	I		X	X	X	X	X
	Fathead Minnow	Pimephales promelas	I					X	X
	Golden Shiner	Notemigonus crysoleucas	I		X	X	X	X	X
	Goldfish	Carassius auratus	I			X	X	X	X
	Hardhead	Mylopharodon conocephalus	N, SSC	X	X		X		
	Hitch	Lavinia exilicaudia	N, SSC				X	X	X
	Sacramento Blackfish	Orthodon microlepidotus	N, SSC			X	X	X	X
	Sacramento Pikeminnow	Ptychocheilus grandis	N	X	X	X	X	X	X
	Sacramento Splittail	Pogonichthys macrolepidotus	N, SSC					X	X
	Speckled dace	Rhinichthys osculus	N	X					
Embiotocidae: Surfperch Family	Tule Perch	Hysterocarpus traski	N, SSC				X	X	X
Gobiidae: Goby Family	Yellowfin Goby	Acanthogobius flavimanus	I					X	X
Ictaluridae: Catfish Family	Black Bullhead	Ameiurus melas	I				X	X	X
	Brown Bullhead	Ameiurus nebulosus	I				X	X	X
	Channel Catfish	Ictalurus punctatus	I		X	X	X	X	X

Family	Species	Scientific Name	Status	North Fork Mokelumne River Above Pardee Reservoir	Pardee Reservoir	Camanche Reservoir	Camanche Dam to WIDD	WIDD to Cosumnes River	Cosumnes River to San Joaquin River
	White Catfish	Ameiurus catus	I		X	X	X	X	X
Moronidae: Striped Bass Family	Striped Bass	Morone saxatilis	I				X	X	X
Osmeridae: Smelt Family	Delta Smelt	Hypomesus transpacificus	N, FT, CE					X	X
	Wakasagi	Hypomesus nipponensis	I					X	
Percidae: Perch Family	Bigscale Logperch	Percina macrolepida	I				X	X	X
Petromyzontidae: Lamprey Family	Pacific Lamprey	Lampetra tridentata	N, SSC				X	X	
Poeciliidae: Livebearers	Western Mosquitofish	Gambusia affinis	I			X	X	X	X
Salmonidae: Salmon and Trout Family	Brown Trout	Salmo trutta	I	X	X[a]	X[a]	X		
	Fall-run Chinook Salmon	Oncorhynchus tshawytscha	N, SSC				X	X	X
	Spring-run Chinook Salmon[b]	Oncorhynchus tshawytscha	N, FT, ST				X[b]	X[b]	X[b]
	Chum Salmon	Oncorhynchus keta	N				X		
	Kokanee	Oncorhynchus nerka	I	X	X[a]	X[a]	X	X	
	Rainbow Trout	Oncorhynchus mykiss	N	X	X	X			
	Steelhead/Rainbow Trout	Oncorhynchus mykiss	N, FT, SCC				X	X	X

Sources: Fisheries data from the EBMUD fish community and outmigration monitoring programs from 2005–2025; CNRA (2018).

Status Definitions: CE = Candidate Endangered (State); FPT = Proposed Threatened (Federal); SSC = Species of Special Concern (State); I =Introduced; FT =Threatened (Federal); ST = Threatened (State); N =Native

[a] Kokanee and Brown Trout are known to occur in Pardee Reservoir and occasionally in Camanche Reservoir but have not been detected in historical fish community sample sites.

[b] Non-hatchery origin and hatchery origin Central Valley Spring-run Chinook Salmon from the Feather River Fish Hatchery and the San Joaquin River Restoration Program have been documented in the Mokelumne River (EBMUD 2024; Regional Mark Information System Database 2024). The occurrence of Central Valley spring-run Chinook Salmon strays in the Mokelumne River is likely due to the proximity of the Mokelumne River to the Sacramento River basin. While there is no monitoring conducted for Central Valley spring-run Chinook Salmon in the Mokelumne River, anecdotal observations (EBMUD pers. comm. 2023) indicate that Central Valley spring-run Chinook Salmon are present in some years in the Mokelumne River.

Table 4.4-2. Amphibian and aquatic reptiles observed during EBMUD pond monitoring within the Project area.

Family	Species	Scientific Name	Status	Ponds Surrounding Pardee Reservoir	Ponds Surrounding Camanche Reservoir
Ambystomatidae: Mole Salamander Family	California Tiger Salamander	Ambystoma californiense	ST, FT		X
Bufonidae: True Toad Family	Western Toad	Anaxyrus boreas	N	X	X
Hylidae: Tree Frog Family	Pacific Chorus Frog	Pseudacris regilla	N	X	X
Ranidae: True Frog Family	American Bullfrog	Rana catesbeiana	I	X	X
Salamandridae: True Salamander and Newt Family	Sierra Newt	Taricha sierrae	N	X	
Scaphiopodidae: American Spadefoot Family	Western Spadefoot	Spea hammondii	N, FPT		X
Emydidae: Hard-shelled Turtle Family	Northwestern Pond Turtle	Actinemys marmorata	N, FPT	X	X
	Red-eared Slider	Trachemys scripta elegans	I		X

Sources: Amphibian and aquatic reptile data from the EBMUD aquatic dipnet surveys, nighttime eyeshine surveys, daytime visual encounter surveys, and pit trap array surveys from 2015–2025.

Status Definitions: CE = Candidate Endangered (State); FPT = Proposed Threatened (Federal); I =Introduced; SSC = Species of Special Concern (State); N = Native; ST = Threatened (State); FT =Threatened (Federal)

Fish Passage Barriers

No fish passage barriers exist in the Mokelumne River immediately upstream of Pardee Reservoir or within the reservoir elevation fluctuation zone (varial zone) of Pardee Reservoir. Fish passage barriers farther upstream are discussed below in Potential Anadromous Fish Habitat.

Potential Anadromous Fish Habitat

In late 2013, the Foothill Conservancy, in partnership with the California Sportfishing Protection Alliance and EBMUD, along with key interested parties, initiated a process to assess the potential to establish a reproducing population of Chinook Salmon in the upper Mokelumne River above Pardee Reservoir. EBMUD Fisheries and Wildlife staff

participated in the Upper Mokelumne River Anadromous Fish Restoration Work Group as subject matter experts to provide technical assistance. The group later was called the Salmonid Restoration Team (SRT).[8]

A habitat assessment found that there are about 14 miles of historical suitable habitat to support both adult and juvenile fall-run Chinook Salmon in the Upper Mokelumne River, roughly from the Middle Bar Bridge to just upstream of the confluence of the North and Middle forks of the Mokelumne (Brown et al. 2018). It was determined that spring and late-fall Chinook Salmon and winter-run steelhead very likely had access to habitats in the river up to Bald Rock Fall in the North Fork (at El. 406 meters/1,333 feet) and at least to a boulder jam on the lower Middle Fork (at El 356 meters/1,169 feet) (Boyd 2014).

Prior to initiating the pilot study, a pathology risk assessment was conducted, in consultation with the CDFW and USFWS pathologists, to determine if the risks were manageable. During the risk assessment, two potentially infectious diseases (infectious hematopoietic necrosis virus [IHN] and whirling disease) posed the majority of the risk involved with the reintroduction effort. Potentially transporting infected fish upstream of the dams, thereby introducing the disease into the water upstream where it currently does not exist, could infect the water supply used by the hatchery. Due to the risk of disease transmission and the expense and space requirements of any appropriate treatment facility, the SRT decided to not pursue the project.

Fish and Aquatic Community

Sampling efforts have been carried out by PG&E and Amador County in the Mokelumne River from the Electra Powerhouse downstream to Pardee Reservoir. These surveys identified the presence of Sacramento Sucker (*Catostomus occidentalis*), Sacramento Pikeminnow (*Ptychocheilus grandis*), California Roach (*Lavinia symmetricus*), Hardhead (*Mylopharodon conocephalus*), Brown Trout, Rainbow Trout, and kokanee (CNRA 2018). EBMUD has collected anecdotal data (2015, 2016, and 2018) in this reach during sampling events for investigation of presence of IHN in salmonids occurring in this reach as part of the SRT program described above. This sampling effort was conducted in 2015, 2016, and 2018 and consisted of boat electrofishing targeting salmonid catch only, which included Brown Trout, Rainbow Trout, and kokanee.

[8] Several interested parties engaged to collaborate on what later would be called the SRT, including CDFW, USFS, USFWS, U.S. Bureau of Land Management, NOAA, NMFS, Roaring Camp, CCWD, JVID, PG&E, Western Water Strategies, CPUD, California Valley Miwok Tribe, Buenavista Rancheria, Trout Unlimited, CalTrout, AWA, and several members of the public. The SRT met regularly and developed a pilot project to reintroduce a small number of adult fall-run Chinook Salmon into the upper watershed.

4.4.2 PARDEE RESERVOIR

4.4.2.1 EXISTING AQUATIC HABITAT

Water Temperature and Water Quality

The Pardee and Camanche reservoirs work in tandem to help manage temperature and water quality to support habitat conditions for the fisheries below Camanche Reservoir. Section 3.5.4.2 of the Project Description and Section 4.3.5, *Water Resources*, provide expanded discussion on temperature and cold-water pool management and water quality, respectively.

Extensive water temperature and DO profile data have been collected in Pardee Reservoir by EBMUD from 1998 to present. Section 4.3.5 and Volume II – Appendix F provide a summary of the available data. Pardee and Camanche reservoirs are managed to maintain thermal stratification in Camanche Reservoir as late in the year as possible. Stratification in Camanche Reservoir through the end of October is typically supported by releasing cold water from Pardee Reservoir when necessary and when possible. Pardee Reservoir temperatures are monitored and managed through the summer to maximize cold water available for transfer in October.

Temperatures on the surface range from a monthly average temperature of 11°C in January/February to 25.7°C in August (2009–2024). Temperatures lower in the water column are cooler and typically remain below 10°C until June. Monthly average temperatures in the hypolimnion generally peak in November, averaging 13°C (2009–2024).

DO profiles collected at station PADA near Pardee Dam indicate that the reservoir has high DO concentrations in the epilimnion throughout the year. DO levels in the hypolimnion start out relatively high in the winter following turnover, but degrade over time, with average monthly concentrations below 4 mg/L in many years. Some years, such as 2014 and 2015, saw DO concentrations in the epilimnion in late fall of less than 1 mg/L.

Gradient, Channel Geometry, and Riparian Vegetation

Pardee Reservoir typically is operated between 170,000 and 200,000 acre-feet and has ranged from 48,000 acre-feet (March 1977) to 212,000 acre-feet (May 1984). Due to the large varial zone, there is limited riparian vegetation except for seasonal grasses and herbs. See Section 4.6 (*Wetlands, Riparian, and Littoral Habitat*) for description of annual grasslands around the reservoir areas.

Hydrology and Instream Flow Habitat

Mokelumne River inflows to Pardee Reservoir are summarized in Section 4.3.2.1. Flows are generally highest from April through June, with median monthly flows for that period averaging 1,499 cfs. Minimum flows occur from August through October, with an average median monthly flow for that period of 522 cfs. Monthly minimum and maximum flows for the years 1929 through 2024 range from 9 cfs (October) to 6,930 cfs (February).

Pardee Reservoir generally fills in the spring, with storage peaking near the beginning of June (on average) (see Figure 3.5-4 in Section 3.5.4.2). Storage steadily declines from June through the beginning of October.

A short reach (approximately 1–2 miles) within the reservoir footprint varies temporally from riverine (lotic) in the fall/winter to reservoir (lentic) during the spring/summer, as inflow decreases and storage increases.

Fish Passage Barriers

Fish passage is not provided at the Pardee Dam.

4.4.2.2 FISH AND AQUATIC COMMUNITY

Algae (e.g., toxic algae)

At Pardee Reservoir, plankton samples for harmful algal blooms (HABs) and cyanotoxins are collected from the surface and from the level of the open gates of the outlet towers at least monthly and more frequently when algal activity is high. If a significant number of algae with cyanotoxin-producing potential are found, cyanotoxin samples would be collected for analysis. Such toxin-producing algae have never been detected in the main body of Pardee Reservoir.

Cyanotoxins can be harmful, potentially even fatal, to people or animals that come into contact with or drink the water. Additionally, it is possible for fish and waterfowl to accumulate the toxins in their organs, which can in turn present a hazard to humans who consume those fish or waterfowl. If the presence of cyanotoxins was suspected or confirmed, appropriate signage would be placed in the area to warn visitors of the danger.

Fish Assemblage

Biennial electrofishing surveys were established at Pardee Reservoir in 2011. Goals of these surveys include monitoring fish species composition, detecting gross shifts in species abundance, and facilitating early detections of exotic species introductions. This

monitoring is an important tool for surveying fish communities, providing managers with data needed to make informed aquatic resource management decisions.

Five standardized electrofishing sites were established in Pardee Reservoir (Figure 4.4-1). Timed night-time electrofishing surveys were conducted at each fixed survey site. All monitoring events were conducted by one boat operator and three netters using a Smith Root model SR-18E electrofishing boat.

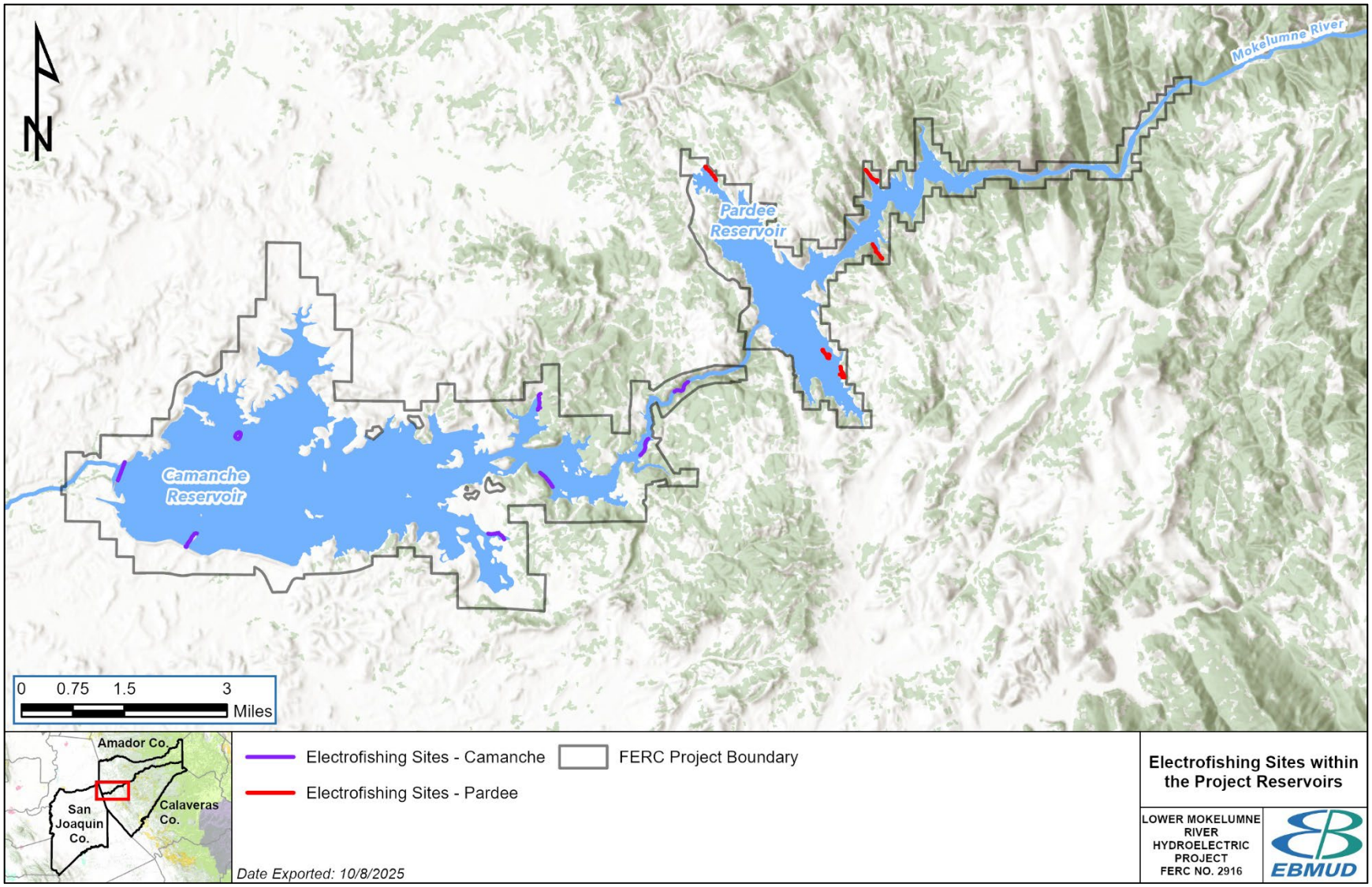


Figure 4.4-1. Pardee and Camanche reservoir electrofishing sites between 2011 and 2023.

Table 4.4-3 presents the catch results and size ranges from biennial electrofishing surveys conducted in Pardee Reservoir since 2011. A total of 5,456 fish were captured from 19 fish species (6 native and 13 introduced). This includes 71 Lepomis (sunfish) hybrids and one unknown juvenile black bass not identified to species. Non-native fish dominated sampling, making up over 99 percent of the total catch. Sampling revealed one native California species of special concern, the Hardhead. Sixteen Hardhead were captured at three sites during the 2019 and 2023 surveys.

Table 4.4-3. Fish species observed during EBMUD electrofishing surveys at Pardee Reservoir between 2011 and 2023.

Species Common Name	Total Count	Ave. Length (mm)	Min. Length (mm)	Max. Length (mm)
Black Crappie	15	79	43	176
Bluegill	2,533	66	21	180
Brown Trout	2	78	76	80
California Roach	2	109	108	110
Channel Catfish	39	373	72	570
Common Carp	31	476	75	775
Golden Shiner	2	127	90	164
Green Sunfish	1,011	57	27	172
Hardhead	16	102	44	167
Largemouth Bass	953	162	17	536
Prickly Sculpin	12	52	27	84
Rainbow Trout	6	371	323	431
Redear Sunfish	350	92	33	274
Sacramento Pikeminnow	14	115	86	195
Sacramento Sucker	60	67	21	326
Smallmouth Bass	216	139	25	463
Spotted Bass	120	52	28	242
Threadfin Shad	1	103	103	103
White Catfish	1	48	48	48

Migratory Fish

Kokanee were originally introduced into Pardee in 1961 and have periodically been caught by anglers in Camanche. There is evidence that kokanee ascend the Mokelumne River above Pardee and spawn in gravel beds near PG&E's Electra Powerhouse. However, kokanee are a pelagic species and so have not been caught during EBMUD biennial

electrofishing surveys in Pardee Reservoir due to gear limitations, but are a popular sport fishery for the Reservoir

Amphibians and Aquatic Reptiles

Sampling for amphibians on the Pardee watershed only occurs in the upland habitat (Figure 4.4-2) that is not affected by Project operations. Pardee Reservoir is not sampled for amphibians due to the high number of predatory fish in the reservoir. Upland ponds are sampled annually in the spring using dip nets and/or a beach seine. A total of 34 ponds are located on the Pardee watershed, of which 28 are sampled. The remaining six are not sampled due to environmental hazards. In addition, these 28 ponds are surveyed at night every 3 years, opposite the 2 years that the Camanche watershed is surveyed for breeding amphibians.

Amphibians observed on the Pardee watershed include western spadefoot (*Spea hammondii*), western toad (*Anaxyrus boreas*), American bullfrog (*Lithobates catesbeianus*), Sierra newt (*Taricha sierrae*), and Sierran treefrog (*Pseudacris sierra*).

Northwestern pond turtles (*Actinemys marmorata*) are also known to occur on the Pardee watershed. They have been observed during spring pond and preconstruction surveys. Given the diversity of age classes, it is assumed that they breed within the watershed, but the breeding rate is not known.

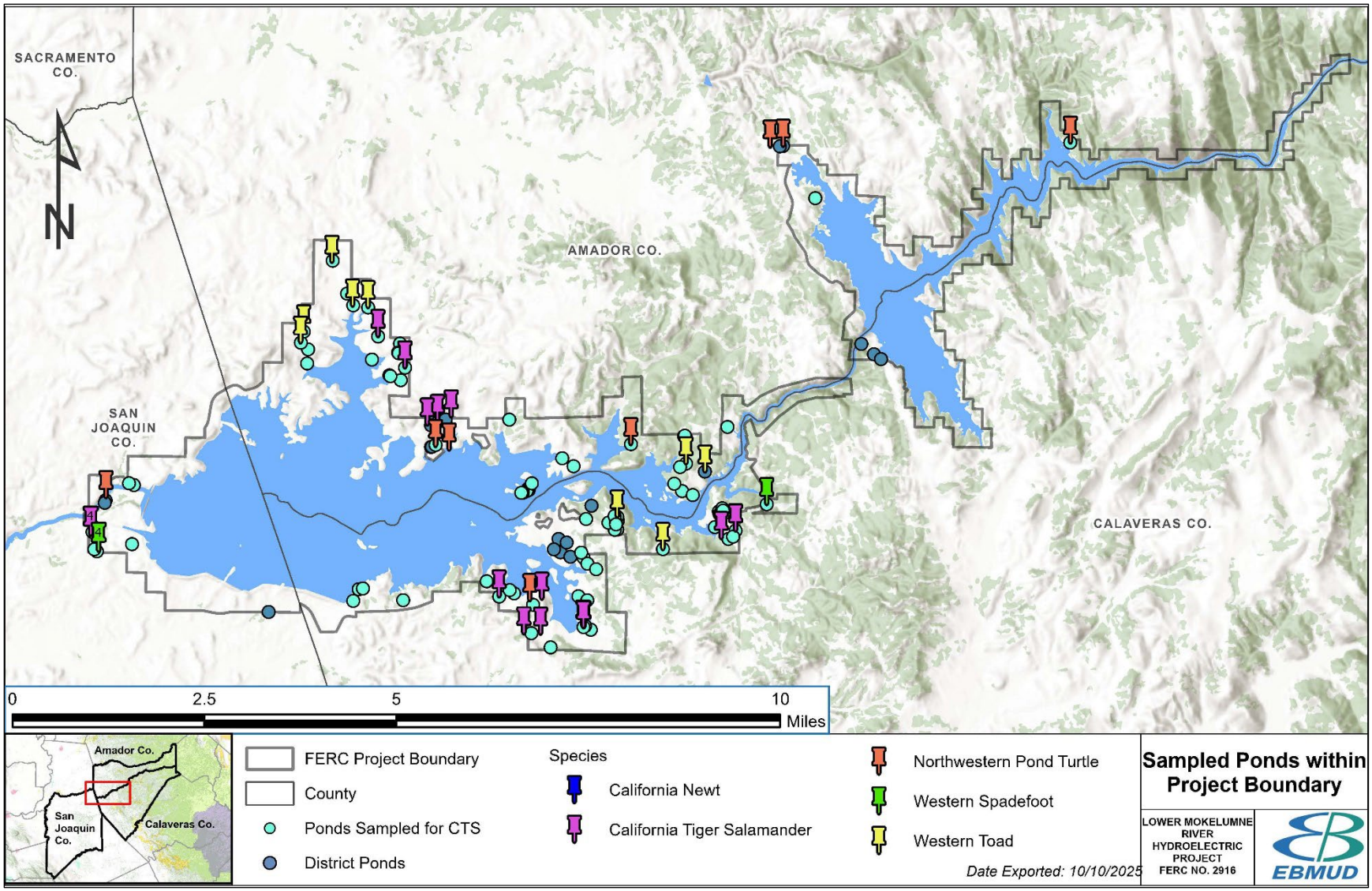


Figure 4.4-2. Sampled ponds surrounding Pardee and Camanche reservoirs.

Invasive Species

EBMUD has an Invasive Aquatic Species Control Program that aims to prevent non-native invasive aquatic species from becoming established in EBMUD reservoirs and water system infrastructure. The program originally focused on Dreissenid mussels, including quagga (*D. bugensis*) and zebra mussels (*D. polymorpha*), but is designed to provide a barrier against other potentially invasive organisms. Pond surveys are conducted annually in the spring, in accordance with the Safe Harbor Agreement, and any incidental observances of invasive aquatic species are noted and actions identified as appropriate. Additionally, all river surveys provide an opportunity to detect aquatic invasive species occurrences.

EBMUD also has an Invasive Aquatic Species Response Plan that provides a response framework for EBMUD staff should an infestation of non-native invasive aquatic species be discovered in EBMUD reservoirs and water system infrastructure. The primary focus of the program was Dreissenid mussels, including quagga and zebra mussels, but it is designed to provide a response plan for other potentially invasive organisms. The response plan is intended to be put into action following confirmation of infestation of aquatic invasive species.

EBMUD's primary method to prevent the introduction of invasive mussels from recreation boats into Pardee and Camanche reservoirs is its vessel screening, inspection, and decontamination program. As part of this program, 70 percent of boats launched on Pardee and 40 percent of boats launched at Camanche are inspected prior to launching, when launching is allowed.

In October of 2024, a population of Golden mussel (*Limnoperna fortune*) was discovered in the Sacramento-San Joaquin Delta near Stockton. The Golden mussel poses a significant threat to water conveyance infrastructure and aquatic ecosystems. EBMUD is monitoring the spread and developing a plan to respond to this discovery. In response to the introduction of Golden mussels in the Delta, EBMUD conducted Golden mussel veliger tow and eDNA sampling in both Pardee and Camanche reservoirs. No Golden mussels were detected. Currently, there are no known populations of invasive mussels in Camanche or Pardee reservoirs. However, out of an abundance of caution, with the goal of preventing the introduction of Golden mussels in EBMUD reservoirs, all boat launches were closed for the 2025 season. This closure allowed EBMUD time to study how to prevent and respond to the Golden mussel infestation. The closure applied to private boats and other watercraft, including kayaks and paddleboards; however, it excludes rental boats and boats with a permanent slip for Camanche that were in the water or in on-site dry storage when boat launches closed in November 2024.

Bullfrogs are also an invasive species and are present in most of the waterbodies on the Pardee watershed. All life stages are removed when the opportunity is offered, as a maintenance activity under EBMUD's Safe Harbor Agreement with the USFWS. Methods used include capture by hand, dipnet, and beach seine. In addition, frog gigs and air rifles (lead-free pellets) are used. When permitted by CDFW, some ponds are drained to remove tadpoles before they metamorphose. Since 2009, approximately 45,000 bullfrogs have been removed from within the Project area.

Perennial ponds surrounding Pardee Reservoir may also have black bass (*Micropterus sp.*), sunfish (*Lepomis* sp.), or Mosquitofish (*Gambusia affinis*) present, which prey upon native amphibians and aquatic reptiles. The origin of the fish was from past plantings, pre-2000, or washed in from upstream ponds during rain events. Prior to 2024, permanent ponds with a high number of fish were drained, when CDFW permitted to remove the fish. Approximately 20,000 non-native fish have been removed from ponds on EBMUD lands in the Pardee and Camanche watersheds. The species removed during these efforts include sunfish, black bass, carp (*Cyprididae sp.*), Goldfish (*Carassius auratus*), and Mosquitofish. Since 2024, CDFW has not allowed EBMUD to drain ponds for predator removal.

Red-eared sliders (semi-aquatic turtle, *Trachemys scripta elegans*) are known to occur on the Pardee watershed. They are observed during spring pond surveys and during preconstruction surveys. It is assumed that they breed within the Project area due to the diversity of age classes observed, but the breeding rate is not known. To date, no efforts have been made to control them.

4.4.3 CAMANCHE RESERVOIR

4.4.3.1 EXISTING AQUATIC HABITAT

Water Temperature and Water Quality

The Pardee and Camanche reservoirs work in tandem to help manage temperature and water quality to support habitat conditions for the fisheries. Section 3.5 and Section 4.3.5 provide expanded discussion on temperature and cold-water pool management and water quality, respectively.

Extensive water temperature and DO profile data have been collected in Camanche Reservoir by EBMUD from 1990 to present. Sections 4.3.4 and 4.3.5 and Volume II – Appendix F provide a summary of the available data. Generally, Pardee and Camanche reservoirs are managed to keep Camanche Reservoir thermally stratified as late in the year as possible; stratification generally breaks down at the end of November or early December. In winter, Camanche Reservoir is well mixed with generally uniform water

quality from the surface to the bottom of the reservoir. Minimum temperatures occurring in late January or early February range from 46°F (8°C) to 52°F (11°C) with DO ranging from 10 mg/L to 12 mg/L throughout the water column. Surface temperatures warm up over summer to a peak of 81°F (27°C) to 82°F (28°C) in late July to early August. Hypolimnion temperature generally warms slowly at a rate of about 1.8°F (1°C) every 30 to 45 days from March through October, reaching a peak temperature in the range of 59°F (15°C) to 61.5°F (16.4°C) before reservoir stratification becomes unstable, the reservoir mixes in late fall to early winter, and reservoir release temperatures reverse trend decreasing through winter.

As Camanche Reservoir stratifies, DO levels are generally lower in the hypolimnion while DO stays high at the surface, in the range of 10 mg/L to 12 mg/L (see Volume II – Appendix F). When DO levels get low in the hypolimnion,[9] the hypolimnetic oxygenation system is utilized to maintain oxygen levels and prevent anoxic conditions (see Section 4.3.5.6 for more information on the hypolimnetic oxygenation system). Releases from Camanche Dam are sluiced starting in late spring through summer to maintain a minimum DO of 7 mg/L at Station 11 downstream of the dam until stratification breaks down and the reservoir water column becomes well mixed in late fall to early winter.

In a thermal context, a gaining reach refers to a river that gains heat where temperature readings at downstream gages are generally warmer than upstream stations versus a losing reach where downstream stations are generally lower in temperature than upstream stations. The Lower Mokelumne River temperatures downstream of Camanche Dam transition from a heat-losing to a heat-gaining system in the transition from winter to spring in February or March. The Lower Mokelumne then transitions back to a heat-losing system in the transition from fall to winter conditions typically in late October to early November.

Gradient, Channel Geometry, and Riparian Vegetation

The upper reach of Camanche Reservoir is highly channelized, primarily comprised of Jurassic Gopher Ridge metavolcanics as described in Section 4.2, *Geology and Soils*. The gradient is approximately 0.7 percent. Section 4.6 (*Wetlands, Riparian, and Littoral Habitat*) provides information on the riparian vegetation around the reservoir.

[9] Generally when either: (1) the DO level in the Camanche Reservoir hypolimnion is projected to drop to 2 mg/L as measured at CAMD, or (2) when DO drops to 2 mg/L as measured at CAMC.

Hydrology and Instream Flow Habitat

Inflow to Camanche Reservoir is determined by upstream releases from Pardee Reservoir. Camanche Reservoir generally fills in the spring and remains full until the end of June, at which point storage starts to decline (see Figure 3.5-5).

Inflows into Camanche Reservoir are generally highest from March through June, with monthly average flow rates ranging from about 1300 cfs to 1750 cfs. The lowest flow period is August through November, with monthly average flows generally around 500 cfs. Flow statistics are provided in Section 4.3.2.

The upper reach within the reservoir footprint varies temporally from riverine (lotic) in the fall/winter to reservoir (lentic) during the spring/summer when storage increases. The flow in this upper reach of Camanche Reservoir from Pardee Powerhouse fluctuates on a sub-daily basis up to the maximum capacity of the powerhouses, which is 1,392 cfs. During spill periods, the flow rate can be much higher. The peak historical flow was 41,300 cfs in January of 1997. When Camanche Reservoir is at full capacity, the reservoir extends within about 1,500 feet of the downstream toe of Pardee Dam. Figure 4.4-3 shows the Camanche Reservoir extents at normal pool elevation.

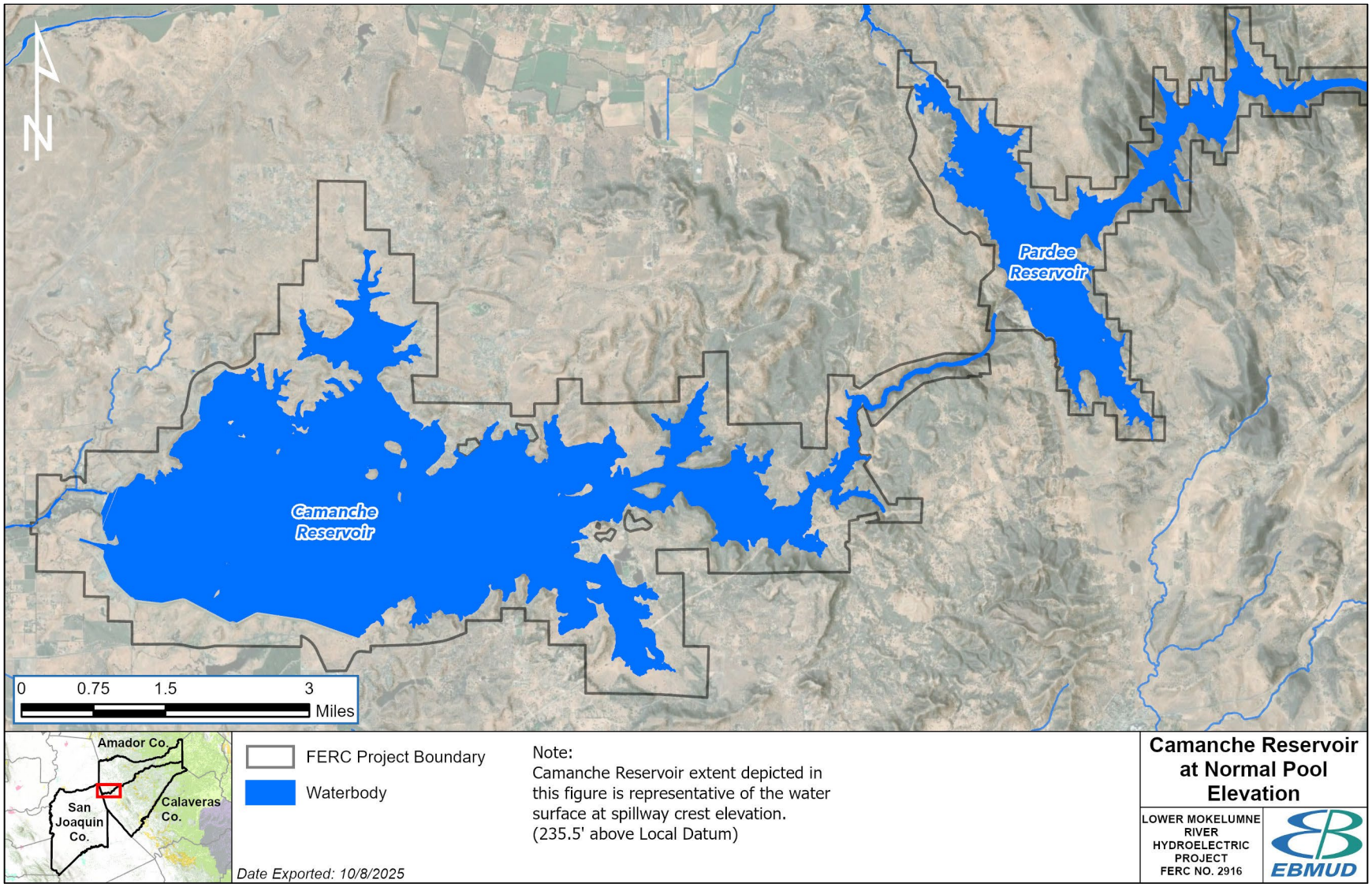


Figure 4.4-3. Camanche Reservoir at normal pool elevation.

Fish Passage Barriers

Fish passage is not provided at the Camanche Dam.

4.4.3.2 FISH AND AQUATIC COMMUNITY

Algae (e.g., toxic algae)

HABs with verified presence of cyanotoxins have occurred in the Rabbit Creek arm of Camanche Reservoir, as well as small ponds in the hills north of Camanche Reservoir on EBMUD property.

Plankton samples are collected at Camanche Reservoir from the surface and from the level of the open gates of the outlet towers at least monthly and more frequently when algal activity is high. Such toxin-producing algae have not been detected in the main body of Camanche Reservoir at sufficient concentrations to trigger additional laboratory sampling. In an abundance of caution, cyanotoxin samples were collected weekly for 2 months at CASS WTP in 2015 when cyanotoxins were detected in Rabbit Creek, which at the time was not flowing into the reservoir at the surface level due to low water levels. All results at CASS WTP were non-detect.

Cyanotoxins can be harmful, potentially even fatal, to people or animals that come into contact with them or drink water contaminated by them. Additionally, it is possible for fish and waterfowl to accumulate the toxins in their organs, which can in turn present a hazard to humans who consume those fish or waterfowl. If the presence of cyanotoxins was suspected or confirmed, appropriate signage would be placed in the area to warn visitors of the danger.

Fish Assemblage

Biennial electrofishing surveys were established at Camanche Reservoir in 2011. Goals of these surveys include monitoring fish species composition, detecting gross shifts in species abundance, and facilitating early detections of exotic species introductions. This monitoring is an important tool for surveying fish communities, providing managers with data needed to make informed aquatic resource management decisions.

Eight standardized electrofishing sites were established in Camanche Reservoir (Figure 4.4-1). Timed night-time electrofishing surveys were conducted at each fixed survey site. All monitoring events were conducted by one boat operator and three netters using a Smith Root model SR-18E electrofishing boat.

Table 4.4-4 shows the catch results and size ranges from biennial electrofishing surveys conducted in Camanche Reservoir since 2011. A total of 8,982 fish were captured from 19 fish species (4 native and 15 introduced). This includes 136 Lepomis hybrids and 78 unknown black bass not identified to species. Non-native fish dominated sampling, making up over 99 percent of the total catch. Sampling revealed one native California species of special concern. One Sacramento Blackfish (*Orthodon microlepidotus*) was captured during the 2013 survey.

Table 4.4-4. Fish species observed during EBMUD electrofishing surveys at Camanche Reservoir between 2011 and 2023.

Species Common Name	Total Count	Ave. Length (mm)	Min. Length (mm)	Max. Length (mm)
Black Crappie	120	67	22	350
Bluegill	2,458	74	19	160
Channel Catfish	46	304	45	602
Common Carp	279	436	97	700
Golden Shiner	1	101	101	101
Goldfish	63	283	30	564
Green Sunfish	1,175	73	26	249
Largemouth Bass	1,338	117	33	513
Prickly Sculpin	12	43	30	66
Rainbow Trout	17	378	256	435
Redear Sunfish	174	102	45	205
Sacramento Pikeminnow	8	78	31	127
Sacramento Blackfish	1	58	58	58
Smallmouth Bass	13	97	32	367
Spotted Bass	1,422	122	20	522
Threadfin Shad	1,632	64	24	129
Western mosquitofish	1	29	29	29
White Catfish	7	237	61	491
White Crappie	1	56	56	56

Migratory Fish

Kokanee was originally introduced into Pardee in 1961 and has periodically been caught by anglers in Camanche, but kokanee have not been caught during EBMUD biennial electrofishing surveys. Kokanee are pelagic fish and catch of these may be gear limited. These fish presumably gained access to Camanche during Pardee Reservoir spill events associated with seasonal flooding. It appears large fluctuations in the surface elevation

of Camanche Reservoir, associated with drought conditions, may periodically extirpate kokanee from the reservoir.

Amphibians and Aquatic Reptiles

Sampling for amphibians on the Camanche and Pardee watersheds only occurs in the upland habitat. Camanche and Pardee reservoirs are not sampled for amphibians due to the high number of predatory fish in the reservoir. Upland ponds are sampled annually in the spring using dipnets and/or a beach seine. A total of 107 ponds are located in the Camanche watershed, of which 87 are sampled. The remaining 20 are not sampled due to environmental hazards. These 107 ponds are surveyed at night for breeding amphibians over a 3-year period, one-third every year.

Four known California tiger salamander (*Ambystoma californiense*) breeding ponds were monitored to generate a population estimate for each pond. Approximately 554 unique individuals were captured at the ponds, but the annual recapture rate was too low to generate a population estimate for each pond. During these surveys, 175 western spadefoot were also captured. No effort was made to identify individual western spadefoot.

Amphibians observed on the Camanche watershed include California tiger salamander, western spadefoot, western toad, American bullfrog, Sierra newt, and Sierran treefrog.

Northwestern pond turtles are known to occur on the Camanche watershed. They are observed during spring pond surveys and during preconstruction surveys. Given the diversity of age classes, it is assumed that they breed within the watershed, but the breeding rate is not known.

Invasive Species

The Golden mussel poses a significant threat to water conveyance infrastructure and aquatic ecosystems. EBMUD is monitoring the spread of the Golden mussel and is developing a plan to respond to its discovery. In response to the introduction of Golden mussels in the Delta, EBMUD conducted Golden mussel veliger tow and eDNA sampling in both Pardee and Camanche reservoirs. No Golden mussels were detected. At this time, there are no known populations of invasive mussels in Camanche or Pardee reservoirs. However, to prevent the introduction of Golden mussels into EBMUD reservoirs, all boat launches are closed for the 2025 season as a precautionary measure. This closure allowed EBMUD time to study how to prevent and respond to the Golden mussel infestation. The closure applied to private boats and other watercraft, including kayaks

and paddleboards, excluding boats with a permanent slip for Camanche that were in the water or in onsite dry storage when boat launches closed in November 2024.

Invasive bullfrogs are present in most of the waterbodies on the Camanche watershed. All life stages are removed when the opportunity is offered. Methods used include capture by hand, dipnet, and beach seine. In addition, frog gigs and air rifles (lead-free pellets) are used. When permitted by CDFW, some ponds are drained to remove tadpoles before they metamorphose. Since 2009, approximately 45,000 bullfrogs have been removed from the Project area.

Perennial ponds surrounding Camanche Reservoir may have black bass, sunfish, or Mosquitofish present, which prey upon native amphibians and aquatic reptiles. The origin of the fish was from past plantings, pre-2000, or washed in from upstream ponds during rain events. Prior to 2024, permanent ponds with a high number of fish were drained, when CDFW permitted to remove the fish. Approximately 20,000 non-native fish have been removed from ponds on EBMUD lands in the Pardee and Camanche watersheds. Species include sunfish, black bass, carp, Goldfish, and Mosquitofish. Since 2024 CDFW has not allowed EBMUD to drain ponds for predator removal. As stated above, any incidental observances of invasive aquatic species found during regular surveys are noted and actions identified as appropriate. Additionally, all river surveys provide an opportunity to detect aquatic invasive species occurrences.

Red-eared sliders are known to occur on the Camanche watershed. They are observed during spring pond surveys and during preconstruction surveys. It is assumed that they breed within the watershed due to the diversity of age classes observed, but the breeding rate is not known. To date no efforts have been made to control them.

Fish Planting

Since its construction, Camanche Reservoir has been a popular destination for recreational fishing. Fish stocking in Camanche Reservoir is discussed in detail in Section 4.8.2.

4.4.4 LOWER MOKELUMNE RIVER

4.4.4.1 EXISTING AQUATIC HABITAT

Water Temperature and Water Quality

Extensive water temperature and DO data have been collected in the Mokelumne River below Camanche Reservoir by EBMUD and other parties from about 1990 to present. Immediately downstream of Camanche Reservoir, water temperatures are coolest from

January through March, with monthly temperatures averaging below 11°C in most years. Maximum temperatures generally occur in September and October once the cold-water reserves in Camanche have been expended. Average monthly temperatures during these months range from 13.6°C to 18.6°C based on data collected between 1998 and 2024. Volume II – Appendix F has a complete summary of available temperature data.

Gradient, Channel Geometry, and Riparian Vegetation

The Lower Mokelumne River extends from Camanche Dam at RM 64 as measured from the mouth of the Sacramento-San Joaquin Delta to its confluence with the San Joaquin River. The Lower Mokelumne River ranges in elevation from approximately El. 92 feet at the base of Camanche Dam to sea level at Thorton, California. The gradient ranges from 0.1 percent near Camanche Dam to 0.02 percent near the Cosumnes River confluence. Tidal influence from the Delta can reach as far upstream as WIDD (RM 38.6). The reach below Woodbridge Dam is characterized primarily by flat water habitats (pools and runs) with mud and sand substrates. Lodi Lake, a seasonal impoundment formed by WIDD, is characterized by low water velocities and mud substrates. The river between Lodi Lake and Camanche Dam is characterized by alternating bars and flat-water habitats. The uppermost 10 miles of this reach below Camanche Dam support salmon and steelhead spawning. This segment is characterized by higher gradient runs and riffles with gravel-cobble substrates. Fisheries sampling sites in the Lower Mokelumne River are shown in Figure 4.4-4.

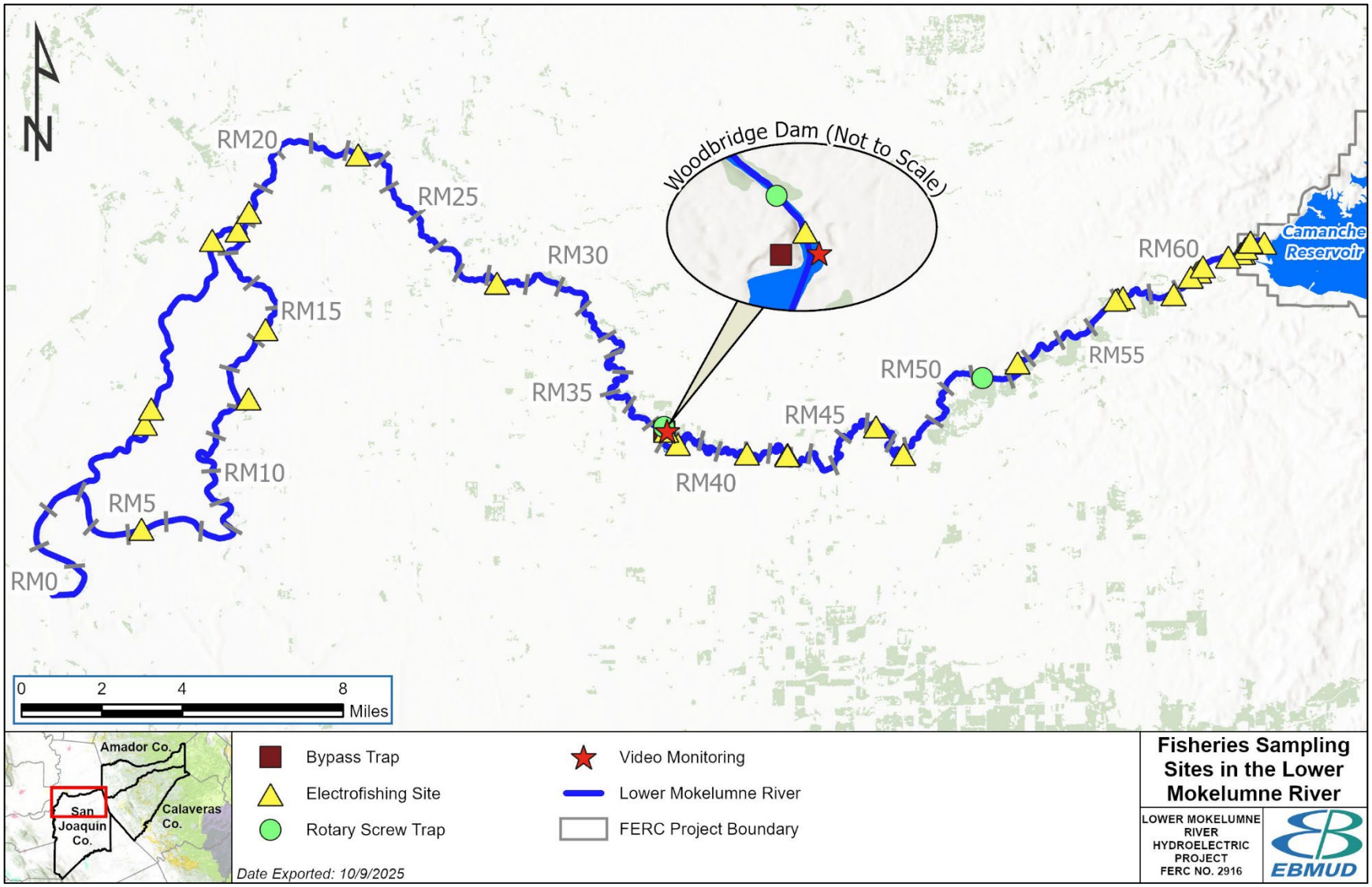


Figure 4.4-4. Fisheries sampling sites in the Lower Mokelumne River.

Spawning Gravel

Historically, the Lower Mokelumne River was considered deficient in Chinook Salmon spawning habitat. Historical and geomorphic assessments of the Lower Mokelumne River document the severe deficiencies prior to restoration efforts. Historic gold and aggregate mining stripped hundreds of thousands of tons of gravel from the riverbed, while upstream dams, most notably Pardee (constructed in 1927) and Camanche (constructed in 1964), interrupted natural sediment transport, creating a bedload deficit of roughly 40,000–47,000 cubic meters (Wheaton et al. 2004). Habitat assessments, conducted in 2001 below Camanche Dam, demonstrated a uniform pool–glide morphology in the historic spawning area with excessive depths and low velocities that are unsuitable for Chinook Salmon spawning. The University of California, Davis (UC Davis) Spawning Habitat Integrated Rehabilitation Approach (SHIRA) project on the Mokelumne River also demonstrated deficiencies of adequate gravels, with 56 percent of the modeled reach classified as non-spawning habitat (UC Davis SHIRA Project 2001). The SHIRA study findings led to a gravel augmentation and channel enhancement project between EBMUD and UC Davis. Furthermore, California Environmental Quality Act (CEQA) filings for spawning and rearing habitat projects (EBMUD 2014a) confirmed the deficiency of available spawning gravel for Chinook Salmon in the Mokelumne River due to the previously described impacts.

However, EBMUD's spawning gravel rehabilitation program, combined with ongoing spawning gravel maintenance projects, has created enough spawning habitat in the Lower Mokelumne River to meet the Central Valley Project Improvement Act (CVPIA) Chinook Salmon doubling goal for Mokelumne origin salmon, such that spawning habitat in the Lower Mokelumne River is no longer a limiting factor. Recent modeling efforts by FlowWest and EBMUD staff (EBMUD 2024) have indicated that restoration efforts over the last 25 years have successfully remedied this deficit (see Habitat section below). Based on the recent modeling efforts, EBMUD staff estimates approximately 19.26 acres (at 400 cfs) of viable spawning habitat exists in the Lower Mokelumne, which is more than twice the 8 acres required to support 60 percent of the doubling goal, which should be natural-origin Chinook Salmon adults.

The need for improving spawning habitat on the Mokelumne River was identified in the early 1990s while negotiating ecosystem protection measures during the development of the JSA. Additionally, the CVPIA Final Restoration Plan defined a priority action for the Mokelumne River as the need to replenish spawning gravel (USFWS 1992). EBMUD has completed the following restoration actions as described below for the Lower Mokelumne River.

Since 1990, EBMUD has placed approximately 56,837 cubic yards of spawning gravel, with the bulk of gravel ranging in size from 1–4 inches. However, smaller gravel (starting at 5/16 inches) has been incorporated into the spawning gravel projects for steelhead while also placing larger cobbles (up to 8 inches) and boulders in the Lower Mokelumne River to increase habitat diversity.

The EBMUD spawning gravel rehabilitation work can be divided into three distinct periods: 1990 to 1998; 1999 to 2016; and 2017 to present. The period from 1990 to 1998 involved site-specific projects that placed spawning gravel at existing spawning areas to improve these habitats as a means of increasing the reproductive success of salmonid species in the Lower Mokelumne River. Projects were implemented from RM 64 to approximately RM 57, with a total of 6,375 cubic yards of spawning gravel placed.

During the second period (1999-2016), EBMUD's spawning gravel rehabilitation program was defined by the development of SHIRA. Several factors contributed to the program's success. One key element was the JSA, signed in 1998 by EBMUD, USFWS, and CDFW, with NMFS joining as a technical advisor. The JSA established the Lower Mokelumne River Partnership, which aimed to develop plans for protecting and enhancing the Mokelumne River ecosystem. Additionally, the JSA created the Lower Mokelumne River Ecosystem Protection Program to promote cooperative actions for improving the natural production of anadromous fish and their habitats. The agreement also included a $2 million Partnership Fund to support these initiatives. Also, during this period, USFWS prepared a plan for the Anadromous Fish Restoration Program (AFRP). The Mokelumne River was included in the AFRP evaluation and, as a result, AFRP and the CVPIA Restoration Fund provided funding for habitat improvement actions along the Lower Mokelumne River. In addition, a partnership was created between EBMUD and UC Davis to design and implement gravel placement projects on the Lower Mokelumne River to rehabilitate spawning habitat in the stream. The projects were designed and monitored using the SHIRA, which uses the status of salmonid spawning physical habitat conditions as an indicator of ecosystem health. During this phase, the bulk of the work was implemented from RM 64 to RM 62, but extended downstream to RM 57, with a total of 44,995 cubic yards of spawning gravel placed.

Gravel additions during this period were used to rehabilitate the river's longitudinal profile thereby increasing bed slope and floodplain connectivity. This led to improved physical habitat conditions for spawning within accelerated flow regions and increased the area of winter rearing on floodplains. The bed slope was doubled within the first river mile below Camanche Dam, enabling spawning gravel to become mobile during high flows. This process redistributed spawning substrate from the upper extent of the available

spawning habitat to downstream, thereby enhancing existing spawning habitats and creating new ones.

Following the completion of the reach-scale projects, spawning gravel maintenance is the focus of the third phase of EBMUD's spawning gravel rehabilitation program that began in 2017 and continues to the present. Annual projects typically range in size from 300 to 800 cubic yards. The goal is to continue to restore geomorphic processes and improve salmonid spawning habitat, all while maintaining channel slope for sediment transport.

Floodplain Restoration

EBMUD has begun to create floodplain habitats within the Mokelumne River Day Use Area to allow juvenile salmonids access to critical foraging and refugia habitat. Since 2015, EBMUD has created five floodplain habitats on a total of 4 acres. An additional benefit of completing floodplain restoration projects is the ability to harvest spawning gravel that has been locked in the banks and reintroduce it into the river channel. Since 2015, all material removed for floodplain creation has been screened, with appropriate size spawning gravels either being directly imported back into the river during the same project window or stockpiled for future spawning gravel projects. EBMUD recognizes the need to implement additional downstream floodplain restoration projects and is currently working on a 25-acre floodplain restoration project with private landowners.

Hydrology and Instream Flow Habitat

Hydrology

EBMUD operates Pardee and Camanche reservoirs in a coordinated manner to meet its water supply needs while concurrently making releases from Camanche Reservoir to satisfy downstream senior water rights and regulatory and environmental obligations. Flow downstream of Camanche Dam is affected by:

- instream flow requirements under the JSA to protect and enhance conditions for the anadromous fish and ecosystem of the Lower Mokelumne River;
- entitlements held by NSJWCD and WID;
- diversions by other individual water right holders and riparian landowners; and
- carriage losses from evaporation, seepage from the river, and evapotranspiration by riparian vegetation.

To ensure that EBMUD can maintain the minimum regulatory flows and simultaneously ensure sufficient flows are available to meet senior downstream water rights, EBMUD releases additional flows from Camanche Dam. Water diverted by downstream riparian diverters and individual appropriators is not measured by EBMUD directly and is

estimated based on historical monthly average losses observed on the river. Section 4.3.3.1 and Figure 4.3-9 provide more information on the various diverters along the Lower Mokelumne River. EBMUD estimates that there are more than 300 such diverters along the Lower Mokelumne River to its confluence with the San Joaquin River (EBMUD 2019).

Resulting minimum required releases from Camanche Reservoir range from about 135,000 acre-feet in critically dry years to about 315,000 acre-feet in normal and above-normal wet years.

The JSA for the Lower Mokelumne River Project, discussed in detail in Section 3.5.2, has been effective in managing water resources and protecting fish populations. Since its inception, the agreement has guided successful management of water releases to protect the salmon and steelhead fishery while maintaining genetic diversity. EBMUD has implemented various measures, including flood space commitments and habitat restoration, to support the fishery's sustainability. The agreement has been reviewed and updated to ensure continued effectiveness and adapt to changing conditions. Overall, the JSA has demonstrated a commitment to sustainable management and the protection of the Lower Mokelumne River ecosystem.

Habitat Availability

EBMUD has recently updated the habitat quantification for the Mokelumne River. The updated modeling analysis provides detailed information on the suitable habitat acreage for fall-run Chinook Salmon, encompassing spawning, juvenile rearing, and floodplain rearing habitats.

These habitat suitability acreages were derived using EBMUD's updated Hydrologic Engineering Center's River Analysis System (HEC-RAS) hydrodynamic model (EBMUD 2024), which simulates flow conditions ranging from 100 to 5,000 cfs and generates depth and velocity data for each reach. The model incorporates updated topographic and bathymetric data (2012–2015), collected during the low-flow drought period, to more accurately represent the physical conditions from Camanche Dam downstream to New Hope Landing, upstream of the North and South Mokelumne River forks within the Sacramento-San Joaquin Delta.

The updated model outputs utilize habitat suitability indices developed by Gutierrez et al. (2019), which serve as the basis for habitat quantification (Table 4.4-5; Figure 4.4-5). EBMUD collaborated with FlowWest staff to process the HEC-RAS outputs using the updated habitat suitability indices, generating suitable habitat acreage across flow conditions. These quantifications were finalized by EBMUD in May 2024 and represent

the “best available science” for habitat accounting in the Lower Mokelumne River. However, EBMUD continues to refine the model, and staff are currently working to update the model using new LiDAR data that incorporates floodplain habitat developed since 2015.

Table 4.4-5. Habitat suitability criteria for spawning, in-channel rearing, and floodplain rearing habitats.

	Spawning		In-Channel Rearing		Floodplain Rearing	
	Min	Max	Min	Max	Min	Max
Depth (ft)	1	2.5	0.5	4	0.5	4
Velocity (ft/sec)	1	4	0	3	0	3

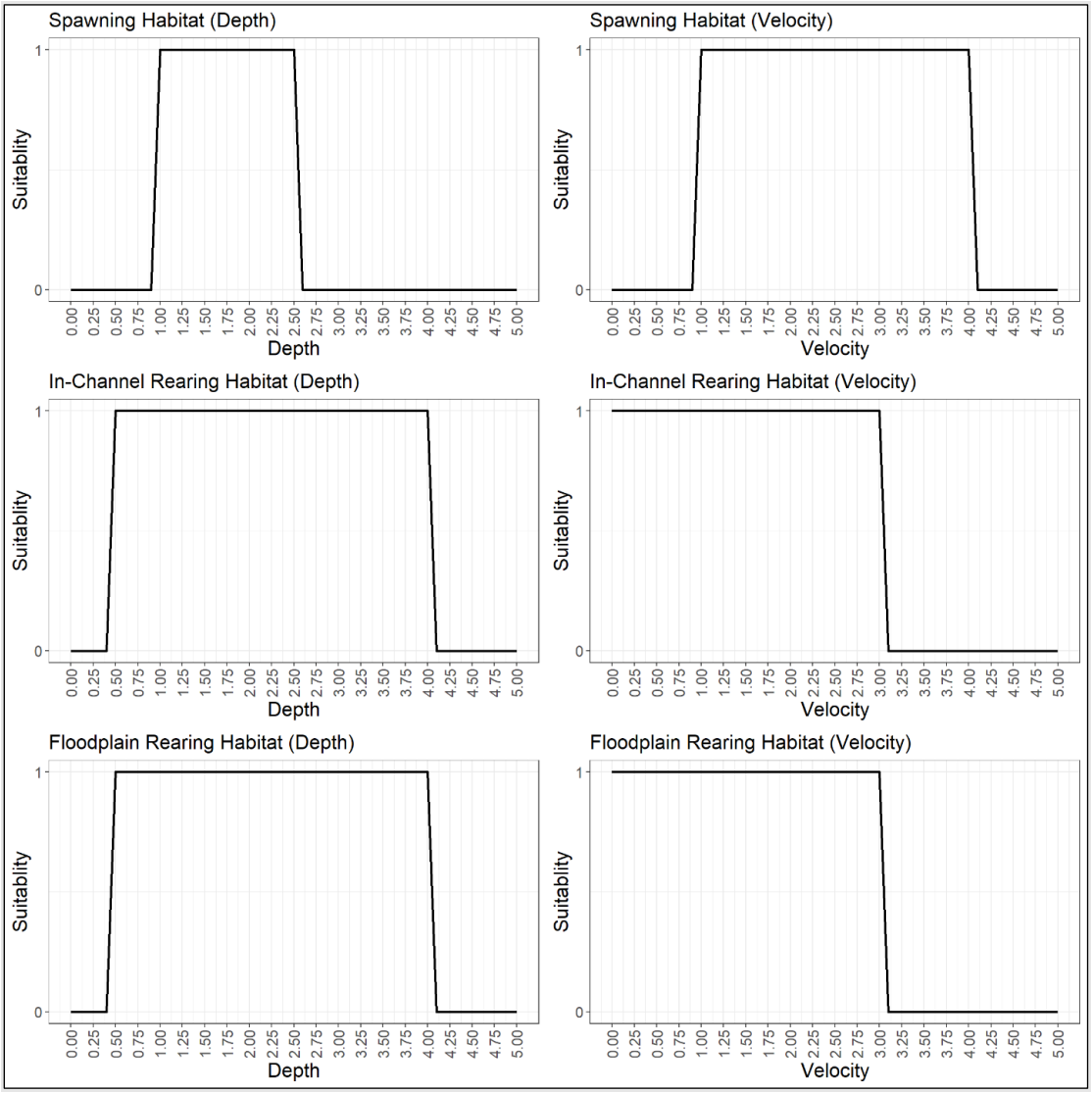


Figure 4.4-5. Habitat suitability indices for spawning habitat in the Lower Mokelumne River used to inform the habitat modeling in May 2024.

Table 4.4-6 summarizes the HEC-RAS hydrodynamic model totals of habitat suitability acreages in the Lower Mokelumne River for spawning, juvenile in-channel rearing, and floodplain habitat from Camanche Dam downstream to New Hope Landing. Discharge influences both flow depth and velocity, which results in changes to the availability of suitable habitat for fall-run Chinook Salmon.

Table 4.4-6. Habitat suitability acreages for spawning, juvenile in-channel rearing, and floodplain rearing habitats in the Lower Mokelumne River.

Flow (cfs)	Spawning Suitable Acres	Juvenile In-Channel Suitable Acres[1]	Floodplain Suitable Acres[1]
100	7.88	77.83	1.68
200	15.74	82.79	2.38
400	19.26	81.20	3.99
600	15.72	67.23	11.56
800	9.66	50.88	20.66
1000	4.92	37.40	27.58
1400	1.48	18.30	35.48
1800	0.68	7.87	40.19
2200	0.39	2.55	46.37
2600	0.25	0.78	54.77
3000	0.16	0.43	66.13
3400	0.10	0.27	81.23
3800	0.06	0.20	96.14
4200	0.04	0.15	113.64
4600	0.03	0.12	139.88
5000	0.03	0.10	162.06

[1] Reach 3 total acreages, incorporating Lodi Lake, were calculated with the Woodbridge Irrigation District Dam installed.

Fish Passage Barriers

EBMUD's construction of Camanche Dam created a fish passage barrier to salmonid spawning and rearing habitat above the Lower Mokelumne River Watershed. EBMUD therefore agreed to provide funds for the original construction of the MRFH in 1964 to meet that mitigation responsibility (see Mokelumne River Fish Hatchery section for details).

WIDD, owned and operated by the WID, has a ladder and fish screens that were rebuilt in two phases: in 2005, three ladders were installed, and in 2008, WID updated the fish screens and added a bypass pipeline. Video monitoring was initiated in the fall of 1990 by EBMUD to track upstream migration of fish species (WID 2002). Overall, the upgrades to the monitoring system have dramatically improved ecological outcomes and data

quality. The data have helped guide river flow management, hatchery operations, and restoration strategies (EBMUD 2011a).

Based on information from the California Fish Passage Assessment Database, over 90 percent of the Lower Mokelumne River water diversions lack screens designed to prevent losses of fish. The highest volume of water is diverted from April through September. Juvenile fish emigration and community data on the Lower Mokelumne River demonstrate overlapping time frames between rearing, emigration, and the operation of riparian water diversions. However, variation in size, infrastructure, configuration, diversion timing and magnitude, and location make it difficult to identify which diversions are most likely to have adverse impacts to native anadromous fishes on the Lower Mokelumne River. In response to this need, EBMUD developed a relative risk model to assess potential risk factors with funding from CVPIA (EBMUD 2019). From 2021 to present, EBMUD has received grant funds from various sources to screen six high priority riparian diversions.

Habitat Designations

NMFS identifies essential fish habitat (EFH) for fish species that are commercially managed under the Magnuson-Stevens Fishery Conservation and Management Act. The NOAA Fisheries EFH Habitat Mapper online tool (accessed November 13, 2024) depicts EFH for Chinook Salmon on the Mokelumne River below Camanche Dam (NOAA 2025). EFH exists for spawning and egg incubation as well as juvenile rearing. Spawning and egg incubation occur from RM 64–54, juvenile rearing from RM 64–38.6; EFH for migratory corridors is downstream of the WIDD and extends to the confluence with the San Joaquin River. See Figure 4.4-4, Fisheries sampling sites in the Lower Mokelumne River, illustrating river miles.

The Lower Mokelumne River, downstream of Camanche Dam, is also designated critical fish habitat for California Central Valley Distinct Population Segment steelhead (70 Federal Register [FR] 52488).

4.4.4.2 FISH AND AQUATIC COMMUNITY

Benthic Macroinvertebrates and Aquatic Mollusks

From 1996–2002, EBMUD conducted an assessment of the benthic macroinvertebrate community in the Lower Mokelumne River to investigate relationships between salmonid spawning gravel augmentation projects, Chinook Salmon redd densities, and the benthic macroinvertebrate communities in spawning areas in the river (Merz and Chan 2005). Benthic macroinvertebrate collection was performed at spawning gravel enhancement sites along the Lower Mokelumne River between Camanche Dam (RM 64) and RM 57.4

(Figure 4.4-6). Sample sites were composed of riffle habitats known to have fall-run Chinook Salmon spawning. Relative abundance, dry biomass, diversity, and taxonomic richness of benthic macroinvertebrates were calculated for the study period, as well as for each season.

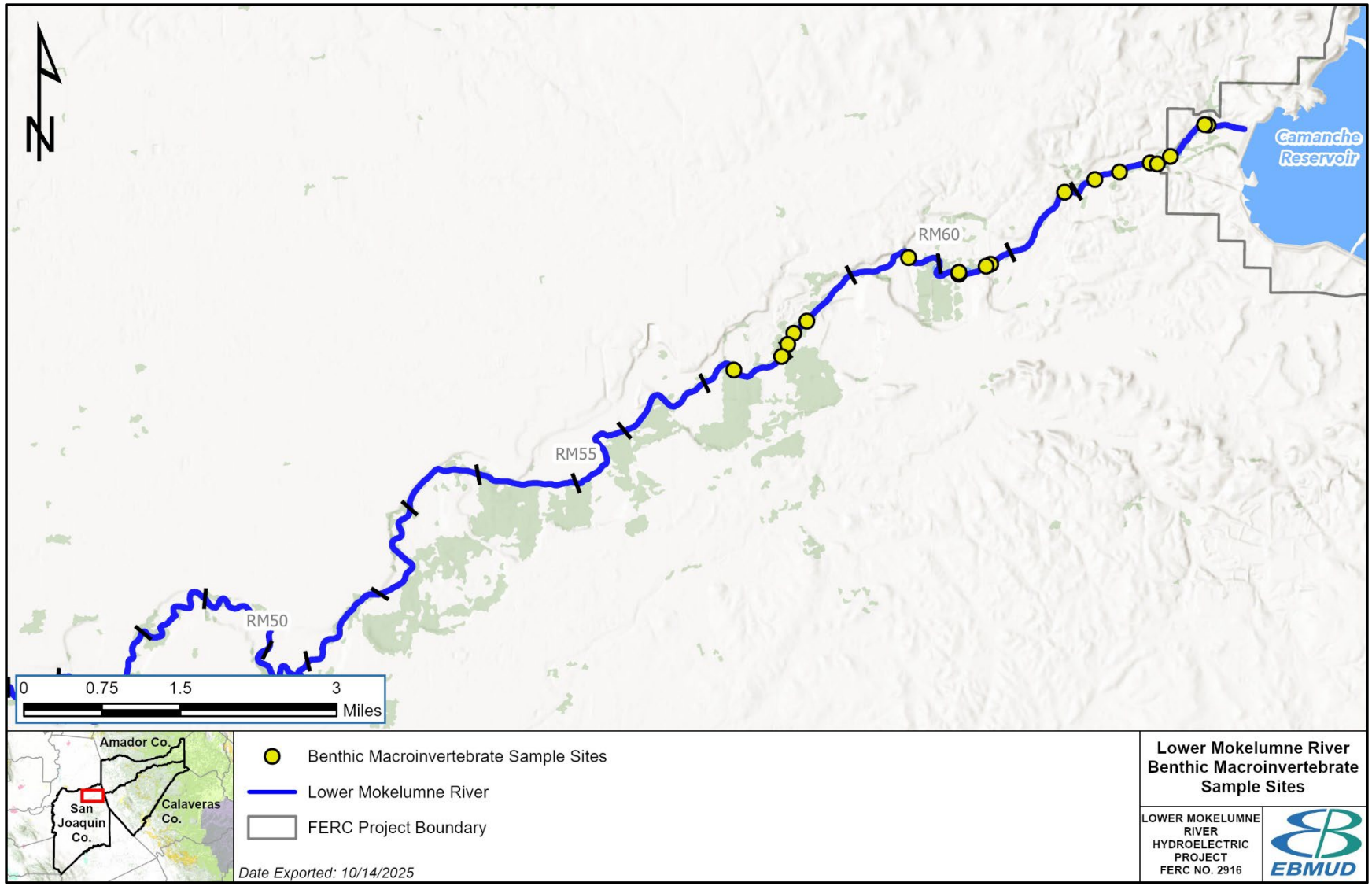


Figure 4.4-6. Benthic macroinvertebrate sampling locations in the Lower Mokelumne River between 1996 and 2000.

