A COMPREHENSIVE PLAN TO EVALUATE THE VIABILITY OF FORECAST INFORMED RESERVOIR OPERATIONS (FIRO) FOR LAKE MENDOCINO

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GLOSSARY OF TERMS AND ACRONYMS

TERM	ACRONYM	DEFINITION
Acre feet		An acre-foot is a unit of volume in reference to large-scale water resources, such as reservoirs and river flows, equal to one acre of water one feet deep.
Atmospheric River	AR	Relatively narrow regions in the atmosphere that are responsible for most of the horizontal transport of water vapor outside of the tropics.
Bureau of Reclamation	BOR	Federal water management agency
California Department of Water Resources	DWR	State water management agency
California Data Exchange Center	CDEC	A centralized location to store and process real-time hydrologic information gathered by various cooperators throughout the State.
California Nevada River Forecast Center	CNRFC	Division of NWS that forecasts floods and other river conditions.
CalWater		A field campaign focusing on the roles played by ARs and aerosols in the variability of water supply and extreme precipitation on the West Coast.
Center for Western Weather and Water Extremes	CW3E	Research center based at Scripps Institute of Oceanography, UC San Diego.
Community Hydrologic Prediction System	CHPS	Used by CNRFC to conduct operational hydrologic forecasting.
Cubic Feet per Second	CFS	A water flow of one cubic foot passing a measurement point in a second.
Coyote Valley Dam	CVD	Dam that created Lake Mendocino
Lake Mendocino FIRO Decision Support System	LM-FIRO DSS	An information and analysis system using current and predicted conditions to analyze possible outcomes of reservoir operations decisions
Encroachment		A structure or activity that changes the course, current or cross section of a body of water.
Earth System Research Laboratory-Physical Sciences Division	ESRL-PSD	Division of NOAA that conducts weather and climate research to observe and understand Earth's physical environment, and to improve weather and climate predictions.

Engineer Research and Development Center	ERDC	Division of USACE that conducts research and development in support of the soldier, military installations, and the USACE civil works, as well as for other agencies.
European Centre for Medium-Range Weather Forecasts	ECMWF	European intergovernmental organization that provides medium range forecasts.
Forcing		The external forces that act upon the meteorological and hydrological system to cause changes in those systems. Precipitation and temperature are examples of forcing's that cause changes in the Russian River watershed, leading in some cases to floods.
Forecast Informed Reservoir Operations	FIRO	A management strategy using monitoring data and improved forecasting to flexibly operate reservoirs.
Global Ensemble Forecast System	GEFS	A weather forecast model that attempts to quantify the amount of uncertainty in a forecast.
Hydrologic Engineering Center	HEC	The designated Center of Expertise for the USACE in surface and groundwater hydrology, river hydraulics and sediment transport, hydrologic statistics and risk analysis, reservoir system analysis, planning analysis, real-time water control management and closely associated technical subjects."
Hydrologic Engineering Center-Flood Impact Analysis	HEC-FIA	A software package that analyzes the consequences from a flood event, by calculating damages to structures and contents, losses to agriculture, and estimating the potential for life loss.
Hydrologic Engineering Center-Reservoir Simulation System	HEC-ResSIM	A model for simulating reservoir system operation, given observed and forecasted inflows and a reservoir operation policy.
Integrated Water Resources Science and Services	IWRRS	Consortium of federal agencies with water resources missions.
Lake Mendocino Water Supply Manual	Manual	USACE document that prescribes operations of Lake Mendocino, including releases.
Lake Mendocino Rule Curve	Rule Curve	A graph that depicts prescribed reservoir releases, based on date and water levels.

Mendocino County Russian River Flood Control and Conservation Improvement District	Mendocino County Flood District	Water supplier in Mendocino County.
National Integrated Drought Information System	NIDIS	A federal nexus of drought information, policy and research for drought monitoring, forecasting, and early warning.
National Centers for Environmental Prediction	NCEP	Division of NWS that determine data requirements, data processing techniques, and presentation methods for products distributed to users of climatic, hydrologic, meteorological, space weather, and oceanographic information.
National Oceanic and Atmospheric Administration	NOAA	Federal agency responsible for protecting marine and coastal resources and for understanding climate, weather, and oceans.
NOAA's Habitat Blueprint	Habitat Blueprint	A framework for NOAA to think and act strategically across programs and with partner organizations to address the growing challenge of coastal and marine habitat loss and degradation.
National Weather Service	NWS	Division of NOAA that provides weather, water, and climate data, forecasts and warnings.
National Marine Fisheries Service	NMFS	Division of NOAA responsible for protecting marine resources.
Numerical Weather Predictions	NWP	Uses mathematical models of the atmosphere and oceans to predict the weather based on current weather conditions.
Office of Oceanic and Atmospheric Research	OAR	Division of NOAA that focuses on research of systems that support the planet.
Potter Valley Project	PVP	A hydroelectric project owned by Pacific Gas & Electric that diverts water from the Eel River to the Russian River watershed through Lake Mendocino.
Ramping rate		The rate at which discharge from a powerhouse or dam changes.
Reservoir Simulation System	ResSim	See "HEC-ResSIM"
Sonoma County Water Agency	Water Agency	Wholesale water supplier in Sonoma and Marin counties.

US Army Corps of Engineers	USACE	The U.S. Army Corps of Engineers delivers engineering services to customers in more than 130 countries worldwide. The agency owns and operates Lake Mendocino for flood control and recreation.
US Geological Survey	USGS	Federal mapping agency that collects, monitors, analyzes, and provides scientific understanding about natural resource conditions.
Warm Springs Dam	WSD	Dam that created Lake Mendocino
Weather Research and Forecast model	WRF	A numerical weather prediction system designed for both atmospheric research and operational forecasting needs.

A Comprehensive Plan to Evaluate the Viability of Forecast Informed Reservoir Operations (FIRO) for Lake Mendocino

September 2015

Executive Summary

As California reels from a drought of historic proportions, water suppliers and policy makers have been exploring ways to increase water storage. The debate over new dams has raged in California for several decades, and even if policymakers agreed today to build additional reservoirs it will likely be another decade before anything is constructed.

Another storage solution is to maximize the use of existing reservoirs, while not compromising their critical flood control functions. Flood control managers are understandably wary of filling a reservoir until they are certain that another major storm won't arrive. As a result, California reservoirs often enter the dry season only partially filled. If water managers had more accurate information about upcoming storms (or the lack of storms) and the watershed's capacity to hold water, they could adjust water levels in reservoirs to maximize both water supply and flood control functions with greater confidence.

Forecast Informed Reservoir Operations (FIRO) is a management strategy that uses data from watershed monitoring programs and improved weather and water forecasting to help water managers selectively retain or release water from reservoirs in a flexible manner that more accurately reflects prevailing and anticipated conditions. FIRO represents an innovative use of emerging science and technology to optimize limited resources and relieve potential impacts of climate change without building expensive new reservoir infrastructure.

The goal of FIRO is to enable modest adjustments from standard flood control guidelines when there are minimal risks of adverse impacts of such deviations to improve water supply and environmental outcomes without diminishing flood protection or dam safety. Examples where FIRO can have tangible benefits include:

> <u>Drought mitigation scenario</u> - when recent storms have caused moderate-to-high reservoir levels, but no major precipitation is predicted for several days, water is retained at higher levels than currently allowed (unless a new storm appears before spring refill) to provide adequate supplies during the summer;
> <u>Flood mitigation scenario</u> - when a storm is predicted to be intense enough to risk flooding, or the watershed is known to be saturated, water could be released from the reservoir to lower reservoir levels below what is currently allowed (as long as confidence is high that the storm will at least refill the reservoir to the level of the standard conservation pool).
> <u>Ecosystem benefits</u> - increased reservoir storage can improve the timing and volume of releases so as to improve water quality conditions and reliable stream flow for federally-listed salmonids.

The vision is simple: FIRO will help increase flexibility in reservoir operations to benefit flood control and water supply operations and to enhance fisheries habitat. The mission is straightforward: Carry out a proof-of-concept viability assessment using Lake Mendocino as a model and develop a process that can be used to possibly test FIRO at other reservoirs.

The purpose of this work plan is to develop a framework for evaluating whether it is viable to better utilize forecasting capabilities to increase storage in Lake Mendocino, which provides water supply, flood protection, flows for federally listed threatened and endangered salmonids and other aquatic resources, and recreation. The work plan describes current technical and scientific capabilities and details technical/scientific programs that will support demonstration and development of FIRO with the goal of improved reservoir management. The effort will produce a preliminary viability assessment in early 2016 that can be used to inform a response to a likely request for a "minor deviation" to store more water before spring refill 2016. The full viability assessment will be completed in roughly 5 years after completion of the full program of activities described within this workplan. It is envisioned that the full viability assessment could inform a request for a future "major deviation" in Lake Mendocino operations.

The FIRO Steering committee (see Appendix A), formed in 2014 and consisting of representatives from federal, state and county agencies as well as the University of California-San Diego (Scripps Institution of Oceanography, Center for Western Weather and Water Extremes) is undertaking a preliminary viability assessment according to the following steps:

- Develop evaluation criteria and methodology
- Develop evaluation scenarios
- Evaluate model results
- Evaluate FIRO viability (preliminary) and assess benefits
- Develop implementation strategies
- Carry out technical and scientific research necessary to support Lake Mendocino FIRO viability assessment and potential implementation of FIRO

This results of this work plan should inform decisions that need to be made to further explore the viability of the FIRO approach with the ultimate goal of improving water resources management in the Russian River Basin. For a fact sheet on this effort, see Appendix B.

SECTION 1 INTRODUCTION

Lake Mendocino is located on the East Fork of the Russian River in Mendocino County, California. Created in 1958 by the Coyote Valley Dam (CVD), it provides flood control, water supply, recreation and stream flow regulation. The U.S. Army Corps of Engineers (USACE) owns and operates the dam in accordance with the Lake Mendocino Water Control Manual (1959, revised in 1986). Sonoma County Water Agency (Water Agency) is the local partner that manages water stored in Lake Mendocino for water supply.

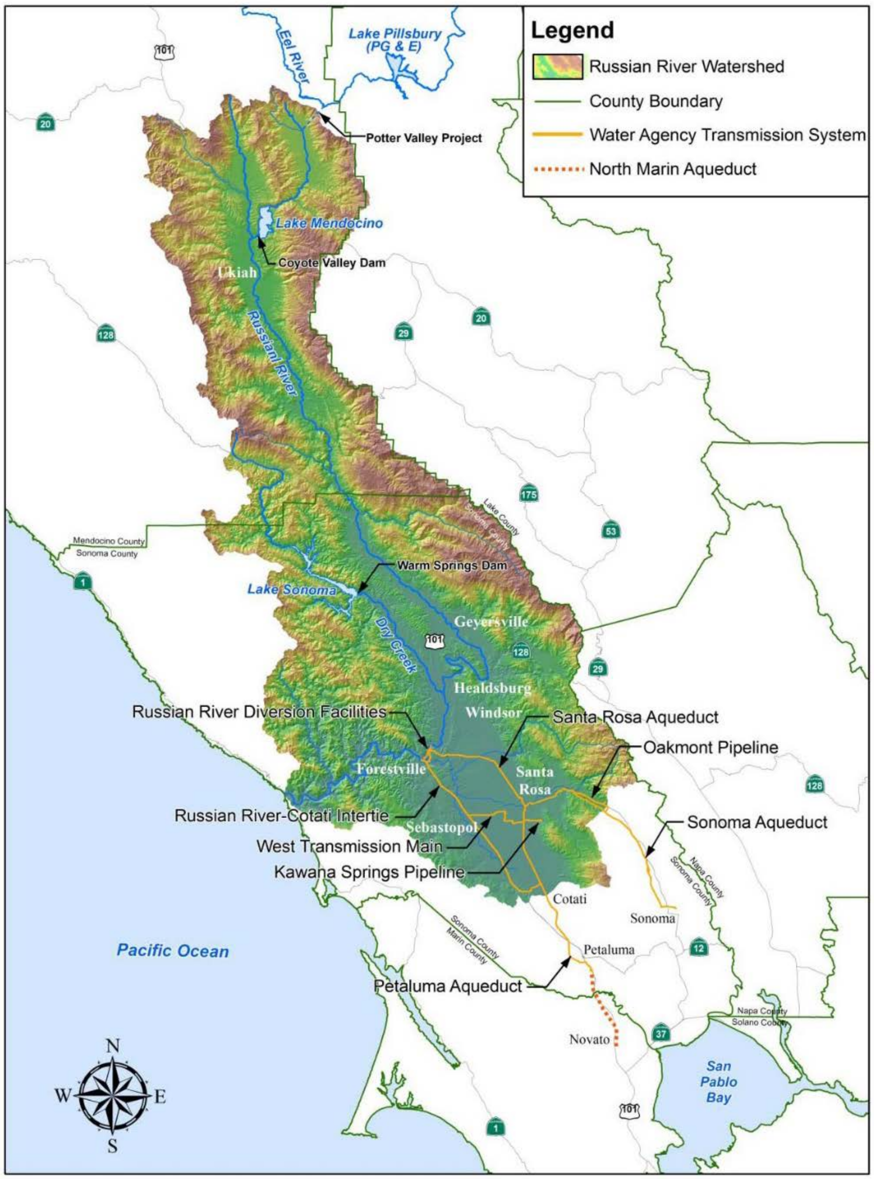

Figure 1.0. Map of Russian River watershed, including Sonoma County Water Agency transmission system. Source: Sonoma County Water Agency.

The Lake Mendocino Water Control Manual (Manual) specifies elevations for an upper volume of reservoir storage that must be kept available for capturing storm runoff and reducing flood risk and a lower volume of storage that may be used for water supply. During a flood event, runoff is captured by the reservoir and released soon after to create storage space for another potential storm. The Manual is based on typical historical weather patterns– wet during the winter, dry otherwise.

The Challenge: The Manual utilizes gross estimates of flood potential to establish reservoir storage and release requirements. It does not account for changing conditions in the watershed—for example, increased variation in dry and wet weather patterns and reductions to imported flows into the Lake that have occurred since 1986. Also, the Manual's reservoir operations procedures were developed decades ago, without the benefit of current science that more accurately predicts weather and streamflow.

Given reduced supplies, changed hydrologic conditions, and technological advances, some adjustments to the current reservoir operating procedures may be possible to optimize the goals of maintaining flood control while bolstering water supply reliability for downstream users and the environment (e.g., to support recovery of endangered and threatened salmonids). Modern observation and prediction technology could be used to reduce flood risk by supporting decisions of greater reservoir level drawdown in advance of storms. Or, such technology might be used to improve supply reliability by permitting more storm runoff to be retained for water supply while still preserving flood risk reduction objectives.

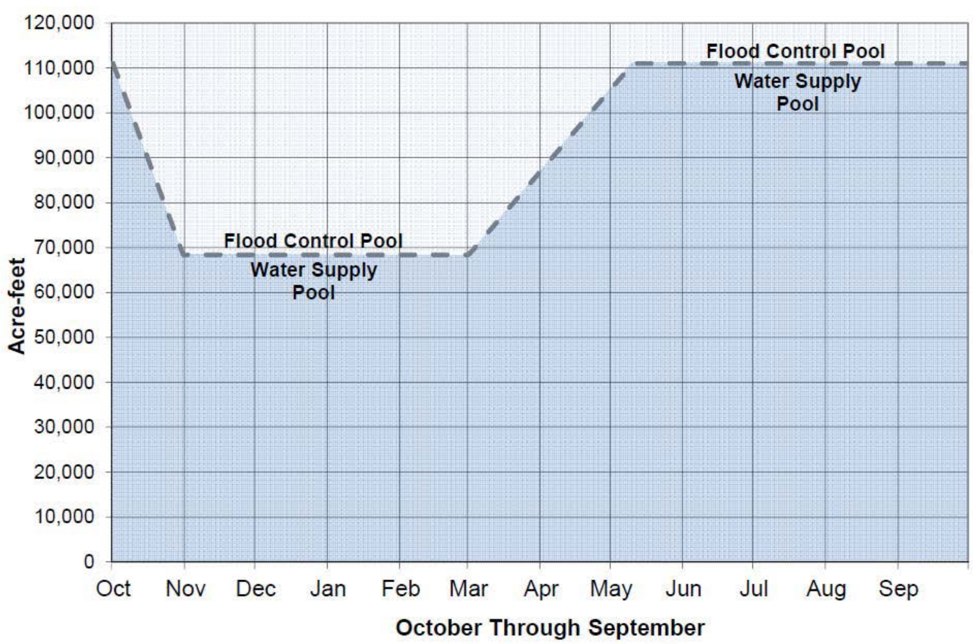

Figure 1.1. Graph of Lake Mendocino Rule Curve. Water must be released from lake between November 1 and March 1, when water levels are above 68,000 acre feet.

For example, following an atmospheric river-type storm in December 2012, water was released to create flood space according to the Manual, dropping reservoir levels by more than 35%. 2013 was the driest year on record, resulting in little inflow to refill the reservoir. By December 2013 lake levels were extremely low and remained low through 2014. Ideally, water from the December 2012 event could have been retained based on a longer-term precipitation forecasts, lessening the impact of drought.

The Potential Solution: An interagency Steering Committee was formed to explore methods for better balancing flood control and water supply needs. The committee, consisting of state and federal agencies, the Center for Western Water and Weather Extremes (CW3E) and Sonoma County Water Agency are working together on a preliminary viability assessment to determine if Forecast Informed Reservoir Operations (FIRO) at Lake Mendocino can improve water supply, maintain flood risk reduction, and achieve additional ecosystem benefits. Recent studies show the potential for improved predictability of atmospheric rivers, which provide 50% of the region's precipitation and cause most of the Russian River's floods. Also, recently developed modeling capabilities and detailed field studies have provided a greater understanding of the hydrologic processes and watershed conditions defining soil storage capacity and the relationship between runoff and recharge in the watershed that affects the reservoir inflow from rain invents.

FIRO is a management strategy that uses data from watershed monitoring and modern weather and water forecasting to help water managers selectively retain or release water from reservoirs in a manner that reflects current and forecasted conditions. FIRO's utilization of modern technology can optimize the use of limited resources and represents a viable climate change adaptation strategy. The goal of FIRO is to update standard flood control guidelines in order to improve water supply and environmental outcomes without diminishing flood risk reduction or dam safety. Examples of tangible benefits include:

> *Improve Supply Reliability for Downstream Uses* - When storms cause moderate-to-high reservoir levels, normal operation is to release water to re-establish flood control space. With FIRO, some of that water could be retained for future supply as long as no major precipitation is predicted for several days and it can be demonstrated that the retained water can be released past downstream flood prone areas before the arrival of the next storm. This strategy will permit earlier supply capture in some years, improving summer season supply reliability for downstream water users and improving the timing and volume of releases to protect water quality and provide flows needed for recovery of salmonid populations.
>
> *Enhance Flood Risk Reduction* - When a storm is predicted to cause flooding, normal operations call for release of reservoir water and drawdown of water levels. With FIRO, release decisions would consider weather observations and predictions and the current watershed conditions, which, in some cases, would indicate greater drawdown for flood risk reduction so long as there is confidence that the amount of precipitation and runoff will restore reservoir levels for water supply after the storm.

Tangible Outcomes: The full Lake Mendocino FIRO assessment will include identification, assessment and enhancement of the best science available to improve operations to maximize flood control, water supply and ecosystem benefits. The evaluation will identify realistic, short-term steps to provide more accurate and timely information about weather and watershed conditions. In addition to benefitting Lake Mendocino, the project has transferability potential throughout the western U.S. Lake Mendocino is not the only reservoir facing challenges. Water managers nationwide are grappling with the triple challenges of water supply, flood protection and ecosystem health in the face of climate change. In the long-term, infrastructure solutions may be required. But in the short-term, changes in reservoir operations could result in better water management. Identifying and navigating the steps necessary to change reservoir operations can be intimidating. One goal of Lake Mendocino FIRO participants is to document and share a process that can be replicated in other communities.

SECTION 2 BACKGROUND

2.1 Interagency Cooperation

Project Team

The FIRO Steering Committee, a multi-agency team, comprised of water managers (flood, water supply, and fisheries) and scientists (hydrology, weather/climate, modeling) has been formed to undertake the above-described evaluation (see Appendix A for list of FIRO Steering Committee members). This team represents a collaboration among local, state, and federal agencies and could serve as a model for similar efforts for other facilities. It will be critical that the project team continue to coordinate across their respective organizations during the demonstration study and subsequent activities. This effort includes procuring funding for projects identified in the demonstration study.

Working Group Participants/Projects

Under the umbrella of the Integrated Water Resources Science and Services (IWRSS), a collaborative effort between NOAA, USACE and USGS, the FIRO Steering Committee is working with a larger working group to broaden input on and participation in the preliminary viability assessment to determine if FIRO can improve water supply, flood control and ecosystem benefits at Lake Mendocino. The interests of each of the primary agencies are described below.

The Sonoma County Water Agency (Water Agency) is motivated by the possibility of more water available for water supply – especially in dry years when lake levels are extremely low. The Water Agency has been working actively with many of the FIRO partners for several years on a variety of projects, and is also interested in furthering transfer of science-based information to systems nationwide that face similar challenges.

The USACE is motivated by the possibility of updating a rule curve that was developed in the 1950s (with some modifications in the 1980s) that no longer accurately reflects current conditions. In addition, better forecasting could provide the USACE critical information during large storms, possibly allowing greater flexibility to drop water levels below the rule curve to help prepare for imminent flood events.

National Atmospheric and Oceanic Administration (NOAA) has several interests: the Russian River Watershed is designated as a Habitat Focus Area under NOAA's Habitat Blueprint; its National Marine Fisheries Service (NMFS) is deeply involved in the recovery of three species that depend on the Russian River, endangered coho salmon, threatened Chinook salmon and steelhead trout; and NOAA's Office of Atmospheric Research (OAR), and the California-Nevada Rivers Forecast Center (CNRFC) are directly involved in forecasting improvements in the region.

Figure 2.0 Photo of Lake Mendocino FIRO Working Group. August 2014.

US Geological Survey (USGS) has been involved in hydrologic monitoring and research for over a decade in the Russian River watershed, including stream gage monitoring, development of soil moisture monitoring methods and integrated modeling of rainfall-runoff, soil moisture, and surface/ground water flow.

The Corps and the Bureau of Reclamation (BOR) are cooperating on a similar project near Sacramento, CA (at Folsom Lake) and is interested in sharing information and processes.

State and regional stakeholders are also involved, including the California Department of Water Resources (DWR), which has worked closely in the watershed on several projects. The Mendocino County Russian River Flood Control and Water Conservation Improvement District (Mendocino Flood Control District) also has rights to Lake Mendocino water, and helps represents the interests of other, smaller water districts and communities that depend on the lake for water supply.

Finally, the CW3E, a non-governmental organization (NGO) affiliated with Scripps, is engaged in cutting edge meteorology (with a focus on atmospheric rivers) to help communities prepare for and adapt to climate change. Since atmospheric rivers produce about 50 percent of the rainfall in the Russian River watershed, CW3E's involvement provides important data.

Many of these agencies already work together on projects in the watershed that are focused on developing better data and information sharing, including the Habitat Blueprint, the National Integrated Drought Information System (NIDIS) and NOAA's Hydrometeorology Testbed (HMT).

Through years of cooperative projects, these and an extended list of partners in the Russian River watershed have developed a high-level of understanding and trust. The watershed is isolated from large state and federal water projects, which allows it to serve as a low-risk "test site" for innovative projects. This trust and the willingness to experiment provide a foundation for a process that requires agencies to work cooperatively and outside of traditional silos.

Several federal agencies, including NOAA, USACE, BOR and USGS, deal with water science, water management and water supply issues. Three initiatives are particularly relevant to FIRO, and have contributed to the information sharing that helped launch Lake Mendocino FIRO:

- Integrated Regional Water Science and Services (IWRSS)
- NOAA's Habitat Blueprint: Russian River Habitat Area
- National Integrated Drought Information System (NIDIS)

The IWRSS, NOAA's Habitat Blueprint, and NIDIS have similar missions directed to understanding climate, weather, water availability and the resources and the people who are affected by them. The three initiatives work across various federal and state and local agencies to share resources to help solve water resource issues at various scales. Collectively, they provide a strong conduit for bringing critical issues to the attention of agency leadership, stakeholders and partners. All three initiatives have identified the Russian River as an area to focus these efforts to serve as an example for the rest of California. This section briefly describes these initiatives, participants, and interconnections.

Integrated Regional Water Science and Services (IWRSS)

In 2009, a consortium of NOAA, USACE, and USGS, began working together to improve "the flow of information across organizational and geographic boundaries and to establish a shared comprehensive view of the water resources landscape – a common operating picture. The design involves boosting collaboration efforts across these same boundaries and working to improve modeling and synthesis, and produce a new, comprehensive and consistent suite of high-resolution water resources analyses and prediction information. And it involves a full-court press to engage the water resource management community and other key stakeholders, to work closely with them on multiple fronts to make sure we're useful."

"The IWRSS project is designed to demonstrate some basic capabilities nationally, and to demonstrate regionally a more intensive and comprehensive package – working towards an *integrative water resources information system* that knits together water resources information, products and services across geographic and organizational scales." (*IWRSS: An Integrated and Adaptive Roadmap for Operational Implementation*).(http://www.nws.noaa.gov/oh/nwc/IWRSS_ROADMAP_FINAL.pdf)

The Russian River watershed was chosen as one regional location to pilot the IWRSS process, and in 2013, a regional "Extreme Events" workshop was held. The workshop brought together nearly 100 stakeholders with the goal of assessing extreme weather events (floods and droughts) and identifying information gaps to better predict and respond to these events.

Three primary areas of concern were identified in the 2013 workshop, and in 2014, IWRSS worked with the Water Agency on a second workshop where participants chose to focus on modeling capability, data-sharing and FIRO for Lake Mendocino. The FIRO group left that meeting with the goal of holding a summer workshop to further explore the challenges, opportunities and gaps associated with integrating forecast and current watershed condition information into the decision process for reservoir and water management. A planning committee was created, which included representatives from IWRSS agencies, the Water Agency, CW3E and the DWR.

Habitat Blueprint
NOAA's **Habitat Blueprint** provides a forward looking framework for the Agency to think and act strategically across programs and with partner organizations to address the growing challenge of coastal and marine **habitat loss and degradation.** The goal of the Habitat Blueprint is to increase the effectiveness of NOAA's efforts to improve habitat conditions for fisheries, coastal and marine life, along with other economic, cultural, and environmental benefits. NOAA's expertise in flood and weather forecasting, integrated monitoring, habitat protection and restoration, stakeholder education, and coastal and ocean planning and management are critical to addressing issues within the Russian River Watershed**.** Hence, in December 2012, the Russian River watershed was chosen as the first Habitat Focus Area under NOAA's Habitat Blueprint.

The objectives identified in the Russian River Habitat Focus Area include:

- Rebuilding endangered and threatened fish stocks to sustainable levels through habitat protection and restoration.
- Improving frost, rainfall, and river forecasts in the Russian River watershed through improved data collection and modeling.
- Increasing community resiliency to flooding damage through improved planning and water management strategies.

National Integrated Drought Information System (NIDIS)
NIDIS was created through bipartisan efforts in Congress in 2006 (Public Law 109-430) as the nexus of drought information, policy and research for drought monitoring, forecasting, and early warning. NIDIS is a dynamic and accessible drought risk information system that provides users with the capacity to determine the potential impacts of drought, and the decision support tools needed to better prepare for and mitigate the effects of drought. NIDIS promotes collaboration among government agencies, states, communities, Tribes, and individuals at all levels to share information about drought, and provide resources for planning, forecasting, managing, and recovering from drought.

The NIDIS partnership provides leadership and networking among all sectors to plan for and cope with the impacts of drought, supports research on the science of drought, including indicators, risk assessment and resilience, creates location-specific early warning systems for drought management, and develops educational resources, interactive systems and tools to assist communities in learning about and dealing with drought. The NIDIS Reauthorization Act of 2014 expanded the original mandate for research, monitoring, and forecasting to enhance the predictive capability of the length and severity of droughts to also consider the role of extreme precipitation events in reducing the severity or ending drought conditions.

The Russian River pilot activity began in 2012 and following two workshops with interested stakeholders identified the concept of extremes as the key factor that will guide the decisions regarding drought preparation, education, and resource management. Because the region relies on two major reservoirs for water supply and is obligated to maintain environmental flows for fisheries, drought is defined by the reservoir in the upper watershed, Lake Mendocino. Successful NIDIS implementation involves defining indicators and triggers, early warning criteria, and community involvement and education. Recent funding from NOAA has enabled CW3E, NOAA, USGS, and the Water Agency to begin working together to develop drought scenarios and further atmospheric river research to inform the development of a stakeholder driven drought readiness plan for the Russian River.

2.2 Russian River Watershed

The Russian River is a primary water supply for Mendocino, Sonoma and Marin counties. The Water Agency is a wholesale supplier of water from the Russian River to urban areas in Sonoma and Marin counties, serving over 600,000 people. In addition, the Russian River and adjacent alluvial aquifers provide the water supply for several cities, communities, rural residents, and agriculture in the watershed. The Russian River and tributaries also support three salmonid species listed under the state and federal Endangered Species Act. A brief description of key characteristics of the Russian River watershed are provided here for context, including predominant weather conditions controlling the hydrometeorology, as well as the physiology, hydrology and key water management facilities and operations.

Weather and Climate of the Russian River Area

The Russian River watershed is influenced by its proximity to the Pacific Ocean and its year is divided into wet and dry seasons. About 93 percent of the annual precipitation normally falls from October to May. Winters are cool, and below-freezing temperatures seldom occur and snow does not normally accumulate anywhere in the watershed for more than a short period. Average annual precipitation ranges from about 35 to 80 inches, with amounts generally increasing with elevation. Much of this rain, occurs in just a few atmospheric river storms (AR) each year. ARs provide 40-50% of that rainfall (Dettinger et al. 2011; Ralph et al. 2013). These highly productive AR storms are key to ending droughts (in wet seasons) in the area since 1950 (i.e., 60% of droughts were “busted” by ARs; Dettinger 2013).

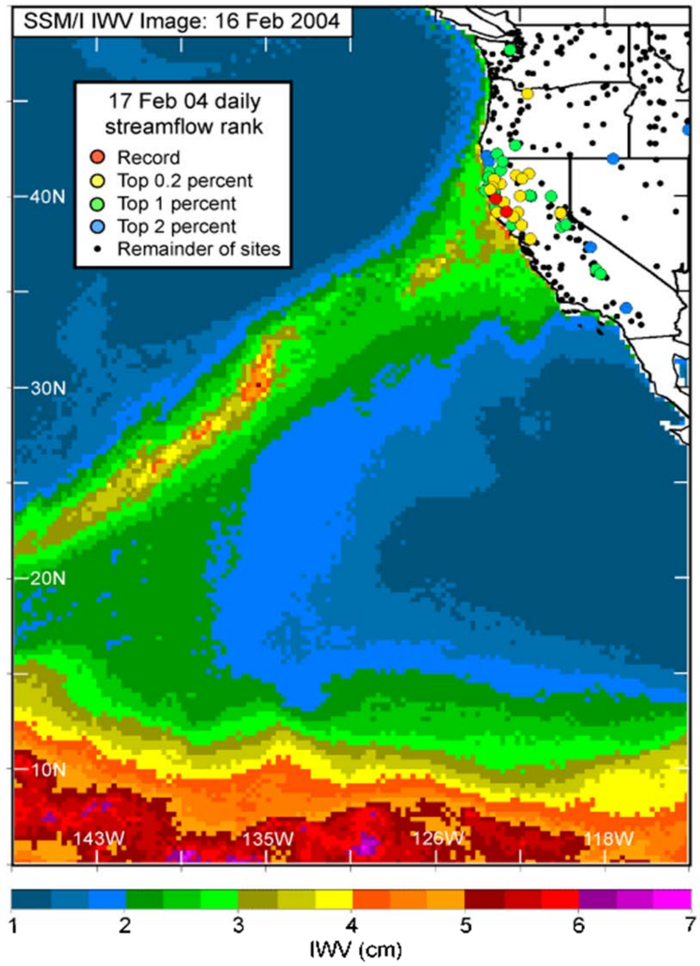

Figure 2.1. Image of an atmospheric river over the Pacific making landfall over the Russian River, and its hydrologic impacts seen from satellite-observed water vapor offshore and USGS streamgage data onshore (dots) (Ralph et al. 2006, Geophys, Res. Lett.)

Although ARs beneficially provide a large share of the overall water resources, they can cause flooding when they are strong and stall over the area. Historically, 87% of all (39) declared floods since 1948 were driven by winter ARs (Ralph et al. 2006). Thus the water resources, floods and droughts of the Russian River basin are closely, but complexly connected; historically in a majority of cases, the connection has been in the form of a land-falling AR. Drought in Northern California is not uncommon (Dettinger et al. 2011), but the high pressure blocks that are involved derive from multiple forms of climate variation and atmospheric circulation, and may occur within both phases of ENSO (el Nino-Southern Oscillation) (e.g. Namias 1978; Dettinger et al. 1998; Cayan et al. 1998). AR events, which may prevent or defeat prolonged dry spells (Dettinger 2013) can be influenced by phases of ENSO.

Physiography and Hydrology

The Russian River watershed drains an area of 1,485 square miles that includes much of Sonoma and Mendocino counties. The watershed is located within the North Coast Ranges geomorphic province of California. It is 110 miles in length and flows generally southward and then westward to the discharge point at the Pacific Ocean, 20 miles west of Santa Rosa. The river has several tributaries of varying size that contribute flow, primarily during the winter and spring. The watershed is bounded by the coastal mountain ranges with elevations ranging up to 3,500 feet above sea level. Land use in the watershed is generally rural agricultural with several urban/residential areas as shown on Figure 2.2.

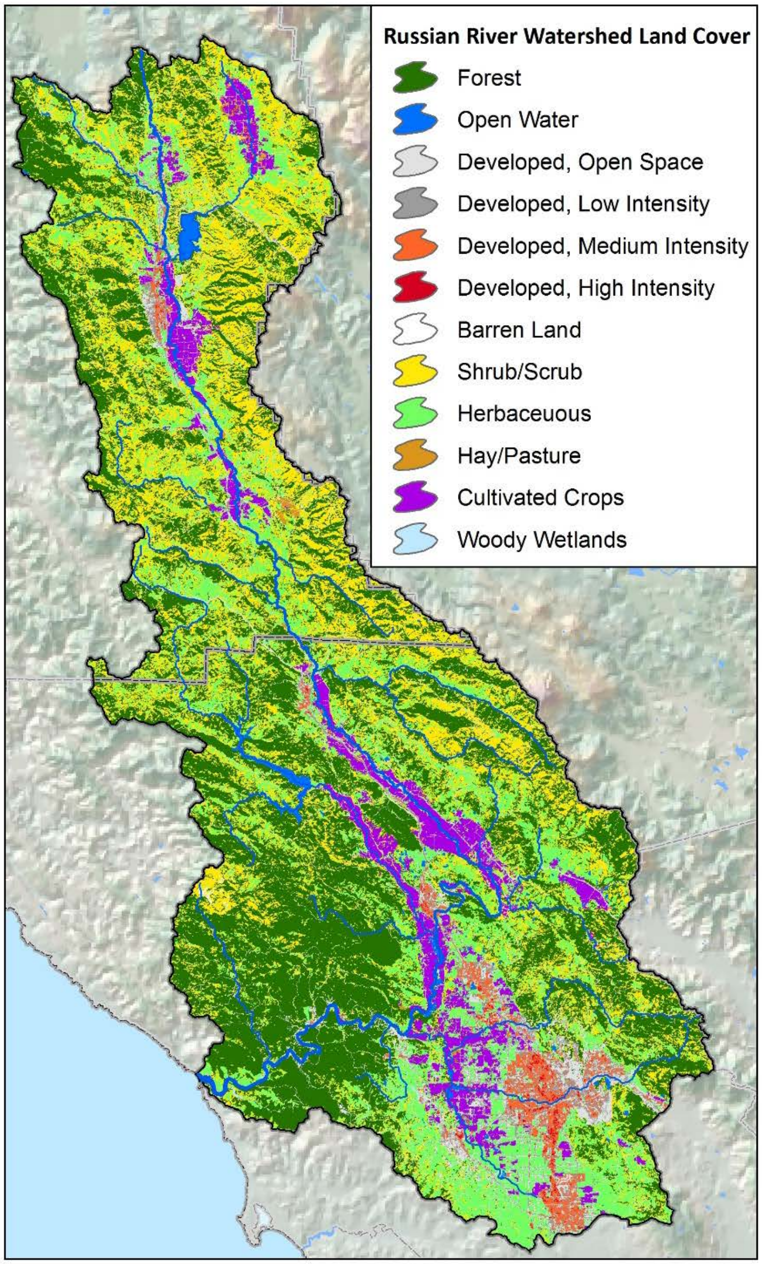

Figure 2.2. Map of Russian River watershed depicting developed and undeveloped areas by land type. Source: North Coast Resource Partnership, using USGS land use data.

The Russian River exhibits "flashy" hydrology with generally lower summer and fall flows (below 200 cubic feet per second) primarily from reservoir releases and elevated natural flow during the wet season (typically November through April) punctuated by rapidly increasing short-term high flow events resulting from extreme storms events, mostly ARs. The flood of record occurred in February, 1986, when flows at Guerneville reached 102,000 cubic feet per second. Since the completion of Coyote Valley Dam in 1958, the upper Russian River has reached flood stage at the Hopland discharge gage nine times (16% of the years) and at the Healdsburg gage six times (11% of the years). Since the completion of Warm Springs Dam in 1983 the Russian River at the Guerneville gage in the lower river has reached flood stage 12 times (39% of the years).

Water Management Facilities and Operations

Two federal projects impound water in the Russian River watershed: the Coyote Valley Dam (CVD) on the Russian River (forming Lake Mendocino), and the Warm Springs Dam on Dry Creek (a tributary of the Russian River) in Sonoma County (forming Lake Sonoma). Because the Water Agency was the local sponsor for the dams and partially financed their construction, it has the right to control releases from the water supply pools of both reservoirs. PG&E's Potter Valley Project, discussed below, imports water from the Eel River into the Russian River watershed.

Lake Sonoma and Lake Mendocino and their associated facilities, collectively referred to as the Russian River Project, are operated in accordance with criteria established by the State Water Resource Control Board's Decision 1610, which established minimum instream flow requirements for Dry Creek and the Russian River. The Water Agency makes no diversions from the Russian River between Lake Mendocino and the Russian River's confluence with Dry Creek, but does authorize diversions by others under its water rights permits. Flood management releases from both reservoirs are controlled by the USACE. The Water Agency diverts water from the Russian and conveys the water via its transmission system to its customers.

Lake Pillsbury and the Potter Valley Project (PVP)

PG&E's PVP, constructed in 1908, diverts water from the Eel River into the Russian River watershed. Water is stored in Lake Pillsbury (constructed for the PVP in 1922) on the Eel River, then moves through a diversion tunnel to the Potter Valley powerhouse in the Russian River watershed. The water is discharged from the powerhouse into a canal from which the Potter Valley Irrigation District diverts water. The water then flows into the East Fork of the Russian River to Lake Mendocino. PVP diversions are regulated by a license issued to PG&E by the Federal Energy Regulatory Commission (FERC) and serve multiple purposes, including power generation, Potter Valley agricultural irrigation, and minimum instream flow requirements in the East Fork of the Russian River. PG&E's license was amended in 2004, resulting in significant reductions to PVP diversions starting in 2006, resulting in lower inflow to Lake Mendocino.

Lake Mendocino and Coyote Valley Dam (CVD)
CVD impounds water, forming Lake Mendocino on the East Fork of the Russian River. Lake Mendocino has operated since 1959 and captures water from two sources: (1) runoff from a drainage area of approximately 105 square miles and (2) Eel River water diverted by PG&E's PVP. Natural drainage and stream flow (as opposed to reservoir releases) contribute the majority of the Russian River flow downstream of CVD and above Dry Creek during the rainy season (November through April). In contrast, during the drier months of May through October, water released from Lake Mendocino accounts for most of the water in the Russian River upstream of Dry Creek. The Water Agency and the Mendocino Flood Control District have water right permits authorizing storage up to the design capacity of 122,500 acre-feet per year (ac-ft/yr) in the reservoir. The water supply pool capacity of Lake Mendocino is currently 68,400 ac-ft. The Water Agency controls releases from the water supply pool in Lake Mendocino. However, the USACE manages flood control releases when the water level exceeds the top of the water supply pool elevation. The USACE allows the Water Agency to encroach into the flood pool in the spring so that the summer water supply pool can be increased to 111,000 ac-ft.

Lake Sonoma and Warm Springs Dam
Water stored behind Warm Springs Dam, completed in 1983, forms Lake Sonoma. It captures runoff from a drainage area of approximately 130 square miles on Dry Creek, a major tributary of the Russian River. It has a design capacity of 381,000 ac-ft at the spillway crest and a design water supply pool capacity of 245,000 acre-feet. The Water Agency controls water supply releases from Lake Sonoma and the USACE manages flood control releases. Releases from the dam flow into Dry Creek, which meets the Russian River 14 miles downstream.

Natural drainage and stream flow (as opposed to reservoir releases) contribute the majority of the Dry Creek flow downstream of Warm Springs Dam during the rainy season. During the dry season, reservoir releases contribute the majority of the flow in Dry Creek. Such reservoir discharges supply flow to meet minimum instream flow requirements and municipal, domestic, and industrial demands in the lower Russian River area. Water released from Lake Sonoma and runoff from other tributaries contribute to meeting these demands.

2.3 Water Management Challenges

There are multiple, significant challenges associated with the operation of CVD. This section outlines challenges associated with water supply, flood control and ecosystem management. A key challenge is illustrated in Figure 2.3, below. It shows how, 2004-2014 the reservoir has not been able to refill in the spring.

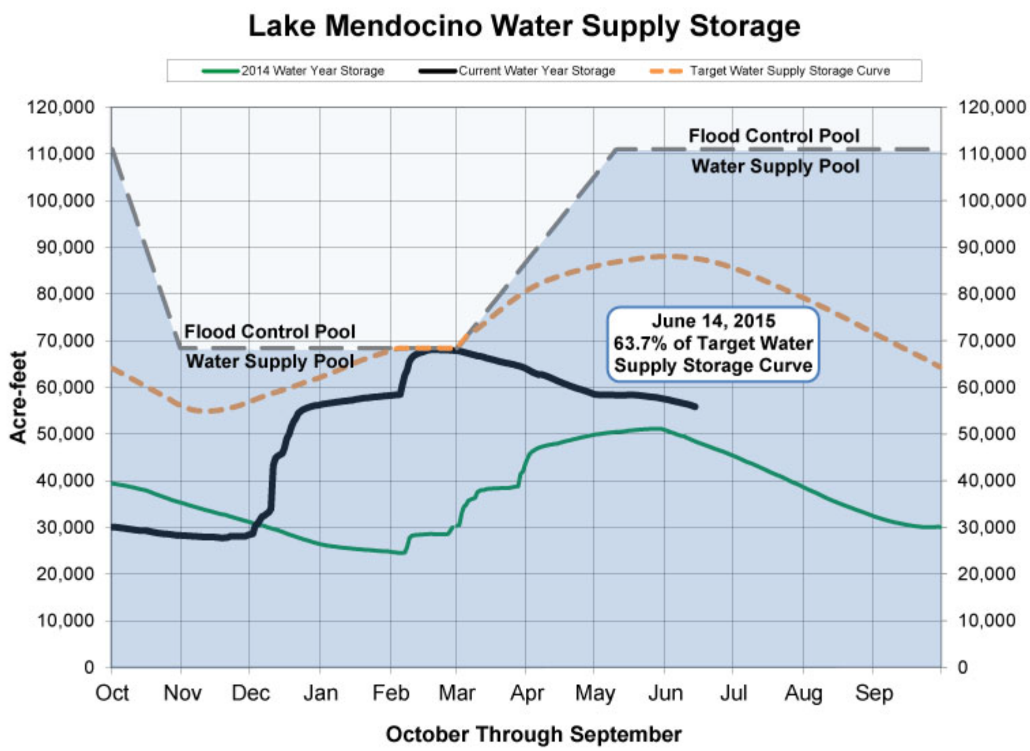

Figure 2.3. Graph illustrating June 2015 water level at Lake Mendocino (black line), courtesy of Sonoma County Water Agency. Atmospheric river storms in early December and February brought water level up to roughly normal for 1 March. However, very little precipitation and inflow occurred after that, which has been common in the past several years. Thus the reservoir has been unable to refill to provide adequate water supply through the dry summer [Water year 2014 (green line) and average of Water years 2004-2014 (blue line)].

Water Supply Management

The Water Agency is the local sponsor for Lake Mendocino and controls and coordinates water supply releases from the CVD. There are several water supply challenges, including minimal coordination with people who use water downstream; a federal biological opinion that requires flow changes; an out-of-date rule curve for determining flows; and reduced inflows from the Eel River watershed.

The Water Agency controls water releases from CVD in accordance with its water rights permits and provisions of Decision 1610 (Appendix D), which the State Water Resources Control Board (State Water Board) adopted on April 17, 1986. The Water Agency's permits authorize diversions to storage in Lake Mendocino, re-diversions of water released from storage and direct diversions at points downstream. The Water Agency makes releases from CVD to: (1) meet downstream demands of agricultural and residential water users and several public and municipal systems; and (2) maintain minimum in-stream flows in the upper river to its confluence with Dry Creek. These minimum flow requirements vary based on the hydrologic year type, which are also prescribed as a hydrologic index specified by Decision 1610. There is little to no coordination between water diverters below Lake Mendocino, nor between water diverters and the Water Agency. The Water Agency's operations are also subject to the Russian River Biological Opinion issued by the National Marine Fisheries Service on September 24, 2008.

The hydrologic year type for the Russian River system is based on cumulative inflow into Lake Pillsbury, which is located on the upper Eel River and was formed in 1921 by the construction of Scott Dam (Figure 7). This hydrologic index is not located in the Russian River watershed and reflects Lake Mendocino's dependence of PG&E's Potter Valley Hydroelectric Project (PVP). Lake Pillsbury is part of the PVP, 9.4 megawatt storage and diversion project, that has been in operation for more than 100 years. PG&E's operation of the project results in an inter-basin transfer of water from the upper Eel River into the East Branch Russian River across a natural divide.

Figure 2.4. Photo of Scott Dam on the South Fork Eel River. Source: Sonoma County Water Agency.

Since 2006, the diversion through PVP has averaged 72,000 acre-feet annually, representing a significant reduction of inflow into Lake Mendocino. Furthermore, much of the reduction in PVP diversions since 2006 is a result of the amended license significantly constraining PVP operations during the spring. Reduced inflow from PVP during the spring directly conflicts the with Lake Mendocino's design as a smaller reservoir with an increasing water supply pool in the spring as flood risks decrease. Further, modeling conducted by the Water Agency for the 2015 Lake Mendocino Water Supply Reliability Report finds that Lake Mendocino will become increasingly unreliable in a variety of climate change scenarios.

Flood Control Management

CVD operations are governed by the Water Control Manual that dictates ranges of release flows depending on pool level, non-regulated flows in the Russian, damaging flood stages downstream of the dam and on current releases. The rate-of-change (ramping) standards were developed as part of consultations with NMFS and from geotechnical considerations to prevent stranding fish and to minimize bank damage. In general, the operation is designed to store water during a flood event, then release soon thereafter to create storage space for another potential event. Seasonal differences in required flood space are the result of nearly 100 years of hydromet data, and are based on typical weather patterns -- wet during the winter, dry otherwise. Since much of the basin is not regulated by dam operations, the Water Control Manual is designed to prevent flooding when possible in the Hopland and Guerneville areas, and in concert with Warm Springs dam operations. See the attached water control diagram for specifics (Appendix E).

Deviations from the water control manual are subject to review and approval by the USACE. On December 18, 2014, the South Pacific Division of the Corps issued a policy entitled; *Engineering and Design Guidance on the Preparation of Deviations from Approved Water Control Plans*. This policy described the procedures for emergency, unplanned, and planned (minor and major) deviations to water control manuals. Planned minor deviations are defined as follows: *"limited by 1) flood control pool elevation will not vary more than 2 feet from what would have been the water surface elevation under the approved Water Control Plan or ii) storage difference from approved Water Control Manual will not exceed 5% of the total storage. Minor deviations should not last more than 10 days. Longer minor deviation must be coordinated with the SPD Senior H&H/Water Control Engineer."* The policy also states that for a planned major deviation, a risk and uncertainty analysis must be performed to determine potential consequences of the deviation.

Environmental Resource Management

The NMFS has issued two biological opinions that pertain to water storage in the Russian River: (1) the PVP Biological Opinion in 2002 (Eel and Russian rivers transbasin diversion); and (2) the Russian River Biological Opinion in 2008. Project elements addressed in the Russian River Biological Opinion include operations and water supply releases at Warm Springs and CVD, flood control operations, channel maintenance (Water Agency and Mendocino Flood Control Agency), estuary/lagoon management, fish hatchery operations at Don Clausen Fish Hatchery and Coyote Valley Fish Facility, and other Water Agency diversion facilities and operations.

Specific to Lake Mendocino and CVD operations, the Russian River Biological Opinion identifies three primary project elements impacting fisheries: (1) higher summer flows/velocity from CVD releases effecting juvenile steelhead rearing habitat in the upper main stem Russian River (modify Decision 1610); (2) chronic turbidity issues associated with Lake Mendocino discharge; and (3) water discharge ramping rates (up/down) and annual dam inspections (suspended releases to the East Branch Russian River).

Other environmental resource management (fisheries) consideration regarding future operations at CVD include the cold-water pool management for juvenile steelhead rearing and fall-run adult Chinook salmon within the upper mainstem Russian River, fall release flows for upstream migrating adult Chinook salmon during dry and critically dry fall/early winter periods, combined release strategies with Warm Springs Dam influencing estuary and lower river flow conditions, and blockwater (amounts of water reserved for specific uses) allocations for critical and/or emergency fisheries management situations. NMFS believes that improved reservoir water storage reliability within Lake Mendocino will afford more operational flexibility that can aid and enhance fisheries management. Additionally, with improved forecast reliability, fisheries managers can better prepare for drought scenarios that impact hatchery operations and recreational fishing opportunities within the main stem Russian River.

2.4 Current Capabilities

A robust monitoring program is critical to provide operators and managers information on current watershed conditions and also to help inform models both for long-range planning and real-time operations. There are currently several efforts underway to monitor watershed conditions, including river and tributary flow, soil moisture, precipitation, atmospheric rivers and water quality. Similarly, a foundation of FIRO is the ability to forecast key conditions both in terms of hydrology, but also in terms of the meteorological and hydrologic and land surface conditions that drive the streamflow. This section emphasizes the current state of monitoring and prediction.

Flow Monitoring

The U.S. Geological Survey (USGS) currently monitors flow at 27 gage sites within the Russian River basin. Twelve of the gaging stations are on the mainstem of the Russian River and Dry Creek. The Water Agency and the Corps use data collected from these stations to help inform and plan reservoir releases. Additional flow monitoring stations have been installed and monitored by other entities such as non-governmental and private organizations, but data from these sites is typically not available on a real-time basis.

Currently the distribution of gages downstream of Lake Mendocino is adequate to inform current water supply and flood operations of Coyote Valley Dam. However, an ongoing issue associated with the gage site used to estimate releases from the reservoir is caused by backwater of the gage during periods of elevated flows downstream caused by natural runoff. This backwatering causes an overestimation of reservoir releases.

Figure 2.4. Map showing Russian River stream monitoring stations. Sonoma County Water Agency.

Water Quality: Water temperature, turbidity, and dissolved oxygen

A thorough understanding of water quality conditions associated with seasonal changes in Lake Mendocino limnology is fundamental to developing flow prescriptions that support salmon and steelhead life histories downstream of Coyote Dam. Essential parameters to achieve adequate water quality conditions below Lake Mendocino for salmonids include temperature, turbidity and dissolved oxygen. Some of these water quality parameters are currently being monitored in the upper Russian River; however, data gaps need to be remedied in order to support a comprehensive modeling framework designed to forecast Lake Mendocino discharge water quality conditions.

The Water Agency funds the USGS to monitor water quality in real time at a number of gage sites in the Russian River Basin. Additionally the Water Agency also independently monitors water quality at a number of locations along the Russian River and Dry Creek. Data from these sites is not available in real time, but is downloaded every one to three weeks by Water Agency technicians. These monitoring sites provide resource managers valuable data on ongoing conditions to help inform real-time operations. These data have also been useful for the development of analytic tools such as the Water Agency's HEC-5Q water quality model, which is currently being used for the development and evaluation of management alternatives required under the Russian River Biological Opinion.

An ongoing issue for river reaches downstream of Lake Mendocino has been highly turbid reservoir releases. It is believed that during periods of sustained high releases, turbulent flow conditions around the outlet structure draw in fine sediment which is easily mobilized off of the bottom of the reservoir and result in highly turbid releases.

More extensive monitoring of water quality conditions for reservoir inflow, stored water and outflow could lead to better understanding the causes of turbidity.

Current upper Russian River water quality data collections sites:

Water temperature:

a. Russian River at Hopland - USGG gage (11462500)
b. Russian River at Cloverdale - USGS gage (11463000)
c. Russian River at Jimtown - USGS gage (11463682)
d. Russian River at Diggers Bend – USGS gage (11463980)

Turbidity:

e. East Branch Russian River near USGS gage (11461500) - Corps gage
f. East Branch Russian River Coyote Dam outlet structure - Corps gage
g. West Branch Russian River at Lake Mendocino Drive - Corps gage
h. Mainstem Russian River at Talmage – Corps gage

In effort to better quantify seasonal changes in Lake Mendocino limnology and pervasive issues with high turbidity associated with reservoir releases, the following additions to existing monitoring are recommended:

1) Monitoring of turbidity of inflow into Lake Mendocino at the USGS Calpella gage;
2) Monitoring of temperature, dissolved oxygen and turbidity at the outlet structure with the deployment of a vertical array of 3 to 5 instruments to monitor conditions at discrete depths below water surface; and

3) Monitoring of temperature, dissolved oxygen, and turbidity just downstream of the outfall of the outlet structure.

Data collected under these monitoring recommendations can be used to better understand the seasonal temperature and dissolved oxygen stratification and turnover of the reservoir as well as the ongoing issue of turbid releases which result in degraded habitat conditions downstream. These data will be used to support and validate future comprehensive modeling efforts.

Precipitation and Soil Moisture Monitoring in the Russian-Napa Watersheds
The precipitation and soil moisture monitoring program in both the Russian and Napa watersheds is a collaborative project between ESRL-PSD, DWR, SCWA, USGS, and USACE. ESRL-PSD is installing rain gauge and soil moisture monitoring sites above Lake Mendocino to monitor watershed conditions and augment the existing ESRL-PSD network in the Russian. The soil moisture data will be used by the USGS to determine soil storage capacity to estimate runoff into the reservoir. Rain gauge data will be used together with the S-PROF radars to improve precipitation monitoring in the watershed, especially above Lake Mendocino. Retrospective analyses of QPE during extreme precipitation events will be conducted and data sets provided to ACE for design study analysis. A NOAA P-3 research aircraft was deployed during the 2014-2015 winter season for the CalWater 2 field program, and flights over the S-PROF network will be evaluated.

Weather Forecasting
The weather forecasting described in this section is limited to that which directly supports the forecasting of inflow to Lake Mendocino.

Operational weather forecast in support of hydrologic forecast operations is well established in the Russian River Basin. Precipitation forecasts are based on NWP models operated by NOAA, ECMWF, and others. Current operational hydrologic models supported by the CNRFC utilize five days of precipitation and temperature forecasts at six-hour time steps. The CNRFC conducts the final assessment of the forecasts, however, reliance is placed on input from NCEP's WPC as well as WFO Monterey.

Precipitation and temperature forecasts are updated twice per day in the rainy season (November through April), once per day in the "summer", and four times per day anytime there is flooding or a substantial threat of flooding. While surface temperature forecasts are part of the equation, the Russian River rarely receives snowfall and as such frozen precipitation and snowpack modeling are not a significant factor.

Because the majority of precipitation and the vast majority of heavy sustained precipitation events that result in flooding come in the form of ARs, over the past 15 years, a great deal of effort has gone into detecting ARs and understanding their impact on the hydrology. The Russian River Basin has been one of several focus areas. This work is led by NOAA's OAR/PSD in collaboration with other elements of NOAA, Scripps Institution of Oceanography, California

DWR, and the Water Agency. Investments in instrumentation (AR observatories, soil moisture sensors, precipitation gages, and gap filling radars) have helped and continue to build the body of understanding associated with AR behavior, impacts, and prediction. In addition, substantial work has been directed toward mesoscale atmospheric modeling that can leverage what has been learned and assimilate newly available information. The goal of this modeling effort is to improve high-resolution (time and space) short-term weather forecasts associated with AR events. Operational forecaster tools that assist in the detection and classification of AR events are under development.

Gaps in weather forecasting all align with the ability to confidently predict high-resolution (time and space) precipitation with lead times from hours to two weeks. Several days lead-time could provide reservoir operators the time they need to make adjustments to storage contents before storm impacts are significantly felt. This is a tall order. Continued work in the physics of AR formation and prediction is needed along with the observational investments that validate the prediction process.

Hydrologic Forecasting

Operational hydrologic forecasting for Lake Mendocino as well as the full Russian River Basin is well established. Five-day lead-time forecasts are generated twice per day in the rainy season, once per day in the dry season, and every six hours during flood events. This is consistent with the updating of the five-day precipitation and temperature forecasts. Flood warnings for the Russian are issued by WFOs Eureka and Monterey based on guidance developed by the CNRFC. Inflow forecasts for Lake Mendocino and Lake Sonoma are transmitted directly to the USACE and available online.

The CNRFC conducts operational hydrologic forecasting using the Community Hydrologic Prediction System (CHPS). CHPS supports and manages the data, models, model parameters, and model states needed to execute models, visual results, quality control output, and generate customer information (products). The Lake Mendocino inflow watershed configuration employs (1) a rain-snow separation operation, (2) a snow model, (3) a Sacramento soil moisture accounting model, (4) a unit hydrograph operation, and (5) a reservoir model. The model was calibrated over the full available history of the lake with emphasis on the most recent 10-year period.

The Lake Mendocino watershed model is calibrated to simulate the full natural inflow to the lake. This means that historical records were adjusted for the diversion into the basin from the Eel River watershed through the Potter Valley diversion. The records for this positive diversion into the basin are not perfect. In addition, there are diversions within the Lake Mendocino watershed for irrigation. No reasonable data exist for these within basin diversions. Monthly estimates of these diversions are integrated into the CNRFC model to avoid negative computed natural inflows (observed minus Potter Valley diversion).

The CNRFC modeling system for Lake Mendocino (and the full Russian River) can be run in an ensemble mode to provide short, medium, and long-range probabilistic hydrologic forecasts.

Currently, the ensemble forecasts are forced with 15 days of the GEFS followed by climatology for the remainder of the 365-day run. The ensemble system can be run in a hindcast mode for the 1985-2010 period. This hindcast can be used to establish the reliability of the utility and reliability of the hydrologic forecasts.

The confident prediction of "very little rain" over the next seven days during the rainy season may prove to be as or more valuable than the prediction of high flows during an AR event in the management scheme for Lake Mendocino. An analysis of archived forecasts as well as hindcasts will be necessary to evaluate this hypothesis.

Observational gaps that have the best potential to improve hydrologic forecasting include improved precipitation estimates as well as improved stream gaging in the watershed above Lake Mendocino to better assess the volume of water imported from the Eel River and the diversions that take place within the watershed.

As observed and forecast forcings (precipitation and temperature) improve and exhibit skill at higher temporal and spatial resolutions, it begins to make sense to investigate distributed hydrologic models (DHMs). USACE's ERDC and NOAA's ESRL-PSD have initiated prototyping work in this area. The objective is to simulate and forecast small, typically ungagged basins within the Russian River watershed primarily for fisheries management. Many challenges and opportunities exist for exploring soil moisture and streamflow data assimilation and adjustment as well and the integration and impact of reservoir regulation.

SECTION 3 FIRO VIABILILTY ASSESSMENT PROCESS

3.1 Approach

As previously discussed, there are significant challenges with current operations of Lake Mendocino. The future will likely add additional stresses to the reservoir and the communities and ecosystems that depend on water releases. Modeling analysis has indicated that it is likely that growth in water use and climate change will result in reductions in average rainfall and less frequent, but more intense storms. Further, it is not likely that additional surface water reservoirs will be constructed in the foreseeable future, so optimizing the operations of existing reservoirs is a key strategy to address these challenges.

FIRO represents a suite of several actions that could be implemented to improve the overall function of Lake Mendocino. Some of these actions may be more feasible to implement in the near-term while others are long-term endeavors, requiring further research and study. Consequently, it is likely that if FIRO is implemented and incorporated into operations, it will be done incrementally, as various actions are deemed to meet criteria for implementation.

FIRO will provide a formal setting for developing and operating with a more-flexible, "smart" rule curve that uses better available data and forecasts to inform release decisions. FIRO is based on focused research activities on associated meteorological, hydrological, ecosystem and water management information needs, and a process to take advantage of advances in science and technology.

Even incremental changes in reservoir management could improve resiliency to drought and extreme stresses from climate change in order to maximize water supply, flood protection and ecosystem health. While USACE is committed to these goals (and to providing recreation opportunities for lake users), its primary objective is dam safety. Proposed changes to reservoir operations must include assurances that dam safety won’t be compromised. The viability assessment will include a combined benefit and risk analysis, to characterize and where possible quantify the water supply, flood protection, and environmental benefits of implementing FIRO at Lake Mendocino.

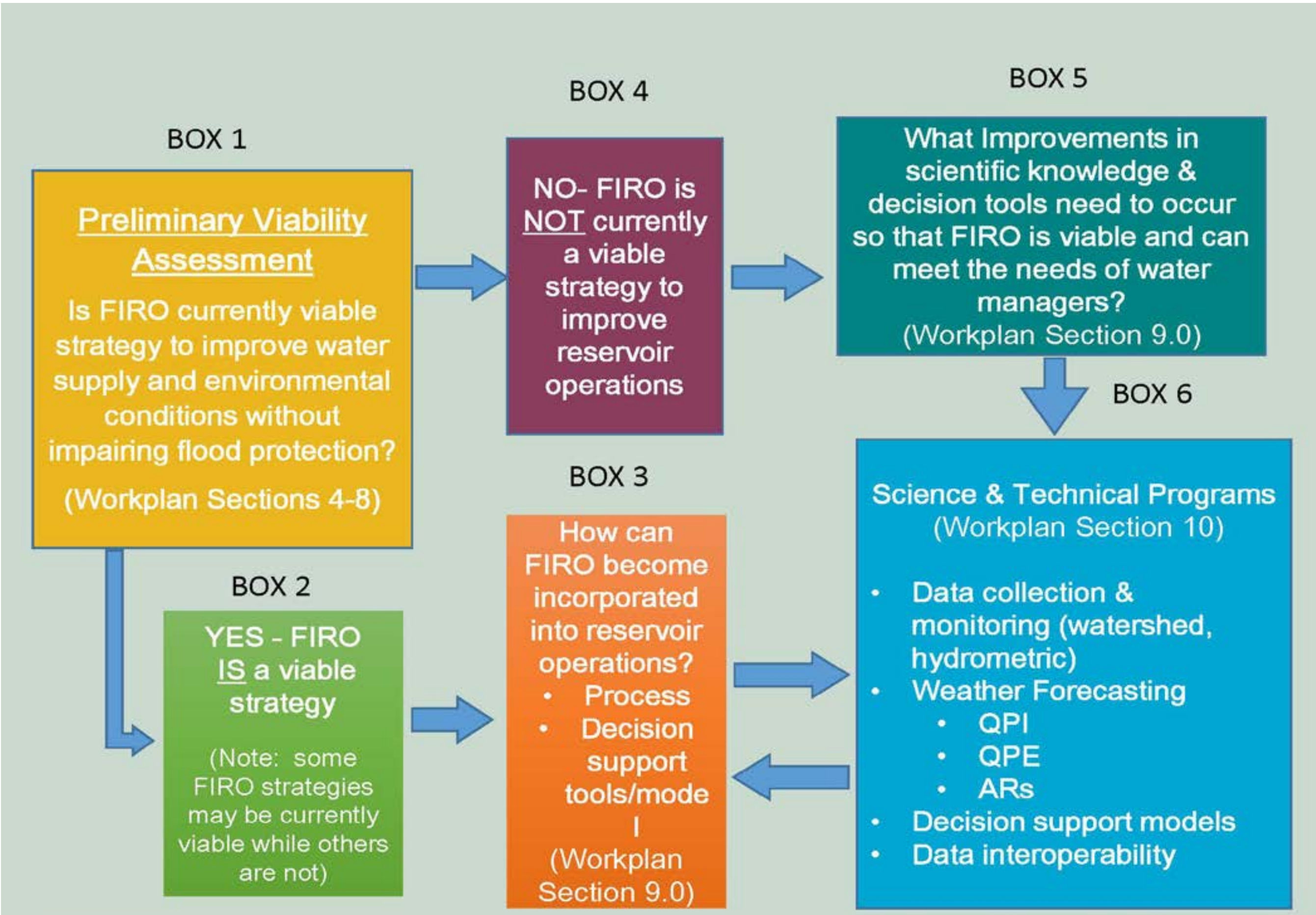

Figure 3.0. Flow diagram depicting the FIRO Viability Assessment Process for a Go-Not Yet decision

The first step in understanding the role FIRO may play in addressing water supply challenges is to evaluate whether there are any actions that can currently be undertaken to improve the status quo and increase the overall availability of water resources by more effectively balancing flood and drought risks in the Russian River Basin.

The preliminary viability assessment is targeted for completion in 2016, and could provide key information to support approval of a request for a "minor deviation" to operations for late 2016. The full viability assessment will be conducted over the next five years using the framework established in this work plan. One of its targets will be to provide the scientific and technical foundation upon which to base a future request to the USACE for a "major deviation." (Note: The South Pacific Division of the Corps recently developed a policy for deviations to the Water Control Manuals for its reservoirs. This policy specifies allowable limits and incursions into the flood control pool for minor deviations. Major deviations, per the new policy, will require a risk and uncertainty analysis.)

Figure 3.0 illustrates the proposed approach and decision detailed in this work plan for conducting the demonstration study. Beginning with Box 1 of Figure 3.0, the viability evaluation will answer the following question:

Is FIRO currently a viable strategy to improve water supply and environmental conditions without impairing flood protections?

To answer this question, the scope of the viability analysis, as described in this work plan, consists of: (1) developing evaluation criteria, methodology, and modeling approach; (2) developing modeling scenarios; (3) evaluating modeling results; (4) assessing benefits; and (5) evaluating viability of FIRO actions.

It is envisioned that a preliminary viability assessment will be completed within a year, based primarily on consideration of past forecast skill in the context of the FIRO operational considerations and requirements. This assessment could inform a decision on a possible request for a "minor deviation." Given the challenge of predicting the storms and conditions that will ultimately determine the viability of FIRO on Lake Mendocino, it is expected that the full assessment of viability will require targeted research efforts (see below and section 8) and "parallel" real-time systems tests (without actual changes to operations) that will occur over the next five years. If the conclusion of either the preliminary or full viability assessments is that there is at least one or more action that improve the overall performance of Lake Mendocino (Box 2, Figure 9), the effort then will address the following question (Box 3, Figure 3.0):

How can FIRO become incorporated into reservoir operations?

Section 7 of this work plan describes how implementation strategies and decision support tools could be developed for FIRO actions deemed to be viable for operationalizing. For FIRO actions that are not found to currently viable or are only partially viable to improve the performance of Lake Mendocino (Box 5, Figure 3.0), the effort then effort will focus on answering the following question:

What improvements in scientific knowledge and decision support systems need to occur so that FIRO can meet the needs of water managers?

To address this question, Section 8 of this work plan (Box 6, Figure 3.0), describes several initiatives (data collection, monitoring, forecasting, model develop, and data interoperability) to improve the scientific understanding and technical capabilities with the goal of ultimately being able to operationalize at least some FIRO actions in the future.

As shown in Figure 3.0, even if there are some actions that can be currently be operationalized, there also must be a long-term effort of improvement and refinement by continuing pursue science and technical programs (Box 6) that can continually feed back into reservoir operations (Box 3).

SECTION 4 EVALUATION FRAMEWORK, SCENARIOS AND CRITERIA

This section describes the process that the FIRO Steering Committee will undertake to assess the viability of FIRO for Lake Mendocino, starting with a description of the evaluation framework, scenarios to be modeled, and criteria that will be used to inform decision-making.

4.1 Evaluation Framework

In order to emulate the Russian River system operation under a variety of management schemes fed by different types of information, one or more systems model must be developed to analyze the viability of implementing FIRO. In concept, the systems models describe the physical characteristics of the watershed (stream reaches, dams, infrastructure, vulnerable resources, and benefit opportunities), as well as the inputs required to drive a simulation. The generalized system evaluation model is shown in Figure 9. Several of the constituent parts are provided within the suite of HEC models.

For the viability assessment process, system models of varying complexity that represent many if not all aspects of the Russian River are for the most part already in place. Implementing a multimodel ensemble approach (Johnson and Swinbank, 2009) to analyze how changes in reservoir operations will impact the Russian River Basin provides a mechanism to understand and differentiate between system sensitivity and model-dependent sensitivity. Changes to these models are needed to connect to various sources of inputs and operating criteria. Larger, more significant changes are needed for the most comprehensive reservoir model, RESSIM, to take advantage of forecast information. Since the Control Manual does not specify release requirements for Lake Mendocino if below the control curve, the investments made by the Water Agency to develop a full range of conditions RESSIM model for Lake Mendocino will be heavily leveraged. These adaptions are described in Appendix F.

In order to scope the potential for FIRO to deliver greater benefits than today's existing operation, it is imperative to exercise the systems models with scenarios that represent the extremes of weather and water prediction extremes and a variety of reservoir operation decision rules. Note that the most comprehensive systems model is fundamentally the same as the FIRO-DSS described in Section 7 while the less complex system models provide mechanisms capabilities to rapidly explore and test hypothesized responses to changes in operations. The approach of employing models of varying complexity ensures access to the best available science to inform the viability assessment process while making the transition from evaluation to operations relatively straightforward and ensures predictable results.

4.2 Evaluation Scenarios

Case 1. Existing Condition

The systems models can be exercised over the period of record (1971-present) using the existing Control Manual rules integrated into the decision logic of RESSIM and the other models. Note that the Control Manual only addresses releases when the storage is above TOC.

Case 2. Perfect Forecasts

The case will require new configurations of RESSIM and the other models that are able to take full advantage of inflow and downstream streamflow forecasts that are without error out to 6 months into the future. While this case is not realistic, it provides a means of identifying the maximum potential benefit associated with the utilization of forecasts in the decision process. The systems model can be exercised over the full period of record (1971-present). This RESSIM configuration will serve as the basis for a subsequent configuration that leverages forecasts that contain uncertainty.

Case 3. Current Forecast Skill

This case will evaluate the utility of the current streamflow forecasts as well as the ability of RESSIM and the other models to leverage forecasts that include uncertainty in its decision logic. The initial set of evaluations could make use of the RESSIM and other model configurations developed for Case 2, however it is likely that a revised set of criteria and rules that considers the uncertainty of the forecasts will be more effective. Two sets of historical forecasts are available for evaluation: a 1985-2010 ensemble based reforecast as well as the single value forecasts actually issued since January 2005.

Case 4. Near Perfect (observed) Meteorology

This case is aimed at identifying the potential benefits of improved hydrologic modeling combined with the refinement of observed precipitation and temperature. The evaluation can be performed for the 1971-present period. The RESSIM configuration developed for Case 2 would be most applicable to this application.

In developing robust and effective water management strategies, it is best to look at benefits and costs over an extended period of time. It is not realistic to expect any management strategy to work perfectly in all circumstances and as such the evaluation should focus on long-term gains. Nonetheless, there are key flood and drought events in the Russian River where the performance of the system will need to be closely examined in order to build confidence and community support. In addition, it may be instructive to evaluate system resiliency associated with selected climate change scenarios.

4.3 Development of Evaluation Criteria

Development of evaluation criteria in order to inform decisions that are made about the viability assessment is an important task for the Lake Mendocino FIRO Steering Committee. Each of the agencies representing major interests under consideration (water supply, flood control, fisheries and recreation) will work together to develop clear, objective measures against which we can gauge whether FIRO is a viable option and, if not, what more information is needed to demonstrate viability. Metrics will need to be developed to answer the following basic questions: Can FIRO increase water supply reliability and environmental conditions while maintaining the same flood protection capacity? Can FIRO enable improved flood protection capacity while not compromising water supply?

In order to help measure benefits, an economic benefit assessment is proposed (see Section 6) to monetize, to the extent possible, the various benefits (and costs) of FIRO, under the different scenarios, to balance tradeoffs and examine how best to maximize benefits while minimizing risks.

Some preliminary considerations for development of the criteria can be found in Appendix F.

4.4 Envisioned Improvements to Facilitate FIRO

Existing technologies and science are expected to provide meaningful benefits through the FIRO concept. The story, does not however, end there. With the FIRO framework in place, improvements in the science and technology can be effectively leveraged. Science and technology investments can be grouped into four basic categories as follows:

1. *Improvements to weather forecasts.* Investments made to refine the skill and better characterize the uncertainty of physical weather element forecasts needed to drive hydrologic models directly contribute to improved system performance. Investments are needed at all temporal and spatial scales. The most potent enhancements will address weather forecast improvements that cover the next 7 to 14 days. Post-processing to bias-correct and sharpen the output from operational model forecast systems is an example of the approaches that will be employed to provide the forecast skill and reliability that is needed to inform reservoir operations. As skill develops in seasonal and subseasonal forecasts, the FIRO framework provides a ready context for integration and use.
2. *Improvements to hydrologic models.* Hydrologic models in current operational use are reliable but dated. Models, such as that being developed at the NOAA National Water Center, that better leverage available information and have well developed data assimilation processes will improve the performance of FIRO and the quality of information available to the decision support model.
3. *Improvement to observation systems.* Significant investments have been made in observations, yet much remains to be done. Better observations serve operations as well as research. The observation portfolio in the Russian River generally lacks details when it comes to diversions and losses. Investments in this area could yield keen insight that improves the performance of the system for all stakeholders.
4. *Improvements to decision support models and tools.* Decision support models transform data into information that decision makers can use to carry out their specific responsibilities. Enhancements to existing decisions models, particularly those who acknowledge and leverage uncertainty will contribute to the potential value of FIRO.

SECTION 5 EVALUATE MODEL RESULTS

FIRO viability assessment requires quantitative information as inputs to a Lake Mendocino FIRO Decision Support System (LM-FIRO DSS). Much of this input takes the form of numerical model output of time series that can be deterministic, an ensemble mean or probabilistic at a point or over a gridded area. The reservoir operations “final release schedule” requires many inputs, including the following modeling outputs (each of which has observational inputs that help drive or constrain that model):

- Impact analysis tool (impact to water levels and structures and ecosystem conditions)
- Channel and reservoir routing model
- Reservoir release decision model
- Runoff forecast model
- Precipitation (and temperature and wind) forecast model

In reality, there are various existing models of each type, and new models can be developed to fill gaps. Uncertainties in each of the necessary inputs to the LM-FIRO DSS can each contribute to uncertainties in the reservoir operations decisions. Thus, the Lake Mendocino FIRO work plan incorporates evaluations of these models in terms of their performance on FIRO-related outputs.

The evaluations involve comparisons between the model predictions and reality using observations as the basis against which to evaluate. In a predictive mode this is done by assimilating all observations into the model as part of “initialization,” running the model in predictive mode, and then using observations from the same sites to compare with the predicted values. This can be done in both a retrospective way by looking at past cases of importance (e.g., December 2012), and by running real-time experiments.

Because forecasting of extreme precipitation in this region hinges on the location, strength, duration and orientation of land-falling atmospheric rivers, from the meteorological side, weather models need to be evaluated not only in terms of their precipitation specifically, but also representation of key features of ARs and orographic precipitation. Another factor that may contribute significantly is how aerosols impact clouds and precipitation. Existing weather models have not been tailored to AR and extreme precipitation forecasts in the region and are primitive in their handling of aerosols. They also do not necessarily take full advantage of existing observations in terms of data assimilation.

NOAA will continue to develop and evaluate operational forecast systems predictions of extreme precipitation events and resulting hydrologic impacts. To help fill this gap, Scripps is developing an experimental tailored version of the Weather Research and Forecast model (WRF) optimized to Western US extreme precipitation prediction and especially ARs. This experimental model is called West-WRF and will be evaluated in great detail specifically for Lake Mendocino FIRO. Post-processing to bias-correct and sharpen the output from operational and experimental model forecast systems will be evaluated to assess the benefits of these efforts. The evaluations of the operational and experimental forecast systems will be uniquely detailed for the Russian River Basin because of the availability of many special observations in the area, including precipitation, atmospheric river conditions, precipitation aloft and detailed precipitation at the ground. Additionally, new coastal radar measurements may become available in the next couple of years.

Similar to the meteorological model evaluation method, existing runoff models will be evaluated and a specialized hydrologic may be developed that is tailored to Lake Mendocino FIRO's needs. Unique measurements of soil moisture will be used to help drive and evaluate these models, along with standard and new stream gages (both on the Russian River main stem and its tributaries).

An example of the unique meteorological and hydrologic model evaluations that are possible is illustrated by the analysis of many ARs that hit the Russian River and showed that 75% of the variance in storm total precipitation in ARs is controlled by variance in the strength and duration of the ARs (Figure 5.0). It also showed that 62% of variance in storm-total runoff is controlled by AR strength and duration, and another 17% is controlled by variance in precursor soil moisture. The models will be evaluated in terms of their ability to reproduce this observed behavior.

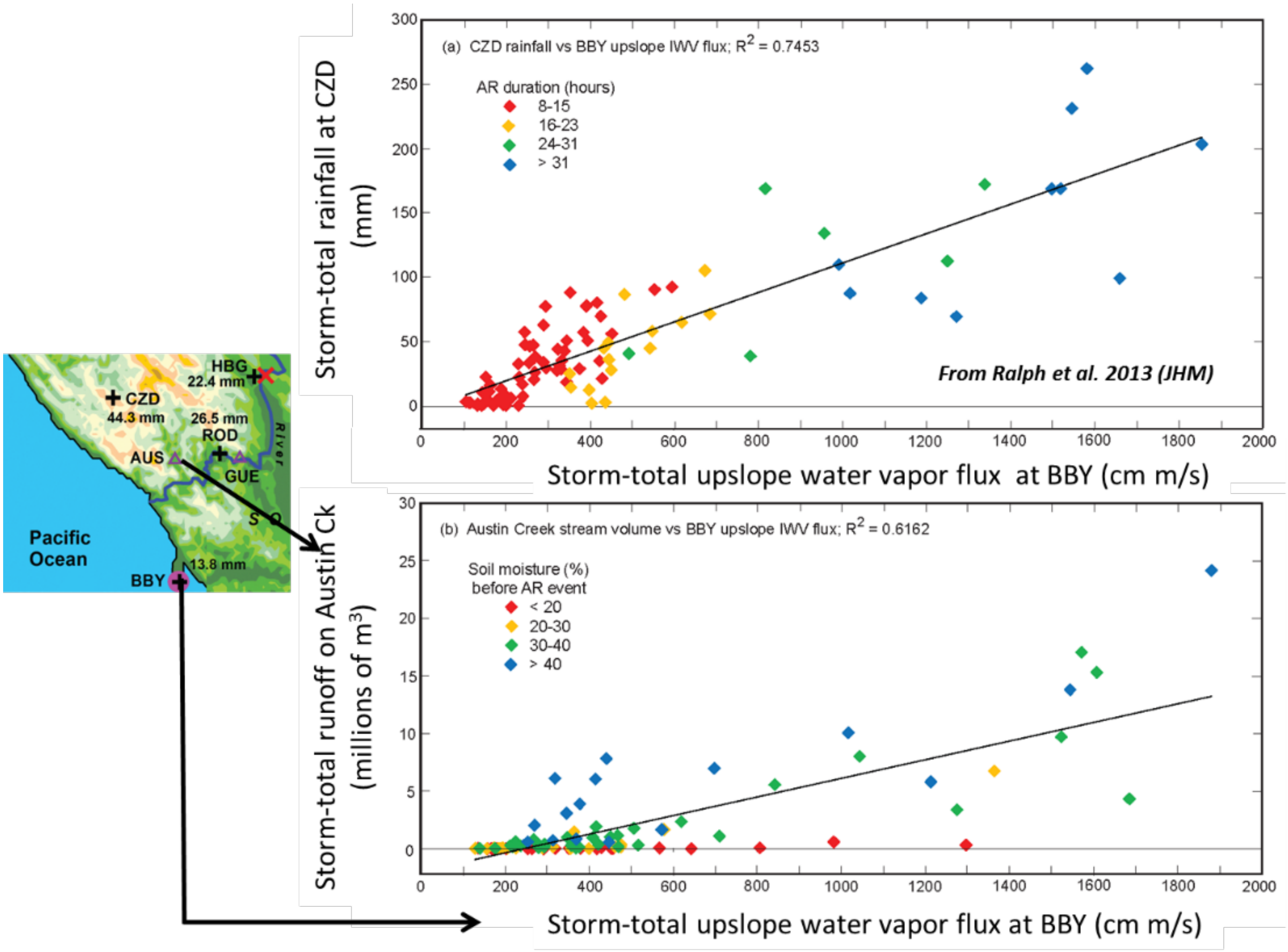

Figure 5.0. Two graphs illustrating variance in storm-total rainfall and vapor in Russian River and in the Austin Creek subwatershed. Source: Dr. F. Martin Ralph et al. 2013

SECTION 6 ASSESS BENEFITS

6.1 Identify Economic Benefits

The primary FIRO benefits to be assessed stem from improved precipitation (and non-precipitation) and reservoir storage forecasting, which would theoretically allow deviations from the rule curve or changes to the manual. Allowing more water storage in the reservoir during rainfall events enables release of this water during periods of low flow.

Benefits of reservoir operations can be generally categorized into three areas: 1) flood damages avoided, 2) water supply, and 3) environmental services (including fisheries and recreation). NOAA's Office of Program Planning and Integration (PPI; http://www.ppi.noaa.gov/economics/) and National Ocean Service conduct benefits assessments for ecosystem services, as well as other water resource values. A recent report by ESRL-PSD (Johnson 2014) has developed a regional accounting approach for the above three categories and provides a reconnaissance-level characterization of benefits associated with advanced precipitation forecasts. This project will advance that work to provide a more solid basis for benefits accounting supportive to reservoir operations decisions. The approach will involve coordination with the reservoir operations tasks to obtain reservoir storage and river flow time series that can be related to the various benefits categories.

In order to quantify benefits, an important first step is to determine the change in the amount of water released during periods of low flow (and high water demand). In addition to the quantity of water released during low flow periods, we also need to assume a total number of dry periods that could benefit and the timeframe over which these occur (because benefits occurring in the future are discounted). Another criterion to consider is the longevity of the project. Generally in cost-benefit analyses the timeframe is the life of the infrastructure. If FIRO results in any new infrastructure anticipated, we would need an associated lifespan. If no new infrastructure is created for FIRO, other methods will be needed to determine longevity.

The flood reduction analysis should also assess a range of flood events from the 2-year event up to the 500-year event in order to compute an expected value of loss prevented over a range of storm events. Close coordination with other tasks will be required to simulate this range of events.

A foundational consideration will be translating FIRO into additional reservoir storage and releases. For the purposes of this analysis we will need to establish flow target(s) that FIRO could reasonably be expected to achieve. For example, 10,000 acre-feet of additional storage (and thus low-flow releases) per year is one target that has been discussed, recognizing that during some years there will be less or more opportunities for this to happen (Johnson, 2014). Examining the record of monthly inflow volumes and conducting a life-cycle analysis of volumes that could result from additional storage throughout the year to assess FIRO benefit may make more realistic estimates.

Note that the release of 10,000 acre-feet of water can provide multiple benefits to multiple users: even small changes in streamflow may have numerous additive downstream effects. For example, an acre-foot of streamflow increase might be used for recreation, agriculture, power production, and municipal water supply, while at the same time helping assimilate wastes and enhance fish habitat. “The aggregate value of a change in streamflow is equal to the sum of its values in the different instream and offstream uses to which the water is put during its journey to the sea” (Brown, 2004).

The economic analysis must also be based on a defined geographic area. While this analysis is focused on the Russian River watershed, we need to confirm where within the watershed benefits would accrue. Where data exists, it would need to be extracted from the area(s) associated with both costs and benefits. (Note: it is anticipated that most data will likely be available from Sonoma County.)

The following socio-economic benefits will be considered for monetization:

- Agriculture (primarily wine industry) – production revenue
- Municipal and industrial water supply – value of water for these purposes
- Riverine/lacustrine habitats and fish populations – improved fish habitat
- Recreation -boating, sport fishing, and related support services
- Flooding - avoided flood damages

6.2 Develop logic model, identify sources of information/data on benefits and determine methodology to assess benefits

After determining the benefits to be assessed, the next step is to construct a logic model that clearly makes linkages between FIRO and the resulting economic benefits. This is important in order to establish a causal relationship. Below is a simple examples of a logic models:

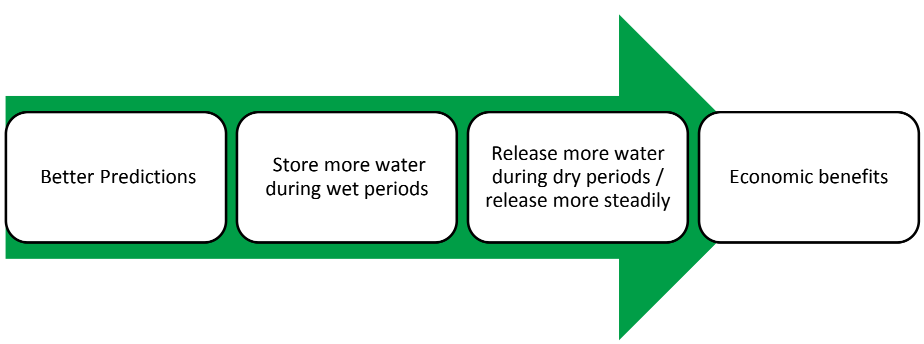

Figure 6.0. Depiction of a logic model of the economic benefits of better weather predictions.

After confirming the logic models and their underlying assumptions, the next step is to ascertain what data is needed to estimate benefits and the methods that are most appropriate to monetize the benefits. The methodology chosen will be based on availability of data as well as other factors. Methodologies include:

- Market Valuation
    - Benefits inferred from prices set by the buying and selling of a good or service
    - Includes productivity, hedonic pricing and travel cost methods
- Avoided Costs
    - Benefits derived from elimination of an expenditure
- Benefit Transfer
    - Applies findings from studies of similar sites
- Contingent Valuation
    - Directly ask how much one values a good/service/resource
    - Derive willingness to pay

6.3 Establish Bookend Scenarios for Economic Benefit Analysis

Once the benefits are identified, data assessed and methods determined, it is necessary to "bookend" monetized benefits based on modeling scenarios determined in previous work plan sections. Variables in the assessment scenarios include timeframe, storage targets, frequency of storage opportunities up to the target (and possible interim targets), target for increased flood release and/or increased flood event lead times and frequency of these occurrences. From previous task outputs, establish operational "constraints" (high water, low water, ramping rate(s), other factors including supply (allocation), environmental factors etc., to define a range of possible operational outcomes for analysis.

6.4 Conduct Economic Analysis, Compare Benefits to Costs

Economic analysts use the data gathered, the selected method, the bookend scenarios and the selected benefits to monetize benefits. Where benefits cannot be monetized, they will be qualitatively described, with examples, as available, from the literature or case studies to illustrate benefits. The benefits will then be aggregated, expenditures to date factored in as appropriate, and the aggregate benefits will be compared to costs of the project. Project costs shall consider costs associated with reservoir operational and/or infrastructure changes necessary to implement FIRO.

SECTION 7.0 IMPLEMENTATION STRATEGIES

There are two distinct and critical components associated with implementing a forecast informed water management paradigm for Lake Mendocino. The bulk of the work described in this document is focused on creating a new set of procedures that allow for more efficient use of available water and potentially greater capacity to mitigate flood damages. All the technology and science in the world will not benefit the management of Lake Mendocino unless they are formally accepted and integrated into the set of "approved practices." This process of navigating the approval and socialization process is briefly described in Section 7.1.

Successful implementation of the FIRO management strategy described earlier will provide information to managers to enable them to select release schedules that reflect more accurately prevailing and anticipated conditions in the watershed. To achieve this, data from enhanced watershed monitoring programs and information from improved weather and water forecasting must be efficiently and systematically stored, organized, retrieved, analyzed, and presented to water managers. This will be accomplished with a decision support system (DSS) designed, developed, and deployed for the Lake Mendocino forecast-informed water management program. This system is described in Sections 7.2-7.5

7.1 Pathway toward Formal Acceptance and Use

Up until this point, this work plan has largely been silent on the fact that whatever new management paradigm is recommended, it must be formally accepted by the USACE and socialized with stakeholders in the Russian River Basin. This will not be simple, inexpensive, or quick. This plan does not include a prescription for accomplishing this. Rather this plan recognizes the critical nature of the work, the partnership upon which it depends, particularly the high level of engagement by the USACE, and commits the interagency team to defining the process and working toward achieving our objectives from the very beginning of the project.

7.2 The Lake Mendocino FIRO decision support system (Lake Mendocino FIRO-DSS)

Successful implementation of the FIRO management strategy described earlier will provide information to managers to enable them to select release schedules that reflect more accurately prevailing and anticipated conditions in the watershed. To achieve this, data from enhanced watershed monitoring programs and information from improved weather and water forecasting must be efficiently and systematically stored, organized, retrieved, analyzed, and presented to water managers. This will be accomplished with a decision support system designed, developed, and deployed for the Lake Mendocino forecast-informed water management program.

7.2.1 Lake Mendocino FIRO-DSS goals, objectives, and constraints

The goal of the Lake Mendocino FIRO-DSS is to provide information that leads to improved management of water in Lake Mendocino for all purposes, for both near-term and long-term operation. To reach this goal, the Lake Mendocino FIRO-DSS is designed and developed to meet the following objectives:

- Accelerate and enhance collection, display, and subsequent analysis of data on weather and water conditions in the watershed.
- Enhance quantitative knowledge of future water and weather conditions in the watershed and enable use of that enhanced knowledge in decision-making.
- Provide operators, regulators, and forecasters with better quantitative information about the likely effects of operation decisions, both in the near-term and long-term.
- Enhance sharing of data and information, thus enabling collaborative, cooperative decision making by operators, with input from regulators, and forecasters.

Constraints on design, development, and deployment of the Lake Mendocino FIRO-DSS require it:

- Be implementable in the near term, using readily available information technology (IT) infrastructure.
- Be scalable and flexible so improvements in weather forecasting, system monitoring, modeling, and displaying and disseminating information can be included as those become available over the longer term.
- Be useful to and usable by all agencies cooperating to improve Lake Mendocino water management.
- Provide information to improve decision making for both flood and drought operation.
- Integrate gracefully with the NWS's forecast modeling system and the Corps' reservoir operation modeling system.
- Fit within the context of and be capable of integration with the existing California DWR data exchange system (referred to herein as CDEC, but also including other components of the state's expanding data dissemination system.)
- Have implementation, operation, and maintenance costs that are acceptable within the budgetary requirements of the agencies involved.
- Be redundant, ensuring if one component of the DSS fails operators will have alternative sources of data and information for decision-making.
- Be sufficiently flexible to accommodate changes to system operation and features. For example, if physical changes are made to dam components or downstream channels, the DSS should not require re-programming to represent the modified system.
- Be sufficiently flexible to accommodate anticipated changes to the Water Control Manual, which directs certain aspects of operation of Lake Mendocino, and changes that come about as a consequence of lessons learned by operators.
- Be modular, with components that are separable and replaceable.
- Be readily usable by system operators, considering use of the Lake Mendocino FIRO-DSS will not be the primary task for most operators. This will require, for example, a certain level of "friendliness" in the user interface, along with detailed documentation to which operators can refer.

- Provide sufficient information to answer questions likely to be asked during operation decision-making during both floods and droughts. As the questions asked vary from event to event and will expand as users of the Lake Mendocino FIRO-DSS gain familiarity with its capabilities, satisfying this constraint will require the FIRO-DSS be customizable, without extensive reprogramming.
- Provide an “audit trail,” archiving information so users can conduct forensic analyses after floods and droughts, recreate the events, testing the Lake Mendocino FIRO-DSS, improving decision making, and training.
- Synchronize the copies of FIRO-DSS components deployed at offices of various participants.
- Use existing components (especially models) if suitable. For example, the Lake Mendocino FIRO-DSS could use the Corps’ HEC-ResSim reservoir system simulation application for release selection and downstream impact analysis instead of developing a new application for that.
- Acknowledge and treat uncertainty about forecasts and natural behavior of the system quantitatively in development of information presented to operators.

7.2.2 Proposed structure of Lake Mendocino FIRO-DSS

Figure 7.1 illustrates conceptually the overall structure of a Lake Mendocino FIRO-DSS that provides information for improved management of water in Lake Mendocino. Flow of data and information in the FIRO-DSS is shown with arrows. For simplicity, components are shown and labeled separately; when developed and deployed, some of the components—especially various databases—may be combined.

Key components of the Lake Mendocino FIRO-DSS include:

Databases of observations. Databases store time series of historical precipitation and temperature (item 2) and series of current and past lake and stream levels (item 3).

Databases of forecasted weather, runoff, and system states. Forecasts of future weather conditions are stored (item 1), as are forecasts of future watershed runoff (item 6), and forecasts of system conditions if candidate release schedules are followed (item 11).

Databases of properties of the watershed, channels, dam, reservoir. For convenience, properties of the reservoir, dam, and channels, and related representations of properties are stored in a database, represented by item 4 in Figure 7.1.

Models. The Lake Mendocino FIRO-DSS includes a runoff forecast model (item 5), a reservoir release decision model (item 8), a channel and reservoir routing model (item 10), and an impact analysis model (item 12).

Database of water control manual. Desired operation objectives and priorities and required operation rules are stored in digital form in a database (item 7).

Databases of release schedules. Proposed release schedules are stored in a database (items 9 and 14).

Decision maker(s). The proposed DSS is not an automated control system. Instead, human decision makers (item 13) consider results to develop a final release schedule.

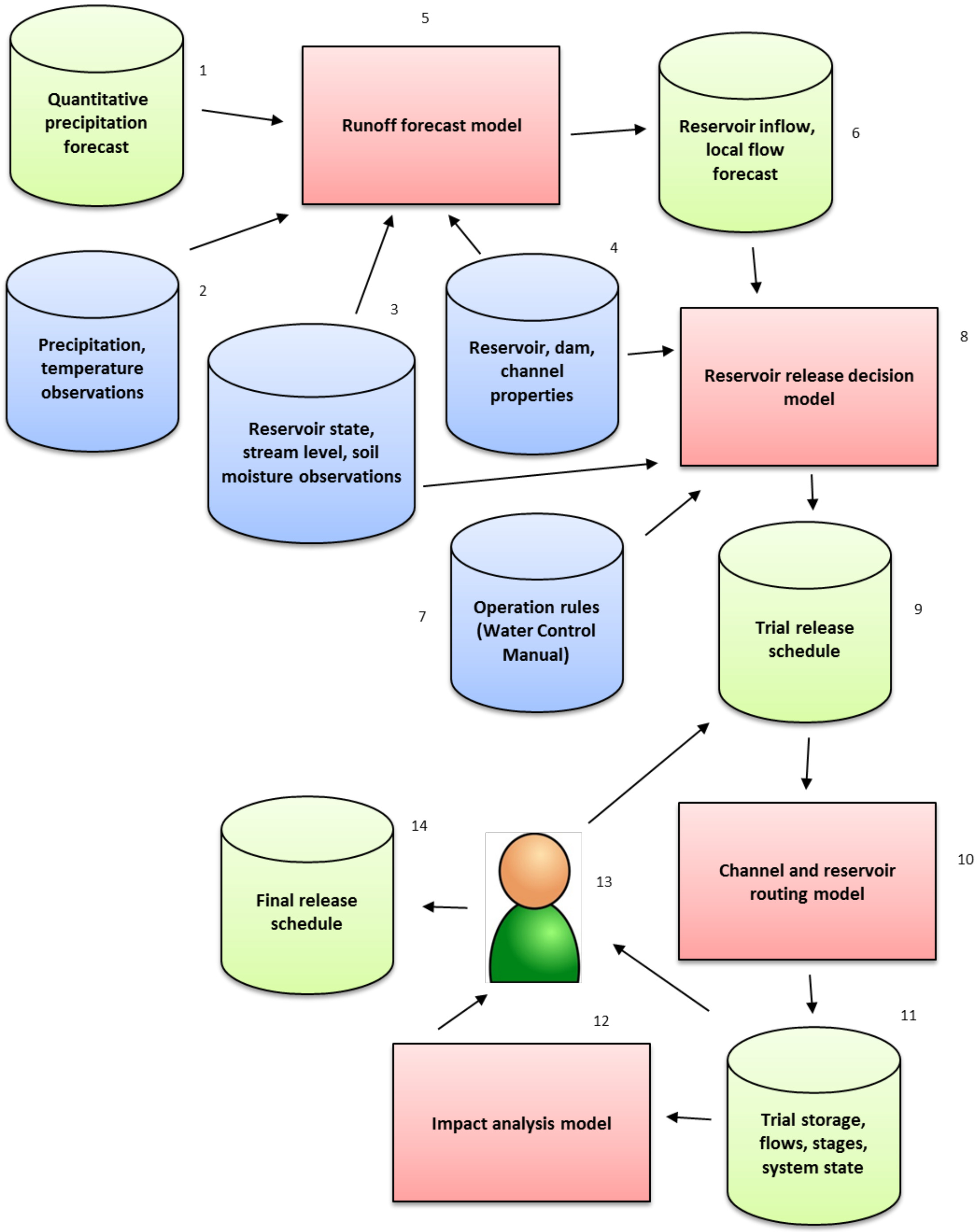

Figure 7.1 Components of FIRO decision support system will inform release schedule selection

7.2.3 Workflow with Lake Mendocino FIRO-DSS

The anticipated workflow with the Lake Mendocino FIRO-DSS illustrated in Figure 7.1 Is as follows:

1. Forecasts of future weather conditions—both near-term and longer-term—are made. These forecasts use enhanced methods described elsewhere in the report. The forecasts are provided as time series of precipitation and temperature as needed for watershed runoff forecasting. The time series are stored in a database (item 1) accessible to the forecast model (or models). The frequency with which forecasts are made and stored is consistent with the frequency of forecasts of hydrologic conditions.
2. To create boundary conditions for runoff forecasting, the time series of future weather forecasted are appended to time series of recent historical observations of precipitation and temperature. The historical observations are stored in a database (item 2). The state of California maintains a database of historical observations, which is used for the Lake Mendocino FIRO-DSS.
3. Current reservoir, dam, and channel conditions are determined to set model initial conditions for the models. These are determined by accessing a database in which these data are stored (items 3). Again, the state maintains such a database; it is used for the Lake Mendocino FIRO-DSS.
4. A forecast of future reservoir inflow and uncontrolled runoff downstream of the reservoir is made with a watershed model (item 5). The model requires certain data on properties of the reservoir, dam, and channels; to ensure consistency amongst models as properties are changed; these data are stored in a database (item 4). Many of the same data are needed by the reservoir release selection model (item 8), so the common database simplifies changing properties. The forecasted flow and stage series are stored in a database (item 6).
5. When the inflow and local flow forecast is available, a reservoir release selection model (item 8) is executed to determine a feasible trial release schedule considering the current state of the system, forecasted future flows, and rules in the water control manual (item 7). The trial release schedule is stored in a database (item 9).
6. To assess the system-wide impacts of the trial release schedule, a channel and reservoir routing model (item 10) is executed. This hydraulic model computes flows and stages throughout the system for the period forecasted and stores those flows and stages in a database (item 11).
7. To evaluate the economic, environmental, and public safety impact of the proposed release schedule and the corresponding flows and stages throughout the system, an impact analysis model (item 12) is executed. The resulting reports of selected measures of impact are provided to decision makers (item 13). The decision makers consider the impact reports, reports of stages, flows, storage, and other states of the system, and accept or refine the proposed release schedule. If the schedule is refined by the decision maker, the analysis of system-wide impacts is repeated (step 6). If the schedule is accepted, this final release schedule (item 14) is communicated to operators as release orders.
8. The process repeats, beginning at step 1 with a new forecast of precipitation.

7.2.4 Lake Mendocino FIRO-DSS component description

To meet the need for near-term results within budgetary requirements of the agencies involved, the DSS incorporates components based upon existing state-of-practice models and databases from USACE, the NWS, and DWR to the extent feasible. New components are developed only as needed. These components are described in more detail below.

7.2.5 Hydrometeorological observing and forecast system

Precipitation, temperature and wind observations and predictions are made with a combination of standard, larger-scale/national weather observing and prediction systems and a specialized set of observational and forecast tools tailored to the needs of the DSS for the Russian River specifically. These tools include a unique set of detailed weather and soil moisture observations (especially as provided by a unique observing network in the region sponsored by the Water Agency, DWR and NOAA/PSD). It also includes a regionally optimized weather prediction model run at high spatial resolution and for the domains and lead times and specifically required for Lake Mendocino FIRO-DSS (e.g., the West-WRF model). It also includes atmospheric-river-focused prediction tools that quantify the position; timing, strength, orientation and duration of predicted land-falling atmospheric rivers as well as their associated precipitation and temperature. The forecast information is provided with estimates of forecast uncertainty.

7.2.6 Runoff forecast model

Runoff forecasts are made with the California-Nevada River Forecast Center's (CNRFC's) Community Hydrologic Prediction System (CHPS) modeling infrastructure, which relies mainly on real-time data retrieved through the CDEC and meteorological forecasts that are an outcome of other work completed through this study. CNRFC and DWR Division of Flood Management (DFM) staff process and quality control the real-time hydrometeorological data from the CDEC database, as well as other sources such as the USGS and USACE. Other inputs into the CHPS runoff forecast model are databases of properties of the watershed, channels, dam, and reservoir (item 4 in Figure 7.1), which are maintained by the NWS.

Using CHPS, NWS staff hydrologists generate forecasts of watershed runoff, including both reservoir inflows and the local, uncontrolled flows downstream of the reservoirs. These forecasts are stored in the CDEC database (item 6 in Figure 7.1) for dissemination and use by the CNRFC's customers, including the Water Agency and USACE. This permits efficient, rapid exchange with all agencies involved.

7.2.7 Reservoir release decision model

Reservoir operators use a reservoir release decision model coupled with the outputs of the runoff forecast model (inflow, local flow, and water level forecasts) to make decisions about releases, including decisions about current operations—how much to release now, and future operations—how much to release in the future if the forecasts are correct (or, perhaps, not correct). When making release decisions, the operators consider the needs of their customers, the authorized operation purposes, approved operation rules, and the current state of their reservoirs.

For the FIRO-DSS, HEC-ResSim--the USACE's standard-of-practice reservoir simulation model for both real-time and planning applications—will be used. The Water Agency and USACE have developed cooperatively an HEC-ResSim model and thus are familiar with the capabilities. That model will be integrated into the FIRO-DSS, exploiting connections between HEC-ResSim to CNRFC forecasts. (These connections were developed by DWR and the CNRFC to support coordinated operations of reservoirs on the Yuba-Feather rivers system.)

HEC-ResSim would be used in the Lake Mendocino FIRO-DSS both to propose and to assess release schedules, so it serves both at item 8 and item 10 in the figure. The topology of the reservoir system, the properties of the water control facilities and conveyances, and the operation rules are defined in a specialized HEC-ResSim configuration database. This HEC-ResSim database is modified with a specialized editor that is a component of the HEC-ResSim software package.

In application, HEC-ResSim initially follows strictly the release rules from the water control manual to propose a trial release schedule, give each new forecast and the current state of the system. Future system conditions that arise from following that release schedule are evaluated using a simplified channel routing model integrated in HEC-ResSim, and results are presented to operators.

Operators would be able to override and alter the release schedule using a user interface developed especially for this Lake Mendocino FIRO-DSS. If operators propose an alternate release schedule, the proposed schedule would be stored, then retrieved and analyzed with the channel and reservoir routing capabilities of HEC-ResSim, bypassing the release decision model. Results would be provided to the operators, and the process is repeated until operators are satisfied with the release schedule and the resulting conditions in the system.

7.2.8 Channel and reservoir routing model

HEC-ResSim channel and reservoir routing capabilities will be used in the Lake Mendocino FIRO-DSS to predict system conditions that result from following a proposed release schedule. The channel routing capabilities are consistent with those included in the runoff-forecasting model. The channel routing model predicts discharge rates throughout the system by solving simplified forms of the relevant hydrodynamic equations. The result of the reservoir simulation is a set of discharge hydrographs at key downstream locations. If stage predictions are relevant to decision making, rating curves are used to transform discharge rates to stage.

If routing capabilities beyond those of the simplified models of HEC-ResSim are needed for decision-making, the Lake Mendocino FIRO-DSS can include also HEC-RAS. This is an unsteady open channel flow routing model, also developed by USACE, and linked conveniently with other models proposed as components of the Lake Mendocino FIRO-DSS.

7.2.9 Impact analysis model

Physical, economic, environmental, life safety, and other impacts of a proposed release schedule are evaluated with what is identified here as an impact analysis model. In this context, that model (or more likely, models) includes a variety of graphical and tabular displays of predicted system states that occur if the release schedule is followed. A variety of applications are available for this analysis, including the USACE's HEC-FIA application and spreadsheets that can be integrated with the Lake Mendocino FIRO-DSS (with storages, flows, stages, etc. exported to individual users to meet their unique needs.

7.2.10 User interface

An interface will link the operators to the DSS and facilitates operator examination of impacts and specification of release schedules. For broadest and most convenient use, a web interface is proposed, with information from the analyses formatted and served to users without necessity of formal user training in, for example, particular details of use of HEC-ResSim.

7.3 Implementation Timeline

The work plan implementation will occur collaboratively, requiring close coordination and cooperation among several entities. Organizationally, the FIRO team has formed three major task groups to focus efforts around three key issue areas:

- Preliminary Viability Assessment, with a focus on forecasting, modeling and economic benefit assessment
- Procedural Matters, with a focus on the Corps' deviation policy and Dam Safety Action Classification (DSAC) rating system
- Scientific Research needed to support FIRO, with a focus on both short-term and longer-term needs

These task teams are underway and are in the process of developing a detailed list of tasks and an associated schedule over the next year and beyond. Below is an overall schedule for the work plan over the next 12-15 months, followed by a projected six-year timeline for completing major project tasks.

Forecast Informed Reservoir Operations Work Plan Timeline – Preliminary Viability Assessment

July - September 2015	October – December 2015	January – March 2016	April – June 2016	July - September 2016	October – December 2016
· Complete Workplan · Form task groups · Assess data, information & models · Identify optimum monitoring sites · Develop evaluation criteria & methodology · Determine range of water travel times to ocean	· Develop preliminary viability study strategy · Agree on forecasting scenarios and other inputs · Convene modeling discussion, agree on model(s) and lead modelers · Develop evaluation scenarios · Evaluate past forecast performance	· Assemble models & process algorithms · Identify role of mesoscale frontal waves in stalling ARs · Develop DSAC & deviation policy scenarios · Install monitoring stations in Lake Mendocino watershed · Evaluate past reservoir operations	· Preliminary model results available · Begin economic benefits analysis for flood damages · Determine economic benefits approach for other values	· Final modeling analysis available · Conduct stress test · Finalize flood impact assessment · Begin economic benefits assessment for other FIRO values · Synthesize atmospheric river scientific advances	· Deliver preliminary FIRO viability assessment · Refine scenario testing strategies for years 2 & 3 · Identify priority research activities

Six-Year Major Tasks Timeline, Lake Mendocino Forecast Informed Reservoir Operations

	2014/15	2015/16	2016/17	Year 4	Year 5	Year 6
Create Lake Mendocino FIRO Steering committee and produce work plan	X					
Quantify requirements and past performance	X	X				
Complete "Preliminary FIRO Viability Assessment"		X				
Create FIRO Decision Support System, West-WRF and experimental Hydro model		X	X	X		
Deploy sensors in Lake Mendocino area		X	X	X		
Carry out offshore field campaign to improve atmospheric river forecasts			X	X		
Table-top tests of FIRO				X	X	
Demonstrate forecast-informed operations in "parallel" mode					X	X
Develop draft Major deviation request				X	X	
Explore application to 2 other reservoirs					X	X
Advance science supporting FIRO	X	X	X	X	X	X
Quantitative assessment of impacts of atmospheric-river forecast-informed reservoir operations on Lake Mendocino						X

SECTION 8.0 TECHNICAL AND SCIENTIFIC RESEARCH NECESSARY TO SUPPORT LAKE MENDOCINO FIRO VIABILITY ASSESSMENT AND POTENTIAL IMPLEMENTATION OF FIIRO

Why is research needed for FIRO?

For hypothetical future events, FIRO viability will hinge on a wide range of current and predicted conditions at the time. These include weather, land surface, hydrology, streamflow, water quality, ecological and reservoir operations conditions. FIRO decisions may also be affected by priorities influenced by the broader context of perceived flood, drought and ecosystem health (as indicated by salmonid species) risks. Each of the associated disciplines represents a community of practice with its own current capabilities and gaps in terms of performance.

One of the first steps the FIRO team has undertaken is to quantify what are the technical requirements that would need to be met to demonstrate that FIRO is partially or fully viable for Lake Mendocino. For example, the geometries of the Russian River watershed, built infrastructure, and the CVD have led to a preliminary estimate that a 7-day lead time will be required to (a) safely release 10,000 AF of water from CVD (requiring 2 days) with sufficient time for the water to travel past the most vulnerable communities/facilities downstream (5 more days). From a streamflow prediction standpoint this lead-time requirement demands accurate forecasts related to heavy precipitation with similar lead times, which will depend ultimately on accurate forecasts of atmospheric river landfall. Current forecasts for AR landfalls are within roughly 500 km uncertainty in landfall location at 5 days lead time based on 3 winters studied (Wick et al. 2013), and extreme precipitation is remarkably challenging to predict (Ralph et al. 2010).

To the extent that FIRO is based strictly on accurate long-lead forecasts of the details of the largest storms, it will be necessary to improve the skill of forecasts of AR landfall to be within roughly 100 km of actual landfall positions at 6-10 days lead time. However, multi-week dry periods may have greater current predictability, and FIRO strategies may also capitalize on the recognition of long periods with low likelihoods of dangerous storms “before” water is likely to need to be released, which would substantially improve the potential for partial FIRO viability. Thus research is also needed to quantify current and prospective skills associated with forecasting AR-landfall “lulls.” This is but one example of many areas of research that will be needed to enable FIRO.

Both incremental and breakthrough advances are needed

The overarching approach of the FIRO team is to perform a preliminary viability assessment, followed by a more thorough assessment involving testing in a parallel operations mode. Much like the example of needed AR and precipitation forecast skill improvements described above, the FIRO steering committee has identified a number of promising research directions that will improve the likelihood of FIRO viability and that will allow very accurate assessments to be completed. Some of these directions represent evaluations and improvement of existing tools for monitoring, prediction and operations. However, some gaps in current capabilities will only be resolved by a rethinking of how to approach or avoid the gaps. Filling these gaps will likely involve entirely new management strategies and scientific methods, tools and capabilities.

The committee proposes to pursue both the incremental improvements to current methods/tools and new research to enable the breakthrough advances required for full viability. Intermediate options involving both are also needed, as for example the development of a high resolution weather prediction model tailored to the AR phenomena and associated extreme precipitation on spatial-temporal scales appropriate to reservoir operations in the Russian River watershed.

Observations, modeling, physical understanding, decision support systems

The committee has concluded that there is no single "silver bullet" technical solution to enabling FIRO. An improved portfolio of information will be critical to effectively balance flood and drought risks in the Russian River Basin. It is recognized that the viability of FIRO will depend upon advances involving the major pillars of (1) monitoring of key current conditions, (2) predictive models and methods for key physical parameters, (3) tools that can integrate these predictions in and analyses of potential streamflow outcomes and associated impacts, and (4) production of quantitative guidance for operators regarding risk of various operations options in real-time.

"Prediction and monitoring of key current conditions" include quantitative understanding, tracking, and prediction of natural physical systems and natural phenomena (meteorological, hydrological, land surface, salmonid), the built systems, their current and potential operations, and potential downstream consequences and impacts of current and near-term situations for the system as a whole. Specific examples include expanded observations and monitoring of the physical system to improve understanding of extreme precipitation behavior, impacts, prediction and flood risk. Enhanced understanding of water-release dependent ramping rates and of minimum in stream flows are needed identify critical environmental thresholds. Improved reliability and skill of extended weather forecasts are needed both for atmospheric rivers and for exceedance/non-exceedance of extreme precipitation events. Operational and experimental hydrometeorological modeling and probabilistic forecasts at the appropriate spatial and temporal scales are needed to adequately inform reservoir operation decision making. Thus, the research agenda incorporates key aspects of each topic. FIRO team incorporates diverse and complementary strengths in its research objectives

FIRO team incorporates diverse and complementary strengths in its research objectives

The FIRO team includes representatives from a wide range of federal, state, local, university and private sector organizations with the requisite capabilities and knowledge to pursue the diverse set of technical challenges FIRO is tackling. In broad terms USACE brings expertise in reservoir operations, dam safety, flood risk management, hydraulic prediction systems; NOAA has core capabilities in weather and hydrologic monitoring, research and predictions, as well as in implementations, tracking and planning for fisheries ecology and salmonid recovery; USGS hydrologic models and monitoring are key in the region; Scripps' has key expertise in atmospheric-river science, regional-to-global hydroclimate predictions, and numerical weather modeling; private sector representatives bring key capabilities and histories in planning, reservoir operations decision support systems, and other tools; CA DWR brings expertise in many areas ranging from enhanced flood response and emergency preparedness methods to drought preparation and response and climate change factors; USBR brings expertise in keys areas of water management and extreme event risk assessment, local agencies (like SCWA) bring the deep, realistic and historical knowledge of the needs, tradeoffs, economics and opportunities for using FIRO to improve water supply outcomes with no diminishment of flood protection.

Programmatic strategies to organize and advance the necessary research

There is no single existing research program that has the necessary breadth and depth of disciplines and capabilities that will be needed to fully assess the viability of FIRO. There is no single organization capable of carrying out all the necessary research and development. Nonetheless, taken as a whole, the partners already involved in developing this FIRO Workplan do provide most of the necessary range of capabilities. In addition, some partners have the potential to direct their own internal research staff and facilities to engage in this effort to carry out some elements of the workplan. However, the level of federal research funding today is such that in many cases additional funding will be needed to support major new directions even within existing federal agencies. Other key participants in this effort are at universities or private companies and require significant funding to bring their expertise and vision to the FIRO team. The fundamental approach programmatically has been for members of the team to take our Workplan to their executives for consideration of internal and program support, and to leverage existing related research efforts, such as CalWater and HMT.

As FIRO viability assessment activities move forward, a more formal and directly funded structure may be useful for engaging and allowing all team members (plus others that may be recruited) to focus on, and make the necessary advances towards, filling scientific, modeling, monitoring and decision-support tools needed for FIRO viability. In addition, outreach can be undertaken to inform key individuals who affect long-term research policy and funding so that they are aware of the potential large benefits and needs for FIRO.