Macroinvertebrate sampling was dominated by *Baetidae* (small minnow mayflies), *Chironomidae* (midges), and *Hydropsychidae* (common net spinner caddisflies). *Glossosomatidae*, *Hydracarina*, *Hydroptilidae*, *Tipulidae*, *Simuliidae*, *Tricorythidae*, and *Dugesia* sp. Each constituted at least 1 percent of the total number of organisms collected. However, *Hydropsychidae* and, to a lesser extent, *Glossosomatidae* accounted for a significantly higher percentage of dry biomass. This was primarily due to the substantial differences in overall size and weight of the caddisfly (*Hydropsychidae*) taxon. Although 101 taxa were collected, their distribution was uneven. The benthic fauna in the riffle habitats of the Lower Mokelumne River were predominantly composed of *Chironomidae*, with 39 taxa represented, along with families *Baetidae* and *Hydropsychidae*. These findings suggest that salmonid spawning gravel enhancement sites, utilizing cleaned gravels from adjacent floodplain materials, are quickly incorporated into the stream ecosystem, thereby promoting increased densities and biomass of benthic macroinvertebrate.

Lower Mokelumne Fish Assemblage

EBMUD has been conducting fish community surveys in the Lower Mokelumne River since 1997. Since 2001, the sites in the Delta portion of the Lower Mokelumne River fish community survey have been consistently sampled. Sample sites extend from the basin below Camanche Dam downstream to the San Joaquin River (Figure 4.4-2).

Selected non-wadable and swift water (velocities > 0.91 meters per second) habitats are sampled with a Smith-Root SR-18E electrofishing boat during the winter, spring, and summer. Sampled sites were chosen to best represent the habitat diversity and fish community of each reach in the Lower Mokelumne River with the intent of detecting all the species present in numbers proportional to actual in-river abundance.

To characterize the fish community of the Lower Mokelumne River, fish community data from boat electrofishing surveys between 2001 and 2016 were summarized (Del Real et al. 2018). Based on count, presence, and abundance data, the two most abundant fish species collected between 2001 and 2016 were native species: Sacramento Sucker and Prickly Sculpin (*Cottus asper*) (Figure 4.4-7). The next two most abundant fish species collected were Chinook Salmon and Largemouth Bass. Largemouth Bass were detected in sample units more often than Chinook Salmon and had a higher overall count. These four species accounted for 38 percent of the total catch. The species with an individual abundance greater than 2 percent of the total, in descending order, include Redear Sunfish (*Lepomis microlophus*) (8 percent), Bluegill (8 percent), Hitch (*Lavinia exilicaudia*) (8 percent), steelhead (6 percent), Spotted Bass (5 percent), Tule Perch (*Hysterocarpus traski*) (4 percent), Inland Silverside (*Menidia beryllina*) (4 percent), and Golden Shiner

(*Notemigonus crysoleucas*) (4 percent). "Other" species in Figure 4.4-7, which include 25 species with individual percentages of the total population ≤2 percent, make up a combined 14 percent of the fish population.

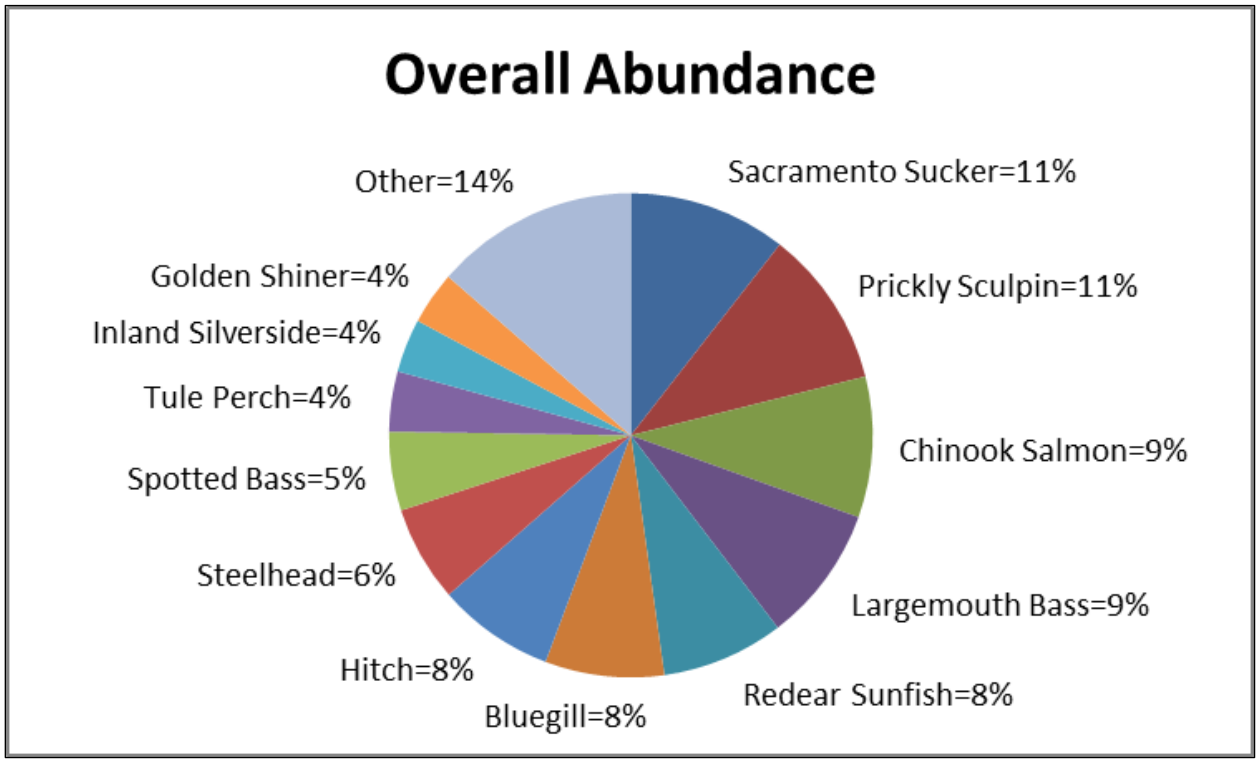


Figure 4.4-7. Species overall abundance within Lower Mokelumne River fish community sample sites from the base of Camanche Dam to the San Joaquin River between 2001 and 2016. "Other" includes species which make up 2 percent or less of the overall species composition (Del Real et al. 2018).

Ongoing fish community monitoring results indicate that EBMUD management actions, guided by the JSA flow and non-flow measures designed around Chinook Salmon life stage requirements, continue to support native fishes (Figure 4.4-7 and Figure 4.4-8). The data show that the Lower Mokelumne River is comprised of two discrete fish communities with distinct population structures above and below WIDD (Del Real et al. 2018). Above the WIDD, the river is managed largely by operations of Pardee and Camanche reservoirs and supports the dominance of native species. Even with the presence of introduced species above the WIDD, native species remain dominant (Del Real et al. 2018). Downstream of the WIDD, the Lower Mokelumne River is influenced more by Delta management and consists predominantly of introduced species (Figure 4.4-8).

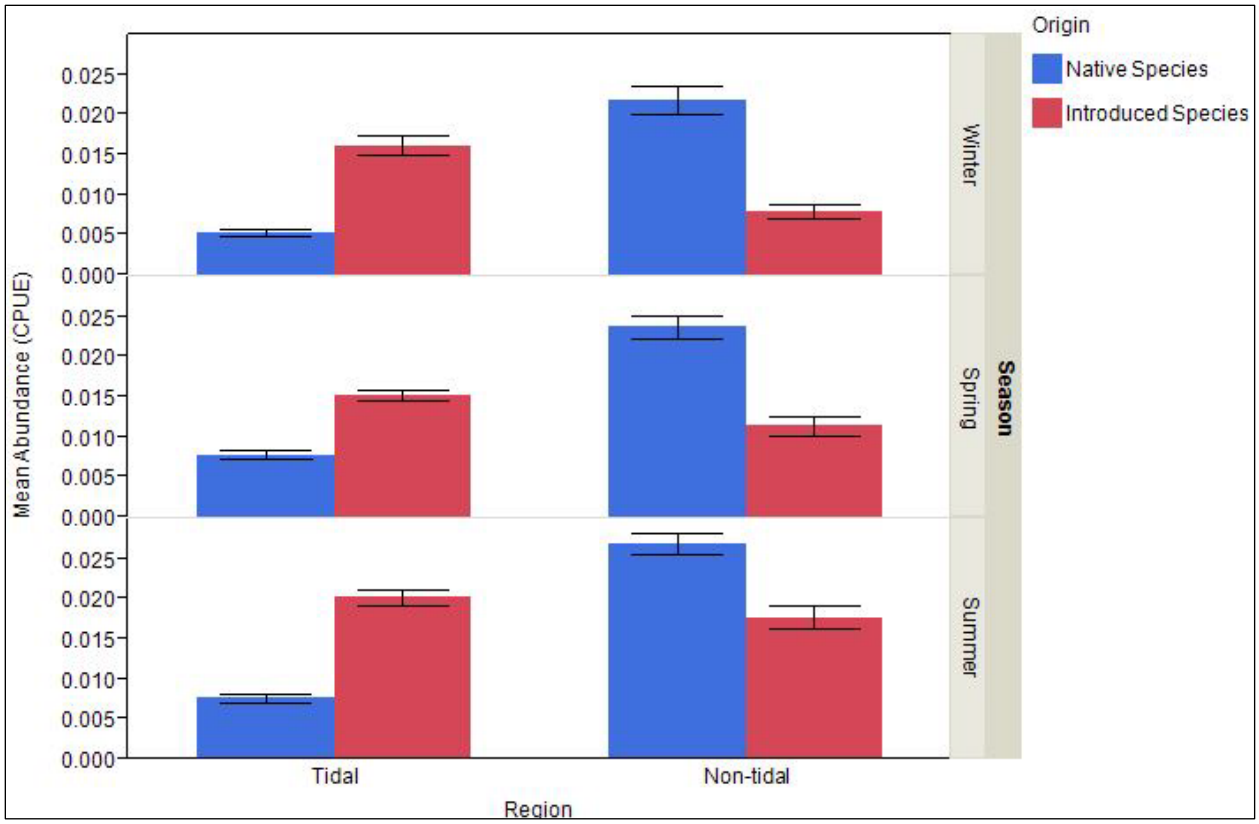


Figure 4.4-8. Mean abundance ±1 SE of native and introduced species within the Lower Mokelumne River by region. For this assessment, the sample site at Feist Ranch (RM 29.3) is considered the upper extent of tidal influence.

Predatory Striped Bass (*Morone saxatilis*) typically do not utilize the fish ladder to pass the WIDD into the upper river reach. Occasionally Striped Bass are detected upstream, indicating that some individuals do either pass the WIDD via the fish ladder or swim over it at very high flows. However, these detections are rare, and Striped Bass are primarily restricted to river reaches downstream of the WIDD.

Special-Status Species

Since 2005, special-status species observed in the Lower Mokelumne River include: Hardhead (SSC), Hitch (SSC), Sacramento Blackfish (SSC), Sacramento Splittail (*Pogonichthys macrolepidotus*) (SSC), Tule Perch (SSC), Delta Smelt (*Hypomesus transpacificus*) (FT, SE), Pacific Lamprey (*Lampetra tridentata*) (SSC), fall-run Chinook Salmon (SSC), spring-run Chinook Salmon (FT, ST), and steelhead (FT) (Table 4.4-1). Section 4.7 covers rare, threatened, and endangered species in greater detail.

Lower Mokelumne River Management Fish Species

Chinook Salmon and steelhead are the primary management species in the Lower Mokelumne River because of their cultural, recreational, and (for fall-run Chinook Salmon) commercial value.

Fall-Run Chinook Salmon

Fall-run Chinook Salmon are the most abundant and widely distributed of the four Chinook Salmon runs in the Central Valley (Williams 2006). They historically spawned in the Central Valley and lower foothill reaches of all major tributaries of the Sacramento and San Joaquin rivers. Dams currently restrict their distribution to the lowermost reaches of their historical spawning habitat where populations are sustained by natural and hatchery production.

Regulatory Status

NMFS conducted a status review of the Central Valley fall/late fall–run Chinook Salmon Evolutionarily Significant Unit (ESU) in 1999 and concluded that this ESU did not warrant listing as threatened or endangered under the ESA (64 FR 50394). This ESU is classified as a species of concern (69 FR 19975).

Life History and Habitat Requirements

Central Valley fall-run Chinook Salmon have an ocean-type life history in which adults enter freshwater at an advanced stage of maturity, move rapidly to spawning areas in lower mainstem and tributary reaches, and spawn within a few days or weeks of freshwater entry. Central Valley fall-run Chinook Salmon typically enter spawning streams from July through December and spawn from October through December. Most fry emerge from December through March and typically emigrate from their natal streams within 1 to 7 months of emergence, entering the estuary as fry or smolts primarily from January through June. This life-history pattern has allowed fall-run Chinook Salmon to sustain relatively large populations in low-elevation reaches of the Central Valley floor below dams where unfavorable water temperature and low-flow conditions frequently occur in summer.

Since 2010, when year-round fish passage monitoring at the WIDD was reimplemented, adult fall-run Chinook Salmon in the Lower Mokelumne River return in August (0.1 percent), September (2 percent), October (49 percent), November (39 percent), December (10 percent), and January (0.2 percent). During this period, adults actively migrate through the lower reaches of the Lower Mokelumne River above the confluence with the

San Joaquin River until they reach the primary spawning areas between the Elliott Road Bridge and Camanche Dam (Figure 4.4-1).

Chinook Salmon typically spawn in the Lower Mokelumne River from October through December (Figure 4.4-9), primarily between the Elliott Road Bridge and Camanche Dam. Upon reaching spawning areas, female Chinook Salmon dig depressions in the riverbed where they deposit their eggs. Females typically select sites with gravel-cobble substrates and sufficient subsurface flows to provide oxygen to the developing embryos. Following fertilization of the eggs by an attending male, the female buries the eggs with gravel and then spends up to 3 weeks defending the nest (redd) from other females. All Chinook Salmon die after spawning. Annual EBMUD redd surveys document and count all Chinook Salmon redds within the Lower Mokelumne River (Figure 4.4-10).

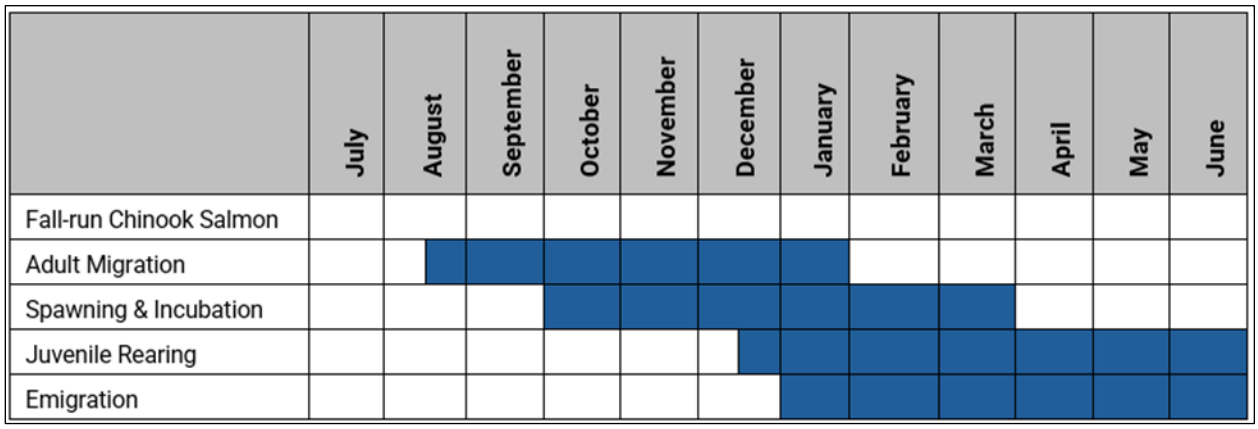


Figure 4.4-9. Fall-run Chinook Salmon life stages in the Lower Mokelumne River.

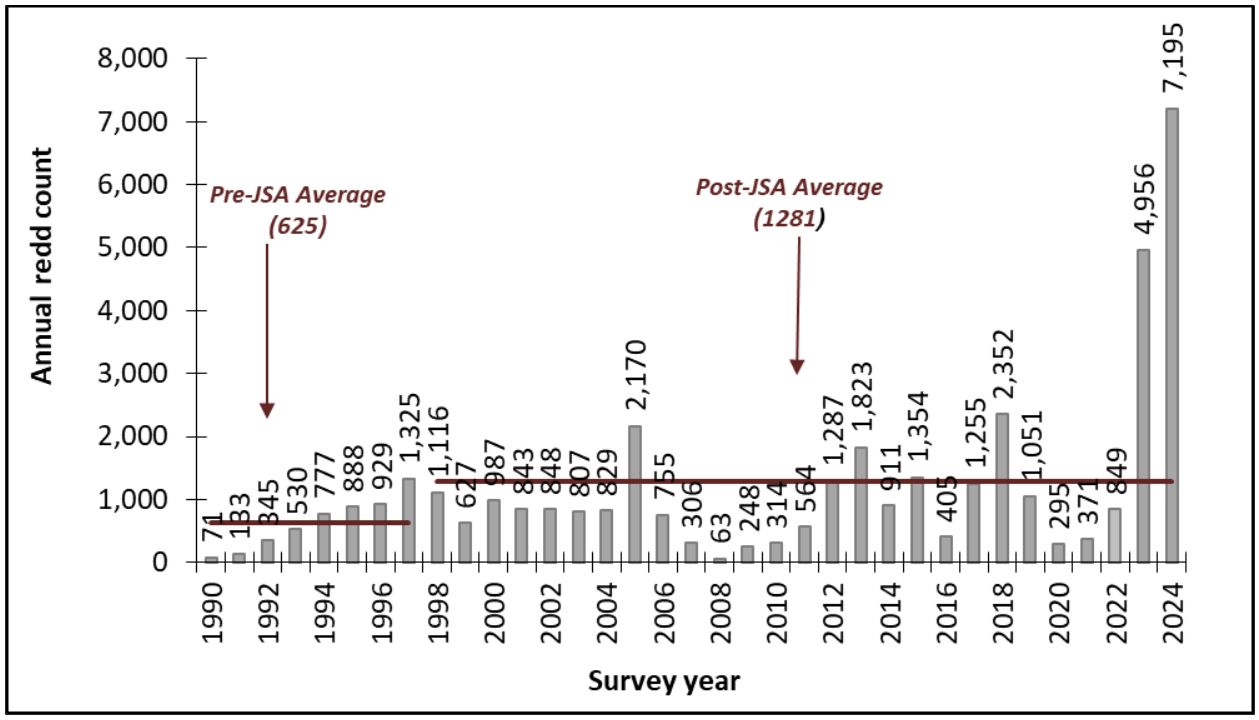


Figure 4.4-10. EBMUD Chinook Salmon redd survey results.

The incubation period extends from the time of spawning to fry emergence and is controlled largely by water temperature. Based on general relationships between water temperature and emergence times, the incubation period in the Lower Mokelumne River extends primarily from the onset of spawning through March.

After emergence, Chinook Salmon fry disperse downstream or reside for several months in the Lower Mokelumne River from Camanche Dam downstream to Woodbridge Dam before emigrating to the ocean. In the Lower Mokelumne River, EBMUD outmigration monitoring since 1992 suggests a bimodal emigration pattern occurs with a distinct fry emigration period from January through March (about 66 percent of total juvenile outmigration on average) and a distinct smolt emigration period from April through June (about 33 percent of total juvenile outmigration on average). Small numbers of yearling smolts (<1 percent of out-migrating Chinook Salmon) are observed passing downstream of the WIDD between December and May. Yearling smolts are juvenile Chinook Salmon that have stayed in freshwater past their first summer, which is atypical. Two distinct life history patterns exist for young of year juvenile Chinook Salmon, natal rearing and non-natal rearing (Apgar et al 2020). When certain hydrologic conditions exist (e.g., under higher flow conditions), fry disperse downstream from spawning areas soon after emergence. These movements, facilitated by peak winter flows, result in dispersal of fry throughout the lower reaches of the spawning streams and upper reaches of the Bay-Delta estuary, where they seek out shallow river margins, floodplains, and tidal wetlands;

these are termed non-natal rearing juveniles, as they are rearing far from their natal areas. During dryer hydrologic conditions, more fry remain in rearing habitat near the spawning areas, where they rear for several months before emigrating in the late spring. This life history pattern is termed natal rearing. The Mokelumne River Chinook Salmon population expresses both of these patterns in differing hydrologic years.

The transition from fry to the juvenile life stage (parr) occurs at a length of approximately 1.8 to 2.4 inches and is generally associated with rapid growth and increased utilization of deeper, higher velocity habitats. Newly emerged fry that remain in their natal stream move to shallow water along the margins of the river where they complete their transition from yolk-sac to external feeding. As they grow, juvenile salmon move into deeper areas of the channel near cover, faster currents, and higher concentrations of food.

During emigration, juvenile Chinook Salmon undergo a series of behavioral, physiological, and morphological changes as they transition from parr to smolts and prepare to enter the marine environment.

Population Status

EBMUD has been monitoring adult fall-run Chinook Salmon escapement in the Lower Mokelumne River using video monitoring and trapping at the WIDD at RM 39 since fall 1990. In 1997, WID initiated a rebuilding of the dam, fish ladders, and fish screening facilities on the Lower Mokelumne River. Carcass surveys and video monitoring were conducted simultaneously in the fall of 2003 to determine the accuracy and precision of estimates generated by carcass surveys versus video monitoring and trapping at WIDD During the fall of 2004, carcass surveys and video monitoring were again both completed successfully to estimate Chinook Salmon escapement. Between 2005 and 2007, the Lower Mokelumne River fall-run Chinook Salmon escapement was estimated by conducting carcass surveys for in-river escapement and adding the salmon trapped at the MRFH for a total Mokelumne River fall-run Chinook Salmon escapement (Workman 2007). Due to low returns of Chinook Salmon during 2008 and 2009, salmon per redd estimates were multiplied by the salmon redd counts to estimate in-river escapement. Since 2010, coordination between EBMUD and WID ensured that Lodi Lake has remained full throughout the Chinook Salmon run. This allows EBMUD to document the Lower Mokelumne Chinook Salmon escapement via video monitoring operations.

EBMUD's video monitoring in the high stage ladder at WIDD is conducted year-round, except for a short period of time when the dam is lowered for annual maintenance. WID lowers the dam at the end of January or early February. As water is routed through the low stage ladder, video monitoring operations are suspended. Once the air bladders of

WIDD are reinflated and water is routed through the high stage ladder, video monitoring resumes.

Annual escapement (i.e., numbers of adults returning to spawn) of fall-run Chinook Salmon in the Lower Mokelumne River has varied considerably over the period of record (Figure 4.4-11).

Coinciding with the 1987–1992 drought, adult salmon returns to the river declined markedly, averaging less than 840 adults annually. EBMUD implemented experimental management actions beginning in the mid-1990s that, in combination with favorable hydrologic conditions in the watershed, improved habitat conditions and resulted in an increasing trend in the abundance of juvenile salmon produced in the river and the numbers of adult fall-run Chinook Salmon returning to the river to spawn. In addition, in 1998 EBMUD, together with CDFW and USFWS, signed the JSA, which contains a suite of comprehensive flow and non-flow measures to protect and enhance the MRFH as described in Appendix B and Appendix C.

Chinook Salmon escapement from 1993 through 2006 averaged over 8,000 annually. The adult return to the river in 2007–2009 was, however, the lowest since implementing the JSA. These low escapements of adult fall-run Chinook Salmon to the river reflected a regional decline of Central Valley fall-run Chinook Salmon attributed primarily to poor marine survival that began in spring 2005, compounded by drought, past and present fish management, hatchery practices, and inland habitat conditions (Lindley et al. 2007). Following the return of better oceanic conditions and the end of the 2007–2009 drought, fishery returns on the Mokelumne rebounded. For example, the 2011 return was 18,596 fall-run Chinook Salmon, a record for the Mokelumne River during the 1940–2011 period (Figure 4.4-11).

From 2012 through 2016, drought conditions returned to the Central Valley. However, Chinook Salmon escapement remained elevated for 4 consecutive years with over 12,000 salmon returning to the Lower Mokelumne River. Multiple factors contributed to the strong Chinook Salmon runs during this period. Effective flow management, including fall pulse flows from Camanche Reservoir to attract returning fish, coordination with the U.S. Bureau of Reclamation to close the Delta Cross Channel to reduce straying, and management of the Camanche cold water pool to support spawning, incubation, and rearing all played crucial roles. Hatchery management (refer to the Mokelumne River Fish Hatchery section for details) has included significant infrastructure investments including chillers, an ultraviolet light water treatment system, and sand filters to improve egg survival. Collaboration on the release of juvenile fish to improve survival to the ocean and management of the fish ladder leading into the hatchery to support both hatchery

and natural spawners also contributed to strong returns during these years. In addition, habitat enhancement to improve natural river spawning and rearing in partnership with both the USFWS AFRP and the CDFW continue to support Lower Mokelumne River salmon populations.

Ongoing coordination and collaboration aimed at continued fisheries improvements, including the Healthy Rivers and Landscapes Program Early Implementation actions and funding provided by the California Department of Water Resources, supported an historic salmon run of 28,698 in 2023-2024. This record was surpassed the following year with 35,450 salmon returning to the Lower Mokelumne River in 2025. The statewide closure of California's 2023 and 2024 commercial and recreational salmon fishing seasons, aimed at protecting the Central Valley fall-run Chinook Salmon population, has positively impacted the number of fish returning to freshwater. However, record returns have not been observed consistently elsewhere in the Central Valley. The Sacramento River has been slow to recover, and MRFH supported the Coleman National Fish Hatchery by providing green eggs in 2023, and in 2024, Coleman was also supported by the Feather River and Nimbus Fish Hatcheries, along with the MRFH.

Salmon escapement within the Lower Mokelumne River can be viewed as three distinct time periods: the salmon counts before Camanche Dam was built, the period after Camanche Dam was built but before the JSA was signed, and the post-JSA period, which provides flow and non-flow measures to protect and enhance fish resources of the Lower Mokelumne River ecosystem. Within Figure 4.4-11, the vertical gray bars are annual fall-run Chinook Salmon counts, while the black horizontal lines depicted the average salmon escapement for each of these three time periods. Positive fish responses to JSA flows and non-flow actions have resulted in increasing average escapement to 11,164. This long-term average exceeds the Lower Mokelumne River CVPIA doubling goal of 9,300.

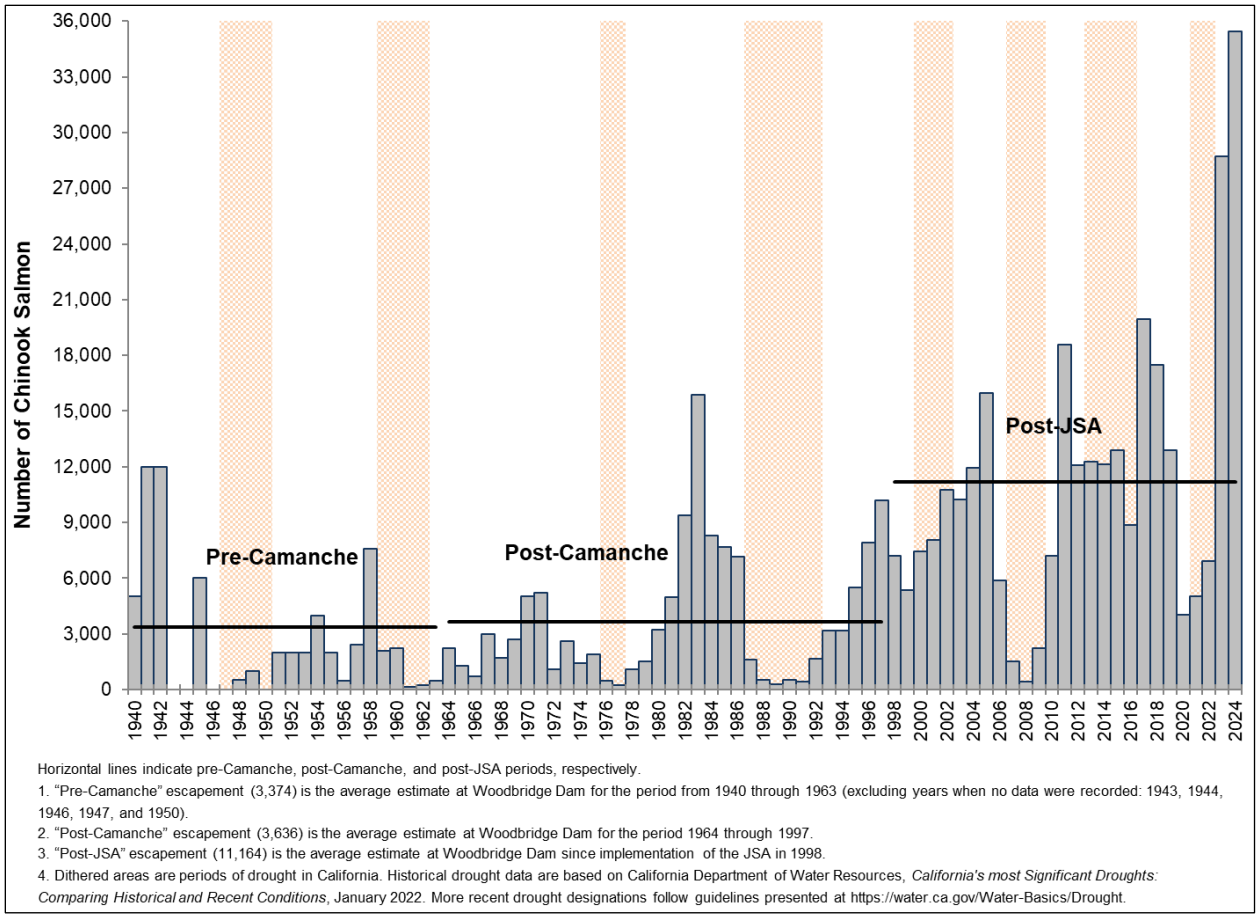


Figure 4.4-11. Estimated annual spawning escapement of fall-run Chinook Salmon in the Lower Mokelumne River, 1940–2024.

In addition to escapement monitoring, the emigration of juvenile Chinook Salmon on the Lower Mokelumne River is monitored using two rotary screw traps and the WID bypass trap (Figure 4.4-4). EBMUD has been monitoring juvenile salmonid emigration on the Lower Mokelumne River since 1990 (Bianchi et al. 1992; Bilski et al. 2013; Marine 2000; Workman et al. 2007). In 2008, EBMUD implemented an additional rotary screw trap location, just downstream of the available salmonid spawning habitat within the Lower Mokelumne River. This is downstream of over 99 percent of Chinook Salmon spawning habitat, as nearly all salmonid spawning occurs in the uppermost 10-mile reach of the Lower Mokelumne River below Camanche Dam (Setka 2004).

The rotary screw trap operated at the upstream location is near the Elliott Road Bridge, adjacent to property owned by Vino Farms, at RM 54.3. The downstream location was operated just below the WIDD, and adjacent to the Lodi Golf and Country Club at RM 38.4. A smolt bypass trap is also operated in the bypass pipe at WIDD (RM 38.6), when accessible. During high flows, the bypass trap is inundated with water and inaccessible. The bypass trap conveys fish that are screened off the Woodbridge Irrigation Canal when

WID is diverting water from the Lower Mokelumne River. The bypass trap is operated when the WID diverts water into their canals.

Fish traps are operated with the objectives of estimating the abundance and monitoring the emigration patterns of anadromous Chinook Salmon in the Lower Mokelumne River. Additional objectives include assessing salmon egg to fry survival using the redd counts and the upstream trap and determining juvenile survival between the upstream and downstream traps. Abundance estimates are generated for juvenile Chinook Salmon using a stratified mark-recovery approach with a single partial capture trap (developed by Volkhardt et al. 2007). At the bypass trap, all salmon are counted and then released downstream of the rotary screw trap. To estimate the total salmon outmigration abundance from the Lower Mokelumne River, the bypass trap count is added to the downstream rotary screw trap estimate (Table 4.4-7).

Table 4.4-7. In-river Chinook Salmon abundance and estimated survival between the upstream and downstream trapping locations since the upstream rotary screw trap was installed (Brood Year 2009).

Brood Year	Upstream Abundance Estimate	Downstream Abundance Estimate	Survival Between Traps (%)
2009	124,279	67,349	54.19
2010	842,570	281,500	33.41
2011	202,772	51,799	25.55
2012	1,203,754	147,590	12.26
2013	595,070	169,864	28.55
2014	431,677	61,305	14.20
2015	856,127	134,593	15.72
2016	No Estimate	326,455	N/A
2017	456,372	40,117	8.79
2018	4,693,253	2,799,209	59.64
2019	214,226	24,097	11.25
2020	197,004	82,145	41.70
2021	107,931	61,415	56.90
2022	≥ 842,449*	184,242	≤ 21.84
2023	1,781,298	444,117	24.93

*Incomplete abundance estimate (trap pulled on March 16, 2023).

EBMUD's biologists have used VEMCO brand telemetry equipment from 2007-2017 to conduct research that supports EBMUD's compliance with regulatory requirements. The Interagency Acoustic Telemetry Advisory Group (ITAG) and Enhanced Acoustic Telemetry (EAT) group have advanced the collaborative nature of data collection in the Delta, which

allows for assessment of management actions that ultimately benefit EBMUD, particularly as it relates to water rights and water availability. ITAG and EAT are interagency coordination groups that were formed to support the planning, scheduling, and implementation of coordinated telemetry projects. These groups provide a platform for members to discuss collaboration between agencies that ensures the successful development, implementation, and performance of telemetry projects. They further ensure that the strategic receiver arrays throughout the San Joaquin and Sacramento rivers and Bay-Delta are maintained, operated, and recovered, and tagged fish detections are disseminated to appropriate researchers (Figure 4.4-12). Lastly, these groups develop and review strategies to further improve coordination among agencies and between various telemetry projects.

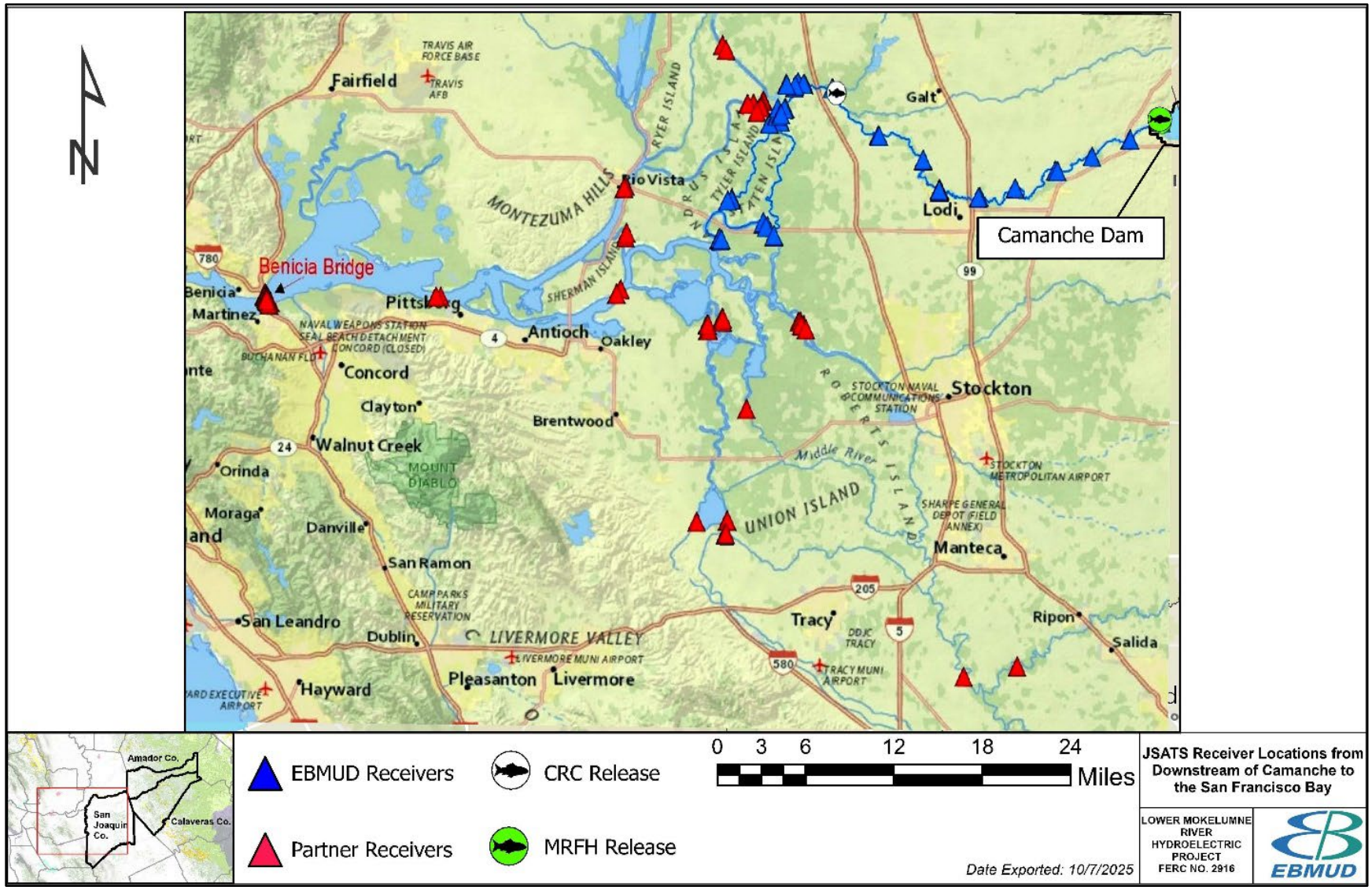


Figure 4.4-12. EBMUD Juvenile Salmon Acoustic Telemetry System (JSATS) study of outmigrant Chinook Salmon smolts, including release locations and receiver arrays.

To take advantage of this research opportunity, EBMUD initiated an acoustic telemetry study in 2021 utilizing Juvenile Salmon Acoustic Telemetry System technologies focused on Chinook Salmon outmigration dynamics. Table 4.4-8 summarizes survival estimates through the Delta, to Benicia Bridge.

Table 4.4-8. Chinook Salmon acoustic telemetry survival to Benicia Bridge from 2021–2024.

Year	Survival (%)	SE	95% Lower Confidence Interval	95% Upper Confidence Interval	Detection Efficiency (%)	Tagged Salmon Released
2021	0.1	0.1	0	0.7	100	960
2022	0.1	0.1			100	957
2023	14.8	1.1	12.8	17	98.1	1,104
2024	0.8	0.3	0.4	1.7	100	913

Spawning Run Timing

Fall-run Chinook Salmon spawners return to the Lower Mokelumne River from August through January (see Figure 4.4-9 above). Figure 4.4-13 below depicts the cumulative count of the fall-run Chinook Salmon run. The timing of this run is depicted in Figure 4.4-14.

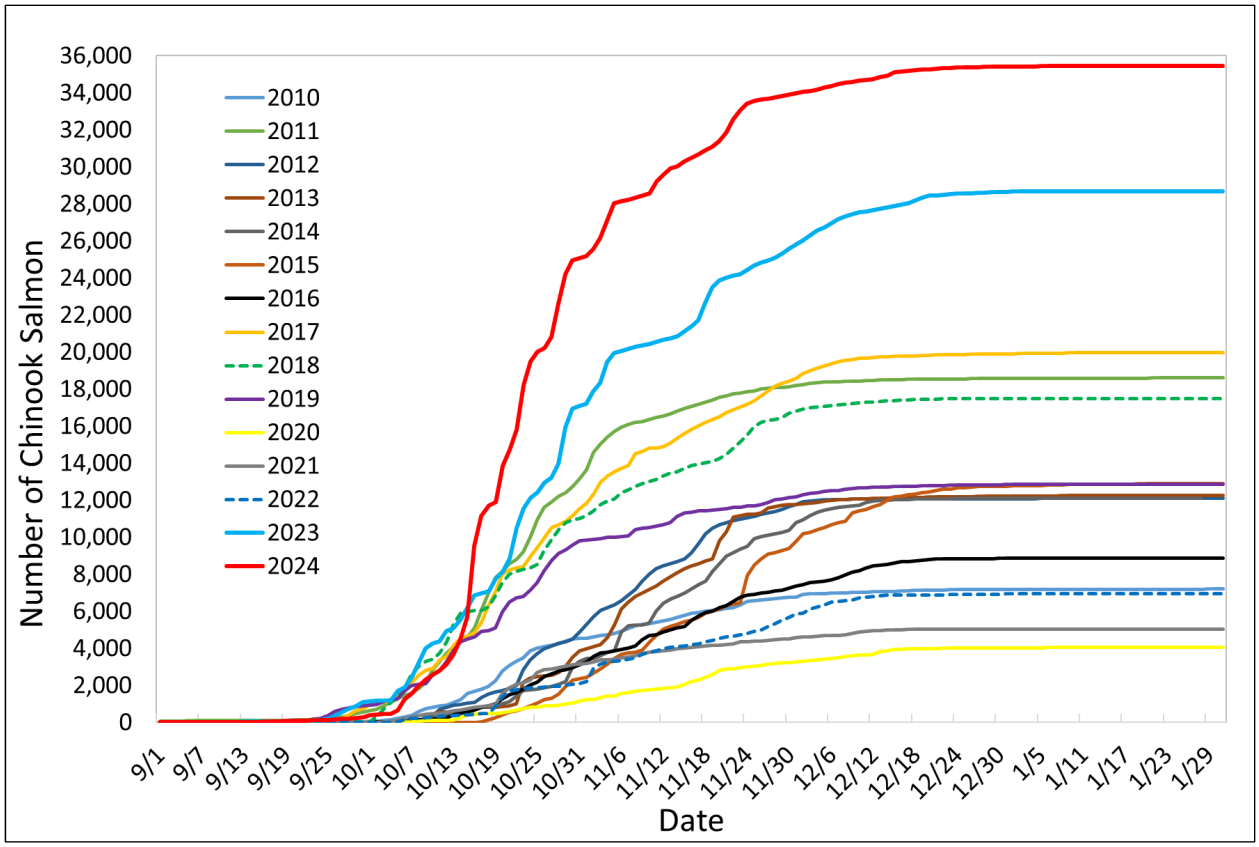


Figure 4.4-13. Cumulative count of Chinook Salmon in the Lower Mokelumne River from 2010–2024.

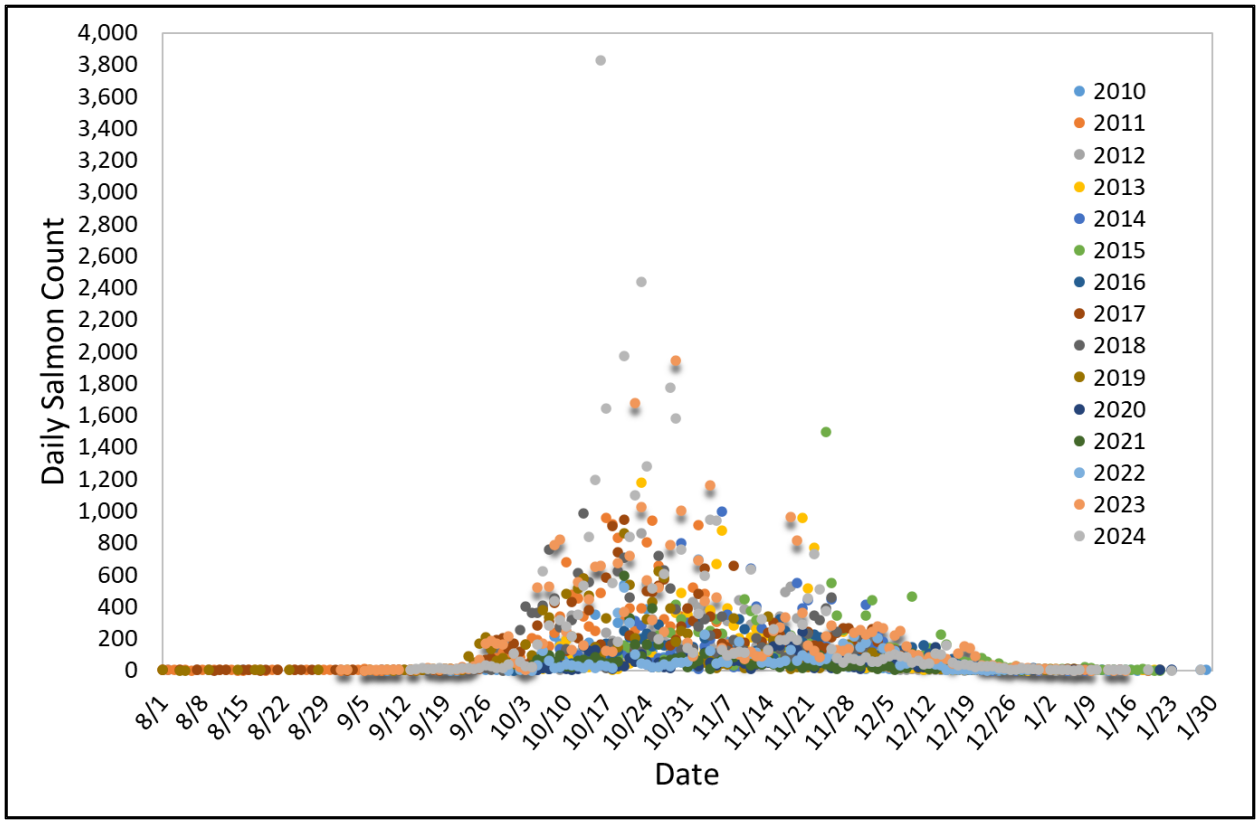


Figure 4.4-14. Daily counts of Chinook Salmon in the Lower Mokelumne River at WIDD from 2010–2024.

During the Lower Mokelumne River salmon run for the years 2010-2024, 10 percent of Chinook Salmon had passed the WIDD between October 9 and October 26; 50 percent passed the WIDD between October 24 and November 23; and 90 percent passed the WIDD between November 24 and December 12 (Table 4.4-9).

Table 4.4-9. Dates when 10 percent, 50 percent, and 90 percent of fall-run Chinook Salmon passed WIDD (2010-2024).

Year	10%	50%	90%
2010	Oct. 9	Oct. 24	Nov. 24
2011	Oct. 9	Oct. 24	Nov. 13
2012	Oct. 17	Nov. 3	Nov. 22
2013	Oct. 23	Nov. 6	Nov. 22
2014	Oct. 22	Nov. 11	Dec. 2
2015	Oct. 26	Nov. 23	Dec. 12
2016	Oct. 18	Nov. 9	Dec. 8
2017	Oct. 7	Oct. 26	Nov. 27
2018	Oct. 6	Oct. 26	Nov. 25
2019	Oct. 5	Oct. 21	Nov. 21
2020	Oct. 16	Nov. 15	Dec. 11

Year	10%	50%	90%
2021	Oct. 12	Oct. 25	Dec. 1
2022	Oct. 19	Nov. 8	Dec. 4
2023	Oct. 8	Oct. 29	Dec. 2
2024	Oct. 13	Oct. 23	Nov. 22

Spring-Run Chinook Salmon

Between 2005 and 2024, there have been 12 years in which salmon passage was documented during the upstream migration run timing for Central Valley spring-run Chinook Salmon and 8 years during which no spring-run salmon were recorded (Figure 4.4-15). During this period, the maximum annual count of salmon passage between February and July was 77 in 2011. Recovered coded wire tags indicate that hatchery-produced spring-run salmon entering the Lower Mokelumne River have originated from either the San Joaquin River Conservation Hatchery or the Feather River Fish Hatchery.

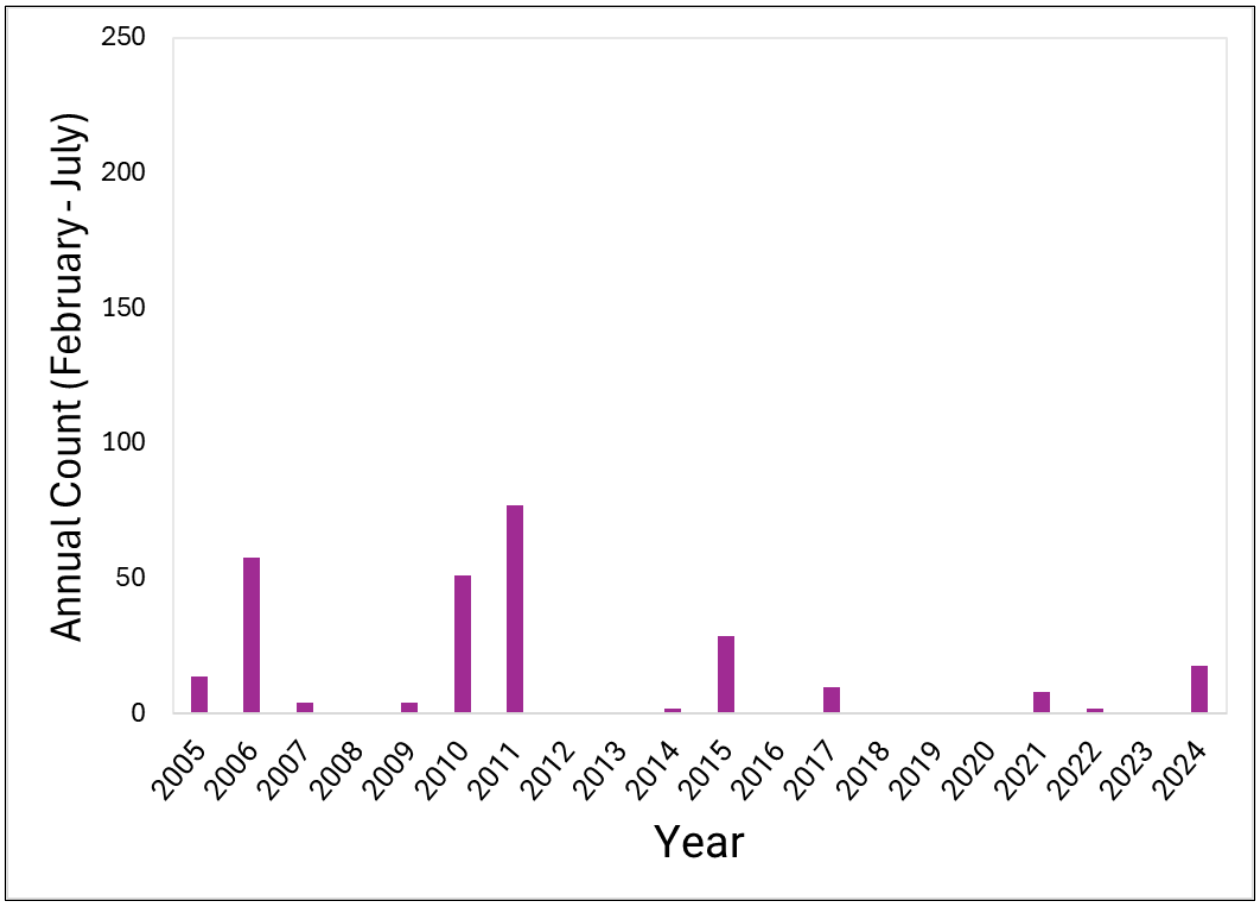


Figure 4.4-15. Spring-run Chinook Salmon passage counts within the Lower Mokelumne River.

Based on the population viability framework for evaluating spring-run Chinook Salmon developed by Lindley et al. (2007), a very small population with an effective population equal to or less than 50 fish would suffer severe inbreeding depression and have a high risk of extinction. As an effective population size is smaller than annual escapement counts due to variability in reproductive success among spawning individuals, annual counts of 250 salmon or more would be needed to avoid inbreeding depression. The Lower Mokelumne River does not meet this threshold for spring-run Chinook Salmon.

Based on this assessment, the Lower Mokelumne River does not support a viable population of spring-run Chinook Salmon. This conclusion is drawn from the 8 years since 2005 with no recorded spring-run salmon entering the river, the consistently low numbers of spring-time migrants straying into the river, and the lack of suitable holding habitat for spring-run salmon.

Steelhead

Steelhead and resident Rainbow Trout, collectively referred to as *O. mykiss*, were once widespread in the Central Valley before dams blocked access to most of their historical spawning and rearing habitat. All extant populations of Central Valley steelhead are recognized as winter-run, based on their state of sexual maturity and time of river entry. Although these populations occur largely in the upper Sacramento River and its tributaries, steelhead adults and juveniles have been documented in other accessible rivers throughout the Central Valley (Good et al. 2005), including the Lower Mokelumne River.

O. mykiss may exhibit anadromy or freshwater residency. Resident forms are usually referred to as Rainbow Trout, while anadromous forms, which spend a portion of their life cycle in coastal marine waters, are termed steelhead. Resident Rainbow Trout can produce anadromous progeny, and anadromous steelhead can produce resident progeny in the Central Valley (Zimmerman et al. 2008).

Regulatory Status

Prior to the establishment of the MRFH (refer to the Mokelumne River Fish Hatchery section for details), there were numerous releases of steelhead from the Mount Shasta, Mount Whitney, Basin Creek, Fern Creek, Kaweah, and Mormon Creek hatcheries into the San Joaquin River Basin (West Coast Steelhead Biological Review Team 1998). There is no documentation of egg collections from San Joaquin River basin sources, so it is presumed that these hatchery releases came from sources in the Eel River and Scott Creek and San Lorenzo basins (West Coast Steelhead Biological Review Team 1998). However, the exact origin of these steelhead releases is unknown.

CDFW determined that by 1952, steelhead were "virtually nonexistent" in the Mokelumne River below Pardee Dam (California Department of Fish and Game 1959), most likely the result of mining, cannery, and winery waste discharges. From 1953 to 1959, CDFW released more than 1,250,000 steelhead fingerlings between Pardee Dam and Thornton to revitalize the Mokelumne steelhead population.

NMFS listed the Central Valley steelhead Distinct Population Segment (DPS) as a threatened species in 1998 (63 FR 13347). Critical habitat designated by NMFS for steelhead includes the Delta and Central Valley Rivers, including the tributaries (Lower Mokelumne River below Camanche Reservoir) and mainstem of the San Joaquin River and the Sacramento River. Natural-origin anadromous steelhead in the Lower Mokelumne River were designated as part of the Central Valley steelhead DPS.

Within NMFS's 5-Year Review: Summary and Evaluation California Central Valley Steelhead Distinct Population Segment report (NMFS 2016), a new analysis of the genetic relationships between the four Central Valley steelhead hatcheries was evaluated. Pearse and Garza (2015) clearly demonstrated that steelhead from the MRFH are nearly genetically identical to fish from the Feather River Fish Hatchery, suggesting that there is little carryover of genes from the Nimbus stock. Given the new genetic evidence, NMFS proposed that the MRFH be added to the California Central Valley steelhead DPS, as Feather River Fish Hatchery fish are considered to be a native Central Valley stock and are listed as part of the California Central Valley steelhead DPS (81 FR 72759). In a final rule posted in the Federal Register, effective December 17, 2020 (85 FR 81822), NMFS updated the Central Valley steelhead listing to include, among other changes and clarifications, the addition of the MRFH segment of the Mokelumne River steelhead population. These changes are based on the 2016 NMFS 5-year status review under the federal ESA.

Life History and Habitat Requirements

The Lower Mokelumne River supports a self-sustaining, naturally spawning *O. mykiss* population that supports anadromy (McEwan 2001; NMFS 2014). However, steelhead runs on the Lower Mokelumne River appear to be supported largely by hatchery production (see Steelhead Hatchery Production section for details).

Like Chinook Salmon, steelhead deposit their eggs in excavated gravel nests or redds. Unlike salmon, some adults survive spawning (referred to as kelts), return to the ocean, and then return to freshwater to spawn again. Based on general relationships between water temperature and emergence times, the incubation period extends primarily from December through May.

Central Valley steelhead typically rear in freshwater for 1 or 2 years before emigrating to the ocean. Juvenile steelhead have been reported to emigrate from natal streams during fall, winter, and spring, but the peak emigration period for naturally produced juveniles typically occurs in late winter and spring (Nobriga and Cadrett 2003). Juveniles are typically observed passing Woodbridge Dam from February through June, including young-of-year (fish born in the year of capture) that appear from March through June.

Zimmerman et al. (2008) revealed that the Central Valley *O. mykiss* population is skewed toward the non-anadromous resident form, as 77 percent of the analyzed *O. mykiss* in that study were progeny of resident Rainbow Trout. Similarly, results from Del Real et al. (2012) suggested a large proportion (78 percent) of natural origin *O. mykiss* in Lower Mokelumne River demonstrate a resident life history. An analysis of hatchery and natural origin adult *O. mykiss* otolith collected from 2009 to 2012 at the MRFH and within the Lower Mokelumne River demonstrated that the natural origin, in-river *O. mykiss* population is a relatively closed group of resident fish. However, hatchery origin *O. mykiss* are members of a single well mixed population with approximately equal mix of anadromous and resident forms having higher reproductive exchange between the two life forms and potentially with other hatchery *O. mykiss* and neighboring natural populations (Donohoe et al. 2015).

Population Status

In 2005, EBMUD developed a population estimate of natural-origin *O. mykiss* in the Lower Mokelumne River from Camanche Dam downstream to the Woodbridge Dam using boat electrofishing surveys to implement a mark-recapture study with passive integrated transponder (PIT) tags. That estimate was about 9,215 adult *O. mykiss*. Due to challenges with monitoring steelhead, population estimates for the Lower Mokelumne River steelhead are not produced for either video monitoring operations, which count returning spawners, or outmigration monitoring via rotary screw traps. Video monitoring operations cease during the steelhead migration (typically in February) when Lodi Lake is drained for annual maintenance conducted by WID. For the rotary screw trap operations, trap calibrations using steelhead are not conducted and therefore no population estimate is generated.

Steelhead spawning/redd surveys have been conducted in the Lower Mokelumne River since 1994 (Figure 4.4-16). The maximum number of redds counted was 173 in 2024. Occasionally, during periods of high flows, the Mokelumne River becomes unwadeable, and persistent high flows may cause yearly surveys to be incomplete or even cancelled altogether.

With the NMFS Recovery Plan, the Mokelumne River population below Camanche Dam was designated as a Core 2 (NMFS 2014). Core 2 populations are assumed to have the potential to meet the moderate risk of extinction criteria.

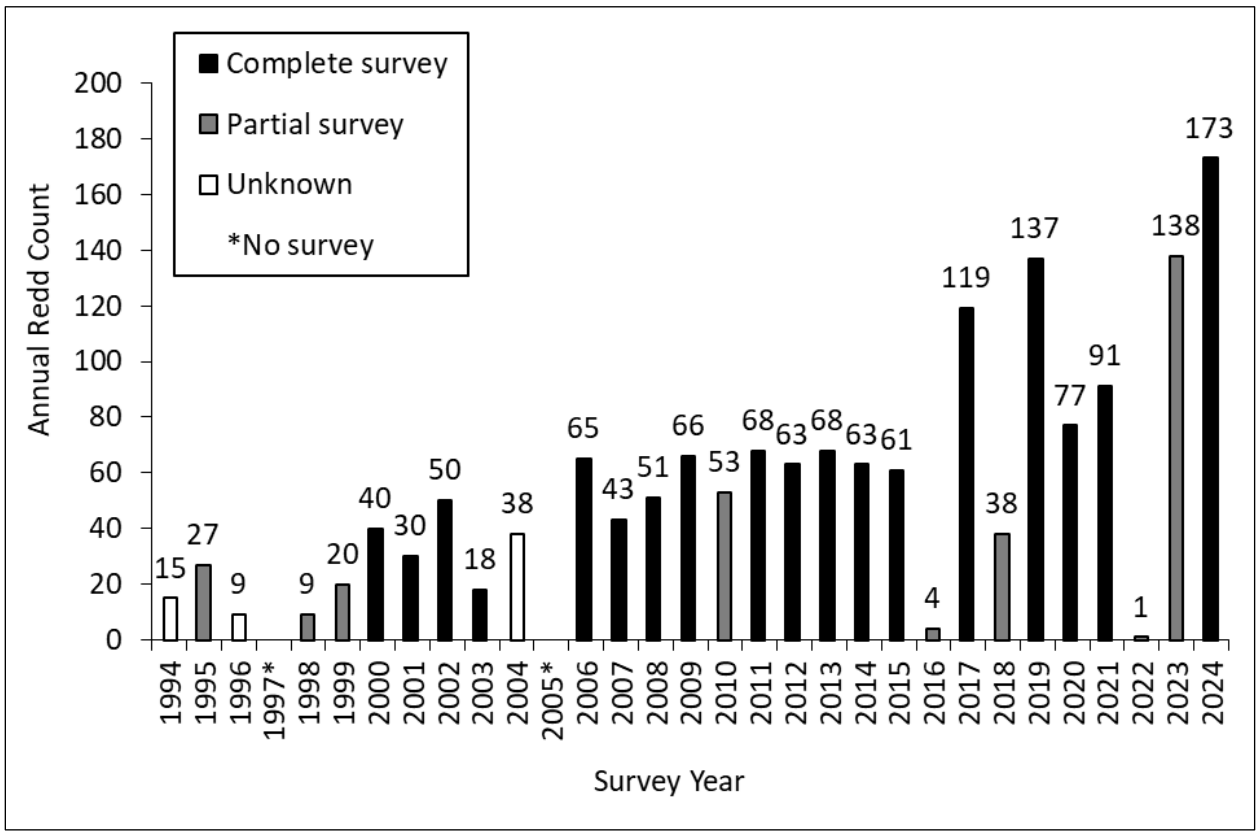


Figure 4.4-16. Annual redd counts in the Lower Mokelumne River 1994-2024.

Spawning Run Timing

Year-round video monitoring of the WIDD fish ladder, by EBMUD, began in 2010. The only exception to this continuous monitoring is during periods when water is redirected from the Woodbridge high-stage ladder to one of two low-stage ladders. This generally takes place every February when, due to annual dam maintenance, Lodi Lake is drained for 2 to 3 weeks. This renders the high-stage ladder inoperable, preventing the counting of migrating steelhead.

The MRFH classifies steelhead as adults if they measure 18 inches (457 millimeters) or greater. Fish counted using video monitoring are measured in 50-millimeter increments, with any steelhead measuring 450 millimeters or greater categorized as adults.

Based on data from 2010 through 2024, 93 percent of adult steelhead in the Lower Mokelumne River migrate upstream between September and January, excluding the period in February when the WIDD is lowered for annual maintenance (Figure 4.4-17). It can be safely assumed that some steelhead passages in February are missed annually. Additionally, some steelhead may not be guided past the viewing window and counted because the Woodbridge Dam fish ladder was designed to facilitate the monitoring of larger Chinook Salmon and the bar racks that guide fish in front of a viewing window have a distance between bars that does not meet the minimum steelhead monitoring standard of less than one inch.

Most steelhead spawn in the upper reaches of the Lower Mokelumne River from December through March (Figure 4.4-18).

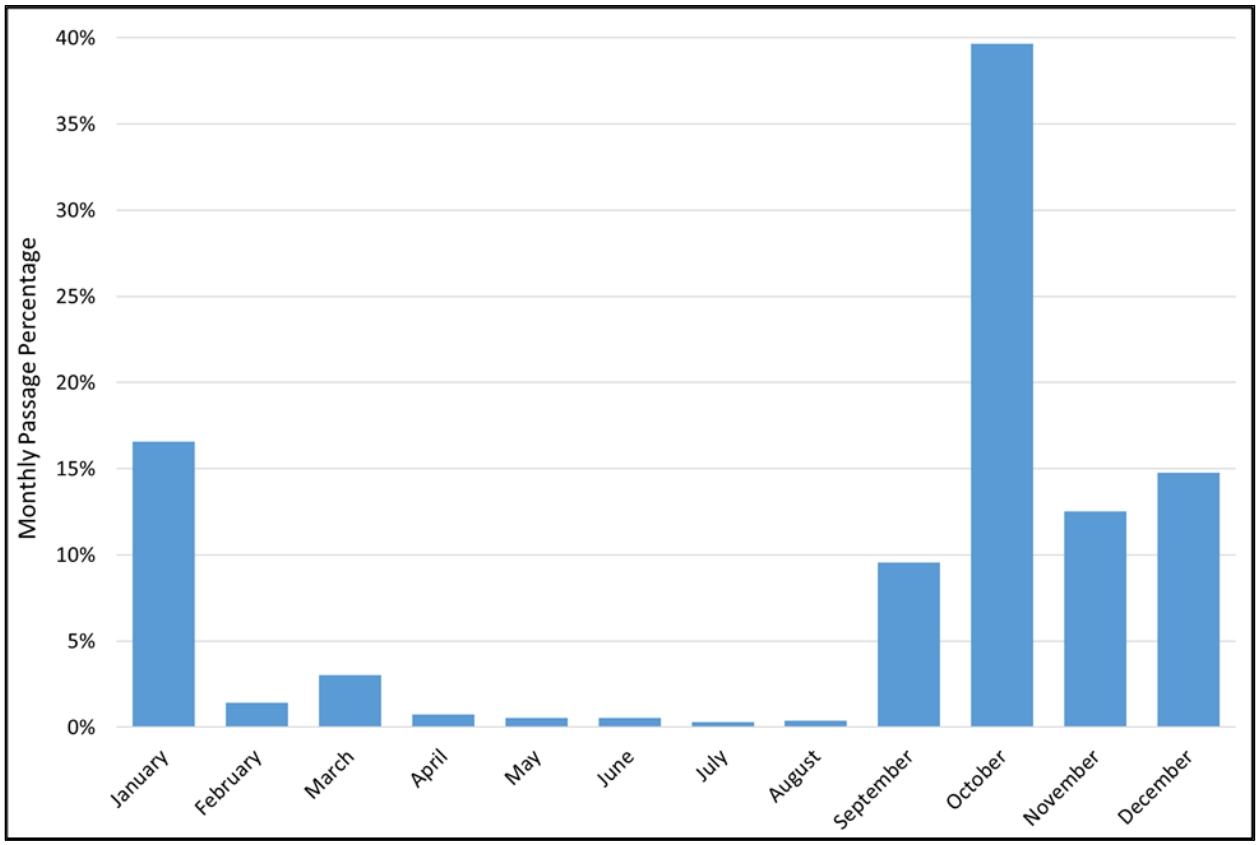


Figure 4.4-17. Monthly timing of adult (≥ 18 inches) steelhead passage at WIDD (2010-2024), excluding the period in February when WIDD is lowered for annual maintenance.

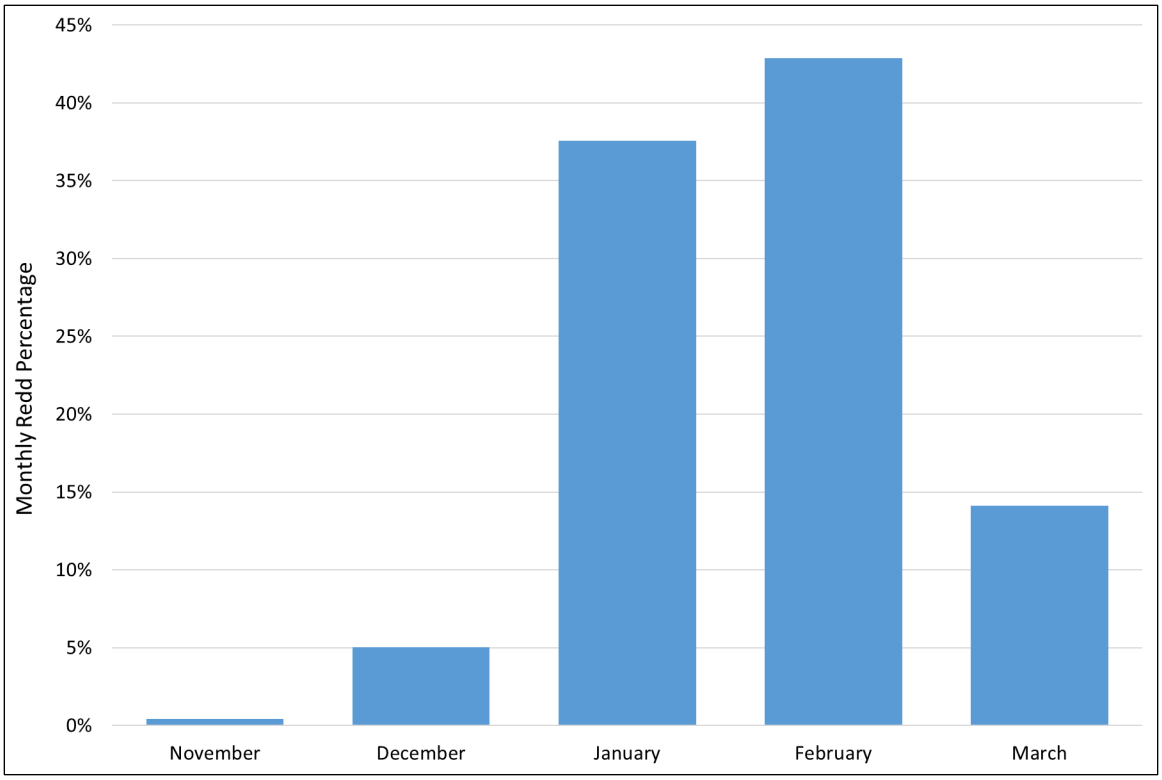


Figure 4.4-18. Monthly timing of steelhead spawning on the Lower Mokelumne River 2000-2024.

Mokelumne River Fish Hatchery

EBMUD initiated the construction of Camanche Reservoir in 1963. As mitigation for blocking access to salmonid spawning grounds, EBMUD provided funding for the original construction of the MRFH in 1964 and continues to fund the mitigation programs for fall-run Chinook Salmon and steelhead at the facility. The hatchery is located on the south bank of the Mokelumne River at the base of Camanche Dam. This facility is cooperatively managed by CDFW and EBMUD, while CDFW oversees the hatchery according to a hatchery operating and maintenance agreement with EBMUD (CDFG 2004). EBMUD, in collaboration with CDFW, modernized the facility in 2002.

Chinook Salmon Hatchery Production

The MRFH conducts artificial propagation of fall-run Chinook Salmon to mitigate for lost habitat due to construction of Camanche Dam and to enhance economically important commercial fisheries and popular sport fisheries in the ocean and rivers of California. The fall-run Chinook Salmon Mitigation Element production is supported by EBMUD mitigation funding, while the Ocean Enhancement Element is supported by the Commercial Salmon Stamp Fund.

Since 2007, the MRFH has participated in the constant fractional marking (CFM) program and has ensured that a minimum of 25 percent of Chinook Salmon production at this facility is tagged with a microscopic (≤ 1 millimeter) coded-wire tag and marked with a clipped adipose fin to allow for visual identification. Heads of adipose fin clipped adult salmon returning to the Mokelumne River are collected to recover the coded wire tags. Heads are collected at the hatchery and during coded wire tag recovery surveys within the spawning reaches of the river. Annual reports on the recovery of CFM coded wire tags in the Central Valley and ocean fisheries by CDFW summarize the (1) proportions of hatchery- and natural-origin salmon returns to Central Valley hatcheries and natural areas, (2) the relative recovery and stray rates for hatchery-origin salmon released, and (3) the relative recovery and contribution rates of hatchery-origin salmon, by run and release type, to ocean and inland harvests (Dean and Lindley 2023).

The regular annual fall-run Chinook Salmon production goal for the MRFH is 6.4 million juvenile Chinook Salmon, as follows:

- EBMUD fall-run Chinook Salmon Mitigation Element: up to 3,400,000 smolts, at 27.2 fish/kilogram (60 fish per pound).
- CDFW fall-run Chinook Salmon Ocean Enhancement Element: up to 3,000,000 smolts, at 20.4 per fish/kilogram (45 fish per pound).

Additional production goals may include rearing Chinook Salmon for special studies requested by researchers and increased production to enhance commercial ocean fisheries. Recently, the hatchery has significantly increased its annual production by rearing an additional 2.6 million smolts to support CDFW's fall-run Chinook Salmon Drought Enhancement program and Climate Change Resiliency initiative.

The annual production goal of 6.4 million smolts is readily attainable given the existing hatchery infrastructure; and it provides operational flexibility for spawning, rearing, marking, and tagging of Chinook Salmon, in addition to meeting steelhead mitigation goals (see below). Ongoing hatchery improvements and investments are based on this production threshold. Increased production, for example, up to 9 million smolts as a result of CDFW drought and climate initiatives, has the potential to strain the capacity of the hatchery and impact optimal rearing densities.

Steelhead Hatchery Production

Following completion of Camanche Dam in 1964, Nimbus Hatchery stock, as well as steelhead from Coleman National Fish Hatchery and Feather River Fish Hatchery, were introduced to the Mokelumne River (California Department of Fish and Game 1995; Cramer et al. 1995; McEwan and Jackson 1996). Nimbus Hatchery, situated on the

American River (a tributary to the Sacramento River), was initially stocked with Eel River winter steelhead from the Van Arsdale Fisheries Station and returning American River steelhead. Over time, stocks from the Mad River, Russian River, and Sacramento River were also integrated into the Nimbus Hatchery population (California Department of Fish and Game 1995; Cramer et al. 1995). The MRFH and Nimbus Hatchery stocks were excluded from the Central Valley DPS, originally, because of their genetic affinities with mixed steelhead stocks (Good et al. 2005; NMFS 1998). Steelhead egg transfers, along with occasional fingerling transfers, from the Nimbus Fish Hatchery were discontinued after the 2000/2001 season. Similarly, transfers from the Feather River Fish Hatchery stock were discontinued after the 2008/2009 season.

Since then, CDFW and EBMUD have supplemented the population with Mokelumne-origin steelhead. This objective is consistent with current policies and management direction to minimize adverse genetic and ecologic interactions between hatchery and natural populations of anadromous fish (California Department of Fish and Game and EBMUD 2012). In 2020, the Mokelumne Hatchery steelhead were included in the Central Valley DPS as mentioned above.

The annual steelhead production goal supported by EBMUD mitigation funding is 250,000 juvenile steelhead. The juvenile steelhead are released as yearlings at approximately 12 months of age and have an average weight of 0.25 pounds each (approximately 62,500 pounds of biomass per year).

From 1988 through 2024, there has been an increasing trend in the returns of adult steelhead back to the MRFH. This has been attributed to shifts in management practices, with an emphasis on release timing (February–March), release strategy (new moon), and release location (above tidal influence when conditions allow). It is believed that these practices give hatchery-produced steelhead more time to acclimate and improved ability to evade predators within the Sacramento-San Joaquin Delta.

Amphibians and Aquatic Reptiles

EBMUD does not conduct any targeted amphibian or aquatic reptile surveys within the Lower Mokelumne River.

Invasive Aquatic Species

In December 2003, New Zealand mud snails (NZMS, *Potamopyrgus antipodarum*) were first observed during salmon carcass surveys approximately 5 RM below Camanche Dam. Preliminary surveys indicated population densities as high as 38,000 NZMS • m-2 (dry weight: 14.96 g • m-2) in January 2004 (EBMUD unpublished data). Since 2003, the

NZMS population appears to be spreading within the Lower Mokelumne River. The persistence of the NZMS, since the first 2003 observation, has raised concerns about potential impacts to the Mokelumne River, including changes to the population dynamics of resident benthic invertebrates, periphyton production, and a subsequent decrease in food availability for resident and migratory fish.

Distribution of NZMS was examined using samples collected from August through December 2006. This study was conducted on an approximately 6-mile stretch of the Lower Mokelumne River, extending from above Highway 88 downstream to Elliott Road. Sample sites were selected based on the location of gravel bars and overlap with sites included in previous macroinvertebrate studies (Figure 4.4-19).

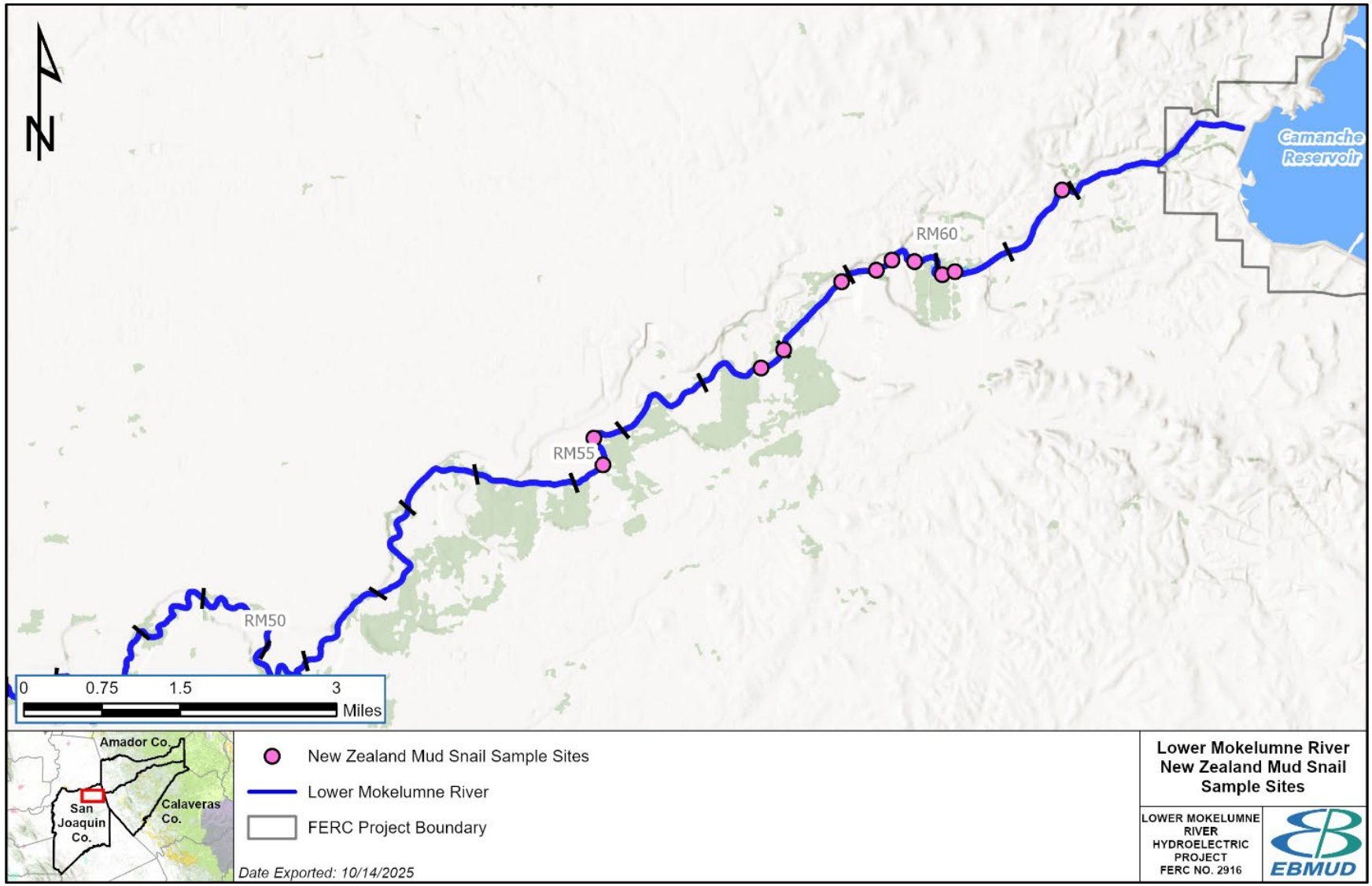


Figure 4.4-19. Lower Mokelumne River NZMS sample sites.

The study supports previous work indicating NZMS have the potential to reduce benthic macroinvertebrate diversity in streams they invade (Washburn et al. 2007). However, a dramatic drop in snail densities between RM 8.2 and 8.5 was discovered, suggesting the downstream range may be limited to the salmonid spawning reach due to habitat requirements and an associated decline in numbers with a significant change in overall channel parameters. Ongoing general observations indicate annual variation in the abundance and range of NZMS, limiting the overall impacts to the macroinvertebrate populations with no discernable impacts to salmonid populations.

Additional aquatic invasive species observed within the Lower Mokelumne River include water hyacinth (*Eichornia crassipes*), Brazilian waterweed (*Egeria densa*), American bullfrog, and red swamp crayfish (*Procambarus clarkii*).

In October of 2024, a population of Golden mussel was discovered in the Sacramento-San Joaquin Delta near Stockton. The Golden mussel poses a significant threat to water conveyance infrastructure and aquatic ecosystems. EBMUD is monitoring the spread and developing a plan to respond to this discovery.

4.4.5 DELTA/OCEAN

4.4.5.1 DELTA

The health of the Sacramento-San Joaquin Delta (Delta) is critical for Mokelumne fish that migrate through it. For Mokelumne-origin salmonids, operation of the South Delta water diversions and pumps impact Delta flow patterns and affect salmon and steelhead migration to and from the ocean. EBMUD has worked cooperatively with the state and federal regulatory agencies to develop and implement a flow agreement, the JSA, that protects Mokelumne fish. Under the JSA, the Mokelumne contributes proportionate flows into the Delta.

Elevated spring and summer temperatures in the Delta can negatively impact salmonid outmigrants. The JSA with the CDFW, USFWS, and EBMUD recommends implementing a trap and truck program of anadromous salmonids during critical years. The goal of trapping and trucking is to reduce mortalities associated with elevated water temperatures and predation on out-migrating smolts downstream of WIDD and within the Delta. During a trapping and trucking operation, juvenile salmon and steelhead would be trapped at Woodbridge Dam using existing salmonid outmigration monitoring methodologies and then transported to a downstream release site with similar water temperatures.

The current criteria, approved by the PSC, to initiate trapping and trucking is that water temperature at the Frandy gage (RM 28.6) must exceed 24°C or have a 7-day moving average of over 20°C in April, May, or June during dry and critically dry water year types. Additionally, trapping and trucking activities will be suspended if the 5-day average count of Chinook Salmon falls below 50 per day.

For returning Mokelumne-origin salmon spawners, it is easy for them to lose their way and end up in a different waterway than their natal stream, as the Delta is a complex system of waterways. Pulse flows on the Lower Mokelumne River have been used to mimic storm flows, attracting fish upstream to reduce straying and increase returns to the Mokelumne River. Additionally, short-term closures of the Delta Cross Channel gates during fall salmon migration have helped more Mokelumne origin salmon find their way back to the Mokelumne River. With the channel gates closed, flow from a potential route to the Sacramento River is temporarily reduced, keeping fish from straying.

4.4.5.2 OCEAN

Southern resident killer whale (SRKW, *Orcinus orca*) occur in nearshore coastal areas off California and are listed as endangered (70 FR 69903; November 18, 2005), and critical habitat has been designated (71 FR 69054; November 29, 2006). In general, factors affecting Chinook Salmon, including non-listed (fall-run and late fall-run), in the freshwater environment in the Central Valley contribute to the health, productivity, and abundance of Chinook Salmon that ultimately survive to reach the ocean environment and influence the prey base and health of SRKW. In total, the available data suggest that Central Valley Chinook Salmon constitute a sizeable percentage of Chinook Salmon that would be expected to be encountered by SRKW in coastal waters off California and Oregon, and at least a small portion of Chinook Salmon in the ocean as far north as British Columbia (NMFS 2019).

4.5 WILDLIFE AND BOTANICAL RESOURCES

This section describes botanical and terrestrial wildlife resources in the vicinity of EBMUD's Lower Mokelumne River Project (FERC No. 2916). FERC content requirements for this section are specified in 18 CFR Chapter I § 5.6 (d)(3)(v), and 5.6 (d)(3)(vii), respectively. Refer to Section 4.7 for a description of rare, threatened, and endangered botanical and terrestrial wildlife resources. A description of aquatic resources in the vicinity of the Project is included in Section 4.4, *Fish and Aquatic Resources*.

4.5.1 INFORMATION SOURCES

Information in this section is primarily based on data from resource agency files, reports, and databases; published literature; and field studies completed by EBMUD.

The following sources were reviewed to obtain information on botanical and wildlife resources in the vicinity of the Project. The Project vicinity is defined to include areas within 1 mile of the FERC Project boundary.

- Order Issuing New License for the Lower Mokelumne River Project (FERC No. 2916) as Amended on November 15, 1984 (FERC 1981, 1984)
- CDFW's California Natural Diversity Database (CNDDB) (CNDDB 2025)
- The California Native Plant Society's (CNPS) Inventory of Rare, Threatened, and Endangered Plants (CNPS 2025)
- *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988)
- California Wildlife Habitat Relationships (CWHR) System life history accounts and range maps (CDFW 2021)
- USFWS Birds of Conservation Concern (BCC) (USFWS 2021)
- USFWS Information for Planning and Consultation (IPaC) website, which includes BCC (USFWS 2025a)
- EBMUD Geographic Information System (GIS) survey and observation data (EBMUD 2025c)

4.5.2 BOTANICAL RESOURCES

This section describes botanical resources in the vicinity of the Project, including CWHR system habitats and common plants; plant species having a specific California Rare Plant Rank (CRPR); and non-native invasive plants (NNIP).

4.5.2.1 CWHR HABITATS AND COMMON PLANTS

Information on CWHR System habitats was analyzed to characterize habitat conditions and identify common plant species in the vicinity of the Project. The CWHR System

classifies habitats based on *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988). Classifications consider stage, class, and vegetation structure (tree, shrub, herb, aquatic, agricultural, developed, and non-vegetated).

Maps of CWHR System habitats within 1 mile of the FERC Project boundary were developed using CWHR Habitat Range shapefiles (CDFW 2021) overlain on a map of the Lower Mokelumne River Project. A 1-mile extent was determined to be the sufficient area to encompass no-disturbance buffers that state and federal agencies use when determining potential impacts to wildlife species. Descriptions of each CWHR System habitat present within 1 mile, including descriptions of common plant species found in each alliance, were obtained from *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988) and are provided in Volume II – Appendix G.

In addition, the following Project-specific sources provided additional information on habitats in the immediate vicinity of the Project:

- Order Issuing New License for the Lower Mokelumne River Project (FERC No. 2916) as Amended on November 15, 1984 (FERC 1981, 1984).

There are generally no regulatory protections associated with CWHR habitats.

CDFW also maps the location of sensitive natural communities through the CNDDB (CDFW 2025a; CNDDB 2025). These are vegetation community types that have been assigned by CDFW a rarity ranking of S1, S2, or S3.[10]

Riparian habitats are afforded protections under Sections 1600–1607 of the California Fish and Game Code (as administered by CDFW). Riparian, wetland, and littoral habitats are addressed in detail in Section 4.6.

Refer to Table 4.5-1 for a list of CWHR habitats that are present within 1 mile of the FERC Project boundary and their acreages and percentage cover. Figure V-6, Volume V, shows the extent of each habitat within 1 mile of the FERC Project boundary. A description of each CWHR habitat, including common plant species associated with each alliance, is provided in Volume II – Appendix G. Additional information on wetland, riparian, and littoral habitats is presented in Section 4.6, *Wetland, Riparian, and Littoral Habitat*.

[10] State rankings range from 1 (very rare and threatened) to 5 (demonstrably secure).

Table 4.5-1. CWHR wildlife habitats within 1 mile of the FERC Project boundary.

CWHR Wildlife Habitats	Acreage	Percentage (%)
Herb-Dominated Habitats		
Annual Grassland (AGS)	21,934.37	38.42
Pasture (PAS)	36.25	0.06
Wet Meadow (WTM)	4.45	0.01
Shrub-Dominated Habitats		
Chamise Redshank Chaparral (CRC)	734.60	1.29
Mixed Chaparral (MCH)	3,818.58	6.69
Tree-Dominated Habitats		
Blue Oak- Foothill Pine (BOP)	4,300.36	7.53
Blue Oak Woodland (BOW)	13,993.72	24.51
Montane Hardwood (MHW)	622.51	1.09
Valley Foothill Riparian (VRI)	465.18	0.81
Valley Oak Woodland (VOW)	28.47	0.05
Non-Vegetated or Human-Affected Areas		
Barren (BAR)	233.83	0.41
Cropland (CRP)	57.78	0.10
Deciduous Orchard (DOR)	292.80	0.51
Evergreen Orchard (EOR)	9.09	0.02
Irrigated Hayfield (IRH)	106.14	0.19
Urban (URB)	660.72	1.16
Vineyard (VIN)	315.31	0.55
Aquatic Areas		
Fresh Emergent Wetland (FEW)	111.20	0.19
Lacustrine (LAC)	9,311.76	6.31
Riverine (RIV)	55.62	0.10

The following sensitive natural community types are known to occur within 1 mile of the FERC Project boundary:

- Ione Chaparral – CDFW Sensitive Natural Community Ranking S1 (CDFW 2025a). This sensitive natural community type is found near Camanche Reservoir on the north and south shores (CNDDB 2025).

Figure V-6, Volume V, shows the extent of this sensitive natural community within 1 mile of the FERC Project boundary.

4.5.2.2 CALIFORNIA RARE PLANT RANKED PLANTS

CNPS has defined the following rankings for California native plants: 1B—Plants Rare, Threatened, or Endangered in California and Elsewhere; 2B—Plants Presumed Extirpated in California but Common Elsewhere; and 3—Plants About Which More Information is Needed. Plant species with a CRPR also include a “Threat Ranks” at each level including the following:

- 0.1 – Seriously threatened in California (over 80 percent of occurrences threatened / high degree and immediacy of threat)
- 0.2 – Moderately threatened in California (20-80 percent occurrences threatened / moderate degree and immediacy of threat)
- 0.3 – Not very threatened in California (less than 20 percent of occurrences threatened / low degree and immediacy of threat or no current threats known)

This section focuses on California native plants that have been designated as CRPR 1B.1, 1B.2, and 1B.3; 2B.1, 2B.2, and 2B.3; and 3.1 and 3.2, and that are not addressed in Section 4.7, *Rare, Threatened, and Endangered Species*. A comprehensive list of these CRPR plant species was compiled from the following sources:

- CNDDB (2025) was queried to generate a list of CRPR plants occurring within 1 mile of the Lower Mokelumne River Project.
- The CNPS Inventory of Rare, Threatened, and Endangered Plants (CNPS 2025) was queried to generate a list of CRPR plants occurring within 1 mile of the Lower Mokelumne River Project.

This comprehensive list was then evaluated to determine which plant species occur in the vicinity of the Project based on a review of the following:

- CWHR System habitats present in the vicinity of the Project (CDFW 2021).
- Supplemental information (e.g., habitat descriptions and known occurrences) obtained from a review of the following Project-specific sources:
    - Order Issuing New License for the Lower Mokelumne River Project (FERC No. 2916) as Amended on November 15, 1984 (FERC 1981, 1984).

The geographic location, elevation of the Project, and CWHR habitats and other habitat features present were then reviewed to determine those species that may potentially occur. Plant species on the comprehensive list were then categorized as follows:

- **Known to occur in the vicinity of the Project:** Plants with recorded populations in the vicinity of the Project, as determined by CNDDB.
- **May potentially occur in the vicinity of the Project:** Plants that may potentially occur in the vicinity of the Project based on the geographic location and elevation of the Project, and vegetation alliances and other habitat features present.
- **Unlikely to occur in the vicinity of the Project:** Plants that are unlikely to occur because their range does not overlap the Project; or for which the vicinity of the Project does not support appropriate habitat.

Table 4.5-2 provides a comprehensive list of CRPR plant species evaluated for their potential to occur in the vicinity of the Project. Species listed in the table are categorized

as known to occur; potentially occurring in appropriate habitat; or unlikely to occur. Table 4.5-2 also summarizes pertinent information for each species, including status, blooming period, and preferred habitat, with information on the location of occurrences, if applicable. Figure V-7, Volume V, provides the location of CRPR plants in the vicinity of the Project and within 1 mile of the FERC Project boundary. Volume II – Appendix G, provides life history information for each species known to occur or potentially occurring in the vicinity of the Project.

Seven CRPR species are known to occur within 1 mile of the FERC Project boundary. These include:

- Henderson's bent grass (*Agrostis hendersonii*) (CRPR 3.2);
- Hoover's calycadenia (*Calycadenia hooveri*) (CRPR 1B.3);
- Spicate calycadenia (*Calycadenia spicata*) (CRPR 1B.3)'
- Tuolumne button-celery (*Eryngium pinnatisectum*) (CRPR 1B.2);
- Stanislaus monkeyflower (*Erythranthe marmorata*) (CRPR 1B.1);
- Legenere (*Legenere limosa*) (CRPR 1B.1); and
- Patterson's navarretia (*Navarretia paradoxiclara*) (CRPR 1B.3).

Eight special-status species have not been documented in the Project vicinity but have the potential to occur based on the geographic location and elevation of the Project and habitats present.

The remaining species listed on Table 4.5-2 are considered unlikely to occur, either because the Project is outside the geographic or elevation range of the species, and/or the Project vicinity does not support appropriate habitat for the species.

Table 4.5-2. California Rare Plant Ranked plant species known or potentially occurring in the Project vicinity.

Scientific/Common Name	Federal/ State Status	California Rare Plant Rank (CRPR)	Blooming Period/Fertile	Habitat	Likelihood for Occurrence
Known to Occur.					
Henderson's bent grass *Agrostis hendersonii*	—	3.2	April – June	Occurs in freshwater wetlands, valley grassland, and wetland-riparian in vernal pools from 230 to 1,000 feet.	**Known to Occur.** There is one small population within the FERC boundary located on the southwestern shore of Camanche Reservoir (CNDDB 2025).
Hoover's calycadenia *Calycadenia hooveri*	—	1B.3	July - September	Cismontane woodland, valley and foothill grasslands in rocky soils from 215 to 985 feet.	**Known to Occur.** There is one population recorded from 1978 along the south shore of Camanche Reservoir in the FERC Project boundary (CNDDB 2025). Another population is located just outside the FERC Project boundary, but within a 1-mile buffer.
Spicate calycadenia *Calycadenia spicata*	—	1B.3	May – September	Cismontane woodland, valley and foothill grasslands growing in clay, rocky soils, disturbed areas and along roadsides from 130 to 4,595 feet.	**Known to Occur.** There is one population from 1971 located just outside of the FERC boundary located northwest of Camanche Reservoir (CNDDB 2025).
Tuolumne button-celery *Eryngium pinnatisectum*	—	1B.2	May – August	Cismontane woodland, lower montane coniferous forest, and vernal pools in mesic soils from 230 to 3,000 feet	**Known to Occur.** There is one population recorded from 1978 along the south shore of Camanche Reservoir in the FERC Project boundary (CNDDB 2025).
Stanislaus monkeyflower *Erythranthe marmorata*	—	1B.1	March – May	Cismontane woodland, and lower montane coniferous forest from 330 – 2,955 feet.	**Known to Occur.** The FERC Project boundary is within the elevation range and contains appropriate habitat. There is one population located just outside of the FERC boundary located directly east of Pardee Reservoir (CNDDB 2025). The date of this record is unknown.
Legenere *Legenere limosa*	—	1B.1	April – June	Vernal pools from 5 – 2,885 feet.	**Known to Occur.** The Project is within the elevation range of this species and contains appropriate habitat. There is one population from 2001 located west of Camanche Reservoir in a vernal pool system along a dirt ranch road (CNDDB 2025).
Patterson's navarretia *Navarretia paradoxiclara*	—	1B.3	May – June (July)	Meadows and seeps often found in openings and drainages growing in serpentine and vernally mesic soils from 490 – 1,410 feet.	**Known to Occur.** There is one population recorded from 1923 located just outside of the FERC boundary southeast of Camanche Reservoir (CNDDB 2025).
May Potentially Occur.					
Big-scale balsamroot *Balsamorhiza macrolepis*	—	1B.2	March – June	Chaparral, cismontane woodland, valley and foothill grassland. Can occur in serpentine soils. Grows from 150 – 5,100 feet.	**May Potentially Occur.** There are no records of this species occurring within 1 mile of the FERC boundary. The nearest known record of this species is approximately 6 miles north of the Project vicinity, however this observation was made in 1895. The FERC Project boundary is within the elevation range of this species and contains appropriate habitat.
Bisbee Peak rush-rose *Crocanthemum suffrutescens*	—	3.2	April – August	Chaparral in disturbed or burned areas on lone soil from 245 to 2,200 feet.	**May Potentially Occur.** The FERC boundary is within the elevation range of this species and contains appropriate habitat.
Mariposa cryptantha *Cryptantha mariposae*	—	1B.3	April – June	Chaparral in rocky and serpentinite soils from 655 – 2,135 feet.	**May Potentially Occur.** The FERC boundary is within the elevation range of this species and contains appropriate habitat.
Dwarf downingia *Downingia pusilla*	—	2B.2	March – May	Valley and foothill grassland, and vernal pools often in mesic soils from 5 – 1,460 feet.	**May Potentially Occur.** The FERC boundary is within the elevation range of this species and contains appropriate habitat.

Scientific/Common Name	Federal/ State Status	California Rare Plant Rank (CRPR)	Blooming Period/Fertile	Habitat	Likelihood for Occurrence
Parry's horkelia *Horkelia parryi*	–	1B.2	April – September	Chaparral and cismontane woodland in Ione formation and other soils from 260 – 3,510 feet.	**May Potentially Occur.** The FERC Project boundary is within the elevation range and contains appropriate habitat. There is one population located just outside of the FERC boundary northeast of Camanche Reservoir (CNDDB 2025).
Ahart's dwarf rush *Juncus leiospermus* var. *ahartii*	–	1B.2	March – May	Valley and foothill grasslands in mesic soils from 100 – 750 feet.	**May Potentially Occur.** The FERC boundary is within the elevation range of this species and contains appropriate habitat.
Pincushion navarretia *Navarretia myersii* ssp. *myersii*	–	1B.1	April – May	Vernal pools in acidic soils from 65 to 1,085 feet.	**May Potentially Occur.** The FERC boundary is within the elevation range of this species and contains appropriate habitat.
Sanford's arrowhead *Sagittaria sanfordii*	–	1B.2	May – October (Nov)	Marshes and swamps from 0 – 2,135 feet.	**May Potentially Occur.** The FERC boundary is within the elevation range of this species and contains appropriate habitat.
Unlikely to occur.					
Red Hills soaproot *Chlorogalum grandiflorum*	–	1B.2	(April) May – June	Chaparral, cismontane woodland, and lower montane coniferous forest in gabbroic and serpentine from 805 – 5,545 feet.	**Unlikely to occur.** The upper elevation limit of the Project is approximately 750 feet, below the elevational range for this species.
Congdon's lomatium *Lomatium congdonii*	–	1B.2	March – June	Chaparral and cismontane woodland in serpentine soils from 985 to 6,890 feet.	**Unlikely to occur.** The upper elevation limit of the Project is approximately 750 feet, below the elevational range for this species.
Prairie wedge grass *Sphenopholis obtusata*	–	2B.2	April – July	Cismontane woodland, meadows and seeps in mesic areas from 985 – 6,560 feet.	**Unlikely to occur.** The upper elevation limit of the Project is approximately 750 feet, below the elevational range for this species.

CNPS Rare Plant Rank: 1B = Rare, threatened or endangered in California and elsewhere; 2B = Rare in California but more common elsewhere; 4 = Plants of limited distribution – a watchlist; _.1 = Seriously threatened in California (over 80 percent of occurrences threatened/high degree and immediacy of threat); _.2 = Moderately threatened in California (20 to 80 percent occurrences threatened); _.3 = Not very threatened in California (<20 percent of occurrences threatened or no current threats known) ; CBR = Considered but rejected

4.5.2.3 NON-NATIVE INVASIVE PLANTS

Information on NNIPs potentially occurring in the vicinity of the Project was obtained from the California Invasive Plant Council (Cal-IPC) Invasive Plan Inventory (Inventory) (Cal-IPC 2025). Cal-IPC defines NNIPs as plants that (1) are not native to, yet can spread into, wildland ecosystems; and (2) that also displace native species, hybridize with native species, alter biological communities, or alter ecosystem processes (Cal-IPC 2025).

The Inventory categorizes plants as High, Moderate, or Limited, according to the degree of ecological impact in California (Cal-IPC 2025).

- **High.** Severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. Most are widely distributed ecologically.
- **Moderate.** Substantial and apparent—but generally not severe—ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal, though establishment is generally dependent upon ecological disturbance. Ecological amplitude and distribution may range from limited to widespread.
- **Limited.** Invasive but ecological impacts are minor on a statewide level (or not enough information to justify a higher score). Their reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution are generally limited, but these species may be locally persistent and problematic.

The Inventory was queried to obtain a list of NNIPs based on two parameters:

- Jepson region: The Inventory uses geographic floristic provinces and subdivisions within California as described by the Jepson Flora Project (2025). The Lower Mokelumne River Project is within the California Floristic Province and the central Sierra Nevada foothills subdivision.
- Habitat types: Based on a comparison with habitats within 1 mile of the FERC Project boundary, six habitat types were selected: freshwater aquatic, scrub, grassland, riparian, woodland, and forest habitat.

The query of the Cal-IPC Inventory yielded a list of 155 NNIPs potentially occurring in the vicinity of the Project. Refer to Table 4.5-3 for a list of these species and the habitat(s) they typically occur in.

Table 4.5-3. NNIPs potentially occurring in the Project vicinity.

Scientific Name	Common Name	Cal-IPC Rating	Habitat Types Present					
			Freshwater and Estuarine Aquatic Systems	Scrub and Chaparral	Grasslands, Vernal Pools, Meadows, and Herb Communities	Riparian and Bottomland	Woodland	Forest
Acacia dealbata	silver wattle	Moderate				X	X	X
Aegilops triuncialis	barb goatgrass	High			X	X	X	
Agrostis avenacea	Pacific bentgrass	Limited			X			
Agrostis stolonifera	creeping bent	Limited			X	X		
Ailanthus altissima	tree-of-heaven	Moderate			X	X		X
Alhagi maurorum	camelthorn	Moderate			X	X		
Alternanthera philoxeroides	alligatorweed	High	X					
Arundo donax	giant reed	High			X	X	X	
Asparagus asparagoides	bridal creeper	Moderate				X		
Asphodelus fistulosus	onion weed	Moderate			X			
Atriplex semibaccata	Australian saltbush	Moderate			X		X	
Avena barbata	slender oat	Moderate		X	X		X	
Avena fatua	wild oats	Moderate		X	X		X	
Bellardia trixago	Bellardia	Limited			X			
Brachypodium distachyon	annual false-brome	Moderate		X			X	
Brassica nigra	black mustard	Moderate		X	X	X		
Brassica rapa	field mustard	Limited		X	X	X		
Briza maxima	big quakinggrass	Limited		X			X	
Bromus diandrus	ripgut brome	Moderate		X	X	X	X	X
Bromus hordeaceus	soft brome	Limited		X	X		X	
Bromus japonicus	Japanese brome	Limited			X			X
Bromus madritensis ssp. *rubens*	red brome	High		X	X	X	X	
Bromus tectorum	cheatgrass	High		X	X		X	X
Carduus acanthoides	plumeless thistle	Limited			X			
Carduus nutans	musk thistle	Moderate			X			X
Carduus pycnocephalus	Italian thistle	Moderate		X	X	X	X	
Carduus tenuiflorus	slenderflower thistle	Limited			X	X	X	
Carthamus lanatus	woolly distaff thistle	High			X		X	
Centaurea calcitrapa	purple starthistle	Moderate		X				
Centaurea diffusa	diffuse knapweed	Moderate				X	X	
Centaurea melitensis	tocalote	Moderate		X	X			
Centaurea solstitialis	yellow starthistle	High		X	X	X		
Centaurea stoebe ssp. *micranthos*	spotted knapweed	High			X	X	X	X

Scientific Name	Common Name	Cal-IPC Rating	Habitat Types Present					
			Freshwater and Estuarine Aquatic Systems	Scrub and Chaparral	Grasslands, Vernal Pools, Meadows, and Herb Communities	Riparian and Bottomland	Woodland	Forest
Centaurea virgata ssp. *squarrosa*	squarrose knapweed	Moderate		X				
Chondrilla juncea	skeleton weed	Moderate			X		X	X
Cirsium arvense	Canada thistle	Moderate		X	X	X		X
Cirsium vulgare	bull thistle	Moderate		X	X	X	X	X
Conium maculatum	poison-hemlock	Moderate		X	X	X		
Cortaderia jubata	jubatagrass	High				X		
Cortaderia selloana	pampasgrass	High				X		
Cotula coronopifolia	common brassbuttons	Limited			X (vernal pool)			
Crataegus monogyna	English hawthorn	Limited				X	X	
Cynara cardunculus	artichoke thistle	Moderate		X		X		
Cynodon dactylon	Bermuda grass	Moderate				X		
Cynoglossum officinale	common houndstongue	Moderate			X			X
Cynosurus echinatus	hedgehog dogtail	Moderate		X	X	X	X	X
Cytisus scoparius	Scotch broom	High		X		X	X	X
Dactylis glomerata	orchard grass	Limited		X			X	
Delairea odorata	Cape-ivy	High				X		
Descurainia sophia	tansy mustard	Limited		X	X	X	X	
Digitalis purpurea	foxglove	Limited		X	X	X		
Dipsacus fullonum	wild teasel	Moderate			X	X		
Dipsacus sativus	Fuller's teasel	Moderate			X	X		
Dittrichia graveolens	stinkwort	Moderate			X	X		
Egeria densa	Brazilian *Egeria*	High	X					
Ehrharta calycina	purple veldtgrass	High		X			X	
Ehrharta erecta	panic veldtgrass	Moderate				X		
Eichhornia crassipes	water hyacinth	High	X					
Elaeagnus angustifolia	Russian olive	Moderate				X		
Elymus caput-medusae	medusahead	High		X	X	X	X	
Erodium cicutarium	redstem filaree	Limited		X	X		X	
Eucalyptus globulus	blue gum	Limited		X		X		
Euphorbia oblongata	eggleaf spurge	Limited			X	X	X	
Euphorbia virgata	leafy spurge	High			X		X	
Fallopia japonica	Japanese knotweed	Moderate					X	
Festuca arundinacea	reed fescue	Moderate			X	X	X	
Festuca myuros	rat-tail fescue	Moderate		X	X	X	X	X

Scientific Name	Common Name	Cal-IPC Rating	Habitat Types Present					
			Freshwater and Estuarine Aquatic Systems	Scrub and Chaparral	Grasslands, Vernal Pools, Meadows, and Herb Communities	Riparian and Bottomland	Woodland	Forest
Festuca perennis	Italian ryegrass	Moderate		X	X	X	X	
Ficus carica	edible fig	Moderate				X		
Foeniculum vulgare	fennel	Moderate		X	X	X		
Genista monspessulana	French broom	High		X		X	X	
Geranium dissectum	cutleaf *Geranium*	Limited			X	X	X	X
Glyceria declinata	mannagrass	Moderate			X	X		
Hedera helix	English ivy	High				X		
Helminthotheca echioides	bristly ox-tongue	Limited			X	X		
Hirschfeldia incana	short-pod mustard	Moderate		X	X	X		
Holcus lanatus	common velvet grass	Moderate			X			
Hordeum marinum	Mediterranean barley	Moderate		X	X		X	X
Hordeum murinum	hare barley	Moderate		X	X		X	X
Hydrilla verticillata	*Hydrilla*	High	X					
Hypericum perforatum	St. John's wort	Limited			X		X	X
Hypochaeris glabra	smooth cat's-ear	Limited		X	X	X	X	
Hypochaeris radicata	rough cat's-ear	Moderate		X	X	X		
Ilex aquifolium	English holly	Limited				X		
Iris pseudacorus	yellowflag *Iris*	Limited				X		
Isatis tinctoria	dyer's woad	Moderate			X			
Kochia scoparia	*Kochia*	Limited		X	X			
Lepidium chalepense	lens-podded hoary cress	Moderate			X	X		
Lepidium draba	heart-podded hoary cress	Moderate			X	X		
Lepidium latifolium	perennial pepperweed	High			X	X		
Leucanthemum vulgare	ox-eye daisy	Moderate			X			X
Ligustrum lucidum	glossy privet	Limited				X	X	
Limnobium spongia	South American spongeplant	High	X					
Limonium duriusculum	European sea lavender	Moderate		X		X		
Linaria dalmatica ssp. *dalmatica*	Dalmatian toadflax	Moderate						X
Linaria vulgaris	yellow toadflax	Moderate			X	X		X
Lobularia maritima	sweet *Alyssum*	Limited				X		
Ludwigia peploides	floating water primrose	High	X					
Lythrum hyssopifolia	hyssop loosestrife	Moderate			X			
Lythrum salicaria	purple loosestrife	High			X	X		

Scientific Name	Common Name	Cal-IPC Rating	Habitat Types Present					
			Freshwater and Estuarine Aquatic Systems	Scrub and Chaparral	Grasslands, Vernal Pools, Meadows, and Herb Communities	Riparian and Bottomland	Woodland	Forest
Marrubium vulgare	horehound	Limited		X	X	X	X	
Medicago polymorpha	California burclover	Limited			X		X	X
Mentha pulegium	pennyroyal	Moderate		X	X	X		
Myriophyllum aquaticum	parrotfeather	High	X					
Myriophyllum spicatum	spike watermilfoil	High	X					
Nicotiana glauca	tree tobacco	Moderate			X	X		
Olea europaea	olive	Limited			X	X	X	
Onopordum acanthium	Scotch thistle	High			X			
Parentucellia viscosa	yellow glandweed	Limited			X			
Pennisetum clandestinum	Kikuyu grass	Limited			X	X		
Phalaris aquatica	harding grass	Moderate			X	X	X	
Phytolacca americana	common pokeweed	Limited				X		
Plantago lanceolata	English plantain	Limited			X	X		X
Poa pratensis	Kentucky bluegrass	Limited			X	X		X
Polypogon monspeliensis	rabbitsfoot grass	Limited			X	X		
Potamogeton crispus	curly-leaved pondweed	Moderate	X					
Prunus cerasifera	cherry plum	Limited		X		X	X	
Pyracantha angustifolia	narrowleaf firethorn	Limited				X		
Pyracantha coccinea	scarlet firethorn	Limited				X		
Pyracantha crenulata	Nepalese firethorn	Limited				X		
Ranunculus repens	creeping buttercup	Limited				X		
Raphanus sativus	wild radish	Limited			X		X	
Rhaponticum repens	Russian knapweed	Moderate			X	X		X
Ricinus communis	castor bean	Limited				X		
Robinia pseudoacacia	black locust	Limited			X	X		
Rubus armeniacus	Himalayan blackberry	High			X	X		X
Rumex acetosella	sheep sorrel	Moderate		X		X		X
Rumex crispus	curly dock	Limited		X	X	X		
Saccharum ravennae	ravennagrass	Moderate				X		
Salsola soda	glasswort	Moderate			X			
Salvia aethiopis	Mediterranean sage	Limited						X
Saponaria officinalis	bouncing-bet	Limited				X		
Schinus molle	Peruvian peppertree	Limited		X	X	X		
Schinus terebinthifolia	Brazilian pepper tree	Moderate				X		
Senecio jacobaea	tansy ragwort	Limited				X		X

Scientific Name	Common Name	Cal-IPC Rating	Habitat Types Present					
			Freshwater and Estuarine Aquatic Systems	Scrub and Chaparral	Grasslands, Vernal Pools, Meadows, and Herb Communities	Riparian and Bottomland	Woodland	Forest
Sesbania punicea	scarlet *Wisteria*	High				X		
Silybum marianum	milk thistle	Limited		X	X	X	X	
Sinapis arvensis	wild mustard	Limited			X			
Sisymbrium irio	London rocket	Limited		X	X	X		
Spartium junceum	Spanish broom	High		X		X		
Stipa miliacea var. *miliacea*	smilo grass	Limited		X	X	X		
Tamarix aphylla	athel	Limited				X		
Tamarix chinensis	Chinese tamarisk	High			X	X		
Tamarix gallica	French tamarisk	High			X	X		
Tamarix parviflora	smallflower tamarisk	High			X	X		
Tamarix ramosissima	saltcedar	High			X	X		
Tanacetum vulgare	common tansy	Moderate			X	X		
Torilis arvensis	hedgeparsley	Moderate			X	X	X	
Triadica sebifera	Chinese tallow tree	Moderate				X		
Tribulus terrestris	puncture vine	Limited			X	X		
Trifolium hirtum	rose clover	Limited			X		X	
Ulex europaeus	gorse	High		X		X		
Verbascum thapsus	woolly mullein	Limited			X	X	X	X
Vinca major	periwinkle	Moderate				X		
Washingtonia robusta	Mexican fan palm	Moderate				X		

Notes:

[1] The Cal-IPC Invasive Plant Inventory categorizes plants as High, Moderate, or Limited, according to the degree of ecological impact in California (Cal-IPC 2025).

- **High.** Severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. Most are widely distributed ecologically.
- **Moderate.** Substantial and apparent—but generally not severe—ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal, though establishment is generally dependent upon ecological disturbance. Ecological amplitude and distribution may range from limited to widespread.
- **Limited.** Invasive but their ecological impacts are minor on a statewide level or there was not enough information to justify a higher score. Their reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution are generally limited, but these species may be locally persistent and problematic.

[2] The Cal-IPC Invasive Plant Inventory creates a query based on generalized habitat types. There is no crosswalk available between Cal-IPC habitat types and CWHR alliances. Therefore, the habitat types that closely matched CWHR habitats in the Project vicinity were selected. These included the following: 1) grassland, vernal pools, meadows, and other herb communities; 2) riparian and bottomland habitat; 3) woodland habitat, and 4) scrub and chaparral.

Twenty-two NNIP species, including barb goatgrass (*Aegilops triuncialis*), tree-of-heaven (*Ailanthus altissima*), giant reed (*Arundo donax*), wild oats (*Avena fatua*), black mustard (*Brassica nigra*), ripgut brome (*Bromus diandrus*), yellow starthistle (*Centaurea solstitialis*), bull thistle (*Cirsium vulgare*), artichoke thistle (*Cynara cardunculus*), Bermuda grass (*Cynodon dactylon*), Scotch broom (*Cytisus scoparius*), water hyacinth (*Eichhornia crassipes*), medusahead (*Elymus caput-medusae*), edible fig (*Ficus carica*), floating water primrose (*Ludwigia peploides*), olive (*Olea europaea*), black locust (*Robinia pseudoacacia*), Himalayan blackberry (*Rubus armeniacus*), Russian thistle (*Salsola tragus*), milk thistle (*Silybum marianum*), wild mustard *(Sinapis arvensis*), and puncture vine (*Tribulus terrestris*) are known to be present in the overall Mokelumne River watershed, but it is unknown how many of these populations fall specifically within the Project vicinity (EBMUD 2025c).

4.5.3 WILDLIFE RESOURCES

This section describes common wildlife species, wildlife species designated by USFWS as BCC and/or CDFW as California Species of Special Concern (SSC), and game species. Refer to Section 4.7, *Rare, Threatened, and Endangered Species*, for information on other special-status wildlife resources known or potentially occurring in the vicinity of the Project. Section 4.5.2.1, *CWHR Habitats and Common Plants*, describes wildlife habitats present in the vicinity of the Project.

4.5.3.1. COMMON WILDLIFE SPECIES

Information on wildlife habitats was obtained to characterize habitat conditions and identify common wildlife species in the vicinity of the Project. As described previously, habitat information is based on *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988) and CDFW's California Wildlife Habitat Relationship System Database, Version 9.0 (CDFW 2021).

Refer to Table 4.5-1 for a list of the habitats that occur within 1 mile of the FERC Project boundary. Habitat descriptions, excerpted from Mayer and Laudenslayer (1988), are provided in Volume II – Appendix G. Table II-G.2-1 provides a list of representative common wildlife species that are found in the wildlife habitats in the vicinity of the Project and is included in Volume II – Appendix G.2. Figure 4.5-1 shows the location of common raptor nests that were recorded during EBMUD's annual nesting bird surveys in support of their Routine Maintenance Agreement with CDFW (CDFW 2022).

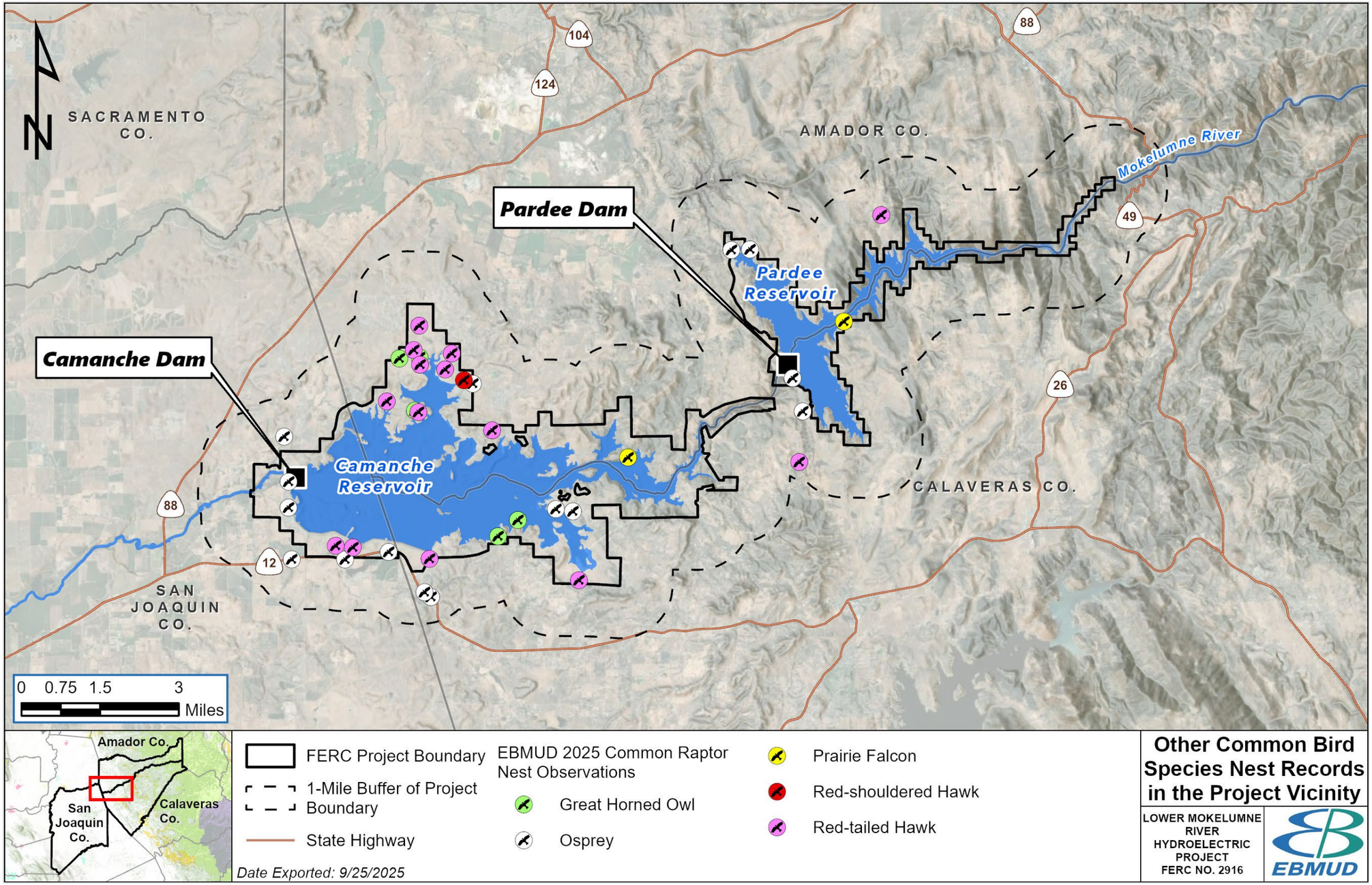


Figure 4.5-1. Bird species nest records in the Project vicinity.

4.5.3.2. WILDLIFE DESIGNATED AS BCC OR SSC

This section describes wildlife designated by USFWS as BCC and/or CDFW as SSC that occur or may potentially occur in the vicinity of the Project. This section addresses only SSC terrestrial wildlife species. Aquatic species designated as SSC, including fish and aquatic amphibians and reptiles, are addressed in Section 4.4, *Fish and Aquatic Resources*.

A comprehensive list of BCC and SSC wildlife species was compiled from the following sources:

- CNDDB (2025) queried to generate a list of special-status wildlife occurring within 1 mile of the FERC Project boundary.
- CDFW's *State and Federally Listed Endangered and Threatened Animals of California* (CDFW 2025) reviewed to generate a list of state-listed species potentially occurring in the vicinity of the Project.
- EBMUD GIS databases and incidental wildlife observations (EBMUD 2025c).
- Cornell Lab of Ornithology's eBird citizen science database (eBird 2025).
- Species records from the application iNaturalist (iNaturalist 2025).
- USFWS BCC (USFWS 2021, 2025a).

This comprehensive list was then evaluated to determine which BCC and SSC wildlife species occur or may potentially occur in the vicinity of the Project based on a review of the following:

- Supplemental information (e.g., habitat descriptions and occurrences) obtained from a review of the following Project-specific sources:
- Order Issuing New License for the Lower Mokelumne River Project (FERC No. 2916) as Amended on November 15, 1984 (FERC 1981, 1984).

The geographic location and elevation of the Project and habitats present were then reviewed to determine those species that may potentially occur. Wildlife species on the list were then categorized as follows:

- **Known to occur in the vicinity of the Project:** Wildlife species with recorded occurrences in the vicinity of the Project, as determined by CNDDB or EBMUD studies.
- **May potentially occur in the vicinity of the Project:** Wildlife species that may potentially occur in the vicinity of the Project based on the geographic location and elevation of the Project and wildlife habitats present.

- **Unlikely to occur in the vicinity of the Project:** Wildlife species that are unlikely to occur because their range does not overlap the Project; or for which the vicinity of the Project does not support appropriate habitat.

Table 4.5-4 provides a comprehensive list of BCC and SSC wildlife species evaluated for their potential to occur in the vicinity of the Project. Species listed in the table are categorized as known to occur; potentially occurring in appropriate habitat; or unlikely to occur. Table 4.5-4 also summarizes pertinent information for each species, including status and preferred habitat, with information on the location of the occurrence, if applicable. Figure V-8, Volume V, provides the location of special-status wildlife that occur in the vicinity of the Project and within 1 mile of the FERC Project boundary. Volume II – Appendix G.1 provides life history information for wildlife categorized in Table 4.5-4 as known to occur or potentially occurring in the vicinity of the Project.

Twenty-two BCC and SSC species are known to occur in the vicinity of the Project. These are:

- Common loon (*Gavia immer*) (SSC);
- Clark's grebe (*Aechmophorus clarkii*) (BCC);
- Western grebe (*Aechmophorus occidentalis*) (BCC);
- American white pelican (*Pelecanus erythrorhynchos*) (SSC);
- Northern harrier (*Circus hudsonius*) (BCC, SSC);
- Marbled godwit (*Limosa fedoa*) (BCC);
- Willet (*Tringa semipalmata*) (BCC);
- California gull (*Larus californicus*) (BCC);
- Short-eared owl (*Asio flammeus*) (BCC, SSC);
- Western screech-owl (*Megascops kennicottii cardonensis*) (BCC);
- Nuttall's woodpecker (*Dryobates nuttallii*) (BCC);
- Yellow-billed magpie *(Pica nuttallii*) (BCC);
- Loggerhead shrike (*Lanius ludovicianus*) (SSC);
- Oak titmouse (*Baelophus inornatus*) (BCC);
- Wrentit (*Chamaea fasciata*) (BCC);
- California thrasher (*Toxostoma redivivum*) (BCC);
- Yellow-breasted chat (*Icteria virens*) (SSC);
- Lawrence's goldfinch (*Spinus lawrencei*) (BCC);

- Pallid bat (*Antrozous pallidus*) (SSC);
- Townsend's big-eared bat (*Corynorhinus townsendii*) (SSC);
- Western mastiff bat (*Eumops perotis californicus*) (SSC); and
- Western red bat (*Lasiurus frantzii*) (SSC).

Fourteen species have not been documented in the vicinity of the Project but have the potential to occur based on geographic location and elevation of the Project and wildlife habitats present.

The remaining species listed on Table 4.5-4 are considered unlikely to occur, either because the Project is outside the known range of the species, and/or the vicinity of the Project does not support appropriate habitat.

Table 4.5-4. Wildlife designated as BCC or California SSC with potential to occur in the Project vicinity.[a]

Species Common Name/Scientific Name	Federal Status	State Status	Habitat Description	Likelihood for Occurrence
Known to Occur in the Project Vicinity				
Birds				
Gavia immer Common loon	—	SSC	An uncommon migrant that may be seen in large, deep lakes and reservoirs during wintering and migration.	Known to occur. This species has been observed on Camanche and Pardee reservoirs by EBMUD biologists (EBMUD 2025c). Suitable wintering habitat is present on Project reservoirs.
Aechmophorus clarkii Clark's grebe	BCC	—	Common in coast and estuarine areas, uncommon on large lakes in inland areas at low elevations. Breeds on large, marshy lakes with emergent vegetation habitat.	Known to occur. This species has been observed on Camanche and Pardee reservoirs by EBMUD biologists (EBMUD 2025c). Suitable non-breeding habitat is present on Project reservoirs.
Aechmophorus occidentalis Western grebe	BCC	—	Common in coast and estuarine areas, uncommon on large lakes in inland areas at low elevations. Breeds on large, marshy lakes with emergent vegetation habitat.	Known to occur. This species has been observed on Camanche and Pardee reservoirs by EBMUD biologists (EBMUD 2025c). Suitable non-breeding habitat is present on Project reservoirs.
Pelecanus erythrorhynchos American white pelican	—	SSC	Only nesting records in California are from large lakes in Klamath Basin. Winter resident in the San Francisco Bay and large lakes and estuaries in the Central Valley.	Known to occur. This species has been observed on Camanche and Pardee reservoirs by EBMUD biologists (EBMUD 2025c). Suitable non-breeding habitat is present on Project reservoirs.
Northern harrier *Circus hudsonius*	BCC	SSC	A common winter visitor in southern California, but an increasingly rare breeding species in the region. Nests on the ground in marshes or grassy meadows. Feed on ground-dwelling mammals and other prey. They are migratory birds that spend winters in California.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable breeding and foraging habitat is present within the Project vicinity.
Limosa fedoa Marbled godwit	BCC	—	Most common on estuarine mudflats, but also occurs on sandy beaches, open shores, saline emergent wetlands, and adjacent wet upland fields.	Known to occur. Suitable non-breeding habitat for this species is present along the north shore of Camanche Reservoir. There are eBird records of this species from this area (eBird 2025).
Tringa semipalmata Willet	BCC	—	Winters in estuarine habitats, saline emergent wetlands, and salt ponds, but also in wetland habitats in the Central Valley. Breeds in wet meadows in Modoc, Lassen, and Plumas counties.	Known to occur. Suitable non-breeding habitat for this species is present along the north shore of Camanche Reservoir. There are eBird records of this species from this area (eBird 2025). This species has been observed on Camanche and Pardee reservoirs by EBMUD biologists (EBMUD 2025c).
Larus californicus California gull	BCC	—	Sandy beaches, mudflats, rocky intertidal, and pelagic areas of marine and estuarine habitats, as well as fresh and saline emergent wetlands. Inland, frequents lacustrine, riverine, and cropland habitats, landfill dumps, and open lawns in cities.	Known to occur. This species has been observed on Camanche and Pardee reservoirs by EBMUD biologists (EBMUD 2025c). There are eBird records of this species on Project reservoirs (eBird 2025).
Asio flammeus Short-eared owl	BCC	SSC	Widespread winter migrant in the Central Valley, usually found in open areas with few trees, such as annual and perennial grasslands, prairies, dunes, meadows, irrigated lands, and saline and fresh emergent wetlands.	Known to occur. This species has been observed by EBMUD biologists at Camanche Reservoir (EBMUD 2025c). Suitable breeding and foraging habitat is present within the Project vicinity.
Kennicottii cardonensis Western screech-owl *Megascops*	BCC	—	Open oak, pinyon-juniper, riparian, redwood, and mixed conifer habitats. Found in small towns, suburbs, farms, ranches, and meadows.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists, though it is unknown if observations are this subspecies (EBMUD 2025c). Suitable breeding and foraging habitat is present within the Project vicinity.

Species Common Name/Scientific Name	Federal Status	State Status	Habitat Description	Likelihood for Occurrence
Drbates nuttallii Nuttall's woodpecker	BCC	—	Found in low elevation riparian, deciduous, and oak forest habitat.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable breeding and foraging habitat is present within the Project vicinity.
Pica nuttallii Yellow-billed magpie	BCC	—	Valley foothill hardwood, valley foothill hardwood-conifer, valley foothill riparian, orchard-vineyard, cropland, pasture, and urban habitat.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable breeding and foraging habitat is present within the Project vicinity.
Lanius ludovicianus Loggerhead shrike	—	SSC	Prefers open habitats with scattered shrubs, trees, posts, fences, utility lines, or other perches in the lowlands and foothills throughout California.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable habitat is present within the Project vicinity.
Baelophus inornatus Oak titmouse	BCC	—	Valley foothill and mountain hardwood, valley foothill hardwood-conifer, and riparian habitat.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable breeding and foraging habitat is present within the Project vicinity.
Chamaea fasciata Wrentit	BCC	—	A common resident of California chaparral habitat. Also frequents shrub understory of coniferous habitats.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable breeding and foraging habitat is present within the Project vicinity.
Toxostoma redivivum California thrasher	BCC	—	Occupies moderate to dense chaparral habitats and, less commonly, extensive thickets in young or open valley foothill riparian habitat.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable breeding and foraging habitat is present within the Project vicinity.
Icteria virens Yellow-breasted chat	—	SSC	An uncommon summer resident and migrant in coastal California and the foothills of the Sierra Nevada. Breeds in valley foothill riparian and desert riparian habitats. Requires riparian thickets of willow and brushy tangles near watercourses for cover. Found at elevations up to 4,800 ft in valley foothill riparian habitats and up to 6,500 ft in the eastern Sierra Nevada.	Known to occur. Suitable breeding and foraging habitat is present within the FERC Project boundary. There is one CNDDB occurrence from 1995 where a breeding pair was observed in willow riparian habitat in an adjacent eucalyptus grove near the Mokelumne River (CNDDB 2025).
Spinus lawrencei Lawrence's goldfinch	BCC	—	Uncommon in foothills surrounding Central Valley, mostly from April through September. Breeds in open oak or other arid woodland and chaparral, near water. Typical habitats include valley foothill hardwood, valley foothill hardwood-conifer.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable breeding and foraging habitat is present within the Project vicinity.
Mammals				
Antrozous pallidus Pallid bat	—	SSC	Grasslands, shrublands, woodlands, and forests from sea level to 10,000 feet in elevation. Typically, day roosts in caves, crevices, or mines. Night roosts are in more open areas. Requires open habitat for foraging. Pallid bat hibernates in winter. The maternity season is April – July.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable breeding and foraging habitat is present within the Project vicinity.
Corynorhinus townsendii Townsend's big-eared bat	—	SSC	Found in all but alpine and subalpine habitats; most abundant in mesic habitats up to 6,000 feet in elevation. Requires caves, mines, tunnels, buildings, or other man-made structures for roosting. Hibernates October through April. Locally migratory only. Extremely sensitive to disturbance and may abandon a roost if disturbed. Their maternity season is May – August.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable habitat is present within the Project vicinity. There is one CNDDB occurrence from 1957 located 2.5 miles south of the FERC Project boundary (CNDDB 2025).
Eumops perotis californicus Western mastiff bat	—	SSC	Found in variety of habitats including desert scrub, chaparral, oak woodland, ponderosa pine, meadows and mixed conifer forests up to 4,600 feet in elevation. Distribution is likely limited by availability of significant rock features offering suitable roosting habitat.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable habitat is present within the Project vicinity.

Species Common Name/Scientific Name	Federal Status	State Status	Habitat Description	Likelihood for Occurrence
Lasiurus frantzii Western red bat	—	SSC	Roosts in forests and woodlands from seal 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.	Known to occur. This species has been observed in the Project vicinity by EBMUD biologists (EBMUD 2025c). Suitable habitat is present within the Project vicinity.
May Potentially Occur in the Project Vicinity				
Reptiles				
Phrynosoma blainvillii Coast horned lizard	—	SSC	Found in open areas of sandy soil in valleys, foothills, and semi-arid mountains. Prefers areas of low vegetation within grasslands, forests, woodlands, and chaparral. Commonly found along sandy washes and dirt roads. The elevational range extends up to 4,000 feet in the Sierra Nevada foothills and up to 6,000 feet in the mountains of southern California.	May potentially occur in suitable habitats. Suitable habitat is present in the Project vicinity. There are two iNaturalist occurrences of this species south of the FERC Project boundary (iNaturalist 2025).
Birds				
Aythya americana Redhead	—	SSC	Found in lacustrine habitats during the summer, also found in Central Valley foothills and coastal lowlands. Nests in freshwater emergent wetlands bordering open water.	May potentially occur in suitable habitats. Suitable habitat is present in the Project vicinity.
Asio otus Long-eared owl	—	SSC	Found in dense riparian habitat or other thickets in foothills and mountains with small, densely canopied trees for roosting and nesting. More common in Great Basin regions of California.	May potentially occur in suitable habitats. Suitable habitat is present in the Project vicinity.
Charadrius montanus Mountain plover	—	SSC	Winter resident on short grasslands and plowed fields of the Central Valley below 3,200 feet in elevation.	May potentially occur in suitable habitats. Suitable habitat is present in the Project vicinity.
Cypseloides nagger Black swift	BCC	SSC	Nests in moist crevice or cave on sea cliffs above the surf, or on cliffs behind, or adjacent to, waterfalls in deep canyons. Forages widely over many habitats. does not winter in the California.	May potentially occur in suitable habitats. Suitable foraging habitat is present within the Project vicinity.
Dryobates albolarvatus gravirostris White-headed woodpecker	BCC	—	Montane coniferous forests up to lodgepole pine and red fir habitats. Occasionally found at lower elevations/	May potentially occur in suitable habitats. May potentially occur in suitable ponderosa pine habitats near Pardee Reservoir.
Contopus cooperi Olive-sided flycatcher	BCC	SSC	Uncommon to common, summer resident in a wide variety of forest and woodland habitats. Nesting habitats include mixed conifer, montane hardwood-conifer, Douglas-fir, redwood, red fir, and lodgepole pine forests from 3,000 to 9,000 feet in elevation.	May potentially occur as a migrant. Most likely to use habitats in the Project vicinity for migration because the Project is not within the preferred elevation range for breeding.
Progne subis Purple martin	—	SSC	An uncommon, local summer resident in wooded low- to mid-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 in suitable habitats. Suitable habitat is present in the Project vicinity.
Setophaga petechia Yellow warbler	—	SSC	Breeds in riparian woodlands from coastal and desert lowlands at elevations up to 8,000 feet in the Sierra Nevada. Also breeds in montane chaparral, open ponderosa pine, and mixed conifer habitats with substantial amounts of brush.	May potentially occur in suitable habitats. Suitable habitat is present in the Project vicinity.
Ammodramus savannarum Grasshopper sparrow	—	SSC	Grassland habitats with dense escape cover and tall herbaceous plants for perches.	May potentially occur in suitable habitats. Suitable habitat is present in the Project vicinity.