Table 8.1 Immediately required research activities

Research Direction or Topic
Forecasting/Prediction Improvements & Tools
Quantify past performance of weather and streamflow predictions, and reservoir operations
Improve the detecting and tracking atmospheric rivers over the Pacific Ocean and at landfall
Determine the causes of major forecast errors in past strong ARs and flood events
Improve forecasting of atmospheric river landfall position, strength and orientation
Improve prediction of the duration of atmospheric river conditions over the Russian River
Diagnose the role of mesoscale frontal waves in causing long-duration AR conditions over the Russian River
Study the origins and predictions of the strong high pressure ridge that persisted over the Eastern Pacific in recent winters
Develop a specialized weather prediction mode tailored to AR and precipitation prediction for the Russian River
Develop reforecasting data set to improve bias-correcting and post-processing of precipitation forecasts
Improve exceedance/non-exceedance extreme precipitation forecasts from 0-10 days lead times)
Test the value of assimilation of measurements using dropsondes released from aircraft offshore
Improving microphysics in numerical weather models to improve forecasts of orographic precipitation
Quantify aerosol impacts on orographic precipitation in the region
Implement an enhanced hydrometeorological monitoring network

Hydrologic Tools
Develop and test distributed hydrologic modeling capabilities
Quantify correlations between soil moisture, precipitation, Lake Mendocino storage and tributary flows
Quantify and model relations between Lake Mendocino operations and operations of other flood- and water-management systems within the river basin, as well as correlations with unmanaged flows and floods
Explore how hydrologic loading factors affecting the Coyote Valley Dam safety rating could potentially be improved
Soil moisture monitoring, assessment and data assimilation
Fisheries-related Research
Improve understanding of water quality issues due to current reservoir operations (i.e., temperature and turbidity)
Lake Mendocino water quality monitoring (i.e., temperature, dissolved oxygen, and turbidity) for reservoir inflow, stored water and reservoir outflow
Develop a more reliable method of estimating flow of reservoir releases, such as the installation of an index-velocity meter at the current gaging site or the implementation of some alternative method to directly estimate reservoir releases.
Evaluation of options and flow impacts of various ramping rates and potential impacts to salmonids (i.e., ramp up/down)
Data Coordination and Modeling
Data coordination and interoperability
Develop stress test scenarios
Apply DHM for selected stress test flood events
Use ResSim to evaluate stress tests
Reservoir simulation
Agent-based reservoir operations modeling
Establish bookend scenarios for benefit and economic analysis
Reservoir operations benefits assessment
Risk-Benefit analysis
Explore the impact of more accurate and efficient infiltration modeling on hydrologic flow prediction
Explore the benefits of coupling water quality models (CEQual-W2, a water quality and hydrodynamic model in 2D -- longitudinal-vertical -- for rivers, estuaries, lakes, reservoirs and river basin systems) with ResSim reservoir operations simulation
Improve full coverage and real-time (and what-if) mapping and prediction of flood-flow inundations throughout the basin

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**Steering Committee members*

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+ Resource Support

IMPROVING RELIABILITY FOR DROUGHTS & FLOODS: FORECAST-INFORMED RESERVOIR OPERATIONS (FIRO)

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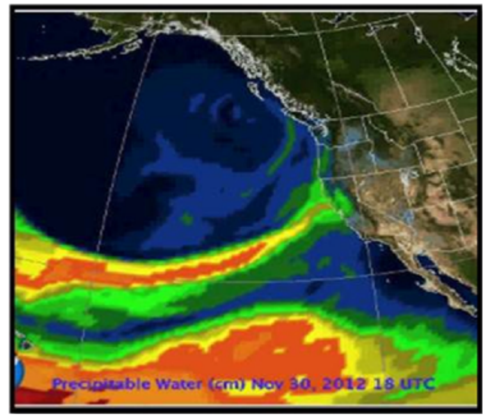

BACKGROUND Lake Mendocino is located on the East Fork of the Russian River in Mendocino County, California. Created in 1958 by the Coyote Valley Dam, it provides flood control, water supply, recreation and stream flow regulation. The U.S. Army Corps of Engineers (Corps) owns and operates the dam in accordance with the Lake Mendocino Water Control Manual (1959, revised in 1986). Sonoma County Water Agency is the local partner that manages water stored in Lake Mendocino for water supply.

The Manual specifies elevations for an upper volume of reservoir storage that must be kept available for capturing storm runoff and reducing flood risk and a lower volume of storage that may be used for water supply. During a flood event, runoff is captured by the reservoir and released soon after to create storage space for another potential storm. The Manual is based on typical historical weather patterns– wet during the winter, dry otherwise.

THE PROBLEM

The Manual utilizes gross estimates of flood potential to establish reservoir storage and release requirements. It does not account for changing conditions in the watershed—for example, increased variation in dry and wet weather patterns and reductions to imported flows into the Lake that have occurred since 1986. Also, the Manual's reservoir operations procedures were developed decades ago, without the benefit of current science that more accurately predicts weather and streamflow.

Given reduced supplies, changed hydrologic conditions, and technological advances, some adjustments to the current reservoir operating procedures may be possible to optimize the goals of maintaining flood control while bolstering water supply reliability for downstream users and the environment (e.g., to support recovery of endangered and threatened fish). Modern observation and prediction technology could be used to reduce flood risk by supporting decisions of greater reservoir level drawdown in advance of storms. Or, such technology might be used to improve supply reliability by permitting more storm runoff to be retained for water supply while still preserving flood risk reduction objectives.

(over)

For example, following an atmospheric river-type storm in December 2012, water was released to create flood space according to the Manual, dropping reservoir levels by more than 35%. 2013 was the driest year on record, resulting in little inflow to refill the reservoir. By December 2013 lake levels were extremely low and remained low through 2014. Ideally, water from the December 2012 event could have been retained based on a longer-term precipitation forecasts, lessening the impact of drought.

THE POTENTIAL SOLUTION An interagency Steering Committee was formed to explore methods for better balancing flood control and water supply needs. The committee, consisting of state and federal agencies, the Center for Western Water and Weather Extremes (CW3E) at UC San Diego and Sonoma County Water Agency are working together on a viability study to determine if Forecast-Informed Reservoir Operations (FIRO) at Lake Mendocino can improve water supply, maintain flood risk reduction, and achieve additional ecosystem benefits. Recent studies show the potential for improved predictability of atmospheric rivers, which provide 50% of the region's precipitation and cause most of the Russian River's floods.

FIRO is a management strategy that uses data from watershed monitoring and modern weather and water forecasting to help water managers selectively retain or release water from reservoirs in a manner that reflects current and forecasted conditions. FIRO's utilization of modern technology can optimize the use of limited resources and represents a viable climate change adaptation strategy.

The goal of FIRO is to update standard flood control guidelines in order to improve water supply and environmental outcomes without diminishing flood risk reduction or dam safety. Examples of tangible benefits include:

Improve Supply Reliability for Downstream Uses - When storms cause moderate-to-high reservoir levels, normal operation is to release water to re-establish flood control space. With FIRO, some of that water could be retained for future supply as long as no major precipitation is predicted for several days and it can be demonstrated that the retained water can be released past downstream flood prone areas before the arrival of the next storm. This strategy will permit earlier supply capture in some years, improving summer season supply reliability for downstream water users and improving the timing and volume of releases to protect water quality and provide flows needed for recovery of fish populations.

Enhance Flood Risk Reduction - When a storm is predicted to cause flooding, normal operations call for release of reservoir water and drawdown of water levels. With FIRO, release decisions would consider weather observations and predictions, which, in some cases, would indicate greater drawdown for flood risk reduction so long as there is confidence that the amount of precipitation and runoff will restore reservoir levels for water supply after the storm.

PROJECT STATUS A workshop was held in August 2014, at University of California San Diego/Scripps Institution of Oceanography. Thirty-two representatives from multiple agencies met for three days to scope out an appraisal-level FIRO study. A work plan is now being drafted for release in early 2015. The FIRO study is expected to occur over the next five years (depending on funding).

Tangible outcomes from the full Lake Mendocino FIRO study will include identification, assessment and enhancement of the best science available to improve operations to maximize flood control, water supply and ecosystem benefits. The evaluation will identify realistic, short-term steps to provide more accurate and timely information about weather and watershed conditions. In addition to benefitting Lake Mendocino, the project has transferability potential throughout the western U.S.

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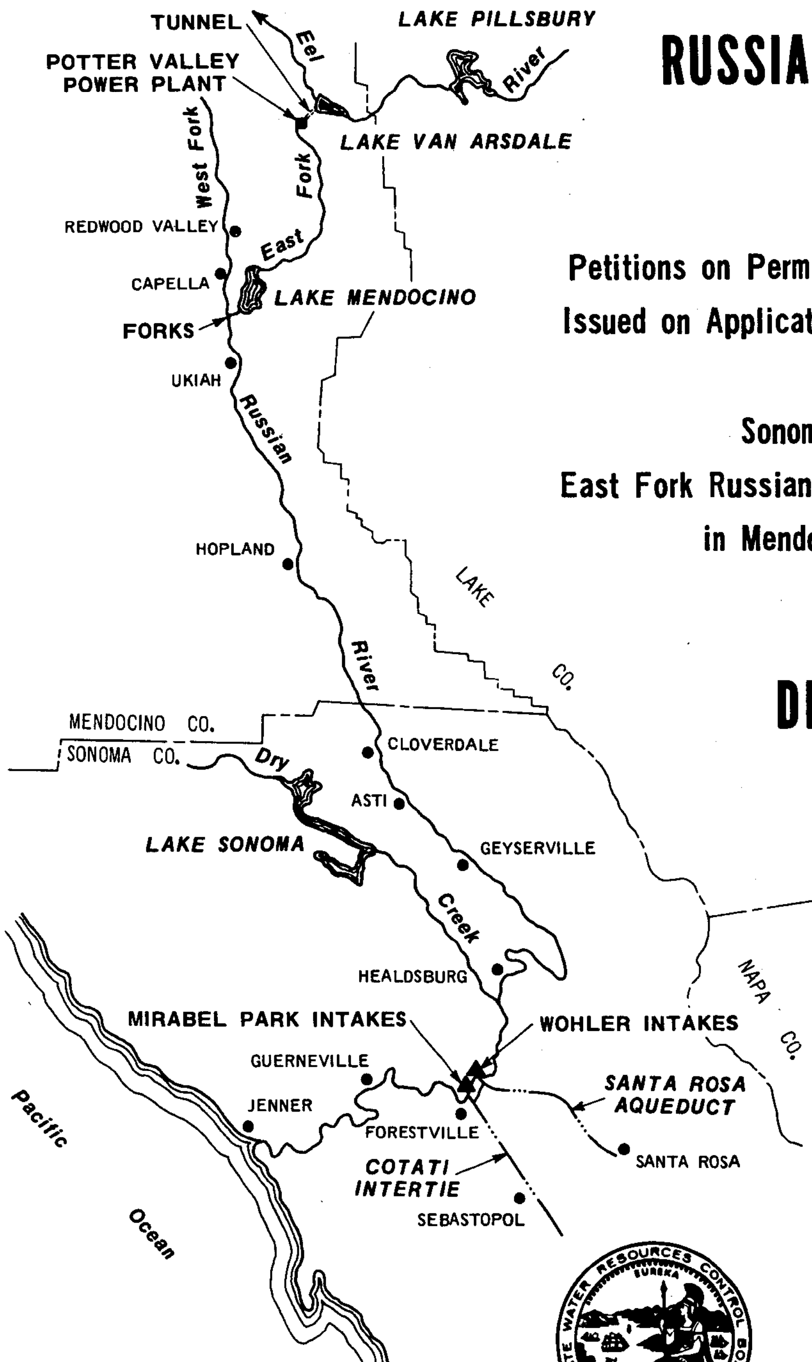

RUSSIAN RIVER PROJECT

Application 19351

and

Petitions on Permits 12947A, 12949, 12950, and 16596

Issued on Applications 12919A, 15736, 15737, and 19351

of

Sonoma County Water Agency

East Fork Russian River, Russian River, and Dry Creek

in Mendocino and Sonoma Counties

DECISION 1610

STATE WATER RESOURCES CONTROL BOARD · CALIFORNIA

April 1986

STATE WATER RESOURCES CONTROL BOARD

STATE OF CALIFORNIA

George Deukmejian, Governor

STATE WATER RESOURCES CONTROL BOARD

Darlene E. Ruiz, VICE *Chairwoman*
Edwin H. Finster, Member
Eliseo Samaniego, Member
Danny Walsh, Member

Raymond Walsh, Interim Executive Director

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

In the Matter of Application 19351 and Permits 12947A, 12949, 12950, and 16596 Issued on Applications 12919A, 15736, 15737, and 19351, SONOMA COUNTY WATER AGENCY, Applicant, Permittee, and Petitioner, DEPARTMENT OF FISH AND GAME, MENDOCINO COUNTY AND MENDOCINO COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, MENDOCINO COUNTY RUSSIAN RIVER FLOOD CONTROL AND WATER CONSERVATION IMPROVEMENT DISTRICT, MASONITE CORPORATION, FITCH MOUNTAIN WATER CO., INC., FITCH MOUNTAIN ASSOCIATION, INC., TOOMEY PUMP, INC., CHRIS J. AND CONSTANCE E. MILLER, RESIDENTS OF REDWOOD DRIVE, TROWBRIDGE RECREATION, INC., AND CITY OF CLOVERDALE, Protestants, UNITED ANGLERS OF CALIFORNIA, ALEXANDER VALLEY ASSOCIATION, RUSSIAN RIVER WATER RIGHTS PROTECTIVE ASSOCIATION, CITY OF HEALDSBURG, HEALDSBURG CHAMBER OF COMMERCE, RIO LINDO ADVENTIST ACADEMY, and JORDAN VINEYARDS AND WINERY, Interested Parties.	DECISION 1610 SOURCES: East Fork Russian River, Russian River, and Dry Creek COUNTIES: Sonoma and Mendocino

DECISION APPROVING APPLICATION IN PART
AND APPROVING PETITIONS IN PART

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STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

In the Matter of Application 19351 and Permits 12947A, 12949, 12950, and 16596 Issued on Applications 12919A, 15736, 15737, and 19351, SONOMA COUNTY WATER AGENCY, Applicant, Permittee, and Petitioner, DEPARTMENT OF FISH AND GAME, MENDOCINO COUNTY AND MENDOCINO COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, MENDOCINO COUNTY RUSSIAN RIVER FLOOD CONTROL AND WATER CONSERVATION IMPROVEMENT DISTRICT, MASONITE CORPORATION, FITCH MOUNTAIN WATER CO., INC., FITCH MOUNTAIN ASSOCIATION, INC., TOOMEY PUMP, INC., CHRIS J. AND CONSTANCE E. MILLER, RESIDENTS OF REDWOOD DRIVE, TROWBRIDGE RECREATION, INC., AND CITY OF CLOVERDALE, Protestants, UNITED ANGLERS OF CALIFORNIA, ALEXANDER VALLEY ASSOCIATION, RUSSIAN RIVER WATER RIGHTS PROTECTIVE ASSOCIATION, CITY OF HEALDSBURG, HEALDSBURG CHAMBER OF COMMERCE, RIO LINDO ADVENTIST ACADEMY, and JORDAN VINEYARDS AND WINERY, Interested Parties.	DECISION 1610 SOURCES: East Fork Russian River, Russian River, and Dry Creek COUNTIES: Sonoma and Mendocino

DECISION APPROVING APPLICATION IN PART
AND APPROVING PETITIONS IN PART

BY BOARD MEMBER FINSTER:

1.0 INTRODUCTION

Sonoma County Water Agency (hereinafter referred to as "SCWA") having requested partial approval of the direct diversion portion of

Application 19351 (previously permitted for storage) and having filed petitions to extend time to complete construction and use of water under Permits 12947A, 12949, and 12950, to amend terms and conditions of Permits 12947A, 12949, and 12950, to change the place of use under Permit 12947A, and to amend the terms and conditions of Permit 16596 issued on Application 19351; notice having been given and protests having been received; notice of hearing having been given; a public hearing having been held before the State Water Resources Control Board on fifteen dates between October 29, 1984 and February 28, 1985; applicant, protestants and interested parties having appeared and presented evidence; the Board having considered all evidence in the record; the Board finds as follows:

2.0 BACKGROUND

Applicant and petitioner SCWA currently holds four permits to appropriate water for the Russian River Project from the Russian River, the East Fork Russian River, and Dry Creek. The Board's predecessor, the State Water Rights Board, approved three of these permits in Decision D 1030. Therein, the Board's predecessor approved issuance of permits jointly to SCWA and to Mendocino County Russian River Flood Control and Water Conservation Improvement District (Mendocino Improvement District) on Applications 12919A and 12920A. In the same decision the Board approved SCWA's Applications 15736 and 15737 (Permits 12949 and 12950). Together, these permits authorized diversion to storage at Coyote Dam and direct diversion and rediversion of water from the

Russian River at various points. Subsequently, the Board in Decision 1416 approved in part Application 19351 (Permit 16596) for storage of water at Warm Springs Dam on Dry Creek, but restricted the use of such water to in-channel purposes until further hearing and order of the Board. The Board withheld action on the direct diversion portion of Application 19351.

In 1974 the Board reviewed the permits approved in Decision D 1030 on Applications 12919A, 12920A, 15736 and 15737, and ordered the permits amended in Order WR 74-30 to, among other things, (1) limit the combined direct diversion and rediversion of stored water at the Wohler and Mirabel Park pumping facilities to 37,544 acre-feet per annum (hereinafter afa), (2) combine the purposes of use under Applications 12919A and 12920A into Application 12919A, (3) revoke the permit on Application 12920A as no longer necessary, and (4) divide the remaining permit, Permit 12947, into Permits 12947A (held by SCWA) and 12947B (held by Mendocino Improvement District). In Order WR 74-34 the Board granted SCWA reconsideration on the limit of 37,544 afa on its diversions at Wohler and Mirabel. That reconsideration is one of the issues in this decision. It was delayed, along with action on the three petitions filed in 1975, pending completion of an adequate environmental impact report by SCWA.

3.0 SUBSTANCE OF THE PETITIONS AND APPLICATION

SCWA has filed five petitions in addition to the reconsideration of Order WR 74-30, all of which are subjects of this proceeding. The five petitions are as follows:

a. Petition to extend the time to complete construction and use of water (filed in 1975),

b. Petition to increase the maximum combined rates of direct diversion and rediversion of stored water at Wohler and Mirabel under Permits 12947A, 12949, and 12950 from 92 cubic feet per second (hereinafter cfs) and 37,544 afa to 180 cfs and 75,000 afa (filed in 1975),

c. Petition to authorize direct diversion of 180 cfs from the Russian River under Application 19351 (filed in 1975),

d. Add Redwood Valley County Water District as a place of use under Permit 12947A (filed in 1983), and

e. Remove the restriction to in-channel purposes in Permit 16596 on the use of stored water from Lake Sonoma, and allow rediversion of up to 75,000 afa of stored water at the Wohler and Mirabel facilities (filed in 1983).

4.0 PROJECT DESCRIPTION

The Russian River Project is a water diversion and storage project operated by SCWA to furnish water from the Russian River, the East Fork Russian River, and Dry Creek for domestic, industrial, municipal, irrigation, and recreational uses. SCWA supplies water to the City of Cotati, the City of Petaluma, the City of Rohnert Park, the City of

Santa Rosa, the City of Sonoma, the Forestville County Water District, the North Marin Water District, the Valley of the Moon Water District, Marin Municipal Water District, and several individuals.

The Russian River Project includes storage of water at Lake Mendocino on the East Fork Russian River in Mendocino County and at Lake Sonoma on Dry Creek in Sonoma County, diversion and rediversion facilities at Wohler and Mirabel Park in Sonoma County, and an aqueduct system to convey water from the Russian River to the service areas in southern Sonoma County and in Marin County. Much of the water appropriated from the East Fork Russian River originates in the Eel River watershed and is diverted to the East Fork by Pacific Gas and Electric Co. through a hydroelectric power tunnel.

SCWA shares conservation space at Lake Mendocino with Mendocino Improvement District. Together, the two agencies have permits to store up to 122,500 afa in Lake Mendocino. SCWA has a permit to store up to 245,000 afa in Lake Sonoma. The two storage reservoirs are owned by the U. S. Corps of Engineers.

5.0 PROTESTS

There were a total of twenty-two unresolved protests against the five petitions filed by SCWA. Of the protestants, only eleven appeared and participated in the hearing. These were Department of Fish and Game, Mendocino County and Mendocino County Flood Control and Water Conservation District, Mendocino County Russian River Flood Control and Water Conservation Improvement District, Masonite Corporation, Fitch Mountain Water Co., Inc., Fitch Mountain Association, Inc., Toomey Pump, Inc., Chris J. and Constance E. Miller, Residents of Redwood Drive, Trowbridge Recreation, Inc., and City of Cloverdale. The bases for these protests are set forth in Table 5.1. All other protests are dismissed, pursuant to 23 Cal.Adm.Code §731, for failure to appear at the hearing. Additionally, seven interested parties appeared and presented evidence, as follows: United Anglers of California, Alexander Valley Association, Russian River Water Rights Protective Association, City of Healdsburg, Healdsburg Chamber of Commerce, Rio Lindo Adventist Academy, and Jordan Vineyards and Winery.

TABLE 5.1

Protests

PROTESTANT	BASIS: Contrary to Law	Prior Rights	Adverse Environ. Impact	Public Interest	Public Trust
Calif. Dept. of Fish and and Game			X	X	
Mendocino Co. & Mendocino Co. Flood Control and Water Conservation District*	X		X	X	
Fitch Mountain Water Co., Inc.		X		X	
Fitch Mountain Association, Inc.				X	
The Residents of Redwood Drive				X	
Toomey Pump, Inc.				X	
Chris J. & Constance E. Miller and Residents of Redwood Drive			X	X	
Trowbridge Recreation, Inc.					X
City of Cloverdale				X	
Masonite Corporation		X			
Mendocino County Russian River Flood Control and Water Conservation Improvement District			X	X	X

* Also protested on the basis that the petitions involved matters that are not within the Board's jurisdiction.

6.0 VERIFICATION OF SCWA'S FLOW ANALYSES

In the hearing, SCWA introduced in evidence a number of analyses of different operating options and flow scenarios on the Russian River.

These analyses were based on a computer simulation of the upper Eel River and the Russian River. The computer simulation originally was developed by the Department of Water Resources.

When it analyzed the record, the Board reanalyzed the data in the record which SCWA had used for its analyses, using services of the Department of Water Resources, in order to verify independently SCWA's analyses. Several computer simulations were run, some of which were intended to match the scenarios SCWA had run, and some of which analyzed alternative scenarios. In the course of reanalyzing SCWA's scenarios, we found that SCWA's simulations used dry year demands for all except the first year of record modeled. Since dry year agricultural demands are higher than normal year demands, SCWA's simulations predict higher river flows in some reaches and lower reservoir levels than would exist under actual demand situations. Consequently, we rely herein on our own analyses of the various flow scenarios.

7.0 PETITION TO AUTHORIZE DIRECT DIVERSION UNDER APPLICATION 19351

In this proceeding SCWA has petitioned the Board to authorize direct diversion of 180 cfs under Application 19351. Application 19351 was filed on April 12, 1960, for storage in Lake Sonoma and for direct diversion of water from Dry Creek. The Russian River was added as a source of direct diversion on January 12, 1968. SCWA's application, as amended, was for a permit to appropriate 290 cfs by direct diversion and to appropriate 320,000 afa by storage. In Water Right

Decision 1416, the Board authorized storage of 245,000 afa in Lake Sonoma under Application 19351, but withheld action on the direct diversion portion of the application pending further hearing and a showing of need for the water.

7.1 Availability of Unappropriated Water for Direct Diversion

We find that because of the coordinated operation of Lake Sonoma and Lake Mendocino and the minimum flows discussed in paragraph 13, below, unappropriated water will be available in most months in the Russian River at the Wohler and Mirabel diversion points under year 1985 demand levels. However, under year 2020 demand levels, we expect that there will often be no water available for direct diversion under Application 19351 during the months of June, July, August, and September.

7.2 Need for Water Under Direct Diversion Rights

In order to divert water for the Russian River Project to the full extent authorized, and to avoid excessive drawdowns of storage reservoirs, SCWA requires a mixture of available direct diversions and rediversions of stored water. SCWA's current direct diversion rights are 92 cfs from the East Fork Russian River under Permit 12947A, year round, 20 cfs from the Russian River under Permit 12949, year round, and 60 cfs from the Russian River under Permit 12950, from April 1 through September 30 for irrigation and domestic purposes. The 60 cfs available under Permit 12950 is for only a limited season and is primarily for agricultural use. The 92 cfs under Permit 12947A is available only when direct diversion flow reaches Wohler and Mirabel from the East Fork Russian River. During the summer, East Fork flow often will be consumed before it reaches Wohler and Mirabel. Consequently, SCWA's right to direct diversion could be limited at times to the 20 cfs diversion authorized under Permit 12949. As a result, situations could occur where water available for appropriation is present at Wohler and Mirabel, but SCWA has inadequate rights to divert the water. Under such circumstances SWCA might have to release excessive quantities of water from storage, reducing the storage levels in Lake Sonoma or Lake Mendocino . The flow and reservoir levels predicted as a result of the minimum flow requirements ordered by this decision contemplate that SCWA will have adequate direct diversion rights when water is available. Absent adequate direct diversion rights, reservoir storage levels likely would be lower than expected. Consequently, we find that the direct diversion portion of Application 19351 should be approved for the 180 cfs requested. However, direct diversion at Wohler and Mirabel under Application 19351 in combination with Permits 12947A, 12949, and 12950 should not exceed this amount. The amount diverted under this authorization will vary according to availability of water. When the water right is licensed, the authorized direct diversion can be adjusted to the amount actually used within the authorization.

7.3 Disposition of the Remaining 110 Cubic Feet Per Second Under Application 19351

SCWA has requested that the Board withhold action on the remaining 110 cfs not requested to be authorized for diversion at this time under Application 19351. However, we find that SCWA has failed to demonstrate that it has a clear or feasible plan for the use of the additional flow within a reasonable time. Therefore, based on provisions of 23 Cal.Admin.Code §776, we will deny approval of the remaining 110 cfs.

8.0 PETITIONS TO INCREASE THE DIVERSION OF WATER AT WOHLER AND MIRABEL UNDER PERMITS 12947A, 12949, and 12950

SCWA petitioned the Board (1) to amend Permit 12947A to increase the maximum rate of rediversion of stored water at Wohler and Mirabel from 92 cfs to 180 cfs, and (2) to increase the maximum combined direct diversion and rediversion of stored water under Permits 12947A, 12949, and 12950 from 92 cfs and 37,544 afa to 180 cfs and 75,000 afa. However, under the petition the maximum combined direct diversion under the three permits would remain at 92 cfs. Near the end of the hearing, SCWA withdrew that part of its petition that requested an increase in direct diversion and rediversion under Permit 12947A from 37,544 afa to 75,000 afa. The net result of this change is that SCWA has remaining a petition to increase the annual direct diversion from the Russian River under Permits 12949 and 12950, from 37,544 afa to 75,000 afa.

The requested increase from 92 cfs to 180 cfs as a combined limit on direct diversion and rediversion of stored water under Permits 12947A, 12949, and 12950 cannot be approved because, as stated in Order WR 74-34, SCWA's combined net rediversion and direct diversion rights under Permits 12947A, 12949 and 12950 at Wohler and Mirabel are 92 cfs. Further, during the hearing, SCWA agreed that a result of withdrawing its petition as to Permit 12947A would be to limit the combined direct diversion and rediversion to 92 cfs. RT XVII,17:8-9. Additionally, we note that the limit on direct diversion under Permit 12949 is 20 cfs year round, and under Permit 12950 is 60 cfs from April 1 to September 30 of each year. These limits are unchanged.

The Board imposed a combined limit of 37,544 afa of direct diversion and rediversion of stored water at Wohler and Mirabel under Permits 12947A, 12949 and 12950 in Order WR 74-30. Subsequently, in Order WR 74-34, the Board approved reconsideration of this limitation. Permits 12949 and 12950 authorize direct diversion without placing a limit on the total annual diversion. Although the Board in Order WR 74-30 considered a combined limit, the order imposing a limit has never become final as to Permits 12949 and 12950, and may now be changed if water is available for appropriation and the change is in the public interest.

8.1 Availability of Water for Direct Diversion at Wohler and Mirabel in Excess of 37,544 Acre-Feet Per Annum Under Permits 12949 and 12950

We have found in Paragraph 7.1 above that water is available for appropriation by direct diversion at Wohler and Mirabel. Since Permits 12949 and 12950 represent more senior rights than Application 19351, it follows that water is also available under Permits 12949 and 12950 to contribute to an increase in the combined limit of 37,544 afa on the three permits.

9.0 COMBINED LIMIT ON DIRECT DIVERSION AND REDIVERSION AT WOHLER AND MIRABEL

SWCA has asked that the combined annual limit under all four of its permits and application considered herein be raised to or set at 75,000 afa for diversion and rediversion at Wohler and Mirabel. Water is available for this amount of combined direct diversion and rediversion, under the instream flow requirements discussed in paragraph 13.

Additionally, SCWA has presented substantial evidence that its need for water in its places of use will increase to 75,000 afa, and that its proposed uses are beneficial. Consequently, the combined limit on direct diversion and rediversion may be raised to 75,000 afa.

10.0 PETITION TO ADD REDWOOD VALLEY TO THE PLACE OF USE UNDER PERMIT 12947A

SCWA has petitioned to add the service area of the Redwood Valley County Water District, within T16N and T17N, R12W, MDB&M, to its place of use under Permit 12947A, and in conjunction with this change has requested an additional withdrawal from storage at Lake Mendocino of 7,500 afa. SCWA has established that Redwood Valley, because it is growing in population and in agricultural uses, has a need for the water.

10.1 Scope of Permit 12947A

Permit 12947A authorizes the diversion to storage in Lake Mendocino of 122,500 afa. Of the yield from this storage, Mendocino Improvement District may withdraw up to 8,000 afa for use within its place of use under Permit 12947B. Subject to prior rights, a 10,000 acre-foot per annum reservation for use by appropriators in the Russian River Valley in Sonoma County who commence diversions after January 28, 1949, and maintenance of minimum flows, the balance of the water that annually may be diverted to storage in Lake Mendocino is available to SCWA for its use, assuming it has an authorized point of diversion and place of use for the water.

Assuming that the requested withdrawal of 7,500 afa is available from Lake Mendocino without increasing the amount of water authorized for storage therein -- i.e., without storing more than 122,500 afa -- and without impairing any of the uses to which SCWA's right is subject, the change can be approved under SCWA's existing rights. This is because the right is to store water, and an authorization of an additional <u>withdrawal</u> from storage will not increase the amount that may be stored. Consequently, the decision whether to approve the requested change depends upon the availability of water and whether the change will injure any legal user of the water.

10.2 <u>Availability of Water for the Proposed Change</u>

With less than 30,000 acre-feet of carry-over storage, Lake Mendocino's reliability as a storage facility is impaired, since it could go dry if the winter and spring following a lower carry-over were extremely dry. Under the minimum flow requirements discussed in paragraph 13, there would be nine years out of fifty-six when there would be inadequate water to both maintain Lake Mendocino's reliability as a storage facility and serve Redwood Valley.

In years when inadequate water is available, the withdrawal of 7500 afa from Lake Mendocino could deprive other legal users of water. Under term 20 of Permit 12947A, deliveries to Redwood Valley, which is outside the Russian River Valley, are junior to all uses of water within the Russian River Valley. Consequently, any diversion to Redwood Valley under Permit 12947A should be conditioned to ensure that it does not impair other legal uses of water.

The following constraints should be placed on any withdrawal from storage for use in Redwood Valley: (1) During critical and very dry years SCWA should make no withdrawals from storage for Redwood Valley under Permit 12947A; (2) at other times, whenever storage in Lake Mendocino is less than 30,000 acre-feet, Redwood Valley should be delivered from Lake Mendocino no more than 50 percent of its average monthly use; (3) withdrawals from storage for Redwood Valley should be limited to 7500 afa; (4) if withdrawals from storage are ceased pursuant to point (1), they should not be resumed until after October 31 of that year and after storage in Lake Mendocino has risen to above 30,000 acre-feet or until SCWA has demonstrated, to the satisfaction of the Chief of the Division of Water Rights, that storage will not fall below 30,000 acre-feet that year; (5) a conservation program should be developed for Redwood Valley, to ensure that water delivered under this decision is not used wastefully or unreasonably; (6) any agreement between Redwood Valley and SCWA should be made subject to permit provisions for ceasing or reducing withdrawals from storage, and such contract should be provided to the Board; and (7) jurisdiction should be reserved to modify the above requirements or to impose different requirements.

11.0 PETITION FOR EXTENSION OF TIME UNDER PERMITS 12947A, 12949, AND 12950

SCWA petitioned in 1975 for extensions of time under Permits 12947A, 12949 and 12950 to complete construction at Wohler and Mirabel and to apply water to beneficial use. The requested extensions are from December 1, 1975 to December 1, 1987 for construction, and from December 1, 1985 to December 1, 1999 for application of the water to the proposed beneficial use.

We find, based on the evidence, that SCWA is exercising due diligence in construction of the Russian River Project. However, all construction of diversion and rediversion facilities may not be complete until at least the end of 1993. Because of this delay, SCWA during the hearing orally requested that the time to complete construction be extended at least through 1993. No participant in the hearing objected to this request. If the extension were made only to 1987 as originally requested, another extension would have to be processed almost immediately. Consequently, the time to complete construction, allowing for any additional delays, should be extended to December 1, 1995.

Likewise, we find that SCWA is exercising due diligence in applying the water to beneficial use. It is appropriate, based on the evidence, for the application of water to beneficial use to take more time. This helps ensure that water is not wastefully applied. It is possible that SCWA will reach its full beneficial use of water appropriated under these permits by December 1, 1999. Consequently, the requested extension may be approved.

12.0 PETITION TO AMEND PERMIT 16596

Term 5 of Permit 16596 contains restrictive language as follows:

> "No water shall be used except for in-channel purposes until further hearing and order of the Board. Said order shall be preceded by a showing by the permittee of how the water put to beneficial use will be measured and reported."

SCWA petitioned in 1983 for amendment of term 5 of Permit 16596, (1) to authorize rediversion of 75,000 afa of stored water from Lake Sonoma at the Wohler and Mirabel pumping facilities, and (2) to authorize the use of such water for all of the purposes of use set forth in term 3 of Permit 16596. These purposes of use are recreational, domestic, industrial, and municipal. SCWA filed this petition to relieve restrictions in term 5 which the Board placed on its use of Lake Sonoma storage water in Water Right Decision 1416.

The quoted part of term 5 was included in the permit because, according to Decision 1416, SCWA had not shown how the water would be put to beneficial use or how any rediversions of the stored water would be measured and reported. Herein we consider whether SCWA has made a showing adequate to justify the Board's rescission of the quoted part of term 5 and to authorize the requested rediversions and beneficial uses.

12.1 Need For Water

SCWA has a master contract with eight agencies for delivery of a firm supply of water in southern Sonoma County and in northern Marin County. Additionally, SCWA has an offpeak water supply contract with

Marin Municipal Water District. The total demand under these contracts is increasing as the population within the service areas of SCWA's contractors increases. In three recent years (1981, 1984 and 1985), SCWA obtained authorization from the Board to divert and use water over and above that allowed under the 37,544 acre-foot per annum limit on diversion under its permits imposed in Order WR 74-30. Demand in SCWA's service area may reach 75,000 afa by the year 2000. Based on these findings, SCWA has shown that it has a need for additional water, up to 75,000 afa, in its service area. Enough water is not available from SCWA's other rights to satisfy this demand. Consequently, by making this showing, SCWA has satisfied the first of the term 5 permit requirements, that the water will be put to beneficial use if its diversion is approved.

12.2 Accounting for Water

SCWA also has offered a method for measuring and reporting not only the diversions from Lake Sonoma, but also the diversions under Permits 12947A, 12949, and 12950. However, SCWA's proposal contains several inconsistencies, and to some extent disregards legal priorities among the various water rights which SCWA holds. No other proposed accounting method is satisfactory. Nevertheless, the lack of an acceptable accounting method should not by itself be a basis for continuing the restrictions in Term 5. Consequently, rather than require a specific method of accounting at this time, we will require SCWA to record the specific operational data and streamflows listed in the order portion of this decision, and to develop a method of submitting data to the Board on the quantities of direct diversion and rediversion of stored water used under its permits. Such method should be subject to approval by the Chief, Division of Water Rights.

12.3 Beneficial Use

Since the intended recipients of water from Lake Sonoma will put the water to beneficial use for the permitted purposes, authorization to use the water for the permitted purposes is appropriate.

12.4 Adequacy of Supply

In two years of the fifty-six that were modeled, Lake Sonoma's carry-over storage was inadequate to meet normal demands in the following year. Consequently, SCWA should be required to reduce its deliveries in years when storage in Lake Sonoma drops below 100,000 acre-feet before July 15, to ensure that an adequate carryover supply will remain. Also to ensure that Lake Sonoma remains an adequate source of supply for as long as possible, SCWA should develop and implement a master water conservation plan for its service area. Such a plan should use elements of water conservation programs developed by or in conjunction with SCWA's contractors.

13.0 MINIMUM INSTREAM FLOWS FOR THE RUSSIAN RIVER

The central issue in this proceeding affects the Board's determination on all five of the petitions filed by SCWA and on reconsideration of Order WR 74-30. This issue is the minimum instream flows in the Russian River that should be made conditions of SCWA's permits.

13.1 Amendment of Minimum Flow Requirements

In Decision D 1030 and in Decision 1416, the Board incorporated by reference agreements between SCWA or its predecessor and the Department of Fish and Game, which set forth the minimum instream flows to be maintained by SCWA as a condition of Permits 12947A, 12949, 12950, and 16596. The agreement pertaining to Permits 12947A, 12949, and 12950 contains language giving the Board reserved jurisdiction over the permits for the purpose of amending the instream flow requirements, as follows:

> "A. The State Water Rights Board, or any successor to the jurisdiction of said Board, as between the parties hereto, shall have continuing primary authority and jurisdiction over the subject of releases for minimum flows of water herein provided to be maintained in the channel of the Russian River for the protection, preservation and enhancement of fish and wildlife, to modify the same in accordance with law and equities between these parties in the interest of the public welfare to prevent waste, unreasonable or inequitable use, unreasonable or inequitable method of use or unreasonable or inequitable method of diversion of water."

Because of this term, its authority to condition approval of the petitions filed by SCWA and its continuing authority under the public trust (National Audubon Society v. Superior Court, 189 Cal.Rptr. 346, 33 Cal.3d 445 (1983) the Board has jurisdiction to amend the minimum instream flow requirements incorporated by reference in the above four permits.

13.2 Selected Alternative

Fifteen alternative sets of minimum flow requirements were discussed in the course of the proceeding. We conclude that a variation of the March 8, 1985 stipulation between SCWA and the Department of Fish and

Game is the best alternative. In choosing minimum flow requirements we weighed the performance and the effects of the various alternatives. In choosing an alternative we looked for one which generally (a) would not cause Lake Mendocino to go dry, (b) takes account of the continuing sedimentation in Lake Pillsbury, (c) includes dry and critical year criteria, (d) requires actions which are within the jurisdiction of the Board, (e) takes into account the existence of all of the facilities in the Russian River Project, (f) attempts to manage the system in the face of increasing demands for water, (g) includes dry spring criteria, and (h) preserves the fishery and recreation in the river and in Lake Mendocino to the greatest extent possible while serving the needs of the agricultural, municipal, domestic, and industrial uses which are dependent upon the water. We find that a set of minimum flow requirements which uses all of the features of the stipulation dated March 8, 1985 between SCWA and the Department of Fish and Game, except for one modification, will most closely meet these criteria. The selected minimum flow requirements are set forth in our order herein.

Table 13.1 summarizes the projected median flows and the percentage of time at flows less than 200 cfs, 150 cfs, and 100 cfs in the Russian River and the expected Lake Mendocino storage levels under the selected alternative, under year 1985 and year 2020 demand conditions for May through October. It also summarizes the actual median flows and percentage of time at flows less than 200 cfs, 150 cfs, and 100 cfs in the Russian River and in Lake Mendocino since 1959 when Lake Mendocino began storing water.

TABLE 13.1

MEDIAN FLOW (cfs), AND
MEDIAN LAKE MENDOCINO STORAGE VOLUME (acre feet)
UNDER THE SELECTED ALTERNATIVE AND UNDER HISTORICAL
CONDITIONS, AND PERCENT OF TIME AT LESS THAN 200, 150 AND 100 CFS:
MAY THROUGH OCTOBER PERIOD

1985 DEMAND CONDITIONS: SELECTED ALTERNATIVE			
	Guerneville Flow	Healdsburg Flow	Lake Mendocino Volume
May	446	299	89,400
June	229	200	84,300
July	202	200	71,300
August	202	200	61,100
September	185	165	57,700
October	220	174	64,400

2020 DEMAND CONDITIONS: SELECTED ALTERNATIVE			
	Guerneville Flow	Healdsburg Flow	Lake Mendocino Volume
May	376	282	88,600
June	140	200	79,000
July	140	200	62,000
August	140	200	50,500
September	140	165	47,100
October	161	168	48,800

HISTORICAL CONDITIONS			
	Guerneville Flow	Healdsburg Flow	Lake Mendocino Volume
May	510	500	82,900
June	230	232	81,600
July	168	206	73,300
August	170	220	64,000
September	175	205	64,000
October	245	242	62,500

1985 DEMAND CONDITIONS: SELECTED ALTERNATIVE

% Time

	Guerneville Flow			Healdsburg Flow			Lake Mendocino Volume (1000 af)			
	<200	<150	<100	<200	<150	<100	<72.0	<60.0	<50.0	<37.5
May	13	13	11	13	13	11	23	0	0	0
June	27	16	13	27	21	18	30	13	0	0
July	46	14	11	25	20	18	55	29	11	0
August	48	14	11	25	18	14	71	43	21	4
September	64	20	9	88	20	20	100	54	29	9
October	64	18	9	66	21	16	100	43	20	5

2020 DEMAND CONDITIONS: SELECTED ALTERNATIVE

% Time

	Guerneville Flow			Healdsburg Flow			Lake Mendocino Volume (1000 af)			
	<200	<150	<100	<200	<150	<100	<72.0	<60.0	<50.0	<37.5
May	17	13	13	13	13	13	25	4	2	2
June	80	41	13	34	23	20	38	23	5	4
July	96	81	13	34	21	20	70	39	21	7
August	93	85	13	34	21	16	95	68	39	14
September	96	83	13	96	21	21	100	75	59	25
October	80	26	11	86	27	20	100	73	52	21

HISTORICAL CONDITIONS

% Time

	Guerneville Flow			Healdsburg Flow			Lake Mendocino Volume (1000 af)			
	<200	<150	<100	<200	<150	<100	<72.0	<60.0	<50.0	<37.5
May	15	4	4	23	4	4	9	4	0	0
June	46	23	4	35	12	4	13	4	4	0
July	77	19	4	35	4	4	35	13	4	4
August	81	15	4	35	4	4	74	22	13	4
September	62	23	4	38	4	4	83	39	26	9
October	35	8	4	27	4	4	87	39	35	9

In calculating these amounts, and in selecting this alternative, we have assumed that the actual flows will be 15 cfs above the required minimum flow, to allow for an operating range in meeting the requirements. We have also assumed that transitions from one month to the next will be made gradually when the required minimum flows vary widely between consecutive months. It is our intent that the minimum flow requirements should be interpreted as contemplating a smooth transition between months, to avoid adverse environmental effects.

14.0 ENVIRONMENTAL CONSIDERATIONS

14.1 Baseline Used Herein

The environmental effects of approving the petitions, as conditioned by the proposed minimum flow requirements, are set forth herein by comparison with the actual flows and reservoir levels which have occurred since the construction and operation of Coyote Dam. We are using the actual flows and reservoir levels as the baseline herein. Our baseline differs from SCWA's baseline because ours uses actual data rather than projections of flows that would exist if the petitions were not approved. We are using the actual flows and levels as a baseline because they describe the existing physical conditions in the Russian River system. If these flows and levels continued, it is assumed herein that there would be no adverse environmental impacts of the project. Using these flows and levels, we can estimate the environmental effects of our approval of the petitions before us, under the proposed terms and conditions.

14.2 Impact Definition

For purposes of this decision, a significant adverse environmental impact is defined as a significant decrease from our baseline in the river flow or the Lake Mendocino storage. The short-term impact is the immediate effect of instituting a new flow regime in the Russian River under the terms and conditions required by this decision. The long-term impacts are those which are predicted to occur under the demands projected for the year 2020. The impacts are described qualitatively. Since storage in Lake Sonoma was approved under a previous decision, and has just commenced, no baseline exists for Lake Sonoma or for Dry Creek for purposes of this decision.

14.3 Fishery Resources

Fishery resources of the Russian River system are very important for both recreational and commercial fishing. They also generate considerable economic benefits in Sonoma and Mendocino Counties. The Russian River system, for fishery purposes, includes six segments: (1) the upper reach above Cloverdale, with cool water and a narrow channel, which has the best habitat for steelhead trout; (2) the upper middle reach from Healdsburg to Cloverdale, which is the primary reproductive habitat for American shad, and is also occupied by other warmwater species during the summer; (3) the reach below Healdsburg which provides habitat for warmwater species and striped bass; (4) the reach of Dry Creek from Warm Springs Dam to the confluence with the Russian River which is expected, under enhanced flow from the Project, to provide habitat for steelhead trout, silver salmon and king salmon;

(5) and (6) Lake Mendocino and Lake Sonoma, which provide or will provide habitat for trout and warmwater species.

14.3.1 Additional Fishery Studies Should be Done, But Not By SCWA

United Anglers argued that the Board should not make a decision on SCWA's petitions until further studies have been done on the needs of the fisheries of the Russian River. United Anglers argued that inadequate evidence had been presented to decide what flows the fisheries need. We disagree with this contention. Although detailed state of the art studies have not been done, we have enough historical evidence of fishery performance in the Russian River system under various circumstances to reach a decision on the matters before us and to set minimum flow requirements which allocate the available water according to time and year types.

There will be, by the year 2020, inadequate water remaining after all in-basin beneficial uses, including Redwood Valley's use, have satisfied their demands from the Russian River system. This situation will be exacerbated as Lake Pillsbury undergoes sedimentation. Because of the projected shortage, we have in effect allocated the remaining available water under Permits 12947A, 12949, and 12950 first to instream environmental uses including the fishery, and then to SCWA at its diversion facilities, to the extent that downstream minimum flow requirements are met. Substantially higher minimum flows likely would cause the system to go dry in less than normal years, to the detriment of all beneficial uses dependent on it, and would in other years lower Lake Mendocino enough to impair its recreational and environmental uses and reduce its reliability as a water supply.

If sufficient water were available in this proceeding to provide fully for the fisheries, exact evidence of their needs would be important to this decision. However, the SCWA appropriative rights do not include enough water to provide fully for the fish and reliably satisfy other beneficial uses of the water over the long term.

Nevertheless, further investigations into the fisheries of the Russian River should be done, and might help refine the minimum flows herein. Since a primary factor limiting flow in the Russian River is upstream agricultural and municipal demand, the investigations which United Anglers desires should be conducted by the entities which will benefit; namely, the counties of Sonoma and Mendocino and the Department of Fish and Game. We will reserve jurisdiction to amend SCWA's permits if a fishery study is conducted which shows that a different flow schedule would be better, or if further evidence otherwise becomes available which may affect the minimum flows.

14.3.2 No Additional Water is Available in the Russian River Above Healdsburg for Appropriation

As we stated above, inadequate water is available to serve fully all of the beneficial uses of water from the Russian River and its tributaries above Healdsburg. Consequently, after the 10,000 acre-foot reservation for Sonoma County and the 8,000 acre-foot reservation in Permit 12947A for use under Permit 12947B are exhausted, no further permits should be approved for water from the Russian River or any tributary with surface or subsurface hydraulic continuity therewith, without an affirmative showing by the applicant that water can be diverted without affecting the minimum flows or can be diverted under other rights or from other sources during the periods when no unappropriated water is available.

14.3.3 Impact on the Fisheries of Approval of the Petitions

The impact on the fisheries of approval of SCWA's petitions under the terms and conditions ordered herein will operate only during the period when there are no flood control operations. This is generally from May through October. At other times the Corps of Engineers, which is not under the Board's jurisdiction, operates the Russian River Project for flood control.

In the lower reach and the lower middle reach of the river, the short term impact will be a slight enhancement of the warmwater fishery in June through October. The long-term impact will be an adverse but insignificant impact.

In the upper middle reach of the river, impacts on the warmwater fishery cannot be predicted accurately. However, flows will be reduced and will fall below 150 and 100 cfs at Healdsburg more frequently than post-Coyote Dam flows fell below these levels. The increased frequency of reduced flows may have a significant adverse impact on shad and other warmwater fish.

In the upper reach of the river, flows may decrease. Under the normal year regime, the minimum requirements of steelhead trout (200 cfs from May through August and 165 cfs in September and October) nevertheless will be met. The frequency of times when flows fall below 150 cfs and 100 cfs will increase. This increase in frequency of low flows is a significant adverse impact on the steelhead trout fishery. Further, the increased frequency of low flows is a significant and slightly greater adverse impact on the silver salmon fishery, because silver salmon die after spawning, while steelhead trout do not die after spawning.

Under the selected alternative Lake Mendocino will be lowered faster and to lower levels than has been experienced since 1959. When the lake is lower there will be less habitat for fish. Also, the faster lowering of the lake may adversely affect spawning fish in the shallower parts of the lake. Because of these effects, and because the fishing at Lake Mendocino is important to people in the area, the selected alternative will cause a significant adverse impact to the fishery of Lake Mendocino.

The selected alternative will not cause a significant adverse impact to the Dry Creek fishery. The storage of water in Lake Sonoma on Dry Creek was authorized under Decision 1416, and no baseline flow in Dry Creek has been established since Decision 1416. The impact of the Warm Springs project and the Warm Springs hatchery on Dry Creek was discussed in Decision 1416. Likewise, since Lake Sonoma is new, there will be no significant adverse impact on its fisheries as a result of the selected alternative.

14.4 Riparian Vegetation and Habitat

The riparian zone along the Russian River provides habitat for numerous plant and animal species. The reduced average summer flows and the more frequent low flows under the selected alternative may cause a significant adverse impact to riparian vegetation and habitat.

14.5 Recreation and Aesthetics

The Russian River and Lake Mendocino support much water-related recreation. The selected alternative was chosen to preserve to the extent possible both river and Lake Mendocino recreation. However, the reduction of average median July-August flows -- which have been about 220 cfs --, the greater frequency of low flows in the river, the reduced average median July-August storage in Lake Mendocino -- to 66,200 acre-feet under 1985 demands and to 56,300 acre-feet under 2020 demands -- and the greater drawdown of Lake Mendocino, will cause a significant adverse impact on recreation. The aesthetic qualities of the river and of Lake Mendocino likewise will be adversely affected, by the odor of organisms which die as a result of rapid drawdowns in lake levels and reduced river levels.

14.6 Water Quality

The Water Quality Control Plan for the North Coastal Basin includes objectives and standards to preserve the quality of the waters of the Russian River. However, the lower average summer flow in the river and the increased frequency of flows below 150 cfs and 100 cfs will reduce the ability of the river to dilute pollutants. Because of increasing population, recreational use, industrialization, and transportation of hazardous materials in the watershed, the reduced ability to dilute pollutants will increase the potential for degradation of water quality in the river. Thus, the selected alternative may result in a significant adverse impact on water quality.

14.7 CEQA Compliance

SCWA was the lead agency for preparation of the environmental documents under the California Environmental Quality Act. SCWA certified its original final Environmental Impact Report (EIR) on July 8, 1980. However, the EIR was inadequate for the Board's use in considering the petitions SCWA had filed in 1975, and so the Board as a responsible agency filed a legal action against SCWA to require changes in the EIR. The Superior Court found the EIR inadequate and on August 25, 1981 ordered SCWA to prepare a supplemental EIR. The supplemental EIR was certified complete in July 1984. It covers all five petitions considered herein and the reconsideration request, and is adequate for purposes of this decision.

14.7.1 Findings of Overriding Considerations

In making a decision concerning SCWA's petitions we have considered the environmental effects of the project as discussed in the 1980 EIR and the 1984 Supplemental EIR. As we have stated above, approval of the petitions will cause significant adverse environmental impacts. These impacts will occur notwithstanding that (1) we have altered the minimum flows recommended by SCWA and the Department of Fish and Game to give the river fisheries more water in the fall for downstream passage after some dry spring conditions, (2) we have conditioned our approval of the addition of Redwood Valley as a place of use to avoid some of the adverse effects of approving the change, (3) we will for future applications require a showing that a firm source of water is available from other sources during the period when no unappropriated water is available in the Russian River; (4) we will reserve jurisdiction to amend the minimum flow requirements if a study shows that a different feasible flow schedule will benefit the fisheries.

We have balanced the benefits of the proposed project against its environmental risks. We also have balanced different environmental impacts against each other. The Board's only alternative which will not cause a significant adverse impact is to deny SCWA's petitions. Under this option SCWA could not, under its existing permits, meet the future water demands of its customers. Even if we denied the project, however, shortages likely would occur in the river above Healdsburg, and Lake Mendocino's level would drop, because of increased demands from the river above Healdsburg. Thus, we find that the "no project" alternative is not feasible because it will not provide an adequate supply of water for growing demands which can most readily, under current circumstances, be supplied from the Russian River. In order to utilize the river's water optimally for all of its beneficial uses including environmental and public trust uses, the petitions should be approved so that the Lake Sonoma and Lake Mendocino reservoirs can be operated in a coordinated fashion.

The potential impact on the salmonid fishery above Healdsburg is a result of predicted increased demands for out of stream water use in that reach. Higher flows than required herein would cause a reduction in the carryover storage of Lake Mendocino and a danger of running the system dry in a following dry or critical year. A comprehensive study of the Russian River fisheries could provide information to further mitigate this impact. However, such studies are the responsibility of other agencies as explained elsewhere in this decision.

The impacts on the fisheries and on recreation and aesthetics at Lake Mendocino are significant adverse impacts. The impacts will occur because Lake Mendocino will be drawn down lower and more frequently than it has been in the past. However, downstream flows in the Russian River cannot be maintained at levels necessary to maintain other beneficial uses without drawing down Lake Mendocino. Therefore, this impact cannot be mitigated herein.

The significant adverse impacts on canoeing recreation, riparian vegetation, aesthetics, and capacity of the river to dilute wastes above Healdsburg are a result of a reduction in average summer flows and a greater frequency of low flows. In most normal water years canoeing will be possible, aesthetics will be adequate, riparian vegetation will have enough water, and the river will have adequate capacity to dilute wastes. However, the number of years when there is inadequate water for some or all of these uses will increase. This flow regime is necessary, however, to ensure that some carryover storage will remain in Lake Mendocino, so that the river above Healdsburg will not go dry in critical water years.

The considerations set forth above satisfy the Board's responsibilities under the California Environmental Quality Act.

15.0 OTHER MATTERS

A number of matters not discussed above were raised during the hearing. These concerned legal, policy, and procedural matters. They are discussed below.

15.1 Motion to Suspend Hearing

United Anglers moved to suspend the proceeding herein until additional information is available on the needs of the Russian River fisheries, and until the Federal Energy Regulatory Commission gives its final conditional approval to the relicensing of Pacific Gas and Electric's Potter Valley Project. However, as we found in paragraph 14.3.1 above, the record contains sufficient data for us to make a decision on minimum flow requirements in the Russian River. Our decision will be subject to a reservation of jurisdiction to amend the minimum flow requirements if future studies show that amendments might benefit the fisheries or if operating the project under the terms and conditions herein causes unforeseen adverse impacts to the fisheries. Thus, unavailability of data is not a good reason to suspend this proceeding.

Regarding the Potter Valley Project, we recognize that Pacific Gas and Electric Company is in an extended relicensing proceeding, and final action by the Federal Energy Regulatory Commission may modify the bypass flows in the Eel River and therefore modify the amount of Eel

River water being diverted into the Russian River watershed. We do not know when final action will occur, however. Consequently, our appropriate action is a reservation of jurisdiction in SCWA's permits to amend the minimum flow requirements for the Russian River.

For the foregoing reasons, United Angler's motion is denied.

15.2 Request for Findings Pursuant to 23 Cal.Admin.Code §729

Mendocino County requested that we make findings pursuant to 23 Cal.Admin.Code §729 on the economic benefits of the uses of the waters of the Russian River and the alternative means of satisfying the uses. Section 729 requires findings on the benefits and detriments of the various present and prospective beneficial uses of water if requested, to the extent practicable. Findings set forth in this decision identify and evaluate the benefits and detriments of the various uses of water in and from the Russian River, and take into account all economic information in the record. Consequently, the requirement of Section 729 is satisfied.

15.3 Conformance with a General or Coordinated Plan for the Development of Water

Two of the protestants argued that pursuant to Water Code §§1256 and 10504 the Board is obliged to conform its decision to the 1950 U.S. Corps of Engineers plan for the Russian River. (House Document 585, 81st Congress, 2d Session, dated May 9, 1950.) The Corps plan is the basis for congressional authorization of the construction of Coyote Dam and Lake Mendocino (Public Law 516 of 1950, Flood Control Act of 1950). The evidence does not show that the Corps plan requires any specific flow. However, the plan referred to in Water Code §§1256 and 10504 is not the Corps plan but the California Water Plan (Department of Water Resources Bulletin No. 3, as amended). Section 1256 requires that the California Water Plan be considered when the Board determines public interest under Water Code §§1253 and 1255. Section 10504 allows state-filed applications to be assigned or released from priority if the development is not in conflict with the general or coordinated plan or with adopted water quality objectives. This decision takes into account and does not conflict with the California Water Plan. Additionally, this decision is not in conflict either with any congressional directives involved in the approval of Lake Mendocino or with the Water Quality Control Plan for the North Coastal Basin.

15.4 County of Origin Protections

Mendocino County, Mendocino County Flood Control and Water Conservation District, and Mendocino County Russian River Flood Control and Water Conservation Improvement District argue that before SCWA can export more water to Marin County, water should be provided to Mendocino County and the Alexander Valley under county of origin protection laws.

The Board previously has recognized county of origin protections for the Mendocino area (see Decision D 1030, Conditions 9 and 12). Also, Mendocino Improvement District holds an 8,000 afa appropriation under Permit 12947B, which has priority over any export from the Russian River Valley. For Applications 12919A and 12920A, no county of origin protections in addition to those in the original state assignment can be accorded to the Mendocino interests. The assignment of these applications was made under Water Code §10505. Under that section the Department of Finance quantified at 8,000 afa the amount of water required for the county of origin below Lake Mendocino. While this assignment does not prevent the Mendocino interests from buying additional water rights from SCWA, it does not require SCWA to sell Mendocino water rights.

However, Decision D 1030 accorded the Mendocino County interests unquantified county of origin priorities under Permits 12949 and 12950 to water for beneficial use within Potter Valley and within other watersheds in Mendocino County tributary to the Russian River except East Fork Russian River downstream from Coyote Valley Dam.

The Board can accord county of origin protection to the Mendocino interests under the direct diversion portion of Application 19351. This application was approved for diversion to storage in preference to state-filed Application 12918. Application 12918 was rejected and cancelled in Decision 1416, and the permit issued on Application 19351 was made subject to all present and future appropriations within the Russian River watershed. Pursuant to Water Code §10505, the approval of direct diversion under Application 19351 also should be made subject to this same protection.

15.5 Approval by Mendocino Improvement District of Use of Water Outside Mendocino and Sonoma Counties

Mendocino Improvement District argues that SCWA cannot export water from Mendocino or Sonoma Counties without its authorization. The assignment of state filed Applications 12919 and 12920 dated November 14, 1955 is subject to the condition that the use of water covered by the assignment outside the boundaries of Mendocino and Sonoma Counties under Permit 12947A shall be permitted only upon the approval of both SCWA and Mendocino Improvement District. The assignment explains that the intent of this provision is that the two counties will share equitably, considering the amount of water available under each entitlement and the use of facilities, in any proceeds that may be realized from use of water outside the two counties. Apparently, this provision was based on the expectation that surplus water from each agency's basic entitlement would be available for other use until demands anticipated under Permits 12947A and 12947B occurred. Thus, if surplus water were delivered outside the two counties, the exporting party would need the approval of the party whose surplus was being exported, and would have to equitably pay the owner of the surplus water from the proceeds of the export. Although SCWA will be authorized under this decision to increase the amount it may divert under its basic entitlement, and some of the additional water may be delivered in Marin County, none of Mendocino Improvement District's basic entitlement will be diverted outside of the two counties. Consequently, the assignment's provision does not apply to the authorizations made in this decision.

15.6 Reservation of Water for Use in Sonoma County

The Alexander Valley Association argues that Permit 12947A should be made subject to an appropriation of 16,000 afa rather than the 10,000 afa reservation in the permit. This request was not noticed as an issue in the hearing on SCWA's petition.

In Decision D 1030 the maximum diversion from the river for use in the Russian River Valley in Sonoma County was set at 67 cfs. This is the necessary diversion during the month of maximum use if 10,000 acre-feet is to be diverted each year. Thus, more water is not available under the maximum diversion rate. The Board has not reserved jurisdiction to increase the rate of use in the Russian River Valley, and any increase would be at the expense of other beneficial uses. Absent a request by SCWA for a change, therefore, there appears to be no jurisdiction for increasing the reservation to 16,000 afa.

Even if such jurisdiction existed, however, we find that on the record before us the public interest supports leaving the water in the river as long as possible for instream flows past the Alexander Valley, to the mouth of Dry Creek.

15.7 Reservations for Use in Mendocino County and in Sonoma County Above Healdsburg

Mendocino Improvement District argues that the reservations of 8,000 afa for use in Mendocino County under Permit 12947B and of 10,000 afa for use in the Russian River Valley in Sonoma County for uses commencing after January 28, 1949, should continue to have seniority over SCWA's diversions at Wohler and Mirabel. We agree. These reservations were not issues in this proceeding and will not be changed.

15.8 Status of the Permit 12947B Minimum Flow Requirements

The minimum flow requirements of Permit 12947B are unchanged by this decision. Mendocino Improvement District may request that Permit 12947B be conformed to Permit 12947A, and we will accordingly consider it. However, since Mendocino Improvement District does not control releases of water from Lake Mendocino, and holds rights senior to SCWA's diversions from the Russian River Valley, the term has little if any value in Permit 12947B, and likely could be deleted without adverse effects.

15.9 Update Permits

Under this decision we will substantially modify SCWA's four permits. Consequently, we will direct the Division of Water Rights to issue amended permits to SCWA. The amended permits will include the current versions of standard permit terms 12 and 13 in Permits 12949 and 12950, and standard term 12 instead of existing term 10 in Permit 12947A, as a condition of the approval of the petitions. The direct diversion of 180 cfs under Application 19351 will be included in Permit 16596. However, the direct diversion part of Application 19351 was amended on January 12, 1968 to add the Russian River as a source of direct diversion and the Wohler and Mirabel intakes as diversion points. Therefore, the priority date for the direct diversion should be January 12, 1968 rather than the filing date of April 12, 1960, which is the priority date for the authorized storage.

After the data collection requirements specified below are added to Permit 16596, the first part of term 14 of Permit 16596 should be deleted.

15.10 Similar Minimum Flow Requirements in Other Permits

Individual permits for diversion commencing after January 28, 1949 from the Russian River downstream of Lake Mendocino include standard permit term 68. Term 68 requires that diversions cease when the flow in the Russian River is less than 150 cfs between Coyote Dam and Wohler, and less than 125 cfs between Wohler and the Pacific Ocean. Essentially these flows are the same as the current minimum flow requirements of Permits 12947A, 12949, and 12950. Our action herein, however, will amend the minimum flow requirements in Permits 12947A, 12949, and 12950. SCWA has agreed that it will maintain the minimum flows set forth in its stipulation with the Department of Fish and Game dated March 8, 1985. The stipulated flows, with one modification, are identical to the new minimum flows required herein. Consequently, standard permit term 68 can be deleted from the individual post-1949 permits. We will, therefore, give notice of intent to delete standard term 68 or its predecessor terms from existing post-January 28, 1949 permits and licenses.

15.11 Accounting for Water Use

Term 5 of Permit 19351 provides that before the Board will authorize use of stored water from Lake Sonoma except for in-channel purposes, SCWA must show how the water will be measured and reported. SCWA has submitted a proposal for the accounting of all water appropriated and rediverted under the four permits and under the unapproved portion of

Application 19351 considered herein. However, SCWA's proposal contains technical inconsistencies and does not fully comply with the relative water right priorities of the permits. The water right priorities for the permits are very complex, and the parties disagree as to which waters should be accounted as meeting the minimum flows in different parts of the river. Also, the Board does not need to account water to specific permits until it licenses the underlying water rights. Instead, it needs only to be provided certain data. Accordingly, we will order SCWA as a condition of the approval of its petitions, to collect and maintain certain data which the Board can use in the future to decide how much water should be provided in SCWA's water right licenses. Because the collection and maintenance of data is a technical operation, we will delegate to the Chief of the Division of Water Rights authority to modify the data collection requirements as necessary to further the purpose of obtaining adequate data for licensing SCWA's water rights.

15.12 Public Trust Considerations

As we stated in Paragraph 14.7.1, we have balanced the benefits of the proposed project against its environmental risks. In doing so, we have also balanced the public trust interests associated with the proposed project against the public interest in using water outside of the stream.

In this case the public trust protects fishery, riparian, instream, avian, wildlife, and recreational uses of all of the waters of the Russian River system, including Lake Mendocino, Lake Sonoma, Dry

Creek, and the Russian River. Consequently, we have, in the entire system, balanced the public trust uses against the public interest in having a reliable supply of water for delivery to consumptive uses, and against one another. We find the result is reasonable, is in the public interest, and protects public trust uses to the extent feasible.

In Redwood Valley, we have approved a new place of use which may have a significant effect on river flows and reservoir levels. In balancing the competing uses we have decided that SCWA should be allowed, in the public interest, to deliver a certain amount of water to Redwood Valley County Water District for irrigation use. Redwood Valley has an inadequate water supply for its developing uses, and at this time has no feasible source other than Lake Mendocino. Although it needs a firm supply of water, inadequate water is available to supply it every year under Permit 12947A without further impairing public trust uses in Lake Mendocino or in the Russian River, particularly fishery uses. However, the water authorized herein for delivery will help in most years, particularly if Redwood Valley supplements it by further water development measures and conservation.

15.13 Request for Review of Data Analysis

Several parties requested at the end of the hearing that we allow them to review and comment on any computer analyses prepared by our staff, before we announced a draft decision. These requests are denied. We have not released our staff's computer analyses in advance because they are part of our deliberations and analysis of the record, and until a draft of this decision was released, they were confidential.

If the parties wish to critique the analyses that were used in this decision, they will have an opportunity to do so and ask for changes based on their critique by petitioning for reconsideration within the allowed time.

15.14 Riparian Water Rights in Mendocino County

Mendocino Improvement District asserted in the hearing that landowners within its service area have non-appropriative or riparian water rights. We note that all of SCWA's permits herein are subject to any prior water rights. Consequently, if the landowners have any water rights in addition to those appropriative rights issued by this Board that are senior to SCWA's, such rights are not impaired by this decision.

16.0 CONCLUSIONS

We conclude that SCWA's petitions should be approved as follows:

1. The time to complete construction of the project under Permits 12947A, 12949, 12950 and 16596 should be extended to December 1, 1995, and the time to complete beneficial use of water under these permits should be extended to December 1, 1999.

2. The maximum combined rate and quantity of direct diversion and rediversion of stored water under Permit 12947A at the Wohler and Mirabel Park pumping facilities should remain at 92 cfs and 37,544 afa.

The maximum combined rate and quantity of direct diversion and rediversion of stored water under Permits 12947A, 12949, 12950, and 16596 at the Wohler and Mirabel Park pumping facilities should be limited to 180 cfs and 75,000 afa.

3. The unapproved portion of Application 19351 should be approved for the direct diversion of 180 cfs, year round, at the Wohler and Mirabel Park pumping facilities for municipal, industrial, domestic, irrigation and recreational uses within SCWA's service area. This authorization should be added to Permit 16596.

4. The service area of the Redwood Valley County Water District should be added to the place of use under Permit 12947A. The withdrawal from Lake Mendocino storage for this place of use should be limited to a maximum of 7,500 afa, and should be subject to a 50 percent reduction or to ceasing withdrawals when water is inadequate for senior uses.

5. The restriction on use of stored water in term 5 of Permit 16596 should be deleted.

6. The following permit conditions should be deleted and replaced with new minimum flow requirements as applicable to each permit:

   Permit 12947A, term 18
   Permit 12949, term 10
   Permit 12950, term 11
   Permit 16596, terms 12 and 13

7. The remaining unapproved 110 cfs of direct diversion under Application 19351 should be denied.

ORDER

IT IS HEREBY ORDERED that the unapproved direct diversion portion of Application 19351 be approved in part subject to prior water rights, and that the authorized direct diversion be added to Permit 16596.

IT IS FURTHER ORDERED that amended Permits 12947A, 12949, 12950, and 16596 shall be issued which shall contain all existing terms and conditions, as amended, except as modified herein; standard permit terms 6, 10, 11, 12 and 13 (a copy of the Board's standard permits terms is available upon request); and the following amendments:

A. Permit 16596 shall be amended as follows:

1. Term 5 is amended to read:

> "The water appropriated shall be limited to the quantity which can be beneficially used and shall not exceed 180 cfs by direct diversion from the Russian River between January 1 and December 31 of each year, and 245,000 afa by storage to be collected from Dry Creek between October 1 of each year and May 1 of the succeeding year.
>
> "The total rate and quantity of direct diversion and rediversion of stored water at the Wohler and Mirabel Park pumping facilities under this permit, together with that directly diverted and rediverted from storage under Permits 12947A, 12949, and 12950 issue on Applications 12919A, 15936, and 15937 shall not exceed 180 cfs and 75,000 acre-feet per water year of October 1 to September 30."

2. Term 7 is amended to read:

"Construction work shall be completed by December 1, 1995."

3. Term 8 is amended to read:

"Complete application of the water to the authorized use shall be made by December 1, 1999."

4. Term 12 is amended to read:

"For the protection of fish and wildlife in Dry Creek and the Russian River and for the maintenance of recreation in the Russian River, permittee shall pass through or release from storage at Lake Sonoma sufficient water to maintain:

(A) The following minimum flows in Dry Creek between Warm Springs Dam and its confluence with the Russian River:

(1) During normal water supply conditions:

75 cfs* from January 1 through April 30
80 cfs from May 1 through October 31
105 cfs from November 1 through December 30

(2) During dry or critical water supply conditions:

25 cfs from April 1 through October 31
75 cfs from November 1 through March 31

* cubic feet per second

(B) The following minimum flows in the Russian River between its confluence with Dry Creek and the Pacific Ocean, unless the water level in Lake Sonoma is below elevation 292.0 feet with reference to the National Geodetic Vertical Datum of 1929, or unless prohibited by the United States Government:

(1) During normal water supply conditions	125 cfs
(2) During dry water supply conditions	85 cfs
(3) During critical water supply conditions	35 cfs

For the purposes of the requirements in this term, the following definitions shall apply:

(1) Dry water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

8,000 acre-feet as of January 1
39,200 acre-feet as of February 1
65,700 acre-feet as of March 1
114,500 acre-feet as of April 1
145,600 acre-feet as of May 1
160,000 acre-feet as of June 1

(2) Critical water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

4,000 acre-feet as of January 1
20,000 acre-feet as of February 1
45,000 acre-feet as of March 1
50,000 acre-feet as of April 1
70,000 acre-feet as of May 1
75,000 acre-feet as of June 1

(3) Normal water supply conditions exist in the absence of defined dry or critical water supply conditions.

(4) The water supply condition designation for the months of July through December shall be the same as the designation for the previous June. Water supply conditions for January through June shall be redetermined monthly.

(5) Cumulative inflow to Lake Pillsbury is the calculated algebraic sum of releases from Lake Pillsbury, increases in storage in Lake Pillsbury, and evaporation from Lake Pillsbury."

5. Term 13 is deleted.

6. Term 14 is amended to read:

"Permittee shall install a measuring device at or near the mouth of Dry Creek to determine compliance with fish release requirements."

7. A new term is added to read:

"The priority date for the authorized direct diversion under this permit shall be January 12, 1968."

8. A new term is added to read:

"Permittee shall impose a mandatory thirty percent deficiency in deliveries from the Russian River to its service area whenever the quantity of water in storage at Lake Sonoma drops below 100,000 acre-feet before July 15 of any year. The deficiency shall be based on permittee's average monthly deliveries to its service area during the same month of the previous three years. The deficiency shall remain in effect until (1) storage in Lake Sonoma rises to greater than 70,000 acre-feet subsequent to December 31 after having fallen below that level, or (2) permittee has projected, to the satisfaction of the Chief, Division of Water Rights, that storage at Lake Sonoma will not fall below 70,000 acre-feet, or (3) hydrologic conditions result in sufficient flow to satisfy permittee's demands at Wohler and Mirabel Park and minimum flow requirements in the Russian River at Guerneville."

9. A new term is added to read:

"Permittee shall collect and maintain daily data on: (1) the quantity of water pumped at its Wohler and Mirabel Park facilities, including to offstream settling ponds, (2) the average flow in the Russian River at the U. S. Geological Survey streamflow gage near Guerneville, (3) the average flow in Dry Creek below Warm Springs Dam, (4) the average flow at the mouth of Dry Creek, and (5) the operation of Lake Sonoma including the calculated quantities of inflow, discharge to Dry Creek, discharge to the fish hatchery, change in lake volume, lake evaporation, and precipitation on the lake if not included in inflow. Collection and maintenance of streamflow and operational data under this permit is subject to modification, deletion, or replacement by other requirements as ordered by the Chief, Division of Water Rights."

10. A new term is added to read:

"Permittee shall consult with the Division of Water Rights and, within one year from the date of this amended permit, develop a plan satisfactory to the Chief, Division of Water Rights, for submittal of data to the State Water Resources Control Board on the quantities of direct diversion and rediversion of stored water beneficially used under this permit."

11. A new term is added to read:

> "Permittee shall consult with the Division of Water Rights and develop and implement a master water conservation plan for its service area. The proposed plan shall be presented to the State Water Resources Control Board for approval within one year from the date of issuance of this amended permit or such further time as may, for good cause shown, be allowed by the Board. A progress report on the development of the master water conservation plan may be required by the Board at any time within this period.
>
> "All cost effective measures identified in the master water conservation plan shall be implemented in accordance with the schedule for implementation found therein."

12. A new term is added to read:

> "The State Water Resources Control Board reserves jurisdiction over this permit to modify, delete, or add minimum flow requirements or related criteria for the protection of fish and wildlife and the maintenance of recreation in the Russian River should (1) additional fishery studies be conducted in the Russian River, (2) unforeseen adverse impacts occur to the fishery or recreation in the Russian River, or (3) the Federal Energy Regulatory Commission final action on the relicensing of Pacific Gas and Electric Company's Potter Valley hydroelectric project result in modified minimum flow requirements in the Eel River.
>
> "Action by the Board will be taken only after notice to interested parties and opportunity for hearing."

B. Permit 12947A shall be amended as follows:

1. Term 5 is amended to read:

> "The water appropriated shall be limited to water of the East Fork Russian River which can be beneficially used and shall not exceed 92 cfs by direct diversion and 122,500 afa by storage from January 1 to December 31 of each year. The total amount stored in Lake Mendocino under this permit and Permit 12947B issued on Application 12919A shall not exceed 122,500 afa.
>
> "The maximum combined rate of direct diversion and rediversion of stored water under this permit,

together with that under Permits 12949 and 12950 issued on Applications 15736 and 15737 shall not exceed 92 cfs.

"Combined direct diversion and rediversion of stored water under this permit shall be limited to the Wohler and Mirabel Park pumping facilities, and shall not exceed 92 cfs or a maximum amount of 37,544 acre-feet per water year of October 1 to September 30.

"Withdrawals from storage under this permit for use in the service area of the Redwood Valley County Water District shall not exceed 7,500 acre-feet per water year of October 1 to September 30."

2. Term 7 is amended to read:

"Construction work shall be completed by December 1, 1995."

3. Term 8 is amended to read:

"Complete application of the water to the authorized use shall be made by December 1, 1999."

4. Term 18 is amended to read:

"For the protection of fish and wildlife, and for the maintenance of recreation in the Russian River, permittee shall pass through or release from storage at Lake Mendocino sufficient water to maintain:

(A) A continuous streamflow in the East Fork Russian River from Coyote Dam to its confluence with the Russian River of 25 cfs (cfs) at all times.

(B) The following minimum flows in the Russian River between the East Fork Russian River and Dry Creek:

(1) During normal water supply conditions and when the combined water in storage, including dead storage, in Lake Pillsbury and Lake Mendocino on May 31 of any year exceeds 150,000 acre-feet or 90 percent of the estimated water supply storage capacity of the reservoirs, whichever is less:

From June 1 through August 31	185 cfs
From September 1 through March 31	150 cfs
From April 1 through May 31	185 cfs

(2) During normal water supply conditions and when the combined water in storage, including dead storage, in Lake Pillsbury and Lake Mendocino on May 31 of any year is between 150,000 acre-feet or 90 percent of the estimated water supply storage capacity of the reservoirs, whichever is less, and 130,000 acre-feet or 80 percent of the estimated water supply storage capacity of the reservoirs, whichever is less:

From June 1 through March 31	150 cfs
From April 1 through May 31	185 cfs
If from October 1 through December 31, storage in Lake Mendocino is less than 30,000 acre-feet	75 cfs

(3) During normal water supply conditions and when the combined water in storage, including dead storage, in Lake Pillsbury and Lake Mendocino on May 31 of any year is less than 130,000 acre-feet or 80 percent of the estimated water supply storage capacity of the reservoirs, whichever is less:

From June 1 through December 31	75 cfs
From January 1 through March 31	150 cfs
From April 1 through May 31	185 cfs

(4) During dry water supply conditions 75 cfs

(5) During critical water supply conditions 25 cfs

(C) The following minimum flows in the Russian River between its confluence with Dry Creek and the Pacific Ocean to the extent that such flows cannot be met by releases from storage at Lake Sonoma under Permit 16596 issued on Application 19351:

(1) During normal water supply conditions 125 cfs

(2) During dry water supply conditions 85 cfs

(3) During critical water supply conditions 35 cfs

For the purposes of the requirements in this term, the following definitions shall apply:

(1) Dry water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

8,000 acre-feet as of January 1
39,200 acre-feet as of February 1
65,700 acre-feet as of March 1
114,500 acre-feet as of April 1
145,600 acre-feet as of May 1
160,000 acre-feet as of June 1

(2) Critical water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

4,000 acre-feet as of January 1
20,000 acre-feet as of February 1
45,000 acre-feet as of March 1
50,000 acre-feet as of April 1
70,000 acre-feet as of May 1
75,000 acre-feet as of June 1

(3) Normal water supply conditions exist in the absence of defined dry or critical water supply conditions.

(4) The water supply condition designation for the months of July through December shall be the same as the designation for the previous June. Water supply conditions for January through June shall be redetermined monthly.

(5) Cumulative inflow to Lake Pillsbury is the calculated algebraic sum of releases from Lake Pillsbury, increases in storage in Lake Pillsbury, and evaporation from Lake Pillsbury.

(6) Estimated water supply storage space is the calculated reservoir volume below elevation 1,828.3 feet in Lake Pillsbury and below elevation 749.0 feet in Lake Mendocino. Both elevations refer to the National Geodetic Vertical Datum of 1929. The calculation shall use the most recent two reservoir volume surveys made by the U. S. Geological Survey, U. S. Army Corps of Engineers, or other responsible agency to determine the rate of sedimentation to be assumed from the date of the most recent reservoir volume survey."

5. A new term is added to read:

> "The total rate and quantity of direct diversion and rediversion of stored water at the Wohler and Mirabel Park pumping facilities under this permit, together with that directly diverted and rediverted from storage under Permits 12949, 12950, and 16596, issued on Applications 15736, 15737, and 19351, shall not exceed 180 cfs and 75,000 acre-feet per water year of October 1 to September 30."

6. A new term is added to read:

> "Withdrawals from storage under this permit for use within the service area of the Redwood Valley County Water District shall be subject to the following restrictions:
>
> (a) Said withdrawals shall be discontinued whenever cumulative inflow to Lake Pillsbury during the current water year is less than 50,000 acre-feet on April 1, or less than 90,000 acre-feet on May 1. Withdrawals shall not resume until storage in Lake Mendocino rises to more than 30,000 acre-feet subsequent to October 31 after having fallen below that level, or until permittee has projected, to the satisfaction of the Chief, Division of Water Rights, that storage at Lake Mendocino will not fall below 30,000 acre-feet.
>
> (b) Said withdrawals, if not already discontinued under condition (a) above, shall be restricted to a monthly quantity no greater than fifty percent of the average monthly use in the service area of the Redwood Valley County Water District during the same month of the previous three years, whenever storage in Lake Mendocino is below 30,000 acre-feet."

7. A new term is added to read:

> "Any agreement between permittee and the Redwood Valley County Water District for withdrawals from storage at Lake Mendocino under this permit shall be subject to discontinuation, curtailment, or special conditions placed on said withdrawals pursuant to this permit, as this permit is now or may be amended in the future. A copy of any such contract shall be submitted to the State Water Resources Control Board."

8. A new term is added to read:

"The State Water Resources Control Board reserves jurisdiction over this permit to modify, delete, or impose additional conditions concerning the withdrawal of storage from Lake Mendocino for use within the service area of the Redwood Valley County Water District. Action by the Board will be taken only after notice to interested parties and opportunity for hearing."

9. A new term is added to read:

"Permittee shall collect and maintain average daily flow data for the following U.S. Geological Survey streamflow gaging stations:

Potter Valley Powerhouse Tailrace
East Fork Russian River near Ukiah
Russian River near Ukiah
The summation of the above two (flow at the Forks)
Russian River near Hopland
Russian River near Cloverdale
Russian River near Healdsburg
Russian River near Guerneville

"In addition, permittee shall collect and maintain daily data on the quantity of water pumped at its Wohler and Mirabel Park facilities, including water pumped to offstream settling ponds, and on the operation of Lake Mendocino including the calculated quantities of inflow, discharge, change in lake volume, lake evaporation, precipitation on the lake if not included in inflow, direct diversion by Redwood Valley County Water District, and withdrawals from storage for use in Redwood Valley.

"Requirements for collection and maintenance of streamflow and operational data under this permit are subject to modification, deletion, or replacement by other requirements as ordered by the Chief, Division of Water Rights."

10. A new term is added to read:

"Permittee shall consult with the Division of Water Rights and, within one year from the date of this amended permit, develop a plan, satisfactory to the Chief, Division of Water Rights, for submittal of data to the State Water Resources Control Board on the quantities of direct diversion and rediversion of stored water beneficially used under this permit."

11. A new term is added to read:

"Permittee shall consult with the Division of Water Rights and develop and implement a water conservation plan or actions for the service area of Redwood Valley County Water District. The proposed plan or actions shall be presented to the State Water Resources Control Board for approval within one year from the execution of an agreement to deliver water to the service area of the Redwood Valley County Water District or such further time as may, for good cause shown, be allowed by the Board. A progress report on the development of a water conservation program may be required by the Board at any time within this period.

"All cost effective measures identified in the water conservation program shall be implemented in accordance with the schedule for implementation found therein."

12. A new term is added to read:

"The State Water Resources Control Board reserves jurisdiction over this permit to modify, delete, or add minimum flow requirements or related criteria for the protection of fish and wildlife and the maintenance of recreation in the Russian River should (1) additional fishery studies be conducted in the Russian River, (2) unforeseen adverse impacts occur to the fishery or recreation in the Russian River, or (3) the Federal Energy Regulatory Commission final action on the relicensing of Pacific Gas and Electric Company's Potter Valley hydroelectric project result in modified minimum flow requirements in the Eel River.

"Action by the Board will be taken only after notice to interested parties and opportunity for hearing."

C. Permit 12949 shall be amended as follows:

1. Term 1 is amended to read:

"The water appropriated shall be limited to the quantity which can be beneficially used and shall not exceed 20 cfs to be diverted at the Wohler and Mirabel Park pumping facilities from January 1 to December 31 of each year."

2. Term 3 is amended to read:

"The maximum combined rate of diversion under this permit, together with the rate of direct diversion and rediversion of stored water under Permits 12947A and 12950 issued on Applications 12919A and 15737, shall not exceed 92 cfs.

"The total rate and quantity of direct diversion under this permit, together with that directly diverted and rediverted from storage under Permits 12947A, 12950, and 16596 issued on Applications 12919A, 15737, and 19351, shall not exceed 180 cfs and 75,000 acre-feet per water year of October 1 to September 30."

3. Term 5 is amended to read:

"Construction work shall be completed by December 1, 1995."

4. Term 6 is amended to read:

"Complete application of the water to the authorized use shall be made by December 1, 1999."

5. Term 10 is amended to read:

"For the protection of fish and wildlife, and the maintenance of recreation in the Russian River, permittee shall allow sufficient water to bypass the points of diversion to maintain the following minimum flows to the Pacific Ocean:

(1)	During normal water supply conditions	125 cfs*
(2)	During dry water supply conditions	85 cfs
(3)	During critical water supply conditions	35 cfs

*cubic feet per second

For the purposes of the requirements in this term, the following definitions shall apply:

(1) Dry water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

8,000 acre-feet as of January 1
39,200 acre-feet as of February 1
65,700 acre-feet as of March 1

114,500 acre-feet as of April 1
145,600 acre-feet as of May 1
160,000 acre-feet as of June 1

(2) Critical water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

4,000 acre-feet as of January 1
20,000 acre-feet as of February 1
45,000 acre-feet as of March 1
50,000 acre-feet as of April 1
70,000 acre-feet as of May 1
75,000 acre-feet as of June 1

(3) Normal water supply conditions exist in the absence of defined dry or critical water supply conditions.

(4) The water supply condition designation for the months of July through December shall be the same as the designation for the previous June. Water supply conditions for January through June shall be redetermined monthly.

(5) Cumulative inflow to Lake Pillsbury is the calculated algebraic sum of releases for Lake Pillsbury, increases in storage in Lake Pillsbury, and evaporation from Lake Pillsbury."

6. A new term is added to read:

"Permittee shall consult with the Division of Water Rights and, within one year from the date of this amended permit, develop a plan satisfactory to the Chief, Division of Water Rights, for submittal of data to the State Water Resources Control Board on the quantities of direct diversion beneficially used under this permit."

7. A new term is added to read:

"The State Water Resources Control Board reserves jurisdiction over this permit to modify, delete, or add minimum flow requirements or related criteria for the protection of fish and wildlife and the maintenance of recreation in the Russian River should (1) additional fishery studies be conducted in the Russian River, (2) unforeseen adverse impacts occur to the fishery or recreation in the Russian River, or (3) the Federal

Energy Regulatory Commission final action on the relicensing of Pacific Gas and Electric Company's Potter Valley hydroelectric project result in modified minimum flow requirements in the Eel River.

"Action by the Board will be taken only after notice to interested parties and opportunity for hearing."

D. Permit 12950 shall be amended as follows:

1. Term 1 is amended to read:

   "The water appropriated shall be limited to the quantity which can be beneficially used and shall not exceed 60 cfs to be diverted at the Wohler and Mirabel Park pumping facilities from April 1 to September 30 of each year."

2. Term 3 is amended to read:

   "The maximum combined rate of diversion under this permit, together with the rate of direct diversion and rediversion of stored water under Permits 12947A and 12949 issued on Applications 12919A and 15736, shall not exceed 92 cfs.

   "The total rate and quantity of direct diversion under this permit, together with that directly diverted and rediverted from storage under Permits 12947A, 12949, and 16596 issued on Applications 12919A, 15736, and 19351, shall not exceed 180 cfs and 75,000 acre-feet per water year of October 1 to September 30."

3. Term 5 is amended to read:

   "Construction work shall be completed by December 1, 1995."

4. Term 6 is amended to read:

   "Complete application of the water to the authorized use shall be made by December 1, 1999."

5. Term 11 is amended to read:

   "For the protection of fish and wildlife, and the maintenance of recreation in the Russian River, permittee shall allow sufficient water to bypass the points of diversion to maintain the following minimum flows to the Pacific Ocean:

(1)	During normal water supply conditions	125 cfs*
(2)	During dry water supply conditions	85 cfs
(3)	During critical water supply conditions	35 cfs

*cubic feet per second

For the purposes of the requirements in this term, the following definitions shall apply:

(1) Dry water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

8,000 acre-feet as of January 1
39,200 acre-feet as of February 1
65,700 acre-feet as of March 1
114,500 acre-feet as of April 1
145,600 acre-feet as of May 1
160,000 acre-feet as of June 1

(2) Critical water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

4,000 acre-feet as of January 1
20,000 acre-feet as of February 1
45,000 acre-feet as of March 1
50,000 acre-feet as of April 1
70,000 acre-feet as of May 1
75,000 acre-feet as of June 1

(3) Normal water supply conditions exist in the absence of defined dry or critical water supply conditions.

(4) The water supply condition designation for the months of July through December shall be the same as the designation for the previous June. Water supply conditions for January through June shall be redetermined monthly.

(5) Cumulative inflow to Lake Pillsbury is the calculated algebraic sum of releases for Lake Pillsbury, increases in storage in Lake Pillsbury, and evaporation from Lake Pillsbury."

6. A new term is added to read:

> "Permittee shall consult with the Division of Water Rights and, within one year from the date of this amended permit, develop a plan satisfactory to the Chief, Division of Water Rights, for submittal of data to the State Water Resources Control Board on the quantities of direct diversion beneficially used under this permit."

7. A new term is added to read:

> "The State Water Resources Control Board reserves jurisdiction over this permit to modify, delete, or add minimum flow requirements or related criteria for the protection of fish and wildlife and the maintenance of recreation in the Russian River should (1) additional fishery studies be conducted in the Russian River, (2) unforeseen adverse impacts occur to the fishery or recreation in the Russian River, or (3) the Federal Energy Regulatory Commission final action on the relicensing of Pacific Gas and Electric Company's Potter Valley hydroelectric project result in modified minimum flow requirements in the Eel River.
>
> "Action by the Board will be taken only after notice to interested parties and opportunity for hearing."

E. Except as specifically changed by this Order and by any previous orders of this Board concerning these permits, all terms and conditions contained in permits 12947A, 12949, 12950 and 16596 remain in full force and effect.

CERTIFICATION

The undersigned, Executive Director of the State Water Resources Control Board, does hereby certify that the foregoing is a full, true, and correct copy of a decision duly and regularly adopted at a meeting of the State Water Resources Control Board held on April 17, 1986.

AYE: Darlene E. Ruiz
E. H. Finster
Eliseo M. Samaniego
Danny Walsh

NO: None

ABSENT: None

ABSTAIN: None

Raymond Walsh

Raymond Walsh
Interim Executive Director

COYOTE VALLEY DAM AND LAKE MENDOCINO RUSSIAN RIVER, CALIFORNIA

WATER CONTROL MANUAL

PPENDIX I TO
IASTER WATER CONTROL MANUAL
USSIAN RIVER BASIN, CALIFORNIA

JS Army Corps
of Engineers
Sacramento District

AUGUST 1986

COYOTE VALLEY DAM
AND
LAKE MENDOCINO

RUSSIAN RIVER, CALIFORNIA

WATER CONTROL MANUAL
APPENDIX I
TO
MASTER WATER CONTROL MANUAL
RUSSIAN RIVER BASIN, CALIFORNIA

AUGUST 1986

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

COYOTE VALLEY DAM AND LAKE MENDOCINO

PERSONNEL CONCERNED IN THE OPERATION OF COYOTE RESERVOIR

UNIT		OFFICE PHONE	NAME	HOME PHONE
PROJECT OFFICE UKIAH, CALIFORNIA	COYOTE DAM	707-462-7583 (Ukiah)	D. R. CHUBON Park Manager	(Ukiah)
		707-462-7583 (Ukiah)	D. E. PEREGRINA Maintenance Leader	707-462-5143 (Ukiah)
DEPARTMENT OF THE ARMY SACRAMENTO DISTRICT CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA	DISTRICT ENGINEER	916-551-2005*	COL. W. J. SCHOLL District Engineer	
	RESERVOIR CONTROL SECTION	916-551-2088*	R. A. NEAL Chief	916-791-0478 (Roseville)
		916-551-2090* 916-551-2089*	C. D. MATLOCK Hydrologic Data	916-487-2985
		916-551-2093*	R. L. LUNDEEN	916-483-0388
	HYDROLOGIC FACILITIES	916-551-2287*	J. T. JOHNSON	916-685-6135
	OPERATIONS BRANCH	916-551-2109*	M. L. HELM Chief	916-961-1918
		916-551-2110*	A. E. SMITH, JR. Chief, Operations & Maintenance Section	916-652-5280
IRRIGATION INTERESTS	SONOMA COUNTY WATER AGENCY 2425 CLEVELAND AVE. P. O. BOX 11505 SANTA ROSA, CALIFORNIA 95401	707-526-5370 (Santa Rosa)	R. F. BEACH General Manager	707-526-1547 (Santa Rosa)
		707-523-1070 (24-Hour) (Santa Rosa)	R. J. CORTELYOU Civil Engineer III	707-539-5526 (Santa Rosa)
			R. A. MORRISON Chief, Operations & Maintenance	707-544-4893 (Santa Rosa)
COOPERATING AGENCY	PACIFIC GAS & ELECTRIC CO. 77 BEALE ST. SAN FRANCISCO, CALIFORNIA 94106	415-781-4211 (San Francisco) Ext. 1966 or Ext. 1965	DISPATCHER	

FTS: SACRAMENTO 460-ext*
NOTE: *BETWEEN 4:30 PM AND 7:45 AM, OR ON SATURDAY, SUNDAY OR HOLIDAYS USE 916-452-1535 (FLOOD SEASON ONLY)

COYOTE RESERVOIR, EAST FORK RUSSIAN RIVER, CALIFORNIA REV. 22-AUG-85

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

PERTINENT DATA

General

Drainage areas	
E. Fork Russian River at Coyote Valley Dam	105 sq mi
Russian River near Hopland	362 sq mi
Russian River near Healdsburg	793 sq mi
Russian River near Guerneville	1,338 sq mi
Flows at Coyote Valley Dam	
Mean annual runoff (natural & imported — diversions)	265,000 ac-ft
Maximum mean daily inflow (22 Dec 64)	14,160 cfs
Maximum instantaneous inflow (22 Dec 64)	18,700 cfs
Standard project flood peak inflow	25,800 cfs
Standard project flood peak outflow	12,000 cfs
Spillway design flood peak inflow	57,000 cfs
Spillway design flood peak outflow	43,500 cfs

Reservoir

Elevations	
Inactive pool	637.0 ft
Flood control pool, bottom	737.5 ft
Gross pool	764.8 ft
Standard project flood pool	772.4 ft
Spillway design flood pool	781.1 ft
Areas	
Inactive pool	20 acres
Flood control pool, bottom	1,740 acres
Gross pool	1,922 acres
Standard project flood pool	1,995 acres
Spillway design flood pool	4,000 acres
Storage capacities	
Inactive pool	135 ac-ft
Flood control pool, bottom	72,300 ac-ft
Gross pool	122,400 ac-ft
Standard project flood pool	137,300 ac-ft
Spillway design flood pool	155,500 ac-ft

Dam

Type	compacted earthfill with impervious core
Crest elevation	784 ft
Freeboard above spillway design flood	3 ft
Maximum height above streambed	160 ft
Crest length	3,500 ft
Crest width	20 ft
Upstream slope	1 on 4
Downstream slope	1 on 3
Total volume of embankment	6,150,000 cu yd

Spillway

Type	Fixed crest, channel control
Location	in natural saddle near left abutment
Crest length	200 ft
Crest elevation	764.8 ft
Head at spillway design flood pool	16 ft
Discharge capacity at spillway design flood pool	35,800 cfs

Outlet Works

Multi purpose tunnel	
Diameter	12.5 ft
Length	960 ft
Intake elevation	637 ft
Gates, number and size	
Service, hydraulic slide	three 5'0" x 9'0"
Emergency, hydraulic slide	three 5'0" x 9'0"
Discharge capacity, full gate opening	
at bottom of flood control pool	6,500 cfs
at gross pool	7,300 cfs
Plenum chamber	
Exit conduits, number and size	
Flood control	one 11'0" x 16'0"
Powerhouse	one 6'0" x 12'0"
Bypass	one 9'0" x 22'0"
Valves, type and size	
Flood control	one tainter gate 11'0" x 16'0"
	one fixed cone 54" diameter
Powerhouse	
Powerhouse	one gate 18" diameter
Bypass	one fixed cone 108" diameter
Hydroelectric power facilities	
Turbines, number and type	two Francis type
Capacity	one 3,475 hp
	one 1,425 hp
Generator capacity	one 1,000 K
	one 2,500 K
Penstocks diameter	54" and 18"
El. of centerline of turbines	
1,000 K	620.8
2,500 K	622.5
Maximum discharge capacity power mode (includes 108" bypass)	4,375 cfs

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be published in looseleaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep this manual current.

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

WATER CONTROL MANUAL

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EXHIBITS

I - INTRODUCTION

1-01. AUTHORIZATION

The Coyote Valley Dam and Lake Mendocino Water Control Manual, Russian River, California is prepared in accordance with instructions contained in ER 1110-2-240, EM 1110-2-3600, and ETL 1110-2-251.

1-02. PURPOSE AND SCOPE

This manual provides a detailed plan for water control and management at the Coyote Valley Dam and Lake Mendocino Project on the Russian River, California. A map of Lake Mendocino is shown on Plate 1. Location of the project is shown on Plate 2.

1-03. RELATED MANUALS AND REPORTS

Related manuals and reports are as follows:

Manuals

Title	Date
Reservoir Regulation Manual for Coyote Dam	April 1959

Related Reports

Hydropower Analysis	1955
Interim Report on Channel Improvement	March 1957
Master Plan for Public Recreation Development	January 1959
Master Plan for Public Recreation Development Supplement A, Part I	March 1960
Master Plan for Public Recreation Development Supplement A, Part II	July 1961
Master Plan for Public Recreation Development Supplement B, Part I	August 1962
Operation and Maintenance Manual	December 1962
Master Plan for Public Recreation Development Supplement B, Part II	January 1963
Master Plan for Public Recreation Development Supplement B, Part III	April 1965
Master Plan for Public Recreation Development Supplement B, Part IV	June 1968
Lake Mendocino Coyote Dam Slide Area	1968
Mendocino Periodic Inspection and Continuing Evaluation Report No. 1 - General Inspection	September 1969
Master Plan for Public Recreation Development Supplement B, Part V	May 1970
Channel Improvements	1970

Related Reports
(Cont'd)

Title	Date
Review Report for Flood Control and Allied Purposes	February 1973
Mendocino Periodic Inspection and Continuing Evaluation Report No. 2 - Embankment, Outlet Works and Spillway	April 1973
Mendocino Periodic Inspection and Continuing Evaluation Report No. 3 - Embankment, Outlet Works and Spillway	April 1979
Report of Soil Tests, Dynamic Properties	August 1981
Russian River Basin Study	March 1982
Lake Mendocino Power Project - Design Report	August 1983

Design Memoranda

Title	Date
No. 1 - Site Selection	May 1954
No. 2 - Hydrology and Hydraulics	November 1954
No. 3 - Hydro Power Analysis	November 1955
No. 4 - General Design Memorandum	October 1955
No. 5 - Relocations	October 1955
No. 6 - Geology, Soils, Earth Dam Design and Construction Materials	November 1955
No. 7 - Outlet Works and Spillway	December 1955
No. 8 - Real Estate	August 1955
No. 10 - Reservoir Clearing	May 1956

1-04. PROJECT OWNER

The storage space for water conservation is owned by the Sonoma County Water Agency while the remaining part of the project is owned by the U.S. Army Corps of Engineers.

1-05. OPERATING AGENCY

Coyote Valley Dam and Lake Mendocino is operated and maintained by the U.S. Army Corps of Engineers, Sacramento District. Project personnel have a normal tour of duty of 8 hours per day, 5 days per week. At other times they may be reached at their respective residences. Project personnel will be on duty weekends and holidays and at other-than-normal working hours as necessary for effective project operation.

1-06. REGULATING AGENCIES

The Reservoir Control Section, Engineering Division, Sacramento District, Corps of Engineers, is responsible for determining and furnishing operating instructions to damtenders for flood control purposes. The Sonoma County Water Agency is responsible for determining reservoir releases for the purpose of downstream water conservation needs. Sonoma County Water Agency normally coordinates the day-to-day conservation releases with the Park Manager.

II - DESCRIPTION OF PROJECT

2-01. LOCATION

Coyote Valley Dam and Lake Mendocino are located on the East Fork of the Russian River about 5 miles northeast of Ukiah, California. The location of Coyote Valley Dam with respect to the Russian River basin is shown on Plate 2.

2-02. PURPOSE

Lake Mendocino provides storage for flood control, municipal and industrial water supply, irrigation, recreation and power.

2-03. PHYSICAL COMPONENTS

Coyote Valley Dam consists of an earth embankment with a maximum height of 160 feet MSL and crest length of 3,500 feet. Elevation at the top of dam is 784 feet MSL providing 3 feet of freeboard above the spillway design flood pool. Plans, profiles and sections of the dam are shown on Plates 3 and 4.

At gross pool, the reservoir extends about 5 miles from the dam and has an area of 1,920 acres. The capacity of Lake Mendocino at gross pool was originally estimated at 122,500 acre-feet, but a more accurately developed area-capacity table has reduced it to 122,400 acre-feet. Area and capacity curves are presented in Exhibit A on Chart A-1, and a table of capacities is presented on Chart A-2.

The outlet works consists of a single reinforced concrete conduit with a steel liner approximately 720 feet long and 11'-10" in diameter. The post-tensioned reinforced concrete plenum chamber is used to turn the dam releases toward the powerhouse and the 108-inch fixed cone valve during the power generation mode. There are three pairs of 5' x 9' hydraulically operated slide gates in tandem located in a concrete control tower. One of each pair is a service gate and the other an emergency gate. Each service gate has a separate control and gates may be operated singly or in combination. There is one control for the emergency gates which are operated singly by valve manipulation. An auxiliary generator is provided to maintain hydraulic pressure in the event of a commercial power failure. Plan, profile and sections of the outlet works are shown on Plate 5 and outlet works rating curves are shown in Exhibit A on Chart A-3.

The spillway is located in a low saddle about 0.6 mile upstream from the left abutment of the dam. The spillway structure consists of a concrete rectangular weir, 200 feet wide with an ogee-shaped drop of 8 feet to a flip bucket. The trapezoidal approach channel is 200 feet wide and about 800 feet long. The crest is at elevation 764.8 MSL with the invert of the approach channel at elevation 764.0 feet MSL. Plan, profile and sections of the spillway are shown on Plate 6 and a spillway discharge rating curve is shown in Exhibit A on Chart A-4.

The Coyote Valley powerhouse and valve chamber building is located on the south side of the outlet channel. The outlet works contain a steel liner, plenum chamber and tainter valve. The plenum chamber has three separate exit conduits; one 11' x 16' exit used for flood control releases in excess of 4,000 cfs and leading to the existing outlet chute, one 9' x 22' exit, centerline elevation 631.5 MSL leading to the 108-inch fixed cone valve and one 6' x 12' exit, centerline elevation 641.0 MSL leading to the powerhouse. The powerhouse contains one 2,500 KW and one 1,000 KW turbine/generator units, and one 54-inch diameter fixed cone valve and one 18-inch diameter gate valve. An oxygen storage and distribution system is also included for environmental purposes. A general plan of the powerplant is shown on Plate 7.

2-04. RELATED CONTROL FACILITIES

Water has been diverted from the Eel River to the East Fork of the Russian River above Coyote Valley Dam for power generation purposes since 1909. This diversion, called the Potter Valley Project, has a maximum capacity of 350 cfs and maintains flow in the East Fork of the Russian River during the summer months when the river would otherwise be dry or nearly dry. The project consists of an upstream regulating reservoir on the Eel River, Lake Pillsbury, a diversion dam on the Eel River, Cape Horn Dam and a pipeline to the Potter Valley Powerhouse above Lake Mendocino. The diversion system is operated to produce hydroelectric power and to provide ground water accretion and irrigation water to the Potter Valley area with the remainder flowing into the East Fork of the Russian River and Lake Mendocino. It is operated by Pacific Gas and Electric Company and is not coordinated with the operation of Coyote Valley Dam. A tabulation of monthly releases from the Potter Valley Powerhouse is shown on Plate 8. The water diverted for irrigation is included in the figures.

2-05. REAL ESTATE ACQUISITION

Project lands comprise a total of 5,110 acres with 4,888 acres acquired in fee and 222 acres in flowage easement. A map of project boundaries is shown on Plate 9.

2-06. PUBLIC FACILITIES

An Interpretive-Cultural Center is located on a hillside overlooking Lake Mendocino. The center interprets the project environment, its natural and human history, and the Corps' role in water resource activities. The center includes a Pomo Indian education and culture section administered by the Mendo-Lake Pomo Council. The purpose of the Mendo-Lake Pomo Council participating in the center is to preserve and pass on to future generations the Pomo and other Native American cultures and interpret and present these cultures to the general public.

Lake Mendocino includes six developed recreation areas which provide opportunities for camping, boating, fishing, swimming, waterskiing, picnicking, sightseeing and interpretation. All recreational areas were given names in the language of the Pomo Indians. Table 1 on page II-3, presents a tabulation of recreational facilities and Plate 10 shows their location.

TABLE 1

RECREATION FACILITIES

AREA	CAMP UNITS	PICNIC UNITS	RESTROOM FACILITIES	POTABLE WATER	BOAT LAUNCHING LANES	PARKING (PAVED) CAR	PARKING (PAVED) CAR + TRAILER	PARKING (UNPAVED) CAR	CHILDREN'S PLAY AREA
Sho-da-Kai*									
Che-ka-Ka	23	10	Yes	Yes	6	36	75	20	
Pomo		110	Yes	Yes		200			Yes
Ky-en	103	18	Yes	Yes	6	100		40	Yes
Bu-shay	137	16	Yes	Yes		50			Yes
Bita	32		Yes	Yes				10	
Miti	19		Yes						

* no developed facilities

Recreational facilities at Lake Mendocino have primarily been developed by the Corps of Engineers with some facilities developed by the State of California and Mendocino County.

III - HISTORY OF PROJECT

3-01. AUTHORIZATION

The Lake Mendocino Project was authorized by Section 204 of the 1950 Flood Control Act (Public Law 516, 81st Congress, 2nd Session) and in accordance with the recommendation of the Chief of Engineers in House Document Number 585, 81st Congress, 2nd Session. The Flood Control Act, reads in part as follows:

> "The plan for flood-control, water conservation and related purposes, in the Russian River basin, California, is hereby approved substantially in accordance with the recommendations of the Board of Engineers for Rivers and Harbors dated April 22, 1949, and as recommended by the Chief of Engineers in his report dated November 15, 1949, and there is authorized to be appropriated the sum of $11,522,000 for the accomplishment of the initial stage of the plan: Provided, that Section 8 of the Flood Control Act of 1944 shall apply to this project; Provided further, that prior to starting construction, local interests shall contribute the sum of $5,598,000 in cash in full repayment of the conservation benefits: And provided further, that such contribution of $5,598,000 shall be transferred to the Secretary of the Army for application to the cost of construction of the project.

Public Law 404, approved February 10, 1956, authorized an additional $1,165,000 Federal appropriation toward the completion of the initial stage of the flood-control plan of the Russian River, California.

In March 1956, Sonoma County made the required cash contribution to the Secretary of the Interior, who transferred the full amount to the Secretary of the Army in accordance with the authorizing Act. In December 1956, Menocino County reimbursed Sonoma County the sum of $633,000 as its pro-rata share of the water conservation feature of the reservoir. Local interests through these cash contributions have paid in full for the water conservation benefits and, therefore, are not required to contribute toward the annual operation and maintenance costs of the reservoir.

3-02. PLANNING AND DESIGN

Planning and design of the Lake Mendocino Project was accomplished by the U. S. Army Corps of Engineers, San Francisco District and reviewed by authorities at higher levels including the office of the Chief of Engineers in Washington, D.C. The San Francisco District's studies considered single and multi-purpose reservoirs at several sites.

The original plan was presented in House Document Number 585, 81st Congress, 2nd Session. According to the House Document, the plan for flood control in the Russian River Basin consists of the following:

(1) A reservoir on the East Fork of the Russian River having a storage capacity of 122,000 acre-feet with provisions for enlargement to its ultimate capacity of 199,000 acre-feet.

(2) A reservoir on Dry Creek.

(3) Channel-stabilization works on the Russian River.

Studies and investigations subsequent to project authorization resulted in changes to the House Document Plan. The storage capacity was increased from 122,000 acre-feet to 122,500 acre-feet. This increase resulted from the analyses of sediment sampling data from the East Fork of the Russian River which indicated the need for a larger silt reservation. Location of the axis of the dam was shifted downstream about 0.5 miles for structural and design reasons. The spillway was relocated in a saddle about 0.6 mile upstream from the left abutment. This spillway location reduced the width from 410 feet to 200 feet and required a relatively inexpensive type of control structure. Initial studies estimated that 2,425 acres would be required for the reservoir project, however, further studies indicated that 5,110 acres would be required including flowage easements on 222 acres. Minimum flow for downstream recreational purposes was reduced from 200 cfs to 125 cfs by local interests.

3-03. CONSTRUCTION

Construction of Coyote Valley Dam and appurtenances began in July 1956 and was completed in January 1959. The total cost for the dam and reservoir was about $18,325,000.

Development of recreational facilities began immediately after the completion of the dam and was completed in 1975. Construction of the powerplant began in February 1984 with the completion scheduled in 1985. The start-up of commercial power operation is scheduled for 1985.

3-04. RELATED PROJECTS

The ultimate plan for the Russian River Basin includes a reservoir on Dry Creek and the enlargement of Coyote Valley Dam. Warm Springs Dam and Lake Sonoma, located on Dry Creek, has a capacity of 381,000 acre-feet with 130,000 acre-feet for flood control and 212,000 acre-feet for water conservation. The operation of Warm Springs Dam may effect the conservation operation of Coyote Dam but will have no effect on the flood control operation of the project. The operation of Warm Springs Dam is described in Appendix II to Master Water Control Manual Russian River Basin, California entitled "Warm Springs Dam and Lake Sonoma Dry Creek, California Water Control Manual" dated September 1984. When the need for additional water supply arises, Coyote Valley Dam will be raised 36 feet to its ultimate storage capacity of 199,000 acre-feet. According to the House Document, the additional storage will be utilized entirely for water conservation purposes.

Channel improvements were constructed as part of the initial phase of the total approved project at 91 locations along the Russian River from Healdsburg to Calpella. The improvements were turned over to local interests in Sonoma and Mendocino Counties for operation and maintenance.

3-05. MODIFICATIONS TO REGULATION

Yield studies for the authorizing document and the General Design Memorandum for Coyote Valley Dam utilized the flood control space for water supply between 1 April and 15 October. At the time of construction of Coyote Valley Dam, it was believed that the need for the use of the flood control space would not be required by water demand build-up until 1979. Recreation developments at elevation 750 feet MSL were constructed on the basis of this 1979 projected need for use of the space. Release of the flood control space to elevation 761.8 MSL feet would inundate several recreation facilities.

The use of the flood control space to elevation 761.8 feet MSL is permissive. However, Sonoma County Water Agency should demonstrate that the space is needed to supply present demands and will not result in needless storing of water which will have to be dumped prior to the flood control season.

3-06. PRINCIPAL REGULATION PROBLEMS

No major regulation problems exist at this time.

IV - WATERSHED CHARACTERISTICS

4-01. GENERAL CHARACTERISTICS

The Russian River drains an area of 1,485 square miles of the coast range mountains of California. Coyote Valley Dam will control flood runoff from 105 square miles of drainage area on the East Fork of the Russian River. The basin is about 100 miles long and varies from 12 to 32 miles in width. The gorges are rocky and have deep narrow channels. In the alluvial areas, the channel is relatively shallow and wide and meanders across the valley floor causing bank erosion.

The river flows in a southerly direction from its origin north of Ukiah. Major tributaries include the East Fork, Sulphur Creek, Maacama Creek, Dry Creek and Laguna de Santa Rosa. The Russian River flows through Redwood, Ukiah, Hopland and Alexander Valleys. After passing through these valleys, the river crosses the northwestern portion of the Santa Rosa Plains and enters a canyon through which it flows into the Pacific Ocean. The river traverses a total distance of 100 miles.

Channel capacities vary from 7,000 cfs near Ukiah to 35,000 cfs at Guerneville. The Laguna de Santa Rosa is a relatively large, flat area which has its outlet at the river near Mirabel Park. During heavy flows, the outlet from the Laguna has a large enough capacity to permit flow from the main river into the Laguna. The reverse is also true and as a result of this condition the Laguna de Santa Rosa acts as a natural storage basin. A General Map of the basin is presented on Plate 2.

4-02. TOPOGRAPHY

The Russian River drainage basin is essentially a narrow valley lying between two adjacent northern coastal mountain ranges. The mountains to the west of the basin, the Mendocino Range, vary from 1,500 to 3,000 feet MSL. The eastern border of the basin is formed by the Mayacamas Mountains ranging from 3,000 to 4,000 feet MSL. The highest point in the basin is Cobb Mountain with an elevation of 4,480 feet MSL. The distribution of area according to elevation for the basin above Coyote Valley Dam is presented in Table 2.

TABLE 2

AREA DISTRIBUTION BY ELEVATION
RUSSIAN RIVER BASIN ABOVE COYOTE VALLEY DAM

Elevation Range (feet)	Percent of Area
500-1,000	20
1,000-2,000	54
2,000-3,000	21
3,000-4,000	5

A topographic map of the Russian River Basin is presented on Plate 11. Stream profiles of the Russian River are shown on Plate 12.

4-03. GEOLOGY, SOILS AND VEGETATION

The geology of the Russian River Basin is characterized by rocks belonging to the Franciscan-Knoxville Group commonly called Franciscan formation. This formation is composed of conglomerate, graywacke and other impure sandstone, shale, schist and chert. The formation is severely weathered and overlain with deep overburden. Land slides are common. The valley fill of the Ukiah Valley comprises gravelly to sandy sediments that were derived from the erosion of the Ukiah Beds and predominately are blue, clayey, sandy gravels and have the characteristic structure of stream deposition.

The San Andreas Fault is located about 40 miles west of the Russian River. At least two other faults are recognized in the Ukiah region. The Vichy Fault is located about 2 miles east of Ukiah and the Ukiah Fault lies along the east side of the Russian River north of Hopland.

Soils in the valley areas are deep and fertile. They are formed from recent alluvium deposited by the existing streams. Clays, clayey sands and sandy clays are found in the eastern and southeastern portions of the reservoir area. Soils over hard formations are usually shallow and have frequent rock outcrops. The soil in a large part of the Santa Rosa plains is a heavy clay adobe.

The Russian River Basin consists mainly of mountains and hilly areas and is moderately to heavily wooded. Considerable forest and dense chaparrel areas have been burned over in the recent past. Much of the burning was intentional, being done to convert additional areas to a type of vegetation suitable for grazing. Grasslands consist mainly of annual grasses and weeds originally foreign to the basin. Most of the original perennial grasses have died out. Chaparral type growth includes chamise, manizanita, clawothus and other similar plants. Forest areas are made up of oaks, madrone, laurel, redwood and douglas fir. Principal crops grown at the present time are wine grapes and orchard crops. Distribution of vegetation in the basin is presented in Table 3.

TABLE 3

DISTRIBUTION OF VEGETATION
RUSSIAN RIVER BASIN

Description	Percent of Area
Cultivated or urban	15
Grassland-woodland mix	40
Chaparral	20
Forest	25

4-04. SEDIMENT

Provision is made for reserving 4,500 acre-feet of storage in Coyote Valley Dam for sedimentation during the adopted economic 50-year life of the project. This reservation was based on an average of 90 acre-feet per year as derived from the results of a sediment sampling station established in December 1952, just above the damsite by the United States Geological Survey. Suspended sediment data is presented in Table 4 and suspended sediment discharge is presented in Table 5 on page IV-4.

TABLE 4

SUSPENDED SEDIMENT
RUSSIAN RIVER BASIN

Station	Range of Discharges Surveyed (cfs)	Clay		Silt		Sand	
		Range %	Average %	Range %	Average %	Range %	Average %
Potter Valley Powerhouse 1/	82-312	57-92	69	8-33	26	0-10	5
East Fork 2/ Russian River Near Calpella	85-2,440	40-87	62	10-52	30	3-18	8
East Fork 3/ Russian River Near Ukiah	16-1,960	67-94	82	4-33	17	0-2	1
Russian River Near Ukiah	290-9,600	21-77	38	23-59	45	0-42	16
Russian River Near Cloverdale	744-26,500	24-56	38	29-52	39	3-47	23
Russian River Near Guerneville	89-23,600	27-79	41	21-61	46	0-33	12

1/ Total flow diverted from Eel River Basin.
2/ Included flow diverted from Eel River Basin.
3/ Outflow from Coyote Valley Dam.