Species Common Name/Scientific Name	Federal Status	State Status	Habitat Description	Likelihood for Occurrence
Icterus bullockii Bullock's oriole	BCC	—	Breeds primarily in valley foothill riparian, valley foothill hardwood, and valley foothill hardwood-conifer habitats, and corresponding montane habitats, especially in open stands of large trees. Frequents riparian deciduous trees and deciduous oaks.	May potentially occur in suitable habitats. Suitable breeding and foraging habitat is present within the Project vicinity.
Haemorhous cassinii Cassin's finch	BCC	—	Tall, open coniferous forests, in lodgepole pine, red fir, and subalpine conifer habitats, particularly in breeding season. Most numerous near wet meadows and grassy openings.	May potentially occur in suitable habitats. May potentially occur in suitable pine-dominated habitats near Pardee Reservoir.
Mammals				
Euderma maculatum Spotted bat	—	SSC	A widespread, but rare species throughout the western United States. Found in habitats that range from deserts to yellow pine forest. Roosts in caves, rocky crevices and snags and requires open water.	May potentially occur in suitable habitats. Suitable habitat is present within the Project vicinity.
Aplodontia rufa californica Sierra Nevada mountain beaver	—	SSC	Dense riparian and open brushy stages of most forest types at elevations up to 10,100 feet in elevation. Deep, friable soils are required for burrowing along cool, moist microclimates. Line in burrows located in or near deep soils near streams and springs. Typical habitat in the Sierra is montane riparian.	May potentially occur in suitable habitats. Suitable habitat is present in the Project vicinity.
Taxidea taxus American badger	—	SSC	This species is considered a furbearing mammal under the California Fish and Wildlife Code. 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 feet in elevation.	May potentially occur in suitable habitats. Suitable habitat is present within the Project vicinity.
Unlikely to Occur				
Reptiles				
Arizona elegans occidentalis California glossy snake	—	SSC	Found in arid scrubby areas, rocky washes, grasslands, and chaparral in southern Sierra Nevada foothills and coast ranges. Ranges from the eastern San Francisco Bay area south to Baja California.	Unlikely to occur. The Project area is outside the geographic range of this species.
Masticophis flagellum ruddocki San Joaquin coachwhip	—	SSC	Found in open, dry, treeless areas with little or no cover, including valley grasslands and saltbush scrub. Hides in rodent burrows, shaded vegetation, and under surface objects.	Unlikely to occur. The Project area is outside the geographic range of this species.
Birds				
Astur atricapillus American goshawk	—	SSC	Middle to high elevation, mature, dense conifer forests for foraging and nesting. Casual in foothills during winter, northern deserts in pinyon-juniper woodland, and low-elevation riparian habitats.	Unlikely to occur. Dense, old-growth forest habitat is sparsely distributed in the Project vicinity. There are no known occurrences in the Project vicinity (CNDDB 2025).
Geothlypis trichas sinuosa Common yellowthroat (saltmarsh subspecies)	BCC	SSC	Mostly breeds and winters in wet meadow, fresh emergent wetland, and saline emergent wetland habitats; also breeds in valley foothill riparian, and occasionally in desert riparian, annual grassland, and perennial grassland habitats. This subspecies is only found in the San Francisco Bay and coastal Marin, San Francisco, and San Mateo counties.	Unlikely to occur. The Project area is outside the geographic range of this subspecies.

Federal Status: CC = Bird of Conservation Concern

State Status: SSC = California Species of Special Concern

Notes:

[a] The Project vicinity is defined to include areas within 1 mile of the Lower Mokelumne River FERC Project boundary.

4.5.3.3. GAME SPECIES

A game species is an animal that is hunted for sport or sustenance. Information on game species potentially present in the vicinity of the Project is provided in this section because of their commercial and recreational value. Game species are regulated by CDFW and are defined under the California Fish and Game Code as follows:

- Resident and migratory game birds are defined in California Fish and Game Code § 3500. Examples of upland resident game birds listed include blue grouse, wild turkey, mountain quail, and California quail. Upland migratory game birds include (but are not limited to) Wilson's snipe, band-tailed pigeon, and mourning dove.
- Game mammals are defined in California Fish and Game Code § 3950(a) to include (but are not limited to) deer, wild pig, black bear, rabbits and hares, and tree squirrels, as game mammals. Note that mountain lions are included in § 3950 but are explicitly excluded as a game mammal in § 3950.1.

Game species described in the California Fish and Game Code were evaluated for their likelihood to occur based on the geographic and elevation range of the Project and wildlife habitats present. A table was then developed listing each species and its status, followed by a generalized habitat description and a summary of applicable CDFW hunting regulations.

Table II-G.2-2 in Volume II, Appendix G.2, lists the resident and migratory game birds and game mammals that are known or have the potential to occur in the vicinity of the Project, including their habitat requirements and a summary of state hunting regulations for each species. Hunting of game species is permitted during seasons regulated by the CDFW.

A brief description of the Camanche Hills Hunting Preserve (located within the FERC Project boundary), and a summary of the game species in the vicinity of the Project, including resident game birds, migratory game birds and game mammals, is provided below.

Camanche Hills Hunting Preserve

Camanche Hills Hunting Preserve is a 1,500-acre preserve located north of Camanche Reservoir and the Camanche North Shore Recreation Area. Access to the preserve is provided off Jackson Valley Road or Clements Road to Curran Road. The preserve consists of a clubhouse, pro shop, lawn area, and space for small group meetings. There are also three 10-station sporting clay courses, trap and skeet range, five stands, and grouse bunkers.

The Camanche Hills Hunting Preserve is focused on upland game birds and waterfowl. The preserve releases thousands of game birds each year including ring-necked

pheasants (*Phasianus colchicus*), chukar (*Alectoris chukar*), quail, and waterfowl during the hunting season (October through March).

4.6 WETLANDS, RIPARIAN, AND LITTORAL HABITAT

This section describes the riparian, wetland, and littoral resources within the FERC Project boundary associated with EBMUD's Lower Mokelumne River Project (Project). The content requirements for this section are specified in 18 CFR Chapter I § 5.6(d)(3)(vi). FERC regulations require a description of the floodplain, wetlands, riparian, and littoral habitats in the Project vicinity, and must include: (1) a list of plant and animal species that use these habitats; (2) a map showing these habitats; and (3) estimates of the amounts of these habitats. This section also describes vegetation cover along the streambanks and reservoir shorelines, specified in § 5.6(d)(3)(ii)(C).

Project reaches and reservoirs associated with the Project include the following:

- Pardee Reservoir
- Camanche Reservoir
- Mokelumne River downstream of Camanche Dam to WIDD

A floodplain is a relatively flat lowland adjacent to a river, underlain by unconsolidated alluvial deposits, and subject to periodic inundation by the river. The littoral zone occurs in the near-shore areas of lakes/reservoirs where sunlight penetrates to the bottom of the waterbodies such that aquatic plants are able to grow.

Wetland and riparian habitats may occur within the floodplain alongside a stream or within the littoral zone of a reservoir/lake. Hydrologic conditions (including water table elevations, the annual hydrograph, and overbanking flows/reservoir fluctuations) and soil types present define the location and extent of wetland and riparian habitats within the floodplains/littoral zones. Wetlands are areas that are inundated or saturated by surface or groundwater at a sufficient frequency and duration to support vegetation that is adapted to these hydrologic and saturated soil conditions. Wet meadows are a type of wetland found in moist areas that are typically seasonally or temporarily flooded. Riparian habitat is located in transitional areas between the aquatic and terrestrial landscapes regularly influenced by fresh water and normally extend from the edges of waterbodies (e.g., streams, rivers, and lakes) to the edges of the upland communities.

Vernal pools are a unique wetland community that is found in the Project vicinity. Vernal pools are seasonally inundated wetlands formed by depressions in the ground where a hard underground layer prevents the drainage of rainwater (USFWS 2005a). When rain fills the vernal pools in the winter and spring, water collects and remains in the depressions, but the pools dry by the summer and fall.

The Project area in this section is defined to include wetland, riparian, and littoral habitats within the FERC Project boundary and along Project-affected stream reaches and reservoirs. The Project area includes wetland and riparian habitats that are within the floodplains and littoral zones, associated with drainages that feed into Project-affected reaches and reservoirs, or occur as isolated riparian areas and wetlands (e.g., ponds, vernal pools) that are not hydrologically connected to Project-affected stream reaches or reservoirs.

Refer to Table 4.6-1 for a list of Project-affected stream reaches and Project reservoirs.

Table 4.6-1. Project-affected stream reaches and Project reservoirs.

Project-affected Reach/Reservoir	Miles of Reach/Acreage of Reservoir
Project-affected Reach	
Mokelumne River Downstream of Camanche Dam to Woodbridge Irrigation District Dam	24.7 miles
Project Reservoirs	
Pardee Reservoir	2,260 acres
Camanche Reservoir	7,800 acres

4.6.1 INFORMATION SOURCES

Information in this section is primarily based on data from resource agency files, reports, and databases; published literature; and field studies completed by EBMUD. The following sources were reviewed to obtain information on riparian, wetland, and littoral habitats in the Project area:

- Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979);
- Google Earth© imagery;
- CWHR System wetland and riparian classifications (CDFW 2021);
- USFWS National Wetlands Inventory (NWI) wetland and riparian types (USFWS 2025b);
- Order Issuing New License for the Lower Mokelumne River Project (FERC No 2916) as Amended on November 15, 1984 (FERC 1981, 1984); and
- EBMUD GIS survey and observation data (EBMUD 2025c).

4.6.2 PROJECT-AFFECTED REACHES AND FLOODPLAINS

This section provides a description of the floodplains along Project-affected stream reaches, including a description of wetland and riparian habitats within the floodplains and along adjacent drainages. Figure 4.6-1 displays existing information on the spatial extent of wetland and riparian habitats in the Project area, using wetland and riparian classifications described by the CWHR habitats (CDFW 2021). For comparison, Figure 4.6-2 to Figure 4.6-10 display existing information on the spatial extent of wetland and riparian types in the Project area, as defined by the USFWS NWI (USFWS 2025b), and also include EBMUD's data on ponds and vernal pools from routine monitoring conducted under their USFWS Safe Harbor Agreement (EBMUD and USFWS 2009) (refer to Section 4.7, *Rare, Threatened, and Endangered Species*, for more information). Note that the CWHR and NWI GIS layers are based primarily on aerial imagery and often do not capture small-scale wetland/riparian habitats and/or riparian/wetland habitats that are obscured by overhead vegetation.

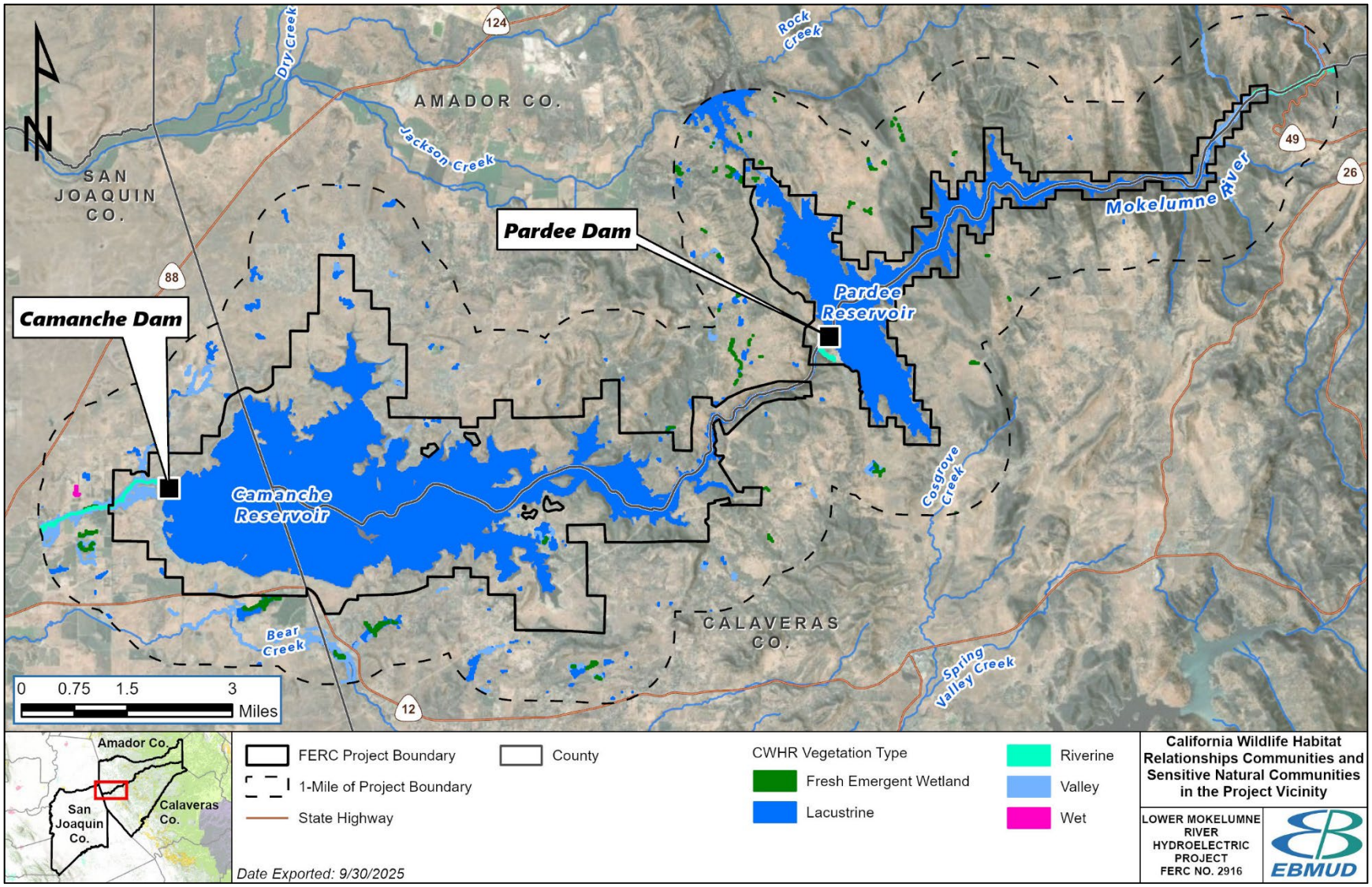


Figure 4.6-1. Spatial extent of CWHR System classified habitats in the Project area.

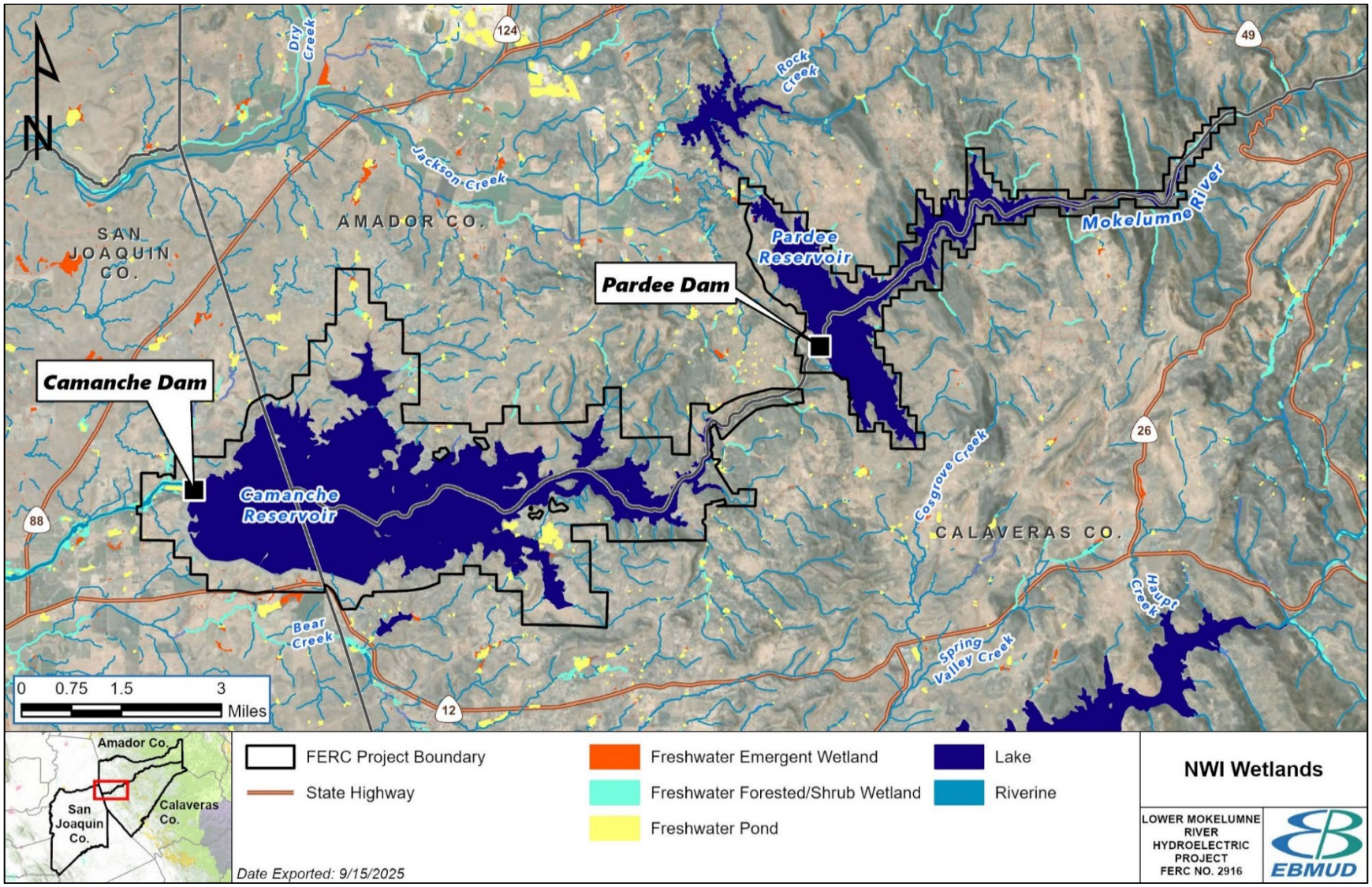


Figure 4.6-2. Spatial extent of NWI classified riparian and wetland types in the Project area – Overview.

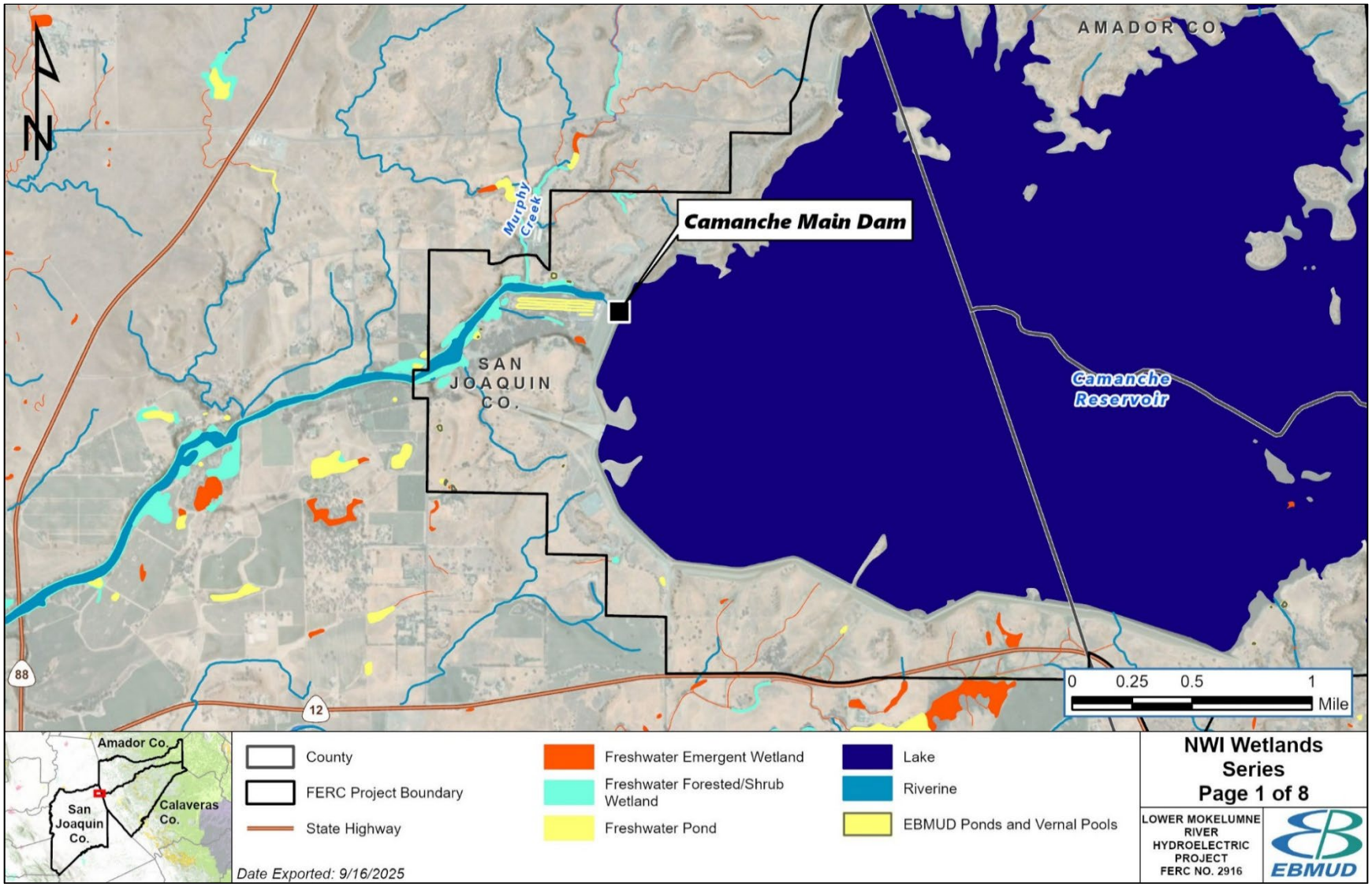


Figure 4.6-3. Spatial extent of NWI classified riparian and wetland types in the Project area – Lower Mokelumne River.

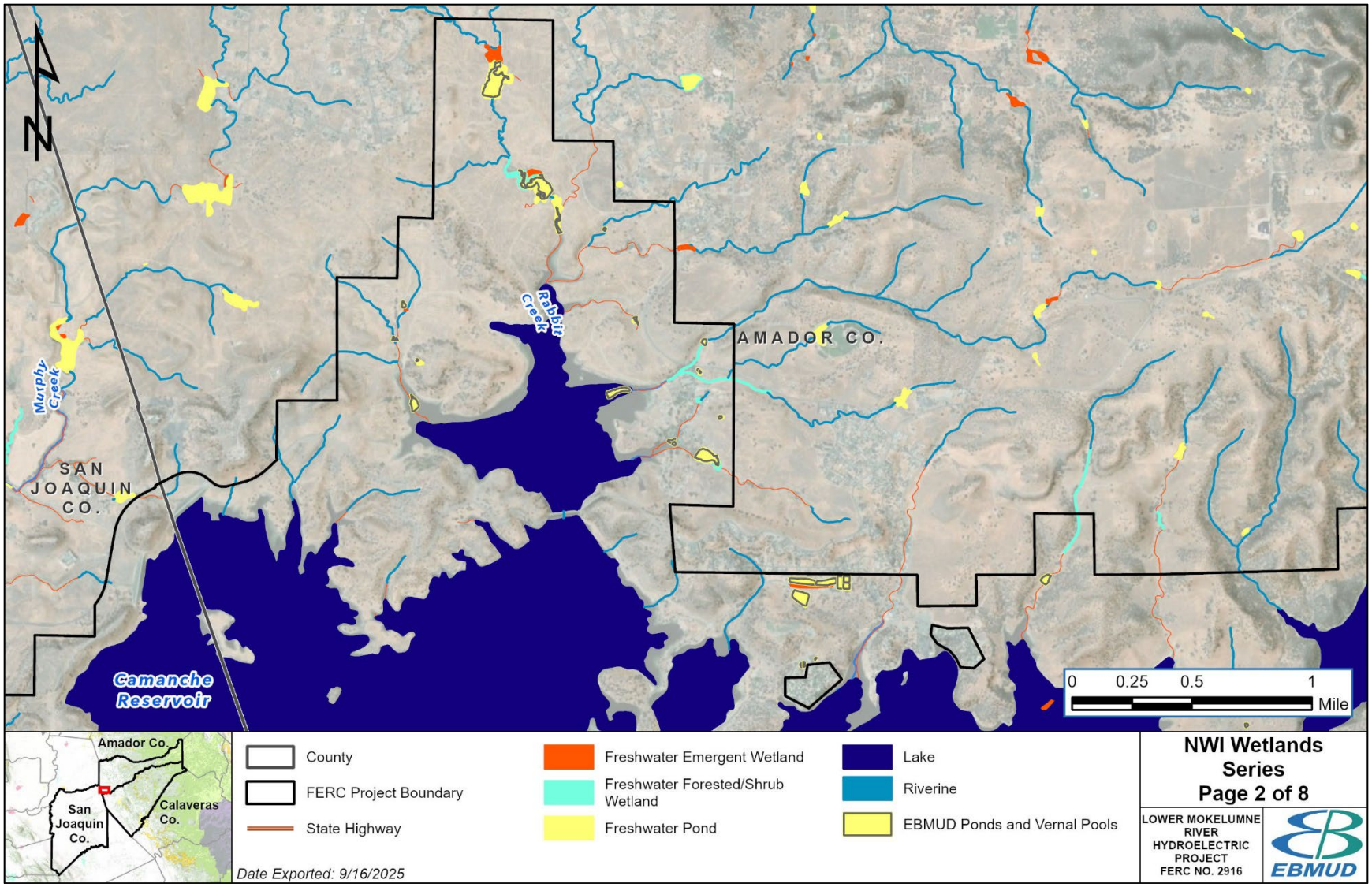


Figure 4.6-4. Spatial extent of NWI classified riparian and wetland types in the Project area – Camanche Reservoir North.

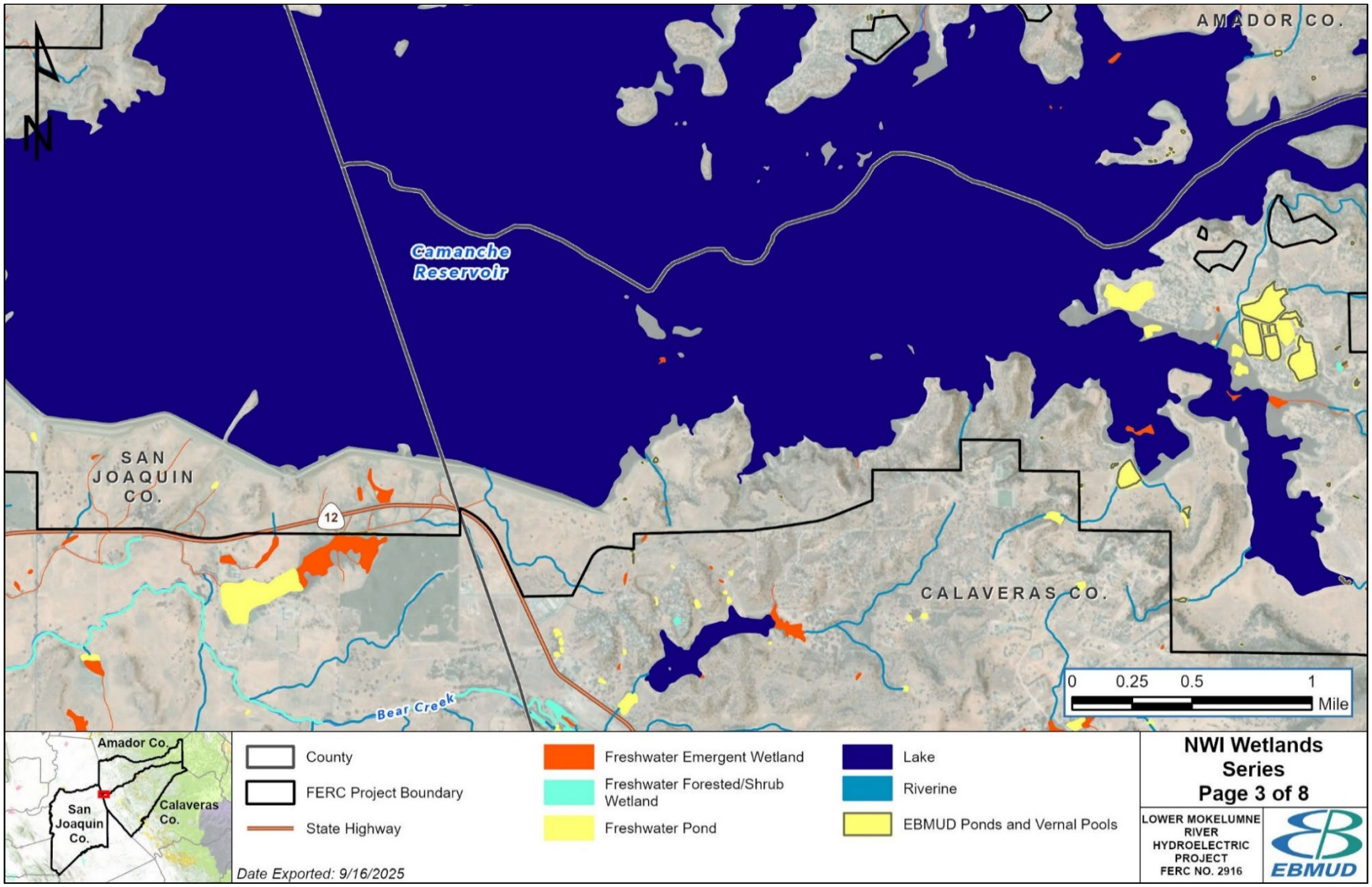


Figure 4.6-5. Spatial extent of NWI classified riparian and wetland types in the Project area – Camanche Reservoir South.

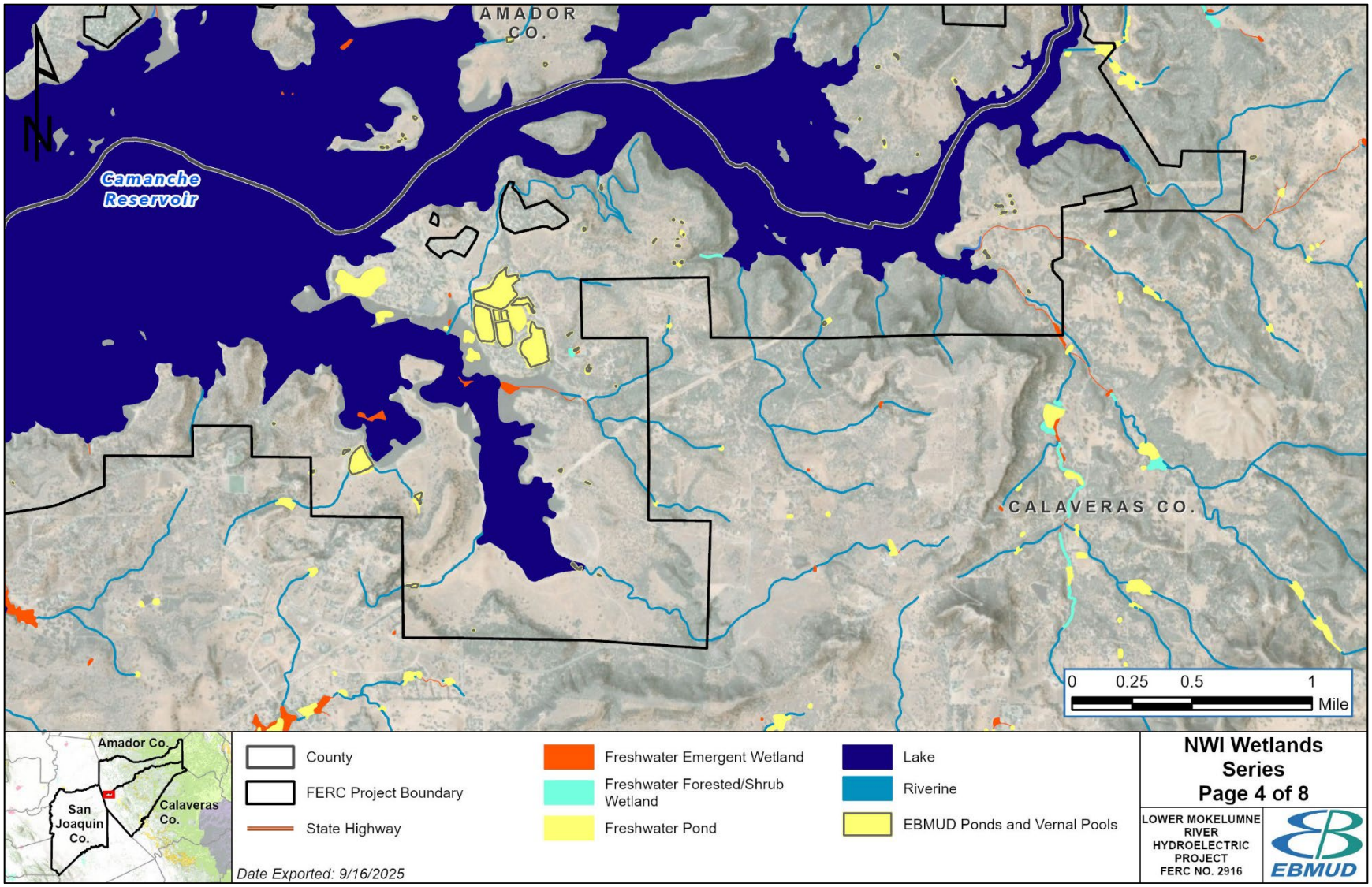


Figure 4.6-6. Spatial extent of NWI classified riparian and wetland types in the Project area – Camanche Reservoir Southeast.

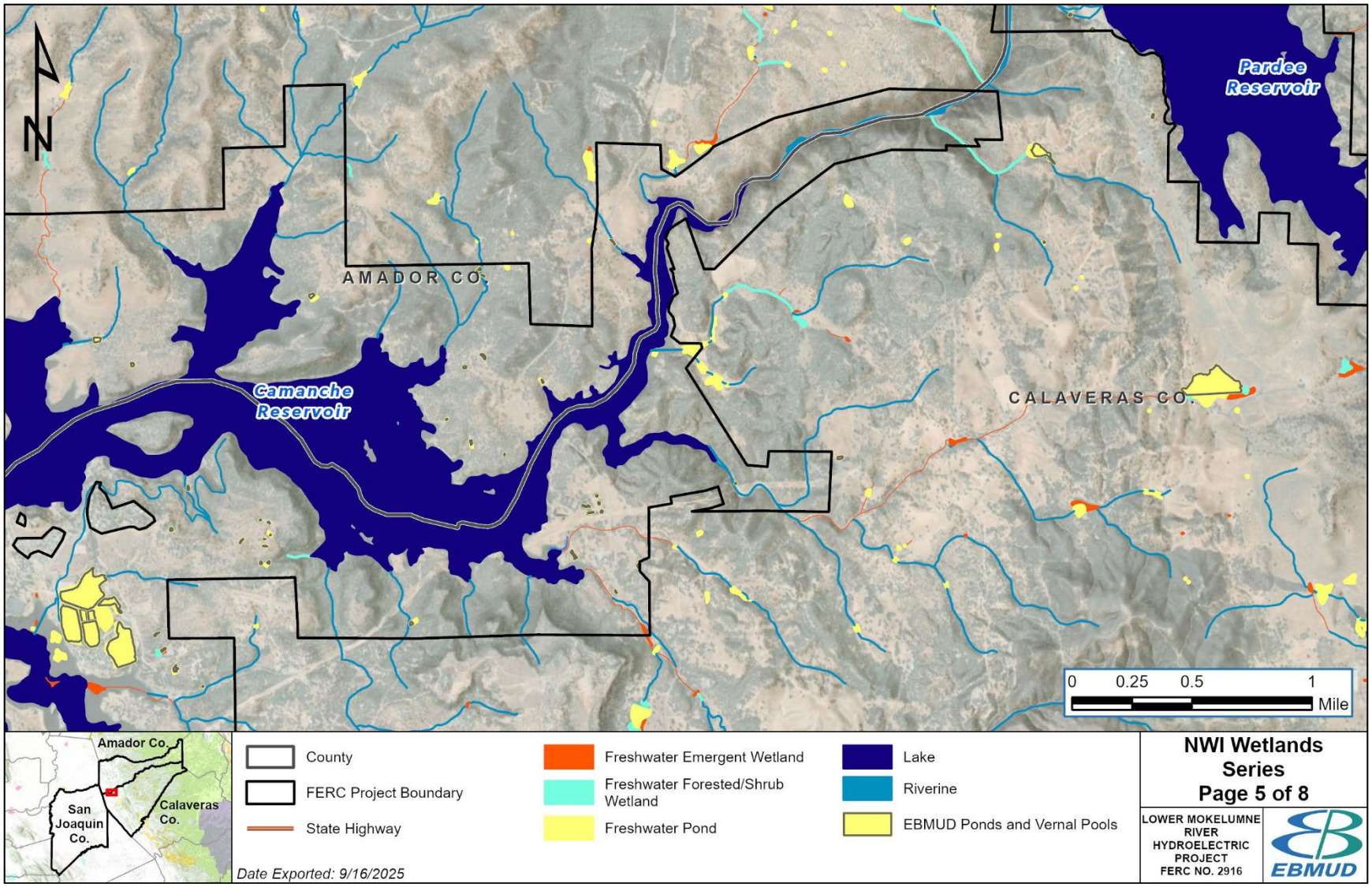


Figure 4.6-7. Spatial extent of NWI classified riparian and wetland types in the Project area – Camanche Reservoir Northeast.

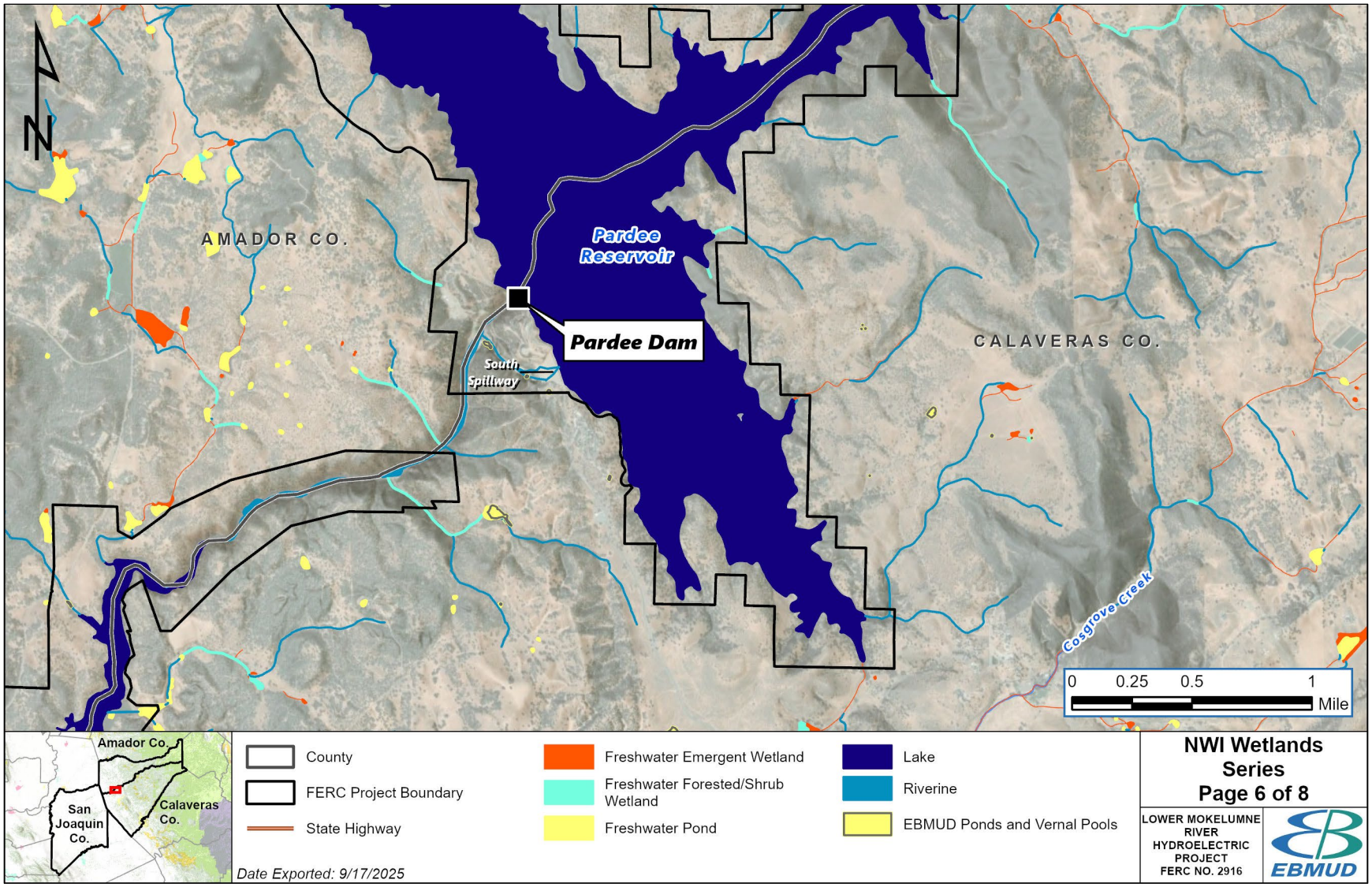


Figure 4.6-8. Spatial extent of NWI classified riparian and wetland types in the Project area – Pardee Reservoir South.

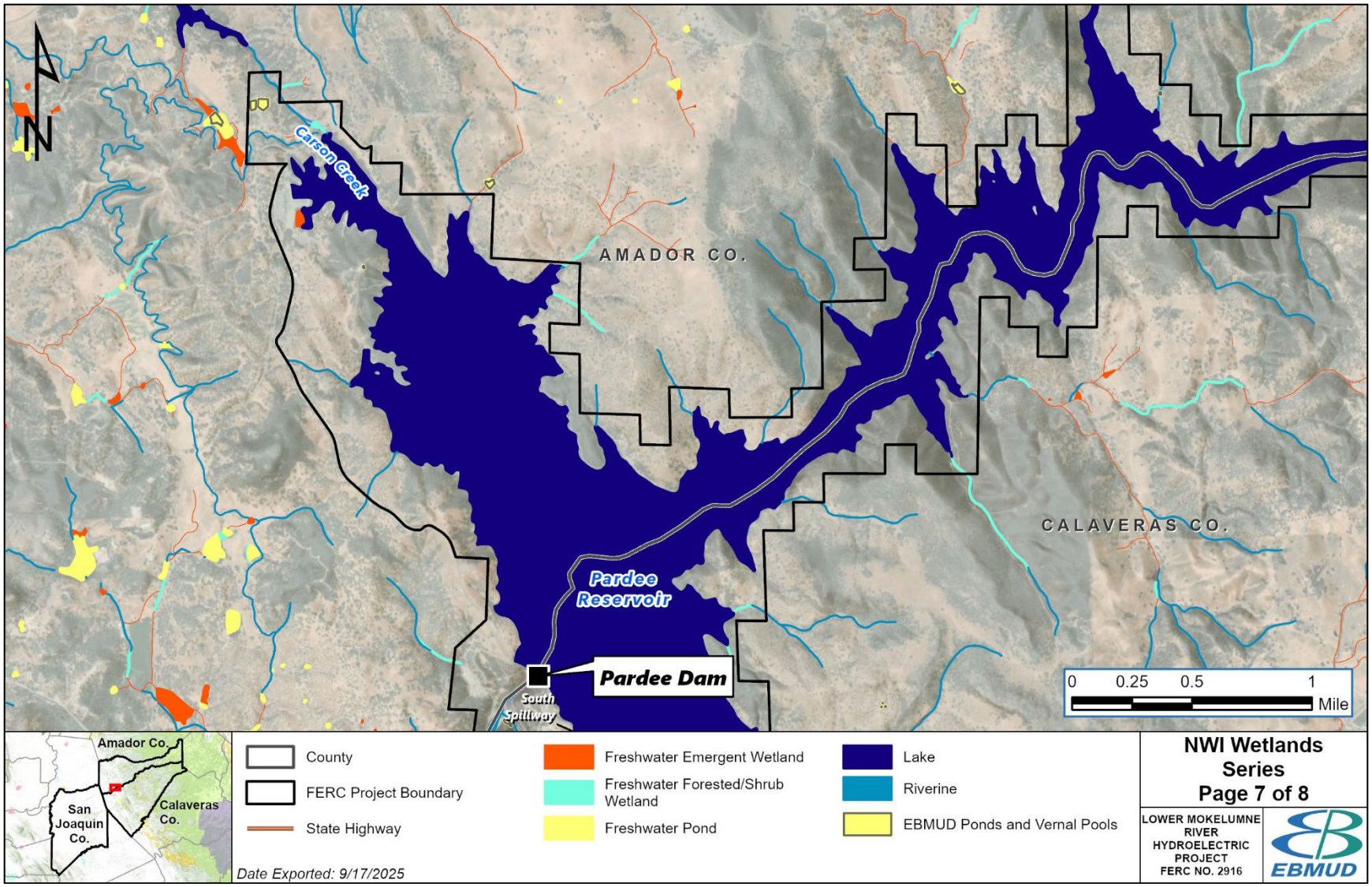


Figure 4.6-9. Spatial extent of NWI classified riparian and wetland types in the Project area – Pardee Reservoir North.

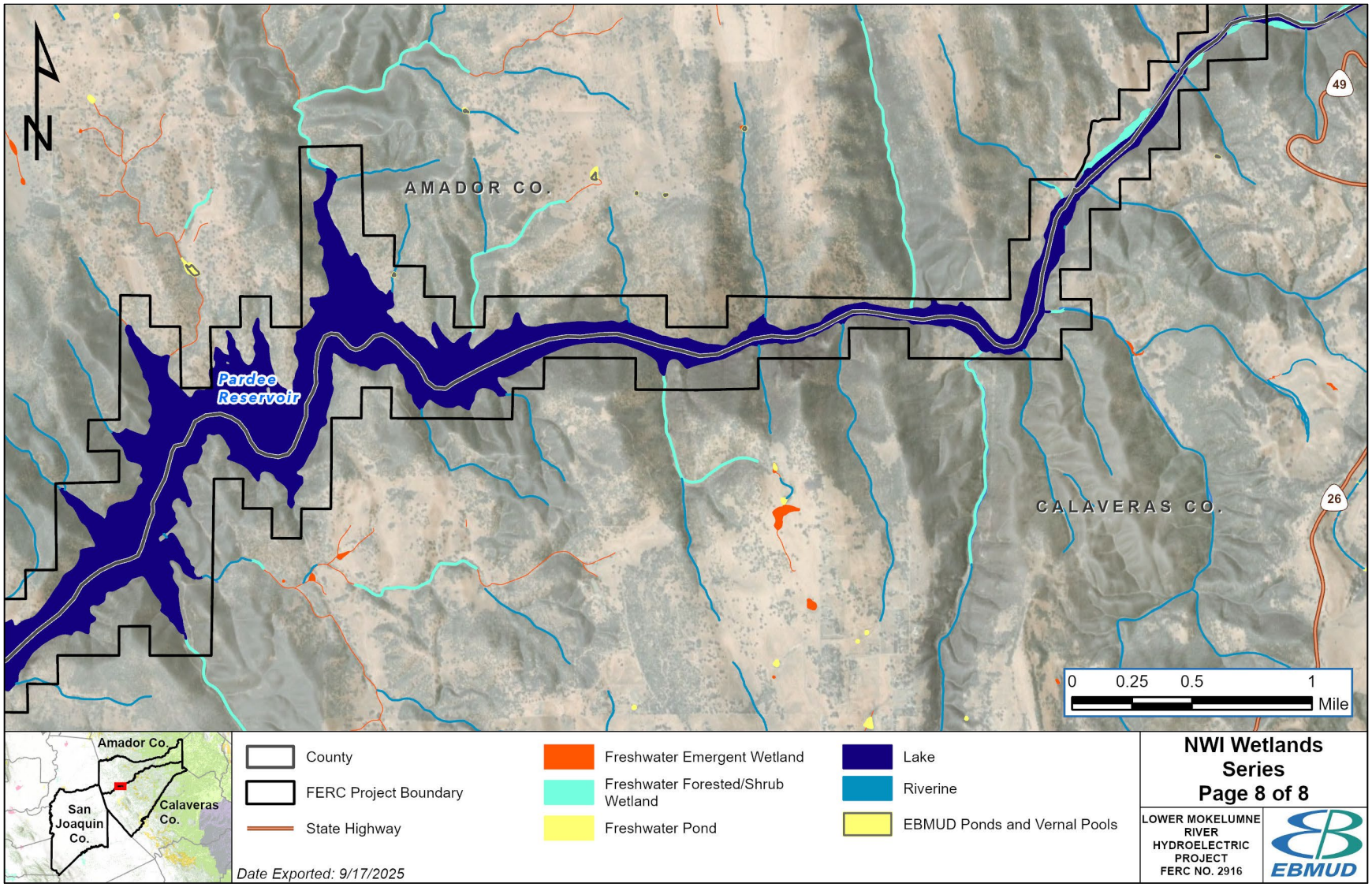


Figure 4.6-10. Spatial extent of NWI classified riparian and wetland types in the Project area – Pardee Reservoir East.

Volume II – Appendix G.3 provides a complete description of CWHR and NWI wetland, riparian, and littoral habitat types found in the Project area. Table 4.6-2 quantifies the extent of CWHR wetland and riparian habitats in the Project area based on available information shown in Figure 4.6-1. Table 4.6-3 quantifies the extent of NWI wetland and riparian habitats in the Project area based on available information shown in Figure 4.6-2 through Figure 4.6-10. Table 4.6-4 shows acreages of ponds (including vernal pools) identified by EBMUD in the Project area.

The following tables provide a description of each Project-affected stream reach.

Table 4.6-2. Acreage of CWHR riparian and wetland habitats in the Project area.

Project Location	CWHR Riparian or Wetland Habitats (acres)		
	Wet Meadow	Valley Foothill Riparian	Fresh Emergent Wetland
Project-affected Reach[a]			
Mokelumne River Downstream of Camanche Dam to WIDD[b]	5.56	1,036.88	67.79
Project Reservoirs[c]			
Pardee Reservoir	0	37.04	1.16
Camanche Reservoir[d]	0	5.29	0
Other Habitats in the FERC Project Boundary			
Other Areas in the FERC Project Boundary	0	43.38	2.72

Notes:

[a] This section presents acreages of each habitat that is within the floodplain/adjacent to Project-affected reaches (i.e., hydrologically connected to the Mokelumne River). A buffer of 500 feet from each bank of the river was used to estimate the extent of habitat.

[b] CWHR also identifies hydrologically connected lacustrine habitats (i.e., ponds) along this reach, totaling approximately 111 acres.

[c] This section presents acreages of each habitat that is within the littoral zone/adjacent to Project reservoirs (i.e., hydrologically connected to the reservoir, either along the shoreline or along tributary drainages).

[d] CWHR also identifies hydrologically connected lacustrine habitats (i.e., ponds) along this reservoir, totaling approximately 68 acres.

Table 4.6-3. Acreages of NWI riparian and wetland types in the Project area.

Project Location	NWI Riparian and Wetland Types (acres)		
	Palustrine Emergent Wetland	Palustrine Forested/Scrub-Shrub Wetland	Ponds
Project-affected Reach[a]			
Mokelumne River Downstream of Camanche Dam to WIDD	19.19	364.76	108.26
Project Reservoirs[b]			
Pardee Reservoir	3.42	11.77	0
Camanche Reservoir	28.79	3.74	57.93
Other Habitats in FERC Project Boundary			
Other Areas in the FERC Project Boundary	25.11	7.01	51.84

Notes:

[a] This section presents acreages of each habitat that is within the floodplain/adjacent to Project-affected reaches (i.e., hydrologically connected to the Mokelumne River). A buffer of 500 feet from each bank of the river was used to estimate the extent of habitat.

[b] This section presents acreages of each habitat that is within the littoral zone/adjacent to Project reservoirs (i.e., hydrologically connected to the reservoir, either along the shoreline or along tributary drainages).

Table 4.6-4. Acreage of ponds (including vernal pools) identified by EBMUD in the Project area.

Project-affected Reach/Reservoir	EBMUD Monitoring Sites (acres)
Project-affected Reacha	
Between Pardee Dam and Camanche Reservoir	
Mokelumne River Downstream of Camanche Dam to WIDD	0.30
Project Reservoirs[b]	
Pardee Reservoir	2.14
Camanche Reservoir	67.86

Notes:

[a] This section presents the number of habitats that are within the floodplain or lands surrounding Project-affected reaches within the FERC Project boundary.

[b] This section presents number of habitats that are within the littoral zone or lands surrounding Project reservoirs within the FERC Project boundary.

4.6.3 PROJECT RESERVOIRS AND LITTORAL ZONES

This section provides a discussion of littoral zones associated with Project reservoirs, including a description of wetland and riparian habitats that occur on the margins

of/upslope of the inundated areas of the reservoir/lake. This section also describes wetland and riparian habitats occurring along drainages feeding into Project reservoirs.

Refer to Figure 4.6-1 through Figure 4.6-10 for existing information on the spatial extent of these wetland and riparian habitats, as classified by CWHR and NWI. Volume II – Appendix G.3 provides a description of CWHR and NWI wetland, riparian, and littoral habitat types associated with Project reservoirs, grouped according to classification system. Table 4.6-2 quantifies the extent of CWHR wetland and riparian habitats in the Project area based on available information shown in Figure 4.6-1. Table 4.6-3 quantifies the extent of NWI wetland and riparian types in the Project area based on available information shown in Figure 4.6-2 through Figure 4.6-10. Table 4.6-4 presents the acreage of EBMUD ponds and vernal pools in the study area based on EBMUD monitoring data (EBMUD 2025c).

4.6.3.1 PARDEE RESERVOIR

Pardee Reservoir is a human-made lake impounded by Pardee Dam. As described previously, CWHR maps are based on aerial imagery and do not capture smaller scale habitat patches. CHWR identifies approximately 37 acres of valley foothill riparian habitat and 1 acre of fresh emergent wetland habitat along Pardee Reservoir. Refer to Figure 4.6-1 for the location of these habitats.

NWI classifies Pardee Reservoir as an artificially diked, impounded lake that is limnetic, with an unconsolidated bottom (USFWS 2025b). NWI maps indicate that approximately 12 acres of palustrine forested/scrub-shrub wetlands along tributary streams and approximately 3 acres of palustrine emergent wetlands can be found adjacent to Pardee Reservoir where tributary streams drain into the reservoir (USFWS 2025b). There is one palustrine emergent wetland identified within the littoral zone of Pardee Reservoir along the West End Dike (USFWS 2025b). Refer to Figure 4.6-8 through Figure 4.6-10 for the location of these riparian and wetland types. NWI also identifies lacustrine littoral habitat elements in the shallow margins of Pardee Reservoir (classification codes L2USAh and L2USCh) (USFWS 2025b). Refer to Volume II – Appendix G.3 for more information.

EBMUD has identified 2.14 acres of ponds/vernal pools that are within the FERC Project boundary surrounding Pardee Reservoir. Refer to Figure 4.6-8 through Figure 4.6-10 for the location of these ponds.

4.6.3.2 CAMANCHE RESERVOIR

Camanche Reservoir is a human-made lake impounded by Camanche Dam. CWHR does not identify any wetland habitat types along Camanche Reservoir but identifies approximately 5 acres of adjacent valley foothill riparian habitat. As described previously,

CWHR maps are based on aerial imagery and often do not capture smaller scale habitat patches. The upper reach of Camanche Reservoir, approximately 1.6 miles long, is the stretch of aquatic habitats between the Camanche Reservoir normal pool elevation and up to the outlet of flow from Pardee Dam. CWHR classifies this upper reach as a mixture of lacustrine and riverine habitat (CWHR 2021). Refer to Figure 4.6-1 for the location of these CWHR habitats.

NWI classifies Camanche Reservoir as an artificially diked, impounded lake that is limnetic, with an unconsolidated bottom (USFWS 2025b). NWI maps indicate that approximately 29 acres of palustrine emergent wetlands, 4 acres of palustrine forested/scrub-shrub wetlands, and 58 acres of hydrologically connected ponds can be found adjacent to Camanche Reservoir, mostly where tributary streams drain into the reservoir. Refer to Figure 4.6-2 through Figure 4.6-8 for the location of these riparian and wetland types. NWI also identifies lacustrine littoral habitat elements in the shallow margins of Camanche Reservoir (classification codes L2USAh and L2USCh). NWI identifies two tributary streams containing approximately 0.1 acre of palustrine scrub-shrub wetlands along tributaries that drain into the upper reach of Camanche Reservoir. NWI classifies the upper reach of Camanche Reservoir as a mixture of lacustrine and riverine (USFWS 2025b). Refer to Volume II – Appendix G.3 for more information.

EBMUD has also identified 67.86 acres of ponds that are within the FERC Project boundary surrounding Camanche Reservoir (EBMUD 2025c). Refer to Figure 4.6-2 through Figure 4.6-8 for the location of these ponds. Based on EBMUD hydrologic data (EBMUD 2025c), the upper reach of Camanche Reservoir is highly channelized and does not offer fish habitat distinct from the reservoir habitat. Refer to Figure 4.4-3 for elevation data that show that the maximum pool of Camanche Reservoir extends to the base of Pardee Dam. Therefore, the upper reach of Camanche Reservoir is better classified as lacustrine habitat rather than riverine.

4.6.4 OTHER WETLANDS AND RIPARIAN HABITATS IN THE FERC PROJECT BOUNDARY

The FERC Project boundary also contains other isolated wetlands and riparian habitats that are found outside floodplains/littoral zones and are not hydrologically connected to Project-affected stream reaches or reservoirs (CDFW 2021, USFWS 2025b, EBMUD 2025c).

CWHR identifies approximately 43 acres of isolated valley foothill riparian habitat, and 3 acres of isolated fresh emergent wetland habitat. Refer to Figure 4.6-1 for the location of these habitats.

NWI identifies approximately 25 acres of isolated palustrine emergent wetlands, 7 acres of isolated palustrine forested/scrub-shrub wetlands, and 52 acres of isolated ponds. Refer to Figure 4.6-2 through Figure 4.6-10 for the location of these riparian and wetland types.

EBMUD monitoring data identified 70 total acres of ponds and vernal pools within the FERC Project boundary. Most, but not all, of these ponds are hydrologically connected to Pardee and Camanche reservoirs or the Mokelumne River below Camanche Dam. Some ponds and vernal pools are isolated. These ponds and vernal pools are important habitats for federally threatened California tiger salamander (*Ambystoma californiense*) and federally proposed threatened western spadefoot (*Spea hammondii*). EBMUD conducts routine habitat assessments for these species as part of their Safe Harbor Agreement with the USFWS (EBMUD and USFWS 2009). Refer to Section 4.7, *Rare, Threatened, and Endangered Species*, for more information on these monitoring efforts.

Volume II – Appendix G.3 provides a description of Classification and Assessment with Landsat of Visible Ecological Groupings (CALVEG) and NWI wetland, riparian, and littoral habitat types in the Project area, grouped according to classification system. Table 4.6-2 quantifies the extent of CWHR wetland and riparian habitats in the Project area based on available information shown in Figure 4.6-1. Table 4.6-3 quantifies the extent of NWI wetland and riparian types in the Project area based on available information shown in Figure 4.6-2 through Figure 4.6-10. Table 4.6-4 presents the acreage of EBMUD ponds and vernal pools in the Project area based on EBMUD monitoring data (EBMUD 2025c).

4.6.5 PLANT AND WILDLIFE SPECIES THAT USE WETLAND AND RIPARIAN HABITAT

Wetland and riparian habitats within the floodplains and littoral zones of the Project-affected stream reaches and Project reservoirs (as well as along tributary drainages) provide habitats for a variety of special-status plant and wildlife species, as well as invasive plants. Riparian corridors provide valuable habitat for riparian nesting birds and provide covered travel corridors for a multitude of wildlife species. Refer to Volume II – Appendix G.2 for common wildlife species using wetland, riparian, and littoral habitat. Volume II – Appendix G.4, identifies special-status species that may potentially use wetland, riparian, and littoral habitats. For more information on common and special-status wildlife species potentially using these habitats, refer to Section 4.4, *Fish and Aquatic Resources*; Section 4.5, *Botanical and Wildlife Resources*; and Section 4.7, *Rare, Threatened, and Endangered Species*.

4.6.5.1 MOKELUMNE RIVER DOWNSTREAM OF CAMANCHE DAM TO WOODBRIDGE IRRIGATION DISTRICT DAM

The Mokelumne River extends approximately 24.7 miles from Camanche Dam to WIDD. The Mokelumne River in this reach contains a wide variety of interconnected riparian, wetland, and pond habitat systems. The Mokelumne River in this reach is relatively wide and has a low gradient compared to upstream segments. Near WIDD, the river contains many meanders and oxbow bends that contain wide bands of riparian and wetland habitats.

According to CWHR, the 24.7-mile stretch of the Mokelumne River in this reach contains interconnected wet meadow, montane riparian, valley foothill riparian, fresh emergent wetland, and lacustrine (pond) habitat. Valley foothill riparian is the dominant habitat type along this reach, comprising approximately 1,037 acres. There are also approximately 68 acres of adjacent fresh emergent wetlands, and 6 acres of adjacent wet meadows. Lacustrine habitats (consisting of human-made hydrologically connected ponds such as Lodi Lake) are also present along this reach, comprising approximately 64 acres. Refer to Figure 4.6-1 for the location of these habitats.

NWI classifies this section of the Mokelumne River as a permanently flooded lower perennial river with an unconsolidated bottom (USFWS 2025b). NWI identifies several riparian and wetland types along this reach, including palustrine forested wetlands, palustrine scrub-shrub wetlands, palustrine emergent wetlands, and ponds. The most abundant riparian and wetland types include palustrine forested/scrub-shrub wetland (approximately 365 acres), ponds (approximately 108 acres), and palustrine emergent wetlands (approximately 19 acres). Many of these wetlands and ponds are further classified as diked/impounded or artificially excavated by human activities (USFWS 2025b). Refer to Figure 4.6-3 for the location of these wetland types.

EBMUD has identified 0.3 acre of ponds/vernal pools that are within the FERC Project boundary along this reach. Refer to Figure 4.6-3 for the location of these ponds.

4.7 RARE, THREATENED, AND ENDANGERED SPECIES

This section describes species considered rare, threatened, or endangered having the potential to occur in the vicinity of EBMUD's Lower Mokelumne River Project (Project). The FERC content requirements for this section are specified in 18 CFR Chapter I § 5.6 (d)(3)(v) and 5.6(d)(3)(vii), respectively. A detailed description of aquatic resources in the vicinity of the Project, with more detailed information on rare, threatened, and endangered aquatic resources, is included in Section 4.4, *Fish and Aquatic Resources*. Information on other botanical and wildlife resources is included in Section 4.5, *Botanical and Wildlife Resources*.

A review of the existing literature was conducted to determine the potential for rare, threatened, or endangered plant and wildlife species to occur in the vicinity of the Project. Information in this section is primarily based on data from resource agency files, reports, and databases; published literature; and field studies conducted by EBMUD over the past 16 years.

The following global sources were reviewed to obtain information on rare, threatened, and endangered plant and wildlife species in the vicinity of the Lower Mokelumne River Project. The Project vicinity is defined to include areas within a 1-mile buffer of the FERC Project boundary:

- CDFW's CNDDB (2025);
- CNPS (2025) Inventory of Rare, Threatened, and Endangered Plants;
- *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988);
- CWHR life history accounts and range maps (CDFW 2021);
- USFWS (2021) BCC;
- USFWS (2025a) IPaC website; and
- EBMUD GIS survey and observation data (EBMUD 2025c).

Additional information sources for specific plant and wildlife species are discussed in Sections 4.7.3 and 4.7.4 below.

4.7.1 DEFINITIONS

For the purposes of this document, rare, threatened, and endangered plant and wildlife species are defined as any species that are granted protection by a federal or state agency. Federally listed plant or wildlife species granted status by USFWS under the federal ESA include threatened (FT), endangered (FE), proposed threatened or endangered (FPT, FPE), candidate (FC), or listed species proposed for delisting (FPD).

The Bald and Golden Eagle Protection Act (Eagle Act) also protects bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*).

State of California listed plant and wildlife species, which are granted status by CDFW under the California Endangered Species Act (CESA), include California threatened (CT), endangered (CE), and candidates for listing as endangered or threatened (CCE, CCT). Plant species listed as rare under CESA are also included (CR). CDFW also protects certain wildlife species that are listed as California Fully Protected (CFP).

California SSC and USFWS BCC do not meet definitions of rare, threatened, or endangered species and are addressed in Section 4.5, *Botanical and Wildlife Resources*.

4.7.2 REGULATORY SETTING

4.7.2.1 FEDERAL ENDANGERED SPECIES ACT

The ESA protects plants and animals listed as endangered or threatened by USFWS. A federally listed species is protected from unauthorized take, which is defined in the ESA as acts to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct" (16 United States Code [USC] Sections 1532[19] and 1538[a]). In this definition, harm includes "any act which actually kills or injures fish or wildlife and emphasizes that such acts may include significant habitat modification or degradation that significantly impairs essential behavioral patterns of fish or wildlife" (50 CFR, Title 50, Section 17.3). Unless performed for scientific or conservation purposes with the permission of USFWS, take of listed species is only permissible if USFWS issues an incidental take permit (ITP). When issuing an ITP, all federal agencies, including USFWS, must ensure that their activities are "not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species" (16 USC 1536[a]). Enforcement of the ESA is administered by USFWS.

The ESA also provides for designation of Critical Habitat, defined as specific areas within the geographical range occupied by a species where physical or biological features "essential to the conservation of the species" are found and "which may require special management considerations or protection" (16 USC 1538[5][A]). Critical Habitat may include areas outside the current geographical area occupied by the species that are nonetheless essential for the conservation of the species.

4.7.2.2 SAFE HARBOR AGREEMENT

EBMUD entered into a Safe Harbor Agreement (SHA) with the purpose of 1) promoting the enhancement and management of habitat for California red-legged frog (*Rana draytonii*), California tiger salamander (*Ambystoma californiense*), and valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) on EBMUD watershed lands in San Joaquin, Amador, and Calaveras counties; and 2) providing certain regulatory assurances to EBMUD. The SHA serves as the basis for USFWS to issue an enhancement of survival permit (Permit) pursuant to Section 10(a)(1)(A) of the ESA. The Permit authorizes a federal level incidental taking of California red-legged frog, California tiger salamander, and valley elderberry longhorn beetle associated with the enhancement and conservation management of these species habitats, other lawful uses of the property (as described in Section 10 of the SHA), and the potential future return of any eligible land to pre-

Agreement conditions (baseline) within the period that the Permit is in effect (2009–2039) (EBMUD and USFWS 2009).

4.7.2.3 BALD AND GOLDEN EAGLE PROTECTION ACT

The Eagle Act (16 USC 6689) provides for the protection of the bald eagle and the golden eagle by prohibiting, except under certain specified conditions, the taking, possession, and commerce of such birds. The 1972 Amendments increased penalties for violating provisions of the Eagle Act and strengthened other enforcement measures. A 1978 Amendment authorizes the Secretary of the Interior to permit the taking of golden eagle nests that interfere with resource development or recovery operations. A 1994 Memorandum from President William Clinton to the Heads of Executive Agencies and Departments established the policy concerning collection and distribution of eagle features for Native American religious purposes.

4.7.2.4 CALIFORNIA ENDANGERED SPECIES ACT

The state of California implements CESA, which is enforced by CDFW. While the provisions of CESA are similar to the ESA, CDFW maintains a list of California rare, threatened, and endangered species, independent of the ESA's threatened and endangered species list. The California list of endangered and threatened species is contained in Title 14, Sections 670.2 (plants) and 670.5 (animals) of the California Code of Regulations.

State-listed threatened and endangered species are protected under provisions of CESA. Activities that may result in the take of individuals (defined in CESA as acts to "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill") are regulated by CDFW. While habitat degradation or modification is not included in the definition of take under CESA, CDFW has interpreted take to include the destruction of nesting, denning, or foraging habitat necessary to maintain a viable breeding population of protected species.

If it is determined that the take would not jeopardize the continued existence of the species, an ITP can be issued by CDFW per Section 2081 of the California Code of Regulations. If a state-listed species is also federally listed, and USFWS has issued an ITP, the ITP issued by USFWS would likely satisfy CDFW's requirements. CDFW may issue a consistency finding in accordance with Section 2080.1 of the California Fish and Game Code.

4.7.2.5 CALIFORNIA FULLY PROTECTED SPECIES

In the 1960s, the state of California created the Fully Protected classification to identify and provide additional protection to those animals that are rare or that face possible

extinction. Lists were created for fish, amphibians, reptiles, birds, and mammals. Most of the species on these lists have subsequently been listed under the state and/or federal ESAs; however, some have not been formally listed.

4.7.2.6 ROUTINE MAINTENANCE AGREEMENT

EBMUD has entered into an Agreement for Routine Maintenance Activities with CDFW for the Mokelumne River watershed, including areas within the FERC Project boundary. Under the Routine Maintenance Agreement, EBMUD can perform maintenance without obtaining a separate Agreement from CDFW provided that the limits of work are consistent with the Agreement, a Verification Request Form or Sub-Notification Form is submitted to CDFW for approval prior to commencing Project activities, and work is performed in accordance with the Agreement. Maintenance activities covered by the Agreement include:

- sediment and debris removal;
- vegetation management;
- crossing and culvert maintenance and repair;
- structure repair and maintenance;
- beaver dam removal;
- culvert replacement (non-fish bearing streams);
- temporary water diversions;
- erosion prevention; and
- environmental stewardship.

The Agreement also includes avoidance and protection measures that must be implemented prior to conducting maintenance activities. This includes, but is not limited to, habitat assessments, annual environmental awareness education, surveys for terrestrial and aquatic wildlife species (both special-status and common), bat habitat surveys prior to tree removal, swallow and bat surveys for any bridge work, and nesting bird surveys. Nesting bird surveys include protocol-level surveys for Swainson's hawk (*Buteo swainsoni*) and burrowing owl (*Athene cunicularia*). Annual raptor nest surveys are conducted on the Camanche and Pardee watersheds starting in March. Initial surveys are conducted from the reservoirs and access roads, where active raptor nests are recorded. Information collected includes the geolocation, age, sex (if possible), habitat, and activity. Active nests are checked every 2 weeks until the nest fledges or fails. Any additional nest located during the season are also monitored in the same way.

Results of surveys and monitoring implemented under the Agreement are documented in annual reports and 4-year status reports to CDFW. The Agreement also requires submission of sensitive species records to the CNDDB.

4.7.3 RARE, THREATENED, AND ENDANGERED PLANTS

This section describes rare, threatened, and endangered plants that are known to occur or may potentially occur in the vicinity of the Project.

A comprehensive list of rare, threatened, and endangered plant species was compiled from the following sources:

- USFWS IPaC website (USFWS 2025a)
- CDFW's CNDDB (CNDDB 2025)
- CNPS Inventory of Rare, Threatened, and Endangered Plants (CNPS 2025)

This comprehensive list was then evaluated to determine which plant species occur in the Project vicinity based on a review of their habitat descriptions compared to maps and descriptions of the CWHR System wildlife habitats described in Section 4.5, *Wildlife and Botanical Resources*.

The geographic location, elevation of the Project, and habitat features present were then reviewed to determine those species that may potentially occur.

- **Known to occur:** Plants with recorded populations in the Project vicinity, as determined by CNDDB or CNPS.
- **May potentially occur:** Plants that may potentially occur in the vicinity of the Project based on CNDDB/CNPS occurrence data, the geographic location and elevation of the Project, and habitat features present.
- **Unlikely to occur in the vicinity of the Project:** Plants that are unlikely to occur because their range does not overlap the Project; or for which the vicinity of the Project does not support appropriate habitat.

Table 4.7-1 provides the comprehensive list of rare, threatened, and endangered plant species evaluated for their potential to occur in the FERC Project boundary. Table 4.7-1 also summarizes pertinent information for each species, including status, blooming period, and preferred habitat, with information on the location of occurrences, if applicable. Volume V, Figure V-1, provides a map of the location of rare, threatened, and endangered plants in the vicinity of the Project.

One rare, threatened, and endangered plant species, the Ione manzanita (*Arctostaphylos myrtifolia*) (FT), is known to occur in the FERC Project boundary.

Five rare, threatened, and endangered plant species have not been documented in the FERC Project boundary but have the potential to occur based on CNDDB/CNPS records in the Project vicinity, geographic location, elevation of the Project, and habitat features present.

Life history information for rare, threatened, and endangered plant species known to occur or potentially occurring in the vicinity of the Project, including the location of USFWS-designated Critical Habitat and applicable recovery plans, is provided below.

Table 4.7-1. Rare, threatened, and endangered plants with potential to occur in the Project vicinity.

Common/Scientific Name	Federal/ State Status	California Rare Plant Rank (RPR)	Blooming Period/ Fertile	Habitat	Likelihood for Occurrence
Known to Occur					
Ione manzanita Arctostaphylos myrtifolia	FT/—	1B.2	November – March	Grows in chaparral and cismontane woodland on acidic, clay, and sandy soil from El. 195–1,905 feet msl.	**Known to occur**. There are several known populations of this species in the FERC Project boundary between the north shores of Camanche and Pardee reservoirs (CNDDB 2025). The FERC Project boundary contains suitable habitat for this species.
May Potentially Occur					
Fleshy owl's-clover Castilleja campestris var. succulenta	FT/CE	1B.2	(March) April – May	Most often grows in acidic vernal pools from El. 165–2,460 feet msl.	**May potentially occur in suitable vernal pool habitat**. There are no records of this species in the FERC Project boundary. The Project vicinity is within the elevation range and contains suitable habitat for this species. USFWS has designated Critical Habitat for this species. There is no Critical Habitat for this species within the FERC Project boundary. The closest Critical Habitat Unit (SUCCL 1) is approximately 7 miles west of Camanche Reservoir.

Common/Scientific Name	Federal/ State Status	California Rare Plant Rank (RPR)	Blooming Period/ Fertile	Habitat	Likelihood for Occurrence
Ione buckwheat Eriogonum apricum var. apricum	FE/CE	1B.1	July – October	Chaparral in openings and on Ione soil from El. 195–475 feet msl.	**May potentially occur in suitable chapparal habitat**. There are no records of this species in the FERC boundary. The Project vicinity is within the elevation range and contains suitable habitat for this species. The nearest known population is from 1983 approximately 2 miles north of the FERC Project boundary (CNDDB 2025).
Irish Hill buckwheat Eriogonum apricum var. prostratum	FE/CE	1B.1	June – July	Chaparral in openings and on Ione soil from El. 295–395 feet msl.	**May potentially occur in suitable chaparral habitat**. There are no records of this species in the FERC boundary. The Project vicinity is within the elevation range and contains suitable habitat for this species.
Boggs Lake hedge-hyssop Gratiola heterosepala	—/CE	1B.2	April – August	Marshes, swamps (lake margins), and vernal pools in clay from El. 35–7,790 feet msl.	**May potentially occur in suitable wetland and vernal pool habitat**. There are no records of this species in the FERC boundary. The Project vicinity is within the elevation range and contains suitable habitat for this species. The nearest known population of this species is from 1990 approximately 2 miles northeast of the FERC Project boundary (CNDDB 2025).

Common/Scientific Name	Federal/ State Status	California Rare Plant Rank (RPR)	Blooming Period/ Fertile	Habitat	Likelihood for Occurrence
Sacramento Orcutt grass Orcuttia viscida	FE/CE	1B.1	April -July (September)	Vernal pools from El. 100–300 feet msl.	**May potentially occur in suitable vernal pool habitat**. There are no records of this species in the FERC boundary. The Project vicinity is within the elevation range and contains suitable habitat for this species. The nearest known population of this species is from 2023 approximately 5 miles northwest of the FERC Project boundary (CNDDB 2025).
Unlikely to Occur					
Delta button-celery Eryngium racem*osum*	—/CE	1B.1	(May) June – October	Riparian scrub in vernally mesic clay depressions from El. 10–100 feet msl.	**Unlikely to occur**. The FERC Project boundary is outside the elevation range of this species.

Federal Status: FE = federally endangered, FT = federally threatened

State Status: CE = California endangered

CRPR: 1B = Rare, threatened or endangered in California and elsewhere, 2B = Rare in California but more common elsewhere, 4 = Plants of limited distribution – a watchlist, _.1 = Seriously threatened in California (over 80 percent of occurrences threatened/high degree and immediacy of threat), _.2 = Moderately threatened in California (20 to 80 percent occurrences threatened), _.3 = Not very threatened in California (< 20 percent of occurrences threatened or no current threats known), CBR = Considered but rejected

4.7.3.1 IONE MANZANITA – KNOWN TO OCCUR

Ione manzanita (FT) is known to occur in the FERC Project boundary between the north shores of Camanche and Pardee reservoirs (CNDDB 2025). Refer to Volume V, Figure V-1, for a map of the location of populations in relation to the FERC Project boundary.

Ione manzanita is an evergreen shrub in the Ericaceae family and lacks a basal burl. Ione manzanita is typically less than 4 feet tall and has a low, spreading appearance. The bark is red, smooth, and waxy, and leaves are olive green. Flowers are white or pinkish and bloom between January and February. This species requires periodic fire events to germinate (USFWS 1999). This species is found in chaparral and cismontane woodland on acidic, clay, and sandy soils between El. 195 to 1,905 feet msl.

USFWS has not designated Critical Habitat, and there is no recovery plan for this species.

4.7.3.2 FLESHY OWL'S-CLOVER – MAY POTENTIALLY OCCUR

Fleshy owl's-clover (*Castilleja campestris* ssp. *succulenta*) (FT, CE) may potentially occur in the FERC Project boundary. Fleshy owl's-clover is a partly parasitic annual belonging to the Orobanchaceae family. The plant is generally 2 to 10 inches tall with brittle, fleshy alternative leaves (USFWS 1997). This subspecies has a dense inflorescence of yellow to white flowers and blooms between April and May (sometimes March). This species mostly grows in acidic vernal pools between El. 165 and 2,460 feet msl.

USFWS has designated Critical Habitat for this species (USFWS 2006). There is no Critical Habitat for this species within the FERC Project boundary. The closest Critical Habitat Unit (SUCCL 1) is approximately 7 miles west of Camanche Reservoir.

Fleshy owl's-clover is covered under a general USFWS recovery plan entitled Recovery Plan for Vernal Pool Ecosystems in California and Oregon (USFWS 2005a). The FERC Project boundary is within the Southern Sierra Foothills Vernal Pool Region. Recovery criteria in the Recovery Plan are not species-specific but include the following general goals:

- Achieve and protect in perpetuity self-sustaining populations throughout the full ecological, geographical, and genetic range by ameliorating or eliminating the threats that caused the species to be listed.
- Stabilize and protect populations so further decline in species status and range are prevented.
- Conduct research necessary to refine reclassification (i.e., downlisting and recovery criteria).

4.7.3.3 IONE BUCKWHEAT – MAY POTENTIALLY OCCUR

Ione buckwheat (*Eriogonum apricum* var. *apricum*) (FE, CE) may potentially occur in the FERC Project boundary. Ione buckwheat is a perennial herb in the Polygonaceae family. Ione buckwheat lacks hairs on the stems and grows to a height of 3 to 8 inches (USFWS 1999). Leaves are basal, and the flower calyx is white with reddish midribs. This subspecies blooms between July and October. This subspecies grows in chaparral openings on Ione soils between El. 195 and 475 feet msl.

USFWS has not designated Critical Habitat, and there is no recovery plan for this species.

4.7.3.4 IRISH HILL BUCKWHEAT – MAY POTENTIALLY OCCUR

Irish Hill buckwheat (*Eriogonum apricum* var. *prostratum*) (FE, CE) may potentially occur in the FERC Project boundary. Irish Hill buckwheat is a perennial herb in the Polygonaceae family. Irish Hill buckwheat has smaller leaves and a more prostrate growth form than Ione buckwheat (USFWS 1999). Leaves are basal, and the flower calyx is white with reddish midribs. This subspecies blooms between June and July. This subspecies grows in chaparral openings on Ione soils between El. 295 and 395 feet msl.

USFWS has not designated Critical Habitat, and there is no recovery plan for this species.

4.7.3.5 BOGGS LAKE HEDGE-HYSSOP – MAY POTENTIALLY OCCUR

Boggs Lake hedge-hyssop (*Gratiola heterosepala*) (CE) may potentially occur in the FERC Project boundary. Boggs Lake hedge-hyssop grows in the Central Valley, inner north coast range, Sierra Nevada foothills, and Modoc Plateau in California. The species is restricted to clay soils in or near shallow water such as the margins of lakes and vernal pools (CDFW 2025a). Small yellow flowers bloom in April through August.

Boggs Lake hedge-hyssop is covered under a general recovery plan entitled *Recovery Plan for Vernal Pool Ecosystems in California and Oregon* (USFWS 2005a). The FERC Project boundary is within the Southern Sierra Foothills Vernal Pool Region. Recovery criteria are the same as described for fleshy owl's-clover.

4.7.3.6 SACRAMENTO ORCUTT GRASS – MAY POTENTIALLY OCCUR

Sacramento Orcutt grass (*Orcuttia viscida*) (FE, CE) may potentially occur in the FERC Project boundary. Sacramento Orcutt grass is a densely tufted annual grass that reaches 1 to 4 inches in height. The plants are sticky. Sacramento Orcutt grass grows in vernal pools between El. 100 and 300 feet msl.

USFWS has designated Critical Habitat for this species (USFWS 2006). There is no Critical Habitat for this species within the FERC Project boundary. The closest Critical Habitat Unit (SACRA 3) is approximately 6 miles northwest of Camanche Reservoir.

Sacramento Orcutt grass is covered under a general recovery plan entitled *Recovery Plan for Vernal Pool Ecosystems in California and Oregon* (USFWS 2005a). The FERC Project boundary is within the Southern Sierra Foothills Vernal Pool Region. Recovery criteria are the same as described for fleshy owl's-clover (see Section 4.7.3.2 above).

4.7.4 RARE, THREATENED, AND ENDANGERED WILDLIFE

This section describes rare, threatened, and endangered wildlife species that occur or may potentially occur in the Project vicinity. Detailed information on listed fish species is addressed in Section 4.4, *Fish and Aquatic Species*.

A comprehensive list of rare, threatened, and endangered wildlife species was compiled from the following sources:

- USFWS IPaC website (USFWS 2025a);
- CDFW's CNDDB (CNDDB 2025); and
- CDFW's *State and Federally Listed Endangered and Threatened Animals of California* (CDFW 2025c).

This comprehensive list was then evaluated to determine which wildlife species are known to occur or may potentially occur in the vicinity of the Project based on a review of the maps and descriptions of CWHR habitats described in Section 4.5, *Wildlife and Botanical Resources*.

The geographic location, elevation of the Project, and habitat features present were then reviewed to determine those species that may potentially occur.

- **Known to occur:** Wildlife species with recorded populations in the FERC Project boundary, as determined by CNDDB or EBMUD data.
- **May potentially occur:** Wildlife species that may potentially occur in the vicinity of the Project based on CNDDB/CNPS occurrence data, the geographic location and elevation of the Project, and habitat features present.
- **Unlikely to occur in the vicinity of the Project:** Wildlife species that are unlikely to occur because their range does not overlap the Project; or for which the vicinity of the Project does not support appropriate habitat.

Table 4.7-2 provides a comprehensive list of rare, threatened, and endangered wildlife species evaluated for their potential to occur in the vicinity of the Project. Table 4.7-2 also summarizes pertinent information for each species, including status and preferred habitat, with information on the location of occurrences, if applicable.

Thirteen rare, threatened, and endangered wildlife species are known to occur in the FERC Project boundary. These include the following species:

- Invertebrates:
    - Crotch bumble bee (*Bombus crotchii*) (CCE)
    - Monarch butterfly (*Danaus plexippus*) (FPT)
    - Valley elderberry longhorn beetle (FT)
- Fish (refer to Section 4.4, *Fish and Aquatic Resources*, for more detailed information):
    - Steelhead – Central Valley DPS (*Oncorhynchus mykiss irideus*) (FT)
- Amphibians:
    - California tiger salamander – Central California DPS (FT, CT)
    - Western spadefoot – Northern DPS (*Spea hammondii*) (FPT)
- Reptiles:
    - Northwestern pond turtle (*Actinemys marmorata*) (FPT)
- Birds:
    - Golden eagle (Eagle Act, CFP)
    - Swainson's hawk (CT)
    - Bald eagle (FD, Eagle Act, CE, CFP)
    - Burrowing owl (CCE) – wintering populations only
    - Tricolored blackbird (*Agelaius tricolor*) (CT)
- Mammals:
    - Ringtail (Bassariscus astutus) (CFP)

Refer to Volume V, Figure V-2, for the location of suitable habitat (i.e., elderberry shrubs) for valley elderberry longhorn beetle. Refer to Volume V, Figure V-3, for the location of known occurrences of rare, threatened, and endangered amphibians and reptiles in the Project vicinity. Refer to Volume V, Figure V-4, for the location of USFWS-designated Critical Habitat for rare, threatened, and endangered species in relation to the FERC Project boundary. Refer to Volume V, Figure V-5, for the location of rare, threatened, and endangered birds in the Project vicinity.

Seven species have not been documented in the FERC Project boundary but have the potential to occur based on CNDDB records in the Project vicinity, geographic location, elevation of the Project, and habitat features present.

Life history information for rare, threatened, and endangered wildlife species known to occur or potentially occurring in the vicinity of the Project, including the location of USFWS-designated Critical Habitat and applicable recovery plans, is provided below.

Table 4.7-2. Rare, threatened, and endangered wildlife species with potential to occur in the Project vicinity.

Species Common Name/ Scientific Name	Federal Status	State Status	Habitat Description	Likelihood for Occurrence
Known to Occur in the Project Vicinity[a]				
Invertebrates				
Crotch bumble bee Bombus crotchii	—	CCE	Found throughout central California in grasslands and shrublands. Requires a variety of floral resources for foraging and nests underground. Overwinters in soft soil or in leaf litter/debris (CDFW 2019).	Known to occur in the FERC Project boundary. There is a record of this species near Camanche North Shore Campground and Mokelumne Hill within the FERC Project boundary (iNaturalist 2025). There is one additional occurrence approximately 1.25 miles southeast of the FERC Project boundary near Pardee Reservoir (CNDDB 2025).
Monarch butterfly Danaus plexippus	FPT	—	Overwintering population in coastal California. In late February or March, monarchs will disperse from wintering areas to interior California. Quality habitat includes milkweed (*Asclepias* spp.), which occur in short and tall grass prairies, livestock pastures, agricultural margins, roadsides, wetland and riparian areas, sandy areas, gardens, open forests, and woodlands.	Known to occur in the FERC Project boundary. There are several occurrences recorded within the FERC Project boundary (iNaturalist 2025).
Valley elderberry longhorn beetle Desmocerus californicus dimorphus	FT	—	Elderberry shrubs throughout the Central Valley and foothills below El. 3,000 feet msl (USFWS 2014).	Known to occur in the FERC Project boundary. There are 804 known elderberry shrubs that have been recorded in the FERC Project boundary (EBMUD 2025c). This species has been observed at the Mokelumne River Day Use Area during past habitat surveys (EBMUD 2025c). The nearest population recorded in CNDDB is from 1991 and is located approximately 2 miles west of the FERC Project boundary (CNDDB 2025). There is designated Critical Habitat for this species. There is no designated Critical Habitat in the FERC Project boundary (USFWS 1980).
Fish				
Steelhead – Central Valley DPS Oncorhynchus mykiss irideus	FT	SSC	Found in the Sacramento and San Joaquin rivers and their tributary streams. Found in streams with deep, low-velocity pools and tolerant of a wide variety of temperatures.	Known to occur. Steelhead are routinely observed in the Mokelumne River downstream of Camanche Dam (EBMUD 2025c). Refer to Section 4.4, *Fish and Aquatic Resources*, for more detailed information on steelhead in the Project vicinity.

Species Common Name/ Scientific Name	Federal Status	State Status	Habitat Description	Likelihood for Occurrence
Amphibians				
California tiger salamander – Central California DPS Ambystoma californiense	FT	CT	Adults are found in grassland or open woodland habitats within rodent burrows for most of the year. Breeds in freshwater shallow ephemeral, semi-permanent, or permanent ponds and vernal pools.	Known to occur. EBMUD conducts annual surveys for sensitive amphibians in all suitable aquatic habitats as defined under their SHA (EBMUD and USFWS 2009). These surveys have been conducted since 2009. There are 13 known breeding ponds within the FERC Project boundary, all in areas surrounding Camanche Reservoir (EBMUD 2025c). California tiger salamander has also been observed incidentally within the FERC Project boundary. There are six additional CNDDB occurrences of this species within 5 miles of the FERC Project boundary (CNDDB 2025). These observations were made between 1974 and 2019. There is no designated Critical Habitat within the FERC Project boundary, but Critical Habitat is located within 1 mile. The nearest Critical Habitat Unit (CV-4) is just outside the FERC Project boundary to the northwest of Camanche Reservoir (USFWS 2005b).
Western spadefoot – Northern DPS Spea hammondii	FPT	SSC	Prefers open areas with sandy or gravelly soils, in a variety of habitats such as mixed woodlands, grasslands, coastal sage scrub, chaparral, sandy washes, lowlands, river floodplains, alluvial fans, playas, alkali flats, and mountains. Requires ephemeral rain pools without non-native predators for breeding. Up to El. 4,500 feet msl in the southern Sierra Foothills.	Known to occur. EBMUD conducts annual surveys for sensitive amphibians in all suitable aquatic habitats as defined under their SHA (EBMUD and USFWS 2009). These surveys have been conducted since 2009, and EBMUD records spadefoot observations during these surveys. Observations have been recorded at five ponds (EBMUD 2025c). There are six known CNDDB occurrences within the FERC Project boundary (CNDDB 2025).
Reptiles				
Northwestern pond turtle Actinemys marmorata	FPT	SSC	Occurs in perennial wetlands and slow-moving creeks and ponds that are at least 1.6 feet deep and support overhanging vegetation and rock outcrops or floating debris for basking from a maximum EL of 6,000 feet msl. Nesting habitat includes upland grasslands or open areas in woodlands and forested areas with good sun exposure, within an average of 150 feet from aquatic habitats.	Known to occur. EBMUD has recorded 17 incidental observations of this species in Pardee and Camanche reservoirs (EBMUD 2025c). Project reservoirs and stream segments contain suitable aquatic foraging habitat for this species. Suitable upland habitat is found in grassland and woodland habitats surrounding the reservoirs. There is one additional CNDDB occurrence from 2008 known within 1 mile of the FERC Project boundary (CNDDB 2025). Refer to Section 4.4, Fish and Aquatic Resources, for more detailed information on northwestern pond turtle in the Project vicinity.
Birds				
Golden eagle Aquila chrysaetos	Eagle Act	CFP	Grasslands and early successional stages of forest and shrub habitats for foraging at elevations up to El. 11,500 feet msl. Secluded cliffs with overhanging ledges or large trees in open areas with unobstructed view for nesting.	**Known to occur.** EBMUD conducts routine nesting bird surveys in the Project vicinity. There is one known nesting location from 2025 within the FERC Project boundary along the south shoreline of Pardee Reservoir (EBMUD 2025c). A historic nest is also known near Patties point upstream on Pardee Reservoir (EBMUD 2025c). Suitable nesting and foraging habitat is present in the Project vicinity.
Swainson's hawk Buteo swainsoni	—	CT	Uncommon breeding resident and migrant in the Central Valley, Klamath Basin, Northeastern Plateau, Lassen County, and Mojave Desert. Breeding habitat includes riparian woodland and trees adjacent to riparian systems. Riparian woodlands, juniper-sage flats, and oak woodlands for nesting. Open grasslands, pastures, and agricultural areas for foraging.	Known to occur. EBMUD conducts routine nesting bird surveys in the Project vicinity. There are three known nesting locations from 2025 within or adjacent to the FERC Project boundary north of Camanche Reservoir (EBMUD 2025c). There is also one historic Swainson's hawk nest near Camanche Dam that was recorded from the early 2000s (EBMUD 2025c). There are three additional occurrences of this species within 1 mile of the FERC Project boundary spanning between 2000 and 2003. Suitable nesting and foraging habitat is present in the Project vicinity.

Species Common Name/ Scientific Name	Federal Status	State Status	Habitat Description	Likelihood for Occurrence
Bald eagle Haliaeetus leucocephalus	FD, Eagle Act	CE, CFP	Year-round resident in ice-free regions of California. Foraging areas include regulated and unregulated rivers, reservoirs, lakes, estuaries, and coastal marine ecosystems. Majority of bald eagles in California breed near reservoirs, and nests are usually located within 1 mile of foraging habitat. Nests are typically placed in the branches of large conifer trees within dense stands of trees (Jackman and Jenkins 2004).	Known to occur. There are 10 active nesting locations from 2025 within the FERC Project boundary (EBMUD 2025c). Seven of the nesting locations are near Camanche Reservoir, and three are near Pardee Reservoir. Suitable nesting and foraging habitat is present in the Project vicinity.
Burrowing owl Athene cuniculata	BCC	CCE, SSC	Breeding habitat includes rodent burrows in sparse grassland, desert, and agricultural habitats. They require open, sparsely vegetated areas on mostly level terrain with an abundance of active small mammal burrows. Found in lowlands throughout California.	Known to winter in suitable habitats. EBMUD conducts routine surveys for this species as part of the Routine Maintenance Agreement with CDFW. Burrowing owls have been observed wintering near Camanche Hills Hunting Preserve and at the Campo Seco staging area (EBMUD 2025c). EBMUD has also recorded observations of this species along the aqueduct (a non-Project facility) approximately 2.5 miles south of the FERC Project boundary (EBMUD 2025c). Suitable nesting and foraging habitat is present in the Project vicinity. The nearest CNDDB observation is approximately 4 miles northwest of the FERC Project boundary (CNDDB 2025).
Tricolored blackbird Agelaius tricolor	BCC	CT, SSC	Highly colonial species, most numerous in the Central Valley and vicinity. Largely endemic to California. Requires open water, protected nesting substrate, and a foraging area with insect prey within three miles of the colony.	Known to occur. There is one known nesting occurrence from 2025 in a pond north of Pardee Reservoir within the FERC Project boundary (EBMUD 2025c). Another breeding observation from 2015 has been recorded south of Camanche Reservoir within the FERC Project boundary (CNDDB 2025).
Mammals				
Ringtail Bassariscus astutus	—	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.	Known to occur. This species has been observed in the FERC Project boundary by EBMUD biologists (EBMUD 2025c). Suitable denning and foraging habitat is present in the Project vicinity.

Species Common Name/ Scientific Name	Federal Status	State Status	Habitat Description	Likelihood for Occurrence
May Potentially Occur in the Project Vicinity[a]				
Invertebrates				
Vernal pool fairy shrimp Branchinecta lynchi	FT	—	Vernal pool ecosystems that hold water for a minimum of 18 days, but not permanently flooded emergent wetlands.	**May potentially occur in suitable vernal pool habitat**. There are no known occurrences of vernal pool fairy shrimp within the FERC Project boundary, but suitable habitat is present. There are two occurrences within 5 miles of the FERC Project boundary (CNDDB 2025). There is designated Critical Habitat for this species. There is no designated Critical Habitat in the FERC Project boundary (USFWS 2006).
Vernal pool tadpole shrimp Lepidurus packardi	FE	—	Vernal pools in the Central Valley containing clear to highly turbid water.	**May potentially occur in suitable vernal pool habitat**. There are no known occurrences of vernal pool tadpole shrimp within the FERC Project boundary, but suitable habitat is present. There is one occurrence within 5 miles of the FERC Project boundary (CNDDB 2025). There is designated Critical Habitat for this species. There is no designated Critical Habitat in the FERC Project boundary (USFWS 2006).
Western bumble bee Bombus occidentalis	—	CCE	The historical range of the western bumble bee includes most of western North America. This species is dependent on continuous access to meadows and grasslands with floral resources from spring through late summer within 0.3 to 0.5 mile of burrowing nests.	**May potentially occur in suitable habitats**. There are no known occurrences within 5 miles of the FERC Project boundary.
Reptiles				
Giant garter snake Thamnophis gigas	FT	CT	Uses a wide variety of habitats within the Californian Central Valley including forests, mixed woodlands, grasslands, chaparrals, and agricultural lands. Often occurs near aquatic habitat including ponds, marshes, and streams where it freely retreats when alarmed.	**May potentially occur in suitable habitats.** There are no known occurrences of this species within 5 miles of the FERC Project boundary. Suitable habitat is likely restricted to the Mokelumne River downstream of Camanche Dam. There is a 1974 occurrence of giant garter snake on the Mokelumne River below Camanche Dam near the town of Thornton (CNDDB 2025).
Birds				
White-tailed kite Elanus leucurus	—	CFP	Rolling foothills and valley margins with scattered oaks; river bottomlands or marshes next to deciduous woodland. Open grasslands, meadows, or marshes for foraging close to isolated, dense-topped trees for nesting and perching.	May potentially occur in suitable habitats. Suitable habitat is present within the FERC Project boundary. Incidental observations of this species have been recorded in the Project vicinity (EBMUD 2025c).
Willow flycatcher Empidonax traillii	—	CE	Summer resident in wet meadow and montane riparian habitats at El. 2,000 to 8,000 feet msl in the Sierra Nevada. Most often occurs in broad, open river valleys or large mountain meadows with lush growth of shrubby willows. Requires meadows at least 1 acre in size for breeding, prefers meadows larger than 10 acres (Green et al. 2003).	May potentially occur as a migrant. The Project is outside of the species nesting geographic range and does not contain suitable nesting habitat. This species has been observed in the FERC Project boundary (EBMUD 2025c), but the species is unlikely to breed in the Project vicinity.

Species Common Name/ Scientific Name	Federal Status	State Status	Habitat Description	Likelihood for Occurrence
Bank swallow Riparia riparia	—	CT	Colonial nester; nests primarily in riparian and other lowland habitats, most often along the banks of the Sacramento and Feather rivers in the northern Central Valley. Requires vertical banks/cliffs with fine-grained/sandy soils near streams, rivers, lakes, or the ocean to dig nesting hole.	May potentially occur in suitable habitat. There are no known nesting colonies within the FERC Project boundary (EBMUD 2025c), but suitable habitat is present. There is one nest record from 2009 along the Mokelumne River below Camanche Dam approximately 2 miles west of the FERC Project boundary (CNDDB 2025).
Unlikely to Occur				
Fish				
Delta smelt Hypomesus transpacificus	FT	CE	Breeds in estuaries, river channels, and tidally influenced backwaters in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties.	Unlikely to occur. Known to occur in the Mokelumne River downstream of the Project, below the WIDD facility. Project-affected reaches do not contain suitable habitat for this species (refer to Section 4.4, *Fish and Aquatic Resources*).
Amphibians				
Foothill yellow-legged frog – South Sierra DPS Rana boylii	FE	CE	Inhabits perennial rocky (pebble or cobble) streams with cool, clear water in a variety of habitats from valley and foothill oak woodland, riparian forest, ponderosa pine, mixed conifer, coastal scrub, and mixed chaparral up to El. 4,500 feet msl.	Unlikely to occur. The nearest known occurrence is approximately 1 mile north of the FERC Project boundary upstream of Pardee Reservoir, but this population is considered extirpated by the CNDDB (CNDDB 2025). There is no proposed Critical Habitat within the FERC Project boundary (USFWS 2025a). The nearest Critical Habitat Unit (SS-4) is approximately 18 miles upstream of the FERC Project boundary on the North Fork Mokelumne River. Refer to Section 4.4, *Fish and Aquatic Resources*, for more detailed information on foothill yellow-legged frog in the Project vicinity.
California red-legged frog Rana draytonii	FT	SSC	Breeding habitat includes aquatic areas with dense, shrubby, or emergent riparian vegetation and a permanent source of deep (greater than 2.33 feet deep) still or slow-moving water. Upland dispersal habitat includes areas within 1 mile of aquatic breeding habitat with no impassable dispersal barriers (suburban areas, suburban developments, wide or fast flowing rivers or streams, lakes greater than 50 acres, and heavily traveled roads without underpasses or culverts).	Unlikely to occur. EBMUD conducts annual surveys for sensitive amphibians in all suitable aquatic habitats as defined under their SHA (EBMUD and USFWS 2009). Surveys include biweekly night surveys at ponds and streams from January through April of each year. These surveys have been conducted since 2009. While suitable habitat is present, EBMUD has never observed California red-legged frog in these surveys. There is one CNDDB occurrence southeast of the FERC Project boundary from 2023 (CNDDB 2025). There is no designated Critical Habitat within the FERC Project boundary (USFWS 2006). The nearest Critical Habitat Unit (CAL-1) is located approximately 0.5 mile south of the FERC Project boundary near Pardee Reservoir.
Birds				
Great gray owl Strix nebulosa	—	CE	Nests in old-growth coniferous forests and forages in montane meadows. Distribution includes high elevations of the Sierra Nevada and Cascade ranges, from El. 4,500 to 7,500 feet msl.	Unlikely to occur. The Project area does not contain suitable meadow habitat, and the FERC Project boundary is outside the typical elevation range of this species. There are no known occurrences within 5 miles of the FERC Project boundary (CNDDB 2025).
California spotted owl – Sierra Nevada DPS Strix occidentalis occidentalis	BCC, FPT	SSC	Dense, old-growth, multi-layered mixed conifer, redwood, Douglas-fir, and oak woodland habitats in the western slope of the Sierra Nevada, from sea level to elevations of approximately El. 7,600 feet msl.	Unlikely to occur. Dense, old-growth forest habitat is sparsely distributed in the FERC Project boundary. There are no known occurrences within 5 miles of the FERC Project boundary (CNDDB 2025).

Species Common Name/ Scientific Name	Federal Status	State Status	Habitat Description	Likelihood for Occurrence
Belding's savannah sparrow Passerculus sandwichensis beldingi	BCC	CE	A rare subspecies of savannah sparrow. Found on marshes in the San Diego Bay and nests in pickleweed salt marsh vegetation along the outer levees of salt ponds.	Unlikely to occur. The Project area is outside the geographic range and does not contain suitable habitat for this subspecies.

Federal Status: BCC = Bird of Conservation Concern, FC = Federal Candidate Species, FE = Federal Endangered, FT = Federal Threatened, FPD = Federal Proposed for Delisting, FPT, FPE = Federal Proposed Threatened/Endangered

State Status: CFP = California Fully Protected, CCT, CCE = State Candidate Threatened/Endangered, CE = California Endangered, CT = California Threatened, SSC = California Species of Special Concern, WL = Watch List

Notes:

[a] Vicinity of the Project is defined to include areas within 1 mile of the FERC Project boundary.

4.7.4.1 INVERTEBRATES

The following sections contain life history information for rare, threatened, and endangered invertebrates that are known to occur or may potentially occur in the Project vicinity.

Crotch Bumble Bee – Known to Occur

This species has been recorded near Camanche North Shore Campground and Mokelumne Hill within the FERC Project boundary (iNaturalist 2025).

The Crotch bumble bee (CCE) can be distinguished from other bumble bee species based on hair coloration. The hair of the face is black with a yellow top of the head, with yellow hair also on the front part of the thorax and with yellow or orange rings on the abdomen (Xerces Society 2018). The Crotch bumble bee typically inhabits open grasslands, scrublands, and adjacent foothills. Nest sites for this species have not been well documented, but *Bombus* species primarily nest underground. The preferred food sources for the Crotch bumble bee include plants in the genera *Asclepias*, *Chaenactis*, *Lupinus*, *Medicago*, *Phacelia*, and *Salvia,* but it most likely forages on the most abundant floral resources available (Xerces Society 2018). This species likely overwinters in soft, disturbed soil or leaf litter, similar to other *Bombus* species. Activity is highest between late February to late October (Xerces Society 2018).

Monarch Butterfly – Known to Occur

There are several occurrences recorded within the FERC Project boundary (iNaturalist 2025).

The monarch butterfly (FPT) has a western and eastern population in the United States and is a long-distance migrator in its North American range. The western population of monarch butterflies occupies breeding habitats during spring and summer months. At the end of the summer, monarchs migrate to overwintering sites located in coastal California and Mexico. In the Sierra Nevada, the western migration begins as early as late July or August, but some breeding can occur in autumn (UC Davis 2025).

Monarch butterflies lay their eggs on obligate milkweed (*Asclepias* spp.) host plants, and larvae emerge after 2 to 5 days. Larvae develop over a period of 9 to 18 days, feeding on the milkweed host and sequestering toxic cardenolides, which they use as a defense against predators. After reaching an appropriate size, the larvae pupate into a chrysalis before emerging 6 to 14 days later as an adult butterfly. Multiple generations of monarchs are produced during the breeding season, and adults live approximately 2 to 5 weeks. In

the arid western North America, milkweeds are often associated with riparian corridors that have higher abundances of floral resources.

Critical Habitat has been proposed for monarch butterfly for coastal wintering sites along the central and southern California coasts (USFWS 2024a). There is no proposed Critical Habitat in the Project vicinity.

Valley Elderberry Longhorn Beetle – Known to Occur

The valley elderberry longhorn beetle was listed as FT by the USFWS in 1980 (USFWS 1980). This species is completely dependent on its host plant, elderberry (*Sambucus* spp.), and is associated with various species of elderberry up to El. 3,000 feet msl. Valley elderberry longhorn beetles generally occur along waterways and in floodplains that support remnant stands or riparian vegetation.

Every 3 years, EBMUD fisheries and wildlife staff survey the FERC Project boundary for the presence of elderberry shrubs (*Sambucus* spp.). The objective of the survey is to obtain Global Positioning System (GPS) coordinates of each elderberry shrub visible from EBMUD roads, trails, and reservoirs and to collect data on each shrub such as condition, size, and whether exit holes exist. These efforts are used to support the required annual monitoring for EBMUD's SHA with the USFWS (EBMUD and USFWS 2009). EBMUD must maintain or exceed the number of baselines elderberry shrubs agreed upon for the duration of the agreement.

The Project area contains 804 suitable elderberry shrub habitats for this species (EBMUD 2025c), and it has been historically observed by EBMUD biologists in the Lower Mokelumne Day Use Area.

USFWS (1980) has designated Critical Habitat for this species. There is no Critical Habitat in the FERC Project boundary. USFWS has developed a Revised Recovery Plan for the valley elderberry longhorn beetle (USFWS 2019). Recovery objectives for this species include the following:

- Preserving resilient populations across the historic range but maintaining occupancy in at least 80 percent of the subbasins where this species is known to occur.
- Protecting and managing a system of connected habitat patches along each river or drainage within each subbasin where the species is known to occur.

Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp – May Potentially Occur

Vernal pool fairy shrimp (*Branchinecta lynchi*) (FT) are small freshwater crustaceans that are only found in vernal pools that hold water during the winter/early spring rainfall cycle. These vernal pools are typically found in depressions above an impervious soil layer, and pools are often found in an undulating landscape with interspersed soil mounds, basins, swales, and drainages that allow this species to move between individual pools (USFWS 2005a). The species is known from a wide range of vernal pool habitats in southern and Central Valley areas of California, and two vernal pool habitats in Jackson County, Oregon (USFWS 2006). Vernal pool fairy shrimp eggs (or cysts) remain dormant in the soil when vernal pool habitats are dry. The species has a short lifespan, enabling it to hatch, mature, and reproduce during the short time period when vernal pools contain water. Vernal pool habitats must contain water for a minimum of 18 days, but more typically up to 39 days for the species to complete its life cycle (Helm 1998). Vernal pool fairy shrimp are often found in the same vernal pool systems as other rare, threatened, and endangered vernal pool plant and animal species (USFWS 2005a).

Vernal pool tadpole shrimp (*Lepidurus packardi*) (FT) are small, freshwater crustaceans that are distinguished by a large, shield-like carapace that covers half of their body. Mature vernal pool tadpole shrimp are between 0.6 to 3.3 inches in length (USFWS 2005a). Vernal pool tadpole shrimp are currently distributed in the Central Valley of California and in the San Francisco Bay area (USFWS 2005a). Vernal pool tadpole shrimp have a relatively long lifespan compared to other vernal pool crustaceans. Vernal pool tadpole shrimp take between 3 to 4 weeks to reach sexual maturity (King et al. 1996). Eggs lie dormant during the dry season but may be able to hatch during the dry season if wet conditions last long enough. Vernal pool tadpole shrimp can be found in more persistent vernal pool systems than vernal pool fairy shrimp, with some pools being inundated for up to 6 months (Helm 1998).

- The USFWS has designed Critical Habitat for these species (USFWS 2006), but there is no Critical Habitat in the FERC Project boundary. These species are covered under a general recovery plan entitled *Recovery Plan for Vernal Pool Ecosystems in California and Oregon* (USFWS 2005a). The FERC Project boundary is within the Southern Sierra Foothills Vernal Pool Region. Recovery criteria in the Recovery Plan are not species-specific, but include the following general goals:
- Achieve and protect in perpetuity self-sustaining populations throughout the full ecological, geographical, and genetic range by ameliorating or eliminating the threats that caused the species to be listed.
- Stabilize and protect populations so further decline in species status and range are prevented.

- Conduct research necessary to refine reclassification (i.e., downlisting and recovery criteria).

Western Bumble Bee – May Potentially Occur

The western bumble bee (*Bombus occidentalis*) (CCE) is found throughout the foothills and mountains of the western United States. It typically occupies open habitats such as grasslands and meadows that support rodent burrows and sufficiently large populations of flowering plants. The western bumble bee overwinters in the ground in abandoned rodent burrows and emerges around mid-March.

The Project area contains grassland habitats for this species, as well as other upland habitats such as shrublands and woodlands that may support floral resources. Therefore, this species may potentially occur in the FERC Project boundary.

4.7.4.2 FISH

Refer to Section 4.4, *Fish and Aquatic Resources*, for detailed information on the steelhead – Central Valley DPS (FT).

4.7.4.3 AMPHIBIANS

The following sections contain life history information for rare, threatened, and endangered amphibians that are known to occur or may potentially occur in the Project vicinity.

California Tiger Salamander – Known to Occur

The California tiger salamander (FT, CT) is a large, stocky, terrestrial salamander with whitish or yellowish markings against a black body. The Central California DPS is endemic to the San Joaquin and Sacramento River valleys, bordering foothills, and central valleys of Central California (USFWS 2017a). The species can be found from sea level to a maximum elevation of El. 1,640 feet msl in the Sierra Nevada foothills (Shaffer et al. 2013).

The California tiger salamander utilizes both aquatic and terrestrial habitats for its life cycle. Egg laying and larval development take place within vernal pools and ponds, but once metamorphs leave the natal ponds, they will spend most of their lifecycle in underground burrows (USFWS 2017a). Adults migrate overland to the breeding pools on rainy nights between November and April (USFWS 2017a), with average dispersal distances of 1,844 feet (0.35 mile) (Searcy and Shaffer 2011) and maximum recorded dispersal of 1.3 miles (Orloff 2007). Females lay eggs on vegetation or debris within the pool habitat. Larvae typically take 3 to 6 months to reach metamorphosis, and

metamorphs depart ponds at night in late spring or early summer (typically May to July). Adults typically breed only once or twice during their life cycle (Trenham et al. 2001). Breeding pools must be free of bullfrogs and non-native fish species (USFWS 2017a).

Terrestrial habitats include annual grasslands and open woodlands with abundant rodent burrows that create underground burrow systems (USFWS 2017a). Large tracts of upland habitats, with multiple breeding ponds, are necessary for this species to persist.

As part of their existing SHA (EBMUD and USFWS 2009), EBMUD monitors California tiger salamander breeding habitat and conducts surveys for this species. EBMUD fisheries and wildlife staff conduct larval dip-netting surveys for California tiger salamanders from March through May each year and also historically conducted pit trap surveys between October 15 and March 15 at four occupied breeding locations. Pit trapping efforts ended in 2022. There are 13 occupied breeding ponds in the FERC Project boundary near Camanche Reservoir, and California tiger salamander have also been incidentally observed within the FERC Project boundary (EBMUD 2025c). Refer to Figure V-3 in Volume V for the location of these observations.

USFWS has designated Critical Habitat for this Central Valley DPS of California tiger salamander (USFWS 2005b). There is no designated Critical Habitat for this species within the FERC Project boundary; however, Critical Habitat Unit CV-4 lies just outside of the FERC Project boundary to the northwest of Camanche Reservoir (USFWS 2005b) (refer to Figure V.4-4). USFWS has developed a Revised Recovery Plan for the California tiger salamander (USFWS 2017a). Recovery objectives for this species include the following:

- Secure self-sustaining populations of Central California tiger salamander throughout the full range of the DPS, ensuring conservation of native genetic variability and diverse habitat types (e.g., across elevation and precipitation gradients).
- Ameliorate or eliminate the threats that caused the species to be listed and any future threats.
- Restore and conserve a healthy ecosystem supportive of Central California tiger salamander populations.

Western Spadefoot – Known to Occur

The western spadefoot (FPT) ranges throughout the Central Valley and adjacent foothills and is usually quite common where it occurs. Elevations of occurrences extend from near sea level to El. 4,460 feet msl (1,363 meters) in the southern Sierra Foothills (Jennings and Hayes 1994). This species occurs primarily in grasslands, but occasional populations

also occur in valley foothill hardwood woodlands. Some populations persist for a few years in orchard or vineyard habitats. Grasslands with shallow temporary pools are optimal habitats for the western spadefoot.

Western spadefoot are mostly found in underground burrows up to 36 inches (0.9 meters) deep (Stebbins 1972). They can also find cover in drying mud cracks, under boards, and other surface objects including decomposing cow dung (Weintraub 1980).

Adult western spadefoots feed on worms and other invertebrates (Stebbins 1972). Tadpoles consume planktonic organisms and algae but are also carnivorous (Bragg 1964) and consume dead aquatic larvae of amphibians, including their own species.

Breeding and egg laying occur almost exclusively in shallow, temporary pools formed by heavy winter rains. Breeding is most common in vernal pools; however, other features such as pools in intermittent streams, artificial ponds, drainage ditches, or roadside pools may be used (USFWS 2023). Egg masses are attached to plant material or the upper surfaces of small, submerged rocks (Stebbins 1951).

This species has been incidentally observed at five ponds within the FERC Project boundary during surveys conducted for other amphibian species (EBMUD 2025c). Refer to Figure V.4-3 for the location of these observations.

Critical Habitat has not been proposed for this species. These species are covered under a general Recovery Plan entitled *Recovery Plan for Vernal Pool Ecosystems in California and Oregon* (USFWS 2005a). The FERC Project boundary is within the Southern Sierra Foothills Vernal Pool Region. Recovery criteria are the same as described under the Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp section above.

4.7.4.4 REPTILES

The following sections contain life history information for rare, threatened, and endangered reptiles that are known to occur or may potentially occur in the Project vicinity.

Northwestern Pond Turtle – Known to Occur

Refer to Section 4.4, *Fish and Aquatic Resources*, for detailed information on the northwestern pond turtle.

Giant Garter Snake – May Potentially Occur

The giant garter snake (*Thamnophis gigas*) (FT, CT) is the largest garter snake in California. This species is endemic to the wetlands of the Sacramento and San Joaquin

valleys of California and is associated with tule marshes and seasonal wetlands created by overbank flooding of rivers and streams. Giant garter snakes are currently found in fragmented wetland systems of marshes, ponds, small lakes, low-gradient streams with silt substrates, and managed waterways. Due to extensive agricultural development, giant garter snakes are now also found in irrigation ditches, drainage canals, rice fields, and adjacent uplands system (USFWS 2017b).

The three features that are critical to the giant garter snake are 1) freshwater aquatic habitat with emergent vegetation cover for foraging, 2) upland areas near aquatic habitat that can be used for basking and for summer sheltering in burrows, and 3) upland refugia that can serve as winter hibernacula. Aquatic habitats require water between March and November, slow-moving water flow with mud substrates, absence of continuous riparian vegetation canopy, abundant small amphibian and fish prey, suitable cover from predators, and no large predatory fish (USFWS 2017b). Upland habitats are used both as refugia during the summer and for hibernacula during the winter. Giant garter snakes are often found in burrows as far as 164 feet (50 meters) from the marsh edge (Wylie et al. 1997). Upland habitats require vegetative cover for basking and predator avoidance. Hibernacula sites include mammal burrows along canal banks and rocky riprap, and they can be found as far as 656 to 820 feet (200 to 250 meters) from the edge of aquatic habitats (Wylie et al. 1997, 2002).

USFWS has not designated Critical Habitat for this species. USFWS has developed a Revised Recovery Plan for the giant garter snake (USFWS 2017b). Recovery objectives for this species include the following:

- Establishing and protecting self-sustaining populations throughout the full ecological, geographical, and genetic range of the species.
- Restoring and conserving healthy Central Valley wetland ecosystems that function to support the species.
- Ameliorating or eliminating, to the extent possible, threats to the species and any foreseeable future threats.

4.7.4.5 BIRDS

The following sections contain life history information for rare, threatened, and endangered birds that are known to occur or may potentially occur in the Project vicinity.

Golden Eagle – Known to Occur

The golden eagle (Eagle Act, CFP) is an uncommon permanent resident and migrant throughout California, except in the center of Central Valley. This species is more common in southern California than in the north. The golden eagle ranges from sea level

up to El. 11,500 feet msl (3,833 meters) (Grinnell and Miller 1944). Their habitat typically includes rolling foothills, mountain areas, sage-juniper flats, and deserts.

This species eats mostly lagomorphs and rodents but will also take other mammals, birds, reptiles, and some carrion. The diet is most varied in nonbreeding season. This species requires open terrain for hunting, such as grasslands, deserts, savannahs, and early successional stages of forest and shrub habitats. This species soars 98 to 297 feet (30 to 90 meters) above ground in search of prey, or makes low, quartering flights, often 23 to 26 feet (7 to 8 meters) above ground. They occasionally search from a perch and fly directly to prey (Carnie 1954) and sometimes pirate food from other predators. It is common for golden eagles to hunt in pairs.

Golden eagles use secluded cliffs with overhanging ledges and large trees for cover. This species nests on cliffs of all heights and in large trees in open areas. Alternative nest sites are maintained, and old nests are reused. Golden eagles build large platform nests, often 10 feet (3 meters) across and 3 feet (1 meter) high, of sticks, twigs, and greenery. They use rugged, open habitats with canyons and escarpments most frequently for nesting. Golden eagles use rolling foothills and mountain terrain, wide arid plateaus deeply cut by streams and canyons, open mountain slopes, and cliffs and rock outcrops. This species breeds from late January through August, with a peak in March through July. Clutches the size of two to three eggs are laid in early February to mid-May. Incubation is 43 to 45 days (Beebe 1974), and the nestling period is usually 65 to 70 days.

There is one currently known nesting location within the FERC Project boundary along the south shoreline of Pardee Reservoir within the FERC Project boundary (EBMUD 2025c). Refer to Volume V, Figure V-5, for the location of this nest. A historic nest location is also known from Pattie's Point.

Swainson's Hawk – Known to Occur

The Swainson's hawk (CT) is a medium-sized raptor with long, pointed wings. The main identifying features of Swainson's hawk are the white throat and dark primary feathers contrasting with a lighter leading edge of the wing. Adult morphs can be light, rufous, or dark. Swainson's hawks are found in open grasslands, prairies, and agricultural landscapes in the Central Valley (CDFW 2016). The species is a long-distance migrant, breeding in California and wintering in Central and South America (Bechard et al. 2010).

Swainson's hawks are territorial and typically return to the same breeding territory, and egg laying initiates in late March to early April. The incubation period lasts 34 to 35 days (Bechard et al. 2010), and young typically fledge in approximately 6 weeks. Migration is

initiated in mid-August, and all Swainson's hawks are typically on the wintering grounds by October (Kochert et al. 2011). In the Central Valley, stick nests are typically constructed in trees on the edge of riparian forests or in riparian corridors. Nest sites are located near large open areas of suitable foraging habitat, which typically includes agricultural cropland (particularly irrigated crops such as hay), grassland, and pasture that provide abundant rodent and insect prey.

EBMUD conducts protocol-level surveys of Swainson's hawk nests in compliance with their Routine Maintenance Agreement. Once nests are identified, they are monitored biweekly until the nest is no longer active. There are three currently known nesting locations of this species within or adjacent to the FERC Project boundary north of Camanche Reservoir (EBMUD 2025c). Refer to Volume V, Figure V-5, for the locations of these nests. Another historic nest location has also been recorded near Camanche Dam (EBMUD 2025c).

Bald Eagle – Known to Occur

The bald eagle (FD, Eagle Act, CE, CFP) is a permanent resident, and winter migrant, and breeds across California, mostly on large reservoirs. The bald eagle was federally delisted from the ESA in 2007. About half of the wintering population is in the Klamath Basin. This species is more common at lower elevations and is typically not found in the high Sierra Nevada. Bald eagles are fairly common as a local winter migrant at a few favored inland waters in southern California. The largest numbers of bald eagles occur at Big Bear Lake, Cachuma Lake, Lake Mathews, Nacimiento Reservoir, San Antonio Reservoir, and along the Colorado River.

This species requires large bodies of water, or free flowing rivers with abundant fish, and adjacent snags or other perches. Bald eagles swoop from hunting perches, or soaring flight, to pluck fish and waterfowl from water. They will wade into shallow water to pursue fish. In flooded fields, bald eagles occasionally pounce on displaced voles, or other small mammals. Groups may feed gregariously, especially on spawning fish. This species scavenges dead fish, water birds, and mammals.

Bald eagles perch high in large, stoutly limbed trees, on snags or broken-topped trees, or on rocks near water. They roost communally in winter in dense, sheltered, remote conifer stands. In Klamath National Forest, winter roosts were 10 to 12 miles (16 to 19 kilometers) from feeding areas (Spencer 1976). This species nests in large, old-growth, or dominant live trees with open branch work, especially ponderosa pine. Their nests most frequently occur in stands with less than 40 percent canopy, but there is usually some foliage shading the nest (Call 1978). The nests are usually located in the largest

tree in a stand and located 50 to 200 feet (16 to 61 meters) above ground, usually below tree crown and near a permanent water source. Nests are typically within 1 mile of aquatic foraging habitat (Jackman and Jenkins 2004). The species of the tree is not so important as height and size. Bald eagles require large, old-growth trees or snags in remote, mixed stands near water.

EBMUD conducts annual raptor nesting surveys by boat at Camanche and Pardee reservoirs from February and then again biweekly until August. Bald eagle surveys are conducted annually in mid-January in cooperation with the US Fish and Wildlife Service since approximately 1985. Pardee and Camanche reservoirs are surveyed simultaneously by boat using a boat operator and observer. Observed raptors are also recorded during these surveys. Information collected includes the geolocation, age, sex (if possible), habitat, and activity. There are seven active bald eagle nests at Camanche Reservoir and three nests at Pardee Reservoir (EBMUD 2025c). Refer to Volume V, Figure V-5, for the locations of these nests.

Burrowing Owl – Known to Occur

The burrowing owl (CCE) is a small owl that is adapted to open and arid grassland, prairie, shrub steppe, and desert shrub habitats. Uniquely, this owl nests and roosts in underground burrows that are excavated by other burrowing animals, such as ground squirrels, coyotes, foxes, badgers, skunks, kangaroo rats, or tortoises. Burrowing owls will also sometimes use burrow surrogates such as culverts, concrete slab and rubble, concrete pipes, or artificial burrow structures (Center for Biological Diversity et al. 2024). Burrowing owls nearly always select burrows surrounded by low vegetative cover and height (Coulombe 1971). The best available science indicates that habitat should include year-round opportunities for breeding, foraging, wintering, and dispersal in landscapes covered by short or sparse vegetation with abundant burrows, well-drained soils, and prey availability (Center for Biological Diversity et al. 2024).

Burrowing owls often nest in loose colonies, and breeding typically occurs between February 1 and August 31. Male owls conduct courtship displays in front of the burrow to attract the female. Egg laying commences in March through May, and the incubation period lasts 29 days (Coulombe 1971). After the young hatch, the burrow becomes crowded, and juveniles often stand at the burrow entrances. Young typically fledge after 44 days (Haug et al. 1993). Adults may move young to satellite burrows at around 10 to 14 days to reduce risk of predation and parasites (Desmond and Savidge 1999; Dechant et al. 1999). Adults feed fledglings at the burrows for another 6 to 8 weeks after fledging. Young owls disperse to find their own burrows in September.

Burrowing owls typically forage at dawn, dusk, and at night, feeding on large insects and small rodents. Abundance of prey is highly correlated with nest success and reproduction (Wisinski et al. 2016).

EBMUD conducts burrowing owl nesting surveys in compliance with their Routine Maintenance Agreement with CDFW. Burrowing owl nests have never been observed within the FERC Project boundary. However, this species has been recorded as a winter migrant at the Camanche Hills Hunting Preserve and near the Campo Seco trailhead in the vicinity of Camanche Reservoir. Burrowing owls have also been observed approximately 2.5 miles south of the FERC Project boundary on adjacent EBMUD properties in open grassland areas (EBMUD 2025c).

Tricolored Blackbird – Known to Occur

The tricolored blackbird (CT) is a year-round resident in California and was listed as threatened under CESA in 2019. This species occurs throughout Central Valley and in coastal districts from Sonoma County south. Tricolored blackbirds breed near fresh water, preferably in emergent wetlands with tall, dense cattails or tules, but also in thickets of willow, blackberry, wild rose, and tall herbs. Nests are usually located a few feet over, or near, fresh water and may be hidden on ground among low vegetation. Tricolored blackbirds build nests of mud and plant materials. This species is highly colonial. The nesting area must be large enough to support a minimum colony of about 50 pairs (Grinnell and Miller 1944). Their breeding season is mid-April into late July.

This species feeds in grassland and cropland habitats and breeds locally in northeastern California. In winter, tricolored blackbird becomes more widespread along the central coast and San Francisco Bay area (Grinnell and Miller 1944; McCaskie et al. 1979) and is found in portions of the Colorado Desert. Its numbers appear to be declining in California (DeHaven et al. 1975).The tricolored blackbird diet consists of insects, spiders, seeds, and cultivated grains, such as rice and oats.

Tricolored blackbirds nest in dense cattails or tules, as well as thickets of willow, blackberry, wild rose, or tall herbs.

Tricolored blackbirds have been observed within the FERC Project boundary (EBMUD 2025c; CNDDB 2025). Refer to Figure V.4-5, for the locations of these observations.

White-tailed Kite – May Potentially Occur

The white-tailed kite (*Elanus leucurus*) (CFP) is a crow-sized raptor with a white head and tail and black shoulders. The eyes are bright red on adults and yellow brown on juveniles.

This species can be found throughout California but is typically found outside of dense forested habitats. White-tailed kites are most abundant west of the Sierra Nevada in lowlands and foothills. This species is known to utilize habitats at the edges and medians of freeways and developments and prefers marshy areas, grasslands, and oak savannas (Peeters and Peeters 2005). The species is often seen hovering (also called kiting).

White-tailed kites breed from February to October, with a peak in May to August. Incubation lasts for about 28 days, and the young fledge in 35 to 40 days. This species primarily feeds on voles (Waian and Stendell 1970) and forages within 0.5 mile of the nest site (Henry 1983).

White-tailed kites have been observed within the Project vicinity (EBMUD 2025c), though no nests have been observed.

Willow Flycatcher – May Potentially Occur

The willow flycatcher (*Empidonax traillii*) (CE) is a summer resident in California, present from late April to September in wet meadow as well as foothill and montane riparian habitats from El. 2,000 to 8,000 feet msl in the Sierra Nevada (Green et al. 2003). The willow flycatcher is distinguished from other similar flycatchers by its song and lack of an eye ring. It is about 6 inches long from the beak to the end of the tail. Its coloration is brownish olive above, with a whitish throat, pale olive breast, and pale-yellow belly. This active bird spends much of the day flying to and from exposed perches to capture flying insects. It nests on the edges of openings in dense willow thickets within wet meadows, usually within 7 feet of the ground. The willow flycatcher generally nests from June to August in riparian (riverside) sites that are moist, shrubby areas, often with standing or running water. Nests are most often in wet meadows at least 10 acres in size (Green et al. 2003), but nests have been recorded in meadows as small as 1 acre. Nests are generally close to the ground in the crotches of shrubs or small trees near water. Usually, three to four eggs are laid, and incubation is about 14 days. Generally, the female incubates the eggs. Both adults feed the young, and food primarily consists of insects. Foraging occurs in the air and among various kinds of vegetation.

Willow flycatchers have been observed on migration within the Project vicinity (EBMUD 2025c), though the FERC Project boundary does not contain suitable nesting habitat.

Bank Swallow – May Potentially Occur

The bank swallow (*Riparia riparia*) (CT) is a member of the swallow family and is distinguished from other swallows by its distinctive brown breast band that contrasts with a white belly. This species feeds on aerial insects and forages over riverine,

grassland, and cropland habitats. The bank swallow is a colonial nester that uses lowland riverbank habitats and coastal bluffs (CDFW 1992). Specifically, nests are constructed in seacliffs of hard consolidated sand, sandy riverbanks, and occasionally actively worked sand and gravel pits. In California, they are most commonly found in steep earthen riverbanks that experience frequent erosion during the winter.

Bank swallows dig burrows to a depth of up to 3 feet into earthen banks. Colonies range in size from 10 burrows to 3,000 burrows (CDFW 1992). Bank swallows begin nesting in late March, and by mid-July most nesting activities are completed and the colony sites are abandoned. This species begins migrating to Central and South America in late August.

CDFW has developed a recovery plan for bank swallows (CDFW 1992) with the following recovery objectives:

- Ensuring that remaining populations do not suffer further declines.
- Ensuring that sufficient habitat is available for this species to persist in California.
- Enhancing existing populations and reestablishing populations in targeted riverine areas.

4.7.4.6 MAMMALS

The following sections contain life history information for rare, threatened, and endangered mammals that are known to occur or may potentially occur in the Project vicinity.

Ringtail – Known to Occur

The ringtail (CFP) is a widely distributed, common to uncommon permanent resident of California. Occurring in various riparian habitats, it is usually found not more than 0.6 mile (1 kilometer) from permanent water. Little information is available on distribution and relative abundance of ringtail among habitats (Grinnell et al. 1937; Schempf and White 1977). Primarily carnivorous, ringtails eat mainly rodents (woodrats and mice) and rabbits. They may also take substantial amounts of birds and eggs, reptiles, invertebrates, fruits, nuts, and some carrion (Taylor 1954; Trapp 1978). The ringtail forages on the ground, among rocks, and in trees, usually near water. This species nests in rock recesses, hollow trees, logs, snags, abandoned burrows, or woodrat nests.

This species has been observed in the Project vicinity (EBMUD 2025c).

4.7.5 FEDERALLY DESIGNATED CRITICAL HABITAT AND HABITAT USE

There is no federally designated Critical Habitat within the FERC Project boundary (USFWS 2025a). There is federally designated Critical Habitat for California tiger salamander in the Project vicinity. Refer to Figure V.3-4, for the location of Critical Habitat in the Project vicinity.

4.8 RECREATION AND LAND USE

EBMUD owns and manages approximately 9,000 acres of water surface and 19,000 acres of surrounding land in the Mokelumne River watershed, including land within the FERC Project boundary. These generally undeveloped lands provide natural habitat for aquatic and terrestrial species, support ecosystem functions, protect water supply in the Pardee and Camanche reservoirs, and provide unique recreational and educational experiences.

4.8.1 REGIONAL RECREATIONAL OPPORTUNITIES

The Project is located in the foothills of the Sierra Nevada Mountain Range. There are nearby national forests, including Eldorado National Forest and Stanislaus National Forest. Outside of the Project boundary, various other entities provide recreational opportunities similar to what is offered at Camanche and Pardee reservoirs. Listed below and shown in Figure 4.8-1 are various recreational opportunities within 50 miles of the Project boundary.

4.8.1.1 LAKE TULLOCH CAMPGROUND, TUOLUMNE/CALAVERAS COUNTIES

Lake Tulloch Campground, located approximately 47 miles from the Project boundary, offers a variety of recreation opportunities including camping, picnicking, boating, water-skiing, personal watercraft riding, non-motorized boating, paddle boarding, hiking, and fishing. The campground offers over 110 sites that include recreational vehicle (RV) spots, cabins, and lakefront camping accommodations (Lake Tulloch Campground 2025).

4.8.1.2 NEW MELONES RESERVOIR, CALAVERAS COUNTY

The New Melones Reservoir, located approximately 34 miles from the Project boundary, offers recreation activities including boating, biking, hunting, hiking, fishing, swimming, water sports, camping, picnicking, and horseback riding. There are two major recreation areas that offer over 300 campsites and 2 group campgrounds (United States Bureau of Reclamation 2025).

4.8.1.3 NEW HOGAN RESERVOIR, CALAVERAS COUNTY

The New Hogan Reservoir, located approximately 10 miles from the Project boundary, provides multiple recreation opportunities, including camping, fishing, boating, picnicking, swimming, hiking, and biking (USACE 2025).

4.8.1.4 LAKE AMADOR RESORT, AMADOR COUNTY

Lake Amador Resort, located approximately 7 miles from the Project boundary, provides many recreation opportunities including camping, fishing, and disc golf. The campground offers over 100 campsites with showers and flush toilets. Additionally, there are over 70 deluxe RV sites located on the property. There is a dual-lane paved boat launch. Additionally, boat rentals are available from the Clubhouse. Lake Amador Resort offers two 18-hole disc golf courses and a disc golf pro shop (Lake Amador Resort 2025).

4.8.1.5 RANCHO SECO RECREATIONAL AREA, SACRAMENTO COUNTY

Rancho Seco Recreational Area, located approximately 19 miles from the Project boundary, offers recreational opportunities including camping, boating, fishing, and swimming. There are 32 tent sites and 21 RV sites available for overnight accommodations (Sacramento Municipal Utility District 2025).

4.8.1.6 FOLSOM LAKE STATE RECREATION AREA, SACRAMENTO/EL DORADO COUNTIES

Folsom Lake State Recreation Area, located approximately 40 miles from the Project boundary, offers opportunities for hiking, biking, running, camping, picnicking, horseback riding, water-skiing, swimming, fishing, and boating (California State Parks 2025).

4.8.1.7 TRAILS SYSTEM

There are no formal trails in the FERC license. However, within the Project vicinity, there are multiple state and regional scenic trails (Figure 4.8-2). The Mokelumne Coast to Crest Trail (MCCT), a California State Park Trail, roughly follows the Mokelumne River from the headwaters at the Sierra Nevada Crest down to Martinez on the Carquinez Strait where the river enters the San Francisco Bay. There are also other regional trails that traverse the Project boundary, including the John Bull Loop Trail, Cooks Mesa Trail, Patti's Point, Rich Gulch Trail, and Middle Bar through Independence Flat. The trails offer views of the surrounding foothills, Mokelumne River, and local wildlife.

John Bull Loop Trail

The John Bull Loop Trail is a 2.4-mile-long trail that branches off the MCCT approximately 1.5 miles from the Campo Seco Staging Area. The trail takes visitors northwest from Lawry Flat and through the rolling hills overlooking Pardee Reservoir. The trail offers

sights of nature from the Pardee View Vista Point and John Bull Peak at over El. 1,000 feet (EBMUD 2025a).

Cooks Mesa Trail Access Point

To make day trips easier between Camanche South Shore Staging Area and the Campo Seco Staging Area, the 12.4-mile distance is divided by the Cooks Mesa Trail access point. The new trail access is 3 miles from the Camanche South Shore Staging Area, 10 miles from the Campo Seco Staging Area, and 100 yards south of the Upper Mokelumne River Watershed Authority on Camanche Parkway South. Cooks Mesa has drinking water, Americans with Disabilities Act (ADA)-accessible chemical toilets, and limited parking. Trailers are prohibited due to the small parking area (EBMUD 2025a).

Patti's Point

A popular section of MCCT, Patti’s Point to James Bar Trail, is a short but steep segment of the trail that descends east from Patti's Point down to James Bar (off Gwin Mine Road) (EBMUD 2025a).

Rich Gulch Trail

Rich Gulch Trail offers a moderate hike (4.2 miles round trip), heading east from Rich Gulch to the Middle Bar access point. This trail follows the river canyon to the Middle Bar Bridge and passes through an area with a rich history (EBMUD 2025a).

Middle Bar through Independence Flat

In October 2012, EBMUD opened this last section of MCCT on EBMUD land. Because the trail alignment east of Highway 49 is not established yet, trail users enter and exit at the Middle Bar Trail access point. The trail offers a loop aspect for pedestrians, following the narrow gauge along the river (EBMUD 2025a).

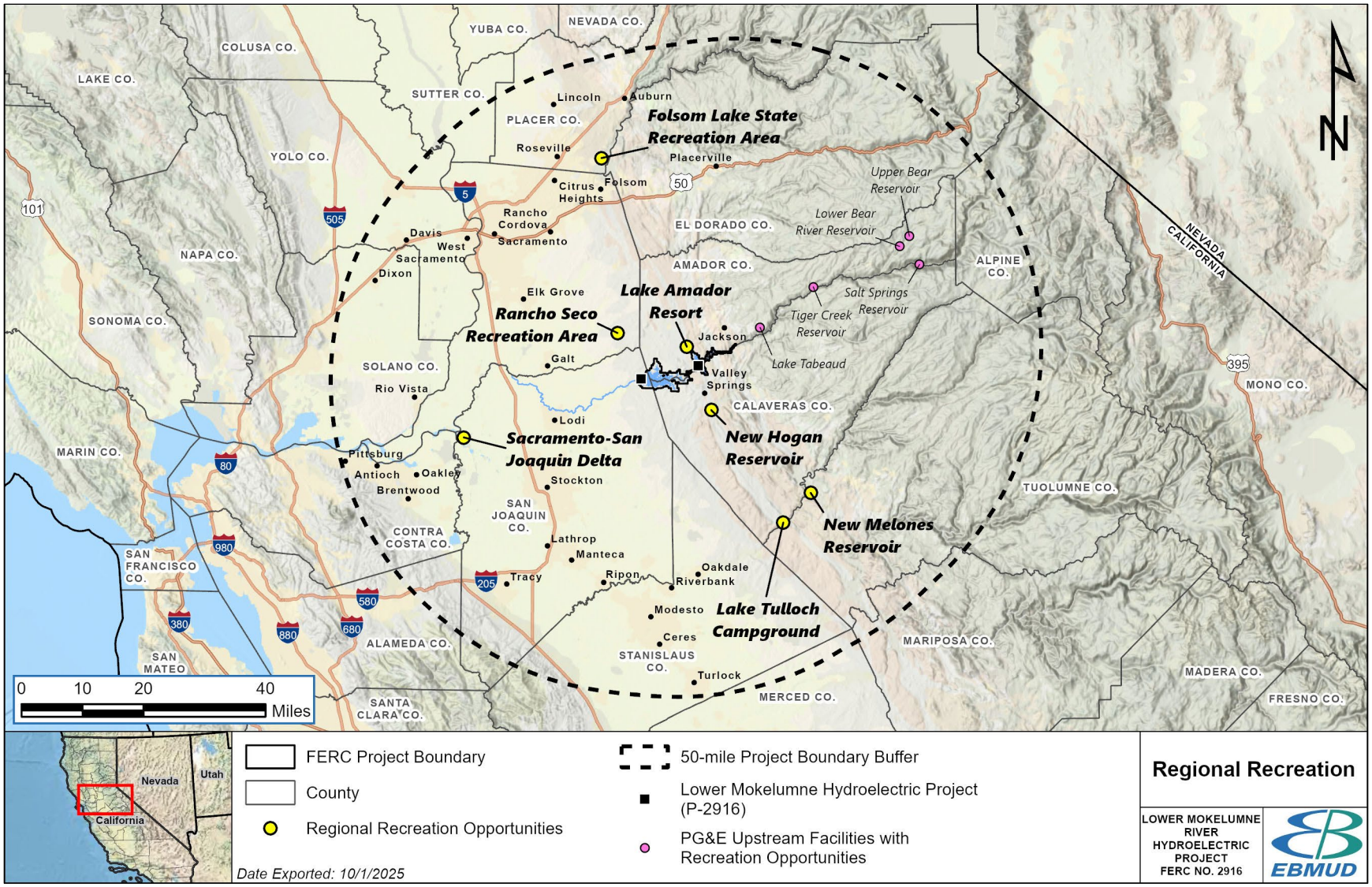


Figure 4.8-1. Regional recreation near the Project.