TABLE 5

SUSPENDED SEDIMENT DISCHARGE
EAST FORK RUSSIAN RIVER

Station	Water Year	Water Discharge (acre-feet)	Suspended Sediment Discharge (tons)
Potter Valley	1965	188,900	38,260
Powerhouse	1966	179,700	15,080
	1967	220,900	21,140
	1968	159,400	15,500
East Fork	1965	329,000	392,000
Russian River	1966	240,500	77,000
Near Calpella	1967	320,100	84,000
	1968	210,100	33,200
East Fork	1965	290,000	109,800
Russian River	1966	233,800	15,060
Near Ukiah	1967	296,100	16,800
	1968	211,100	7,420

4-05. CLIMATE

The climate of the Russian River basin is mild with warm dry summers and cool, wet winters. The proximity of the basin to the Pacific Ocean helps temper the climate. Temperatures at Ukiah normally range from a winter low of about 24° F to a summer high of about 105° F. Normal monthly temperatures for selected stations in the basin are presented in Table 6 on page IV-5. Location of stations are shown on Plate 13.

Normal annual precipitation (NAP) for the watershed above Coyote Valley Dam is about 42.5 inches and ranges from about 39 inches at Coyote Valley Dam to nearly 50 inches in the upper basin. Annual precipitation at Coyote Valley Dam can amount to less than 15 inches in dry years and over 48 inches in wet years. Isohyetal lines of NAP over the basin are shown on Plate 13.

Approximately 90 percent of the annual precipitation occurs from November through April. Winter storms originate over the Pacific Ocean and are associated with frontal systems containing masses of moist air moving inland against mountain barriers. Snow falls infrequently during the winter.

Average monthly precipitation for selected stations are shown on Table 7 on page IV-5.

TABLE 6

TEMPERATURE DATA FOR SELECTED STATIONS

Month	Normal Monthly Temperature (in degrees F) Ukiah (Elevation 623')	Normal Monthly Temperature (in degrees F) Potter Valley Powerhouse (Elevation 1,015')
January	46.0	44.7
February	49.8	48.3
March	51.7	50.4
April	56.1	54.8
May	61.6	60.7
June	67.6	67.1
July	73.7	73.6
August	72.7	72.4
September	69.7	69.0
October	61.5	60.7
November	52.7	51.5
December	47.0	45.7
Annual	59.2	58.2

Source: NOAA, 1941-1970.

TABLE 7

PRECIPITATION DATA FOR SELECTED STATIONS

Month	Average Monthly Precipitation					
	Coyote Valley Dam (Elevation 670')		Potter Valley Powerhouse (Elevation 1,015')		Willits Howard R.S. (Elevation 1,350')	
	Inches	%	Inches	%	Inches	%
July	0.07	0.2	0.05	0.1	0.09	0.2
August	0.27	0.7	0.20	0.4	0.21	0.4
September	0.43	1.1	0.47	1.0	0.69	1.4
October	2.36	6.1	2.84	6.2	3.18	6.6
November	6.38	16.5	6.11	13.4	6.70	14.0
December	7.20	18.6	9.25	20.3	9.65	20.1
January	9.25	24.0	10.24	22.4	9.10	19.1
February	4.80	12.4	6.47	14.2	6.98	14.6
March	4.59	11.9	5.08	11.2	6.38	13.3
April	2.47	6.4	3.07	6.7	3.09	6.4
May	0.60	1.6	1.39	3.0	1.47	3.1
June	0.20	0.5	0.49	1.1	0.40	0.8
Annual	38.62	100	45.66	100	47.94	100
November-April	34.69	89.8	40.22	88.2	41.90	87.5

Basin Annual 42.5 Inches

Historical monthly evaporation data for Lake Mendocino is presented in Table 8.

TABLE 8

**HISTORICAL MONTHLY EVAPORATION
LAKE MENDOCINO**

Month	**Evaporation Inches**	
	Mean	**Standard Deviation**
January	1.05	.34
February	1.23	.24
March	2.14	.42
April	3.33	.70
May	5.09	.62
June	7.11	.65
July	8.43	.65
August	7.62	.74
September	6.87	.64
October	4.26	.63
November	1.81	.39
December	1.00	.26
Total	49.94	

Period: 1960-1982

Total wind movement at Lake Mendocino is measured and recorded daily. Average monthly wind movement at the dam is presented in Table 9.

TABLE 9

**HISTORICAL MONTHLY WIND MOVEMENT
LAKE MENDOCINO**

Month	**Wind Movement, Miles**	
	Mean	**Standard Deviation**
January	764	285
February	884	232
March	1,158	335
April	1,307	215
May	1,396	194
June	1,566	285
July	1,437	320
August	1,436	340
September	1,273	297
October	979	279
November	783	252
December	761	317

Period: 1960-1981

4-06. STORMS AND FLOODS

Floods occur during the rainfall season from November through April. Normally, floods are flashy since concentration times on tributaries are short and streamflows respond rapidly to rainfall. Concentration times vary from less than 4 hours on the smaller tributaries to about 36 hours at Guerneville. The Laguna de Santa Rosa acts as a large storage basin and actually reduces peak discharges below Mirabel Park. During major floods, the Russian River can inundate practically the entire area of level land in the valley along the river.

Stream-gaging records in the Russian River date from 1940. Data on file in newspaper offices and interviews with long time residents of the area disclosed that floods occurred in 1861-1862, 1867, 1871, 1878, 1879, 1881, 1885, 1889, 1890, 1893, 1895, 1924, 1925, 1926, 1931, 1935, and 1936. The greatest of these probably was the 1861-1862 flood. There is no recorded data to estimate the magnitude of these early floods. Historical floodflows since 1940 are presented in Table 10 on page IV-8.

The 1955 flood and the 1964 flood are considered two of the greatest floods of record. In 1955, most streams in the basin experienced two major rises, the second being the highest and responsible for the resulting devastation. In 1964, however, only minor rises preceded the record peaks. During the 1964 flood, Coyote Valley Dam spilled for the first time.

The main damage from these floods was to agricultural property. Riverbank erosion washed away many local bank-protection works and many acres of highly developed farm cropland. Huge log-jams from accumulated orchard trimmings and timber cuttings jammed the bridges crossing many streams, with resulting failure and washout in several cases. Many residental and commercial areas were hard hit, with homes, sawmills and wineries bearing the brunt of the major physical damage. The lower basin is devoted primarily to summer homes and resort property which is located immediately adjacent to the river. It was in these areas that the overflow of the river ravaged the residential and resort areas, inundating homes and resorts.

4-07. RUNOFF CHARACTERISTICS

Approximately 90 percent of the natural runoff in the basin occurs from November through April. Runoff during the months of July to October is negligible, with most of the streams being dry during the greater part of that time. The diversion of water from the Eel River through the Potter Valley Powerhouse maintains the flow in the East Fork and the Russian River below the East Fork during the summer months. Monthly inflows to Lake Mendocino are presented on Plate 14. Potter Valley Powerhouse monthly releases are presented on Plate 8.

The basin responds rapidly to variations in rainfall, thus resulting in flashy floods. Selected recorded runoff data are presented in Table 11 on page IV-9.

TABLE 10

HISTORICAL FLOODFLOWS

Flood	Peak Flow cfs				
	East Fork Russian River Near Calpella	East Fork Russian River Near Ukiah	Russian River Near Hopland	Russian River Near Healdsburg	Russian River Near Guerneville
February - March 1940	(a)	(a)	34,100	67,000	88,400
January 1943	11,200	(a)	34,000	53,300	69,200
December 1945	10,200	(a)	30,100	41,800	56,800
November - December 1950	10,700	(a)	31,200	42,800	53,600
January 1954	10,500	10,300	27,400	53,700	59,900
December 1955	13,300	13,600	45,000	65,400	90,100
February 1958	11,600	4,300	32,300	50,900	68,700
February 1960	(b) 9,160	(a)	22,500	36,100	63,100
January - February 1963	7,940	(a)	21,200	41,800	71,800
December 1964	18,700	6,780	41,500	71,300	93,400
January 1966	9,890	3,200	27,100	49,400	77,000
January 1970	12,400	7,350	27,800	53,500	72,900
January 1974	12,200	6,320	39,700	64,700	74,000
January 1980	10,900	4,740	23,500	39,400	59,700

(a) Station not in operation.
(b) Flows since 1959 reflect operation of Coyote Valley Dam.

TABLE 11

RECORDED RUNOFF DATA

	East Fork Russian River Near Ukiah	West Fork Russian River Near Ukiah	Russian River Near Hopland	Russian River Near Guerneville
Period-of-Record	1952-1982	1953-1982	1940-1982	1940-1982
Drainage Area (sq mi)	105	100	362	1,338
Peak Flow (cfs)	13,600 (Dec 1955)	18,900 (Dec 1955)	45,000 (Dec 1955)	93,400 (Dec 1964)
Average Discharge (cfs)	355	177	722	2,308
Peak Flow (csm)	129	189	124	70
Mean Daily Flow (csm)	3.4	1.6	2.0	1.7
Annual Flow (acre-feet)				
Maximum	381,100 (1958)	265,000 (1956)	967,000 (1958)	3,448,000 (1958)
Minimum	74,700 (1977)	4,200 (1977)	68,000 (1977)	64,200 (1977)
Mean	258,400	128,200	523,100	1,672,000
Annual Flow (inches)				
Maximum	68.1	49.7	50.1	48.3
Minimum	13.3	0.8	3.5	0.9
Mean	46.2	24.0	27.1	23.4

4-08. WATER QUALITY

Lake Mendocino is typical of Northern California reservoirs thermally, becoming isothermal in the winter months and developing strong stratification in the low inflow summer months. Oxygen levels generally follow the same pattern with anoxic conditions developing near the bottom of the reservoir in the late summer. The anoxic conditions that persist in the reservoir in the late summer have had little effect on the quality of reservoir releases.

Since there is no multi-level outlet capability at the project all releases are made through the low-level flood control outlet. Low flows released through the conduit re-generate in the tunnel and in the stilling basin. Odor problems related to hydrogen sulfide formation are confined to the stilling basin area. The release of colder bottom waters during the summer has created a good summer habitat area for cold water fish.

Turbidity has traditionally been the main water quality problem associated with the Lake Mendocino Project. The lake generally becomes turbid with the first heavy runoff of the year and remains turbid until early summer. The persistent turbidity problem associated with the project is the result of water diverted from the Eel River. This water transports a high percentage of very fine sediment that settles out of the water column very slowly. Since Lake Mendocino has a relatively short residence time much of this material never settles out in the reservoir.

The presence of poly-chlorinated biphenols (PCB) is another water quality problem at the project. The source of this material is unknown but it may originate at the Potter Valley Powerhouse as the material is used to stabilize the operating temperatures of electrical equipment. A summary of data obtained from the water quality testing program is presented in Table 12 on page IV-11.

4-09. CHANNEL AND FLOODWAY CHARACTERISTICS

The Russian River flows through a series of broad alluvial valleys connected by steep rocky canyons. Channel capacities in the broad valleys are relatively low and overbank flow occurs in most years. Channel capacities in the canyon areas are larger and flooding occurs less frequently. The map on Plate 15 shows the areas which are susceptible to flooding. Channel capacities for various reaches are presented in Table 13.

TABLE 13

RUSSIAN RIVER CHANNEL CAPACITIES

Location	Bankful Capacity cfs
Ukiah Valley	7,000
Hopland Valley	8,000
Guerneville	35,000

Channel improvement works were constructed during the period from 1956 through the early 1970's and have been turned over to local interests in Sonoma and Mendocino Counties for operation and maintenance. Channel stabilization works constructed included channel clearing and pilot channels, bank protection works consisting of anchored steel jacks in single and multiple rows, flexible fence training structures, wire mesh-gravel revetements and pervious erosion check dams. The type of protection works installed at a specific site was based on field conditions. The anchored steel jacks and flexible fencing were used to prevent banks from undercutting. A gravel blanket revetment, overlain by wire mesh, was used at locations where it was desirable to maintain the existing bank alignment with more rigid control. Pervious erosion control check dams were installed at

TABLE 12

LAKE MENDOCINO
WATER QUALITY SAMPLING PROGRAM
SUMMARY OF TEST RESULTS

	East Fork Russian River Near Calpella		East Fork Russian River Near Ukiah		Standard
	Maximum	Minimum	Maximum	Minimum	
Temperature,°C	29	2	24	7	
Specific Conductance, UMHOS	374	87	271	101	90% < 320 1/
PH	8.5	6.8	8.4	6.9	6.5-8.5 1/
Turbidity, JTU	340	1	150	1	- -
Dissolved Oxygen, mg/l	11.6	8.8	14.3	7.7	7.0 1/
Dissolved Nitrate, mg/L	.16	0	.24	0	1.5 1/
Total Nitrogen, mg/l	1.0	.08	1.1	.03	- -
Total Phosphorus, mg/l	.22	.02	.43	0	- -
Total Dissolved Orthophosphate, mg/l	.37	0	.18	.01	.06 1/
Boron, mg/l	2.2	.2	1.4	.1	.75 2/
Arsenic, g/l	1.7	.1	2.1	.1	50 3/
Mercury, g/l	2.7	.1	2.3	.1	2 3/
Lead, g/l	190	1	190	2	50 3/
Zinc, g/l	30	10	30	3	5,000 3/
Copper, g/l	60	10	60	10	1,000 3/
Cadmium, g/l	.5	.3	.6	.3	10 3/
Chromium, g/l	11	1	10	1	50 3/
PCB, g/l	.24	0	.18	.015	.001 3/

1/ State of California North Coast Regional Water Quality Control Board.
2/ Irrigation Water Standard, for long-term use.
3/ EPA drinking water standards.

various points to control sheet erosion. All of these works tend to stabilize stream flow and to reduce the tendency of the stream to meander.

To minimize bank sloughing and erosion, release changes from Coyote Valley Dam are limited to 1,000 cfs per hour. Reach lengths and flood wave travel times are presented in Table 14.

TABLE 14

REACH LENGTHS AND FLOOD WAVE TRAVEL TIMES

	Length	Travel Time, Hours								
		Discharge cfs								
	Miles	400	1,000	2,000	4,000	6,000	8,000	10,000	20,000	40,000
Forks of the Russian River to Hopland	14	11	9	7.5	6.5	6	6	5.5	5	4.5
Hopland to Cloverdale	16	12.5	9	7	5.5	5	4.5	4	3	2.5
Cloverdale to Healdsburg	28	18.5	13	10.5	9.5	8.5	8	7.5	6.5	6
Healdsburg to Guerneville	16	43	31	26	21	19	18	16.5	14	13

Note: These travel times are approximate.

4-10. UPSTREAM STRUCTURES

See Section 2-04 for a discussion of upstream structures.

4-11. DOWNSTREAM STRUCTURES

During the summer recreational season, 8 small dams and summer road crossings are constructed on the Russian River. Many of these structures impound water for recreation uses. During the middle of May for about one week releases from Lake Mendocino are reduced to the minimum level possible to allow for construction of these summer impoundments. After the impoundments are full the flow past Guerneville should be kept below 400 cfs if possible to avoid exceeding the impoundments capacities. A map showing the approximate location of the summer impoundments is presented on Plate 2.

4-12. ECONOMIC DATA

The most important resource of the basin is its agricultural lands. The production of truck, field and orchard crops, and the raising of sheep, cattle and poultry comprise the principal agricultural activities in the basin. The favorable combination of mild climate and scenic surroundings form an important recreational resources. Minerals are produced commercially but not in such quantity to be of major importance. General business activity exists largely in the fields of distribution and service.

The population of the Russian River basin has increased markedly in recent years and all indications are that such increases will continue. Populations for selected areas in the basin are shown in Table 15.

TABLE 15

RUSSIAN RIVER BASIN
POPULATION

Region	Population			
	1950	1960	1970	1980
Mendocino County	41,000	51,000	59,000	67,000
Sonoma County	103,000	147,000	205,000	292,000
Russian River Basin	65,000	118,000	181,000	226,000
Communities:				
Ukiah	6,100	9,900	10,000	12,000
Cloverdale	1,300	2,800	3,200	4,000
Healdsburg	3,300	4,800	5,400	7,200
Sebastapol	2,600	2,700	3,800	5,500
Santa Rosa	18,000	31,000	48,500	83,200

The Russian River basin is primarily an agricultural area with emphasis placed on orchards and vineyards. The basin is one of the most important wine-grape growing centers of the United States, with vineyards located all along the river valleys. The major industries include wineries and other establishments for the processing of fruit.

Damages caused by major floods usually consist of residential and commercial property damages, agricultural damages and damages to public and transportation facilities. Estimated damages caused by the 1955 flood, the 1964 flood and the 1974 flood are presented in Table 16.

TABLE 16

SUMMARY OF FLOOD DAMAGES
RUSSIAN RIVER BASIN

Flood	Estimated Damage
December 1955	$5,017,200 1/
December 1964	$30,301,000 2/
January 1974	$5,050,000 3/

1/ 1956 Prices, without Coyote Valley Dam.

2/ 1972 Prices, with Coyote Valley Dam.

3/ 1974 Prices, with Coyote Valley Dam.

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. HYDROMETEOROLOGICAL STATIONS

Hydrometeorological information at Lake Mendocino and elsewhere in the basin is monitored through the Hydrologic Automatic Data Acquisition (HADA) system. The Lake Mendocino project office automatically receives precipitation reports, project release data and reservoir stages. It also automatically receives streamflow data from the Hopland gaging station and the Ukiah gaging station. Temperature, wind, evaporation, precipitation and Redwood Valley pumping data at the project must be entered into the subcentral station memory manually with thumb wheels. Data in the Lake Mendocino subcentral station memory can be interrogated by the central station (HADA system) in the Sacramento District Reservoir Control Section office. Normally, the precipitation gages and streamflow gages automatically report every 15 minutes.

The facilities at the project include:

a. A recording float-type water level detector capable of recording pool levels up to the spillway design pool level, supplemented by an electric tape and permanent staff gages.

b. A float-operated digital recording outflow stream gage with inclusive shaft encoder operated data transmission to the project office from just below the dam, supplemented with visual staff gage.

c. Recording streamflow stations on the Russian River at Ukiah and Hopland with visual staff gages.

d. A weather station at the dam consisting of:

1. Recording and non-recording precipitation gages.

2. A wind station recording total wind travel in miles.

3. A weather bureau Class-A evaporation pan with anemometer.

4. A recording hygrothermograph with maximum and minimum thermometers.

In addition to the project gages, the California Department of Water Resources operates a recording, radio-reporting, on-call streamflow gage at Hopland and precipitation gage at Willits. The gages are monitored directly by the State Flood Operations Unit in Sacramento, and the information is available to the Corps of Engineers via telephone and computerized teletype.

Hydrologic and meteorologic data are recorded and published for many sites throughout the Russian River basin as shown on Plates 11 and 13.

5-02. WATER QUALITY STATIONS

The present water-quality monitoring program at Lake Mendocino consists of sampling stations at the inlet to and outlet from the reservoir and one station within the reservoir. Samples are collected according to the following schedule:

(1) Corps of Engineers personnel monitor pH, conductivity, temperature, dissolved oxygen and turbidity twice per month at the East Fork Russian River near Ukiah and East Fork Russian River near Calpella stream - gaging stations. These data are published by the U.S. Geological Survey (USGS). Twice-a-year monitoring is also done for trace elements, general chemical, and nutrients at these stations. Additionally, the Capella station is monitored for biocides, herbicides, and PCB's.

(2) At the Lake Mendocino monitoring station, two vertical profiles are taken by the Corps during each fiscal year for dissolved oxygen, pH, temperature, conductivity and turbidity. While the profiles are being taken, water samples are collected at depths of 5 feet and from near the lake bottom. The samples from the lake are analyzed for trace elements, general chemicals, and nutrients.

5-03. SEDIMENT STATIONS

Twenty sedimentation ranges have been established within Lake Mendocino as shown on Plate 16. In addition, 5 range lines have been established along the East Fork Russian River and the Russian River to monitor degradation of the stream channel below the dam. Since completion of the dam the range lines below the dam have been surveyed 3 times and the reservoir range lines once. From the reservoir survey, conducted in 1975, it appears that reservoir sedimentation rates very closely approximate the rate predicted before the dam was completed. The U.S. Geological Survey maintains three sediment sampling stations in the Russian River Basin: Pena Creek near Geyserville, Dry Creek near Geyserville and Russian River near Guerneville. The results of the sediment sampling are published in the U.S. Geological Survey Water-Data Reports.

5-04. RECORDING HYDROLOGIC DATA

Continuous records consisting of hydrologic data at Lake Mendocino are kept by the Corps of Engineers District office in Sacramento. Outflows and storages for the project are published by the U.S. Geological Survey from the Corps records. Continuous streamflow measurements at several locations throughout the Russian River watershed are recorded and published by the U.S. Geological Survey. Locations of several stations are shown on Plate 11.

5-05. COMMUNICATION NETWORK

Voice communication between the Sacramento office and the project office is either by radio or telephone. The radios in both offices have backup power from standby generators.

The central station of the Hydrologic Automatic Data Acquisition System (HADA) in Sacramento can interrogate the subcentral station at the project by radio or telephone. The central and subcentral stations have backup power from batteries and standby generators.

The stream gaging stations at Ukiah and Hopland report to the subcentral station by radio only. The reservoir stage, outflow gage and precipitation recorder are hard wired to the HADA system.

5-06. COMMUNICATION WITH PROJECT

Oral communications between the project and the Corps of Engineers District office in Sacramento is accomplished by radio or telephone.

Radio reporting project gages are linked to the project office. These gages automatically report at regular intervals.

5-07. PROJECT REPORTING INSTRUCTIONS

During flood operations, reports are made as required by the Reservoir Control Section. Project personnel should report any unusual or unpredicted events or data that may effect operations at the project as soon as possible. Important phone numbers and key operating personnel are shown on page iii located in the front of this manual.

5-08. WARNINGS

The Corps of Engineers, Sacramento District maintains contact with the local district office of the National Weather Service (NWS) at all times concerning general meteorological conditions. Some weather sequences are reported daily and others are reported on six-hour or hourly periods. General forecasts are made twice a day regularly and all pertinent information is made available to the Corps offices. Quantative rainfall forecasts are issued by the NWS office in Sacramento for the Russian River basin. The Joint Federal-State River Forecast Center, which monitors weather conditions and river stages on a year-round basis, provides flood flow and stage forecasts for points along the Russian River. During floods, this center operates on a 24-hour basis and, among other flood emergency activities, advises all interested parties of flood situations as they develop. The center furnishes flood warnings and forecasts and river stages including the Russian River to the local news media, law enforcement agencies, and other responsible agencies for their use and for dissemination to the public. The Sonoma County Water Agency also makes flood flow and stage forecasts for the Russian River.

Sonoma County has a plan for evacuating flood plain areas along the Russian River and its tributaries if required by emergency situations. The California Department of Water Resources, through the Flood Operations Center, coordinates flood fighting activities throughout the State and is authorized to receive requests from local public agencies for assistance during floods. The Corps of Engineers responds to requests for flood fighting and rescue work from the California Office of Emergency Services (OES) when the emergency is beyond the capabilities of state and local governmental agencies.

Pursuant to the provisions of Section 8589.5, Government code of California, emergency procedures must be established for the evacuation and control of areas of potential flooding in the event of sudden failure of a dam. The Corps of Engineers has complied by preparing a map showing areas that would be inundated by failure of Coyote Valley Dam. On the basis of the map, the OES in cooperation with the California Department of Water Resources will designate evacuation areas. The local jurisdiction must then adopt emergency procedures that include, among other things, specific routes to be used for evacuation; traffic control measures, movement of people without their own transportation; shelter of evacuees; evacuation and care of people from institutions; and perimeter security, interior security, and reoccupation of evacuation areas.

VI - HYDROLOGIC FORECASTS

6-01. GENERAL

Detailed forecasts of inflow to Lake Mendocino are not made based on precipitation because of the short time period between rainfall and resultant flow. Rainfall on the Russian River basin does serve as an indication of local runoff potential. Flood stage predictions based on precipitation and upstream flow are made for the Russian River at several key locations by the joint Federal-State River Forecast Center located in Sacramento; however, these predictions are not used in determining flood control releases. Quantitative Precipitation Forecasts (QPF) are used to indicate the potential for future local flow.

6-02. FLOOD CONDITION FORECASTS

Current inflows to Lake Mendocino are estimated from outflows plus the change in storage for the time period immediately preceeding the current one, taking into account an estimated rate of change of inflows. Time requirements for determining reservoir inflow, reservoir outflow and predicting downstream flooding require computational intervals of two hours or less.

The predicted rainfall data from the National Weather Service (NWS) is transmitted to Sacramento District in a format known as the Quantitative Precipitation Forecast (QPF). The QPF is for succeeding 24-hour periods and is broken down into 6-hour increments. When the QPF is 1 inch or more for the next 24 hours or 0.5 inches or more in any 6-hour period, releases will be limited to 2,000 cfs or less.

Predictions of warning and flood stages on the Russian River are computed by the joint Federal-State River Forecast Center using a hydrologic computer model of the basin and are relayed to the Sacramento District via computer terminal. Predicted stages and times of occurrence of flood peaks are prepared for Hopland, Healdsburg and Guerneville.

The California Department of Water Resources operates a precipitation gage at Willets. The information is available to the Sacramento District via computer terminal. The precipitation at Willets gives a good indication of how much rain is coming.

6-03. CONSERVATION PURPOSE FORECASTS

Sonoma County Water Agency (SCWA) is the owner of the conservation pool and has sole jurisdiction of its use. Consequently, forecast determinations based on availability and demand are the responsibility of the SCWA.

6-04. LONG RANGE FORECASTS

Long range forecasting for flood control is not a consideration because of the short duration of storm events and because there is no significant snow in the basin. Long range forecasting for conservation purposes is the responsibility of the Sonoma County Water Agency.

VII - WATER CONTROL PLAN

7-01. GENERAL OBJECTIVES

The Lake Mendocino Project is a multipurpose development with the objectives of providing a high degree of flood protection to areas below Coyote Valley Dam and supplying water needs for domestic, industrial and agricultural uses. Recreation, hydroelectric power generation and downstream fishery enhancement are also provided by the project.

7-02. MAJOR CONSTRAINTS

Releases from Coyote Valley Dam insofar as possible, will be restricted so that the flow at Hopland does not exceed 8,000 cfs. Local flooding at Hopland begins when flows exceed 8,000 cfs. Sloughing is more likely to occur when channel flows decrease rapidly; therefore, rates of changes in releases from Coyote Valley Dam are limited to 1,000 cfs per hour.

7-03. OVERALL PLAN FOR WATER CONTROL

The Coyote Valley Dam and Lake Mendocino Project is operated for flood control and water conservation to meet the following objectives:

(a) to prevent flood flows on the East Fork Russian River from contributing to overbank flood stages on the Russian River below Coyote Valley Dam, insofar as possible;

(b) to provide the maximum amount of water conservation storage without impairment of the flood control functions of the reservoir;

(c) to maintain a minimum continuous flow of 25 cfs immediately below Coyote Valley Dam;

(d) to maintain discharge of 150 cfs or inflow to the reservoir, whichever results in the lower reservoir release at the junction between the east and west forks of the Russian River;

(e) to maintain a minimum discharge of 125 cfs at the Russian River near Guerneville.

7-04. STANDING INSTRUCTIONS TO DAMTENDER

During normal flood periods, the reservoir will be operated in accordance with normal regulations for flood control cited in paragraph 7-05a and Exhibit A of this manual. Exhibit A is designed to function as a separate, complete document for sole use as a guide for flood control operation. Charts required for normal and emergency flood control operation are provided therein.

Instructions for storage and release of floodwaters in the flood control space will be issued by personnel of the Reservoir Control Section, Sacramento District, Corps of Engineers. In the event communications with the Sacramento District offices are disrupted, the reservoir shall be operated in accordance with the emergency regulation for flood control operation in paragraph 7-05b.

7-05. FLOOD CONTROL

a. **Normal Regulation for Flood Control.** Flood control regulation begins when storage in Coyote Valley Dam exceeds the flood control space required at any particular time as determined from the Flood Control Diagram located in Exhibit A. The flood control diagram is the basic project document regarding operation for flood control. This diagram is the result of careful analysis of flood frequency, seasonal flood potential and downstream channel capacities consistent with project objectives and operating experience gained during the last 25 years. The diagram requires:

(1) 50,000 acre-feet of flood control reservation, including sediment reservation, from 15 October to 31 March with allowable encroachment into flood control space beginning on 1 March if there is a need for the water and the Corps of Engineers determines the flood control functions of the project will not be impaired.

(2) 31,400 acre-feet of flood control reservation, including sediment reservation, beginning as early as 1 April and uniformly increasing beginning 5 October to a flood control reservation of 50,000 acre-feet including sediment reservation, on 15 October.

Normally, the summer pool elevation will be kept at elevation 748 feet MSL to maximize recreational opportunities at the reservoir.

When the reservoir pool elevation is below 764.8 MSL feet, flood control releases are made in accordance with the release schedule stated on the Flood Control Diagram. During floods in which flow over the spillway occurs, flood control releases are made in accordance with the emergency release schedule stated on the Flood Control Diagram. Water stored in the flood control space will be released as rapidly as downstream conditions permit.

b. **Emergency Regulation.** If communications with the project are disrupted the following procedures will be followed for project operation:

(1) Continue releases in accordance with the last instructions from the Reservoir Control Section, and make every attempt to re-establish communication.

(2) If communication cannot be re-established, make releases in accordance with the release schedule and if necessary the emergency release schedule on the Flood Control Diagram.

When the diagram indicates that emergency releases should be initiated, it is essential that these releases should be made immediately and that subsequent changes in releases be made as soon as indicated.

7-06. RECREATION

During the summer recreational season, 8 small dams and summer road crossings are constructed on the Russian River. Many of these structures impound water for recreation use. During the middle of May for about one week, releases from Lake Mendocino are reduced to the minimum level possible to allow for construction of these summer impoundments. After the impoundments are full the flow past Guerneville should be kept below 400 cfs if possible to avoid exceeding the impoundment capacities.

7-07. WATER QUALITY

The water quality monitoring program at Coyote Valley Dam continually evaluates the water quality at the project. The monitoring program consists of sampling stations at the inlet to and outlet from the reservoir and one station within the reservoir. With the exception of turbidity, water quality in the Russian River basin is generally good and no specific project operation is required to enhance water quality.

7-08. FISH AND WILDLIFE

The Sonoma County Water Agency entered into an agreement with the State Department of Fish and Game dated August 21, 1959 (Exhibit C), regarding the operation of Coyote Valley Dam. The agreement requires the following:

(1) a minimum flow of 125 cfs through Guerneville.

(2) a minimum flow at the junction of the East Fork and the Russian River of 150 cfs or inflow into Lake Mendocino, whichever is less except that the minimum release from Coyote Valley Dam will be 25 cfs at all times.

7-09. WATER SUPPLY

A proposed plan of operation dated August 4, 1955 was submitted to the Corps of Engineers on August 16, 1955 and approved with minor amendments on November 21, 1955. Under this agreement the Sonoma County Water Agency (SCWA) controls all releases from water supply storage. The SCWA paid cash to the United States Government at the outset of the Coyote Valley Dam Project and has no continuing financial responsibility for any project costs.

Lake Mendocino has a water supply pool of 70,000 acre-feet. Of this storage, 8,000 acre-feet of water was purchased from the SCWA by the Mendocino County Russian River Flood Control and Water Conservation Improvement District; the remaining 62,000 acre-feet being retained by the SCWA. In addition, the SCWA is permitted to encroach into the 48,000 acre-feet flood control pool during late spring and summer.

Order WR 79-15 permits diversion and use in Redwood Valley of 4,000 acre-feet of water annually from Lake Mendocino under the Mendocino County Russian River Flood Control and Water Conservation Improvement District's Permit 12947B. In response to a request from the Redwood Valley County Water District, the SCWA has petitioned the State Water Resources Control Board to add the service area of the Redwood Valley County Water District to the place of use under the SCWA's Permit 12947A. Granting of the SCWA's petitions would allow negotiation of an agreement with Redwood Valley for a firm future water supply of up to 7500 acre-feet annually from Lake Mendocino for municipal, industrial and agricultural use.

Municipal water diversions are concentrated in the Ukiah area and the area between Healdsburg and the confluence of the Laguna de Santa Rosa. SCWA diverts municipal water at its pumping stations in the vicinity of Wohler Bridge below Healdsburg. Diversions take place in all months of the year reaching a maximum in late summer. Travel time from Coyote Valley Dam to Wohler Bridge in the summer months can exceed 5 days thus, considerable foresight in making releases is required if minimum required flows at Guerneville, 75 miles below the dam, are to be maintained.

Present agricultural use of the Russian River Basin is primarily limited to orchards and vineyards with some irrigated pasture lands. Irrigation water is generally needed from May through early October. Vineyardists also divert large amounts of water in the spring to protect their vineyards from frost. A schematic diagram of water use in the Russian River basin is shown on Plate 17.

7-10. HYDROELECTRIC POWER

The power development at Coyote Valley Dam is designed as a two-stage project. Stage one consists of the construction of a steel liner, plenum chamber, and tainter valve in the existing outlet works; one 108-inch diameter fixed cone valve with energy dissipation chamber; and the powerhouse structure containing one 2,500 KW and one 1,000 KW turbine/generator unit, and one 54-inch diameter fixed cone valve and one 18-inch diameter gate valve. An oxygen storage and distribution system is also included for environmental purposes. Stage two, to be constructed when Coyote Valley Dam is raised to elevation 820 feet MSL, will consist of an extension to the powerhouse containing an additional 2,500 KW turbine/generator unit.

The average annual energy the City of Ukiah can expect from the power plant is estimated to be 17.66 GWh with an estimated average annual plant factor of 58%.

7-11. NAVIGATION

Navigation is not a project purpose and there are no navigation projects on the Russian River.

7-12. OTHER

During droughts, flood control is not expected to be a principal factor in the operation of Lake Mendocino. Conservation water and conservation space are managed by Sonoma County Water Agency (SCWA) in accordance with existing contracts. Any information that the Corps of Engineers may have that would be beneficial to drought operation will be passed on to the SCWA.

7-13. DEVIATION FROM NORMAL OPERATION

Occasional deviations from normal operation are expected. Except as discussed below any deviations from normal flood control procedures must beapproved in advance by the District Engineer, Sacramento District, Corps of Engineers. Emergency and some minor deviations can be made at the discretion of the Park Manager.

a. **Emergencies.** Some deviations that can arise from emergency conditions include: drownings or other accidents; equipment or livestock in downstream channels; the dilution of pollutants or flushing of pollutants from downstream sewage discharge points; and failure of important operating facilities. The District Engineer, Sacramento District, Corps of Engineers, will be informed as soon as practicable of any emergency deviations.

b. **Unplanned Minor Deviations.** Unplanned instances not considered emergencies can also create needs for temporary minor deviations from the normal regulation of the reservoir. Construction activities usually account for the greatest part of these minor deviations. Typical construction activities include: utility stream crossings, bridge work, bank protection work and major construction projects. Changes in releases are sometimes necessary for maintenance and inspection. Requests for changes of release rates are generally given for a few hours to a few days. Each request is analyzed on its own circumstances. Consideration is given to upstream watershed conditions, flood potential, reservoir conditions and possible alternative measures. In the interest of maintaining good public relations, the requests are complied with, providing there are no adverse effects on the overall operation of the project for the authorized purposes. The District Engineer will be informed, in advance, if possible, of all minor deviations proposed or anticipated.

c. **Planned Deviations.** Long-term deviations shall be analyzed on their particular circumstances and merits. Sufficient data on flood potential, reservoir and watershed conditions, alternative measures, expected benefits and probable effects on other projects will be presented by letter or telephone to the District Engineer, Sacramento District, Corps of Engineers along with recommendations for review and approval.

7-14. RATE OF RELEASE CHANGE

Releases from Lake Mendocino shall not change more than 1,000 cfs per 1 hour period to permit orderly evacuation of personnel, property, livestock, etc., in advance of rising water downstream, and to minimize bank sloughing and caving as the flow recedes after an extended period of bankful flows.

VIII - EFFECT OF WATER CONTROL PLAN

8-01. GENERAL

The Lake Mendocino Project reduces flood damages in the Russian River basin by controlling its flood releases. The flood control space in Lake Mendocino is sufficient to store all of the runoff of the East Fork Russian River during the occurrence of the 50-year flood at Guerneville.

Water supply storage in Lake Mendocino provides about 60,000 acre-feet of water. This conservation water is used for agricultural, municipal and industrial water supply, recreation and power.

Lake Mendocino creates an environment attractive to many species of fish as well as a habitat for terrestrial wildlife and wildflowers. The lake also provides recreation opportunities. The visitation during 1984 was 1,700,000 visits.

8-02. SPILLWAY DESIGN FLOOD

The spillway design flood is presented in Design Memorandum No. 2, Russian River Reservoir Coyote Valley, California, dated 12 November 1954. This flood was based on an analysis of the maximum possible precipitation prepared by the Hydrometeorological Section of the former Weather Bureau, now the National Weather Service. From this maximum possible precipitation, a probable maximum flood was developed and adopted as the spillway design flood.

The probable maximum flood would result from a combination of the most severe meteorologic and hydrologic conditions considered possible in the basin above the dam. Routing of the spillway design flood through Coyote Valley Dam with the following hydrologic parameters provided a freeboard of 5 feet.

Storm Rainfall	21.13 inches
Storm Runoff	15.85 inches
Storm Losses	5.28 inches
Peak Inflow	66,600 cfs
Inflow Volume	95,800 acre-feet

In 1969, the National Weather Service published Hydrometeorological Report No. 36 which contained revised precipitation amounts. These revised precipitation amounts were used to develop a new probable maximum flood. Routing of this probable maximum flood through Coyote Valley Dam with the following hydrologic parameters decreased the freeboard from 5 feet to 3 feet.

Storm Rainfall	27.80 inches
Storm Runoff	24.52 inches
Storm Losses	4.99 inches
Peak Inflow	57,000 cfs
Inflow Volume	137,000 acre-feet

Routing of the spillway design flood is presented on Plate 18.

8-03. FLOOD CONTROL

The principal objective of the flood control plan is prevention of flooding in the agricultural, urban and suburban areas below Coyote Valley Dam. The flood control space provided in Lake Mendocino is sufficient to store all of the runoff of the East Fork during the occurrence of the 50-year flood at Guerneville located 80 miles downstream from the dam. This intervening local area is 1,225 square miles.

The flood control space provided in Lake Mendocino is based on a Standard Project Flood (SPF) at the dam. The SPF is defined as one that can be expected from the most severe combination of meteorologic and hydrologic conditions characteristic of the region, excluding extremely rare combinations. The original SPF was based on the 1943 flood. The SPF presented in this manual was based on the 1955 flood. The hydrological parameters for the SPF are:

Storm Rainfall	23.15 inches
Storm Runoff	15.30 inches
Storm Losses	7.85 inches
Peak Inflow	25,800 cfs
Inflow Volume	94,800 acre-feet

Precipitation was distributed based on the storm of December 1955 centered over Coyote Valley Dam.

SPF's were also developed for the local area below Coyote Valley Dam concurrent with the SPF storm centered over the dam. Routings of the SPF are presented on Plate 19.

The storm of 18-25 December 1955 produced the most severe multiple-peaked flood of record, while the storm of 21-24 December 1964 produced the maximum discharge in the lower reaches of the Russian River. Flood routings of the December 1955 and December 1964 for pre-Coyote Dam conditions and with Coyote Dam in operation are presented on Plates 20 and 21, respectively.

8-04. RECREATION

Lake Mendocino includes six recreation areas which provide opportunities for a variety of water-oriented activities. During the recreation season, there is over-use of the camping and day-use areas on several occasions. Annual attendance at Lake Mendocino is presented in Table 17 on page VIII-3.

8-05. WATER QUALITY

The water control plan has had minimal adverse impacts on the Russian River and Lake Mendocino water quality. Water quality in the Russian River basin is maintained in accordance with applicable State Water Resources Control Board permits.

8-06. FISH AND WILDLIFE

The East Fork Russian River below Coyote Valley Dam supports both steelhead and resident species of fish. Prior to construction of the dam, river conditions for fish growth were not always favorable because of low flow and high water temperatures in summer and early fall. The project provides flow in the river year around and the low level outlet offsets the warm water conditions downstream of the dam.

TABLE 17

ANNUAL VISITATION
LAKE MENDOCINO

Year	Recreation Days (in thousands)
1964	550.0
1965	676.6
1966	1094.6
1967	891.2
1968	1022.4
1969	1066.5
1970	1064.3
1971	1358.1
1972	1430.6
1973	1317.5
1974	1536.0
1975	1515.0
1976	1264.0
1977	1309.6
1978	1857.1
1979	1786.6
1980	2650.5
1981	2761.4
1982	1870.7
1983	1617.0
1984	1690.0
Average	1444.2

Wildlife found in the area include deer, rabbits, quail and mourning doves. Waterfowl habitat existed along the river prior to construction of the dam and no significant decrease of this habitat has resulted.

8-07. WATER SUPPLY

Under natural conditions, a large portion of annual runoff occurs during late fall and winter. However, need for water exists during late spring and summer. Lake Mendocino stores winter runoff for use during summers and dry years. Up to 92,800 acre-feet of water may be carried over into summer. Approximately 248,700 acre-feet of water is made available from Lake Mendocino annually. This period includes two years of severe drought (1976-1977), during which Lake Mendocino supplied about 233,100 acre-feet of water. A summary of average monthly releases from Coyote Valley Dam is presented in Table 18 on page VIII-4.

TABLE 18

AVERAGE MONTHLY RELEASES
COYOTE VALLEY DAM

Month	Amount (acre-feet)	Percent of Annual
October	14,700	5.9
November	15,100	6.1
December	25,000	10.1
January	40,100	16.1
February	32,900	13.2
March	27,400	11.0
April	19,400	7.8
May	13,500	5.4
June	13,200	5.3
July	15,900	6.4
August	16,700	6.7
September	14,800	6.0
Total	248,700	100

Period of Record: 1959-1982

8-08. HYDROELECTRIC POWER

The hydroelectric power project at Lake Mendocino makes no changes in the storage capacities of the reservoir and does not alter the timing or quantity of releases from the reservoir. Its principal purpose is to use current releases to generate power. The requirements of all prior water rights will still be met. All water diverted by the powerplant will be returned to the river immediately downstream of the powerplant.

8-09. NAVIGATION

None.

8-10. FREQUENCIES

a. **Unregulated Flow Frequencies**. Unregulated flows and statistical parameters for rain floods were developed for the East Fork Russian River near Ukiah and Russian River near Hopland. The results are presented on Plates 22 and 23 respectively. Rain flood frequency curves for peak, 1-day, 3-day, 7-day, 15-day, 30-day and 60-day durations for stations East Fork Russian River near Ukiah, Russian River near Ukiah and Russian River near Hopland are shown on Plates 24, 25 and 26 respectively.

The unregulated frequency curves were based on both actual records and the conversion of differences in storage in Lake Mendocino into flows. Water year 1977 qualified as a low outlier and thus was removed from the statistics. The remaining data for the curves was adjusted using the conditional probability adjustment. Water year 1965 was removed from the systematic record for durations of 7 days or less and treated as an historic event. The flood of 1965 was treated as a 73 year event based on the fact that the flood was the largest on record for the station Eel River at Scotia, which is reasonably adjacent and has a record of 73 years. The statistics were adjusted to give equivalent historically adjusted values.

For the final curve statistics, the standard deviations for each set of curves were smoothed to allow an orderly transition between the curves of the different durations. The standard deviations of the 1-day curves were adopted for the peak flow curves due to incomplete data on the peak flows.

The skew coefficients for the final curves were determined from trends in the skew coefficients produced by the HEC Regional Frequency Program.

b. **Peak Flow Frequencies Project Condition**. Project condition peak flow frequency curves for the Russian River below Coyote Valley Dam and the Russian River near Hopland are shown on Plates 27 and 28, respectively. The curves reflect the operation of Coyote Valley Dam from 1959-1983. In order to extend the frequency curves to include very rare events, hypothetical floods were routed through Lake Mendocino and down the Russian River to Hopland.

c. **Local Flow Frequencies**. Local flow frequency curves were developed to show the contributions to streamflow of areas adjacent to the Russian River beyond the control of current flood control projects. Local frequency curves for stations Russian River near Hopland, Russian River near Cloverdale, and Russian River near Healdsburg are shown on Plates 29, 30 and 31 respectively. In each case, rain flood frequency curves for peak, 1-day, 3-day, 7-day, 15-day, 30-day and 60-day durations were developed.

The local frequency curves were developed by subtracting the natural flows contributed by the East Fork of the Russian River or, when appropriate, the routed releases from Lake Mendocino. Water year 1977 qualified as a low outlier at all stations. The remaining data was adjusted using the conditional probability adjustment.

For the final curve statistics, the standard deviations were smoothed to allow an orderly transition between the curves of different durations. The standard deviations of the 1-day curves were adopted for the peak curves due to incomplete data on the peak flows. The skew coefficients were determined from trends in the skew coefficients produced by the HEC Regional Frequency Program.

d. **Stage-Frequency Curve**. The stage-frequency curve for Lake Mendocino is shown on Plate 32. In order to extend the stage-frequency curve to include very rare events, hypothetical floods were routed through Lake Mendocino. Stage-duration curves are shown on Plate 33, and the seasonal variation of reservoir storage frequency is shown on Plate 34. The stage-frequency curve is based on daily storage records for the period 1959-1983. The level of storage is highest in the spring at the beginning of the recreation season as a result of storing runoff for water supply. Releases made through the summer for downstream water demands draw the reservoir down for the beginning of the winter flood season.

e. **Operation Record**. The official record of Lake Mendocino is published in Water Supply Papers of the U.S. Geological Survey.

Operation of Coyote Valley Dam began in November 1958 and is shown on Plate 35. A record of flood control requirements and storage and flows pertinent to flood control operation is contained in monthly reports submitted to the Chief of Engineers by the District Engineer, Sacramento District, Corps of Engineers, Sacramento, California.

f. **Key Control Points**. The primary point of concern is Hopland. Existing channel capacity through Hopland is 8,000 cfs. Rating curves for stream gaging stations East Fork Russian River near Ukiah, Russian River near Ukiah, Russian River near Hopland and Russian River near Healdsburg are shown on Charts A-5, A-6, A-7, and A-8, respectively, in Exhibit A. These charts are revised periodically to reflect changing channel conditions.

8-11. OTHER STUDIES

The Corps of Engineers does not have in progress, or planned for the immediate future, any studies in the Russian River Basin.

IX - WATER CONTROL MANAGEMENT

9-01. RESPONSIBILITIES AND ORGANIZATION

Names, addresses and telephone numbers of those individuals whose responsibilities are outlined in the following paragraphs are given on the personnel sheet in front of this manual.

a. **Corps of Engineers.** The District Engineer, Sacramento District, Corps of Engineers, is responsible for:

(1) Physically operating the reservoir in accordance with instructions contained in this manual.

(2) Advising operating agencies, the Division Engineer, and the Chief of Engineers of any departure from the flood control regulations.

(3) Preparing monthly operation and other special reports relative to the operation of the reservoir required by the Office, Chief of Engineers.

(4) Preparing revisions to the flood control criteria found herein.

(5) Approving or disapproving deviations from the prescribed flood control criteria contained in Exhibit A on Chart A-10.

b. **Sonoma County Water Agency.** Sonoma County Water Agency is responsible for directing conservation releases for municipal and industrial water supply.

c. **City of Ukiah.** The City of Ukiah is responsible for:

(1) Physically operating the powerplant to meet the release requirements.

(2) Advising operating agencies of any emergencies or departures that occur.

d. **State of California.** The State Water Resources Control Board is responsible for administration of water rights. California State Department of Fish and Game is responsible for determining water releases required for downstream fisheries.

9-02. INTERAGENCY COORDINATION

Flood control operations require close cooperation between the Corps of Engineers, the National Weather Service, California Department of Water Resources and local downstream interests. Conditions often change rapidly during flood control operations and, anticipated conditions have important implications for current actions.

The National Weather Service (NWS) office in Sacramento maintains year round surveillance of weather conditions. The NWS distributes forecasts and is directly responsible to agencies and the public by way of local news media. The NWS maintains and publishes meteorological data pertinent to the Russian River basin.

The U.S. Geological Survey manages several streamflow, sediment, and water quality gages in the Russian River basin. Data acquired from these stations are published in annual reports and preliminary and supplementary data are available on request.

The Corps of Engineers coordinates with the local press about information of public interest on floods and other impacts of project operation.

Operations involving water supply normally requires cooperation between Sonoma County Water Agency and the Corps of Engineers.

9-03. INTERAGENCY AGREEMENTS

A proposed plan of operation dated August 4, 1955 was submitted to the Corps of Engineers on August 16, 1955 and orally approved with minor amendments on November 21, 1955. The agreement between the United States of America and the City of Ukiah, California for Construction, Operation, and Maintenance of Lake Mendocino Power Project at Coyote Dam is presented as Exhibit B. Lake Mendocino shall be operated in compliance with the agreement between Sonoma County Water Agency and California Department of Fish and Game dated August 21, 1959 (Exhibit C).

9-04. COMMISSIONS AND COMPACTS

The commissions who share interest in the Russian River basin water control activities are as follows:

a. **Federal Energy Regulatory Commission.** This agency is responsible for issuing preliminary permits and licenses in the Russian River basin to non-Federal entities for the development of hydroelectric powerplants under its jurisdication, including powerplants utilizing Federal dams where Congress has not authorized power development as a project purpose.

b. **California State Water Resources Control Board.** This agency regulates the diversion and use of water in the Russian River, Lake Sonoma and Lake Mendocino. Any diversion or use of water that does not conform to the terms and conditions of existing permits or licenses, or which constitutes a new diversion or use of water, is subject to the Board's review and approval.

c. **California Department of Water Resources, Central District.** This agency was tasked in 1975 to review existing and projected relationships between water supplies and demands in the Russian River basin which resulted in the report titled "Water Action Plan for the Russian River", dated May 1980.

d. **Regional Water Quality Control Board, North Coast Region.** This state agency has the planning responsibility to determine the future direction of water quality control for protection of the Russian River waters.

9-05. REPORTS

A variety of reports that pertain to the operation of the project are required to be completed at different time intervals. Reports prepared by the Reservoir Control Section include:

a. Reservoir Operation Chart

b. Reservoir Regulation, Daily Data

c. Water Control Manual, Status

d. Water Quality Report

e. End of Month Storage

f. Climatological Data

Immediately after the end of each month, the Park Manager will dispatch to the Reservoir Control Section the charts for that month from the following instruments:

a. Recording precipitation gage

b. Pool elevation recorder

c. Remote recording gages

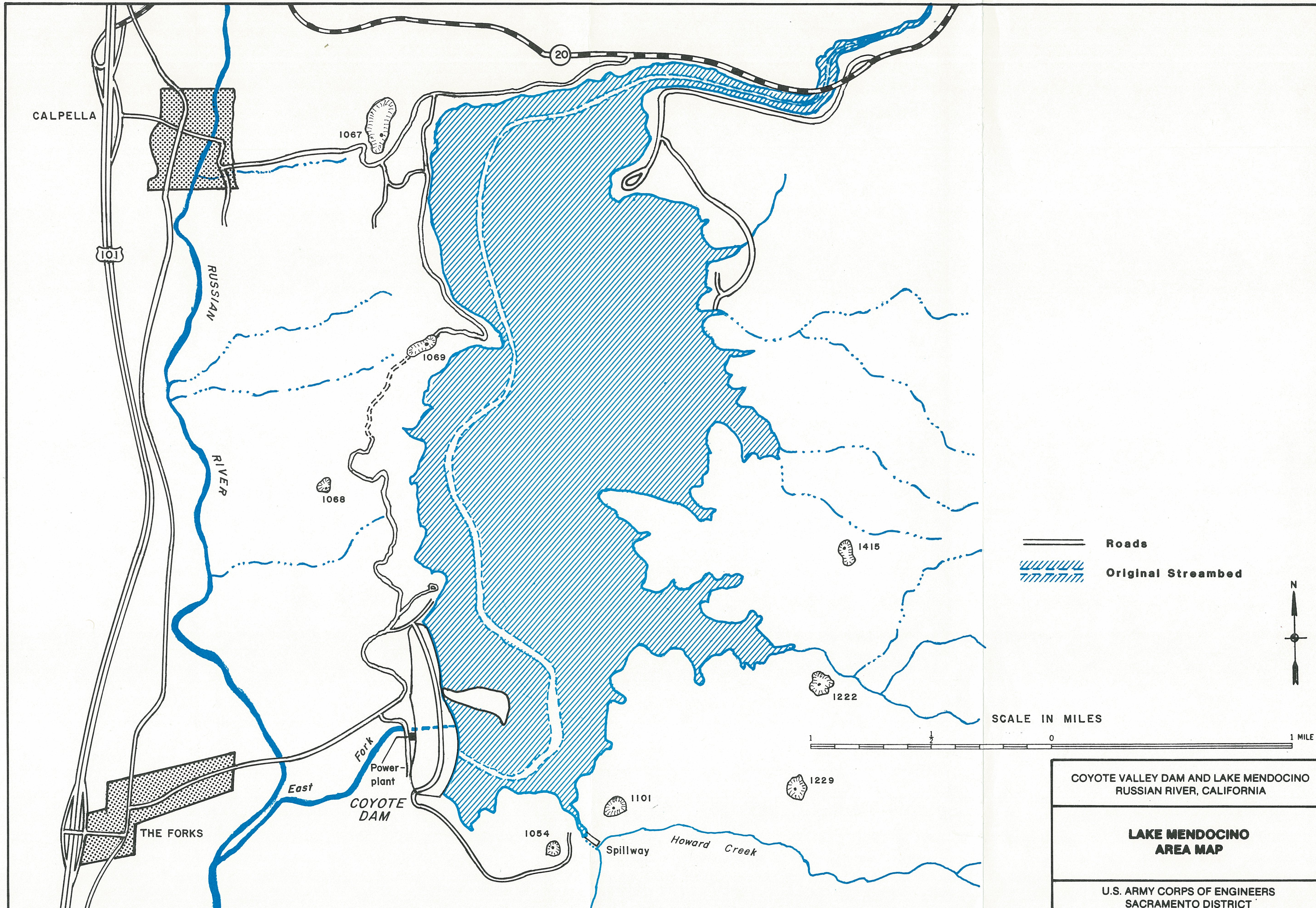

CALPELLA
101
20
1067
RUSSIAN
RIVER
1069
1068
1415
1222
1229
1101
1054
THE FORKS
East
Fork
Power-
plant
COYOTE
DAM
Spillway
Howard
Creek
Roads
Original Streambed
N
SCALE IN MILES
1
½
0
1 MILE
COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA
LAKE MENDOCINO
AREA MAP
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

PLATE 1

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

GENERAL MAP

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

PLATE 2

NOTE: POWERPLANT LOCATION TO BE ADDED WHEN "AS BUILT" DRAWINGS ARE AVAILABLE.