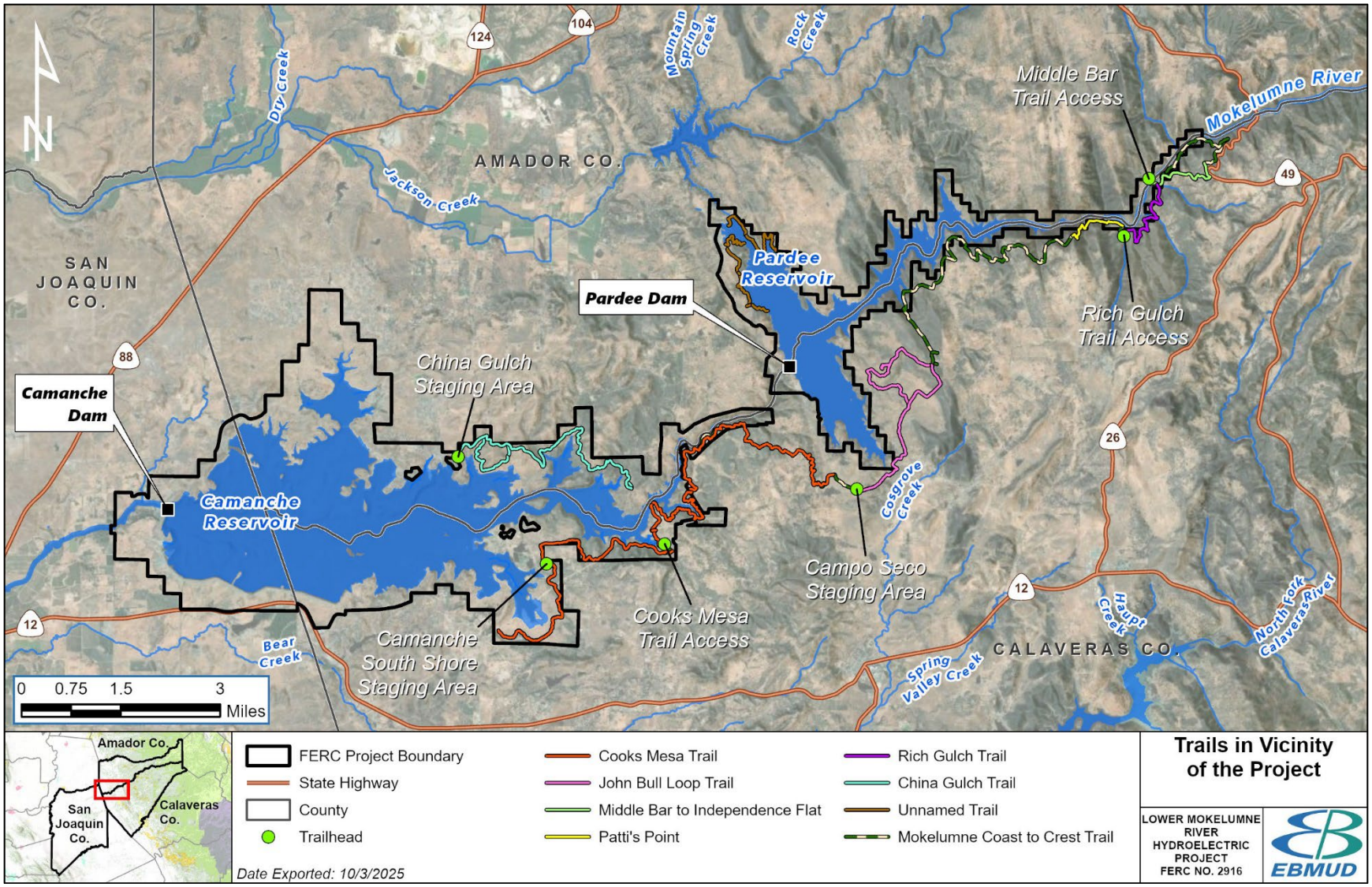


Figure 4.8-2. Mokelumne River watershed trail system.

4.8.2 EXISTING RECREATIONAL SITES WITHIN THE PROJECT BOUNDARY

Within the Project boundary, there are five Project recreation sites including Pardee Recreation Area (Pardee Reservoir), Camanche South Shore Recreation Area (Camanche Reservoir), Camanche North Shore Recreation Area (Camanche Reservoir), Mokelumne River Day Use Area (MRDUA) (Lower Mokelumne River), Camanche Hills Hunting Preserve (CHHP) (Camanche Reservoir), and one non-Project recreation site, Middle Bar Day Use Area.

The Project's 1981 FERC license required upgrades only to the recreation facilities at Pardee Reservoir. CHHP was originally not included in the Project license and Recreation Plan but was subsequently added to satisfy a requirement within EBMUD's agreement with USACE to provide hunting opportunities at Camanche Reservoir. Figure 4.8-3 provides an overview of EBMUD's recreation facilities within the Project boundary. EBMUD owns all the sites but has concessionaires in place at Camanche North Shore, Camanche South Shore, Pardee, and CHHP recreation sites that oversee the maintenance and interaction with visitors.

Although not a license requirement, EBMUD has worked with volunteers to construct more than 33 miles of MCCT that traverses EBMUD land from the Camanche Reservoir to the upper Pardee Reservoir. This trail segment represents about 10 percent of the entire MCCT, which is envisioned to someday link the San Francisco Bay and the Sierra Crest.

EBMUD conducts community outreach to broaden understanding, appreciation, and use of watershed land. Outreach programs are led by rangers, wildlife experts, and other knowledgeable volunteers and provide insight into the natural and human history of the region through talks, guided hikes, and boat tours. Volunteer workdays provide opportunities for community involvement in the Mokelumne River watershed management.

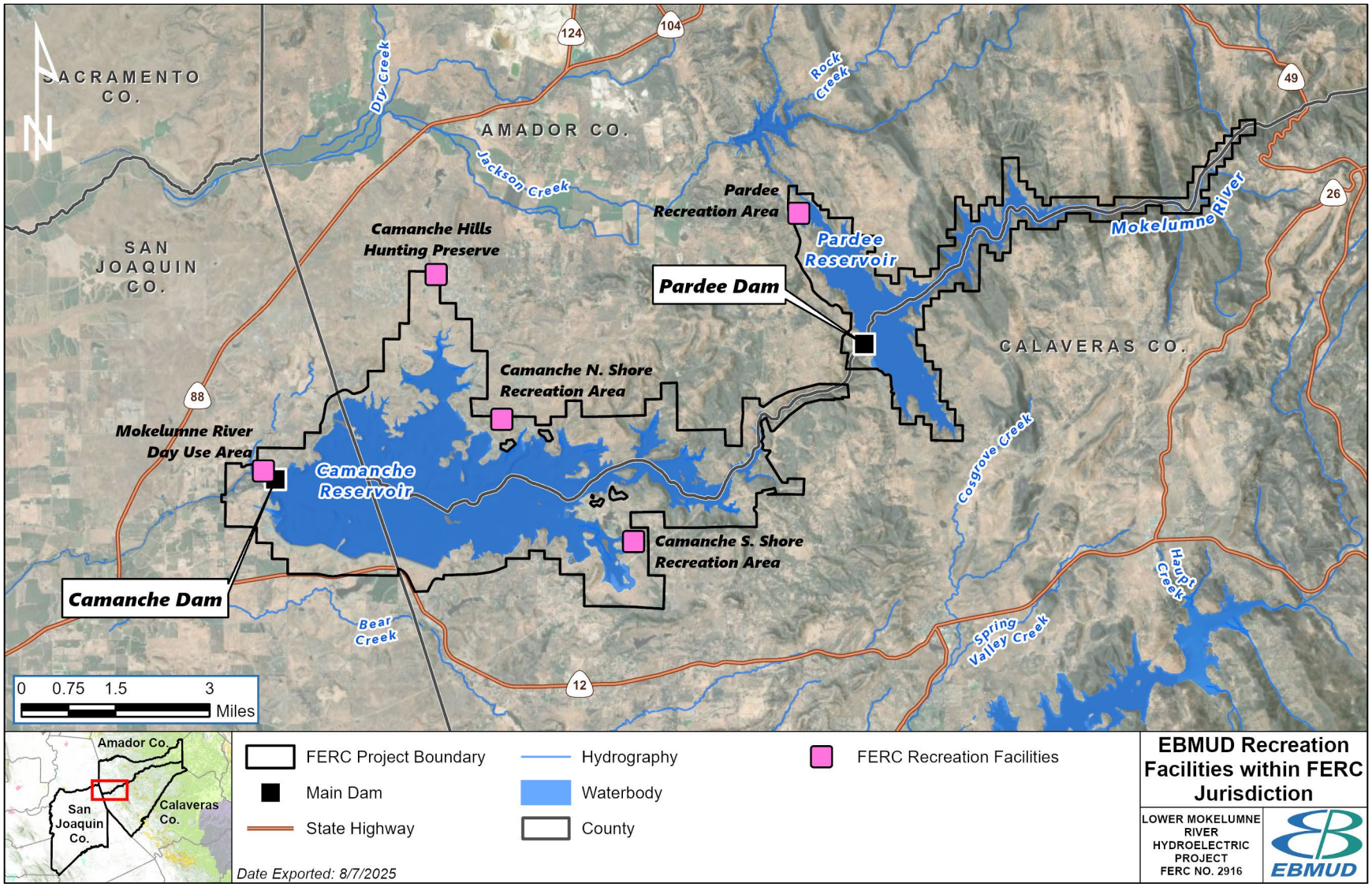


Figure 4.8-3. EBMUD recreation facilities within FERC jurisdiction.

4.8.2.1 WATER AND WASTEWATER TREATMENT PLANTS ASSOCIATED WITH THE RECREATION AREAS

EBMUD owns and operates the water and wastewater treatment plants at the recreation areas located within the Mokelumne Watershed – Camanche North Shore Recreation Area (CANS), Camanche South Shore Recreation Area (CASS), and Pardee Recreation Area (PARA). EBMUD maintains and repairs these wastewater treatment systems, including associated main lines, force mains, laterals, and lift stations.

Section 4.3.4 provides additional details of the Mokelumne watershed facilities regulated water quality programs through the CVRWQCB.

Camanche North Shore Recreation Area

- Camanche North Shore Water Treatment Plant
- Camanche North Shore Sanitary Sewer System
- Camanche North Shore Wastewater Treatment Plant

Camanche South Shore Recreation Area

- Camanche South Shore Water Treatment Plant
- Camanche South Shore Sanitary Sewer System
- Camanche South Shore Wastewater Treatment Plant

Pardee Recreation Area

- Pardee Recreation Area Water Treatment Plant
- Pardee Recreation Area Sanitary Sewer System
- Pardee Recreation Area Wastewater Treatment Plant

4.8.2.2 FISH STOCKING WITHIN PARDEE AND CAMANCHE RESERVOIRS

Both Pardee and Camanche reservoirs are stocked with recreational fish species, coordinated by the concessionaire. The stocking is funded through an EBMUD-led "access ticket" program fee for anglers where the cost of the ticket is banked for fish purchase in the following year. Figure 4.8-4 shows the annual Rainbow Trout fish planting total by pounds within Pardee and Camanche reservoirs.

A valid California fishing license is required for individuals 16 years of age or older. In addition, there is a Pardee fishing access fee of $7.25 per day for each individual 16 years of age and older. Up to 4 children, 15 years of age and younger, may fish without a daily fishing access permit if they are accompanied by a licensed adult with a valid fishing access permit.

This is a put and take fishery, and all fish biomass planted is assumed harvested.

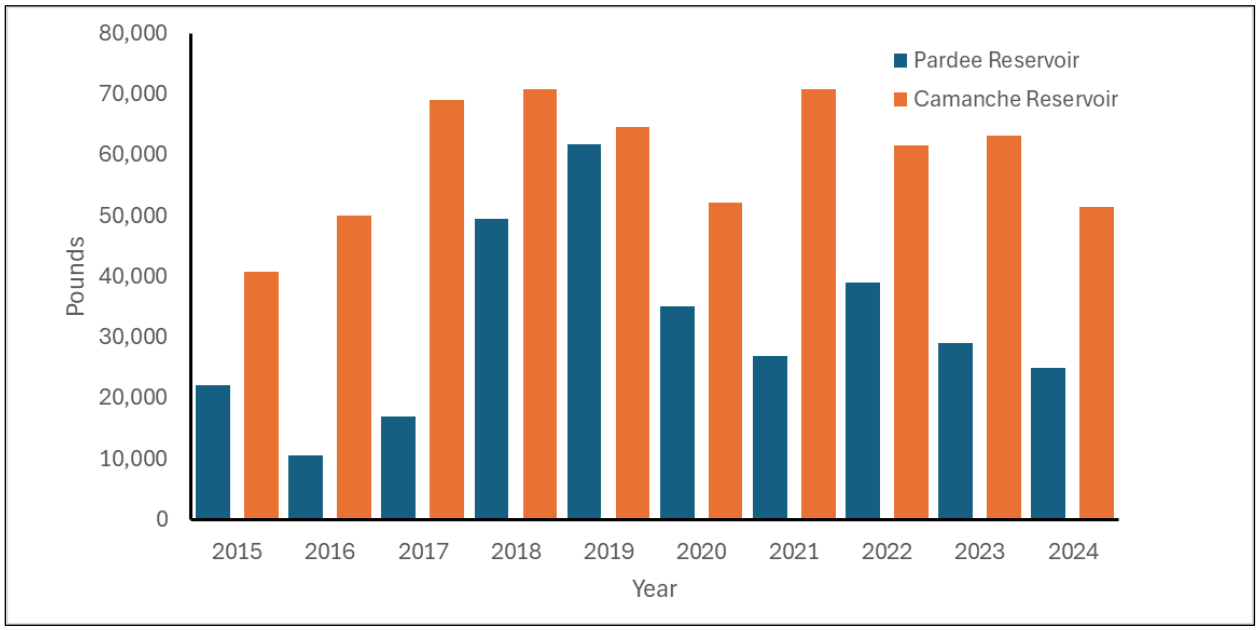


Figure 4.8-4. Annual Rainbow Trout fish planting total by pounds within Pardee and Camanche reservoirs.

Pardee Reservoir

Fishing is a popular activity at the Pardee Recreation Area. About 90 percent of anglers fish for trout, both from the shore and boats. Other available species include Brown Trout, kokanee salmon, black bass, and three species of catfish. EBMUD stocks Pardee Reservoir with approximately 30,000 pounds of Rainbow Trout each year.

Pardee Reservoir is stocked with hatchery Rainbow Trout annually, with additional regular planting of kokanee salmon fingerlings, all coordinated through the on-site concessionaire.

The Pardee access permit funds are used to re-stock the lake with fish. Figure 4.8-5 shows annual total pounds of Rainbow Trout planted in Pardee Reservoir for the last 10 years (2015 to 2024). Figure 4.8-6 shows the annual total pounds (and total count) of kokanee planted in Pardee Reservoir from 2001 to 2024.

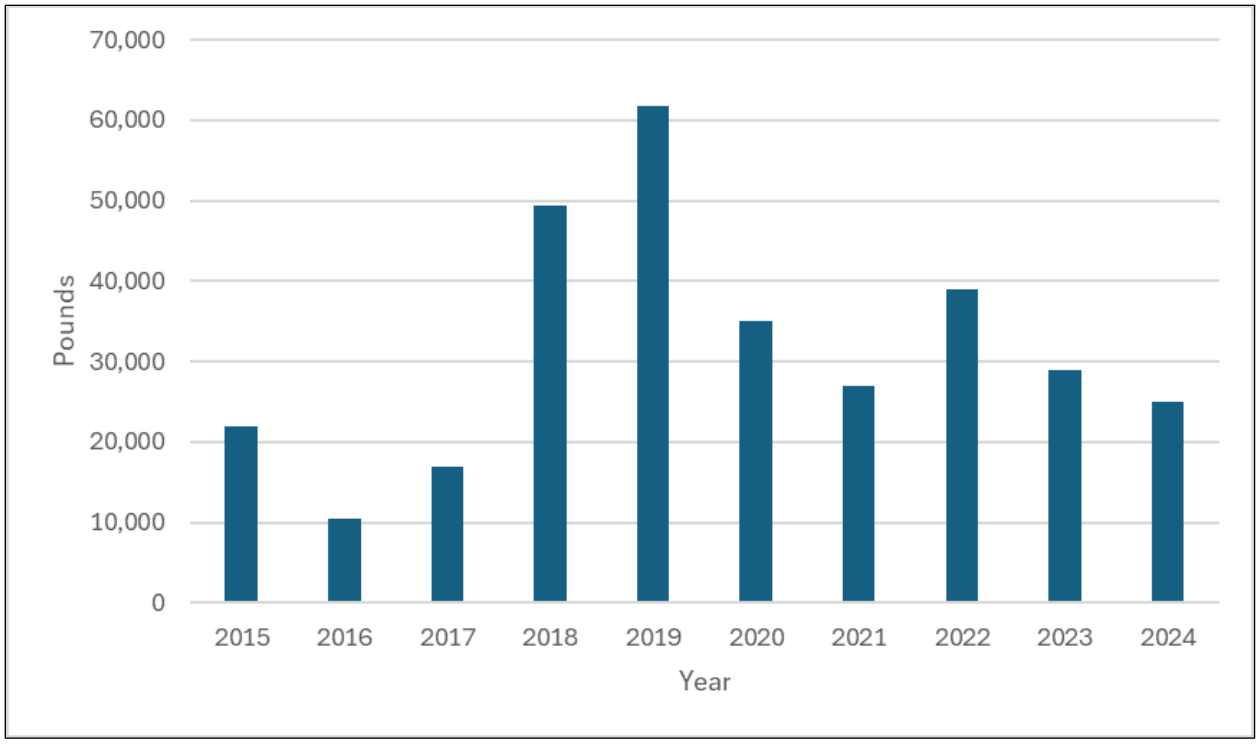


Figure 4.8-5. Annual Rainbow Trout fish planting total by pounds within Pardee Reservoir.

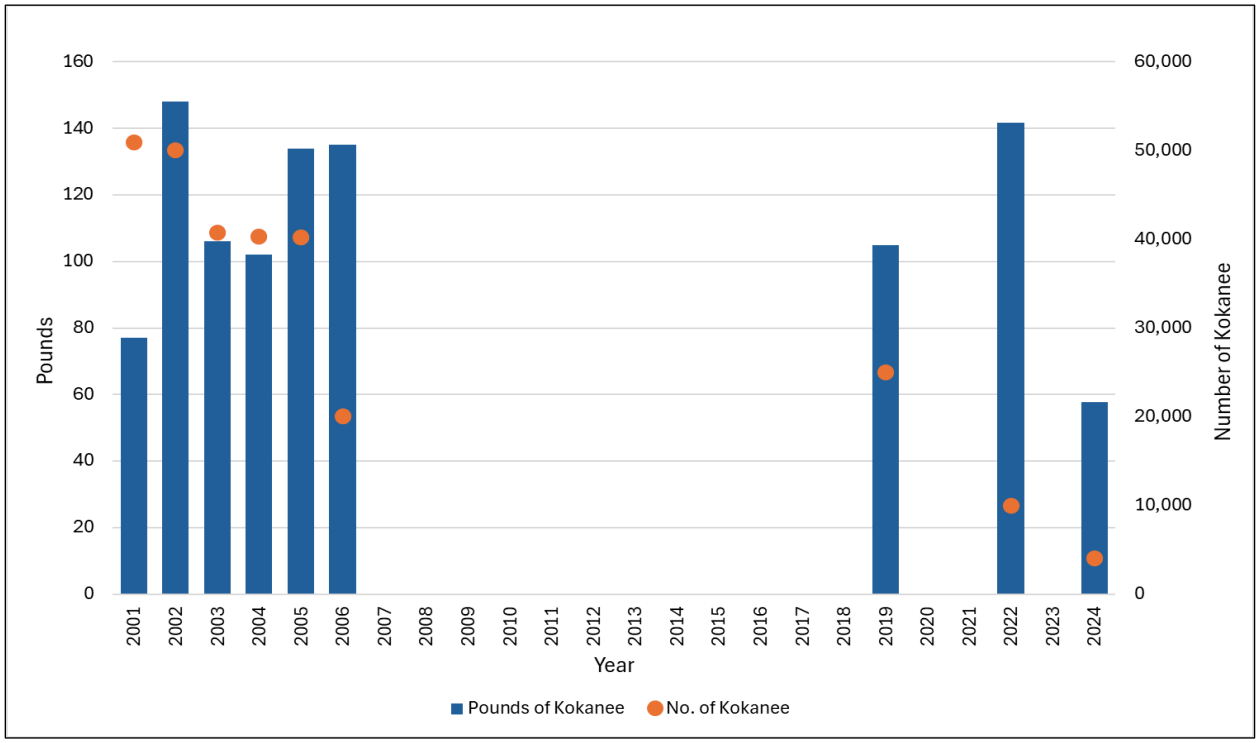


Figure 4.8-6. Kokanee salmon fingerling planting at Pardee Reservoir.

Camanche Reservoir

Rainbow Trout is the primary species stocked in Camanche Reservoir. Angler demand for Rainbow Trout greatly exceeds the capacity of Camanche Reservoir to provide self-sustaining populations and, as a result, 391,500 pounds of Rainbow Trout have been planted from 2015 to 2024 in the reservoir to support this fishery. Annual plantings range from 41,290 pounds to 70,800 pounds. Additionally, 202,450 pounds are planted in a separate trout pond located in the Camanche South Shore Area. In addition to planting Rainbow Trout, 89,240 Florida strain Largemouth Bass have also been planted in Camanche Reservoir since 2016. Stocking Largemouth Bass helps to augment their self-sustaining populations. Their ability to maintain populations of desirable-sized fish, despite heavy fishing pressure, is partly due to the catch-and-release practices of many black bass anglers.

4.8.2.3 PARDEE RECREATION AREA

The Pardee Recreation Area is located in the foothills of the Sierra Nevada of Northern California on the Pardee Reservoir, also known as Pardee Lake. Pardee Recreation Area is open from February 16 to November 10 each year and various use fees are collected by the concessionaire for the amenities offered. It is closed during the migratory bird season from mid-November until mid-February as part of EBMUD's wildlife enhancement program. The Pardee Recreation Area offers campgrounds, boat launch ramps, a marina store, cafe, two swimming pools, boat rental services, and slip rentals. Figure 4.8-7 shows the location of each recreation facility located within the Pardee Recreation Area. The recreation area offers several ADA-accessible features, including accessible campsites (tent and RV), paved pathways, ADA-compliant restrooms and showers, and parking and ramps. The recreation area's maximum capacity is 150 day-use vehicles and 100 day-use trailered boats.

To comply with the state law prohibiting body-water contact, personal watercraft, water skiing, and lake swimming are not allowed within the reservoir.[11]

[11] CA Health & Safety Code § 115825 (2024)

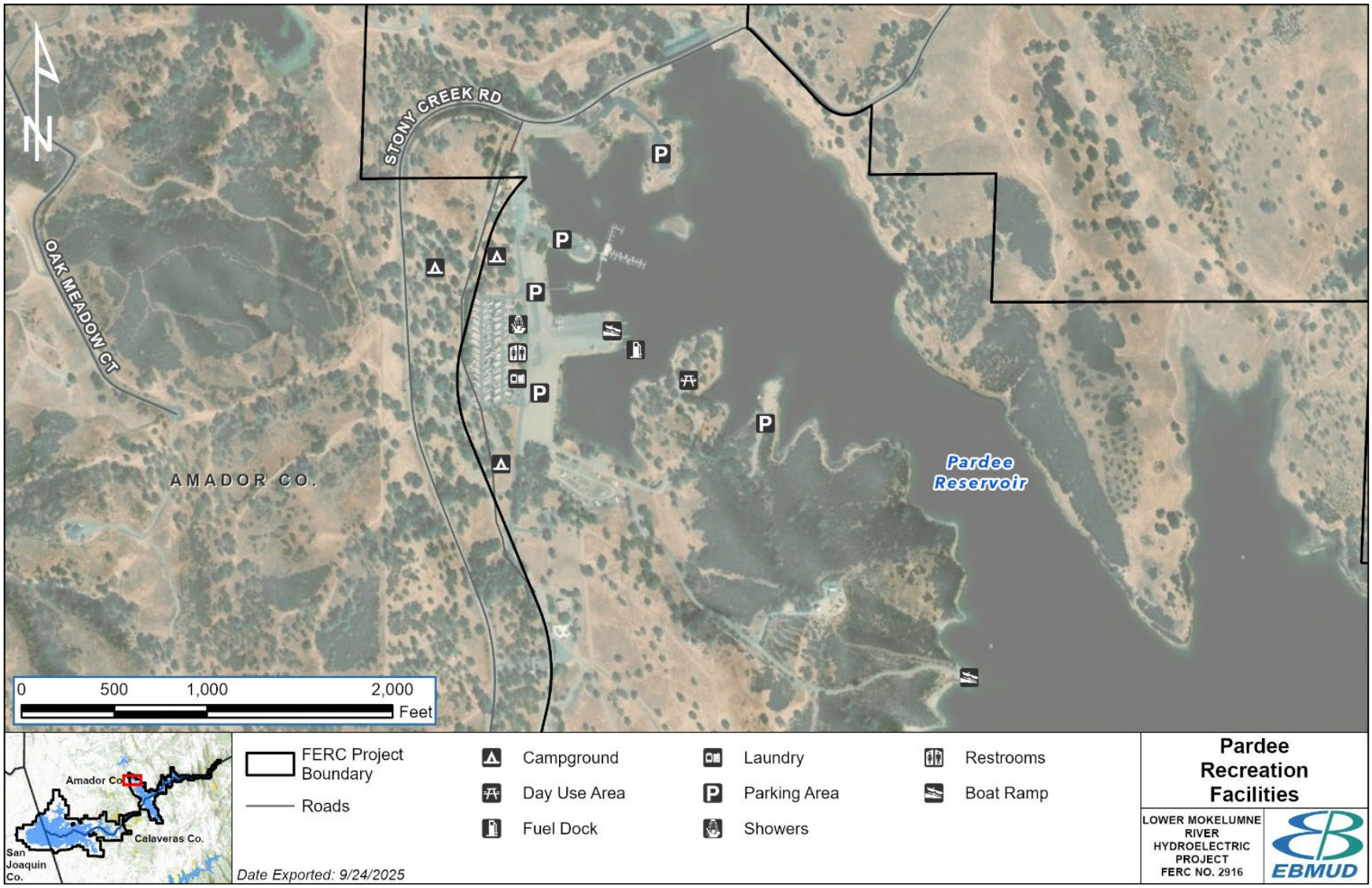


Figure 4.8-7. Lower Mokelumne River Project – Pardee Recreation Area.

Camping

A total of 141 campsites are located within two separate campgrounds (Lakeview Campground and the Oaks Campground). Each campsite contains a picnic table and fire ring. Running water, flush restrooms, laundry facilities, and other amenities are available within a short walking distance. Two ADA-accessible sites are also available. The RV Park features 56 sites with their own picnic tables, fire rings, and electrical, water, and sewer connections (Photo 4.8-1). RV Park guests can also enjoy a new group gathering area (EBMUD 2025b).

Photo 4.8-1. RV on shoreline of Camanche Reservoir (Lake Camanche Recreation Concessionaire).

Boating

Recreationists can bring their own boats or rent motorboats, deluxe boats, pontoon boats, and deluxe pontoons for use on Pardee Lake (EBMUD 2025b). All boats brought by recreationists, when open to launching, must be surveyed and are subject to inspection before launching to prevent invasive mussels from entering the EBMUD water system. Section 4.4.2.2 provides more information on the invasive aquatic species control program.

Hiking

There are multiple hiking trails along the shoreline of Pardee Lake that are publicly accessible.

4.8.2.4 CAMANCHE SOUTH SHORE RECREATION AREA

The Camanche South Shore Recreation Area is located on the Camanche Reservoir, also known as Lake Camanche. The recreation area is open year-round and provides campgrounds, boat launch ramps, a fully stocked marina with cafe, boat rentals, houseboat mooring, and rental berths, as well as rental cottages, cabins, and recreational halls. Camanche South Shore Recreation Area offers several ADA-accessible facilities including campsites, paved pathways, restrooms and showers,

Photo 4.8-2. Camping by Camanche Reservoir (Lake Camanche Recreation Company).

fishing access, and parking and ramps. The recreation area's maximum capacity is 150 day-use vehicles and 100 day-use trailered boats.

Camping

The Camanche South Shore Recreation Area provides several areas for camping opportunities (Photo 4.8-2). Table 4.8-1 provides a summary of the available campgrounds with the associated amenities available at each location. See Figure 4.8-8 for the layout of the Camanche South Shore Campgrounds and see Figure 4.8-9 for the layout of facilities within the Camanche South Shore Recreation Area.

Fishing

Fishing is a popular activity at the Camanche South Shore Recreation Area. Anglers pursue bass, trout, panfish, and catfish. EBMUD stocks approximately 30,000 pounds of Rainbow Trout at the South Shore each year. 15,000 pounds are planted in the main reservoir, and 15,000 pounds are planted in the trout pond.

Boating

Camanche South Shore Recreation Area offers several boating amenities including boat launch ramps, marina store, cafe, boat rental services, houseboat mooring, and covered berth and slip rentals. Recreationists can bring their own boats or rent patio boats, deluxe patio boats, fishing boats, kayaks, and paddle boats for use on Lake Camanche (EBMUD 2025c). When open to launching, all boats brought by recreationists are subject to inspection before launching to prevent invasive species from entering the EBMUD water system. Section 4.4.4.2 provides more information on the invasive aquatic species control program.

Table 4.8-1. Camanche South Shore Recreation Area campgrounds.

Campground	Number of Campsites	Amenities
Arrowhead Campground	27 single and 3 double campsites	Fire rings, picnic tables, drinking fountains, flush restrooms, showers, and portable restrooms
Cottonwood Campground	21 single and 4 double campsites	Fire rings, picnic tables, drinking fountains, flush restrooms, showers, and portable restrooms. ADA Accessible.
Coyote Flat Campground	21 single and 4 double campsites	Fire rings, picnic tables, drinking fountains, and portable restrooms
Gold Run Campground	16 single and 2 group sites each able to accommodate 80 people	Fire rings, picnic tables, drinking fountains, flush restrooms, showers, and a RV dump station nearby. ADA Accessible.
Lakeside Campground	3 single, 1 double, and 1 triple group campsites	Fire rings, picnic tables, drinking fountains, and portable restrooms
Miner's Camp RV Park	108 RV campsites	Water and sewer service, 30- to 50-amp electrical service, and picnic tables
Moccasin Campground	15 single, 6 double, 1 triple, and 1 quad campsites	Fire rings, picnic tables, drinking fountains, flush restrooms, showers, laundry, and a playground. ADA Accessible.
Monument RV Park	99 full hook-up campsites	Full-service RV hook-up campsites include water and sewer services, and 30- to 50-amp electrical service. Other amenities include fire rings and picnic tables
Oaks Campground	28 single, 1 double, and 2 triple campsites	Picnic tables, fire rings, drinking fountains, flush restrooms, and portable restrooms
Riverview Campground	26 single and 1 double campsite	Picnic tables, fire rings, drinking fountains, flush restrooms, and portable restrooms. ADA Accessible.
Sugarloaf Campground	24 single and 1 group campsite that can accommodate 64 people	Picnic tables, fire rings, drinking fountains, flush restrooms, showers, and portable restrooms
Turkey Hill Equestrian Campground	2 single, 2 double, 2 triple, and 1 quadruple campsites	Picnic tables, fire rings, drinking fountains, horse paddocks, and portable restrooms

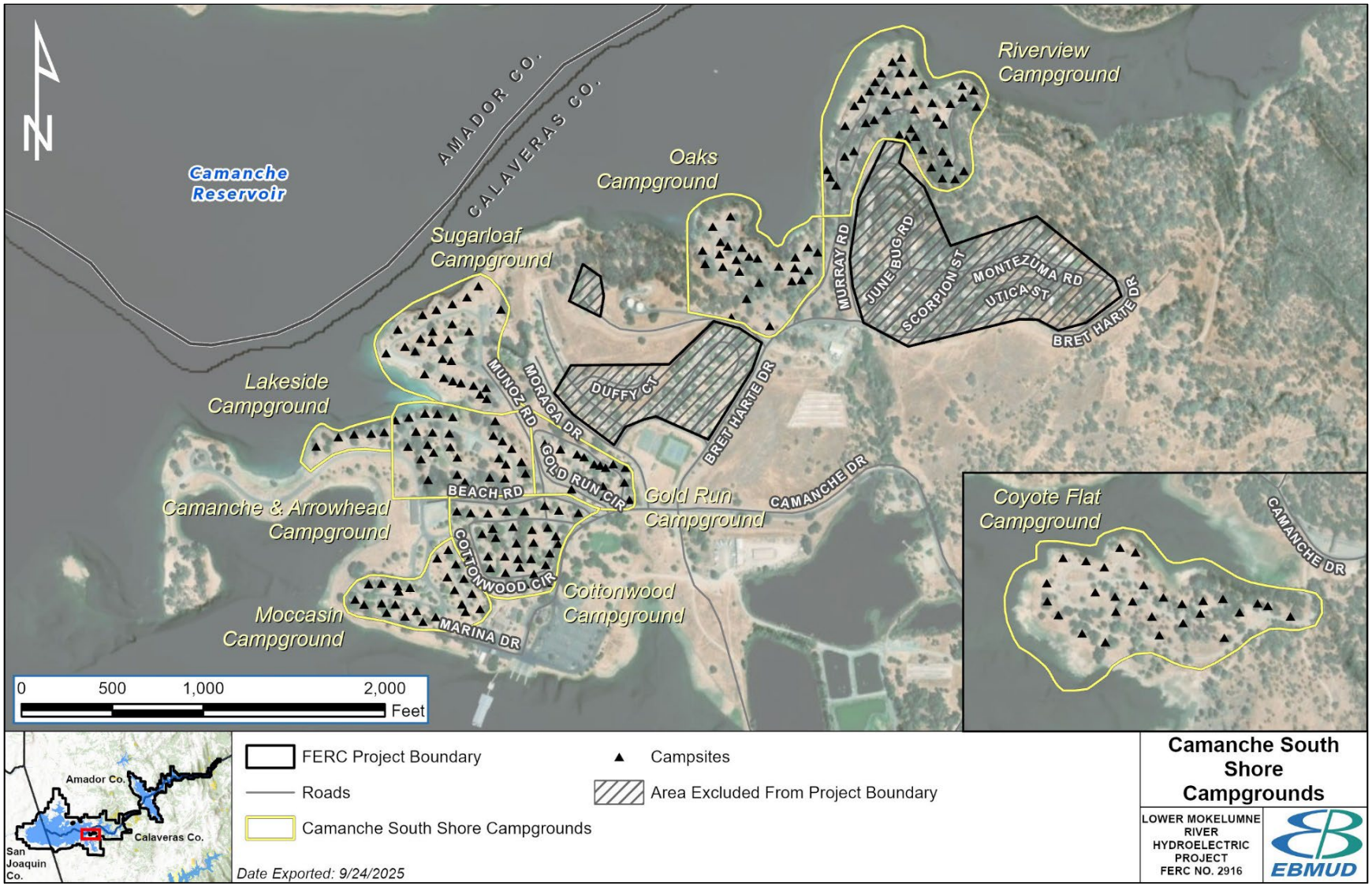


Figure 4.8-8. Lower Mokelumne River Project – Camanche South Shore Campgrounds.

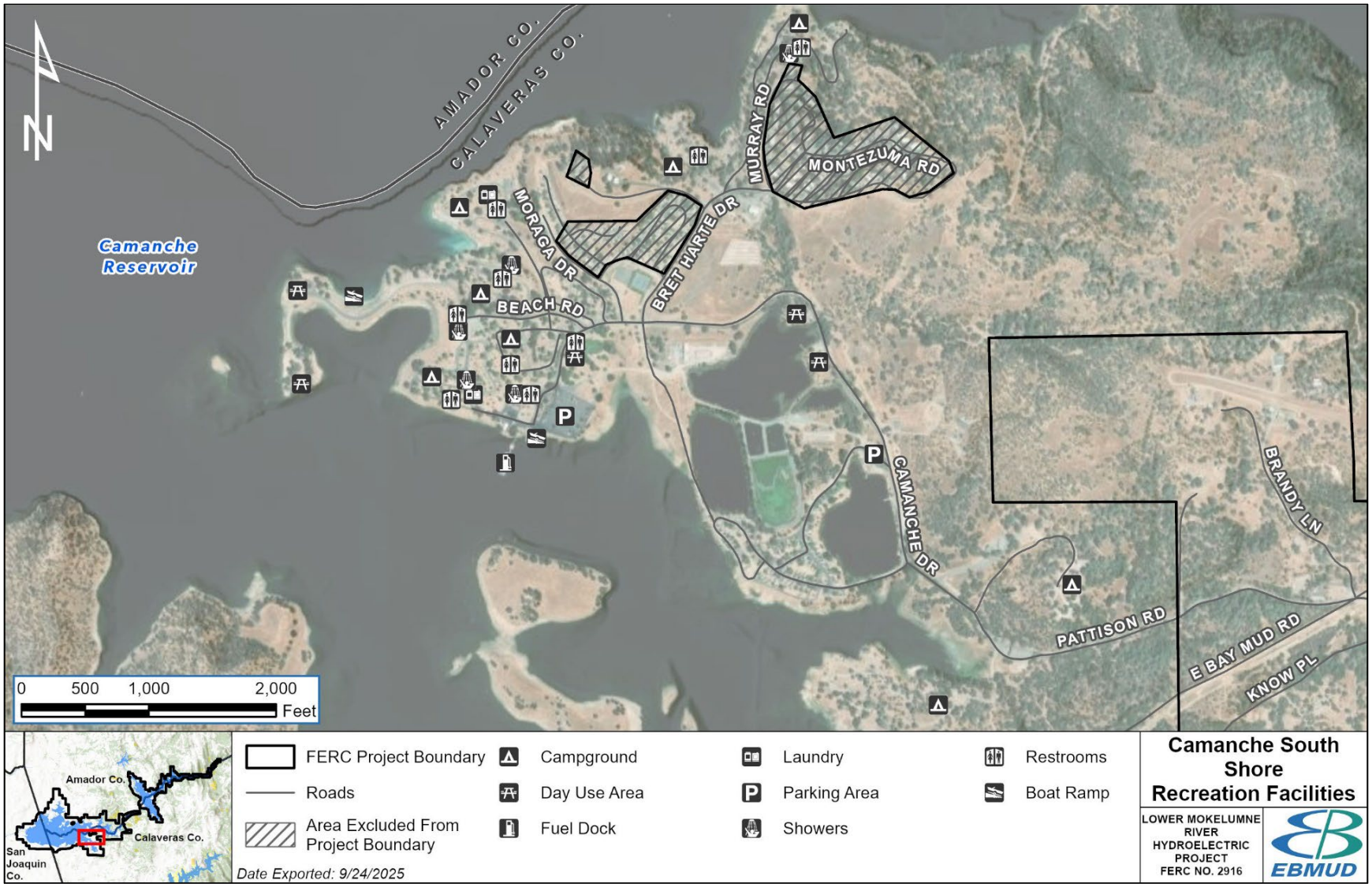


Figure 4.8-9. Lower Mokelumne River Project – Camanche South Shore Recreation Area.

4.8.2.5 CAMANCHE NORTH SHORE RECREATION AREA

The Camanche North Shore Recreation Area is located on Lake Camanche and is open to the public year-round, and various use fees are collected by the concessionaire. The recreation area includes campgrounds, boat launch ramps, a fully stocked marina with cafe, boat rentals, houseboat mooring, and rental berths, as well as rental cottages, cabins, and recreational halls. Camanche North Shore Recreation Area offers several ADA-accessible facilities such as campsites, paved pathways, restrooms and showers, fishing access, and parking and ramps. The recreation area's maximum capacity is 150 day-use vehicles and 100 day-use trailered boats

Camping

The Camanche North Shore Recreation Area provides several camping opportunities (Figure 4.8-10). Table 4.8-2 provides a summary of the available campgrounds with the amenities available at each location. See Figure 4.8-11 for the layout of the Camanche North Shore Campgrounds.

Table 4.8-2. Camanche North Shore Recreation Area campgrounds.

Campground	Number of Campsites	Amenities
Blue Oaks Campground	141 single and 4 group sites able to accommodate 12-72 people	Fire rings, picnic tables, drinking fountains, RV dump station, flush restrooms, showers, and portable restrooms. ADA Accessible
Eagle Beach Campground	3 single and 4 double campsites	Fire rings, picnic tables and portable restrooms. Eagle Beach is only accessible by boat
Peninsula Campground	20 single campsites	Picnic tables, fire rings, and portable restrooms. ADA Accessible
Rabbit Creek Campground	30 single campsites	Fire rings, picnic tables, and portable restrooms
Primitive Campground	20 single dispersed campsites	Portable restrooms

Fishing

Fishing is a popular activity at the Camanche North Shore Recreation Area. Anglers pursue bass, trout, panfish, and catfish. EBMUD stocks approximately 30,000 pounds of Rainbow Trout at the North Shore each year.

Boating

Camanche North Shore Recreation Area offers boat launch ramps, a marina store, a cafe, boat rental services, houseboat mooring, and covered berth and slip rentals.

Recreationists can bring their own boats or rent patio boats, deluxe patio boats, fishing boats, kayaks, and paddle boats for use on Lake Camanche (EBMUD 2025c). When launching is open, all boats brought by recreationists are subject to inspection before launching to prevent invasive mussels from entering the EBMUD water system. Section 4.4.4.2 provides more information on the invasive aquatic species control program.

4.8.2.6 MOKELUMNE RIVER DAY USE AREA

The MRDUA is a small day use park located on the Mokelumne River in San Joaquin County. The MRDUA is located just downstream of Camanche Dam on 1 mile of the Mokelumne River shoreline (Figure 4.8-12). Recreational activities include fishing, swimming, picnicking, and nature watching. Amenities include 15 picnic sites with tables and barbeques, vault toilets, and portable restrooms (EBMUD 2025d). Special consideration has been given to visitors with disabilities with the addition of an ADA-accessible vaulted restroom, trail, picnic site, paved trail and fishing pier. Visitors can hike from the MRDUA to the Mokelumne Fish Hatchery and raft in the downstream stretch of the river.

Fishing season at MRDUA runs from January 1 to March 31 and from the fourth Saturday in May to October 15. Closing the area in April and May seasonally protects the steelhead fishery in compliance with CDFW regulations.

4.8.2.7 CAMANCHE HILLS HUNTING PRESERVE

CHHP is a 1,500-acre hunting preserve and sport shooting facility located in Amador County on the Rabbit Creek arm of Lake Camanche. The hunting season is October through March and is open from 7:00 a.m. to 4:30 p.m. Wednesday through Monday (closed Tuesday) during the hunting season, and closed Mondays and Tuesdays after the hunting season (April through September). The preserve is divided into 12 hunt zones. Hunters pursue upland game birds such as pheasants, chukar, valley quail, and waterfowl (EBMUD 2025d). CHHP offers several varieties of sport shooting including year-round sporting clays, skeet, trap, 5-stands, and grouse bunkers (EBMUD 2025d). Amenities include a clubhouse with dining facilities, a pro shop, bird processing, a gunsmith, picnic areas, and portable restrooms (EBMUD 2025d).

4.8.2.8 MIDDLE BAR DAY USE AREA

The Middle Bar Day Use and Take-Out Area, above the Pardee Reservoir, is a recreation amenity within the Project boundary that is open year-round, located near Middle Bar Bridge on the Mokelumne River. Although the site is not required by EBMUD's FERC license, it is included in EBMUD's Recreation Management Plan that covers all of the EBMUD-owned lands in the watershed and is managed by EBMUD. EBMUD submitted its proposed improvements to the Middle Bar Day Use and Take-Out Area to FERC in July

2002; in September 2002, FERC found that the improvements were “necessary to meet the recreational, safety, and sanitation needs of the public,” and “consistent with the project’s purposes” (FERC 2002). The improvements were completed in May 2003.

Figure 4.8-10. Lower Mokelumne River Project – Camanche North Shore Recreation Area.

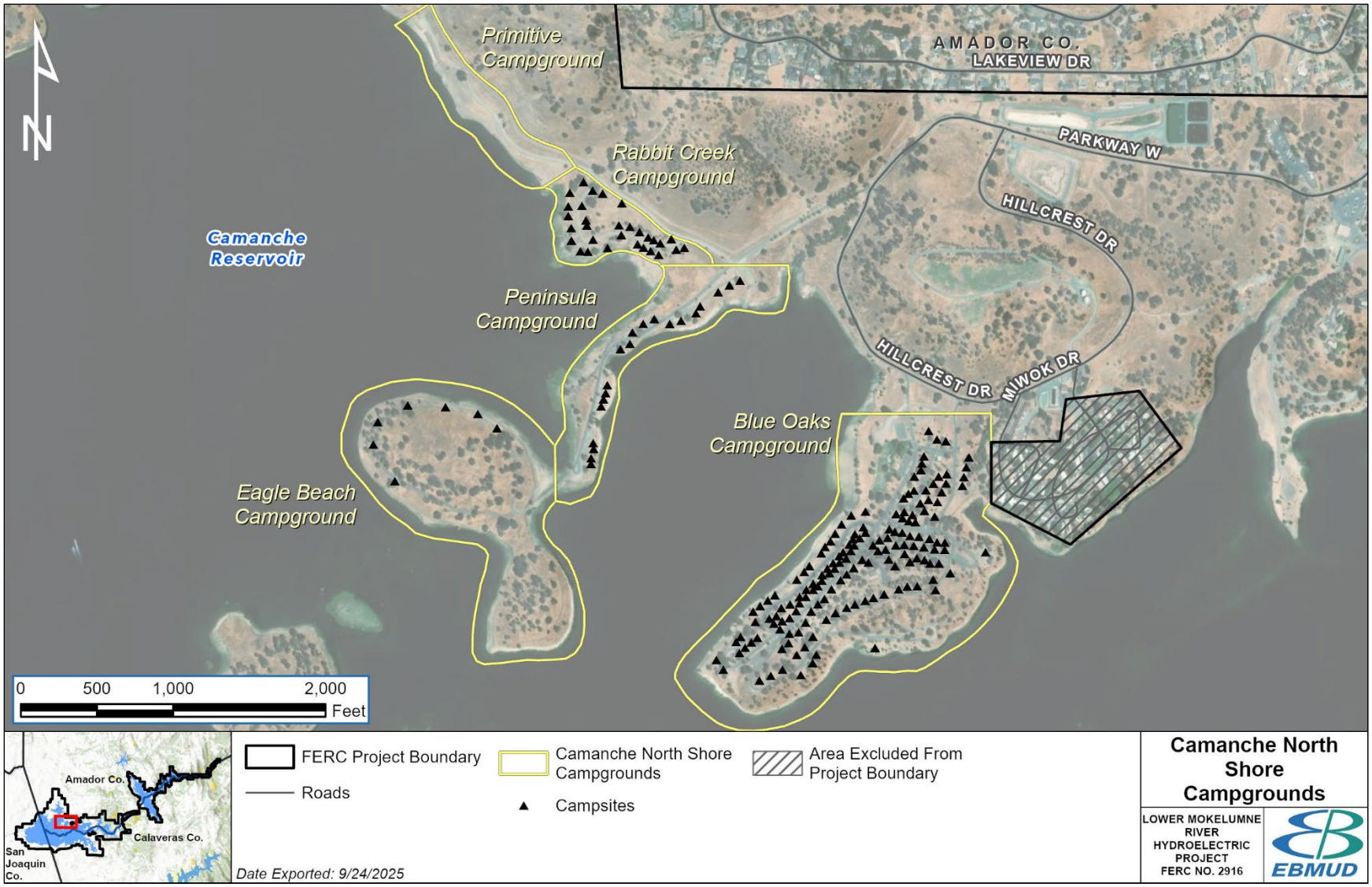


Figure 4.8-11. Lower Mokelumne River Project – Camanche North Shore Campgrounds.

Figure 4.8-12. Lower Mokelumne River Project – Mokelumne River Day Use Area.

Prior to becoming an established take-out area, the primary users of the day use area were anglers fishing from Middle Bar Bridge. However, visitation has increased as increased white-water rafting and kayaking has become more popular. Approximately 2 miles upstream of Middle Bar Bridge, at Highway 49 Bridge, the Bureau of Land Management manages the Big Bar Launch.

The improvements to the Middle Bar Area facilitate egress from the river for whitewater kayakers and rafters, which increases safety and limits body contact with Pardee Reservoir, as the high-water mark of the reservoir comes up to Middle Bar Bridge. The Middle Bar Day Use Area features an off-street parking area that accommodates 20-25 cars, restrooms, waste and recycling containers, and a designated pathway from the river to the roadway near the parking area. The site also includes a short pedestrian pathway from the new parking area to the existing Middle Bar Bridge. EBMUD is responsible for maintaining all the amenities at the site.

4.8.3 PROJECT RECREATION USE OF LANDS AND WATERS

4.8.3.1 CURRENT PROJECT RECREATION USE

EBMUD collects recreation visitor data at all the FERC-approved recreation sites annually. Typical recreation activities include day use, boating, camping, and seasonal RV camping. Figure 4.8-13 provides visitor days of the various areas visited by recreationists by calendar year from 2020 through 2024. The lower usage in part of 2023 was due to the MRDUA being closed March 16 to July 24 due to high flows in the river from the high amount of runoff into the watershed. Figure 4.8-14 and Figure 4.8-15 provide a graphical summary of visitors to the Camanche North and South Shore recreation areas and Pardee Recreation Area, respectively, in 2024, broken out by type of visitation.

The total number of visitors was estimated by applying a "persons-per-use" multiplier to each recorded use type. These multipliers were derived from visual surveys conducted at both Camanche and Pardee reservoirs to reflect typical group sizes associated with each activity.

- **Camanche Reservoir**:
    - Day Use and Boat entries were multiplied by 3
    - Campers were multiplied by 3.5
    - Cottage and Short-Term RV users were multiplied by 4
    - Six-Month RV users were multiplied by 2

- **Pardee Reservoir:**
    - All use types were uniformly multiplied by 3

This approach provides a standardized method for estimating total attendance based on observed usage patterns.

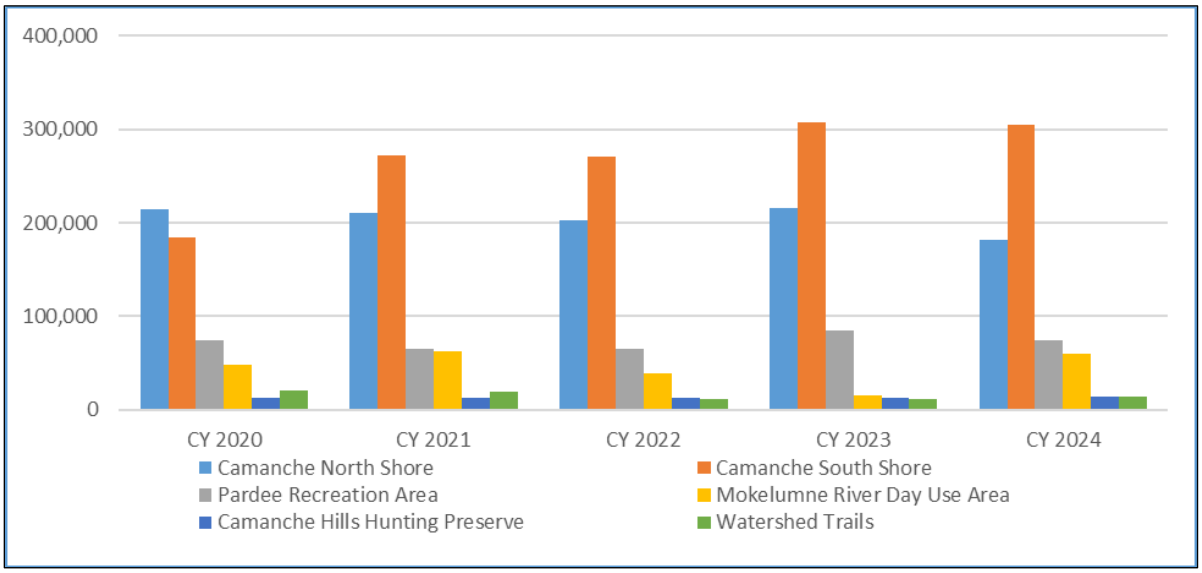


Figure 4.8-13. Overall recreation visitation at the Lower Mokelumne River Project.

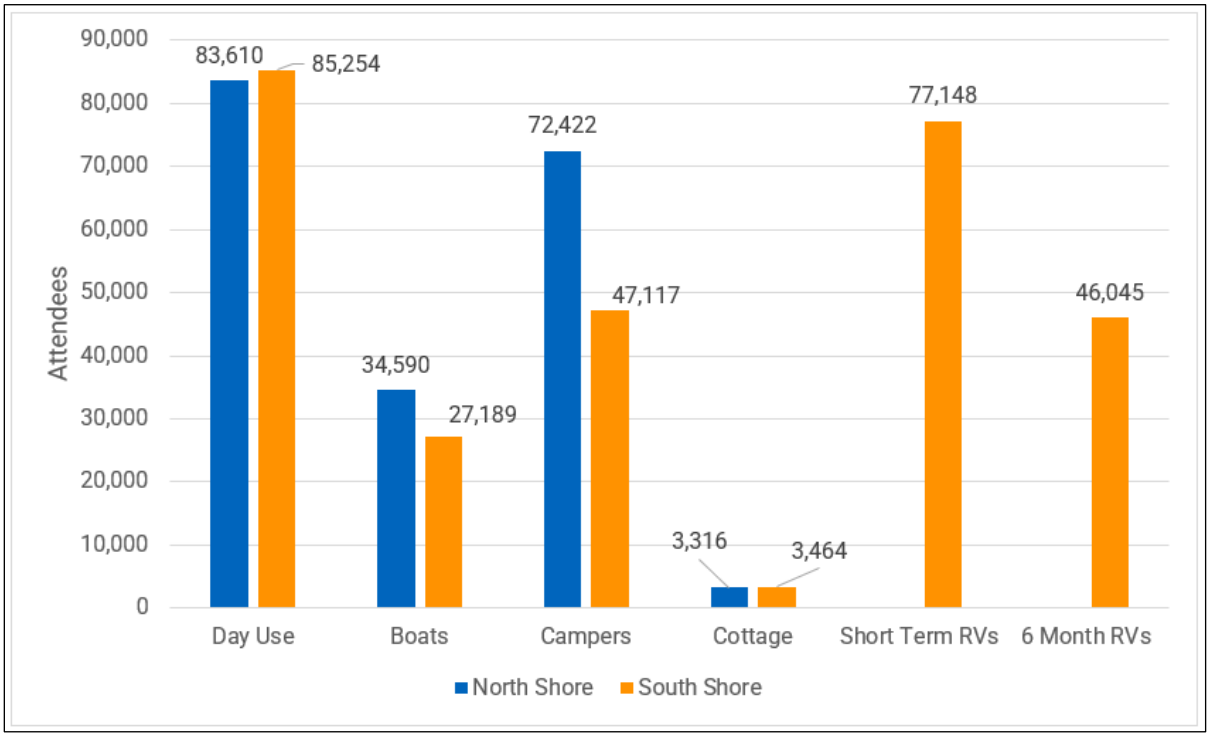


Figure 4.8-14. Camanche Reservoir visitation in 2024.

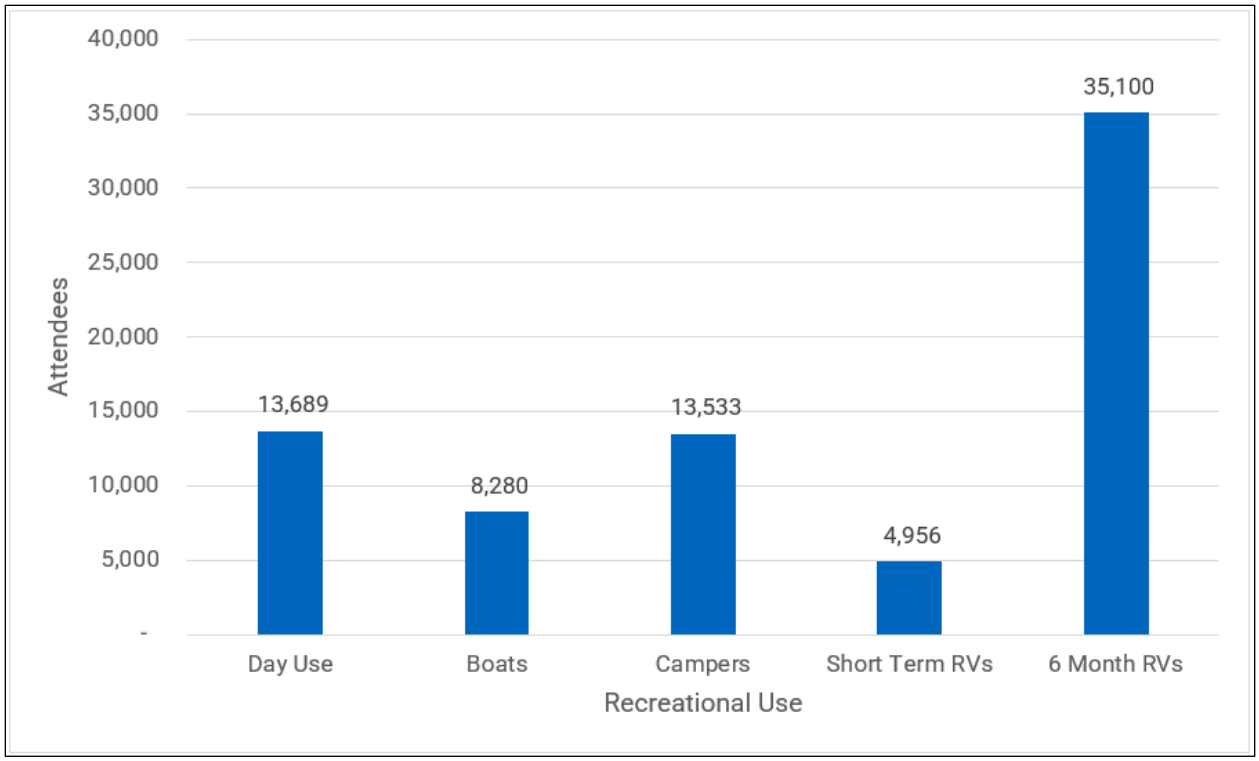


Figure 4.8-15. Pardee Reservoir visitation in 2024.

4.8.3.2 FERC FORM NO. 80 REPORTS

Until recently,[12] licensees were required to file a Licensed Hydropower Development Recreation Report, FERC Form No. 80 (Form 80 Report) for each Project development every 6 years, unless the licensee obtained an exemption from FERC. EBMUD filed its most recent Form 80 Report on March 27, 2015, reporting recreational use data for the 2014 calendar year for Pardee and Camanche reservoirs (EBMUD 2015a). From 2009-2014, EBMUD collected recreational use data at recreation facilities within the Project boundary to estimate annual use, peak season use, peak weekend use, and capacity utilization of each amenity within the Project boundary.

Survey results from the 6 years, 2009-2014, indicated that the recreation facilities at the Pardee, Camanche South Shore, and Camanche North Shore recreation areas are sufficient to meet recreational demand at the Project. Recreation use in that 6-year period reached maximum capacity only a few times, mainly during peak weekends (Memorial Day, Fourth of July, and Labor Day) when camping and RV short-term spaces typically filled. Survey results also showed that day use and boating followed a seasonal trend with

[12] FERC discontinued the Form 80 Report requirement for all projects in December 2018.

the high usage periods associated with popular seasonal fishing at Pardee Reservoir and warm weather flat-water recreation at Camanche Reservoir (EBMUD 2015b).

4.8.4 CURRENT AND FUTURE RECREATION NEEDS LISTED IN EXISTING STATE OR REGIONAL PLANS

EBMUD adopted a Mokelumne Watershed Master Plan: Recreation Management Plan in 2010 (EBMUD 2010) that provides guidance on addressing future recreation facility demand in the Mokelumne River watershed based on projected demand, population demographic changes, existing facility capacities, specific recreation management objectives, and feedback from recreation users. The plan provided future recreation estimates and planning guidance through 2040. Table 4.8-3, excerpted from the Recreation Management Plan, shows a projected increase in recreation demand (EBMUD 2010).

Table 4.8-3. Projected decadal increase (%) in recreation demand.

Recreation Management Unit	2020	2030	2040
Camanche Reservoir	15.1	15.4	15.7
Pardee Reservoir	15.1	15.4	15.7
Camanche Hills Hunting Preserve	8.6	8.7	8.8
Mokelumne River Day Use Area	15.3	15.4	15.6
Trails	13.2	13.4	13.5
Camanche North Shore Recreation Area			
Day Use	15.1	15.4	15.7
Camping	11.6	11.5	11.6
Camanche South Shore Recreation Area			
Day Use	15.1	15.4	15.7
Camping	11.6	11.5	11.6
Recreational Vehicles	11.6	11.5	11.6
Pardee Recreation Area			
Day Use	15.1	15.4	15.7
Camping	11.6	11.5	11.6
Recreation Vehicles	11.6	11.5	11.6

Source: EBMUD 2010

4.8.4.1 2025 CALIFORNIA STATEWIDE COMPREHENSIVE OUTDOOR RECREATION PLAN

According to the California Department of Parks and Recreation (CDPR), the California Statewide Comprehensive Outdoor Recreation Plan (SCORP) is a “five-year plan that establishes grant priorities to address unmet needs for public outdoor recreation land throughout California” (CDPR 2021a). The SCORP also provides policy guidance to all outdoor recreation providers, including federal, state, local, and special district agencies,

that provide outdoor recreational lands, facilities, and services throughout California (CDPR 2021a). While the 2021 SCORP did not offer specific data regarding current and future recreation needs, the following two reports contain essential elements in the Plan's development that provide information relevant to the Project area:

- *California's Vision for Park Equity, 2000-2020: Transforming Park Access with Data and Technology* (CDPR 2021b)
- *Designing Parks Using Community-Based Planning* (CDPR 2021c)

Through a robust community-based planning approach in developing the SCORP (CDPR 2021a), 7 advisory council focus groups along with 30 public focus groups from around the state of California found 5 key areas that needed to be addressed:

1. *New Park Access*
    a. *Create or expand parks in communities that lack sufficient park space. Create new parks within a half mile of underserved communities or expand existing parks to increase the ratio of park acreage per resident in underserved areas. This may include innovative solutions such as acquiring private land from willing sellers such as vacant lots and blighted buildings, converting streets to create or expand parks, or converting closed schools.*
    b. *Acquire private land from willing sellers in natural areas to expand regional parks or create new open space areas for outdoor recreation while preserving nature.*
2. *Multi-Use Parks Designed for All Age Groups In New or Existing Parks*
    a. *Construct recreation features designed to bring families together by supporting art and music, sports, and multi-generational activities.*
    b. *Construct recreation features for all age groups to support active and passive recreation interests.*
    c. *Incorporate project design ideas from all age groups*
3. *Health Design Goals for New or Existing Parks*
    a. *Include recreation features resulting from asking community members for their park design ideas for public health.*
4. *Safety and Beautification of New or Existing Parks*
    a. *Construct lighting for night-time use, restrooms, landscaping, signs, or other enhancements to make the park appear welcoming and support longer hours of use.*
5. *Preservation*
    a. *Through the Land and Water Conservation Fund, place outdoor open space land under new 6(f)(3) protection for public recreation.* (CDPR 2021a)

Based upon its research, the CDPR (2021a) identified that 71 percent of residents in Amador County, 59 percent of residents in Calaveras County, and 27 percent of residents in San Joaquin County lived further than 0.5 mile from a park as compared to the state of California overall, where 21 percent of residents lived further than 0.5 mile from a park. Additionally, CDPR noted that 0 percent of Amador County residents, 0 percent of Calaveras County residents, and 61 percent of San Joaquin County residents lived in areas with less than 3 acres of parks or open space per thousand residents as compared to the state of California, where 61 percent of residents live in areas with less than 3 acres of parks or open space per thousand residents (CDPR 2021a).

4.8.4.2 AMADOR COUNTY GENERAL PLAN

The Amador County General Plan noted that there are 30 parks and/or recreation facilities located within that county. The Amador County Recreation Agency developed a Recreation Master Plan in 2006. The Recreation Master Plan found that a new 20- to 30-acre rural day-use park is needed in the northern portion of the county (Amador County 2016).

According to the Amador County General Plan, the most popular and in-demand recreational services provided by parks and developed recreation areas within Amador County are trails that are used for biking, hiking, walking, and horseback riding (Amador County 2016). For this reason, the Amador County Recreation Agency has been seeking opportunities to expand upon existing recreational trail options. To support these efforts, a Pedestrian and Bicycle Transportation Plan has been adopted by the Amador County Transportation Commission (Amador County 2016). Additionally, Amador County is interested in maintaining opportunities for recreation at publicly owned, undeveloped, open space land to support public recreation and increased tourism (Amador County 2016).

4.8.4.3 CALAVERAS COUNTY PARKS AND RECREATION MASTER PLAN

According to the Calaveras County Parks and Recreation Master Plan, there are 6 county-owned recreation areas, 14 non-county-owned recreation areas, and 10 school facilities (which offer recreation opportunities). A recreation needs assessment was conducted in 2024 in the Calaveras County community to gain a better understanding of how the community engages in parks and recreation within the county. The assessment revealed that Calaveras County residents enjoy visiting local parks, engaging in recreational activities, and value nature and the unique scenic resources of the region. However, there is a demand within the community for additional parks, park amenities and facilities, sports fields, and recreation programs for a variety of recreation uses (Calaveras County 2025).

4.8.4.4 SAN JOAQUIN COUNTY GENERAL PLAN

The San Joaquin County Parks and Recreation Division oversees 9 regional and 12 non-regional parks within the county (totaling 997 acres of parkland) (San Joaquin County 2018). According to the San Joaquin County General Plan (SJCGP), recreation is an important part of the county's economy, and San Joaquin County has a vested interest in meeting the active and passive recreation needs of San Joaquin County residents and visitors. The focus of San Joaquin County's recreation goals (as outlined in the SJCGP) is to protect and support existing recreation areas and parks, while increasing active parkland and comprehensive recreation programs. This goal is further described in GOAL NCR-8 of the SJCGP (San Joaquin County 2016).

4.8.4.5 SHORELINE MANAGEMENT PLAN AND BUFFER ZONES

There are no shoreline management plans or buffer zones associated with either the Camanche or Pardee Project reservoirs because the shorelines of Camanche and Pardee Reservoir are located wholly on EBMUD lands. It is EBMUD's land use policy to provide an effective shoreline buffer that protects and enhances the Project's scenic, recreational, and other environmental values, while ensuring continued safe and reliable production of hydroelectric power.

4.8.4.6 NATIONAL WILD AND SCENIC RIVER SYSTEM

The Project is not located on or adjacent to any national Wild and Scenic River segments.

4.8.4.7 NATIONAL TRAIL SYSTEM

There are no designated national trails located within or adjacent to the Project.

4.8.4.8 STATE PROTECTED RIVER SEGMENTS

There is a river segment that is designated as part of the state's Wild and Scenic River System located outside of the Project boundary above Pardee Dam (Figure 4.8-16). EBMUD and partners in the Sierra Nevada foothills, with leaders in the California government, were able to designate 37 miles of the North Fork and mainstem of the Mokelumne River running through Amador and Calaveras counties as the 12th California Wild and Scenic River segment on June 27, 2018. The designation preserves the river above Pardee Dam, protecting it from new projects that would impact natural river flows or the scenic and recreational value of those areas.

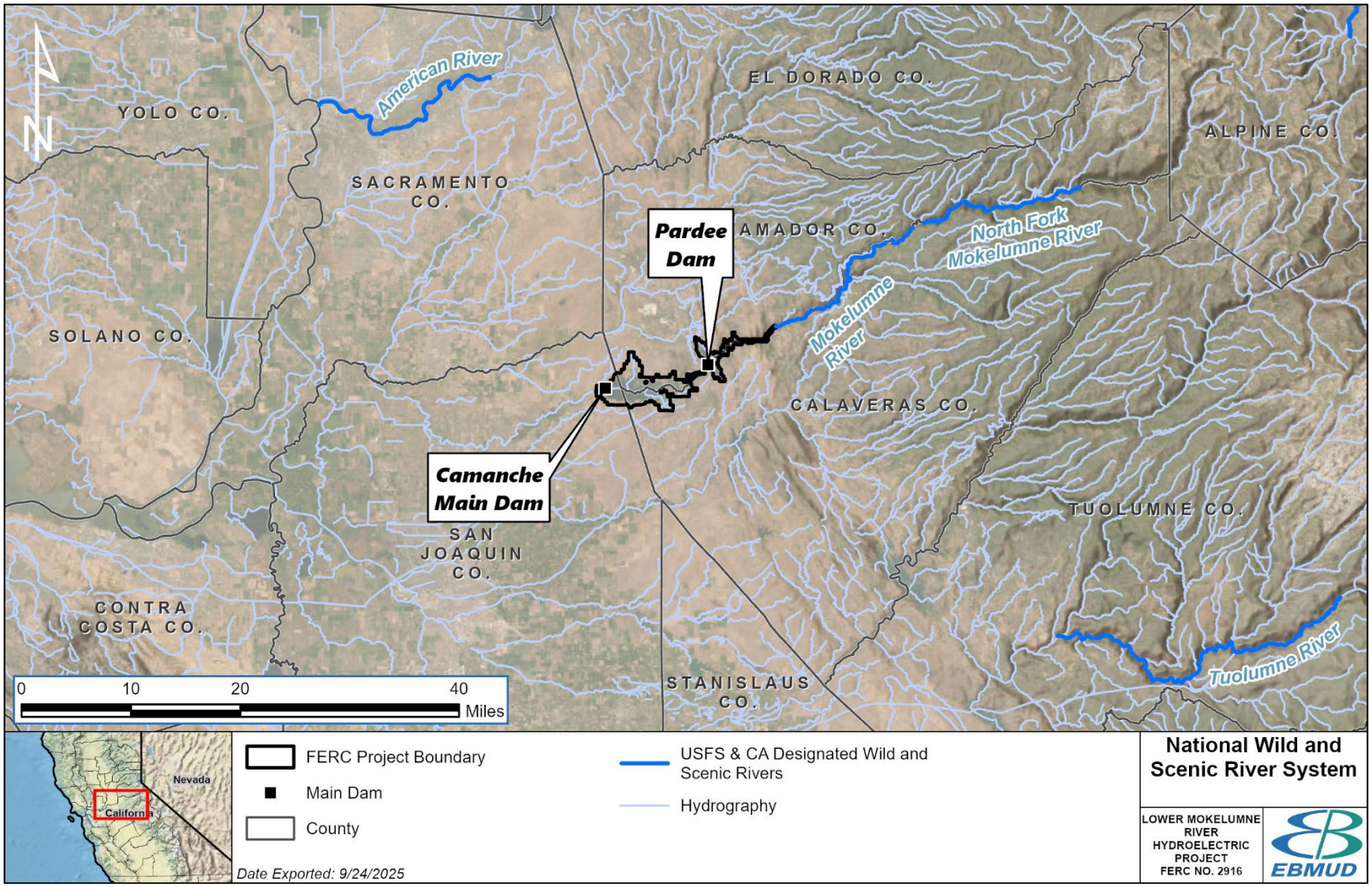


Figure 4.8-16. Wild and Scenic reach of Mokelumne River upstream of the Project.

4.8.4.9 WILDERNESS AREAS

The closest wilderness area to the Project is the Woodbridge Wilderness Area, located approximately 25 miles downstream from Camanche Dam. The wilderness area is open on the first and third weekends of the month from 9:00 a.m. to 12:00 p.m. The Woodbridge Wilderness Area offers a nature area, fishing, walking trails, and access to the Mokelumne River (San Joaquin County Parks 2025). There are no wilderness areas located within the Project boundary.

4.8.5 LAND USE AND MANAGEMENT ADJACENT TO THE PROJECT

Agriculture, rangeland, and associated low density rural residential structures are the dominant land uses in the watershed surrounding the Camanche and Pardee reservoirs. Throughout the watershed, anthropogenic land uses in the watershed primarily include recreational and transportation infrastructure (e.g., campgrounds, marinas, highways, roads) (EBMUD 2010).

EBMUD owns lands adjacent to the Project that provide multiple purposes including a buffer to EBMUD water system infrastructure for security, dam safety, and water quality purposes. The lands are divided into six geographically based categories, as summarized below (EBMUD 2008b).

Watershed Management: Large areas managed for the primary goal of protection of water quality, fire control, and ecological integrity. These lands are generally undeveloped rangeland. Public access to these lands is by permit only.

Natural Preserve: Areas managed for the creation, restoration, and protection of natural systems (aquatic, riparian, and upland habitats) surrounding Pardee and Camanche reservoirs and their tributaries. These areas are typically closed to public access with the exception of permitted access for livestock grazing, educational research and study, and trails connecting with lands in other land use categories.

Recreation Areas: Parcels and sites of various sizes for developed recreation activities including trails.

Community Resource: Generally small areas that support resources of specific community interest, such as cultural and historical sites, vista points, unique geologic features, or unique vegetative communities. Access is typically by permit only.

Mobile Home Park: There are three mobile home parks at Camanche Reservoir, two on Camanche North Shore, and one on Camanche South Shore. These are excluded from the Project boundary.

District Operation: Lands reserved for the exclusive use of EBMUD in carrying out its mission and related business activities, most of which are closed to the public. Exceptions include EBMUD offices serving public recreational and other permitted uses and roadways EBMUD makes available for public use. Operational areas include the following:

- Camanche Dam, spillway, and power generation facilities
- Pardee Dam, spillway, and power generation facilities
- Pardee Center
- Mokelumne Watershed Offices
- Camanche Ranger Headquarters
- Mokelumne River Fish Hatchery
- Aqueduct and accessory facilities
- Utility corridors and accessory facilities

4.8.6 LAND USE AND MANAGEMENT WITHIN THE PROJECT BOUNDARY

The Project is located on the Lower Mokelumne River at RM 82.93 in Amador, Calaveras, and San Joaquin counties in the state of California. The Project is located entirely on EBMUD-owned land. An analysis of the Multi-Resolution Land Characteristics (MRLC) Consortium's 2023 National Land Cover Database (NLCD) provides information on land use by generalizing land cover within the Project boundary (MRLC 2023). As summarized in Table 4.8-4 and shown on Figure 4.8-17, predominant land cover within the Project boundary, aside from open water, is herbaceous, shrub/scrub, evergreen forest (MRLC 2023).

4.8.6.1 NON-PROJECT USE OF PROJECT LANDS

EBMUD has successfully developed four photovoltaic (PV) projects that can generate up to a total of 611 kW of renewable energy within the Project boundary to help offset a portion of the annual energy consumption and support the emissions reductions goals as specified in EBMUD's energy policy. EBMUD installed PV projects at Camanche Recreation Area Water Treatment Plan, Camanche North Shore and South Shore wastewater ponds in 2011, and east of Camanche Dam in 2019.

Table 4.8-4. NLCD land cover within the Project boundary.

Grid Code	Acres	Percentage (%)	Land Class
11	9,090.4	47.7	Open Water
21	420.8	2.2	Developed, Open Space
22	193.9	1.0	Developed, Low Intensity
23	131.4	0.7	Developed, Medium Intensity
24	7.8	0.0	Developed, High Intensity
31	76.3	0.4	Barren Land
41	452.9	2.4	Deciduous Forest
42	924.2	4.8	Evergreen Forest
43	11.1	0.1	Mixed Forest
52	2,829.8	14.8	Shrub/Scrub
71	4,842.2	25.4	Herbaceous
82	0.9	0.0	Cultivated Crops
90	69.4	0.4	Woody Wetlands
95	24.2	0.1	Emergent Herbaceous Wetlands

Source: MRLC 2023

Project land has been used for cattle grazing since settlement in the nineteenth century and was the dominant land use when EBMUD purchased the property in the 1960s (FERC 2016). Cattle grazing continues to be a part of EBMUD's vegetation management program and occurs through grazing leases on the lands surrounding both reservoirs.

Authorized conveyances for non-Project use of Project lands include limited land use permits for seismic recording equipment and communications infrastructure.

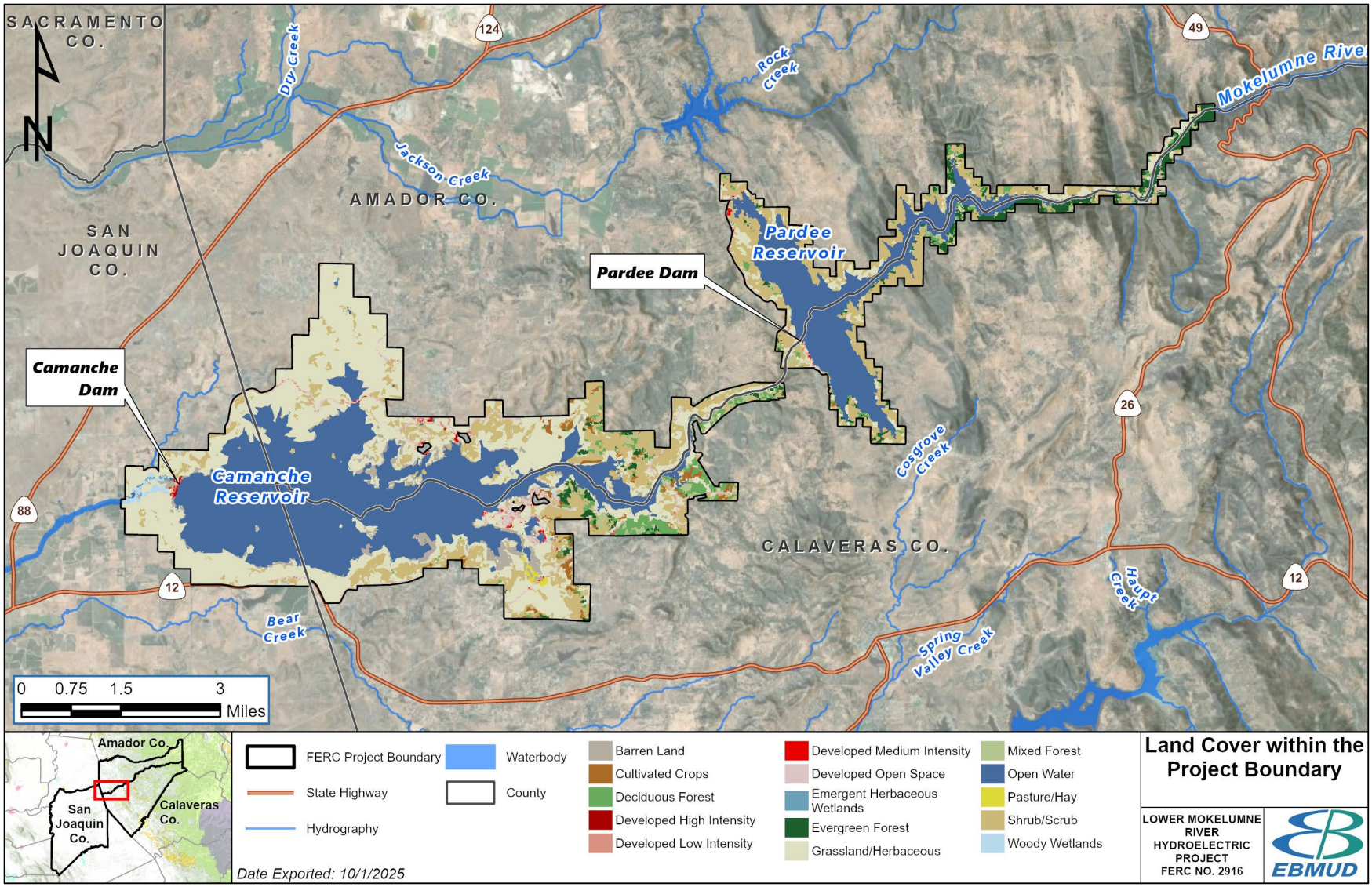


Figure 4.8-17. Land cover map of the Lower Mokelumne River Project.

4.9 AESTHETIC RESOURCES

4.9.1 VISUAL CHARACTER OF PROJECT FACILITIES, AFFECTED LANDS, AND AFFECTED WATERS

4.9.1.1 PROJECT FACILITIES

Pardee Facilities

Pardee Dam was completed in 1929. It is a concrete gravity structure and is 345 feet high at its crest, as measured from the lowest elevation of the downstream limit of the dam, excluding the 6.5-foot-tall parapet wall, and is 1,337 feet long (Photo 4.9-1). Flows from Pardee Dam are released directly into the upper reach of Camanche Reservoir.

Photo 4.9-1. Pardee Dam.

Photo 4.9-2. Pardee Spillway.

Photo 4.9-3. Pardee Powerhouse.

The South Spillway is located approximately 500 feet south of the left abutment of the dam (Photo 4.9-2). It is an ungated, mass-concrete, rock anchored, ogee-shaped weir control structure.

The original powerhouse structure at the base of the Pardee Dam was completed in 1929 (Photo 4.9-3). It is constructed of reinforced concrete and has several floors.

The Jackson Creek Spillway and Dike is a concrete structure flanked with earth embankments and one additional earth dike southwest of the Jackson Creek Spillway (Photo 4.9-4). The concrete siphon spillway, with a crest length of 1,360 feet, was originally constructed by EBMUD to discharge expected flood water into the Jackson Creek drainage basin. The siphon structure has never functioned as a spillway, and the 16 siphon openings were backfilled with concrete to El. 558 feet in 1994. A rockfill buttress was also added downstream of the siphon structure to improve structural stability. The Jackson Creek West End Dike, constructed by EBMUD in 1929, is a saddle dike located a few hundred feet southwest of the Jackson Creek Spillway, and both the spillway's abutments are earthen embankments. They all have two compacted earthfill zones with a curved, reinforced concrete upstream face.

Photo 4.9-4. Jackson Creek Spillway.

Pardee Reservoir lies in the rolling foothills of the Sierra Nevada. The reservoir encompasses approximately 37 miles of shoreline with three main arms extending north, east, and south (Photo 4.9-5). The reservoir's surroundings comprise annual grassland, oak woodland, foothill pine woodland, and chaparral that are largely in a natural state. The built environment surrounding the reservoir is limited, consisting of roads, the main dam, auxiliary dams, and recreational facilities. The specific facilities are located along the western shoreline of the reservoir's north and south arms. Also located to the west, Pardee Dam Road/Sandretto Road extends along the entire length of the reservoir. (EBMUD 2013)

Photo 4.9-5. Pardee Reservoir.

The lake and shoreline contrast sharply with the nearby rolling wooded foothills. Visual quality is highest in the late spring and early summer when reservoir levels are high. This period corresponds with the highest level of viewer exposure because the Pardee Recreation Area is open to the public only from February through October. As summer progresses into winter, reservoir drawdown typically exposes a ring of bare soil along the shoreline.

Vistas available to residents and visitors to the watershed are typical of those found in the lower Sierra Nevada foothills, including rolling hills, waterbodies surrounded by rising hills (Photo 4.9-6), and views of the Sierra Nevada Mountains. Higher elevations in the Project vicinity in the watershed offer scenic views of distant hills and valleys and, from some locations, the Sierra Nevada Mountains rising to the east. Contrasts between the surface water of the reservoirs, the variation in near and distant terrain and vegetation, and the expanse of the sky enhance the quality of these vistas (Photo 4.9-7). From lower elevations, vistas consist of views across the reservoirs or across the rolling landscape surrounding the reservoirs. Because of elevation differences, some near-shore locations also offer longer vistas beyond the reservoirs.

Source: Photo by P. Jain, EBMUD

Photo 4.9-6. View of Pardee Reservoir within the hills at sunrise.

Source: Pardee Lake Recreation 2025

Photo 4.9-7. View of Pardee Reservoir from Pardee Recreation Area.

The reservoir and nearby Project facilities occupy the foreground of the various viewsheds around the Paradee Reservoir and adjacent areas (Photo 4.9-8). Major viewer groups associated with the reservoir and reservoir facilities include the residents of nearby areas, recreationists using the reservoir and trails, users of Pardee Dam/Sandretto Road, and facility staff members. For these viewer groups, exposure and sensitivity are relatively high.

Photo 4.9-8. View of steep cliff in the Pardee Recreation Area.

The Pardee Powerhouse is located at the toe of Pardee Dam, with transmission lines from the existing powerhouse substation and other overhead utility lines that stretch from north to south through this area. South of Pardee Dam, the spillway occupies the foreground of the Mokelumne River/upper Camanche Reservoir viewshed from an observation point, Pardee Dam Road, and adjacent facilities. Overall, the reservoir views are vivid, intact, and unified. They stand out from typical roadside scenery, remain undisturbed in the rural, open space, and harmonize in scale, color, and form. An example of the vast open space is Vista Dos Lagos, which provides views of Pardee and Camanche Reservoirs (Photo 4.9-9).

Photo by C. Swann, EBMUD

Photo 4.9-9. Vista Dos Lagos.

Camanche Facilities

Camanche Main Dam was completed in 1964 and is a zoned compacted earthfill structure (Photo 4.9-10).

Photo 4.9-10. Camanche Dam.

The spillway is located through Dike No. 3, about 1,000 feet left of the left abutment of the Main Dam (Photo 4.9-11). The spillway consists of an unlined approach channel, an ogee control structure, a 1,550-foot-long concrete chute, and an unlined channel that rejoins the Mokelumne River. The concrete chute has approximately 24-foot-tall vertical side walls.

Photo 4.9-11. Camanche Spillway.

Photo 4.9-12. Camanche Powerhouse.

The Camanche Powerhouse (Photo 4.9-12) was added to the dam in July 1983. The powerhouse is located about 250 feet downstream from the Camanche outlet structure on the north bank of the Mokelumne River. The Camanche Powerhouse is a reinforced concrete structure approximately 63 feet wide by 102 feet long.

The landscape surrounding Camanche Reservoir is similar to Pardee Reservoir in that it is a scenic, vista-rich environment (Photo 4.9-13). The dominant vegetation is grassland, chaparral, oak woodland, and foothill pine. The built environment surrounding the reservoir is limited, consisting of dirt roads, the main dam, dikes, and recreational facilities. The multiple recreational sites provide for a peaceful lakeside experience and a tranquil setting for fishing, boating, and camping. The specific facilities are located along the western, northern, and southern shoreline of the reservoir. Within the Project vicinity, there are multiple state and regional scenic trails, which are described in greater detail in Section 4.8.5.2, that provide unique vantage points for photo opportunities in picturesque settings.

Photo 4.9-13. View of Camanche Reservoir and surrounding rolling hills.

Vistas at the Camanche Reservoir occur from higher elevations in the drainage. Similar to the Pardee Reservoir, these vantages offer scenic views of distant hills and valleys and provide a scenic contrast between the surface water of the reservoir, the variation in near and distant terrain and vegetation, and the expanse of the sky. From lower elevations,

vistas consist of views across the reservoirs or across the rolling landscape surrounding the reservoirs (Photo 4.9-14 and Photo 4.9-15). Because of elevation differences, some near-shore locations also offer longer vistas beyond the reservoirs.

Photo 4.9-14. Camanche Reservoir Looking West.

Photo 4.9-15. Camanche Reservoir Looking East.

Mokelumne River Fish Hatchery

The MRFH (Photo 4.9-16), built in 1963 and remodeled in 2002, is located just downstream of the Camanche Reservoir, approximately 2 miles east of Clements (CDFW 2025b). The MRFH works to raise Chinook Salmon and steelhead to release into the Mokelumne River (CDFW 2025b). The MRFH is open to the public, offering formal and self-guided tours, where visitors can see the fish ladder, the Mokelumne River, the MRFH building, and raceways, as well as feed the fish with fish food that the MRFH makes available (CDFW 2025b).

Photo 4.9-16. View of the Mokelumne River Fish Hatchery at the base of the Camanche Dam.

4.9.1.2 AFFECTED LANDS AND AFFECTED WATERS

Mokelumne River Watershed

The Lower Mokelumne River Project comprises two existing major dams, two existing reservoirs, an existing powerhouse at an upstream location (Pardee Dam) with three hydro-generating units, an existing powerhouse at a downstream location (Camanche Dam) that contains three turbine-driven generating units, and various associated facilities at each of the two sites, which are viewable by the public from publicly accessible roads and have been described in detail in Section 3.0.

Upper Mokelumne River Watershed

The Mokelumne River consists of two watersheds, the Upper Mokelumne River watershed (Photo 4.9-17), and the Lower Mokelumne River watershed. The Upper Mokelumne River watershed includes lands draining into the North Fork, Middle Fork, South Fork, and Main Stem Mokelumne River (RMC Water and Environment [RMC] 2007). Highway 49 is the downstream boundary of the approximately 550-square-mile Upper Mokelumne River watershed, which is located within Alpine, Amador, and Calaveras counties (RMC 2007) (Photo 4.9-18. The Upper Mokelumne River watershed has rugged terrain that varies significantly in elevation from El. 585 feet near Highway 49 to El. 10,381 feet at Round Top Peak (RMC 2007). The lower elevations consist of rolling foothills (Photo 4.9-19) that transition as the elevation rises to steep and rocky slopes (RMC 2007).

Source: NOAA 2025 – Photo by John Benson

Photo 4.9-17. Upper Mokelumne River watershed.

Source: RMC 2007

Photo 4.9-18. Mokelumne River at Highway 49.

Source: EBMUD 2025e

Photo 4.9-19. View of rolling foothills and Pardee Reservoir from the John Bull Loop Trail.

The Upper Mokelumne River watershed has minimal development, with vegetation that is dominated by mixed coniferous forest, including ponderosa pine, Douglas fir in the lower elevations, and red fir in higher elevations (RMC 2007). Mixed hardwood forests are found in the riparian areas and include live oak and black oak, and open grasslands are present throughout the lower elevations (RMC 2007) (Photo 4.9-20).

Lower Mokelumne River Watershed

The Lower Mokelumne River watershed includes areas in Amador, Calaveras, San Joaquin, and Sacramento counties. It is characterized by agricultural, urban, and recreational land uses. The watershed supports diverse activities, including farming, municipal water supply, recreation, and for conservation purposes. (CNRA 2018).

Source: RMC 2007

Photo 4.9-20. Mixed forest and grasslands within the Upper Mokelumne River watershed.

The Lower Mokelumne River is characterized by rolling hills and small valleys, with occasional rock outcrops. The dominant natural vegetation is annual grassland and native oak woodlands, occurring in varying densities. The tree canopy cover and species diversity increase in small draws and valley bottoms where water is more readily available. The contrasts in form, color, and texture of this vegetation add visual variety and interest to the landscape. (EBMUD 2008b). Due to the releases from Pardee and Camanche reservoirs, flows are present year-round in the Lower Mokelumne River.

The Lower Mokelumne River watershed, downstream of Camanche Dam, is located in the Central Valley and the Sacramento-San Joaquin Delta (Delta) in San Joaquin and Sacramento counties. The watershed feeding into EBMUD's storage facilities covers an area of 621 square miles and extends from the peak of Round Top (El. 10,364 feet) near the crest of the Sierra Nevada to Camanche Reservoir (El. 235 feet, Project Datum) located in the lower western foothills near Clements (NOAA 2025). Most of the watershed is forested land within the Eldorado and Stanislaus national forests. The Lower Mokelumne River begins downstream of Camanche Dam and runs southwesterly through the town of Lodi, California, and then northwesterly until it is joined by the Cosumnes River. It then enters the Delta, splitting into the North and South fork channels near the Delta Cross Channel (NOAA 2025). Photo 4.9-21 provides a view from the Rich Gulch Trail in the Lower Mokelumne River watershed, and Photo 4.9-22 provides a view of "The Longest Mile," a section of the Mokelumne Coast to Crest Trail (MCCT), also located in the Lower Mokelumne River watershed.

Source: MCCT 2025

Photo 4.9-21. View from Sierra Foothills Rich Gulch Trail.

Source: Calaveras Visitors Bureau 2025

Photo 4.9-22. View of "The Longest Mile."

Agriculture, rangeland, and associated low density rural residential structures are the dominant land uses in the watershed surrounding the Camanche and Pardee reservoirs. Land uses in the watershed primarily include recreational and transportation infrastructure (e.g., campgrounds, marinas, highways, roads). The majority of undeveloped land cover within the watershed primarily consists of grassland, woodland/forest, or chaparral. (EBMUD 2008b).

Most of the land within the watershed is undeveloped open space, left vacant or leased for grazing livestock; however, within the FERC Project boundary, there are six recreation facilities, described in detail in Section 4.8, *Recreation and Land Use*, which provide public recreation including day use, hiking, overnight camping, boating, fishing, hunting, and trap and sporting clay activities.

Nearby Scenic Attractions

Within the Project boundary in the Sierra Foothills, EBMUD offers various recreation activities to enjoy and explore the scenic environment near Pardee and Camanche reservoirs. Public recreation is provided in the form of trails, recreation areas, and facilities, including day use, hiking, overnight camping, boating, fishing, hunting, and trap and sporting clay activities.

Within the vicinity of the Project, there are multiple state and regional scenic trails. The MCCT (Photo 4.9-23), a California State Park Trail, roughly follows the Mokelumne River from the headwaters at the Sierra Nevada Crest down to the town of Martinez on the Carquinez Strait where the river enters the San Francisco Bay. Within the Project boundary, there are 29 continuous miles of the MCCT. Other regional trails within the Project boundary include the John Bull Loop Trail, Cooks Mesa Trail, Patti's Point (Photo 4.9-24), Rich Gulch Trail, and Middle Bar through Independence Flat. The trails offer observation opportunities for the surrounding foothills, Mokelumne River, and wildlife.

Photo 4.9-23. View from along the MCCT from James Bar, facing

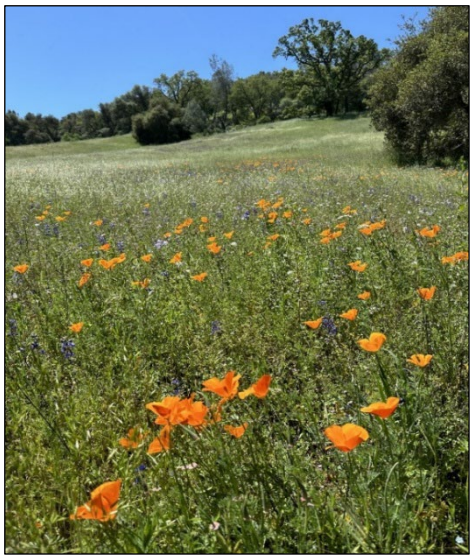


Photo 4.9-24. View at Patti's Point peak.

California State Route 49, also known as the Golden Chain Highway (California Highways 2024), located northeast of the Project, has been listed as eligible to be designated as a State Scenic Highway. This designation would limit the development, outdoor advertising, and other impacts that could affect the scenic quality (Caltrans 2025). The route extends 295 miles from Oakhurst in Madera County, in the Sierra Nevada, and ends where it reaches its northern terminus at State Route 70, in the town of Vinton in Plumas County. The route passes through many historic mining communities of the 1849 California Gold Rush, offering picturesque views and a glimpse into California's Gold Rush past (California Highways 2024).

On June 27, 2018, 37 miles of the North Fork and mainstem of the Mokelumne River running through Amador and Calaveras counties were designated as the 12th California

Wild and Scenic River (Photo 4.9-25) (Digital Democracy 2016; EBMUD 2018). The designation preserves the river above Pardee Dam, protecting it from new projects that may impact natural river flows or the scenic and recreational value of those areas.

Photo 4.9-25. Wild and Scenic River designated portion of the Mokelumne River (upstream from Pardee Reservoir).

4.10 CULTURAL RESOURCES

This section provides an overview of the cultural resources of the Lower Mokelumne River Project, including buildings and structures, archaeological sites, and historic districts, with a focus on those resources that are listed in, or eligible for listing in, the National Register of Historic Places (National Register), pursuant to the National Historic Preservation Act of 1966 (NHPA). Consistent with guidance in 18 CFR § 5.6 (d)(3)(x), this section includes the following: (1) a definition of the Project's area of potential effects (APE) and the cultural resources study area; (2) a review of the cultural setting of the study area; (3) a review of previous efforts to document cultural resources; (4) a list of known built-environment and archaeological resources; and (5) a brief discussion of the potential significance of these resources to Native American Tribes.

A more detailed review of National Register-listed, eligible, and potentially eligible cultural resources, and Project-related impacts to those resources, will be presented in a Historic Properties Management Plan (HPMP).

The specific locations of archaeological sites are considered privileged information because their disclosure can lead to damage to these resources; accordingly, they are not presented in this review.

4.10.1 AREA OF POTENTIAL EFFECTS AND STUDY AREA

A project's APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist" [36 CFR § 800.16(d)]. EBMUD has preliminarily identified the APE for the Lower Mokelumne River Project to include all lands within the FERC Project boundary and any lands outside the FERC Project boundary that may be affected by Project-related activities. A final determination of the Project APE will be made in consultation with Tribes, the California State Historic Preservation Office (SHPO), and FERC staff, as part of the study planning phase of relicensing. For the purposes of this review, the APE equates to the FERC Project boundary. A study area was also defined, that includes a 0.25-mile buffer around the FERC APE (Figure 4.10-1).

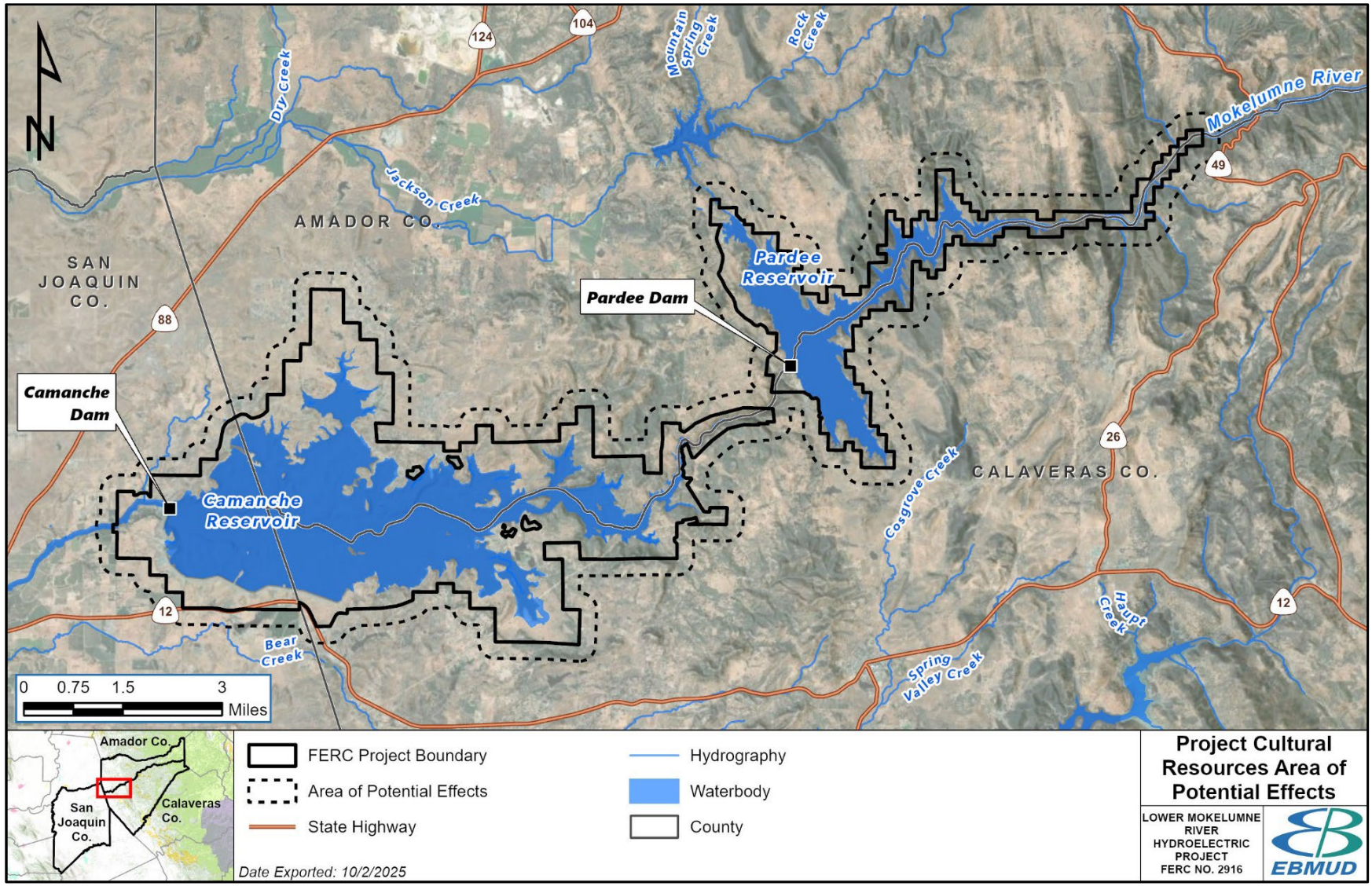


Figure 4.10-1. Project cultural resources study area of potential effects.

4.10.2 INFORMATION SOURCES

The primary information sources for this summary are the Camanche and Pardee reservoirs Cultural Resources Management Plan (CRMP) (DeBaker and Siskin 2019), and the 2021 historic property survey by Demarais et al. (2023). As part of the background research for the 2019 CRMP, cultural resources records searches were conducted at the Northern California Information Center of the California Historical Resources Information System (for portions of the study area within Amador County) and the Central California Information Center (for Calaveras and San Joaquin counties). An updated records search was requested in 2021 as part of the built-environment survey, though it was not discussed in the main text of the 2023 report. This review presents the updated records search data, with some modifications to remove redundant entries. The precontact archaeological sensitivity model discussed below was developed as part of the 2019 CRMP effort.

4.10.3 CULTURAL SETTING

The following sections, excerpted from the 2019 CRMP (DeBaker and Siskin 2019), provide an abbreviated cultural context and include general information pertaining to the precontact history, ethnohistory, and history of the study area. For more detailed background, refer to the 2019 CRMP and to Kimsey et al. (2018).

4.10.3.1 PRECONTACT SETTING

The precontact chronology presented here is based on the Central Sierra Nevada chronology developed by Rosenthal (2008), which presents a synthesis of chronological information from more than 100 excavated sites in the watersheds of the Mokelumne, Calaveras, Stanislaus, and Tuolumne rivers. The chronology extends from the earliest archaeologically documented occupation of the region at 11,500 calibrated years before present (cal BP) to the time of Euro-American contact, and identifies five major time periods: *Early Archaic, Middle Archaic, Late Archaic, Recent Prehistoric I*, and *Recent Prehistoric II*. Each period is distinguished by characteristic artifact types (e.g., projectile points, ornaments), subsistence technologies (e.g., mortar and pestle, bow and arrow), dietary practices (as revealed by dietary remains such as faunal bone and plant macrofossils), and settlement patterns and social organization (as revealed by site patterning and trade items).

Early Archaic (11,500–7000 cal BP)

Well-dated deposits from the Early Archaic are rare. In the Sierra Nevada foothills, sites dating to this period are identified locally at only two sites: Skyrocket (CA-CAL-629/630) in Salt Springs Valley, and Clarks Flat (CAL-342) located upstream from New Melones

Reservoir on the Stanislaus River. Both these sites were discovered in buried stratigraphic contexts. The assemblages from these sites include large numbers of wide-stem and large-stemmed dart points, as well as small numbers of other notched and stemmed projectile points. The Early Archaic stratum at the Skyrocket site included hundreds of handstones and millingslabs, as well as a variety of cobble-core tools, large percussion-flaked "greenstone" bifaces, and comparatively high frequencies of obsidian from the Bodie Hills source located east of the Sierra Crest. Milling equipment was less common at Clarks Flat. Plant macrofossil assemblages recovered from Skyrocket are dominated by gray pine and acorn nutshell but include few if any small seeds or other spring- and summer-ripening plant foods (e.g., manzanita). This suggests that the site was primarily used during the fall and early winter when nut crops were available (plant remains were not sampled at Clarks Flat). The large accumulation of ground stones in the Early Holocene stratum at Skyrocket probably represents the residue of repeated seasonal occupations over millennia. This may suggest that land use in the western Sierra Nevada was seasonally structured, rather than the wide-ranging, highly mobile lifestyle often believed to characterize the Early Archaic throughout the mountain west. This is further supported by the almost exclusive use of local toolstone for the manufacture of bifaces and projectile points at both the Skyrocket and Clarks Flat sites.

Middle Archaic (7000–3000 cal BP)

Middle Archaic sites were once thought to be quite rare in the Sierra Foothills. However, the apparent absence of this record can be attributed primarily to long-standing confusion among archaeologists over when corner-notched dart points first appeared on the western slope. These have commonly been thought to date exclusively to the last 3,000 years, with either broad-stem points (e.g., Stanislaus Broad Stem) or Pinto and Humboldt concave points (both thought to be Middle Holocene markers in the Great Basin) are more commonly associated with this period. However, recent excavations of several well-dated and stratified Middle Archaic sites have clearly revealed that corner-notched dart points were the predominant projectile point form used on the western slope of the north-central Sierra Nevada beginning about 7,000 years ago (Rosenthal 2008). Other stemmed and notched dart points also occurred during the Middle Archaic, but in significantly lower proportions.

The earliest house structures on the western slope were identified in a Middle Archaic stratum at the Edgemont Knoll site near Sonora, in association with large subterranean storage pits. A diverse assemblage of flaked, ground, and battered stone tools, along with comparatively high densities of dietary debris (plant remains and faunal bone) suggests that the Edgemont site served as a major residential base. Archaeobotanical remains, dominated by gray pine and acorn nutshell, reveal that the site was used primarily in the

fall and winter when large quantities of nuts were stored in underground granaries. The overwhelming abundance of nut crops at other Middle Archaic sites in the foothill woodlands suggests a similar season of occupation. In contrast, summer-ripening berries and other fruits are dominant in sites from higher elevations. These differences suggest a pattern of seasonal transhumance, with fall and winter villages located below the snowline in the blue oak/gray pine woodland, and summer camps situated in the coniferous forest zone where annual roots, bulbs, seeds, and fruits are common during warmer months. Faunal assemblages from Middle Archaic sites are dominated by large mammal remains (e.g., deer), a pattern that continues throughout the remainder of the sequence. Soapstone vessels first appeared in the local record during the Middle Archaic, along with various stone pendants, incised slates, and stone beads. The presence of atlatl weights and spurs in these deposits confirms that the dart and atlatl were the primary hunting implements.

Late Archaic (3000–1100 cal BP)

Late Archaic lifeways, technologies, and subsistence patterns were generally similar to those of the Middle Archaic, the primary difference being an increase in the use of obsidian. Handstones and millingslabs make up the vast majority of ground stone implements, just as corner-notched dart points are the most common projectile point type. Various expedient, cobble-core tools, battered cobbles, and other heavily used flake-based implements are common in Late Archaic deposits from the foothills. These heavy processing tools are probably associated with the intensive collection of pine nuts, the primary plant-food remains recovered from Late Archaic foothill sites. Fall-ripening acorn nutshells also occur regularly, but summer grass seeds and fruit and berry pits continue to be rare in foothill deposits and common in higher elevation sites, indicating that seasonal mobility remained the primary strategy for overcoming spatial and seasonal differences in the availability of important plant foods. This pattern of seasonal movements between the foothills and conifer forest is further supported by the distribution of different toolstones. Chert, only available in the foothills of the western Sierra below about 3,000 feet above sea level, is common at Archaic sites in the higher elevations up to about 6,000 feet.

Soapstone vessels remain relatively common in Late Archaic sites, as do various stone ornaments and pendants; however, imported shell beads and other imported ornaments remain uncommon or non-existent at sites in the foothills and higher elevations of the Sierra Nevada, but are ubiquitous in Central Valley sites from this time period.

Recent Prehistoric I and II (1100–100 cal BP)

Archaeological sites dating to the Recent Prehistoric I period (1100-610 cal BP) are under-represented in the foothills of the western Sierra Nevada (Rosenthal 2008). Pervasive drought in the Sierra Nevada may be responsible for a widespread settlement disruption. Research has shown that this period did indeed coincide with a region-wide interval of reduced precipitation known as the Medieval Climatic Anomaly.

Among the most important changes in the archaeological record in the Recent Prehistoric I Period is the introduction of the bow and arrow. This shift in technology is clearly reflected by the dominance of small-stemmed and corner-notched arrow points in Recent Prehistoric I sites. It remains unclear whether bedrock mortars were also first widely used during this time period, but their common occurrence at subsequent Recent Prehistoric II sites suggests that they became an important milling technology by 610 cal BP.

Subsistence remains in Recent Prehistoric I and II sites include many more spring and summer grass seeds and fruits and berry pits than were present in Archaic deposits, indicating that occupation occurred for a longer part of the year, or that sites below the snowline were more regularly used to store warm-season resources for winter use. There also appears to have been greater settlement differentiation during the Recent Prehistoric II period, with clear residential sites often including house-depressions and other structural remains, but also special-use localities consisting simply of bedrock milling features.

As in the Archaic, large mammal remains continue to make up a substantial portion of faunal assemblages from both high- and low-elevation sites for the Recent Prehistoric I and II. Many more specialized technologies are associated with the Recent Prehistoric II period than were evident during the Archaic, including stone drills and the common occurrence of bone awls, suggesting that basketry and other composite implements may have taken on a new importance. The desert side-notched arrow point was first introduced on the western slope at about 610 cal BP. Circular, perforated stone shaft-straighteners are also common in these sites, consistent with use of the bow and arrow. Imported shell beads from coastal California first appear in appreciable amounts in Recent Prehistoric II village sites, as do other rare items such as shell ornaments and bone whistles.

4.10.3.2 ETHNOHISTORIC SETTING (SHELLY DAVIS-KING)

The study area is located along an indistinct territorial boundary of the Plains Miwok, the Northern Sierra Miwok, and the Northern Valley Yokuts (Merriam 1907). The lands of the

Sierra Miwok encompassed the western slopes of the Sierra Nevada between the Fresno River to the south and the Cosumnes River to the north and extended into the lower foothills along the eastern edge of the Central Valley. Kroeber (1925) likewise indicated that the sites fall within the territory of the Northern Sierra Miwok and depicted the ethnographically recorded villages of *Upüsüni*, located approximately 4.5 miles north along Jackson Creek, and *Sakayak-ümni*, located approximately 7 miles west along the Mokelumne River downstream of the Camanche Reservoir.

The Northern Sierra Miwok are a Penutian-speaking group, which, together with Central and Southern Sierra Miwok groups immediately to the south, formed a linguistically related, but culturally distinct contingent of Eastern Miwok peoples who occupied lands from the eastern San Francisco Bay Area to the Sierra Nevada. The Sierra Miwok primarily inhabited the foothills and lower montane forests of present-day Calaveras and Tuolumne counties. Each Sierra Miwok region was broadly defined by several independent and politically distinct Tribelets and lineage groups that shared a common language and culture. These Tribelets, each consisting of approximately 100 to 300 people, controlled resources within specific land bases and contained networks of seasonal campsites and villages, which were largely organized by lineage.

Lifeways of the Sierra Miwok revolved in large measure around the acquisition of seasonally available foods. Winters spent aggregated in villages below the snowline were followed by small-group dispersals to higher (and sometimes lower) elevations in search of ripening plant foods and available game from spring through fall. Lands were burned in late summer to enhance animal browse and seed-bearing plants for harvesting the following year. Acorns were collected for storage and winter consumption, and gray and sugar pines were documented as food sources, as were numerous leafy plants and those producing berries, seeds, and edible roots. Acorns were stored in above-ground granaries, and tools integral to acorn processing included anvils, hammerstones, cobble pestles, portable and bedrock mortars, and coiled baskets; mortars and pestles were also used for milling seeds. Deer, bear, rabbits, and a wide variety of lower calorically ranked animal resources were important game sources of the Sierra Miwok (Kroeber 1925).

In contrast to Merriam and Kroeber, Johnson (1967) placed the sites within the territory of the Plains Miwok, which includes the study area. Levy (1978) also depicted the study area within Plains Miwok territory and indicated that the Tribelet of *Sakayakumne* was the most easterly of Plains Miwok Tribelets along the Mokelumne River. In addition, an extensive study of Mission records and previous archaeological investigations led Milliken (2006) to believe that the Plains Miwok *Macheme* subgroup encompassed the

entire study area, including the Camanche Reservoir area and as far east as Pardee Reservoir along the Mokelumne River.

The Plains Miwok were organized into independent and politically distinct Tribelets and lineage groups, similar to the Sierra Miwok groups, and occupied the Mokelumne River and Cosumnes River drainages extending west to the Sacramento River from the modern cities of Freeport in the north to Rio Vista in the south. Each Tribelet was typically made up of 300 to 500 people. The Plains Miwok shared many aspects of their subsistence and lifeway patterns in common with the Sierra Miwok groups, though a number of important differences existed between them.

As Euro-American settlers came into the region in the nineteenth century for trapping, building roads, searching for gold, and settling, traditional lifeways and territory were forever altered for Native peoples. While traditional Native American life was significantly disrupted, the influx of settlers also resulted in a mixing of cultures. There were many intermarriages with Euro-American settlers, and local Native American Tribes were integrated into the labor force in the pursuit of gold in the mines. The Native American people throughout the foothills and California adapted to lead lives that incorporate traditional values.

Local Tribal involvement in the current pursuit of archaeological investigations remains not only relevant to understanding past Sierra Miwok culture, but also critical to maintaining respectful treatment of Tribal members' ancestors and ancestral lands. The Calaveras Band of Mi-Wuk Tribe has been an active participant in archaeological investigations in the Project area and elsewhere in Calaveras County.

4.10.3.3 HISTORIC SETTING (KIMSEY ET AL. 2018)

The discovery of gold in the Sierra Nevada foothills in the mid-nineteenth century led to the nation's greatest migration, as hundreds of thousands of gold seekers poured into California, transforming its economy, politics, culture, and landscape. During this era, Calaveras and Amador counties became famous for their placer and lode mines. Similar to other California counties, small gold camps grew into towns while food and lumber production developed as secondary industries. During the first years of the Gold Rush, miners typically worked alone or in small groups, initially using hand tools, such as picks, shovels, and variations of the gold pan, to extract deposits. In the 1860s, hydraulic mining techniques were developed, using a powerful jet of water to expose gold-bearing gravels. After 1884, lode mining or hard rock mining, was the principal source of gold extraction in the county, although miners also used mechanical dredging from the 1900s onward as a more expedient method of collecting gold from placer deposits. Large-scale extraction of timber resources developed as a secondary industry after the Gold Rush to support

mining enterprises and the population they brought into the area. Miners required milled lumber for flumes and sluices, and the entire population needed wood for homes, commercial structures, and fuel.

Placer mining, extracting minerals from streambed deposits, was soon initiated on the Mokelumne River. Winters Bar was soon established as one of several successful gold camps along a 10-mile stretch of river that also included, among others, Poverty Bar, Camanche, and Campo Seco in Calaveras County and Lancha Plana and Putts Bar, just north of the river in Amador County. This stretch of the river was particularly rich in gold because it cut through older streambeds with gold-bearing placers. The origin of the name Winters Bar remains unknown and may have derived from the partnership between Kaiser and Winter, who operated a ferry nearby at Lancha Plana. The earliest references to the location date to 1850, and they appeared on maps by the following year. References to Winters Bar also appear frequently in period newspapers as well as mining claims on file at the Calaveras County Archives, and although little is known to date about the community, these records suggest that it contained a sizable population of miners seeking their fortune through the following decade.

In conjunction with the intensive mining occurring along the Mokelumne River, some entrepreneurs sought their fortune by supplying fresh water to mining camps and to rapidly growing cities to the east such as Stockton, San Francisco, and Oakland. Anthony Chabot formed the Contra Costa Water Company in 1866 to supply water in the East Bay. That company and several others were consolidated into the People's Water Company, whose assets were transferred to the East Bay Water Company in 1916. EBMUD purchased the East Bay Water Company in December 1928.

Established in 1923, EBMUD's first task was to source fresh water from far-flung rivers to alleviate a drought, and in 1927, it began construction of the Pardee Dam on the Mokelumne River at the former mining camp Diamond Bar (located approximately 3.5 miles northeast of Winters Bar); the Pardee Reservoir was originally designed to supply water to the East Bay area for the next several decades. In 1949, EBMUD proposed a plan to establish three additional reservoirs along the river and eventually constructed the Camanche Dam in 1964, in part using reclaimed placer dredge tailings. The new reservoirs inundated several Gold Rush-era communities, including Winters and Poverty Bars, Camanche, and Lancha Plana, and submerged them under 40 to 100 feet of water. Numerous county roads and previously identified American pioneer gravesites and Native American burials were relocated in advance of the flooding. While the community of Camanche had survived, only a handful of residents remained at the time EBMUD built the dam and inundated the remnants of the community.

4.10.4 PREVIOUS CULTURAL RESOURCES STUDIES

Formal archaeological study of the area began in the 1950s through the early 1960s, with reconnaissance surveys and excavations conducted in advance of the construction of Camanche Reservoir (Payen 1962; Johnson 1967). These studies were mostly completed by students and professors at Sacramento State College and were selective rather than systematic, both in terms of the areas investigated and the kinds of sites that were recorded. These studies predated the advent of the NHPA, and there was no expectation of systematic inventory or consultation over the effects of undertakings on cultural resources. Nonetheless, these early studies provide the bulk of information about the precontact archaeological resources of the area. Many of the archaeological sites then recorded have since been inundated by the filling of Camanche Reservoir.

Subsequent cultural resources studies began in the early 1980s and continue to the present day. These studies have been driven by compliance with cultural resources law, many on behalf of EBMUD, but also the Bureau of Land Management, PG&E, and other agencies. Some 40 archaeological studies have taken place within the study area (Table 4.10-1). Most of these are small surveys, which in aggregate cover only a small fraction of the study area. Notable archaeological studies include surveys and testing for the Upper Mokelumne Project at the upstream end of Pardee Reservoir (Chavez et al. 1984); the evaluation of the Penn Mine complex upstream of Camanche Reservoir (Nilsson et al. 1999); and the emergency burial recovery at two sites on the southeast shore of Camanche Reservoir (Kimsey et al. 2018).

Table 4.10-1. Previous cultural resources studies.

CA Info Ctr. No.	Other No.	Primary Author	Date	Document Title	Document Publisher
N/A		Demarais et al.	2023	Master Survey Report, East Bay Municipal Utility District, Federal Energy Regulatory Commission Project #2916, Amador, Calaveras, and San Joaquin Counties, California	PaleoWest
N/A		Herbert and Mikesell	1995	Pardee Dam HAER #CA-168	JRP Historical
N/A		Nicchitta and Murphy	2016	Archaeological Survey Report for the Camanche Reservoir Fiber Optic Cable Project (#A00K8F)	
CA-00077		Chavez et al.	1984	Cultural Resources Evaluations for the Upper Mokelumne River Hydroelectric Projects, Calaveras and Amador Countries, California. Middle Bar Project Inventory (FERC NO. 4289).	
CA-00078		Chavez et al.	1985	Cultural Resources Evaluations for the Upper Mokelumne River Hydroelectric Projects, Calaveras and Amador Counties, California: Middle Bar Project Inventory (FERC No. 4289); Supplemental Report for Facilities Locations.	
CA-00122		Decater	1982	An Archeological Survey of the Proposed Cribbs Subdivision, Calaveras County, California.	
CA-00142	SJ-00142	Derr	1981	Archaeological Survey Report for Pacific Telephone Company Underground Cable Project, Highway 12, Clements (Junction Highway 88) to San Andreas, Calaveras and San Joaquin Counties, California.	
CA-00217		Maniery	1991	Mokelumne River and Tributaries, California: Cultural Resources Summary	PAR Environmental
CA-00227		Farrell and Werner	1991	Cultural Resources Survey of Assessor's Parcels 48-018-12 and 48-018-13, Near Wallace, Calaveras County, California.	
CA-00388		Farrell and Werner	1991	A Cultural Resources Survey of APN 4-40-4 Acres Parcel Located Near Burson, Calaveras County, California.	
CA-00389		Farrell and Werner	1991	A Cultural Resources Survey of APN 4-48-23 Located Near Burson, Calaveras County, California.	

CA Info Ctr. No.	Other No.	Primary Author	Date	Document Title	Document Publisher
CA-01970		Napton	1993	Cultural Resources Investigations of the Proposed Pacific Bell Fiber Optic Cable Installation Project, Amador, Calaveras and San Joaquin Counties, California.	
CA-02284		Kennedy	1994	Archaeological Survey of Parcel 48-018-157 on Olivera Court Near Wallace, Calaveras County, California	
CA-02980		Hupman and Chavez	1997	Cultural Resources Investigations for the Penn Mine Project, Calaveras County, California.	
CA-02998		Davis-King	1997	Penn Mine Access Via Arkansas Ferry Road and Hinckley's Run, Calaveras County, California; A Cultural Resource Survey	Davis-King Associates
CA-03361		Nilsson et al.	1999	Comprehensive Report: Archaeological Inventory, Recordation, and Evaluation Within the Penn Mine Long-Term Solution Project Area, Calaveras County, California.	Dames & Moore
CA-03890		Foster	1993	U.S. Army Corps of Engineers, Sacramento District, New Hogan Geological and Seismological Investigation, Calaveras and Amador Counties, California	
CA-03943		Allen and Holson	1994	Archaeological Survey Report for the East Bay Municipal Utility District Camanche South Shore Mine Investigation Project, Final Report.	Pacific Legacy
CA-04806		Barnes	2002	Memo to Field Manager: Subject: Campo Seco Cultural Resource Recordation.	BLM Folsom Field Office
CA-05196		Barnes	2003	Campo Seco Land Exchange, CA-018-S-AC-03/02.	BLM Folsom Field Office
CA-05493		Windmiller	2004	Romick Campo Seco Property, APN 048-00-077 & 048-006-006: Archaeological Resources Inventory, Calaveras County, California.	
CA-05571		Thorpe and Costello	2004	Cultural Resource Survey of Two Parcels of Land Totaling ca. 22 Acres Near Burson for Jess Arceo and Josephine Minor, Calaveras County, California (APNs 048-040-030 and -022).	Foothill Resources

CA Info Ctr. No.	Other No.	Primary Author	Date	Document Title	Document Publisher
CA-05985		McMorris and Hope	2004	Caltrans Historic Bridge Inventory Update: Metal Truss, Movable, and Steel Arch Bridges, Vol.1: Report and Figures	JRP Historical
CA-06205		Barnes	2006	The Coast to Crest Trail Near Campo Seco, CA-018-S-AC-06/04	BLM Folsom Field Office
CA-06289		Parks	2002	Archaeological and Historical Resources Identification Report, Under Programmatic Agreement, Appendix B: Salt Gulch Wildlife Corridor, Calaveras County, California	
CA-06376		Costello	2007	Cultural Resource Survey of a 23.71-Acre Parcel of Land Near Wallace Owned by Danna Tenwolde, Calaveras County, California (APN 048-018-178).	Foothill Resources
CA-06797		Thorpe, Marvin, and Costello	2008	Cultural Resources Study of a 43 Acre Parcel near Burson Calaveras County, CA (APN 048-038-035) Allmon-Puentes Project	Foothill Resources
CA-08448		Strother et al.	2016	Cultural Resources Assessment for the Camanche Reservoir Pedestrian Ramp Project Calaveras County, California	Garcia & Associates
CA-08651		Triplett	2016	Calaveras County Cannabis Letter Reports for GP2016-11, Jason Ragain Property Calaveras County, California	
CA-08793		Siskin and Kimsey	2014	Cultural Resources Survey Report for the Camanche Water Transmission Line Project	Garcia & Associates
CA-08793		Kimsey et al.	2018	Final Burial Recovery and Archaeological Investigations at CA-CAL-237 and CA-CAL-105, Calaveras County, California	Garcia & Associates
CA-09114		Maniery, Taylor, and Maniery	2019	Cultural Resources Inventory and Evaluation for Camanche Surplus Property, Calaveras, Amador and San Joaquin Counties, CA (FERC Project 2916)	PAR Environmental
CA-09211		Sikes and Arrington	2019	Cultural Resources Letter Report for Calaveras Storm Repair Project, Gwin Mine and Hawver Roads, Calaveras County, California	
CA-09229		Cleveland and Koenig	2020	Memorandum: Pardee Reservoir Elevated Tank Historical Resource Evaluation	

CA Info Ctr. No.	Other No.	Primary Author	Date	Document Title	Document Publisher
CA-09259		Koenig	2021	Memorandum: Camanche Reservoir Archaeological Finds and Recommendations	
NCIC-00285	CA-01965; SJ-01965	Johnson	1967	The Archeology of the Camanche Reservoir Locality, California	Sacramento State College
NCIC-00285B		Palumbo	1967	The Archeology of Amador-23	Sacramento State College
NCIC-00543	CA-09098	Payen	1962	Prehistoric Rock Art in the Northern Sierra Nevada, California	Sacramento State College
NCIC-00672		Peak and Associates, Inc.	1995	Cultural Resource Assessment of the Proposed CSA #3 Intertie and Water Treatment Plant, Amador County, California.	Peak & Associates
NCIC-02274		Mabry and Theodoratus	1961	An Analysis of AMA-3, a Rock Shelter Near Ione, California.	
NCIC-02736	CA-04283	O'Brien	2001	Cultural Resources Inventory Report for Camanche Water Treatment Plant Improvements	Jones & Stokes
NCIC-03284		Gilbert	1991	Archeological Survey of Grapevine Gulch VMP RX# 4-019-AEU	
NCIC-05181		Costello and Cook	2003	Cultural Resource Monitoring at the Middle Bar Take-Out Facility Project Amador County, California (CA-AMA-18/H; P-3-720H)	Foothill Resources
NCIC-05188		Chavez and Hupman	2002	Cultural, Archaeological and Historical Resources Evaluation for the Middle Bar Whitewater Take-Out Facility, Mokelumne River, Amador County, California	
NCIC-07232		Wohlgemuth	2006	Archaeological Survey Report for Improvements to the Amador Water Agency WWID #11 Waste Water Treatment Plant and Disposal Facility	Far Western
NCIC-07807		Barnes	2004	Proposed Archery Range	BLM Folsom Field Office

CA Info Ctr. No.	Other No.	Primary Author	Date	Document Title	Document Publisher
NCIC-08102		Slaymaker	1990	An Archaeological Reconnaissance of Camanche Greens, Amador County, California	
NCIC-10108		Jurich and Martinez	2009	Final Cultural Resources Survey Report Camanche Water System Compliance Project Amador County, California	
NCIC-11980		Barnes	2012	Proposed Mokelumne River Commercial Boating Three-year Study (case # CA-018-S-AC-13/01)	BLM Folsom Field Office
NCIC-12057		Neidig and Thomas	2015	Cultural Resources Support for the Butte Fire, Amador and Calaveras Counties, California	Far Western
NCIC-12485		Noah	2014	National Historic Preservation Act, Section 106 Resources Survey, Buena Vista Rancheria of Me-Wuk Indians, Deer Ridge Property	
NCIC-13047		Bal, Frank	2020	Archaeological Survey Report for the East Bay Municipal Utility District Camanche Hills Hunting Preserve Lead Reclamation Project	
NCIC-13517		Ness	2020	Cultural Resources Survey of Camanche Water Transmission Pipeline Extension Project in Ione, Amador County	
SJ-00833		Smith	1981	Wirth Associates: PG&E's Proposed 115 KV Pole Line Survey	
SJ-03379		Southern Pacific	1994	Historic Report (49 CFR 1105.8) Southern Pacific Transportation Company Proposed Abandonment in San Joaquin and Calaveras Counties, California ICC Docket No. AB-12 (Sub-No. 155X).	
SJ-06908		Roark	2008	APE Modification FRWP-2008-02, Additional Spoils, Storage, and Staging Areas on Segments 1 and 2 of the FRWA Pipeline and the Northern Pipeline Segment of the Folsom South Canal Connection, Freeport Regional Water Project-Revision	
SJ-06913		Jones and Stokes	2007	Revised Addendum Cultural Resources Inventory Report for Modifications to the Freeport Regional Water Project Area of Potential Effects Sacramento and San Joaquin Counties, CA-APE Modification FRWP-2007-05	Jones and Stokes

CA Info Ctr. No.	Other No.	Primary Author	Date	Document Title	Document Publisher
SJ-06917		Jones and Stokes	2007	Revised Addendum Cultural Resources Inventory Report for Modifications to the Freeport Regional Water Project Area of Potential Effects, Sacramento and San Joaquin Counties, CA-APE Modification FRWP-2007-04	Jones and Stokes
SJ-06993		Jones and Stokes	2006	Cultural Resources Inventory and Evaluation Report for the Freeport Regional Water Project, Sacramento & San Joaquin Co.'s, CA	Jones and Stokes
SJ-07692		Lassell	1999	Woodbridge Irrigation District, City of Lodi, and U.S. Bureau of Reclamation Draft Lower Mokelumne River Restoration Program Environmental Impact Report/EIS (EXCERPT): Appendix G. Cultural Resources Inventory and Evaluation Report.	
SJ-08440		Strother et al.	2016	Cultural Resources Assessment for the Camanche Photovoltaic Project, Camanche Reservoir, Mokelumne River Watershed, San Joaquin County, California	Garcia & Associates
SJ-08584		Strother	2016	Cultural Resources Inventory Report Addendum: Archaeological Testing within the Area of Potential Effects for the Camanche Photovoltaic Project, Camanche Reservoir, San Joaquin County, California	Garcia & Associates

Surveys of built-environment resources have been relatively few, other than the Penn Mine Project (Nilsson et al. 1999) and the study documenting the Pardee Dam and Reservoir System Historic District (Herbert and Mikesell 1995); however, in advance of the current relicensing effort, a built-environment survey of the FERC boundary was recently conducted (Demarais et al. 2023), providing a nearly complete inventory of the area.

4.10.5 PREVIOUSLY RECORDED CULTURAL RESOURCES

Cultural resources of the Project area include built-environment resources (historic properties), archaeological sites, and (potentially) Tribal cultural resources.

4.10.5.1 BUILT-ENVIRONMENT RESOURCES

The 2023 built-environment inventory formally recorded 54 properties within the FERC boundary (Table 4.10-2) and identified 43 more potential properties that were not formally recorded, mostly because their ages could not be determined. Most of the recorded resources are associated with EBMUD's development of the Pardee and Camanche reservoir projects, and with recreational development on Camanche Reservoir.

Table 4.10-2. Built-environment resources.

Map ID	Name	Build Date	Area	Associations	Eligibility Recommendation
1	Middle Bar Day Use Area	1927	Pardee	Recreation, Community Development, Engineering	Not Eligible
2	Middle Bar Bridge	1912	Pardee	Community Development, Engineering, Recreation	Listed
3	Pardee Reservoir Dock	ca. 1929	Pardee	Recreation	Not Eligible
4	Pardee Outlet Tower	1928–1929	Pardee	Water Management	Listed (contributor to district)
5	Pardee Reservoir South Spillway	1928–1929	Pardee	Water Management	Listed (contributor to district)
6	Barn Workshop	1928–1929	Pardee	EBMUD Facility Management	Not Eligible
7	Pardee Dam	1929	Pardee	Water Management	Listed (contributor to district)
8	Workshops	1997	Pardee	EBMUD Facility Management	Not Evaluated
9	Oaks Campground	ca. 1970	Pardee	Recreation	Not Eligible
10	Pool and Café Complex	1967	Pardee	Recreation	Not Eligible
11	Water Tanks	1962	Pardee	Water Management	Not Eligible
12	Residence	ca. 1960	Pardee	EBMUD Housing	Not Eligible
13	Pardee Recreation Area and North Marina	1968	Pardee	Recreation	Not Eligible
14	Jackson Creek Spillway	1928–1929	Pardee	Water Management	Listed (contributor to district)
15	Wastewater Treatment Plant	1962	Pardee	Water Management	Not Eligible
16	Penn Mine Dump Site	ca. 1861–1960	Camanche	Mining	Not Evaluated
17, 34	Mokelumne Aqueduct	1927–1929	Camanche	Water Management	Eligible
18	Lancha Plana Bridge (Camanche Parkway Bridge)	1964	Camanche	Engineering	Not Eligible

Map ID	Name	Build Date	Area	Associations	Eligibility Recommendation
19	Utility Access Point	ca. 2000	Camanche	Water Management	Not Evaluated
20	Water Treatment Plant	Unknown, between 1962 and 1984	Camanche	Water Management	Not Eligible
21	Cottages at South Camanche Shore	Unknown, between 1962 and 1980	Camanche	Recreation	Not Eligible
22	Sugarloaf Campsite Building A	Unknown, between 1962 and 1980	Camanche	Recreation	Not Eligible
23	Sugarloaf Campsite Building B	Unknown, between 1962 and 1984	Camanche	Recreation	Not Eligible
24	Cottonwood Campground	Unknown, between 1962 and 1980	Camanche	Recreation	Not Eligible
25	Lakeside Hall	ca. 1970	Camanche	Recreation	Not Eligible
26	Campsite Building D	Unknown, between 1962 and 1980	Camanche	Recreation	Not Eligible
27	Recreation Building	1973	Camanche	Recreation	Not Eligible
28	Recreation Courts	1973	Camanche	Recreation	Not Eligible
29	Maintenance Buildings	Unknown, between 1962 and 1980	Camanche	EBMUD Facilities Management	Not Eligible
30	Wastewater Treatment	1969	Camanche	Water Management	Not Eligible
31	Monument RV Park	Unknown, between 1962 and 1980	Camanche	Recreation	Not Eligible
32	Barn	Unknown, between 1962 and 1980	Camanche	EBMUD Facilities Management	Not Eligible
33	South Entry (Camanche)	Unknown, between 1959 and 1980	Camanche	Recreation	Not Eligible
35	Camanche Dike No. 1	1963–1964	Camanche	Water Management	Not Eligible
36	Camanche Reservoir Spillway	1963–1964	Camanche	Water Management	Not Eligible
37	Hatchery Employee Housing	ca. 1963	Camanche	EBMUD Housing	Not Eligible

Map ID	Name	Build Date	Area	Associations	Eligibility Recommendation
38	Mokelumne River Hatchery	1963	Camanche	Conservation, EBMUD Facilities Management	Not Eligible
39	Camanche Dike No. 5	1963–1964	Camanche	Water Management	Not Eligible
40	Camanche Dike No. 6	1963–1964	Camanche	Water Management	Not Eligible
41	Rabbit Creek Causeway	1962	Camanche	Public Thoroughfare	Not Eligible
42	Blue Oaks Campground	1992	Camanche	Recreation	Not Eligible
43	Campground Restroom 1	ca. 1995	Camanche	Recreation	Not Evaluated
44	Campground Restroom 2	ca. 1995	Camanche	Recreation	Not Evaluated
45	Miwok Drive Utility Building	ca. 1995	Camanche	Recreation	Not Evaluated
46	Water Tanks	ca. 1993	Camanche	Water Management	Not Evaluated
47	Wastewater Treatment Ponds	Unknown, between 1962 and 1980	Camanche	Water Management	Not Eligible
48, 49	Residences	ca. 1975	Camanche	EBMUD Housing	Not Eligible
50	Workshop	Unknown, between 1962 and 1980	Camanche	EBMUD Facilities Management	Not Eligible
51	Registration Building and Residences	Unknown, between 1962 and 1984	Camanche	EBMUD Housing	Not Eligible
52	RV Parking	ca. 2005	Camanche	Recreation	Not Evaluated
53	North Shore Resort Marina Building	Unknown, between 1962 and 1980	Camanche	Recreation	Not Eligible
54	Gazebo	1992	Camanche	Recreation	Not Evaluated
55	Camanche Dike No. 2	1927–1929	Camanche	Water Management	Not Eligible
56	Camanche Dike No. 3	1927–1929	Camanche	Water Management	Not Eligible

The Middle Bar Bridge, at the upstream end of Pardee Reservoir, was listed in 1979 on the National Register (Office of Historic Preservation Reference No. 055824), as well as the Pardee Dam and Reservoir System District; the latter includes as contributing elements the main Pardee Dam and Powerhouse, the Jackson Creek Spillway, Pardee South Spillway, and the Pardee Outlet Tower (see Table 4.10-2). Demarais et al. (2023) also recommended the portion of the Mokelumne Aqueduct within the FERC boundary as eligible. The Penn Mine Historic District has been determined National Register-eligible, but Demarais et al. recommended re-evaluation due to the time elapsed since that determination. Demarais et al. recommend 46 other recorded resources not eligible for the National Register, or not suitable for evaluation because they were not of sufficient age. Some resources, such as the system of dikes on Camanche Reservoir, were recommended individually ineligible, but potentially eligible as contributing elements of a district not yet formally recorded.