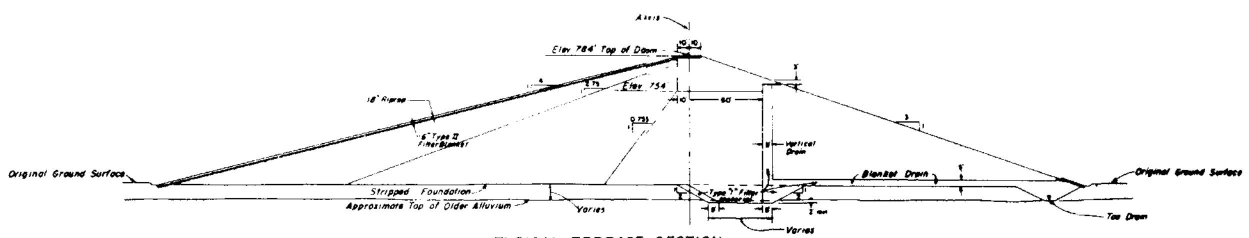
PROFILE ON AXIS OF DAM

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

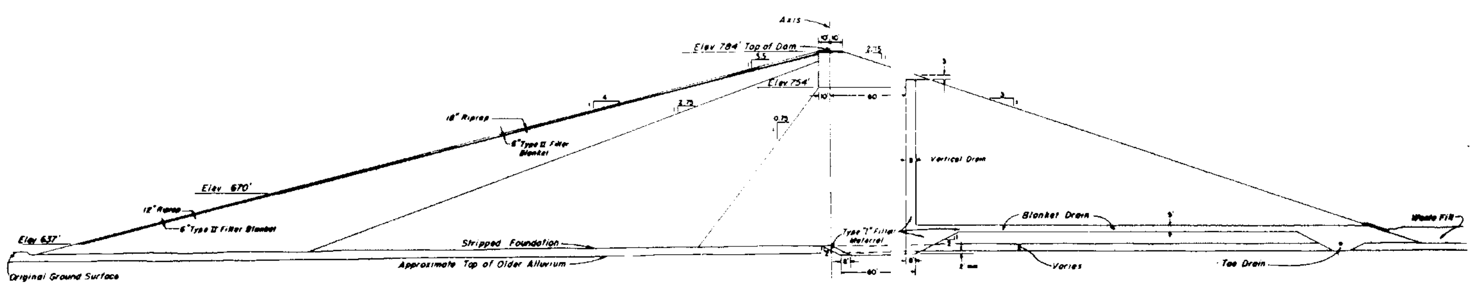
COYOTE VALLEY DAM
PLAN AND ELEVATION

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

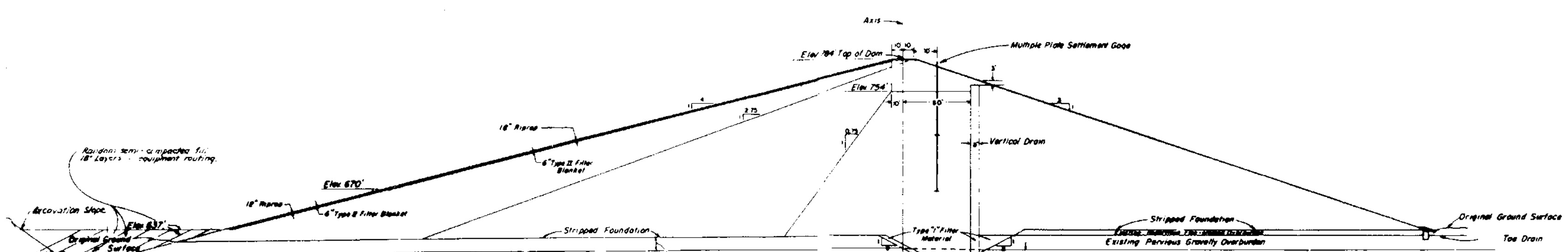
PLATE 3



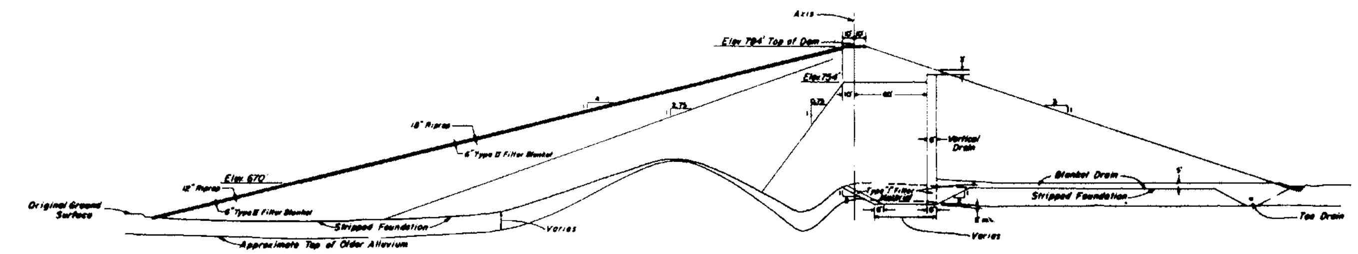
TYPICAL TERRACE SECTION
STATION 113+10± TO STATION 124+00±



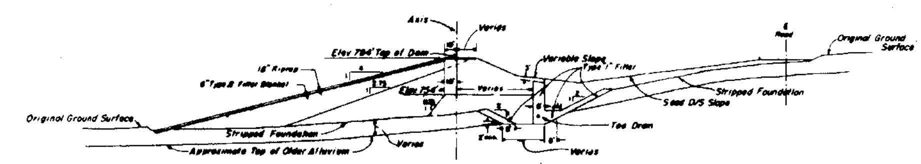
TYPICAL RIVER SECTION
STATION 124+00± TO STATION 126+00±



TYPICAL VALLEY FLOOR SECTION
STATION 126+00± TO STATION 131+00±



TYPICAL LEFT ABUTMENT SECTION
STATION 131+00± TO STATION 132+50±



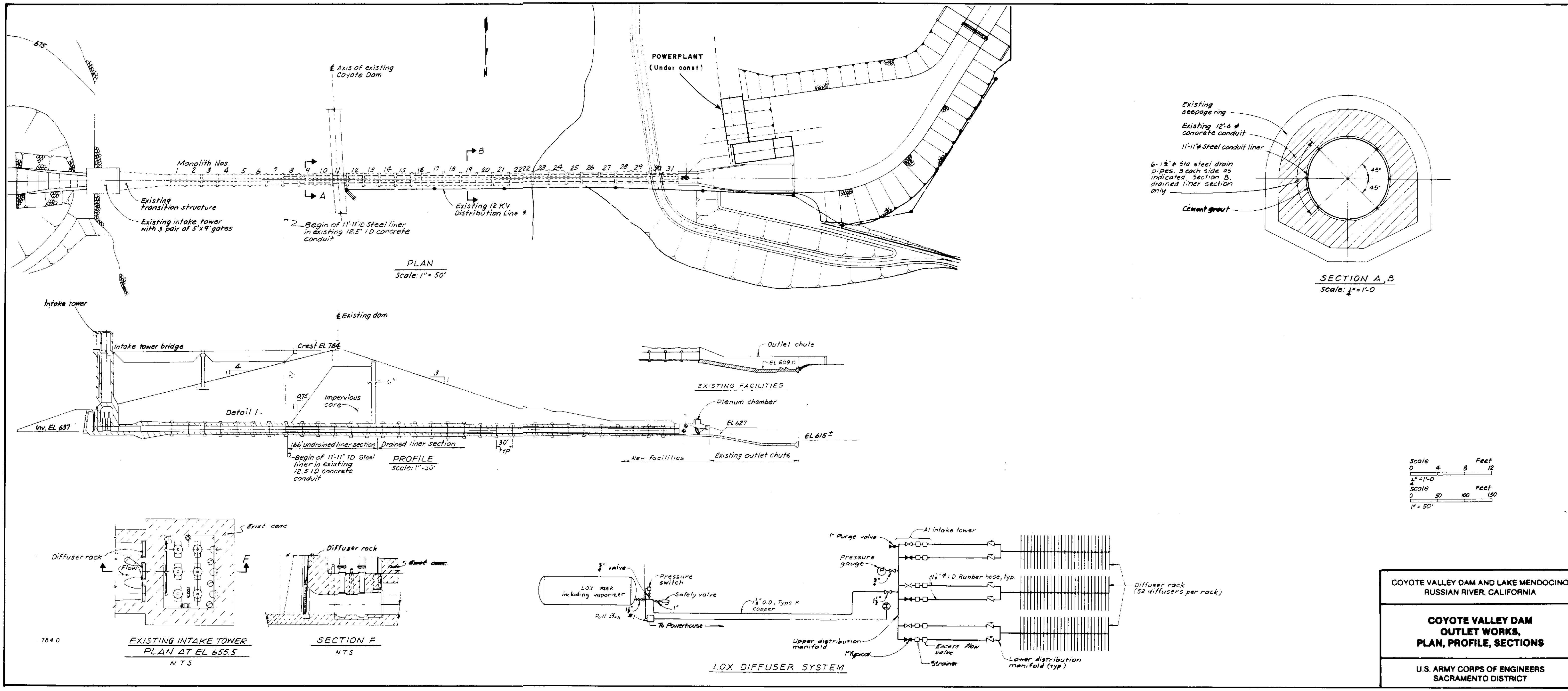
TYPICAL RIGHT ABUTMENT SECTION
STATION 100+90± TO STATION 102+10

SCALE
40 0 40 80 120 FT.

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

COYOTE VALLEY
DAM SECTIONS

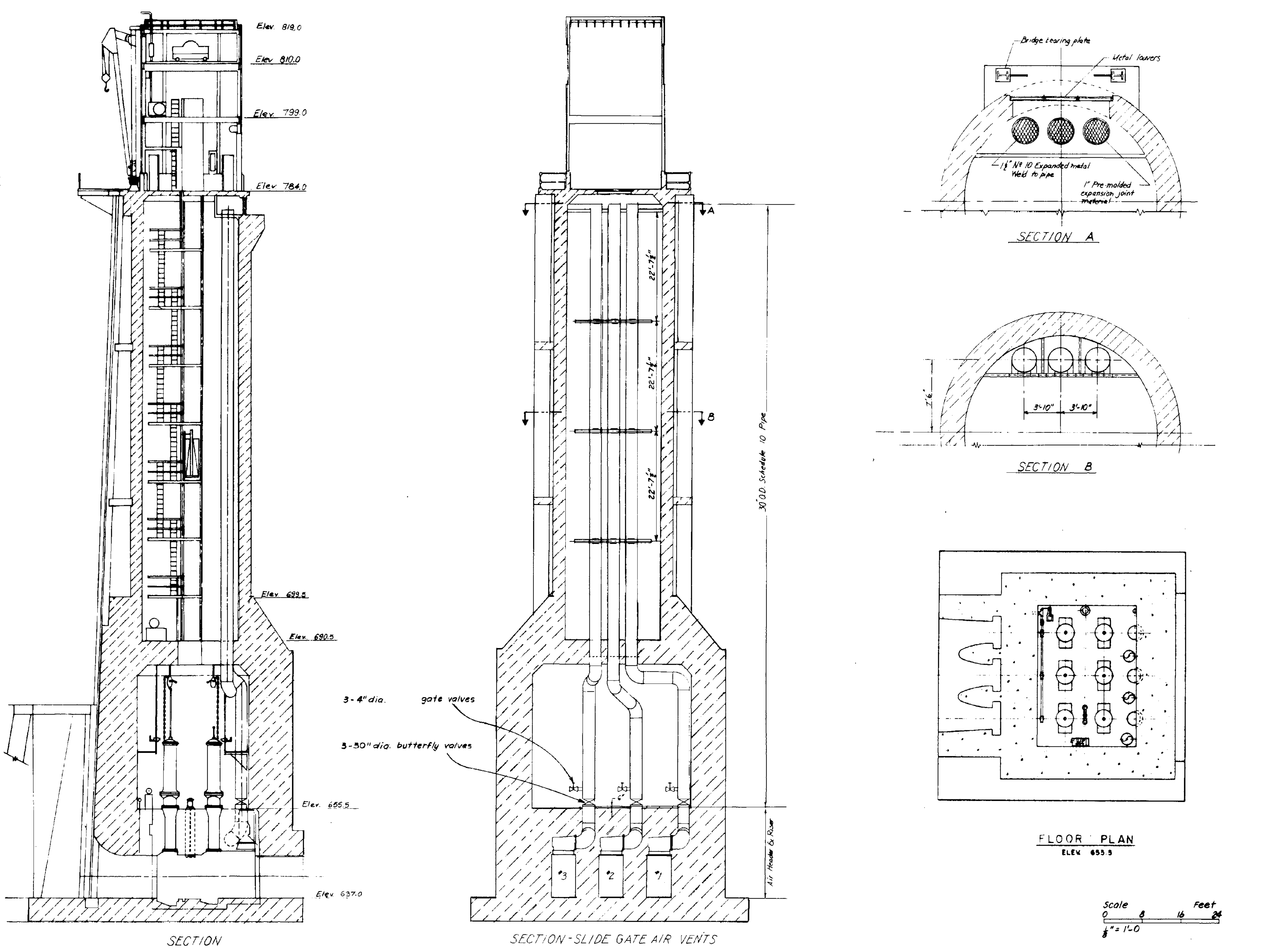
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

COYOTE VALLEY DAM
OUTLET WORKS,
PLAN, PROFILE, SECTIONS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



NOTES:

Service Gates: Three 5' by 9' hydraulically operated slide gates. Control for each gate. Gates may be operated singly or in combination. Speed of opening or closing approximately one foot per minute.

Emergency Gates: Three 5' by 9' hydraulically operated slide gates. One control for all gates. Operated singly by valve manipulation.

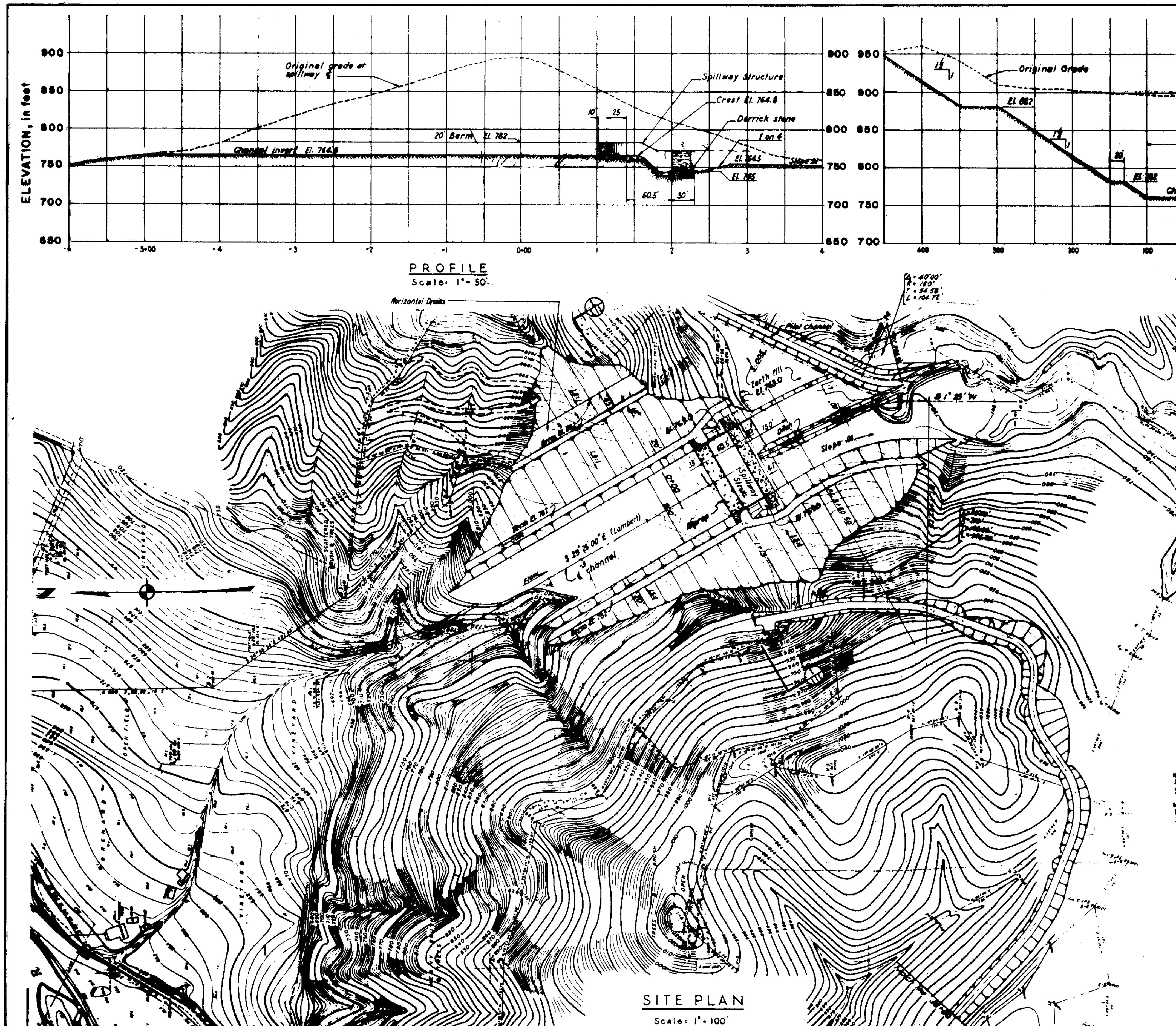
Stoplog Gate: One gate 6'-11½" by 15'-9" fabricated from 14 WF 38 beams - all welded construction. Provided with rollers and rubber seals. Hung on tower with derrick and hoist for lowering on steel gate guides into one of three steel gate frames.

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

COYOTE VALLEY DAM
OUTLET WORKS,
PLAN, PROFILE, SECTIONS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

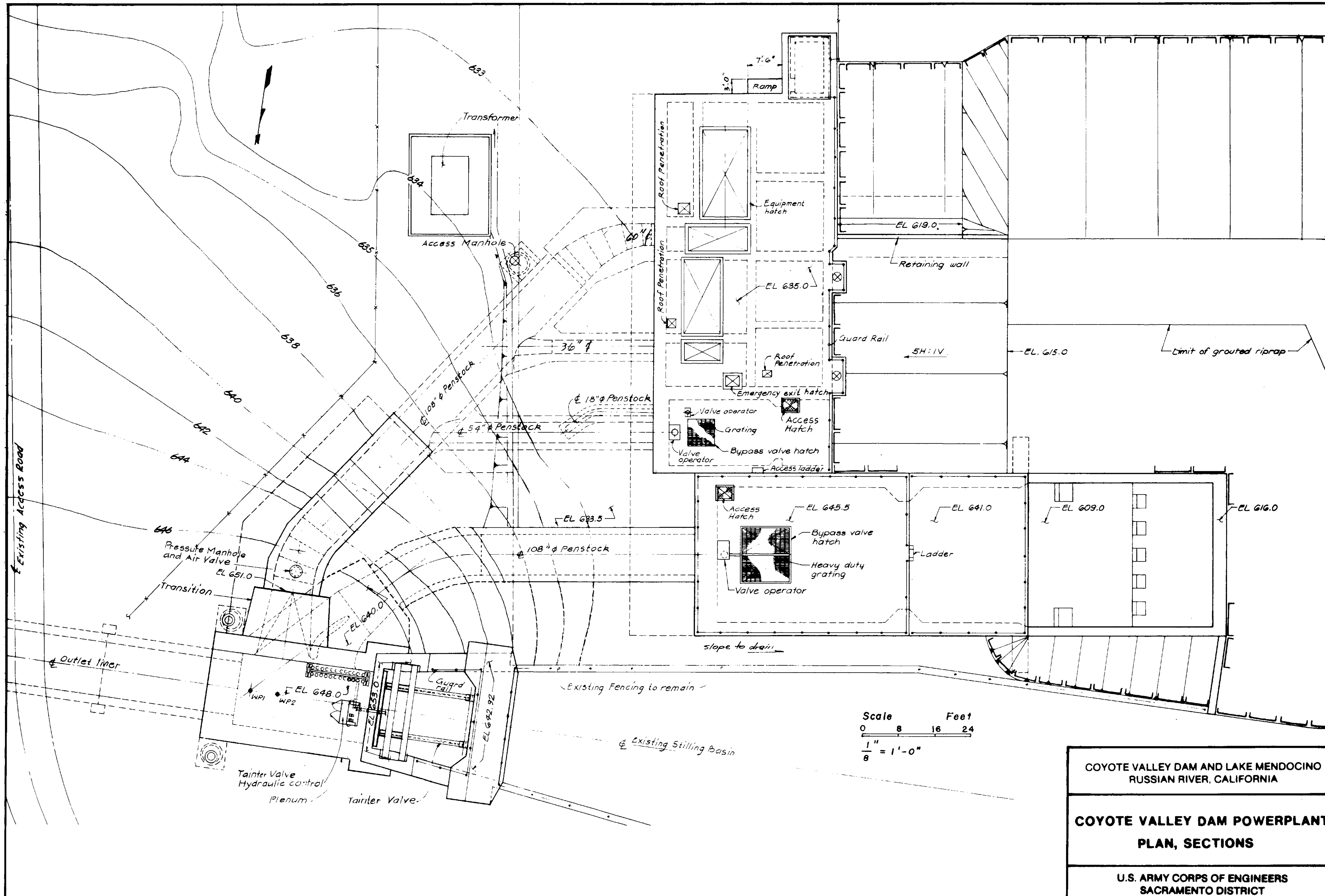
SHEET 2 OF 2 **PLATE 5**



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

COYOTE VALLEY SPILLWAY, PLAN, PROFILE, SECTIONS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

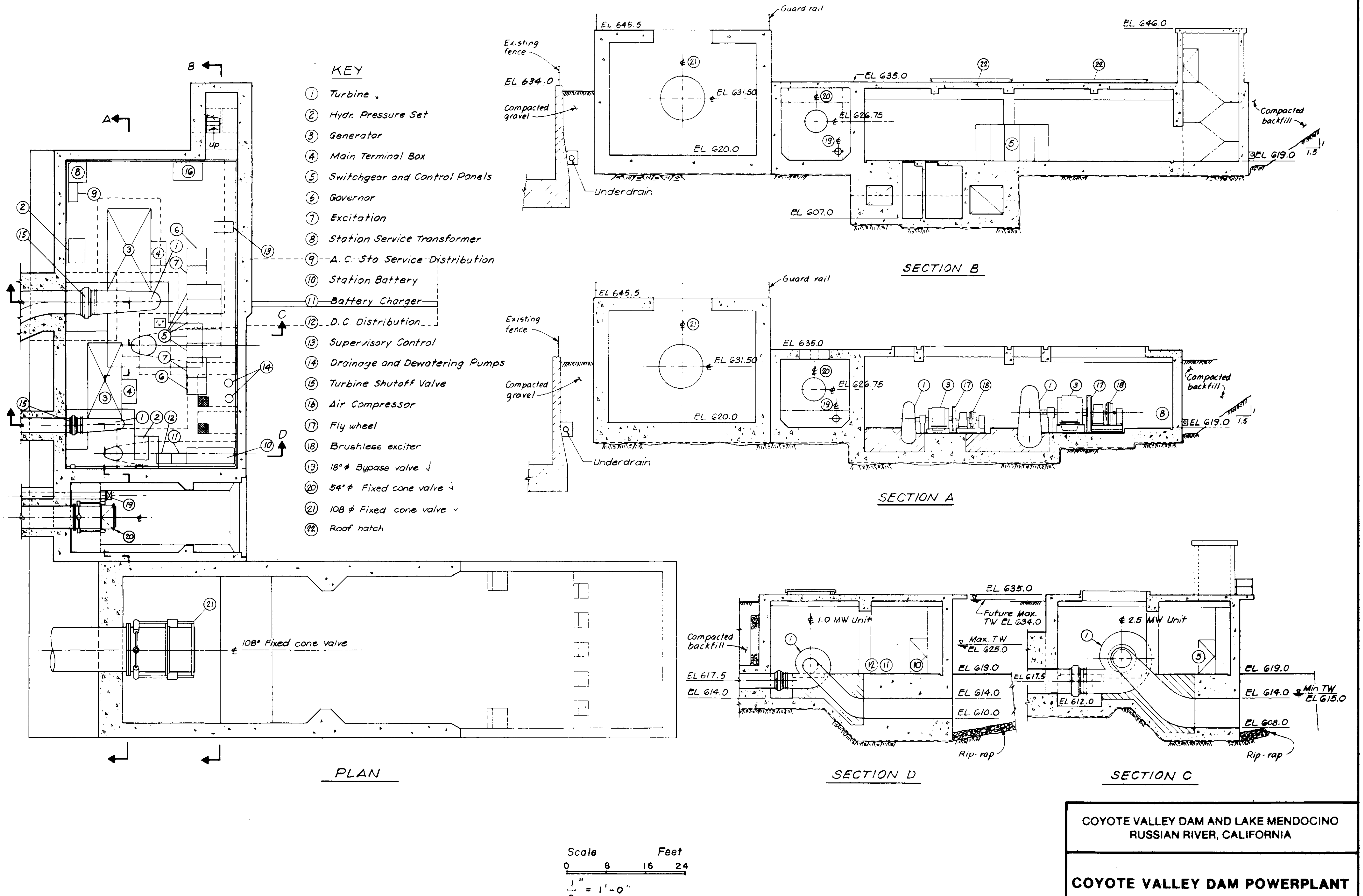


COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

COYOTE VALLEY DAM POWERPLANT

PLAN, SECTIONS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

COYOTE VALLEY DAM POWERPLANT
PLAN, SECTIONS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

POTTER VALLEY POWERHOUSE *
MONTHLY RELEASES
(ACRE-FEET)

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1910	0	0	13,000	14,000	13,000	15,400	15,800	13,900	4,030	1,300	210	520	91,160
1911	930	4,320	10,400	12,000	14,600	16,100	15,500	16,200	14,100	3,310	1,070	1,010	109,540
1912	1,280	2,040	2,680	12,900	14,900	15,900	15,500	15,900	12,400	3,170	960	2,870	100,500
1913	1,780	13,400	13,100	15,900	14,000	15,700	15,300	15,600	9,380	3,150	670	380	118,360
1914	590	5,880	13,400	14,800	14,300	15,400	15,300	15,800	10,400	2,990	930	690	110,480
1915	2,190	2,050	11,700	15,200	13,400	15,700	15,300	15,800	15,000	5,910	2,160	710	115,120
1916	1,070	4,050	15,300	15,900	14,900	15,900	15,800	15,400	7,160	3,210	1,300	740	110,730
1917	1,000	3,240	13,000	16,500	14,700	16,500	15,900	16,700	10,700	2,170	1,240	660	112,310
1918	750	1,720	5,550	7,400	13,400	17,000	16,100	9,580	2,520	750	540	760	76,070
1919	1,030	5,360	7,550	12,900	15,000	17,000	14,800	14,700	4,490	1,340	710	550	95,430
1920	640	1,050	8,670	3,640	2,300	13,800	16,600	11,000	2,290	680	140	160	60,970
1921	1,360	9,700	15,900	15,200	13,800	15,100	14,600	15,400	9,020	2,010	670	600	113,360
1922	240	1,690	7,790	16,400	15,200	16,700	16,300	17,100	16,300	18,600	19,400	18,500	164,220
1923	18,100	13,600	14,700	16,300	14,700	16,300	15,700	16,300	16,400	14,800	13,500	13,200	183,600
1924	14,900	13,100	7,070	4,670	7,080	4,330	3,460	3,810	3,560	3,550	3,550	1,710	70,790
1925	4,630	16,200	18,800	18,100	15,300	18,000	16,500	17,500	17,500	18,200	16,400	16,200	193,330
1926	15,800	14,800	15,300	13,200	13,100	15,500	14,600	15,300	14,900	15,200	16,000	15,200	178,900
1927	15,300	14,900	15,300	14,400	13,600	14,800	14,800	15,300	15,600	16,200	16,800	16,400	183,400
1928	14,800	14,500	15,300	15,400	14,300	15,200	15,100	16,000	16,400	17,100	17,800	16,100	188,000
1929	14,000	11,800	13,300	13,500	11,700	12,400	10,200	9,220	11,700	11,500	11,600	8,630	139,550
1930	5,550	4,720	9,280	16,200	12,600	12,400	13,900	14,300	10,900	11,700	12,800	9,220	133,570
1931	5,040	10,500	15,800	16,600	15,600	16,800	10,000	5,880	5,250	6,640	6,950	9,520	124,580
1932	13,800	16,100	9,470	16,900	15,400	8,120	10,800	13,500	5,370	6,760	6,760	6,370	129,350
1933	11,100	17,600	17,800	8,850	14,200	18,000	17,900	13,600	11,500	14,200	17,700	9,940	172,390
1934	1,410	580	190	4,390	8,500	3,260	3,890	7,500	9,160	10,400	10,800	10,800	70,880
1935	11,430	10,860	11,220	11,410	10,280	11,210	8,200	7,760	7,780	10,740	10,430	10,740	122,060
1936	4,710	7,930	11,080	11,230	10,440	11,110	8,850	9,960	10,510	12,290	11,700	9,840	119,650
1937	11,160	7,760	11,420	10,900	10,130	11,040	10,870	11,040	10,850	11,270	11,430	11,130	129,000
1938	11,460	7,800	9,910	9,910	9,840	4,550	9,430	11,290	11,050	11,800	11,430	10,930	119,400
1939	10,710	11,010	11,080	8,650	9,660	8,280	9,840	11,200	11,000	11,640	11,410	11,790	126,270
1940	12,210	9,190	10,070	11,980	10,570	10,790	11,640	8,900	6,770	9,320	8,600	10,890	120,930
1941	10,970	9,880	10,060	8,060	9,420	12,770	11,560	12,530	11,680	9,200	12,060	12,770	130,960
1942	11,660	12,730	13,030	13,110	11,840	13,180	12,780	13,110	12,270	9,080	8,350	8,360	139,500
1943	8,630	10,300	13,120	12,830	11,840	12,770	12,740	12,470	8,520	9,160	9,610	9,080	131,070
1944	9,410	12,570	3,050	940	12,340	13,220	12,650	13,150	12,630	10,150	10,310	9,890	120,310
1945	9,950	12,750	13,360	13,450	12,100	13,430	13,050	13,100	10,170	10,250	11,080	11,990	144,680
1946	13,370	13,020	11,680	12,380	12,230	13,640	13,370	11,030	9,600	10,030	9,980	9,430	139,760
1947	10,340	10,040	13,210	11,290	9,740	13,280	12,880	5,520	6,470	8,010	9,150	11,360	121,290
1948	13,310	12,790	13,470	13,270	12,570	13,600	13,020	13,320	11,340	6,300	11,340	12,950	147,280
1949	10,960	11,590	10,830	13,380	12,140	13,240	12,950	12,210	5,080	8,730	9,880	9,450	130,440
1950	9,410	11,730	13,480	13,530	10,040	0	9,490	16,330	4,870	12,260	10,800	13,320	125,260
1951	16,650	18,310	17,320	18,640	16,850	19,200	19,390	15,760	10,910	11,310	11,270	10,910	186,520
1952	12,460	15,390	18,730	18,770	16,270	19,190	19,180	20,170	17,070	14,030	19,150	15,000	205,410
1953	13,610	8,760	18,560	5,170	11,030	18,860	19,110	20,000	19,340	19,330	19,650	17,230	190,650
1954	17,110	18,080	18,640	18,000	14,160	16,420	18,460	19,510	12,170	12,500	13,460	17,800	196,310
1955	19,200	14,700	17,990	18,860	17,200	10,680	10,190	17,890	12,690	14,760	14,760	14,730	183,650
1956	14,520	12,590	8,410	16,590	16,550	19,720	19,050	19,430	12,260	14,650	15,340	15,330	184,440
1957	14,320	11,640	6,510	9,990	9,240	18,040	14,840	18,480	12,910	13,130	13,400	13,620	156,120
1958	14,630	18,010	18,390	18,060	14,810	18,190	17,640	15,800	13,850	13,250	12,970	15,850	191,450
1959	17,270	14,330	6,930	17,010	16,760	17,920	9,170	5,350	16,420	19,050	19,360	6,090	165,660
1960	0	9,940	1,480	5,840	17,150	18,350	17,190	15,070	10,090	18,800	6,350	10,270	130,530
1961	16,410	18,160	18,680	18,260	16,390	18,570	18,220	18,440	12,230	7,780	7,840	18,640	189,620
1962	19,140	13,590	18,570	18,960	16,750	18,570	17,040	8,230	10,140	13,520	13,690	11,270	179,470
1963	17,540	18,480	18,530	18,480	16,820	16,170	17,900	18,190	13,020	12,560	13,300	12,360	193,350
1964	13,490	16,340	18,140	18,650	17,160	14,840	4,080	4,000	3,800	8,260	8,950	10,310	138,020
1965	17,090	18,310	15,650	18,580	16,930	9,450	17,680	18,560	12,330	13,480	13,880	16,970	188,910

POTTER VALLEY POWERHOUSE *
MONTHLY RELEASES
(ACRE-FEET)

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1966	17,990	10,930	13,730	18,590	16,870	17,900	18,350	14,110	7,640	12,560	13,560	17,440	179,670
1967	19,420	17,480	18,910	18,910	16,960	17,910	18,110	18,800	17,930	18,750	18,980	18,700	220,860
1968	16,320	10,580	17,950	18,710	17,480	18,580	11,450	4,530	6,600	12,990	13,030	12,650	160,870
1969	17,250	17,800	18,020	17,830	16,080	17,880	17,190	18,380	14,920	13,050	13,230	17,240	198,870
1970	18,410	15,060	13,060	17,930	16,420	17,790	6,370	5,640	7,900	8,290	8,840	15,910	151,620
1971	17,440	16,120	18,890	18,770	17,170	18,850	16,950	18,790	15,010	6,310	4,000	8,070	176,370
1972	10,150	10,670	15,300	18,560	13,280	18,080	15,910	14,790	5,640	15,100	11,150	17,140	165,770
1973	17,320	17,950	12,380	16,900	16,850	16,980	18,540	14,650	8,400	9,140	8,990	16,190	174,290
1974	6,850	1,610	18,940	15,780	13,660	17,830	18,240	18,770	16,190	6,460	5,490	14,870	154,690
1975	17,840	17,320	16,430	15,610	14,310	17,210	16,680	17,110	12,920	8,770	8,220	17,270	179,690
1976	18,250	17,710	17,610	8,280	5,640	7,250	6,720	4,540	5,120	6,320	5,960	12,840	116,240
1977	16,480	15,860	7,500	3,490	650	1,580	1,130	2,400	2,890	3,720	3,600	1,850	61,150
1978	1,050	2,340	9,450	17,150	16,140	17,720	17,750	18,720	16,750	9,270	9,150	12,330	147,820
1979	15,070	17,640	7,310	12,210	16,630	18,240	17,160	18,730	10,060	8,960	8,810	16,820	167,640
1980	17,270	16,790	18,460	18,060	17,380	18,290	18,050	16,710	11,630	9,060	6,430	16,990	185,120
1981	18,540	13,460	14,290	11,410	16,690	17,710	12,020	8,660	8,850	7,850	5,760	12,130	147,370
1982	19,730	16,710	19,120	19,430	18,070	19,740	19,270	20,320	19,340	9,270	9,800	15,560	206,360
1983	10,220	13,300	17,390	19,310	17,660	19,500	18,880	19,440	18,730	17,270	16,810	5,210	193,720

* USGS GAGE, POTTER VALLEY POWERHOUSE TAILRACE, NEAR POTTER VALLEY, CA.

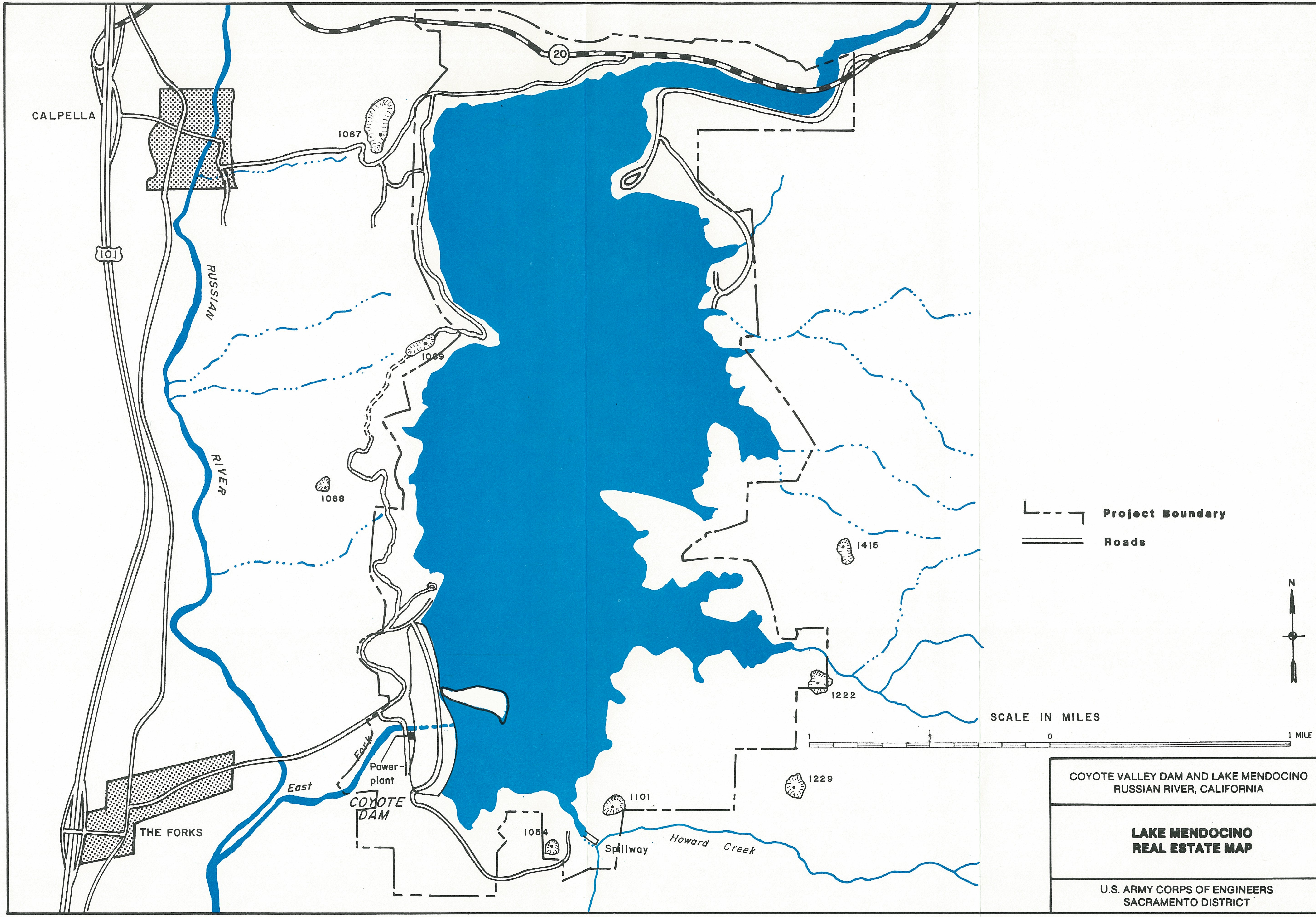
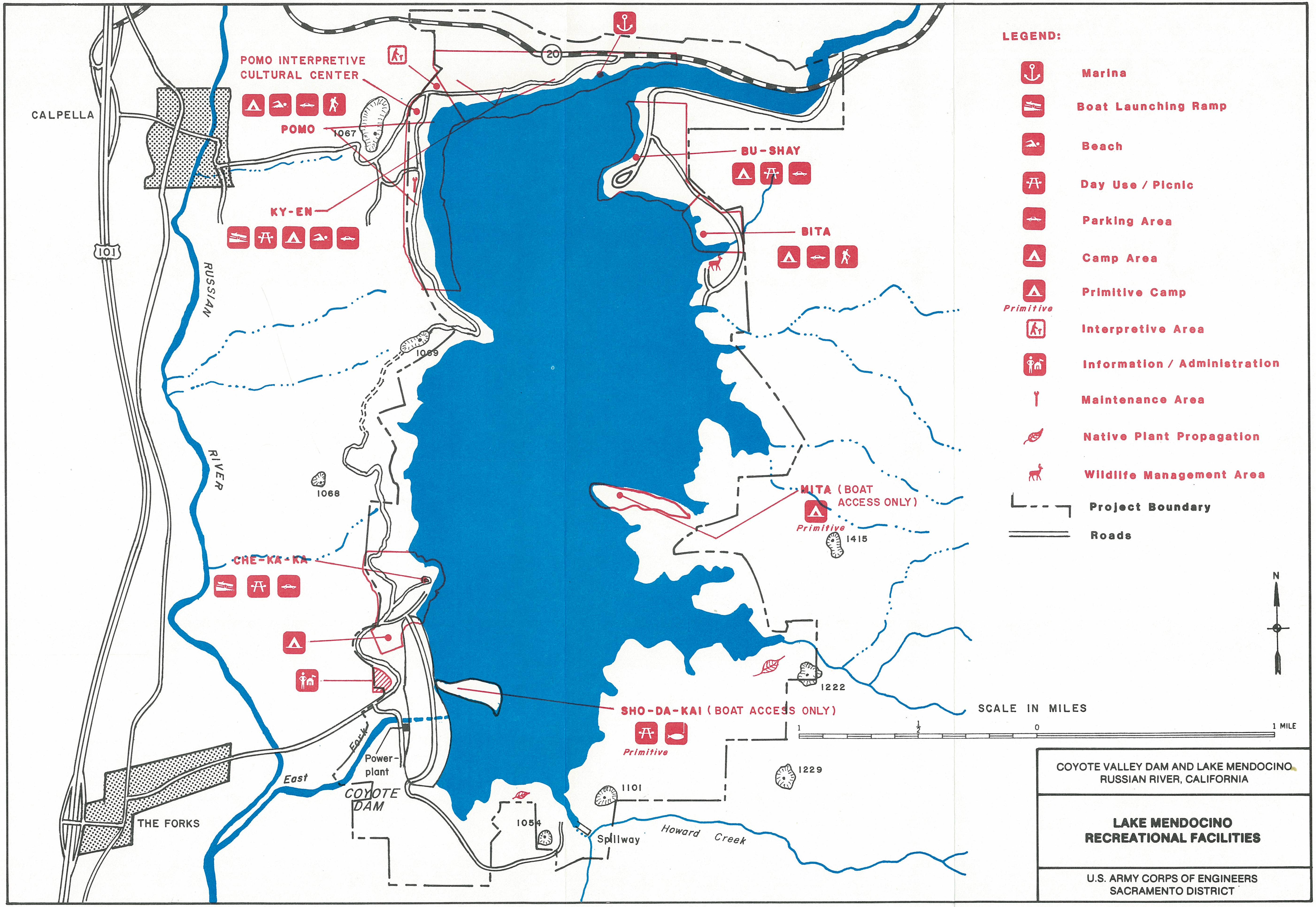

CALPELLA
101
20
RUSSIAN
RIVER
1067
1069
1068
1415
1222
1229
1101
1054
East Fork
Power-plant
COYOTE DAM
THE FORKS
Spillway
Howard Creek
Project Boundary
Roads
N
SCALE IN MILES
1
½
0
1 MILE
COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA
LAKE MENDOCINO
REAL ESTATE MAP
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

PLATE 9


LEGEND:
Marina
Boat Launching Ramp
Beach
Day Use / Picnic
Parking Area
Camp Area
Primitive Camp
Primitive
Interpretive Area
Information / Administration
Maintenance Area
Native Plant Propagation
Wildlife Management Area
Project Boundary
Roads
CALPELLA
POMO INTERPRETIVE CULTURAL CENTER
POMO
KY-EN
BU-SHAY
BITA
MITA (BOAT ACCESS ONLY)
CHE-KA-KA
SHO-DA-KAI (BOAT ACCESS ONLY)
RUSSIAN RIVER
East Fork
Power-plant
COYOTE DAM
THE FORKS
Spillway
Howard Creek
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1101
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SCALE IN MILES
1 ½ 0 1 MILE
COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA
LAKE MENDOCINO RECREATIONAL FACILITIES
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

STREAM GAGING STATIONS														
INDEX NO.	STATIONS	TYPE OF GAGE	LOCATION LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	ELEVATION FEET	ELEVATION DATUM	DRAINAGE AREA (SQ. MI.)	RECORDS BEGAN IN	RECORDS AGENCY IN CHARGE	RECORDS PUBLISHED BY	MAXIMUM FLOW DATE	MAXIMUM FLOW CFS
11471000	POTTER VALLEY POWERHOUSE TAILRACE NEAR POTTER VALLEY	▲	39	22	123	08	1020	TM	—	1909	USGS	USGS	24 APR 53	348*
11461500	EAST FORK RUSSIAN RIVER NEAR CALPELLA	▲↙	39	15	123	08	787.9	MSL	92.2	1941	USGS	USGS	22 DEC 64	18,700
11463000	RUSSIAN RIVER NEAR CLOVERDALE	▲	38	53	123	03	350.0	TM	503	1951	USGS	USGS	22 DEC 64	55,200
11463170	BIG SULPHUR CREEK AT GEYSERS RESORT	▲	38	48	122	48	1420	TM	13.1	1980	USGS	USGS	—	—
11463900	MAACAMA CREEK NEAR KELLOGG	▲	38	38	122	46	188.9	MSL	43.4	1958	USGS	USGS	16 JAN 78	7,360
11465150	PENA CREEK NEAR GEYSERVILLE	▲	38	42	122	58	195	TM	22.3	1978	USGS	USGS	17 FEB 80	3,060
11466500	LAGUNA DE SANTA ROSA NEAR GRATON	▲	38	27	122	50	—	MSL	—	1940	USGS	USGS	23 DEC 64	73.3 FT*
—	LAKE SONOMA POOL LEVEL	▲↙	38	43	123	01	—	—	130	—	USCE	USGS	—	—

*MAX DAILY DISHARGE OR STAGE.
'ACRE-FEET OF STORAGE.
MSL = MEAN SEA LEVEL.
TM = TOPOGRAPHIC MAP.

TYPE OF GAGE:

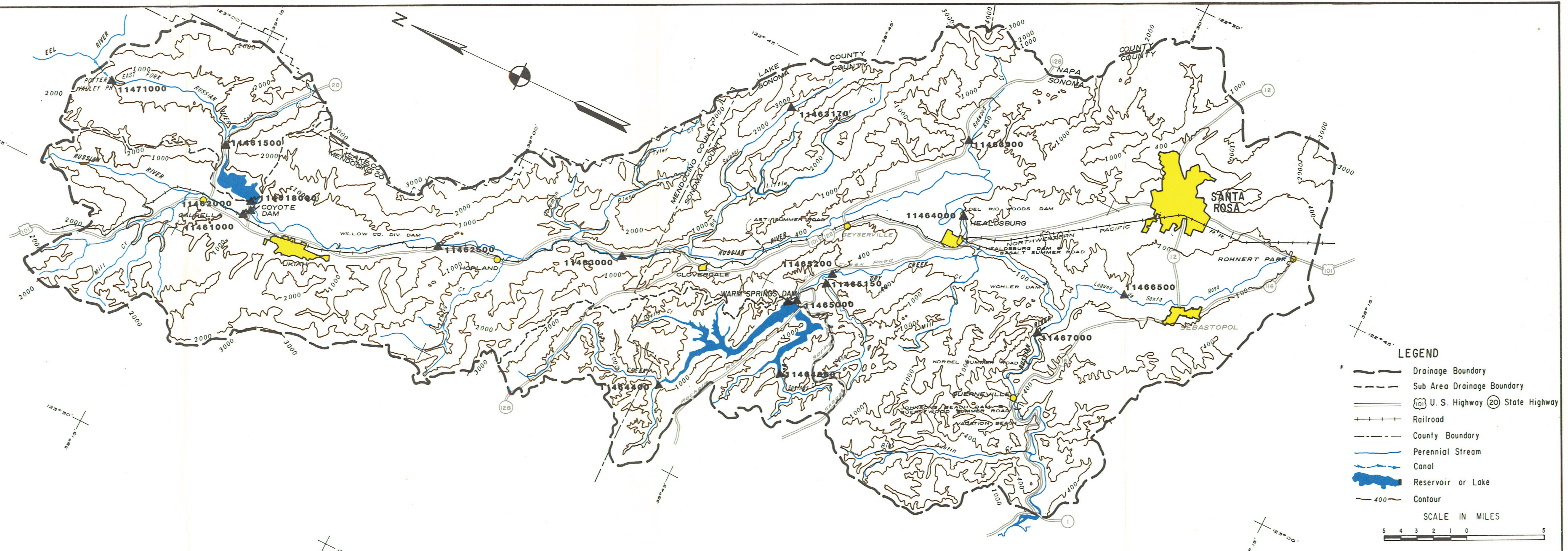
▲ WATER STAGE RECORDER

▲↙ WATER STAGE RECORDER W/TELEPHONE TELEMARK

PROJECT HADA STATIONS														
INDEX NO.	STATIONS	TYPE OF GAGE	LOCATION LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	ELEVATION FEET	ELEVATION DATUM	DRAINAGE AREA (SQ. MI.)	RECORDS BEGAN IN	RECORDS AGENCY IN CHARGE	RECORDS PUBLISHED BY	MAXIMUM FLOW DATE	MAXIMUM FLOW CFS
11461800	LAKE MENDOCINO NEAR UKIAH	▲↙	39	12	123	11	—	—	105	1965	USCE	USGS	24 JAN 70	14,800'
11462000	EAST FORK RUSSIAN RIVER NEAR UKIAH	▲↙	39	12	123	11	614.4	MSL	105	1911	USGS	USGS	24 JAN 70	7,350
11461000	RUSSIAN RIVER NEAR UKIAH	▲↙	39	12	123	12	599.2	MSL	100	1911	USGS	USGS	21 DEC 55	18,900
11462500	RUSSIAN RIVER NEAR HOPLAND	▲↙	39	02	123	08	497.6	MSL	362	1939	USGS	USGS	22 DEC 55	45,000
11464000	RUSSIAN RIVER NEAR HEALDSBURG	▲↙	38	37	122	50	77.0	MSL	793	1939	USGS	USGS	23 DEC 64	71,300
11465200	DRY CREEK NEAR GEYSERVILLE	▲↙	38	42	122	57	158.4	MSL	162	1959	USGS	USGS	31 JAN 63	32,400
11467000	RUSSIAN RIVER NEAR GUERNEVILLE	▲↙	38	31	122	56	20.1	MSL	1338	1939	USGS	USGS	23 DEC 64	93,400
11465000	DRY CREEK BELOW WARM SPRINGS DAM	▲↙	38	43	123	01	200	TM	130	1981	USGS	USGS	—	—

*MAX DAILY DISHARGE OR STAGE.
'ACRE-FEET OF STORAGE.
MSL = MEAN SEA LEVEL.
TM = TOPOGRAPHIC MAP.

WATER QUALITY STATIONS								
INDEX NUMBER	STATION NAME	SYMBOL	LOCATION LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	AGENCY	TYPE & FREQUENCY OF DATA
11-461500	EAST FORK RUSSIAN RIVER NEAR CALPELLA, CA	◆	39	15	123	08	USCE	SEMI-ANNUAL GENERAL PHYSICAL AND CHEMICAL
11-461800	LAKE MENDOCINO NEAR UKIAH, CA	◆	39	12	123	11	USCE	SEMI-ANNUAL GENERAL PHYSICAL AND CHEMICAL
11-462000	EAST FORK RUSSIAN RIVER NEAR UKIAH, CA	◆	39	12	123	11	USGS	SEMI-ANNUAL GENERAL PHYSICAL AND CHEMICAL WITH CONTINUOUS TEMP. RECORDER
11-464000	RUSSIAN RIVER NEAR HEALDSBURG, CA	◆	38	37	122	50	USGS	SEMI-ANNUAL GENERAL PHYSICAL AND CHEMICAL WITH CONTINUOUS TEMP. RECORDER
11-465150	PENA CREEK NEAR GEYSERVILLE	◆	38	42	122	58	USGS	PERIODIC GENERAL PHYSICAL AND CHEMICAL, AND TEMP.
11-465200	DRY CREEK NEAR GEYSERVILLE, CA	◆	38	42	122	57	USGS	SEMI-ANNUAL GENERAL PHYSICAL AND CHEMICAL WITH CONTINUOUS TEMP. RECORDER
11-467000	RUSSIAN RIVER NEAR GUERNEVILLE, CA	◆	38	31	122	56	USGS	CONTINUOUS WATER TEMP. AND SEDIMENT RECORDS

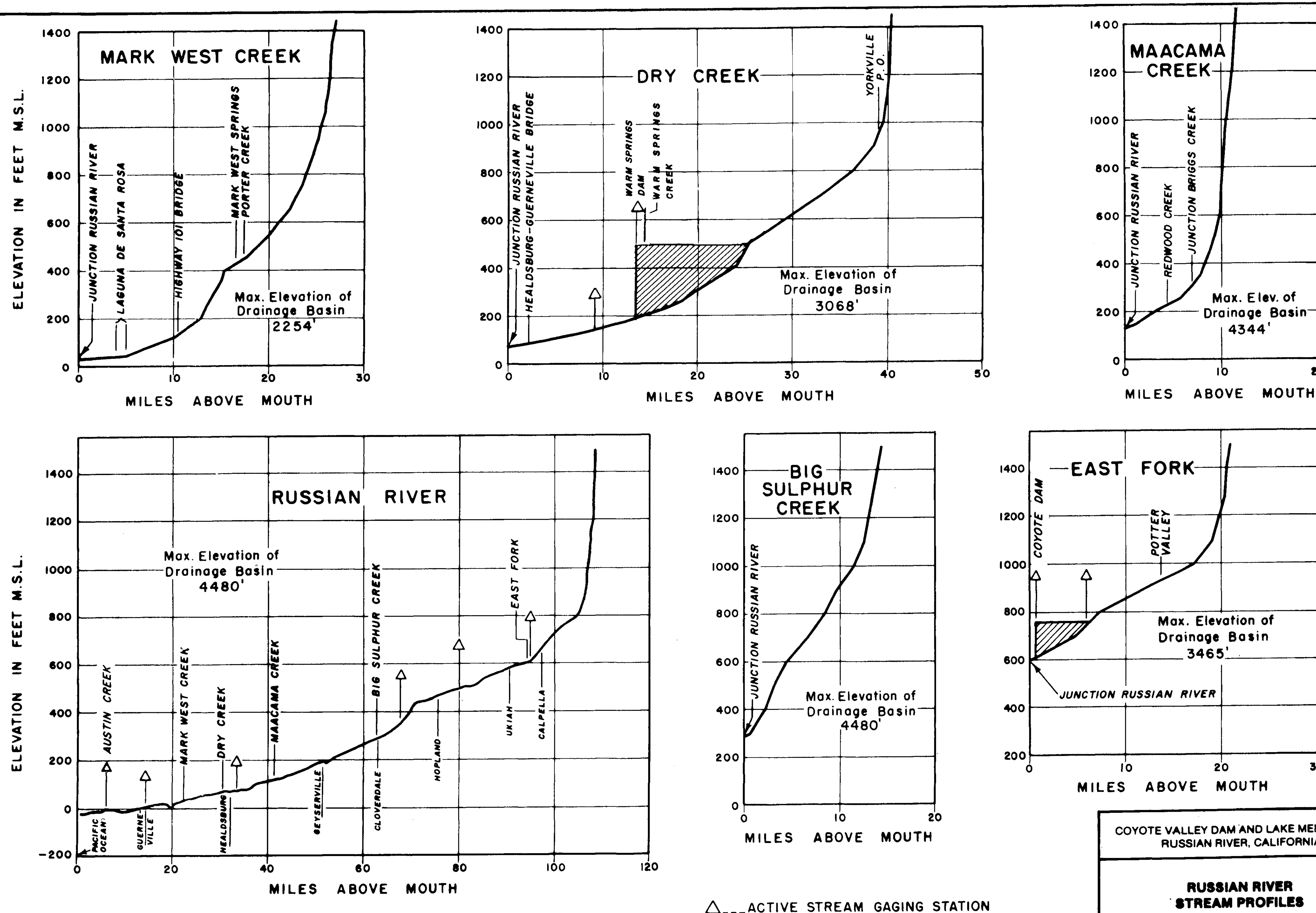


COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

TOPOGRAPHY AND STREAM GAGING STATIONS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

PLATE 11



COYOTE VALLEY DAM AND LAKE MENDOCINO,
RUSSIAN RIVER, CALIFORNIA

RUSSIAN RIVER STREAM PROFILES

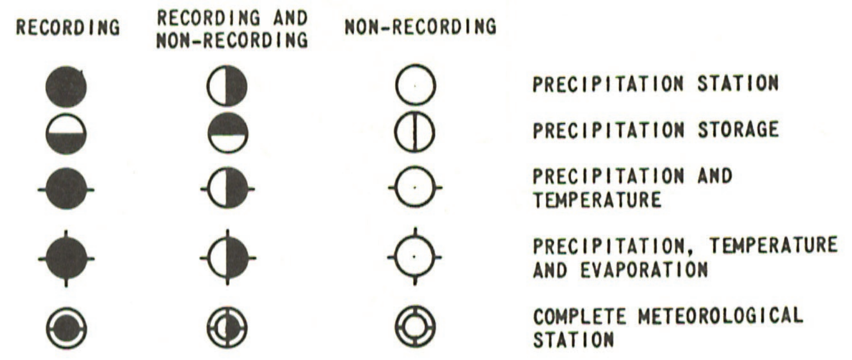
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

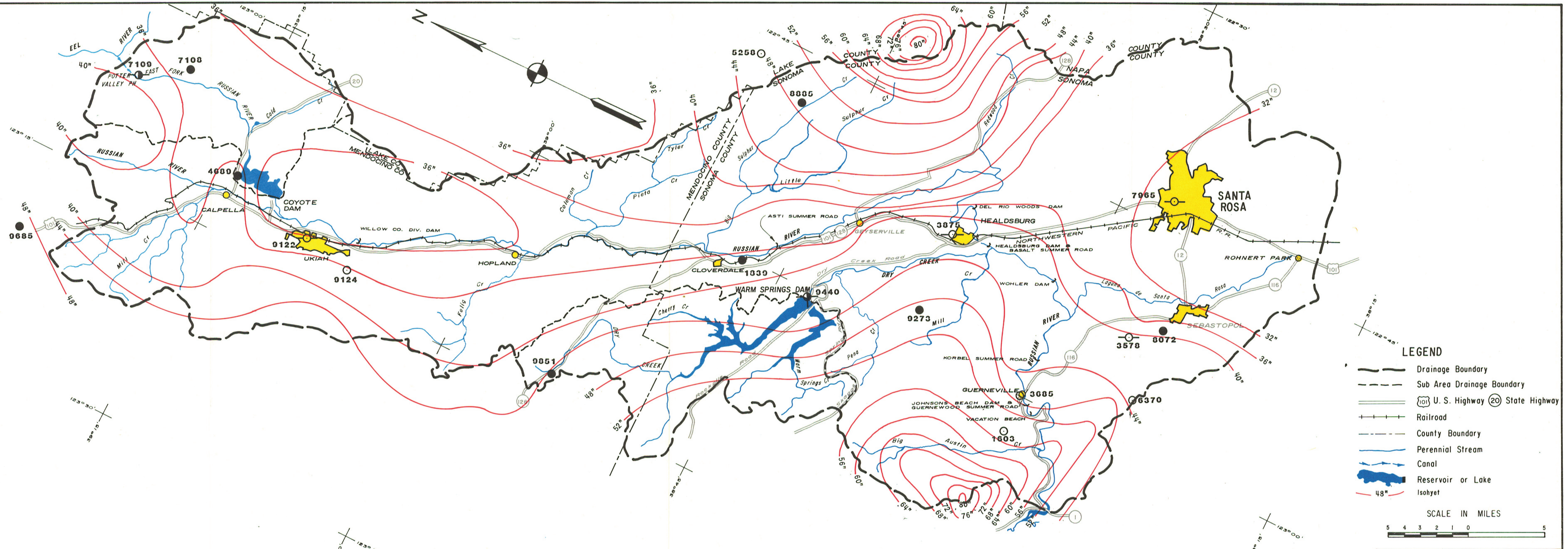
CLIMATOLOGICAL STATIONS									
INDEX NO	STATION NAME	ELEVATION (FEET, MSL)	TYPE OF GAGE	LOCATION				RECORD	
				LATITUDE		LONGITUDE		BEGAN IN	AGENCY IN CHARGE
				DEG	MIN	DEG	MIN		
9685	WILLITS HOWARD FOR RS	1925	●	39	21	123	19	1940	CSFD
7109	POTTER VALLEY PH	1015	◐	39	22	123	08	1911	PG&E
7108	POTTER VALLEY 3 SE	1100	●	39	18	123	04	1952	COE
4689	LAKE MENDOCINO DAM	670	●	39	14	123	11	1971	COE
9122	UKIAH	623	⊙	39	09	123	12	1877	UFD
9124	UKIAH 4 WSW	1900	⊙	39	08	123	16	1951	P
9851	YORKVILLE	1120	●	38	55	123	16	1939	P
1839	CLOVERDALE 1 S	340	●	38	47	123	01	1955	CSFD
8885	THE GEYSERS	1665	●	38	48	122	50	1939	P
9440	WARM SPRINGS DAM	735	◐	38	43	123	00	1972	COE
9273	VENADO	1260	●	38	37	123	01	1939	SCWA
3875	HEALDSBURG	335	⊙	38	37	122	52	1877	HFD
1603	CAZADERO 3 W	1040	⊙	38	32	123	08	1939	P
3685	GUERNEVILLE 2	200	⊙	38	32	123	01	1971	P
7643	ST. HELENA 4 WSW	225	●	38	30	122	28	1907	CSFD
7965	SANTA ROSA	170	⊙	38	27	122	42	1888	P
6370	OCCIDENTAL	960	⊙	38	25	122	58	1940	P
3578	GRATON 1 W	210	⊙	38	26	122	52	1896	P
8072	SEBASTOPOL 4 SSE	140	●	38	21	122	49	1935	COS
5258	MAHNKE	2380	⊙	38	51	122	47	1954	P