4.10.5.2 ARCHAEOLOGICAL SITES

There are 175 recorded archaeological sites within the study area, of which 122 are within the FERC boundary (Table 4.10-3 and Table 4.10-4). The 175 sites include 114 precontact sites, 25 dating to the historic period, 8 with both precontact and historic-period components, and 28 for which no information was available because the studies were in progress at the time of the records searches.

Table 4.10-3. Summary counts of archaeological sites by age.

	Within FERC Project Boundary	Study Area Only	Total
Precontact	103	11	114
Historic	10	15	25
Multi-component	8	0	8
Unknown/no data	1	27	28
Total	122	53	175

Table 4.10-4. Recorded archaeological sites.

Primary No.	Trinomial	Age	Site Type	Historic Type	Last Year Recorded	Associated Reports	Reservoir
P-03-000039	CA-AMA-3	P	Habitation/BRM/Rock art (RS)	-	1950	Heizer 1950 survey, NCIC-00285, NCIC-00543, NCIC-02274	Camanche
P-03-000040	CA-AMA-4	P	Habitation/BRM/Rock art (RS)	-	1950	Heizer 1950 survey, NCIC-00285, NCIC-00543	Camanche
P-03-000041	CA-AMA-5	P	Habitation/BRM (RS)	-	1950	Heizer 1950 survey, NCIC-00285	Camanche
P-03-000042	CA-AMA-6	P	Habitation (RS)	-	1950	Heizer 1950 survey, NCIC-00285	Camanche
P-03-000043	CA-AMA-7	P	Habitation (RS)	-	1950	Heizer 1950 survey, NCIC-00285	Camanche
P-03-000044	CA-AMA-8	P	Habitation/BRM (RS)	-	1950	Heizer 1950 survey, NCIC-00285	Camanche
P-03-000045	CA-AMA-9	P	Artifact scatter (RS)	-	1950	Heizer 1950 survey, NCIC-00285	Camanche
P-03-000046	CA-AMA-10	P	Habitation	-	1950	Heizer 1950 survey, NCIC-00285	Camanche
P-03-000054	CA-AMA-18/H	M	Habitation	Townsite (Middle Bar)	2003	Davis 1953 survey, CA-00077, NCIC-05181	Pardee
P-03-000055	CA-AMA-19/H	M	BRM	Mining	1953	Davis 1953 survey, CA-00077	Pardee
P-03-000056	CA-AMA-20	P	Habitation	-	1953	Davis 1953 survey, NCIC-00285	Camanche
P-03-000057	CA-AMA-21	P	Habitation	-	1953	Davis 1953 survey, NCIC-00285	Camanche
P-03-000058	CA-AMA-22	P	BRM	-	1953	Davis 1953 survey, NCIC-00285	Camanche
P-03-000059	CA-AMA-23	P	Habitation/BRM/HR	-	1953	Davis 1953 survey, NCIC-00285, NCIC-00285B	Camanche
P-03-000080	CA-AMA-44	P	BRM	-	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000081	CA-AMA-45	P	Habitation/BRM (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000082	CA-AMA-46	P	Habitation/BRM (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000083	CA-AMA-47	P	Habitation/BRM/Rock art (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000084	CA-AMA-48	P	Habitation/BRM (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000085	CA-AMA-49	P	Habitation/Rock art/HR (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche

Primary No.	Trinomial	Age	Site Type	Historic Type	Last Year Recorded	Associated Reports	Reservoir
P-03-000086	CA-AMA-50H	M	Habitation (RS)	Other	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000087	CA-AMA-51	P	Habitation/BRM/Rock art (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000088	CA-AMA-52	P	Habitation/BRM/Rock art (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000089	CA-AMA-53	P	Habitation/Rock art (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000090	CA-AMA-54	P	Rock art (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000091	CA-AMA-55	P	Rock art (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-03-000106	CA-AMA-70	P	Habitation/BRM/HR	-	1963	NCIC-00285	Camanche
P-03-000107	CA-AMA-71	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000108	CA-AMA-72	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000109	CA-AMA-73	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000110	CA-AMA-74	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000111	CA-AMA-75	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000112	CA-AMA-76	P	Habitation (RS)	Other	1963	NCIC-00285	Camanche
P-03-000113	CA-AMA-77	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000114	CA-AMA-78	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000115	CA-AMA-79	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000116	CA-AMA-80	P	Artifact scatter/BRM	-	1963	NCIC-00285	Camanche
P-03-000117	CA-AMA-81	M	Isolate	Mining	1963	NCIC-00285	Camanche
P-03-000118	CA-AMA-82	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000119	CA-AMA-83	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000120	CA-AMA-84	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000121	CA-AMA-85	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000122	CA-AMA-86	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000123	CA-AMA-87	P	BRM	-	1963	NCIC-00285	Camanche

Primary No.	Trinomial	Age	Site Type	Historic Type	Last Year Recorded	Associated Reports	Reservoir
P-03-000124	CA-AMA-88	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000125	CA-AMA-89	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000126	CA-AMA-90	P	Habitation/BRM (RS)	-	1963	NCIC-00285	Camanche
P-03-000127	CA-AMA-91	P	Habitation/BRM/HR	-	1963	NCIC-00285	Camanche
P-03-000128	CA-AMA-92	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000129	CA-AMA-93/H	M	BRM	Refuse scatter	1963	NCIC-00285	Camanche
P-03-000130	CA-AMA-94	P	Habitation	-	1963	NCIC-00285	Camanche
P-03-000131	CA-AMA-95	P	Artifact scatter/BRM	-	1963	NCIC-00285	Camanche
P-03-000132	CA-AMA-96	P	Artifact scatter	-	1963	NCIC-00285	Camanche
P-03-000133	CA-AMA-97	P	Artifact scatter/BRM	-	1963	NCIC-00285	Camanche
P-03-000134	CA-AMA-98	P	Artifact scatter (RS)	-	1963	NCIC-00285	Camanche
P-03-000135	CA-AMA-99	P	Unknown (RS)	-	1963	NCIC-00285	Camanche
P-03-000136	CA-AMA-100	P	Artifact scatter (RS)	-	1963	NCIC-00285	Camanche
P-03-000137	CA-AMA-101	P	Artifact scatter/BRM	-	1963	NCIC-00285	Camanche
P-03-000138	CA-AMA-102	P	Unknown (RS)	-	1963	NCIC-00285	Camanche
P-03-000139	CA-AMA-103	P	Unknown (RS)	-	1963	NCIC-00285	Camanche
P-03-000140	CA-AMA-104	P	Habitation/BRM (RS)	-	1963	NCIC-00285	Camanche
P-03-000141	CA-AMA-105	P	Habitation/Rock art (RS)	-	1963	NCIC-00285	Camanche
P-03-000142	CA-AMA-106	P	Artifact scatter (RS)	-	1963	NCIC-00285	Camanche
P-03-000284	CA-AMA-249	P	Habitation/BRM	-	1963	NCIC-00285	Camanche
P-03-000285	CA-AMA-250	P	Artifact scatter/BRM	-	1964	NCIC-00285	Camanche
P-03-000286	CA-AMA-251	P	Artifact scatter/BRM	-	1964	NCIC-00285	Camanche
P-03-000287	CA-AMA-252	P	Habitation	-	1963	NCIC-00285	Camanche
P-03-000289	CA-AMA-254	P	Artifact scatter/BRM	-	1963	NCIC-00285	Camanche
P-03-000290	CA-AMA-255	P	Rock art (RS)	-	1964	NCIC-00285	Camanche

Primary No.	Trinomial	Age	Site Type	Historic Type	Last Year Recorded	Associated Reports	Reservoir
P-03-000291	CA-AMA-256	P	BRM	-	1964	NCIC-00285	Camanche
P-03-000293	CA-AMA-258	P	BRM	-	1963	NCIC-00285	Camanche
P-03-000720	-	H	-	Ditch (Middle Bar Ditch)	2003	NCIC-05181	Pardee
P-03-001392	-	H	-	Dam	2005	-	Camanche
P-03-001916	-	P	Unknown	-	2012	NCIC-11980	Pardee
P-03-002045	-	P	Artifact scatter	-	-	-	-
P-03-002046	-	P	Habitation (RS)	-	-	-	-
P-03-002047	-	P	Artifact scatter	-	-	-	-
P-05-000440	CA-CAL-104	P	Habitation/BRM	-	1953	Davis 1953 survey, NCIC-00285	Camanche
P-05-000441	CA-CAL-105	P	Habitation/BRM	-	2014	Davis 1953 survey, NCIC-00285, CA-08793	Camanche
P-05-000515	CA-CAL-185	P	Habitation/Rock art/HR (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000516	CA-CAL-186	P	Habitation/BRM (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000517	CA-CAL-187	P	Habitation/BRM (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000519	CA-CAL-189	P	Rock art (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000522	CA-CAL-192	P	Habitation/BRM (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000523	CA-CAL-193	P	Habitation/BRM (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000524	CA-CAL-194	P	Habitation/BRM (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000525	CA-CAL-195/H	M	Rock art (RS)	Other	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000526	CA-CAL-196	P	BRM	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000527	CA-CAL-197	P	Rock art (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000528	CA-CAL-198	P	Habitation/Rock art (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000548	CA-CAL-218	P	Habitation/BRM (RS)	-	1963	NCIC-00285	Camanche
P-05-000549	CA-CAL-219	P	Habitation	-	1963	NCIC-00285	Camanche

Primary No.	Trinomial	Age	Site Type	Historic Type	Last Year Recorded	Associated Reports	Reservoir
P-05-000553	CA-CAL-223	P	BRM	-	1963	NCIC-00285	Camanche
P-05-000554	CA-CAL-224	P	Habitation	-	1963	NCIC-00285	Camanche
P-05-000555	CA-CAL-225	P	Artifact scatter	-	1963	NCIC-00285	Camanche
P-05-000556	CA-CAL-226	P	BRM/Rock art	-	1963	NCIC-00285	Camanche
P-05-000557	CA-CAL-227	P	BRM	-	1963	NCIC-00285	Camanche
P-05-000558	CA-CAL-228	P	BRM	-	1963	NCIC-00285	Camanche
P-05-000559	CA-CAL-229	P	BRM	-	1963	NCIC-00285	Camanche
P-05-000561	CA-CAL-231	P	Habitation (RS)	-	1963	NCIC-00285	Camanche
P-05-000562	CA-CAL-232	P	Rock art	-	1963	NCIC-00285	Camanche
P-05-000563	CA-CAL-233	P	BRM	-	1963	NCIC-00285	Camanche
P-05-000565	CA-CAL-235	P	BRM	-	1963	NCIC-00285	Camanche
P-05-000566	CA-CAL-236	P	BRM	-	1963	NCIC-00285	Camanche
P-05-000567	CA-CAL-237/H	M	Habitation/HR	Historic refuse/Foundations	2014	NCIC-00285, CA-08793	Camanche
P-05-000568	CA-CAL-238	P	BRM	-	1963	NCIC-00285	Camanche
P-05-000569	CA-CAL-239	P	BRM	-	1963	NCIC-00285	Camanche
P-05-001280	CA-CAL-964H	H	-	Mining (James Bar)	1983	CA-00077, CA-00217	Pardee
P-05-001283	CA-CAL-967/H	M	BRM	Homestead (Garaventa)	1983	CA-00077, CA-00217	Pardee
P-05-001284	CA-CAL-968H	H	-	Mining	1983	CA-00077, CA-00217	Pardee
P-05-001285	CA-CAL-969	P	Habitation/BRM	-	1983	CA-00077, CA-00217	Pardee
P-05-001520	CA-CAL-1207	P	Rock art (RS)	-	1964	NCIC-00285	Camanche
P-05-001522	CA-CAL-1209	P	Rock art	-	1964	NCIC-00285	Camanche
P-05-002007	CA-CAL-1684H	H	-	Landfill	1998	CA-03361	Camanche
P-05-002112	CA-CAL-1740H	H	-	Mining	-	-	-

Primary No.	Trinomial	Age	Site Type	Historic Type	Last Year Recorded	Associated Reports	Reservoir
P-05-002267	-	H	-	Mining	-	-	-
P-05-003028	-	H	-	Unknown	-	-	-
P-05-003598	-	H	-	Mining	2015	-	Pardee
P-05-003892	-	U	Unknown	-	-	-	-
P-05-003937	-	P	Isolate	-	-	-	-
P-39-004902	CA-SJO-325H	H	-	Road	2005	SJ-06917, SJ-06993	Camanche
P-39-005261	-	P	Isolate	-	2016	SJ-08440, SJ-08584	Camanche
Study area only (1/4-mile buffer)							
P-03-000074	CA-AMA-38	P	Habitation/BRM (RS)	-	1959	NCIC-00285, NCIC-00543	Pardee
P-03-000075	CA-AMA-39	P	BRM	-	1959	NCIC-00285, NCIC-00543	Pardee
P-03-000315	CA-AMA-280H	H	-	Mining	1983	CA-00077	Pardee
P-03-000325	CA-AMA-290H	H	-	Mining	1983	CA-00077	Pardee
P-03-000334	CA-AMA-299	P	BRM	-	1983	CA-00077	Pardee
P-03-001399	-	U	-	-	-	-	-
P-03-001872	-	U	-	-	-	-	-
P-03-001873	-	U	-	-	-	-	-
P-05-000521	CA-CAL-191	P	Habitation/Rock art (RS)	-	1959	NCIC-00285, NCIC-00543	Camanche
P-05-000547	CA-CAL-217	P	Habitation/BRM/HR	-	1963	NCIC-00285	Camanche
P-05-000550	CA-CAL-220	P	BRM	-	1963	NCIC-00285	Camanche
P-05-000551	CA-CAL-221	P	BRM	-	1963	NCIC-00285	Camanche
P-05-000560	CA-CAL-230	P	Habitation (RS)	-	1963	NCIC-00285	Camanche
P-05-000564	CA-CAL-234	P	BRM	-	1963	NCIC-00285	Camanche
P-05-001521	CA-CAL-1208	P	Habitation (RS)	-	1963	NCIC-00285	Camanche
P-05-002002	CA-CAL-1680H	H	-	Homestead	1998	CA-03361	Camanche

Primary No.	Trinomial	Age	Site Type	Historic Type	Last Year Recorded	Associated Reports	Reservoir
P-05-002003	CA-CAL-1681H	H	-	Homestead	1998	CA-03361	Camanche
P-05-002005	CA-CAL-1689H	H	-	Landfill	1998	CA-03361	Camanche
P-05-002006	CA-CAL-1683H	H	-	Landfill	1998	CA-03361	Camanche
P-05-002008	CA-CAL-1685H	H	-	Road	1998	CA-03361	Camanche
P-05-002009	CA-CAL-1686H	H	-	Road	1998	CA-03361	Camanche
P-05-002789	-	H	-	Dam	-	-	-
P-05-002893	-	U	-	-	-	-	-
P-05-002908	-	H	-	Ditch	-	-	-
P-05-003014	CA-CAL-1988H	H	-	Mining	2004	CA-05493	Camanche
P-05-003015	-	H	-	Mining	2004	CA-05493	Camanche
P-05-003016	CA-CAL-1989H	H	-	Foundation	2004	CA-05493	Camanche
P-05-003017	CA-CAL-1990H	H	-	Mining	2004	CA-05493	Camanche
P-05-003597	-	P	BRM	-	2015	-	Pardee
P-05-003768	-	H	-	Mining	2016	CA-08651	Camanche
P-05-003891	-	U	-	-	-	-	-
P-05-003893	-	U	-	-	-	-	-
P-05-003894	-	U	-	-	-	-	-
P-05-003895	-	U	-	-	-	-	-
P-05-003896	-	U	-	-	-	-	-
P-05-003897	-	U	-	-	-	-	-
P-05-003898	-	U	-	-	-	-	-
P-05-003899	-	U	-	-	-	-	-
P-05-003900	-	U	-	-	-	-	-
P-05-003901	-	U	-	-	-	-	-
P-05-003902	-	U	-	-	-	-	-
P-05-003903	-	U	-	-	-	-	-

Primary No.	Trinomial	Age	Site Type	Historic Type	Last Year Recorded	Associated Reports	Reservoir
P-05-003904	-	U	-	-	-	-	-
P-05-003905	-	U	-	-	-	-	-
P-39-000284	-	U	-	-	-	-	-
-	DS-1	U	-	-	-	-	-
-	DS-2	U	-	-	-	-	-
-	DS-3	U	-	-	-	-	-
-	DS-4	U	-	-	-	-	-
-	DS-5	U	-	-	-	-	-
-	DS-6	U	-	-	-	-	-
-	P-S-6	U	-	-	-	-	-
-	P-S-7	U	-	-	-	-	-

P = precontact; M = multi-component; H= historic; BRM = bedrock milling; HR = human remains; RS = rock shelter/cave; U = Unknown

Most of the known sites are in the Camanche Reservoir area, likely due in part to a relative lack of archaeological study in advance of the filling of Pardee Reservoir in the 1920s, but also due to the generally higher archaeological sensitivity of the Camanche basin.

The great majority of the sites are known only from the recording efforts in the 1950s and 1960s, in advance of the construction of Camanche Reservoir. Many sites, particularly open-air artifact scatters, were described only in cursory fashion (e.g., “village site”) during those studies, as the focus was mostly on rock shelters and caves. Seventeen sites were excavated during these studies, including 12 shelters/caves and 5 open-air sites (Johnson 1967; Palumbo 1967).

Precontact and ethnohistoric materials reported in the 2021 records search are categorized here according to the simple typology presented by DeBaker and Siskin (2019), which includes *Habitations, Artifact Scatters, Bedrock Milling Stations,* and *Rock Art* (see Table 4.10-4). The most common precontact site constituents include scatters of lithic tools and debitage, and ground stone tools such as pestles, hopper mortars, and millingstones. The cave and rock shelter sites have been found to contain perishable materials including basketry, arrows and other wooden tools, and bone and hide tools. Shell and bone ornaments were also reported at several sites. The presence of chipped glass and glass trade beads, as well as the co-occurrence of traditional and historic-period materials at several sites, indicates historic-period Native American occupation. Many sites contain bedrock milling features (mortars) in addition to portable grinding tools. Many of the sites recorded in the 1950s and 1960s were described only as bedrock milling stations, although additional materials may well have been overlooked or not mentioned. Rock art, including petroglyphs (carved or pecked designs) and pictographs (painted designs), is present at over 20 sites, especially in cave or shelter settings. House pits, midden soils, and human burials attest to substantial residential occupation at several sites.

Recorded historic-period archaeological sites mostly comprise the remains of mining works, water-control features (ditches, dams), and roads. The National Register-eligible Penn Mine Historic District (P-05-001963) at the upstream end of Camanche Reservoir is the remains of a copper mine with both built-environment and archaeological elements. Other notable historic-period sites include the Middle Bar townsite (P-03-000054); the Garaventa homestead (P-05-001283); and the mining settlement at James Bar (P-05-001280), all near the upstream end of Pardee Reservoir.

Not included in the tally in Table 4.10-3 are two historic settlements that are listed as California Historical Landmarks, but which have not been formally studied or recorded,

and which are now permanently inundated. These include the Camanche townsite (P-05-002243; CHL No. 254) and Lancha Plana (P-03-002047; CHL No. 30).

Very few archaeological sites have been evaluated for National Register eligibility. Only P-05-002007 and P-05-002267, both historic-period sites, have been determined ineligible. No archaeological sites have been determined eligible; however, many of the sites investigated in the 1950s and 1960s before the filling of Camanche Reservoir would unquestionably be found National Register-eligible if formally evaluated.

Many previously recorded sites are likely permanently inundated by the Project reservoirs and thus are out of reach of future management. Others are within the reservoirs' fluctuation zones and have been shown to be subject to erosional impacts as a result (Kimsey et al. 2018). Archaeological sites are also often subject to damage, both intentional and unintentional, from recreational users. A complete accounting of Project-related impacts on a site-by-site basis will be provided in the HPMP.

4.10.5.3 RELIGIOUS AND CULTURAL SIGNIFICANCE TO TRIBES

No Traditional Cultural Properties (TCPs) or other places of religious or cultural significance to Indian Tribes have yet been formally recorded in the study area. These must be identified via Tribal consultation. NHPA regulations require that consultation provides the Tribe(s) a reasonable opportunity to identify their concerns about historic properties; advise on the identification and evaluation of historic properties, including those of traditional religious and cultural importance; articulate their views on the undertaking's effects on such properties; and participate in the resolution of adverse effects.

While formal Tribal consultation specific to the relicensing effort has yet to be conducted, it is reasonable to expect that many or all the precontact sites within the APE, and historic-period sites associated with Native American occupation, will be identified as being of high religious or cultural significance. Many other locations unknown to existing studies may also be identified via consultation. Tribes that may attach religious and cultural significance to historic properties including both federally recognized and other NAHC-listed Tribes, and that will be consulted, are presented in Section 4.12, Tribal Resources.

4.11 SOCIOECONOMIC RESOURCES

The Project area is located in Amador, Calaveras, and San Joaquin counties within northern California. The following section provides socioeconomic data for this region based on United States Census Bureau (U.S. Census) and county data.

4.11.1 GENERAL LAND USE PATTERNS

EBMUD owns all the land within the Project boundary. Areas in the neighboring regions are owned by various entities including EBMUD, Bureau of Land Management, Calaveras County Water District, AWA, JVID, Amador County, Calaveras County, PG&E, and private entities.

San Joaquin County has the highest population density of the three counties, with an average of 560 people per square mile, which is more than double the population density in California (U.S. Census 2024). Amador and Calaveras counties have similar population densities of 68 and 44 people per square mile, respectively, both significantly lower than that of San Joaquin County and California (U.S. Census 2024). Table 4.11-1 shows population density throughout California, and Amador, Calaveras, and San Joaquin counties.

Table 4.11-1. Population density and housing units in the Lower Mokelumne River Project vicinity.

	California	Amador County	Calaveras County	San Joaquin County
Land area (square miles)	155,858	595	1,020	1,392
Persons per square mile (2020)	2534	68	44	560
Housing units (2024)	14,877,904	19,229	27,873	266,969

Source: U.S. Census 2024

4.11.2 POPULATION PATTERNS

The population sizes in Amador and Calaveras counties are similar, with 42,026 residents, and 46,505 residents, respectively, while San Joaquin County has a much larger population of 816,108 residents (U.S. Census 2024). Although California's total population decreased by 0.3 percent between 2020 and 2024, Amador, Calaveras, and San Joaquin counties grew by 3.8, 2.7, and 4.7 percent, respectively. Table 4.11-2 summarizes the population totals for the state of California and the three counties nearest to the Project, as estimated by the U.S. Census for 2024.

Table 4.11-2. Population data in Lower Mokelumne River Project vicinity.

Location	2010 Census Population	2020 Census Population	2024 Census Population Estimate	% Change 2020 – 2024
California	37,253,956	39,538,223	39,431,263	-0.3%
Amador County	38,091	40,474	42,026	+3.8%
Calaveras County	45,578	45,292	46,505	+2.7%

Location	2010 Census Population	2020 Census Population	2024 Census Population Estimate	% Change 2020 – 2024
San Joaquin County	685,306	779,233	816,108	+4.7%

Source: U.S. Census 2024

The racial compositions of Amador and Calaveras counties are similar, and they are different from the racial compositions of San Joaquin County and the state of California as a whole. Amador and Calaveras counties are predominantly White (approximately 75 and 77 percent, respectively). Approximately 16 percent of the population of Amador County is Hispanic or Latino, as is approximately 15 percent of the population of Calaveras County (Table 4.11-3). In contrast, the population of San Joaquin County is predominantly Hispanic or Latino (42.7 percent), which is more similar to the state of California as a whole, which has a 40.4 percent Hispanic or Latino population (Table 4.11-3). The remaining racial groups are comparable between San Joaquin County and the state of California as a whole, with the next largest racial group being White alone (26.7 percent and 34.4 percent, respectively), followed by Asian (20.4 percent of the San Joaquin population, and 16.5 percent of the California population) and African American (8.2 and 6.5 percent of the population, respectively, in San Joaquin County and the state of California; Table 4.11-3) (U.S. Census 2024).

Table 4.11-3. Racial composition in the Lower Mokelumne River Project vicinity.

Race	Amador County	Calaveras County	San Joaquin County	California
White alone, not Hispanic or Latino	74.7%	77.1%	26.7%	34.3%
African American	3.0%	1.1%	8.2%	6.5%
American Indian / Alaska Native	2.2%	2.1%	2.1%	1.7%
Asian	2.0%	2.3%	20.4%	16.5%
Native Hawaiian and Other Pacific Islander	0.4%	0.3%	0.9%	0.5%
Two or More Races	4.0%	4.4%	5.7%	4.3%
Hispanic or Latino	16.5%	15.2%	42.7%	40.4%

Source: U.S. Census 2024

4.11.3 HOUSEHOLD/FAMILY DISTRIBUTION AND INCOME

Household statistics for 2023, including income and poverty levels, are shown in Table 4.11-4. As shown, average household sizes do not vary greatly in the Project vicinity. The average household size in Amador and Calaveras counties is approximately 2.4 and 2.5 persons per household, respectively, while the state of California is slightly higher at

approximately 2.9 persons per household, and San Joaquin County has the highest average household size of approximately 3.2 persons per household (Table 4.11-4) (U.S. Census 2024).

All three counties within the Project vicinity have a lower median household and per capita income level when compared to the state of California, where the median household income is $96,334, and the per capita income is $47,977 (Table 4.11-4) (U.S. Census 2024). San Joaquin County has the highest median household income of the counties in the Project vicinity, at $88,531, but it has the lowest per capita income at $36,192. Amador County has the next highest household income level, with the median household income at $81,526, and the per capita income at $42,602, while the lowest median household income is found in Calaveras County, at $79,877 (U.S. Census 2024). Calaveras County has a slightly lower per capita income compared to Amador County, of $41,078 (Table 4.11-4) (U.S. Census 2024).

The poverty rate across all three counties is similar to that of the state of California, where the poverty rate is 12.0 percent. Amador County has a poverty rate of 11.7 percent, and Calaveras County has a poverty rate of 12.2 percent. The poverty rate in San Joaquin County is 12.6 percent (Table 4.11-4) (U.S. Census 2024).

Table 4.11-4. Household and income statistics.

	Amador County	Calaveras County	San Joaquin County	California
Total Households	16,066	17,897	241,373	13,434,847
Average Household Size	2.35	2.54	3.19	2.86
Median Household Income (2023 dollars)	$81,526	$79,877	$88,531	$96,334
Per Capita Income (2023 dollars)	$42,602	$41,078	$36,192	$47,977
Persons in Poverty	11.7%	12.2%	12.6%	12.0%

Source: U.S. Census 2024

4.11.4 PROJECT VICINITY EMPLOYMENT SOURCES

Unemployment rates and labor force (number of individuals) in the Project vicinity are shown in Table 4.11-5 (California Employment Development Department's [EDD's] Labor Market Information Division [LMID] 2025). The unemployment rates for Calaveras and San Joaquin counties are similar, at 6.0 and 6.3 percent, respectively, while the unemployment rate for Amador County, 5.4 percent, is more similar to the state of California's unemployment rate, 5.3 percent (LMID 2025). The similarly sized populations

in Amador and Calaveras counties have similarly sized workforces, while the workforce in the higher populated San Joaquin County is much larger (LMID 2025).

Table 4.11-5. Labor force and unemployment in the Lower Mokelumne River Project vicinity.

	Amador County	Calaveras County	San Joaquin County	California
Labor Force	15,220	17,860	373,200	19,812,900
Unemployment Rate (%)	5.4%	6.0%	6.3%	5.3%

Source: LMID 2025

Occupations and industries in the Project vicinity for 2023 are shown in Table 4.11-6. Management, business, science, and arts are the most common occupations across all three counties and in the state of California, followed by service occupations in Amador and Calaveras counties, and sales and office occupations in San Joaquin County and the state of California (U.S. Census 2023a). The most common industry for employment across all three counties and the state of California is educational services, and healthcare and social assistance, with 13.8 percent of the workforce in Amador County working in this industry, and 17.8 and 20.6 percent of the workforce in Calaveras County and San Joaquin County working in this industry, respectively (U.S. Census 2023a). The workforce in the state of California includes 21.7 percent in educational services, and healthcare and social assistance (U.S. Census 2023a). Retail trade is also a significant industry across all three counties and the state of California, with 11.7 percent of the workforce in Amador and San Joaquin counties working in retail trade, 12.6 percent in Calaveras County, and 10.1 percent in California (U.S. Census 2023a).

The information industry employs the smallest part of the workforce across all three counties, at 1.4 percent in Amador and San Joaquin counties, and 1.5 percent in Calaveras County (U.S. Census 2023a). Similarly, the categories of (1) agriculture, forestry, fishing and hunting, and mining; and (2) finance and insurance, and real estate and rental and leasing account for small parts of the workforce; each represents less than 6.0 percent of the workforce in each county and in the state of California as a whole (U.S. Census 2023a).

Table 4.11-6. Occupations and industries in the Lower Mokelumne River Project vicinity.

	Amador County	Calaveras County	San Joaquin County	California
Occupation				
Management, business, science, and arts	35.1%	31.1%	31.7%	42.7%
Service	23.9%	22.0%	17.8%	17.4%

	Amador County	Calaveras County	San Joaquin County	California
Sales and office	17.9%	20.8%	19.0%	19.4%
Natural resources, construction, and maintenance	11.5%	15.2%	12.7%	8.7%
Production, transportation, and material moving	11.5%	10.9%	18.9%	11.8%
Industry				
Agriculture, forestry, fishing and hunting, and mining	3.1%	3.5%	4.4%	2.0%
Construction	10.3%	12.5%	8.5%	6.7%
Manufacturing	5.6%	6.6%	9.8%	8.9%
Wholesale trade	1.8%	2.2%	2.5%	2.5%
Retail trade	11.7%	12.6%	11.7%	10.1%
Transportation and warehousing, and utilities	4.3%	6.2%	9.0%	6.0%
Information	1.4%	1.5%	1.4%	2.9%
Finance and insurance, and real estate and rental and leasing	5.6%	5.3%	4.3%	5.7%
Professional, scientific, and management, and administrative, and waste management	11.3%	11.1%	10.4%	14.3%
Educational services, and healthcare and social assistance	13.8%	17.8%	20.6%	21.7%
Arts, entertainment, recreation, and accommodation and food services	12.1%	6.9%	7.9%	9.5%
Other services, except public administration	8.0%	4.5%	4.3%	4.8%
Public administration	11.1%	9.4%	5.1%	4.7%

Source: U.S. Census 2023a

Some of the largest employers in Amador County include: Amador County Sheriff, California Department of Forestry and Fire Protection, Mule Creek State Prison, and Walmart (EDD 2025a). In Calaveras County, some of the largest employers include Ironstone Vineyards, Calaveras County Sheriff, Calaveras High School, and Bear Valley Mountain Resort (EDD 2025b); and in San Joaquin County, some of the largest employers include Amazon, Medline, St. Joseph's Regional Health, and Walmart (EDD 2025c).

4.11.5 ENVIRONMENTAL JUSTICE

The following section is meant to provide an understanding of the number of environmental justice (EJ) communities present in the Lower Mokelumne River Project vicinity, as well as the population of non-English-speaking residents within the Project vicinity, to identify the need for any targeted public engagement efforts related to relicensing the Lower Mokelumne River Project, particularly as may be necessary to meet local and state requirements related to the relicensing.

4.11.5.1 IDENTIFICATION OF ENVIRONMENTAL JUSTICE COMMUNITIES

No construction or changes in operations are currently proposed as part of this relicensing; therefore, a 1-mile radius around the Project boundary was used to identify EJ communities for this analysis. The methods used for identifying and determining EJ status based on race were the "meaningfully greater analysis" and "50 percent" method thresholds:

- To meet EJ criteria using the "meaningfully greater analysis," a block group qualifies as having EJ communities if the total minority population for a block group is at least 10 percent greater than that of the county population, as follows:

  (County minority population percentage) x (1.10) = percentage above which a block group minority population must be for inclusion as an environmental justice community.
- To meet EJ criteria using the "50 percent" method, the total minority population in the block group must be greater than 50 percent to qualify as an EJ community.

The "low-income threshold criteria" was used to identify EJ communities based on income level, where the block group must have a higher percentage of low-income households than the county.

4.11.5.2 ENVIRONMENTAL JUSTICE COMMUNITIES IN THE LOWER MOKELUMNE RIVER PROJECT AREA

Within a 1-mile zone around the Project boundary, there are five census block groups identified as EJ communities that could potentially be affected by continued Project operations resulting from a new license.

Two block groups contain EJ communities that meet only the "meaningfully greater analysis" criterion; two block groups contain EJ communities based both on the "meaningfully greater analysis" threshold and the low-income threshold criteria; and one block group contains an EJ community that meets only the low-income threshold criteria (Table 4.11-7, Figure 4.11-1).

The final community identified includes non-English-speaking individuals. English proficiency alone is not a criterion for meeting EJ status, but it is an important factor in determining how public engagement can be achieved fully; therefore, non-English-speaking populations are identified regardless of their block group's EJ status so the most meaningful engagement can occur. In Amador County, within the 1-mile radius around the Project boundary, there is a 3 percent population of non-English-speaking individuals in Census Tract 000304, Block Group 1. In Calaveras County, Census Tract 000222, Block Group 1 has a 1 percent non-English-speaking population, and in San Joaquin County, 3 percent of the population of Census Tract 004704, Block Group 2 does not speak English (Table 4.11-7).

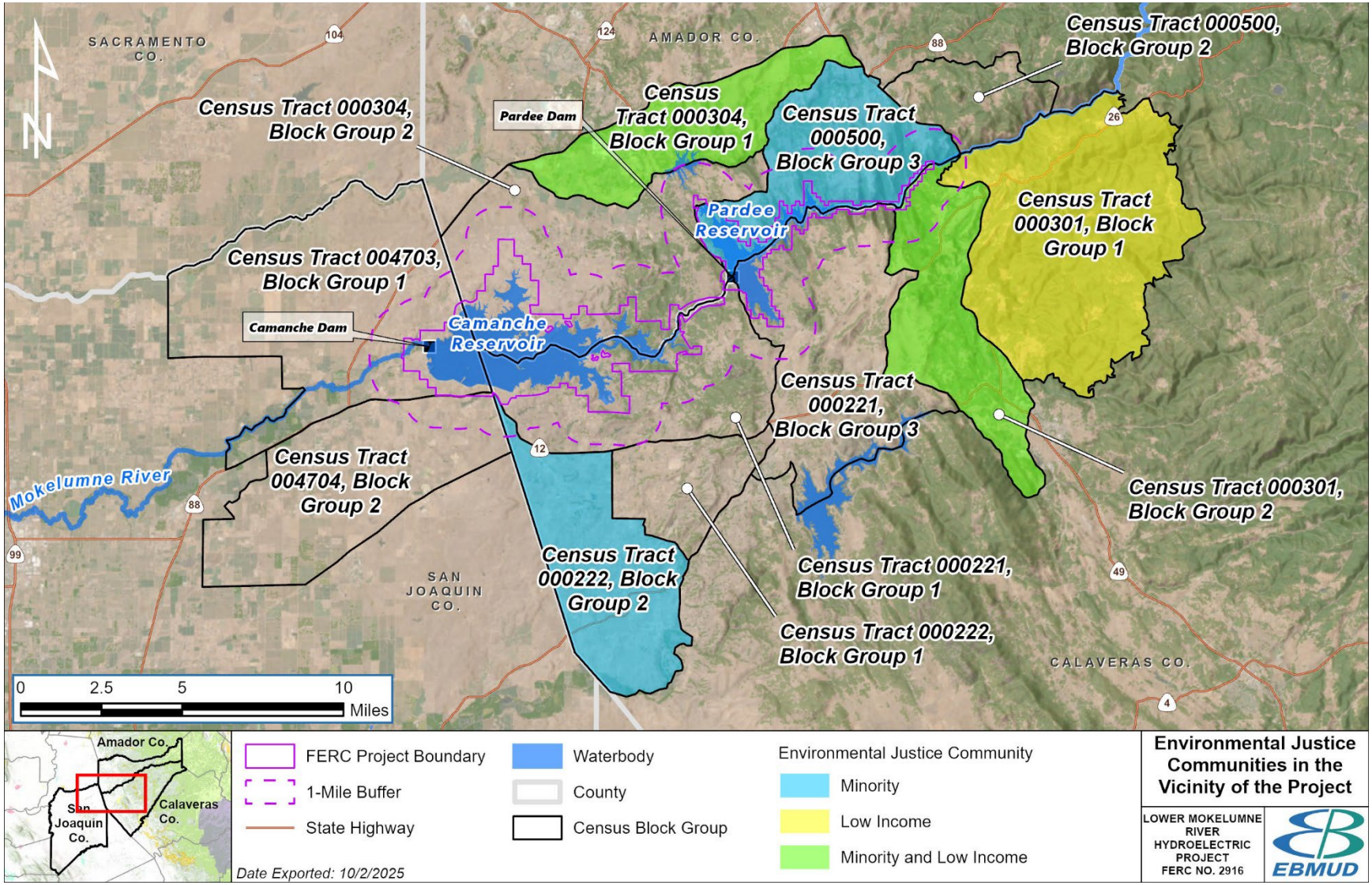


Figure 4.11-1. Census block groups within a 1-mile radius around the Lower Mokelumne River Project.

Table 4.11-7. Current community data for the Lower Mokelumne River Project vicinity.

	Race and Ethnicity Data										Low Income Data	Language Data
Geographic Area	Total Population (count)	White Alone, not Hispanic (count)	African American/ Black (count)	Native American / Alaska Native (count)	Asian (count)	Native Hawaiian & Other Pacific Islander (count)	Some Other Race (count)	Two or More Races (count)	Hispanic or Latino (count)	Total Minority Population (%)	Below Poverty Data (%)	Non-English Speaking Persons Aged 5 Years and Greater (%)
California	39,242,785	13,573,226	20,76,395	107,379	5,906,995	132,838	209,918	1,605,204	15,630,830	65%	12%	3%
Amador County	41,029	30,234	781	398	587	26	489	2,153	6,361	26%	11%	0%
Census Tract 000304, Block Group 2	3,530	2,647	29	148	0	0	174	220	312	25%	7%	0%
Census Tract 000500, Block Group 2	1,036	883	0	0	0	0	13	5	135	15%	8%	0%
Census Tract 000500, Block Group 3	1,665	1,054	6	8	27	0	24	119	427	37%	0%	0%
Census Tract 000304, Block Group 1	1,477	1,011	0	6	117	0	0	106	237	32%	14%	3%
Calaveras County	45,995	35,599	529	424	1,066	24	3	1,947	6,403	23%	11%	0%
Census Tract 000301, Block Group 2	2,261	1,463	179	0	0	0	0	30	589	35%	20%	0%
Census Tract 000221, Block Group 3	2,391	1,861	0	0	0	0	0	181	349	22%	2%	0%
Census Tract 000221, Block Group 1	2,904	2,506	0	0	0	0	3	17	378	14%	8%	0%

	Race and Ethnicity Data										Low Income Data	Language Data
Geographic Area	**Total Population (count)**	**White Alone, not Hispanic (count)**	**African American/ Black (count)**	**Native American / Alaska Native (count)**	**Asian (count)**	**Native Hawaiian & Other Pacific Islander (count)**	**Some Other Race (count)**	**Two or More Races (count)**	**Hispanic or Latino (count)**	**Total Minority Population (%)**	**Below Poverty Data (%)**	**Non-English Speaking Persons Aged 5 Years and Greater (%)**
Census Tract 000222, Block Group 1	1,835	1,453	0	0	53	0	0	190	139	21%	7%	1%
Census Tract 000301, Block Group 1	1,090	922	6	0	0	0	0	49	113	15%	14%	0%
Census Tract 000222, Block Group 2	1,758	1,288	0	0	14	18	0	12	426	27%	3%	0%
San Joaquin County	787,416	220,011	52,610	2,086	137,718	4,388	3,168	34,892	332,543	72%	12%	3%
Census Tract 004703, Block Group 1	959	808	0	0	0	0	1	0	150	16%	10%	0%
Census Tract 004704, Block Group 2	1,439	909	4	0	0	4	0	32	490	37%	9%	3%

Source: U.S. Census 2023b

4.12 TRIBAL RESOURCES

This section presents information about Tribal resources and Native American Tribes (Tribes) known to have cultural interests in the vicinity of the Project. It outlines potential adverse effects to Tribal lands and cultural resources related to Project operations and maintenance and potential mitigation and enhancement measures. This section was developed to comply with FERC's content requirements as specified in 18 CFR § 5.6(d)(3)(xii):

(A) Identification of how existing project construction and operations, and their effects (on water resources, fish and aquatic resources, wildlife and botanical resources, wetland, rare species, recreation and land use, aesthetic resources, cultural resources, and socio-economic resources) may impact tribal cultural or economic interests.

(B) Identify other impacts of existing projects on Indian tribes.

EBMUD has conducted preliminary outreach and started discussions with interested Tribes. Additionally, in 2019, EBMUD worked with the Calaveras Band of Mi-Wuk Indians to develop a Cultural Resources Management Plan (CRMP) for EBMUD-owned land within the FERC Project boundary and vicinity (DeBaker and Siskin 2019). This plan describes protocols for Tribal consultation and involvement in cultural resources.

While the requirements of Section 106 of the National Historic Preservation Act (NHPA) often focus on federally recognized Tribes, there are several non-federally recognized Tribal groups that may also have an interest in this project. Therefore, the discussions herein, and outreach to date, include both federally recognized and California Native American Heritage Commission-listed (NAHC-listed) groups.

Continued operations and maintenance of the Project may have effects on cultural resources in or adjacent to the reservoirs and Project area. Ongoing Tribal engagement to better understand potential impacts and mitigation measures will be conducted to ensure that Tribal interests and concerns are addressed within the Project's boundary and vicinity.

4.12.1 PROPOSED STUDY AREA AND AREA OF POTENTIAL EFFECTS

The APE with respect to Tribal resources is the FERC Project boundary. The larger study area will be defined as a part of future consultation efforts, but for the purposes of this discussion, it is defined as extending 0.25 mile from the FERC boundary.

4.12.2 TRIBAL LANDS AND INTERESTS

No Tribal trust lands are located within the proposed study area; however, Tribes' interests extend beyond trust lands, to include TCPs and other Tribal resources, archaeological sites, and the traditional landscape as a whole.

A TCP is a cultural resource that is eligible for inclusion in the National Register of Historic Places based on its associations with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community. TCPs are rooted in a traditional community's history and are important in maintaining the continuing cultural identity. To date, no TCPs have been identified within the proposed study area, but the potential for these will be investigated further during future consultation.

Tribes have taken an active role in collaborating with EBMUD in preserving archaeological sites within the Project vicinity (see Section 4.10, Cultural Resources). Many of these sites may qualify as elements of a potential TCP and will be evaluated through the relicensing process.

4.12.3 INFORMATION SOURCES

The primary source of information about Tribal resources and interests, which will be gathered via future consultation, is the interested Tribes themselves. In the interim, this review covers existing ethnographic literature (Merriam 1907; Kroeber 1925; Levy 1978), as summarized in the 2019 CRMP. The state NAHC maintains a list of potentially interested Tribes that project proponents can request at the outset of consultation. EBMUD recently obtained a list for the current Project (see Section 4.12.5, Interested Tribes). The NAHC also maintains a Sacred Lands file that identifies sites and landscapes of particular concern to Tribes.

4.12.4 ETHNOGRAPHY

The region surrounding the Camanche and Pardee reservoirs is located along an indistinct territorial boundary of the Plains Miwok, the Northern Sierra Miwok, and the Northern Valley Yokuts (Merriam 1907). The Sierra Miwok encompassed the western slopes of the Sierra Nevada between the Fresno River to the south and the Cosumnes River to the north and extended into the lower foothills along the eastern edge of the Central Valley. Kroeber (1925) also indicated that the sites fall within the territory of the Northern Sierra Miwok and depicted the ethnographically recorded villages of *Upüsüni*, located approximately 4.5 miles north along Jackson Creek, and *Sakayak-ümni*, located approximately 7 miles west along the Mokelumne River downstream of the Camanche Reservoir. A discussion of the traditional lifeways of these groups is presented in Section

4.10, Cultural Resources. Today, these groups are represented politically by a variety of organized Tribes, both federally recognized and not.

4.12.5 INTERESTED TRIBES

EBMUD has identified the following Tribes who may have an interest in the Project, including both federally recognized and other NAHC-listed Tribes:

- Buena Vista Rancheria of Me-Wuk Indians
- California Valley Miwok Tribe (Sheep Ranch Rancheria)
- Chicken Ranch Rancheria of Me-Wuk Indians
- Ione Band of Miwok Indians
- Jackson Rancheria Band of Me-Wuk Indians
- Shingle Springs Band of Miwok Indians
- Susanville Indian Rancheria
- Tule River Indian Tribe
- United Auburn Indian Community of the Auburn Rancheria
- Washoe Tribe of Nevada and California
- Wilton Rancheria
- Calaveras Band of Mi-Wuk Indians
- Nashville Enterprise Miwok-Maidu-Nishinam Tribe
- Pakan'yani Maidu of Strawberry Valley Rancheria

EBMUD intends to request to be designated as FERC's non-federal representative for the purpose of NHPA Section 106 consultation, and it anticipates that it will consult with all the listed groups as part of the relicensing process.

4.12.6 EXISTING CULTURAL RESOURCE MANAGEMENT

Working in consultation with the Calaveras Band of Mi-Wuk Indians, EBMUD prepared a CRMP in 2019. The CRMP outlines the regulatory requirements related to protecting and preserving archaeological and Native American resources. It identified the range of anticipated cultural and Tribal resources that might be found in the vicinity of the two reservoirs and described protocols and management measures for those resources. The CRMP also outlines a decision-making process for determining if activities on the watershed require FERC approval and/or SHPO consultation, and it includes protocols,

monitoring, and management guidelines in the event that cultural resources are identified. This document contains confidential culturally privileged information.

EBMUD hosted early engagement meetings in September and October 2024 to help inform data gathering and identify interested parties and potential concerns, including a session for Tribes specifically that was held on October 2, 2024. EBMUD also hosted a FERC Relicensing Project “Open House” on October 29, 2024, at Pardee Center and invited community groups, resource agencies, Tribes, and other interested parties.

5.0 PRELIMINARY ISSUES, PROJECT EFFECTS, AND POTENTIAL STUDIES LIST

This section presents potential resource issues and lists proposed studies and analyses needed to support evaluation of potential effects from continued Project operations and maintenance. This section also describes existing and proposed environmental measures and relevant comprehensive plans. FERC content requirements for this section are specified in 18 CFR § 5.6(d)(4). Potential resource issues associated with the Project that are listed in subsections herein were identified from the following:

- Review and evaluation of relevant reasonably available information (see Section 4.0, *Description of Existing Environment and Resource Impacts*);
- EBMUD staff's familiarity with Project operations and maintenance and resources in the Project vicinity;
- Early engagement meetings held with interested parties (including resource agencies, Tribes, and interested members of the public), including focused Technical Working Group (TWG) meetings. Finalized meeting materials are available at http://www.ebmud.com/MokRelicense (a list of meetings, notes, and attendee names is found in Volume II – Appendix A); and
- Interested parties' statements provided as part of the Project Questionnaire and written study requests received as part of the TWG meeting process (Volume II – Appendix A).

5.1 PRELIMINARY RESOURCE ISSUES WITH INFORMATION GATHERING NEEDS OR PROPOSED STUDIES

This section identifies preliminary issues for which data gathering, potential studies, and/or analyses may be needed to address Project effects or complete the license application.

EBMUD has compiled a preliminary list of 17 potential Study Plan topics (Table 5.1-1) related to water resources, aquatic resources, wildlife resources, botanical resources, recreation use, and cultural/Tribal resources. For each preliminary topic/resource issue identified below, the following information is included: 1) Study Plan Topic; 2) Potential Resource Issue; and 3) Proposed Study and Approach. Many of these proposed studies have been developed in consultation with TWG members.

EBMUD reviewed and evaluated the study requests submitted by interested parties. From these requests and ongoing discussions in the TWG meetings, EBMUD identified a suite of issues that could result from potential Project-induced effects and have a nexus to ongoing Project operations and maintenance activities.

Proposed studies and/or approaches should be considered preliminary and are subject to modification pending relicensing milestones, as described in Section 2.0, *Process Plan and Schedule*.

Table 5.1-1. Study Plan topics, resource issues, and proposed study and approach.

Study Plan Topic	Potential Resource Issue	Proposed Study and Approach
Water Quality	Project operations and maintenance activities could affect water quality in Project-affected stream reaches and Project reservoirs. The water quality study results will inform the development of potential license requirements. This WR-1 study is needed to assess water quality in the Project-affected reservoirs and river reaches.	Water Quality (WR-1) Characterize existing project water quality of Project reservoirs and Project-affected river reaches. Collect water quality data to supplement existing information as needed. Assess water quality conditions in relation to the objectives/criteria of the Basin Plan (California Regional Water Quality Control Board 2019) and other water quality standards.
Water Temperature	Project operations and maintenance activities could affect water temperature in Project-affected river reaches and Project reservoirs. The WR-2 study results will inform the development of potential license requirements.	Water Temperature (WR-2) Review existing water temperature model applications for Pardee and Camanche reservoirs. Use water temperature models of the existing Project and alternative scenario operations that accurately represent water temperature under existing climate conditions and future climate change conditions. Compare the existing Project water temperature and other potential scenario water temperature model results using existing climate conditions and future climate change conditions.
Hydrology & Operations Modeling	Project operations and maintenance activities affect hydrology in Project-affected reservoirs and Project stream reaches. The WR-3 study results will inform the input into other studies that will then help with development of potential license requirements.	Hydrology & Operations Modeling (WR-3) Model the existing Project hydrology and other potential hydrology scenarios. Perform a hydrologic alteration analysis. Conduct a high flow frequency analysis for hydrology scenarios.

Study Plan Topic	Potential Resource Issue	Proposed Study and Approach
Fish Population	Project operations and maintenance activities have the potential to affect fish populations in the Lower Mokelumne Project reservoirs and river reaches. The FA-1 study results will inform the development of potential license requirements.	Fish Population (FA-1) Document fish species composition, distribution, and abundance in the reservoirs and river reaches. Characterize fish growth, condition factor, and population age structure in the reservoirs and river reaches. Characterize fish stocking. Characterize fish hatchery operations (e.g., species, production goals, genetics, funding).
Instream Flow	Project operations and maintenance activities have the potential to affect instream flows and aquatic resources in the Lower Mokelumne River. The FA-2 study results will inform development of potential license requirements.	Instream Flow (FA-2) Summarize the previous instream flow modeling. Identify the species and life stages and habitat suitability criteria for instream flow modeling. Use habitat versus flow relationships to develop a time series analysis of aquatic habitat under existing Project hydrology and other potential hydrology scenarios. Identify the time periods, flow conditions, and life stages when habitat may be a limiting factor for aquatic resources (fish, benthic macroinvertebrates, other aquatic species, and riparian vegetation) for existing Project operations and other potential hydrology scenarios.
Reservoir Fish Habitat	Project operations have the potential to affect reservoir fish habitat in the Project reservoirs. The FA-3 study results will inform the development of potential license requirements.	Reservoir Fish Habitat (FA-3) Characterize existing Project operations daily water surface elevation patterns and pool habitat volumes (cold water, warm water, dissolved oxygen) at each reservoir using the hydrology and water temperature models in the WR-3 Study and WR-2 Study and historical dissolved oxygen data (2000–2024). Characterize other potential hydrology scenarios using Project daily water surface elevation patterns and pool habitat volumes (cold water, warm water, dissolved oxygen) at each reservoir using the hydrology and water temperature models in the WR-3 Study and WR-2 Study and historical dissolved oxygen data (2000–2024).

Study Plan Topic	Potential Resource Issue	Proposed Study and Approach
Special Status Amphibians & Aquatic Reptiles	Special-status amphibians and reptiles and their habitat are known or could potentially occur in the FERC Project boundary. Implementation of Project operations and maintenance activities could result in direct loss or disturbance of individuals or their habitat. The FA-4 study results will inform the development of potential license requirements.	Special Status Amphibians & Aquatic Reptiles (FA-4) Identify and map potential habitat for northwestern pond turtle (NWPT) (*Actinemys marmorata*) in the study area. Document the distribution and abundance of NWPT populations in the study area. Document the presence of potential NWPT nesting habitat near Project facilities. Sample eDNA for NWPT and foothill yellow-legged frog (FYLF) (*Rana boylii*). Continue existing monitoring required under the Safe Harbor Agreement for California red-legged frog (CRLF) (*Rana draytonii*) and California tiger salamander (CTS) (*Ambystoma californiense*). Continue to document the presence of western spadefoot (WS) (*Spea hammondii*) during monitoring. Characterize habitat for giant garter snake (*Thamnophis gigas*) and WS.
Egg Survival	Chinook Salmon egg survival in the Lower Mokelumne River could potentially be affected by Project operations and maintenance activities. Results from this FA-5 study will inform the development of potential license requirements.	Egg Survival (FA-5) Compile and analyze historical data from the Lower Mokelumne River. **Evaluate the role of thiamine deficiency complex (TDC).** **Investigate the role of water temperature and dissolved oxygen on egg survival.** Quantify in-river egg survival rates. Evaluate reach-scale spawning habitat quality. Develop a mechanistic/empirical model for egg survival.

Study Plan Topic	Potential Resource Issue	Proposed Study and Approach
Juvenile Mortality	Juvenile Chinook Salmon survival in the Lower Mokelumne River could potentially be affected by Project operations and maintenance activities. Results from this FA-6 study will inform development of potential license requirements.	Juvenile Mortality (FA-6) Compile and analyze historical biological, physical, and chemical data Evaluate the role of TDC Monitor physical/chemical environmental conditions Quantify juvenile abundance Monitor reach-specific juvenile survival rates Evaluate spatial mortality bottlenecks by identifying and/or monitoring reach and habitat-specific mortality, habitat and flow-related exposure to mortality sources (e.g., predator density, entrainment), competition, and growth and bioenergetics (e.g., growth versus water temperature). Develop a mechanistic empirical model for outmigration survival
Wildlife Resources	Special-status wildlife resources and their habitats are known or could potentially be present in the FERC Project boundary. Implementation of Project operations and maintenance activities could potentially result in direct loss or disturbance of individuals or their habitat.	Wildlife Resources (TERR-1) Identify special-status wildlife species potentially occurring in California Wildlife Habitat Relationships (CWHR) habitats documented as part of Botanical Resources (TERR-2) Technical Study Plan (TSP). Map potential habitat for monarch butterfly (i.e., milkweed) in conjunction with special-status plant surveys completed as part of the TERR-2 TSP. Document bat roosts present on Project facilities and identify bat species present. Document wildlife mortality at project facilities. Map deer migration routes and important areas in relation to Project facilities.

Study Plan Topic	Potential Resource Issue	Proposed Study and Approach
Botanical Resources	Sensitive natural communities, special-status plant species, and non-native invasive plants (NNIPs) are known to or could potentially be present in the FERC Project boundary. Implementation of Project operations and maintenance activities may result in loss of sensitive natural communities, special-status plant species, or the spread or introduction of NNIPs. Project operations and maintenance may result in direct loss or degradation of CWHR habitats and sensitive natural communities, including communities afforded special recognition by state and federal agencies. Project maintenance activities may result in removal or disturbance of special-status plants, lichens, and moss populations. Project maintenance activities may result in introduction or spread of NNIPs.	Botanical Resources (TERR-2) Document CWHR habitats and sensitive natural communities adjacent to Project facilities. Document special-status plant, lichen, and moss populations at Project facilities. Document NNIPs adjacent to Project facilities.
Wetland, Riparian, & Littoral Habitat	Project operation and maintenance activities could result in direct loss or degradation of jurisdictional Waters of the U.S./State or riparian habitats.	Wetlands, Riparian, & Littoral Habitat (TERR-3) Document Waters of the U.S./State and riparian habitats adjacent to Project facilities and reaches affected by the Project. Determine the relationship between riparian habitats and flow conditions in Project-affected reaches.
Environmental Justice	This study will assist California State Water Resources Control Board staff with the EJ component of its California Environmental Quality Act (CEQA) review related to relicensing the Lower Mokelumne River Project.	Environmental Justice (EJ-1) Identify the presence of EJ communities that may be located within the Project area; Develop strategies to conduct outreach to identified EJ communities to ensure meaningful involvement in the relicensing process is achieved; and Evaluate whether the Lower Mokelumne River Project will have disproportionately high and adverse effects on identified EJ communities within the Project area.

Study Plan Topic	Potential Resource Issue	Proposed Study and Approach
Recreation Facilities Inventory & Condition Assessment	Section 10(a) of the Federal Power Act requires FERC to ensure that the Project, as licensed, will be best adapted to a comprehensive plan for improving or developing the Lower Mokelumne River for the use or benefit of multiple public benefits, including recreation. This REC-1 Study will help inform FERC's licensing decisions relative to public recreation within the Project boundary.	Recreation Facilities Inventory & Condition Assessment (REC-1) Inventory FERC-approved recreation sites within the Project boundary. Field verify, map, and document recreation facilities and amenities within the Project boundary. Document the general condition of recreation facilities and amenities and describe their maintenance, inspection, and/or management practices.
Recreation Use & Needs	Section 10(a) of the Federal Power Act requires FERC to ensure that the Project, as licensed, will be best adapted to a comprehensive plan for improving or developing the Lower Mokelumne River for the use or benefit of multiple public benefits, including recreation. This REC-2 Study will help inform FERC's licensing decisions relative to public recreation within the Project boundary.	Recreation Use & Needs (REC-2) Characterize the existing use of FERC-approved recreation sites in the Project boundary. Estimate the recreation use at each FERC-approved recreation site by day type (i.e., weekday, weekend, peak weekend). Evaluate visitor feedback regarding perception and experience at each FERC-approved recreation site. Estimate the current recreational fishing effort in Pardee and Camanche reservoirs. Identify current and future needs related to FERC-approved recreation sites in the Project boundary. Evaluate whether recreation capacity, and existing facilities and amenities at FERC-approved recreation sites meet current needs. Estimate future recreation use of FERC-approved recreation sites. Estimate future needs for potential new recreation sites and facilities.

Study Plan Topic	Potential Resource Issue	Proposed Study and Approach
Cultural Resources	Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires FERC to ensure that the Project, as licensed, will consider the effects on historic properties (i.e., sites, buildings, structures, objects, or districts that are listed or eligible for listing on the National Register) within the Project boundary or where the Project may have effects outside of the Project boundary. Among the effects to be considered in the Section 106 compliance process are those on cultural and religious significance to Native American Tribes. These effects and their potential resolutions are identified by formal consultation and are described further in the Tribal Resources (CR-2) Study.	Cultural Resources (CR-1) Meet FERC compliance requirements under Section 106 of the NHPA, as amended, by determining if Project-related activities and public access will have an adverse effect on historic properties Identify all archaeological sites and built environment resources within the APE, determine historic properties and cultural resources, and develop the HPMP based on those results.
Tribal Resources	Section 106 of NHPA requires FERC to ensure that the Project, as licensed, will consider the effects on historic properties, in this case Tribal resources (economic ventures; resources of traditional, cultural, or religious importance; and environmental considerations of importance to the American Indian community), within the Project boundary or where the Project may have effects outside of the Project boundary.	Tribal Resources (CR-2) Identify Tribal resources that may be affected by operations and maintenance of the Project through archival research, oral interviews, and field visits and to ensure that such places are not affected by ongoing operation and maintenance.

5.2 EARLY CONSULTATION AND INFORMATION GATHERING CONDUCTED TO DATE

EBMUD initiated early engagement with interested parties in 2024 to inform them about the upcoming relicensing process and obtain input on areas of interest or relating to agency management objectives. The opportunities to provide Project information and engage with these parties are described below; information on the outreach list, distributed materials, and meeting materials is provided in Volume II – Appendix A.

EBMUD hosted early engagement meetings on September 18 and 19, 2024, to help inform the data gathering phase. Interested parties were invited to attend any of the subject meetings related to Fish and Wildlife; Hydrology, and Climate Change; Operations and Hydropower Generation; and Recreation. These meetings included an overview of the relicensing process followed by an opportunity to share initial feedback and/or any additional information (existing reports, studies, etc.) to supplement existing data for the Project.

Additionally, on October 2, 2024, EBMUD invited representatives of local Tribes to participate in an early engagement meeting that gave an overview of the relicensing process and provided an opportunity to share initial feedback and/or any additional information that may supplement existing data. Two Tribes sent representatives: the Calaveras Band of Me-Wuk Indians and the Central Valley Me-Wuk.

On October 11, 2024, a PAD Questionnaire was distributed to solicit feedback from interested parties on their level of interest and involvement in the relicensing process and provide them an opportunity to share concerns, thoughts, and references that would be relevant to the development of the PAD. A copy of the PAD Questionnaire and Interest Form as well as responses received are included in Volume II – Appendix A.

Interested parties and members of the general public were invited to attend an open house event at EBMUD's Pardee Center on October 29, 2024. This event was an opportunity to learn about the relicensing process, learn about the Lower Mokelumne River Project, engage, and ask questions of key EBMUD staff and relicensing team members.

EBMUD held multiple early engagement TWG meetings on four resource topics, Fisheries/Aquatics, Wildlife/Botanical/Rare/Threatened/Endangered, Water Resources, and Tribal/Cultural, from June to September 2025. These meetings provided an opportunity to share preliminary draft Study Plans with interested parties and obtain feedback on the scope, objectives, and methodology of the studies.

Comments received during TWG meetings are included as part of the Consultation Log (Volume II – Appendix A). EBMUD reviewed the comments received and incorporated, as applicable, in the draft Study Plans.

EBMUD proposes to begin implementing studies in spring 2026 and continue into 2027, as needed. Study results will be provided to interested parties after the data are collected, tabulated, summarized, and checked for quality. Specific timelines for completing the draft and final reports will be developed for each study.

5.3 RELEVANT QUALIFYING FEDERAL, STATE, AND TRIBAL COMPREHENSIVE WATERWAY PLANS

Section 10(a)(2)(A) of the Federal Power Act, 16 USC Section 803 (a)(2)(A), requires FERC to consider the extent to which a project is consistent with federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. On April 27, 1988, FERC issued Order No. 481-A, revising Order No. 481, issued October 26, 1987, establishing that FERC will accord Federal Power Act Section 10(a)(2)(A) comprehensive plan status to any federal or state plan that 1) is a comprehensive study of one or more of the beneficial uses of a waterway or waterways; 2) specifies the standards, the data, and the methodology used; and 3) is filed with the FERC Secretary. FERC currently lists 115 comprehensive management plans for the state of California (FERC 2025), of which 24 pertain to waters in the vicinity of the Project (Table 5.3-1).

Table 5.3-1. Qualifying federal, state, or Tribal comprehensive waterways plans potentially relevant to the Project.

Federal, State, Local, or Tribal	Resource Management Plans/Policies
State	California Department of Fish and Game. 1986. California Wild Trout Management Program: Fall River Management Plan. Sacramento, California. April 1986.
State	California Department of Fish and Game. 1990. Central Valley Salmon and Steelhead Restoration and Enhancement Plan. Sacramento, California. April 1990.
State	California Department of Fish and Game. 1991. Lower Mokelumne River Fisheries Management Plan. Sacramento, California. November 1991.
State	California Department of Fish and Game. U.S. Fish and Wildlife Service. National Marine Fisheries Service. Bureau of Reclamation. 1988. Cooperative agreement to implement actions to benefit winter-run Chinook salmon in the Sacramento River Basin. Sacramento, California. May 20, 1988.

Federal, State, Local, or Tribal	Resource Management Plans/Policies
State	California Department of Fish and Game. 1993. Restoring Central Valley Streams: A Plan for Action. Sacramento, California. November 1993.
State	California Department of Fish and Game. 1996. Steelhead Restoration and Management Plan for California. Sacramento, California. February 1996.
State	California Department of Fish and Game. 2003. Strategic Plan for Trout Management: A Plan for 2004 and Beyond. Sacramento, California. November 2003
State	California Department of Fish and Game. 2007. California Wildlife: Conservation Challenges, California's Wildlife Action Plan. Sacramento, California 2007.
State	California Department of Fish and Game. U.S. Fish and Wildlife Service. 2010. Final Hatchery and Stocking Program Environmental Impact Report/Environmental Impact Statement. Sacramento, California. January 2010.
State	California Department of Fish and Wildlife. 2008. California Aquatic Invasive Species Management Plan. Sacramento, California. January 18, 2008
State	California Department of Parks and Recreation. 1998. Public Opinions and Attitudes on Outdoor Recreation in California. Sacramento, California. March 1998.
State	California Department of Parks and Recreation. 1994. California Outdoor Recreation Plan. Sacramento, California. April 1994.
State	California State Water Resources Control Board. 1975. Water Quality Control Plan on the Use and Disposal of Inland Waters Used for Power Plant Cooling. Sacramento, California. June 1975.
State	California State Water Resources Control Board. 2015. ISWEBE Plan: Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California. Sacramento, California. April. [Amended May 2017 and August 2018.]
State	California State Water Resources Control Board. 2017. San Francisco Bay Basin (Region 2) Water Quality Control Plan. Sacramento, California. May 2017.
State	California State Water Resources Control Board. 2017. Water Quality Control Plan for the Central Coast Basin. Sacramento, California. September 2017.
State	California Regional Water Quality Control Board, Central Valley Region. 2019. Water Quality Control Plan for Sacramento and San Joaquin River Basins and Appendices. February 2019. [Amended December 2020].
State	California State Water Resources Control Board. 1975. Thermal Plan: Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California. Sacramento, California. September 1975.

Federal, State, Local, or Tribal	Resource Management Plans/Policies
State	California - The Resources Agency. 1989. Upper Sacramento River Fisheries and Riparian Habitat Management Plan. Sacramento, California. January 1989
Federal	Forest Service. 2000. Mokelumne Wilderness Management Guidelines: Land and Resource Management Plan Amendment. March 2000.
Federal	National Marine Fisheries Service. 2014. Recovery Plan for the Evolutionarily Significant Units of Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the Distinct Population Segment of California Central Valley steelhead. Sacramento, California. July 2014.
Federal	U.S. Fish and Wildlife Service. Canadian Wildlife Service. 1986. North American Waterfowl Management Plan. Department of the Interior. Environment Canada. May 1986
Federal	U.S. Fish and Wildlife Service. 2001. Final Restoration Plan for the Anadromous Fish Restoration Program. Department of the Interior, Sacramento, California. January 9, 2001.
Federal	U.S. Fish and Wildlife Service. No Date. Fisheries USA: The Recreational Fisheries Policy of the U.S. Fish and Wildlife Service. Washington, D.C

5.4 RELEVANT RESOURCE MANAGEMENT PLANS

In addition to the comprehensive waterway plans listed above, some agencies have developed resource management plans to help guide their actions regarding specific resources by jurisdiction. The resource management plans listed below (Table 5.4-1) may be relevant to the Project and useful in the relicensing proceeding for characterizing desired conditions.

Table 5.4-1. Relevant resource management plans.

Federal, State, Local, or Tribal	Resource Management Plans/Policies
Federal	Bureau of Land Management. 2015. Record of Decision and Approved Resource Management Plan for the Great Basin Region, Including the Greater Sage Grouse Sub-Regions of Idaho and Southwestern Montana, Nevada and Northeastern California, Oregon, and Utah. Washington, D.C. September 2015.
Federal	Bureau of Land Management. Forest Service. 1994. Standards and Guidelines for Management of Habitat for Late-successional and Old-growth Forest related Species within the Range of the Northern Spotted Owl. Washington, D.C. April 13, 1994
Federal	U.S. Forest Service. 1988. Eldorado National Forest Land and Resource Management Plan. Department of Agriculture, Placerville, California. December 1988.

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