UFD = UKIAH FIRE DEPT.
P = PRIVATE
SCWA = SONOMA COUNTY WATER AGENCY
HFD = HEALDSBURG FIRE DEPT.
CSFD = CAL. STATE FOREST DEPT.
PFD = PETALUMA FIRE STATION
COE = CORPS OF ENGINEERS
COS = CITY OF SEBASTOPOL
PG&E = PACIFIC GAS & ELECTRIC

DATA SOURCES:
a) CLIMATOLOGICAL DATA — CALIF. OCT '83 VOL 87, NO. 10
b) INDEX TO SOURCES OF HYDROLOGIC DATA, BULLETIN 230-81, DEC. '81

LEGEND FOR CLIMATOLOGICAL STATIONS



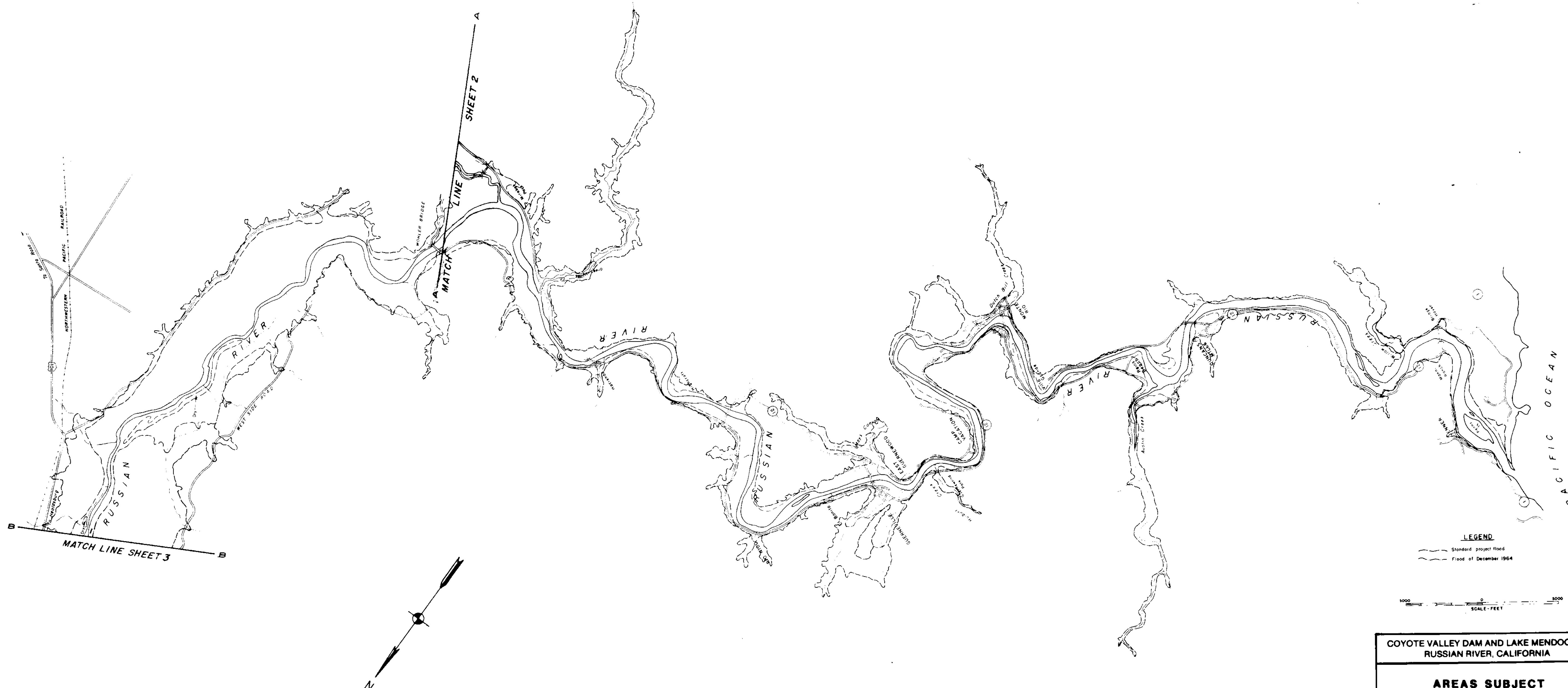


COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

NORMAL ANNUAL PRECIPITATION AND CLIMATOLOGICAL STATIONS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

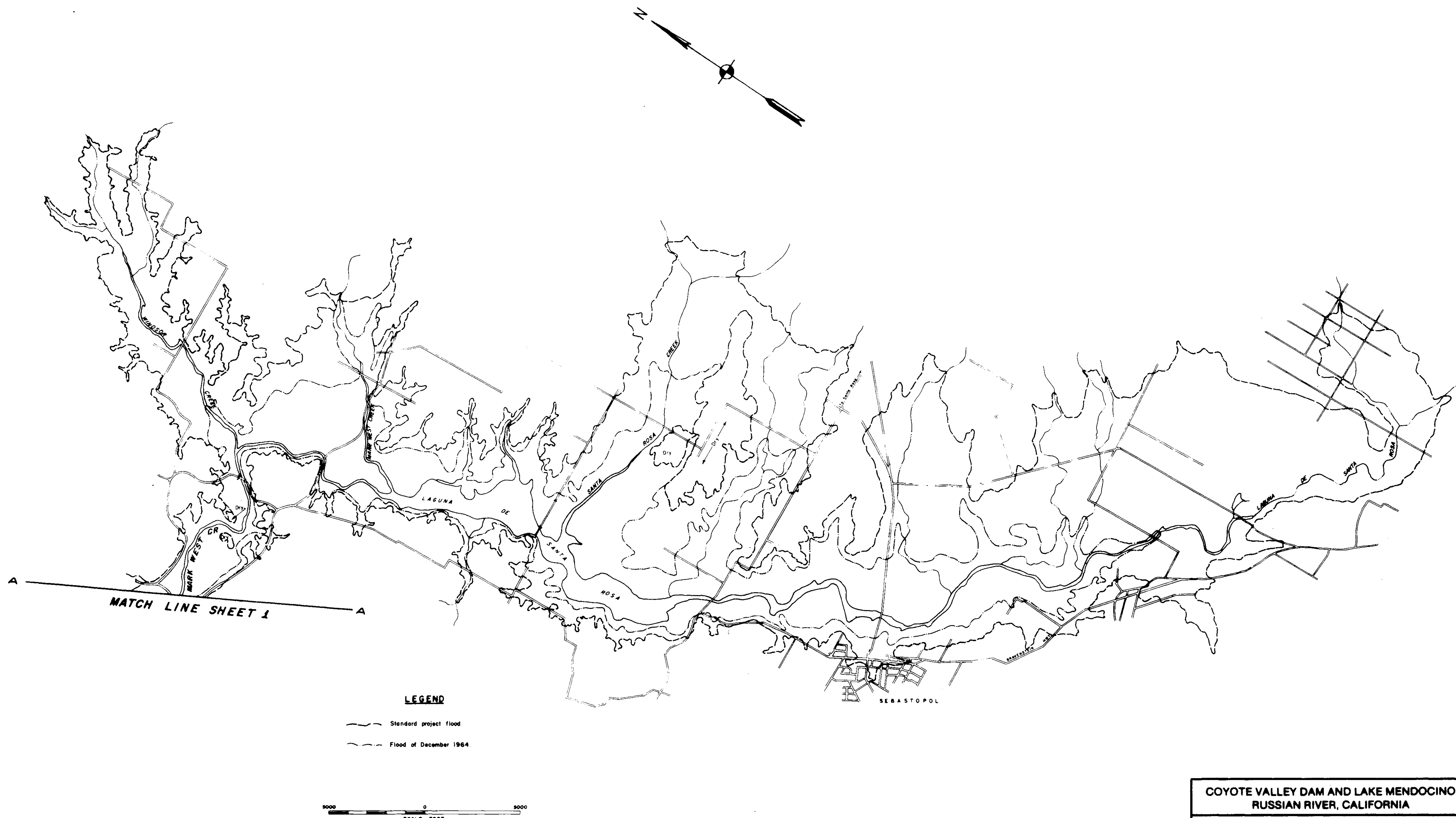
PLATE 13



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

AREAS SUBJECT TO FLOODING

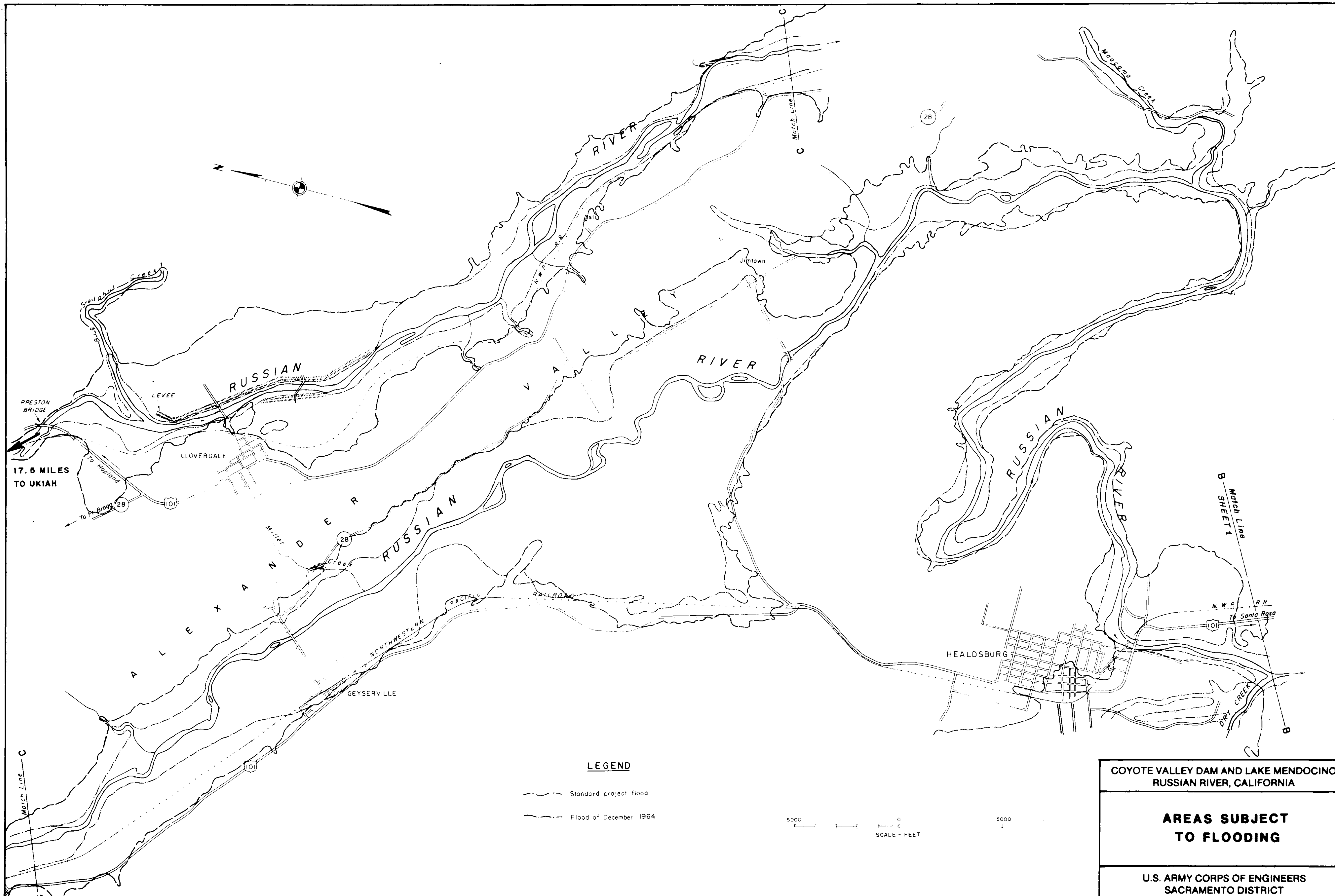
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

AREAS SUBJECT TO FLOODING

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

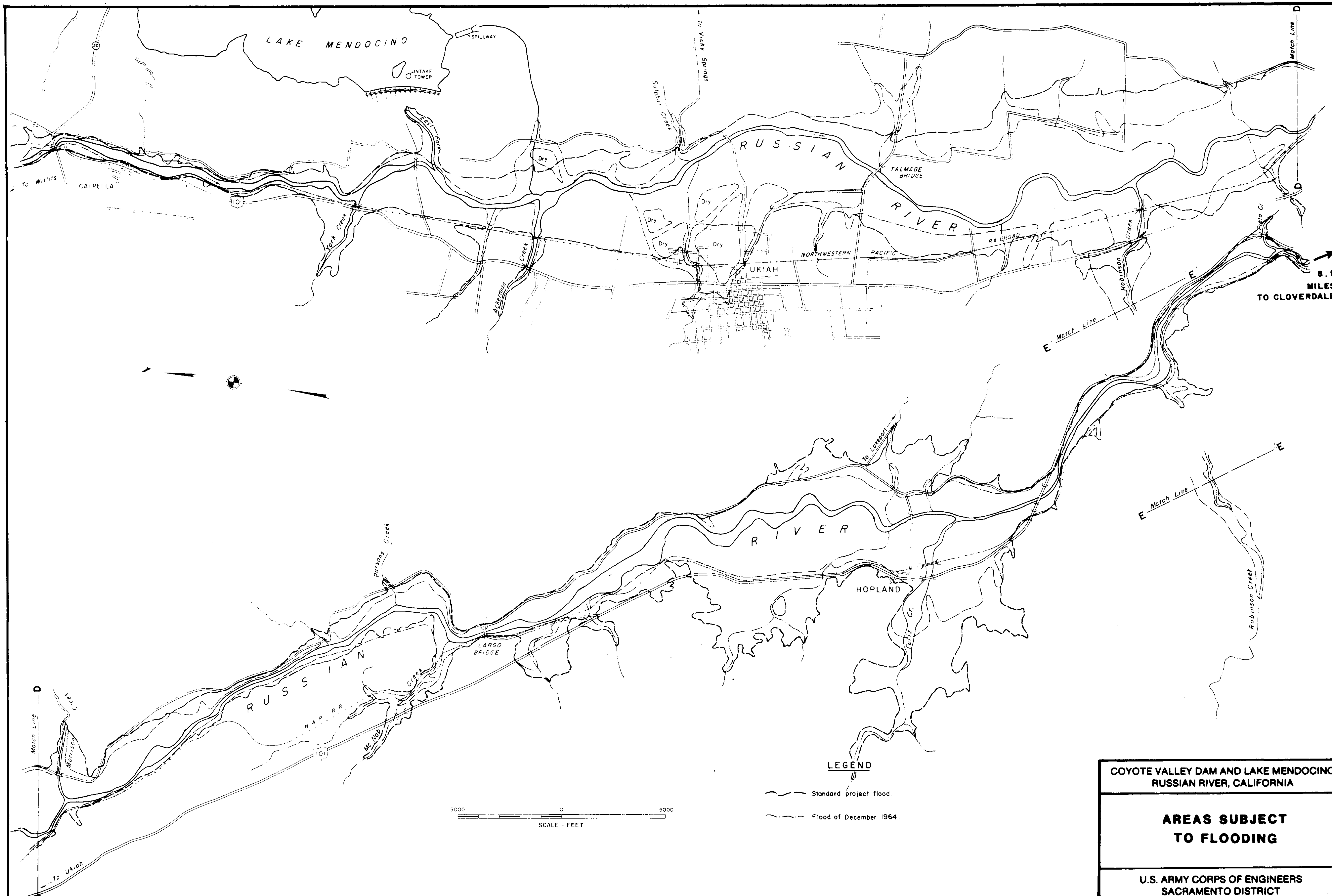


COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

AREAS SUBJECT TO FLOODING

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SHEET 3 OF 4 PLATE 15

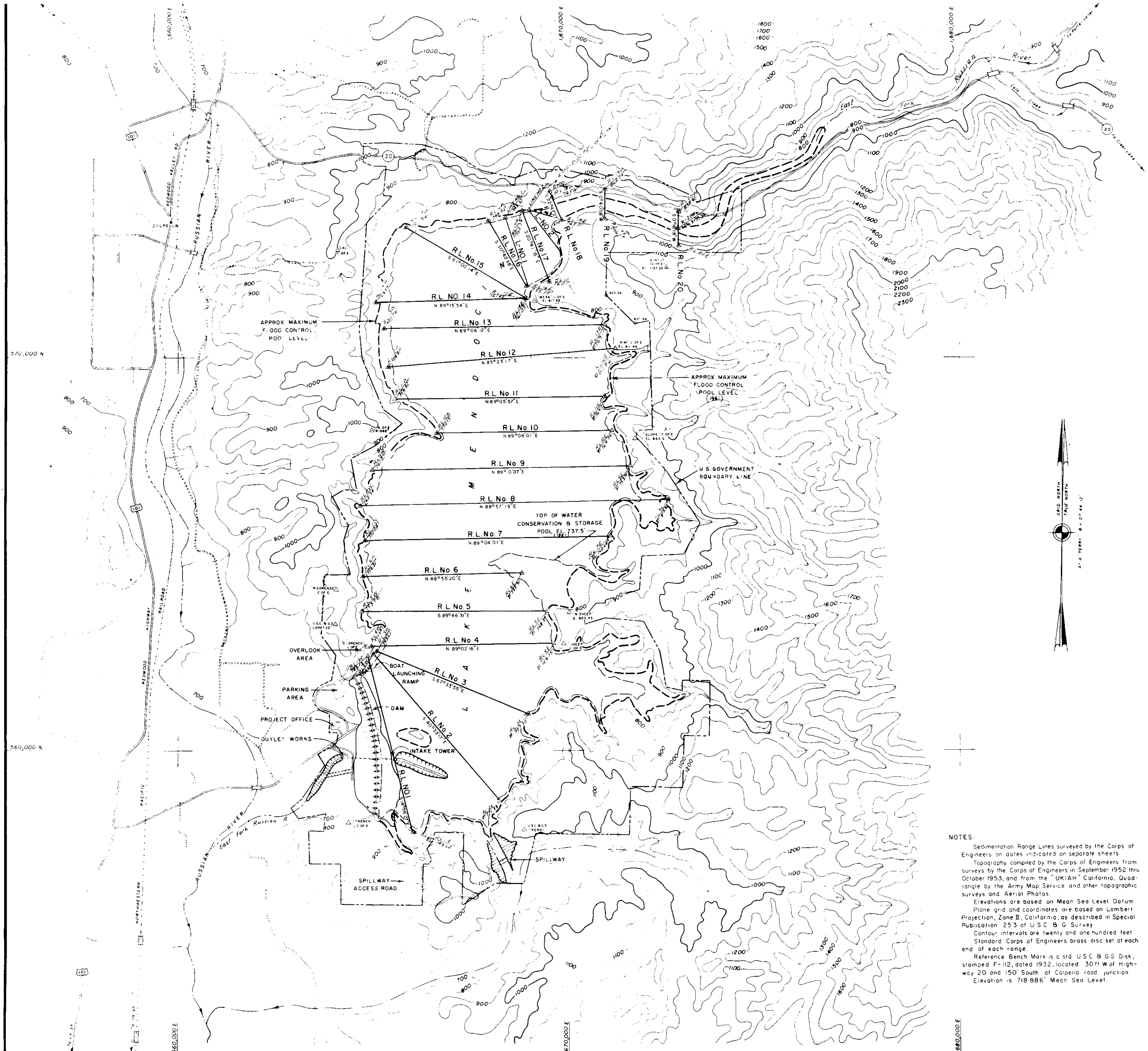


COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

AREAS SUBJECT TO FLOODING

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SHEET 4 OF 4 PLATE 15



RANGE LINE MONUMENTS							
LAMBERT COORDINATES							
WEST MONUMENT				EAST MONUMENT			
NO	X	Y	ELEV	NO.	X	Y	ELEV
1	1,664,888.72	562,424.31	783.13	1	1,666,090.07	557,922.04	749.62
2	1,664,977.71	562,487.161	768.57	2	1,668,229.30	558,721.59	771.88
3	1,665,083.06	562,542.33	753.61	3	1,668,961.81	560,940.90	757.30
4	1,664,954	562,651	777.24	4	1,669,610.12	562,729.12	759.75
5	1,664,716.39	563,558.776	753.78	5	1,669,476.08	563,539.64	768.34
6	1,664,733.928	564,440.346	756.31	6	1,668,801.51	564,516.85	755.91
7	1,664,790.74	565,344.25	766.63	7	1,671,064.66	565,446.43	762.64
8	1,664,709.25	566,242.22	762.34	8	1,672,539.031	566,384.987	815.82
9	1,665,068.36	567,154.99	761.87	9	1,671,566.78	567,249.29	787.92
10	1,666,617.58	568,073.60	770.15	10	1,671,105.67	568,144.07	764.74
11	1,665,749.58	568,961.11	756.82	11	NOT AVAILABLE		764.34
12	1,665,372.570	569,768.294	754.40	12	1,671,182.27	570,236.95	811.46
13	1,665,274.994	570,750.417	750.06	13	1,670,920.49	570,838.75	769.11
14	1,665,041.00	571,417.26	768.59	14	1,668,964.483	571,536.10	761.03
15	1,665,823.248	573,327.537	751.94	15	1,668,949.04	571,595.17	761.40
16	1,667,921.05	573,515.21	748.92	16	1,668,932.30	571,812.79	755.58
17	1,668,802.08	573,750.246	752.39	17	1,669,486.497	571,937.812	760.01
18	1,669,517.30	574,231.37	796.92	18	1,669,815.44	573,504.01	765.01
19	1,670,930.58	574,277.95	868.24	19	1,670,921.71	573,534.06	796.17
20	1,672,801.22	573,717.57	838.40	20	1,672,795.48	572,861.81	
L-1	1,668,381.59	573,572.45	749.27				
L-2	1,669,012.67	573,775.01	750.16				

NOTE:
The above listed west monument coordinates for Ranges 18, 19 and 20 are not the 0+00 of the range, but the second monument on the same side of the reservoir.

The following west monuments of the above list are not the 0 + 00 of the range, but as indicated

Range Line 1 Sta − 1 + 65.90
4 Sta − 1 + 13.10

1000 0 1000 2000 3000 4000 5000
SCALE IN FEET

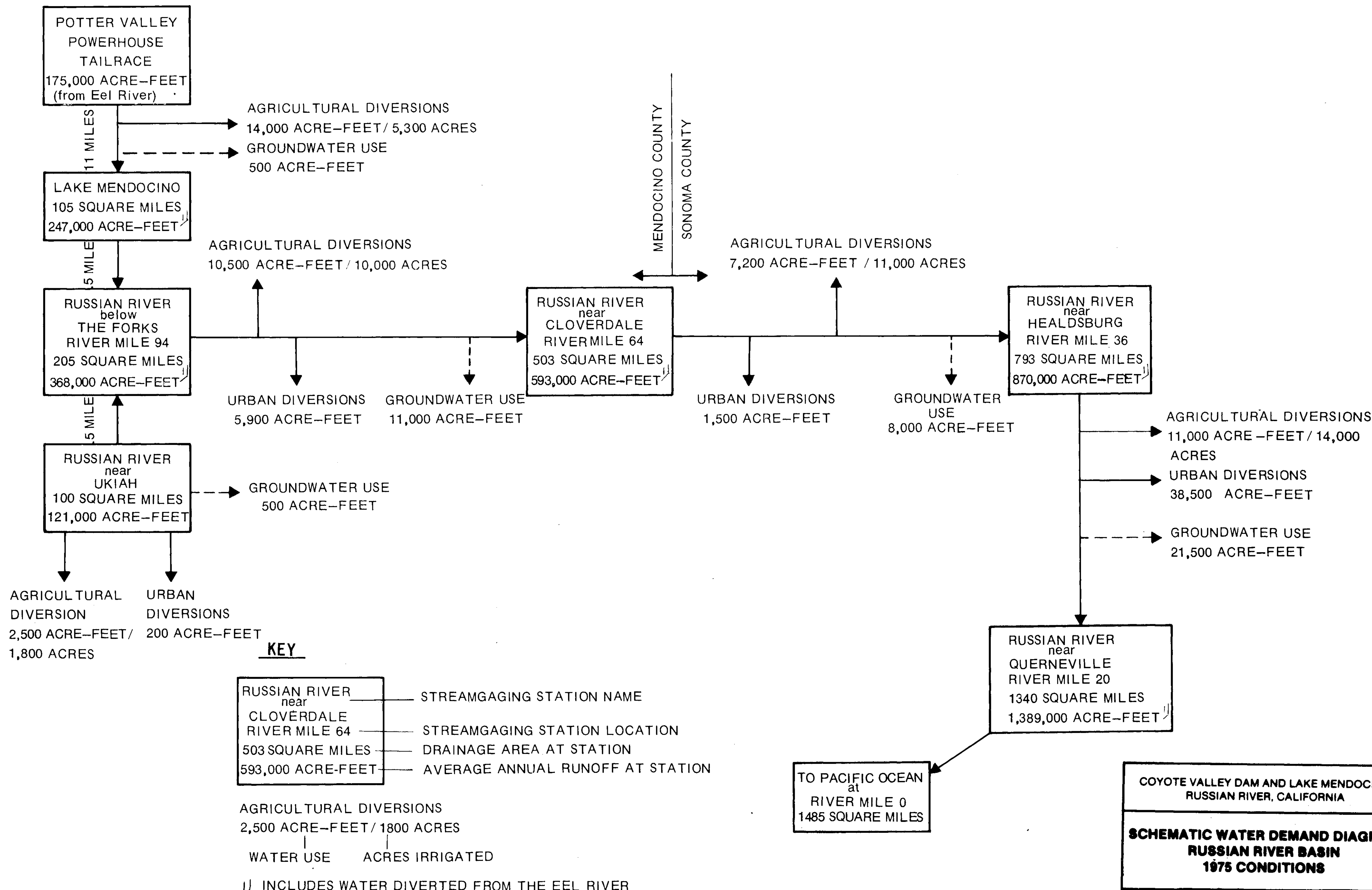
NOTE: THIS DRAWING SUPERSEDES DRAWING DATED 8 MAR. 1961

NOTES:
Sedimentation Range Lines surveyed by the Corps of Engineers on dates indicated on separate sheets.
Topography compiled by the Corps of Engineers from surveys by the Corps of Engineers in September 1952 thru October 1953, and from the "UKIAH" California, Quadrangle by the Army Map Service and other topographic surveys and Aerial Photos.
Elevations are based on Mean Sea Level Datum.
Plane grid and coordinates are based on Lambert Projection, Zone II, California, as described in Special Publication 253 of U.S.C. & G. Survey.
Contour intervals are twenty and one hundred feet.
Standard Corps of Engineers brass disc set at each end of each range.
Reference Bench Mark is a std U.S.C. & G.S. Disk, stamped F-112, dated 1932, located 30 ft. W of Highway 20 and 150' South of Calpella road junction.
Elevation is 718.886' Mean Sea Level.

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

LAKE MENDOCINO
SEDIMENTATION RANGES

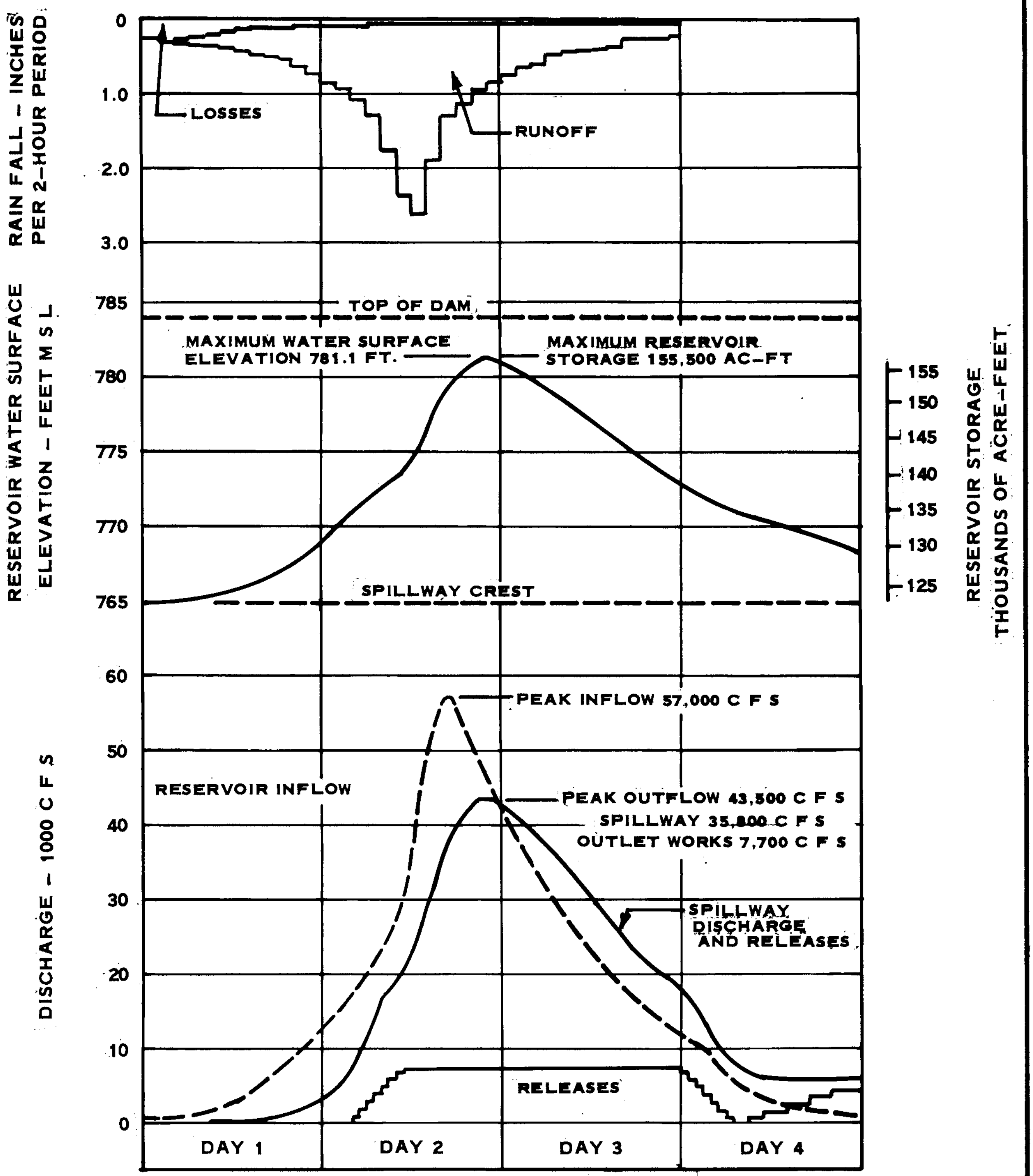
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

SCHEMATIC WATER DEMAND DIAGRAM
RUSSIAN RIVER BASIN
1975 CONDITIONS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



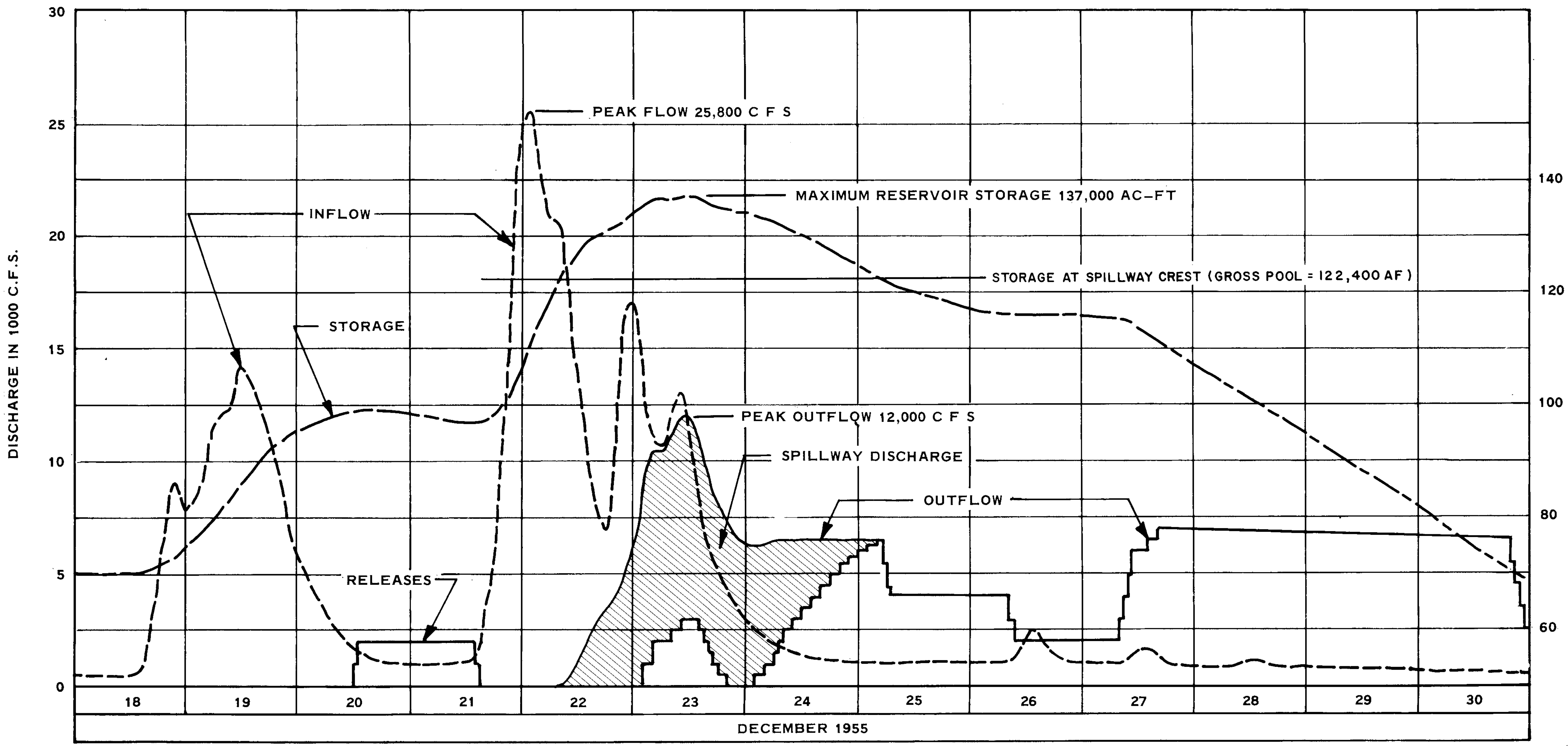
TOTAL RAINFALL	27.80 INCHES
LOSSES	4.99 INCHES
DIRECT RUNOFF	22.81 INCHES
BASE FLOW	1.71 INCHES
TOTAL RUNOFF	24.52 INCHES

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

SPILLWAY DESIGN FLOOD

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

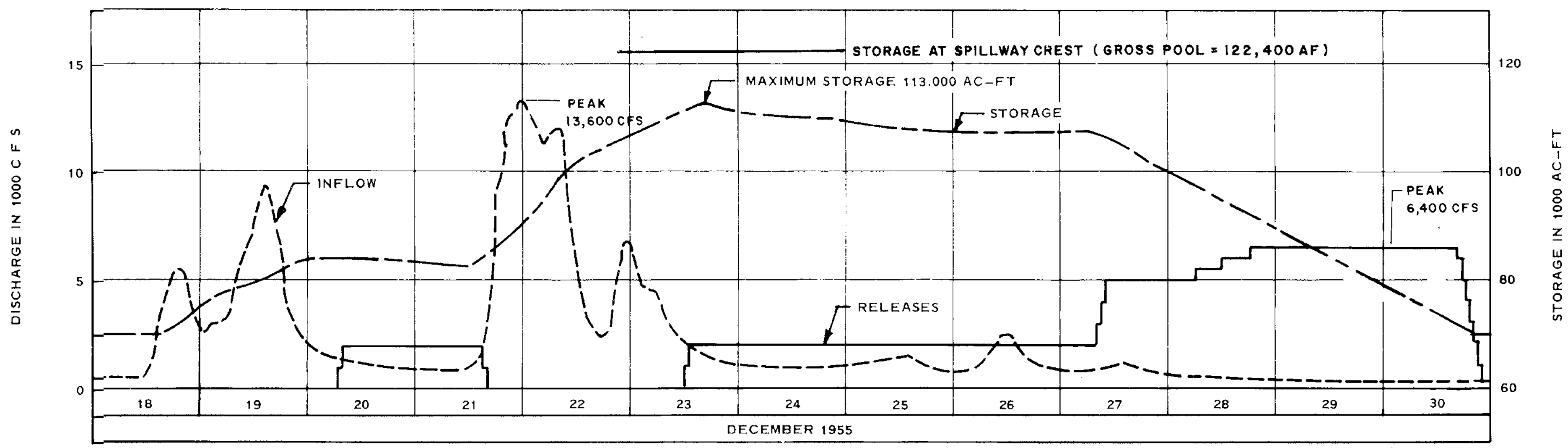
PLATE 18

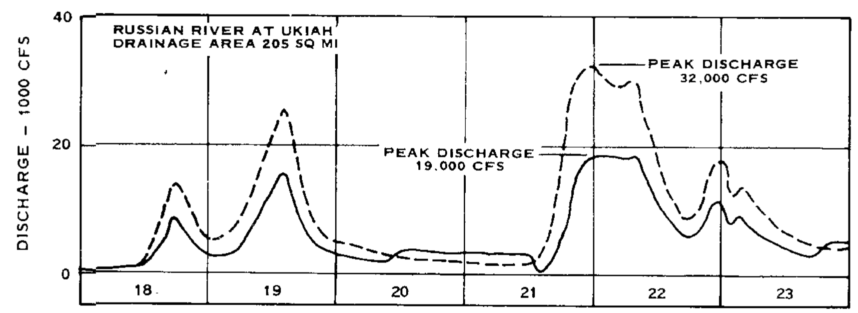


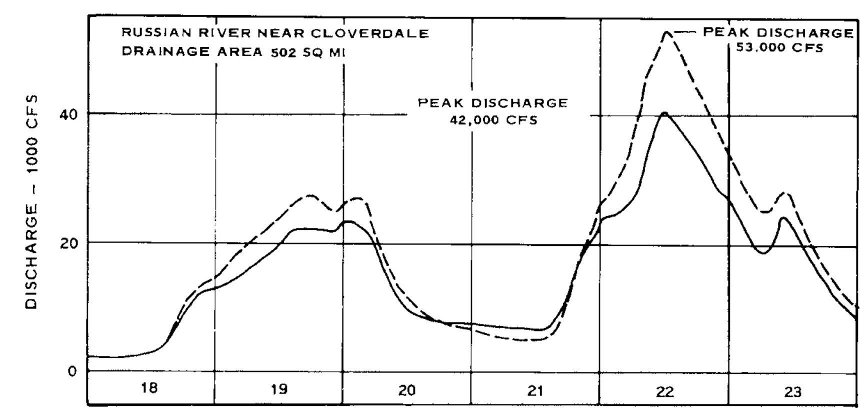
COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

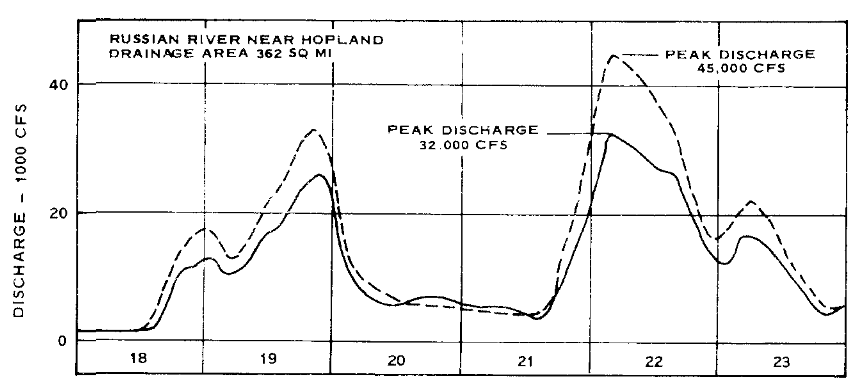
STANDARD PROJECT FLOOD

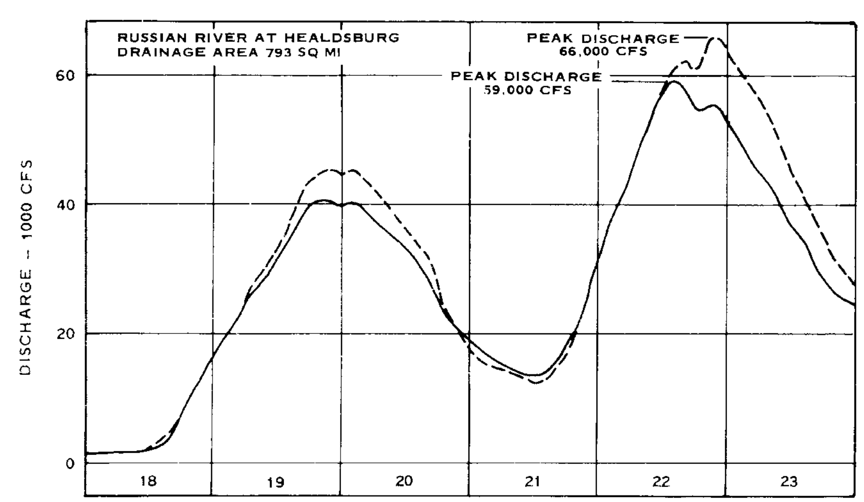
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

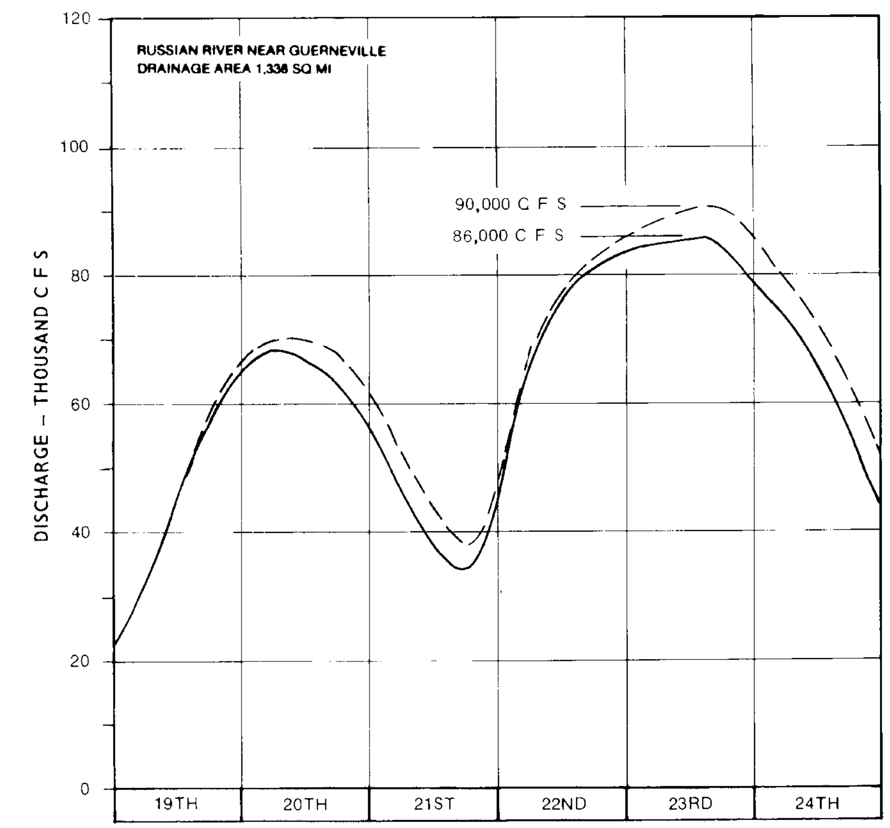












LEGEND:

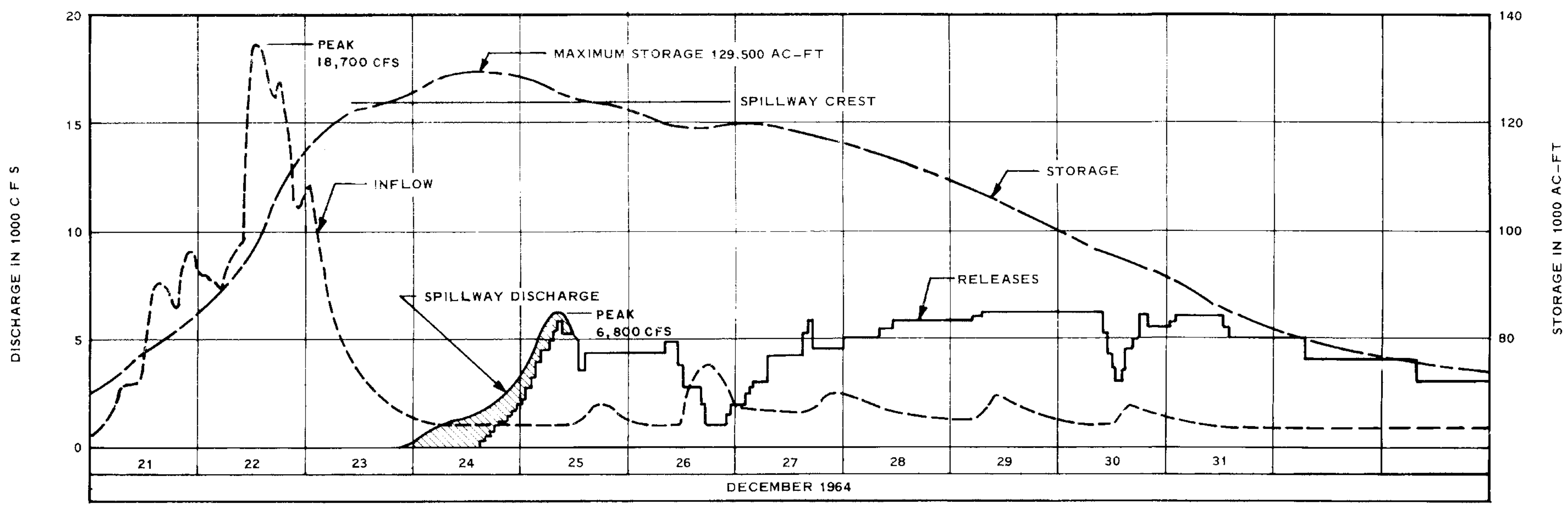
——— PRESENT CONDITIONS, WITH COYOTE DAM

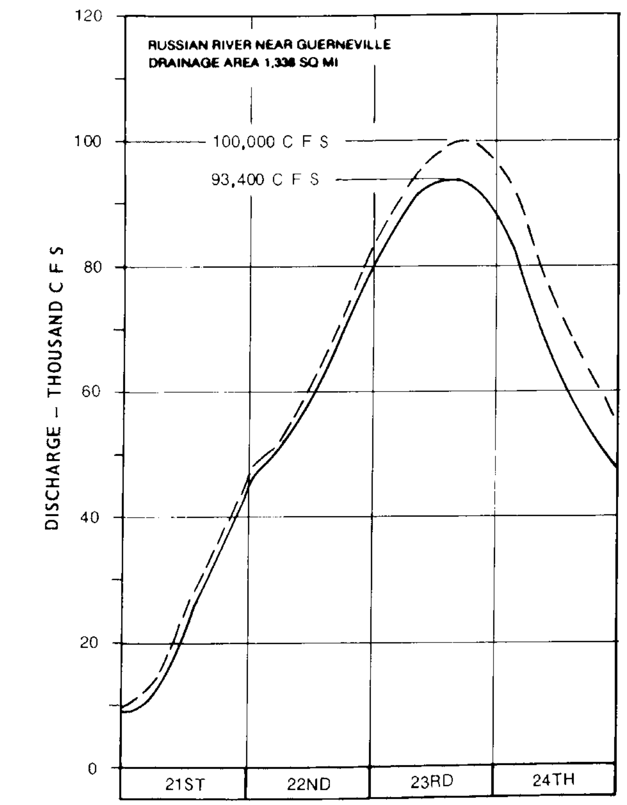
– – – PRE-PROJECT CONDITIONS, WITHOUT COYOTE DAM

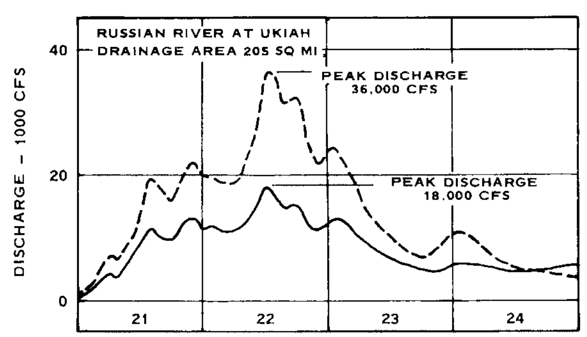
COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

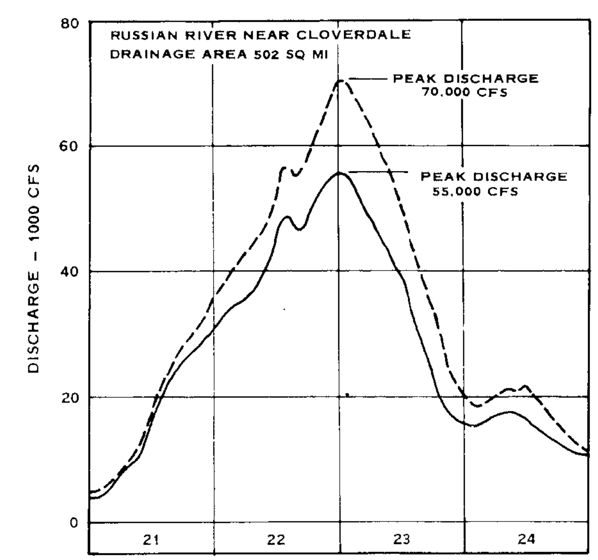
HYPOTHETICAL ROUTING OF 1955 RAIN FLOOD

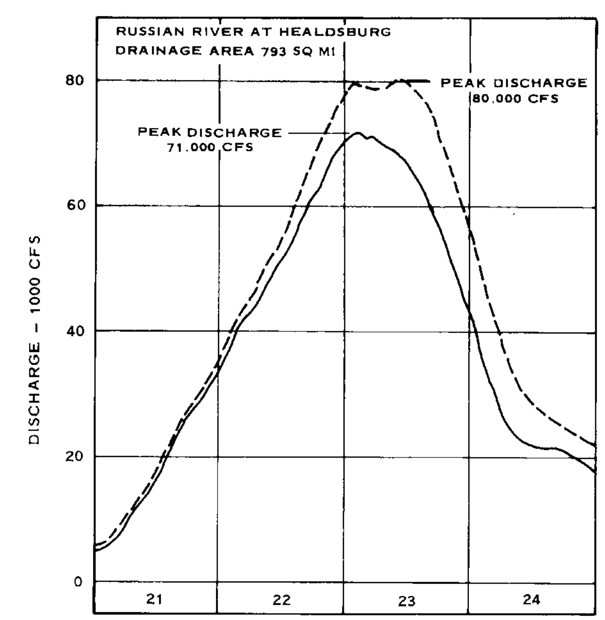
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

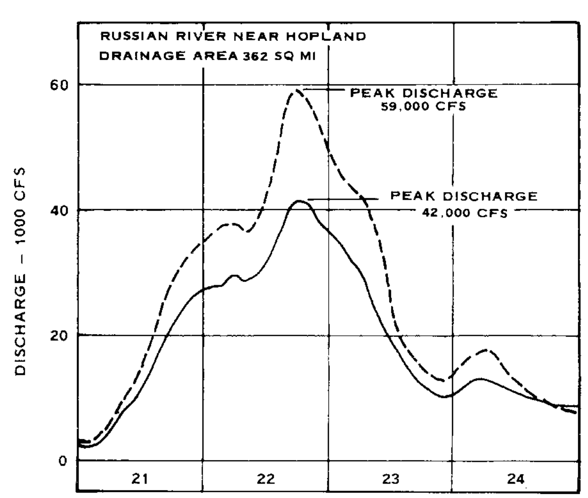












LEGEND:

——— PRESENT CONDITIONS, WITH COYOTE DAM

– – – – PRE-PROJECT CONDITIONS, WITHOUT COYOTE DAM

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

HYPOTHETICAL ROUTING OF 1964 RAIN FLOOD

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

ANNUAL MAXIMUM RAIN FLOODFLOWS
EAST FORK RUSSIAN RIVER BELOW COYOTE VALLEY DAM
UNREGULATED CONDITIONS
(FLOWS IN CFS)

WATER YEAR	PEAK		1-DAY		3-DAY		7-DAY		15-DAY		30-DAY		60-DAY	
	DATE	FLOW	DATE	FLOW	DATE	FLOW	DATE	FLOW	DATE	FLOW	DATE	FLOW	DATE	FLOW
1952	1 Dec	7,980	1 Feb	4,220	14 Jan	2,540	11 Jan	1,860	10 Jan	1,430	10 Jan	1,260	26 Dec	1,070
1953	7 Dec	9,540	9 Jan	3,780	7 Jan	2,510	8 Jan	1,790	6 Jan	1,760	26 Dec	1,300	1 Dec	1,000
1954	17 Jan	10,300	16 Jan	4,540	16 Jan	3,270	16 Jan	1,810	16 Jan	1,310	16 Jan	960	15 Jan	710
1955	5 Dec	2,500	19 Jan	1,320	18 Jan	980	16 Jan	750	15 Jan	600	31 Dec	500	1 Dec	480
1956	21 Dec	13,300	22 Dec	7,300	21 Dec	4,700	18 Dec	3,320	16 Dec	1,880	18 Dec	1,730	5 Dec	1,260
1957														
1958	24 Feb	4,300	25 Feb	4,080	24 Feb	3,160	20 Feb	2,180	12 Dec	2,000	29 Jan	1,770	3 Feb	1,280
1959			16 Feb	2,680	14 Feb	2,140	14 Feb	1,700	10 Feb	1,160	24 Jan	820	6 Jan	690
1960			8 Feb	4,920	7 Feb	3,730	5 Feb	2,180	30 Jan	1,390	7 Feb	990	1 Feb	770
1961			1 Dec	3,320	9 Feb	1,990	9 Feb	1,280	29 Jan	990	25 Jan	740	29 Jan	700
1962			13 Feb	2,710	12 Feb	2,350	12 Feb	1,910	6 Feb	1,290	8 Feb	1,130	7 Feb	790
1963			31 Jan	4,340	30 Jan	2,800	30 Jan	1,570	27 Mar	1,200	27 Mar	1,000	22 Mar	700
1964			21 Jan	4,130	20 Jan	2,090	17 Jan	1,320	17 Jan	850	12 Jan	620	24 Nov	490
1965			22 Dec	14,590	21 Dec	8,710	21 Dec	4,770	22 Dec	3,090	19 Dec	2,150	27 Nov	1,330
1966			4 Jan	7,070	3 Jan	3,900	31 Dec	2,200	23 Dec	1,360	21 Dec	870	28 Dec	680
1967			21 Jan	4,210	20 Jan	2,920	20 Jan	2,200	18 Jan	1,750	18 Jan	1,070	20 Jan	780
1968			14 Jan	2,930	14 Jan	1,720	19 Feb	1,150	11 Feb	740	28 Jan	710	9 Jan	610
1969			23 Dec	4,610	11 Jan	3,580	23 Dec	2,010	23 Dec	1,750	11 Jan	1,450	23 Dec	1,240
1970			23 Jan	7,610	21 Jan	5,120	21 Jan	3,660	13 Jan	3,020	9 Jan	1,890	19 Dec	1,320
1971			16 Jan	7,010	15 Jan	4,240	13 Jan	2,380	26 Nov	1,460	27 Nov	1,050	23 Nov	990
1972			22 Jan	1,550	21 Jan	1,140	21 Jan	790	22 Feb	630	10 Jan	510	19 Jan	480
1973			11 Jan	3,990	11 Jan	3,100	11 Jan	2,350	9 Jan	1,810	9 Jan	1,310	8 Jan	1,030
1974			16 Jan	8,460	14 Jan	4,720	14 Jan	2,850	10 Jan	1,600	21 Dec	1,310	29 Nov	1,010
1975			12 Feb	4,140	21 Mar	2,710	19 Mar	2,430	15 Mar	1,880	6 Mar	1,290	1 Feb	1,210
1976			26 Feb	1,290	26 Feb	1,150	25 Feb	1,060	25 Feb	670	16 Feb	420	25 Oct	330
1977			1 Oct	330	22 Nov	310	20 Nov	300	18 Nov	300	3 Nov	280	1 Oct	280
1978			16 Jan	4,670	14 Jan	3,900	13 Jan	2,680	4 Jan	2,070	14 Jan	1,450	4 Jan	1,220
1979			11 Jan	3,210	20 Feb	2,060	18 Feb	1,870	15 Feb	1,650	13 Feb	1,170	10 Jan	840
1980			13 Jan	5,450	12 Jan	4,380	11 Jan	2,900	9 Jan	1,700	10 Jan	1,350	11 Jan	1,090
1981			28 Jan	2,790	27 Jan	2,340	27 Jan	1,460	22 Jan	1,020	22 Jan	760	22 Jan	600
1982			23 Nov	4,920	30 Mar	3,660	30 Mar	2,730	30 Mar	1,960	25 Mar	1,320	14 Feb	1,120
1983			28 Feb	5,530	28 Feb	4,500	25 Feb	3,130	27 Feb	2,210	27 Feb	1,860	24 Jan	1,550

COMPUTED STATISTICS

	PEAK	1-DAY	3-DAY	7-DAY	15-DAY	30-DAY	60-DAY
YEARS	6	31	31	31	31	31	31
LOG MEAN	3.842	3.596	3.433	3.277	3.136	3.016	2.921
STD. DEV.	.273	.309	.271	.238	.218	.206	.182
SKEW	-.976	-1.375	-1.399	-1.321	-1.027	-.895	-.854

ADOPTED STATISTICS

	PEAK	1-DAY	3-DAY	7-DAY	15-DAY	30-DAY	60-DAY
LOG MEAN	3.848	3.589	3.433	3.268	3.128	3.008	2.911
STD. DEV.	.219	.219	.205	.189	.168	.165	.154
SKEW	-.400	-.400	-.400	-.400	-.400	-.400	-.400

ANNUAL MAXIMUM RAIN FLOODFLOWS
RUSSIAN RIVER NEAR HOPLAND
UNREGULATED CONDITIONS

(FLOWS IN CFS)

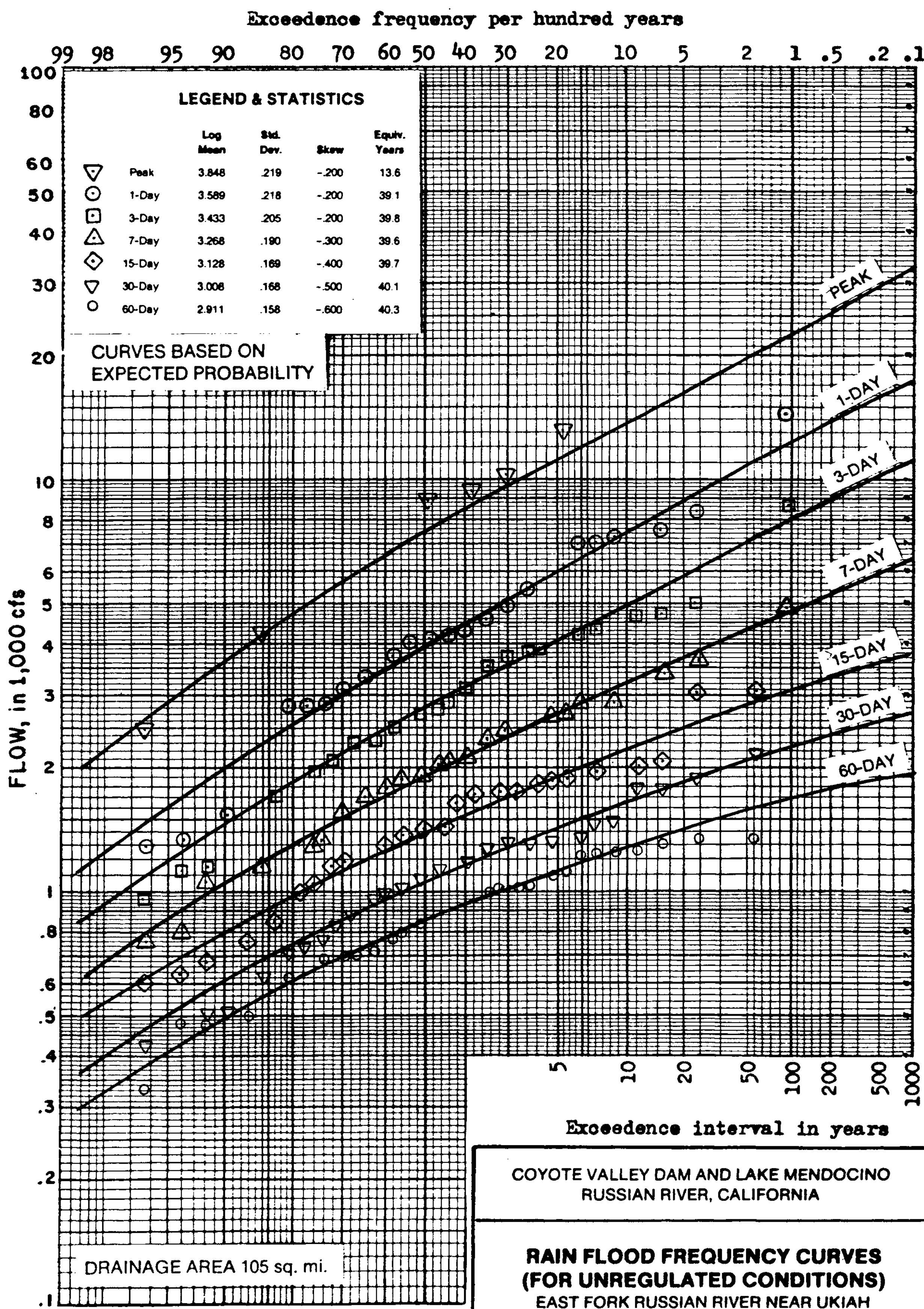
WATER YEAR	PEAK DATE	PEAK FLOW	1-DAY DATE	1-DAY FLOW	3-DAY DATE	3-DAY FLOW	7-DAY DATE	7-DAY FLOW	15-DAY DATE	15-DAY FLOW	30-DAY DATE	30-DAY FLOW	60-DAY DATE	60-DAY FLOW
1940	28 Feb	34,100	28 Feb	25,500	27 Feb	17,840	26 Feb	9,490	17 Feb	5,600	4 Feb	3,830	4 Feb	2,760
1941	11 Feb	21,700	11 Feb	15,900	10 Feb	10,170	8 Feb	6,160	14 Jan	4,250	14 Jan	3,870	5 Jan	3,360
1942	6 Feb	24,500	6 Feb	19,000	4 Feb	13,770	2 Feb	9,270	24 Jan	6,190	22 Jan	4,060	14 Dec	3,560
1943	21 Jan	34,000	21 Jan	22,000	21 Jan	16,430	20 Jan	9,270	20 Jan	5,650	20 Jan	3,380	22 Dec	2,460
1944	4 Mar	12,300	4 Mar	8,880	4 Mar	4,900	29 Feb	3,410	28 Feb	2,070	8 Feb	1,330	24 Jan	1,040
1945	2 Feb	9,470	3 Feb	5,580	1 Feb	4,670	1 Feb	3,590	31 Jan	2,420	31 Jan	1,560	31 Jan	1,430
1946	27 Dec	30,100	27 Dec	21,900	27 Dec	14,350	23 Dec	9,730	22 Dec	7,040	21 Dec	4,310	16 Nov	2,820
1947	10 Mar	10,400	10 Mar	6,630	9 Mar	3,570	9 Mar	2,140	2 Mar	1,900	11 Feb	1,400	11 Feb	990
1948	23 Mar	11,600	23 Mar	8,360	23 Mar	5,520	23 Mar	3,110	23 Mar	2,330	23 Mar	2,120	16 Mar	1,520
1949	19 Mar	9,730	19 Mar	6,060	18 Mar	4,950	16 Mar	3,650	9 Mar	3,290	22 Feb	2,490	4 Feb	1,900
1950	4 Feb	8,980	4 Feb	6,430	4 Feb	4,860	4 Feb	3,070	14 Jan	2,030	14 Jan	1,980	31 Dec	1,250
1951	21 Jan	33,900	3 Dec	17,600	21 Jan	11,310	17 Jan	7,500	10 Jan	4,780	15 Jan	3,720	2 Dec	2,700
1952	28 Dec	20,800	27 Dec	14,000	27 Dec	9,940	26 Dec	6,320	11 Jan	4,570	26 Dec	4,160	26 Dec	3,470
1953	9 Jan	19,200	9 Jan	14,800	7 Jan	8,430	14 Jan	6,180	7 Jan	5,900	26 Dec	4,190	2 Dec	2,920
1954	17 Jan	27,400	17 Jan	17,700	16 Jan	11,190	16 Jan	5,660	16 Jan	4,000	16 Jan	2,810	16 Jan	2,030
1955			19 Jan	4,080	18 Jan	2,960	18 Jan	2,080	16 Jan	1,460	31 Dec	1,160	2 Dec	1,030
1956	22 Dec	45,000	22 Dec	33,800	21 Dec	18,770	18 Dec	13,860	18 Dec	7,710	18 Dec	6,420	6 Dec	4,470
1957	24 Feb	13,400	24 Feb	11,000	23 Feb	7,740	23 Feb	4,950	23 Feb	3,390	23 Feb	2,520	21 Feb	1,590
1958	24 Feb	32,300	24 Feb	18,200	24 Feb	13,200	19 Feb	8,570	12 Feb	7,820	29 Jan	6,750	10 Jan	4,450
1959			16 Feb	9,800	15 Feb	6,720	14 Feb	5,090	10 Feb	3,200	10 Feb	1,990	5 Jan	1,630
1960			8 Feb	20,400	6 Feb	13,060	7 Feb	7,670	1 Feb	4,570	7 Feb	2,820	25 Jan	2,070
1961			1 Dec	11,260	1 Dec	5,620	9 Feb	3,840	31 Jan	2,760	29 Jan	2,000	29 Jan	1,890
1962			13 Feb	11,570	13 Feb	8,870	13 Feb	6,510	8 Feb	4,150	9 Feb	3,390	7 Feb	2,150
1963			31 Jan	14,820	30 Jan	10,060	30 Jan	5,400	5 Apr	3,430	27 Mar	3,060	22 Mar	1,920
1964			21 Jan	8,960	20 Jan	7,150	19 Jan	4,790	17 Jan	3,020	17 Jan	1,890	17 Jan	1,220
1965			22 Dec	48,280	21 Dec	31,600	21 Dec	18,120	22 Dec	10,920	19 Dec	7,520	28 Nov	4,380
1966			4 Jan	21,310	4 Jan	14,380	31 Dec	7,710	28 Dec	4,840	24 Dec	2,870	24 Dec	2,130
1967			21 Jan	16,390	20 Jan	9,370	20 Jan	6,780	20 Jan	5,630	19 Jan	3,250	20 Jan	2,170
1968			14 Jan	7,650	14 Jan	5,320	10 Jan	3,330	10 Jan	2,120	10 Jan	2,030	10 Jan	1,730
1969			13 Jan	15,780	23 Dec	12,220	23 Dec	7,240	12 Jan	6,510	11 Jan	5,100	23 Dec	4,200
1970			23 Jan	24,110	21 Jan	17,350	21 Jan	12,920	13 Jan	10,140	9 Jan	6,080	9 Jan	3,820
1971			16 Jan	23,310	15 Jan	13,430	14 Jan	7,740	12 Jan	4,480	28 Dec	3,010	28 Nov	2,940
1972			23 Jan	4,630	21 Jan	3,150	21 Jan	2,240	22 Feb	1,660	21 Jan	1,170	21 Jan	1,110
1973			12 Jan	13,730	11 Jan	10,140	11 Jan	7,530	9 Jan	5,570	9 Jan	3,870	9 Jan	2,870
1974			16 Jan	23,030	15 Jan	12,120	28 Mar	8,150	27 Mar	4,830	6 Mar	3,310	18 Feb	2,760
1975			12 Feb	12,570	23 Mar	9,410	19 Mar	8,570	16 Mar	6,160	7 Mar	3,970	1 Feb	3,460
1976			26 Feb	3,340	26 Feb	2,650	26 Feb	2,200	24 Feb	1,370	16 Feb	850	17 Feb	590
1977			16 Mar	290	15 Mar	210	15 Mar	160	15 Mar	150	6 Mar	90	8 Feb	70
1978			16 Jan	19,140	15 Jan	14,830	13 Jan	9,930	5 Jan	7,550	22 Dec	4,790	22 Dec	3,880
1979			11 Jan	12,000	11 Jan	5,110	11 Jan	4,490	11 Jan	3,800	11 Jan	2,620	10 Jan	1,860
1980			13 Jan	20,900	12 Jan	16,560	12 Jan	9,510	11 Jan	5,360	23 Dec	3,730	11 Jan	2,950
1981			28 Jan	9,000	27 Jan	7,100	26 Jan	3,820	22 Jan	2,530	22 Jan	1,770	22 Jan	1,310
1982			19 Dec	17,490	18 Dec	12,660	18 Dec	7,350	18 Dec	4,990	12 Dec	3,900	13 Nov	3,030
1983			26 Jan	19,290	28 Feb	13,710	25 Feb	9,520	27 Feb	6,600	26 Feb	5,660	24 Jan	4,820

COMPUTED STATISTICS

	PEAK	1-DAY	3-DAY	7-DAY	15-DAY	30-DAY	60-DAY
YEARS	18	44	44	44	44	44	44
LOG MEAN	4.290	4.088	3.918	3.736	3.579	3.436	3.313
STD. DEV.	.233	.352	.344	.327	.309	.316	.310
SKEW	-.149	-2.336	-2.331	-2.403	-2.184	-2.433	-2.529

ADOPTED STATISTICS

	PEAK	1-DAY	3-DAY	7-DAY	15-DAY	30-DAY	60-DAY
LOG MEAN	4.282	4.120	3.948	3.763	3.607	3.464	3.344
STD. DEV.	.243	.242	.238	.229	.222	.216	.210
SKEW	-.400	-.400	-.400	-.400	-.400	-.400	-.400

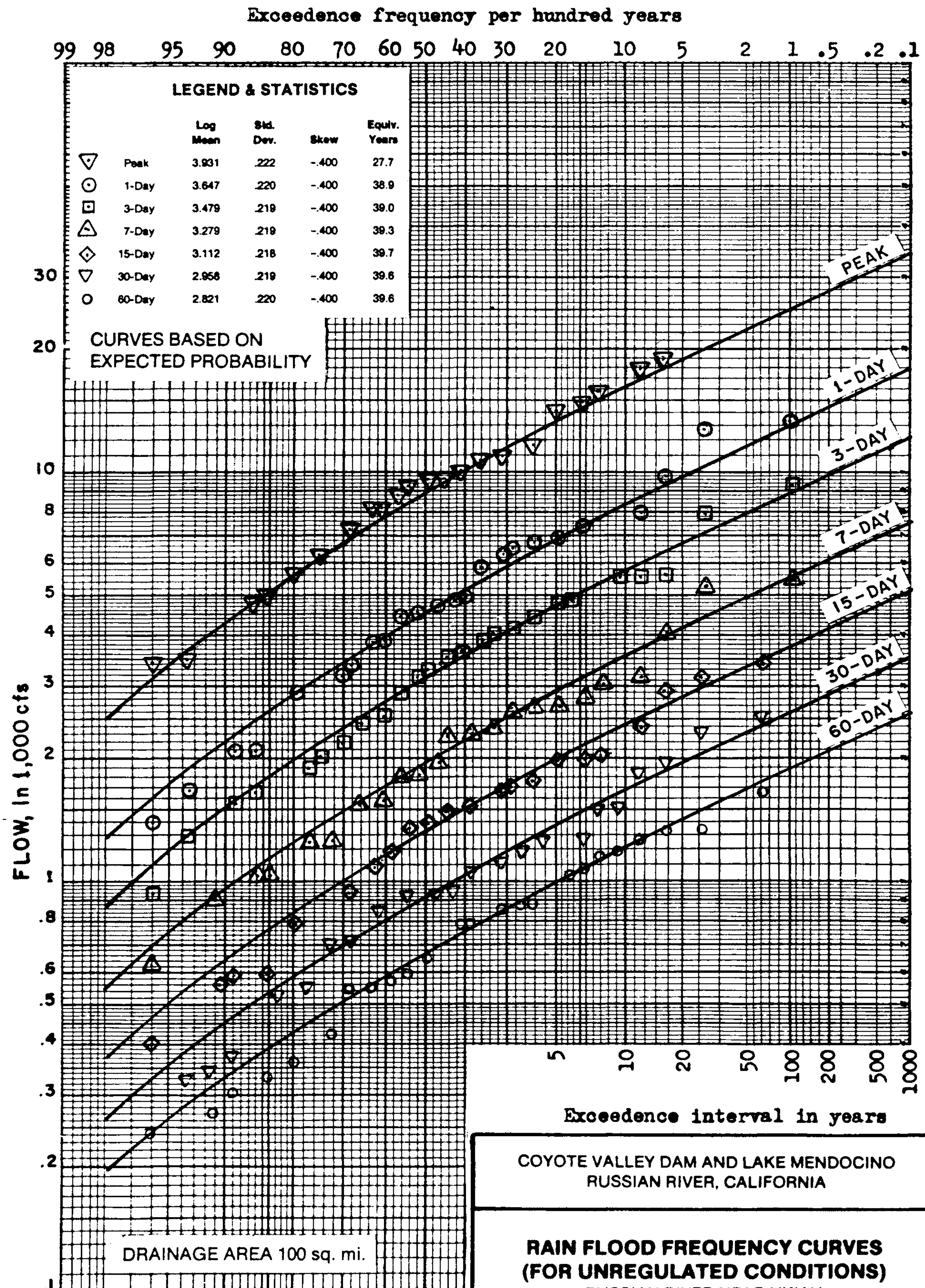


PERIOD OF RECORD
1952 TO 1983

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

RAIN FLOOD FREQUENCY CURVES
(FOR UNREGULATED CONDITIONS)
EAST FORK RUSSIAN RIVER NEAR UKIAH

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

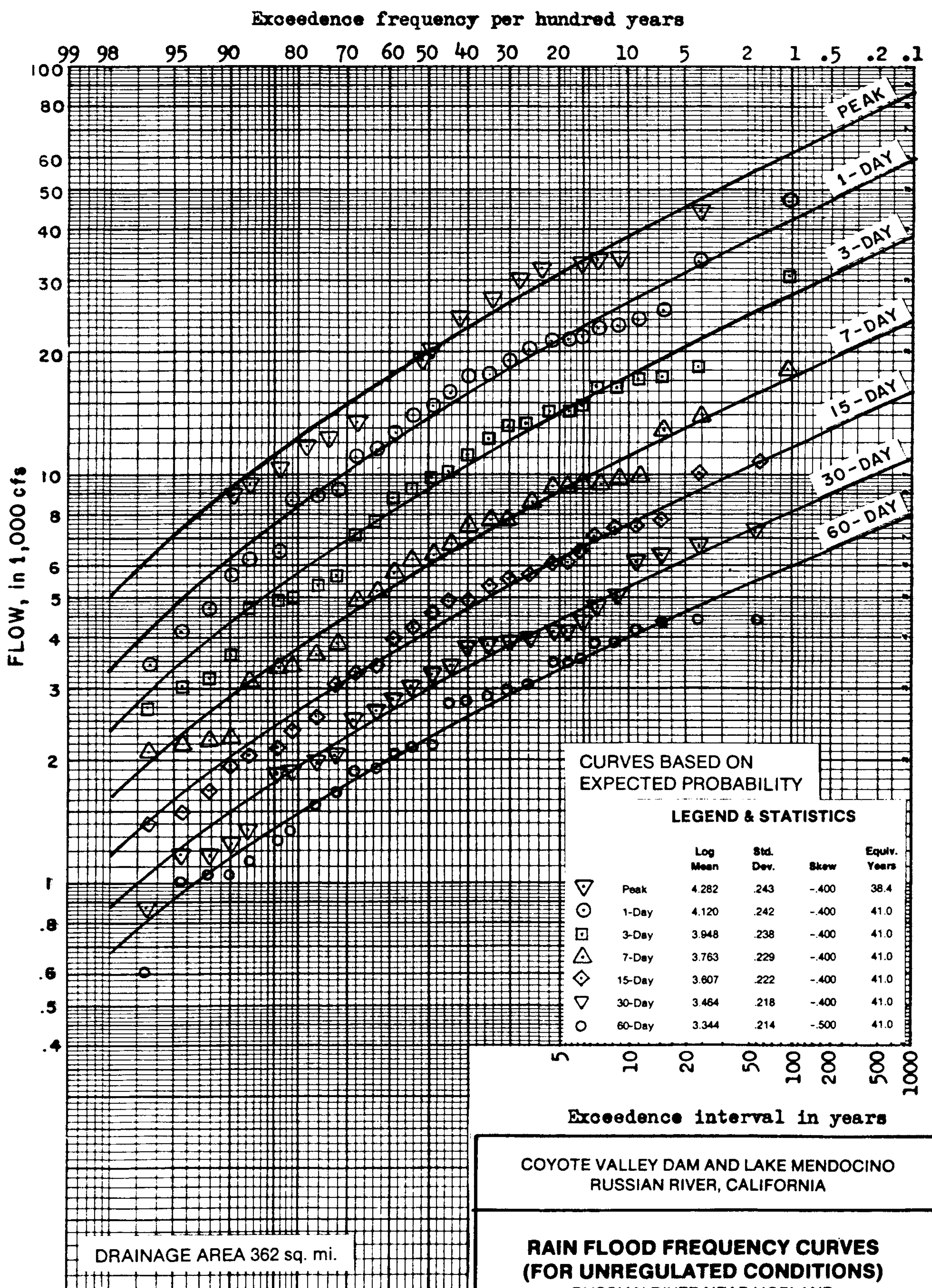


PERIOD OF RECORD
1953 TO 1983

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

RAIN FLOOD FREQUENCY CURVES
(FOR UNREGULATED CONDITIONS)
RUSSIAN RIVER NEAR UKIAH

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

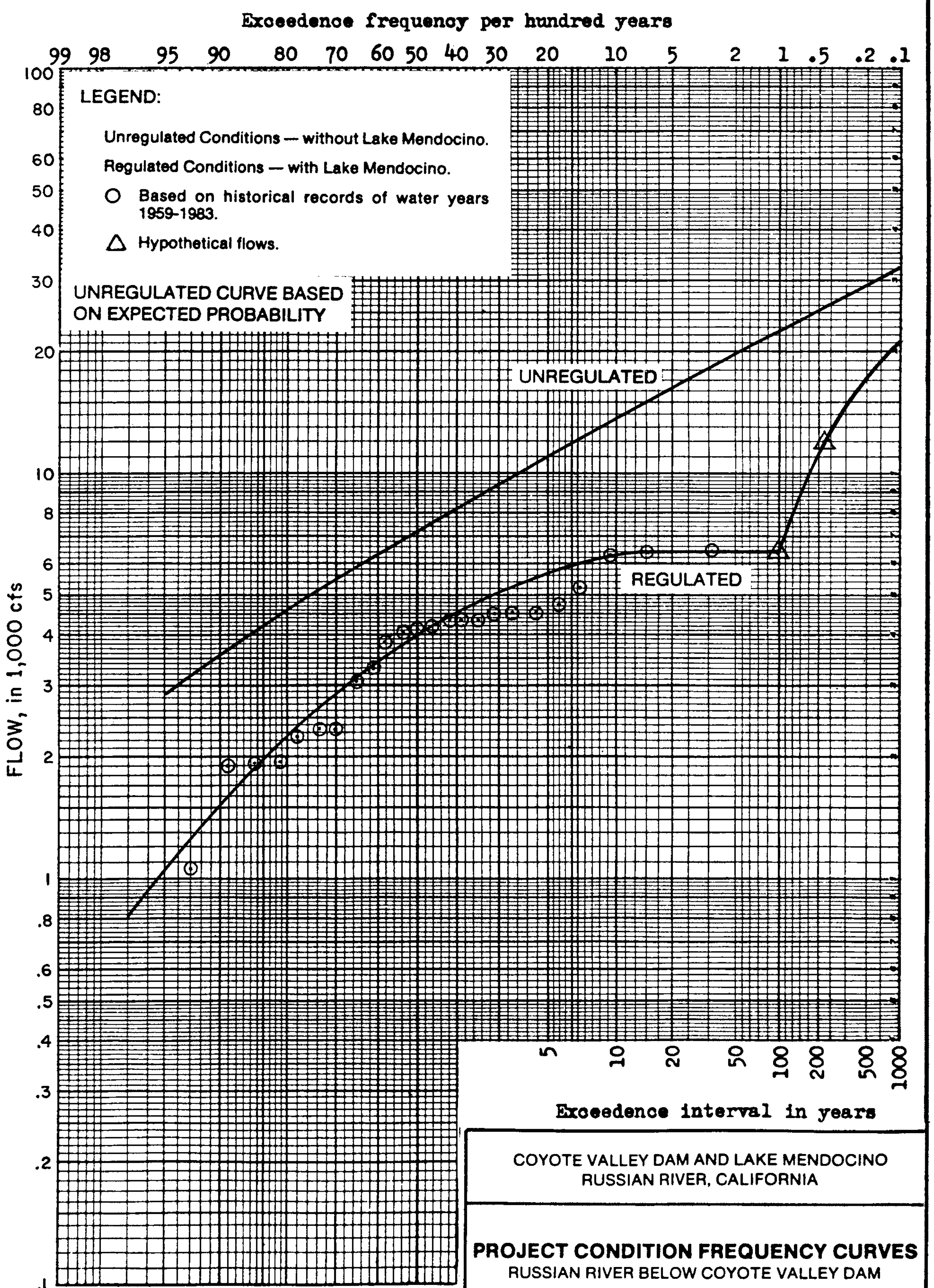


PERIOD OF RECORD
1940 TO 1983

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

RAIN FLOOD FREQUENCY CURVES
(FOR UNREGULATED CONDITIONS)
RUSSIAN RIVER NEAR HOPLAND

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

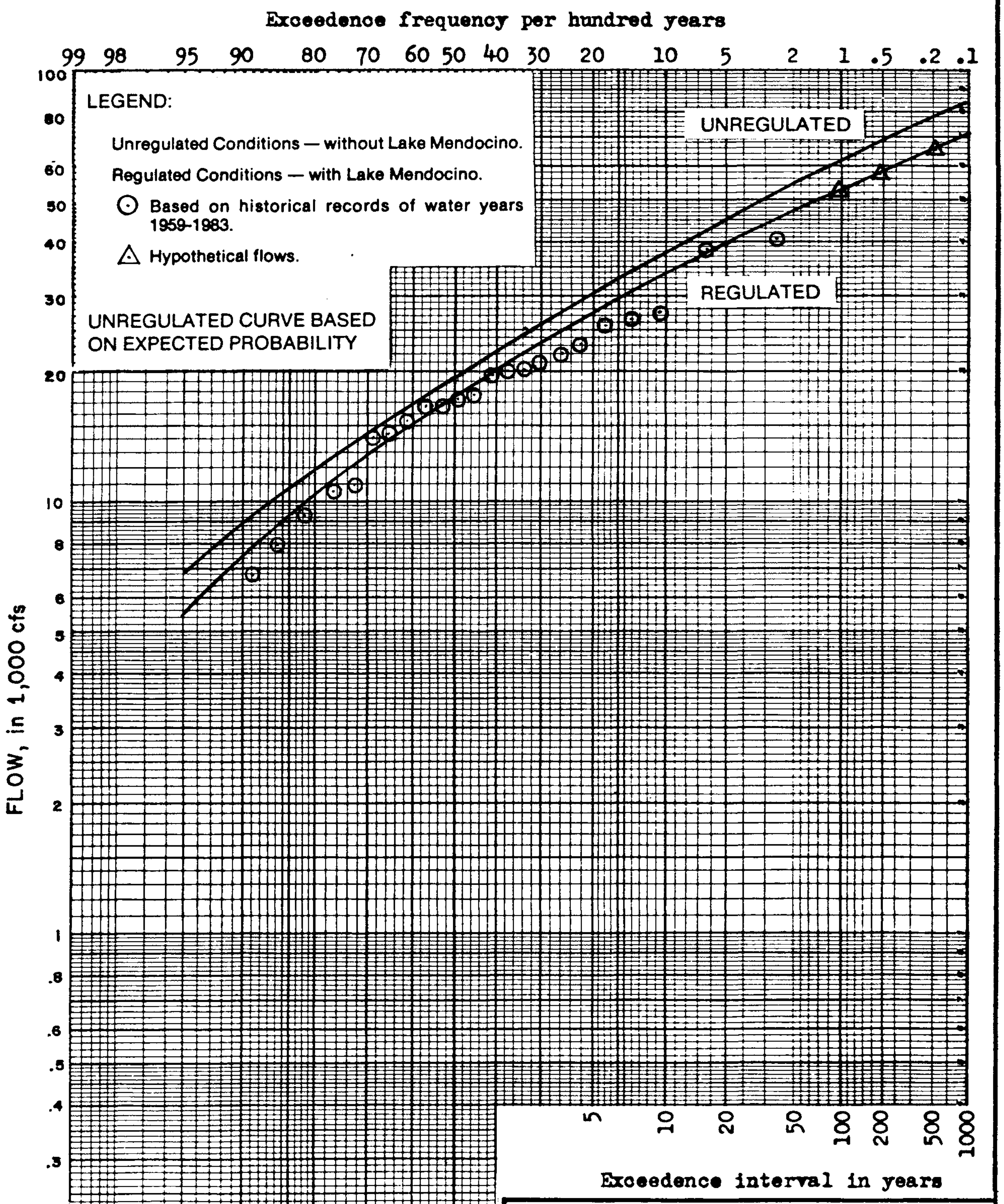


DRAINAGE AREA 105 sq. mi.

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

PROJECT CONDITION FREQUENCY CURVES
RUSSIAN RIVER BELOW COYOTE VALLEY DAM

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

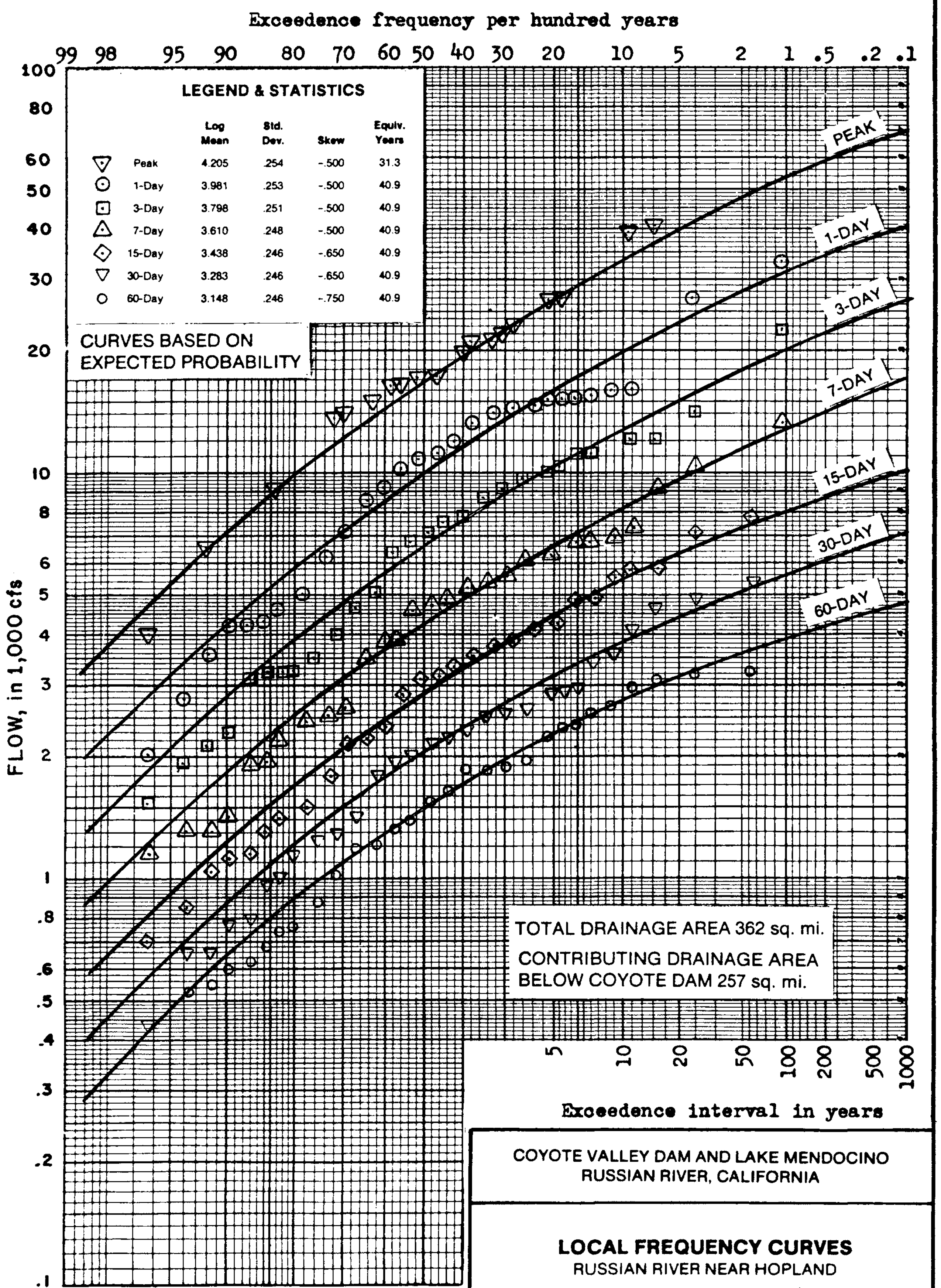


TOTAL DRAINAGE AREA 362 sq. mi.

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

RAIN FLOOD FREQUENCY CURVES
RUSSIAN RIVER NEAR HOPLAND

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

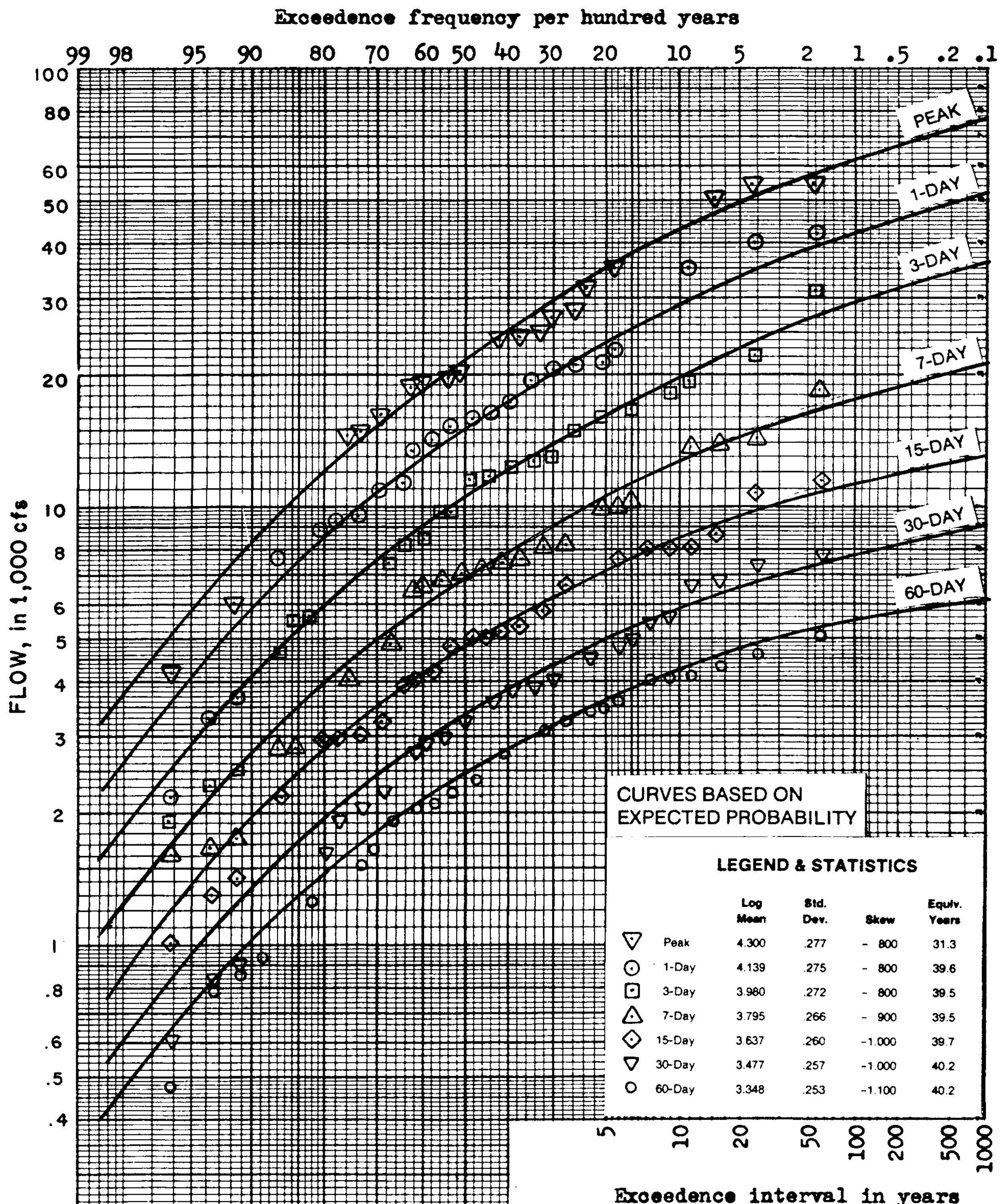


PERIOD OF RECORD
1940 TO 1983

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

LOCAL FREQUENCY CURVES
RUSSIAN RIVER NEAR HOPLAND

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



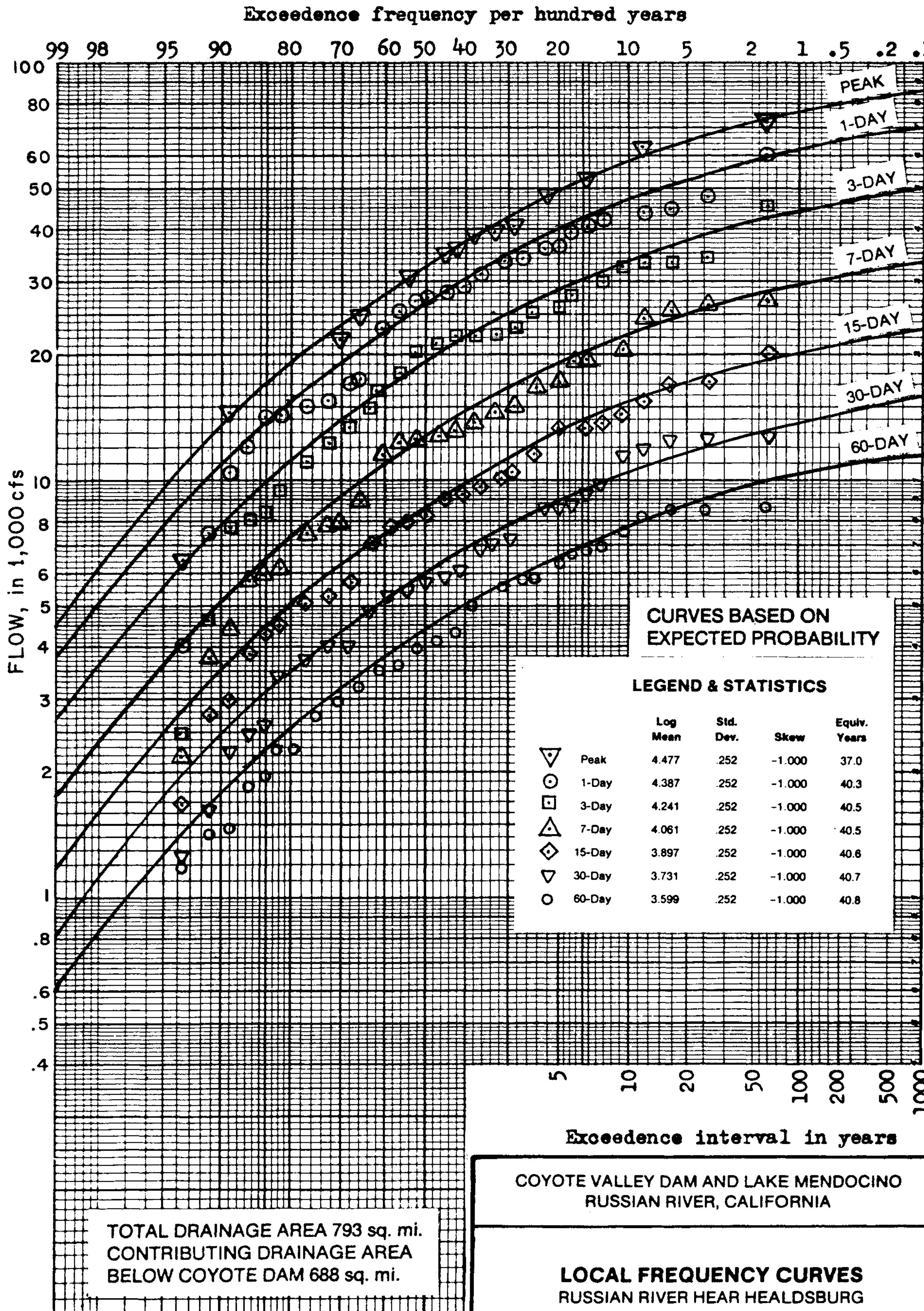
TOTAL DRAINAGE AREA 503 sq. mi.
CONTRIBUTING DRAINAGE AREA
BELOW COYOTE DAM 398 sq. mi.

PERIOD OF RECORD
1952 TO 1983

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

LOCAL FREQUENCY CURVES
RUSSIAN RIVER NEAR CLOVERDALE

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



LEGEND & STATISTICS

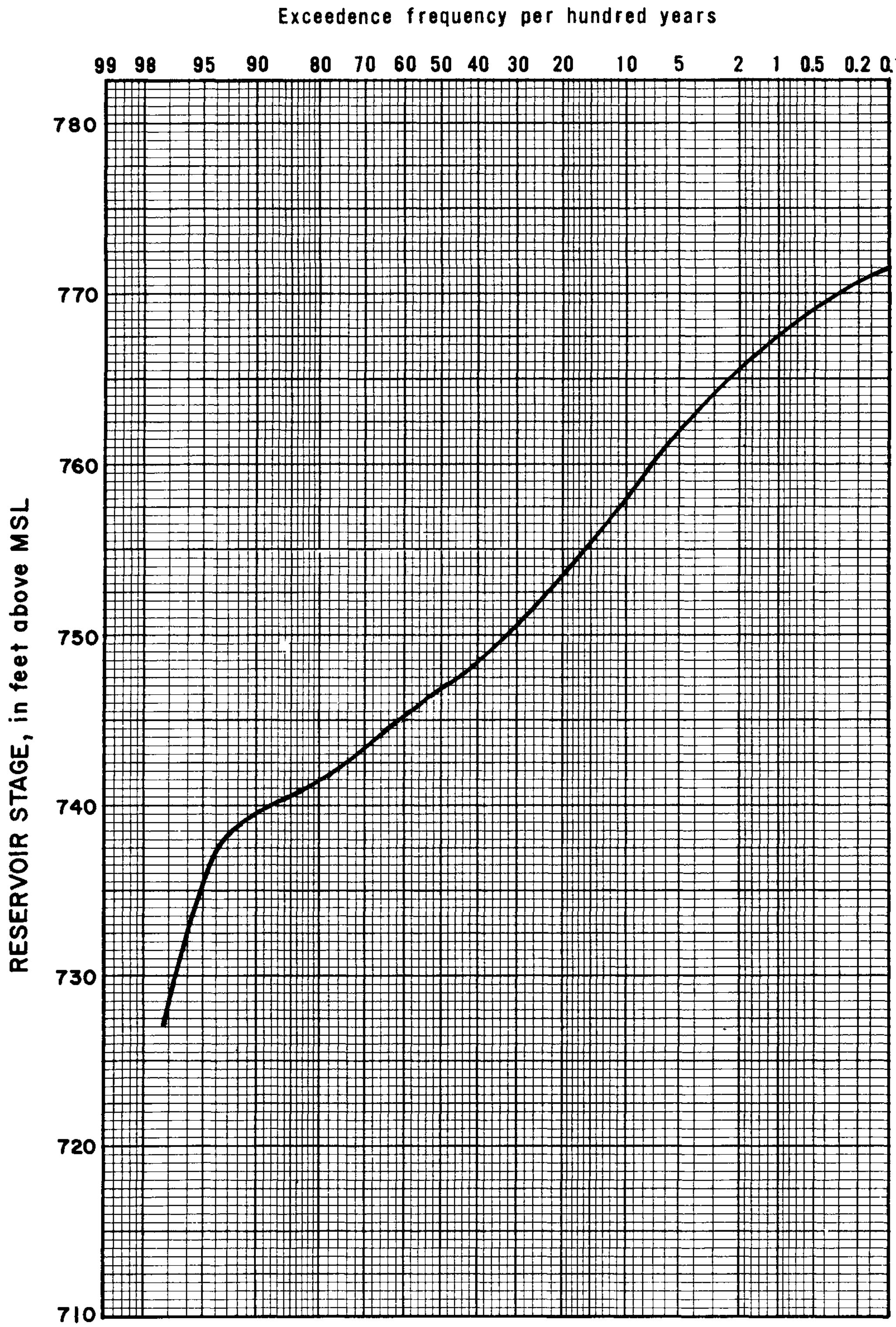
	Log Mean	Std. Dev.	Skew	Equiv. Years
Peak	4.477	.252	-1.000	37.0
1-Day	4.387	.252	-1.000	40.3
3-Day	4.241	.252	-1.000	40.5
7-Day	4.061	.252	-1.000	40.5
15-Day	3.897	.252	-1.000	40.6
30-Day	3.731	.252	-1.000	40.7
60-Day	3.599	.252	-1.000	40.8

PERIOD OF RECORD
1340 TO 1983

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

LOCAL FREQUENCY CURVES
RUSSIAN RIVER HEAR HEALDSBURG

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

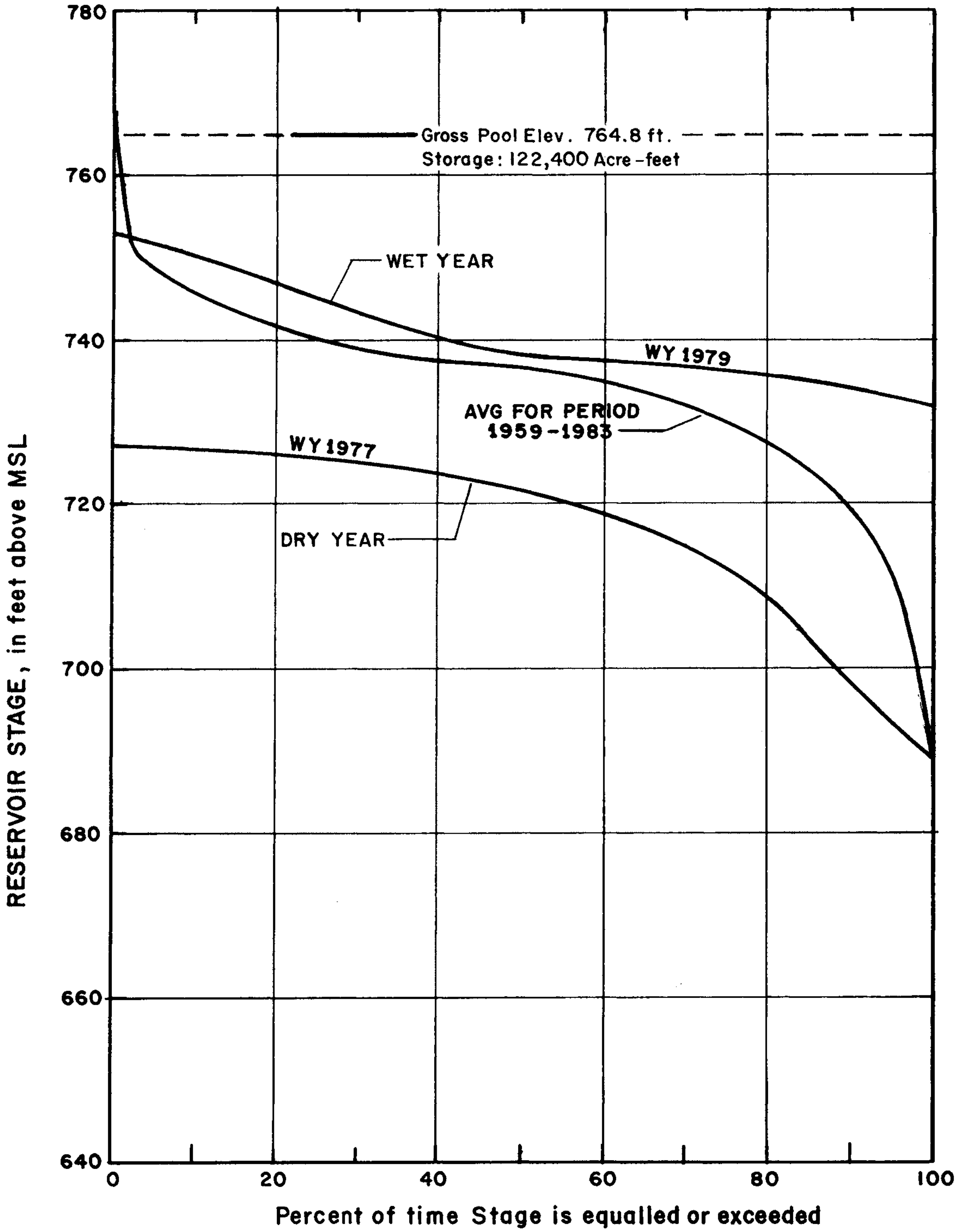


Period of Record: 1959 TO 1983

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

RESERVOIR
STAGE-FREQUENCY CURVE

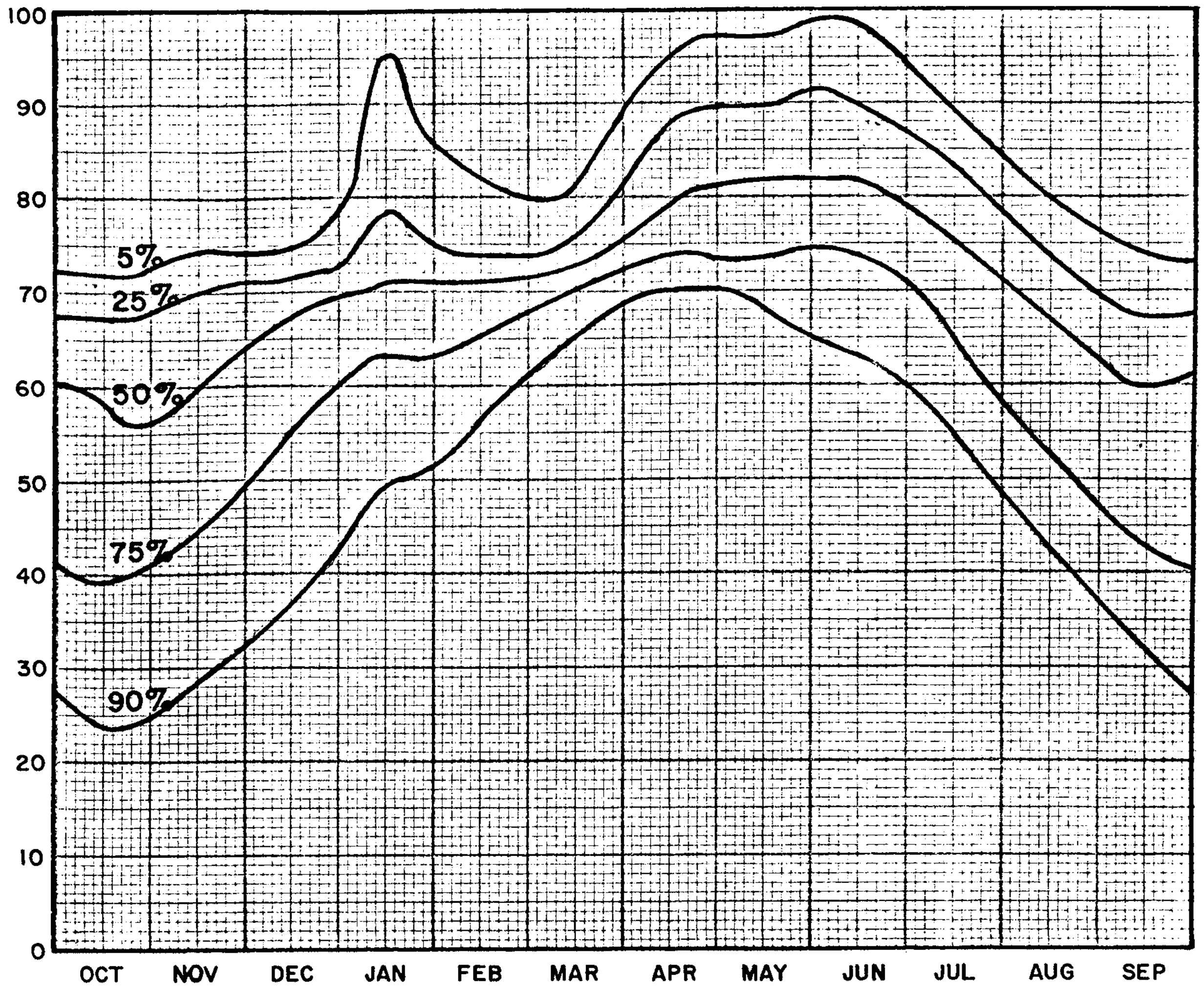
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

RESERVOIR
STAGE-DURATION CURVE

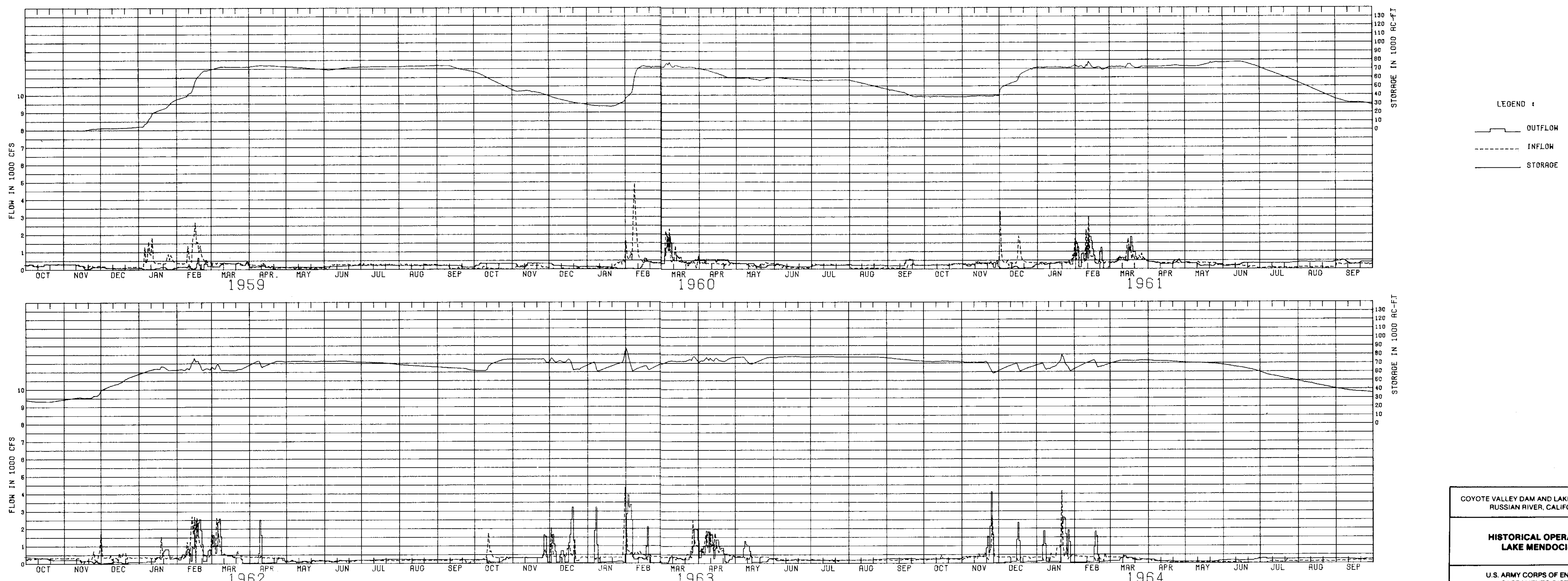
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



NOTE:

Indicated value is percentage of years that the storage is exceeded on a given date, based on daily storage records for the years 1957 – 1983.

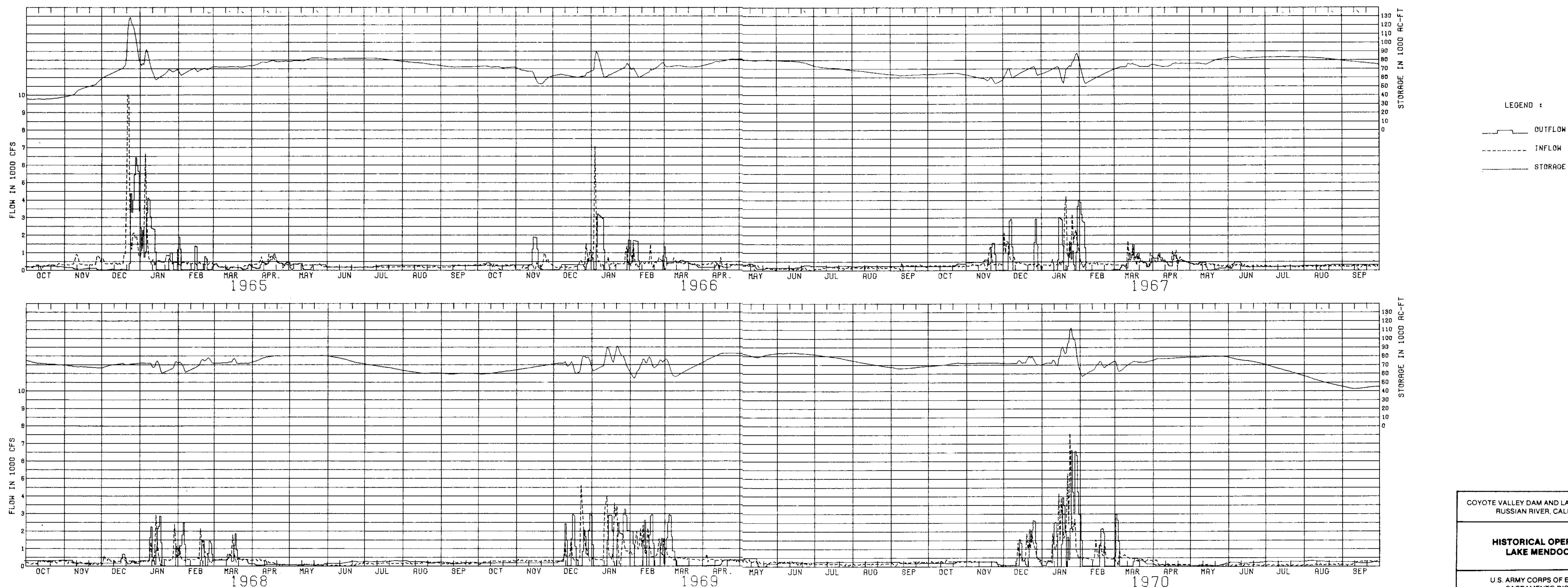
COYOTE VALLEY DAM AND LAKE MENDOCINO RUSSIAN RIVER, CALIFORNIA
SEASONAL VARIATION OF RESERVOIR STORAGE FREQUENCY
U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

HISTORICAL OPERATION
LAKE MENDOCINO

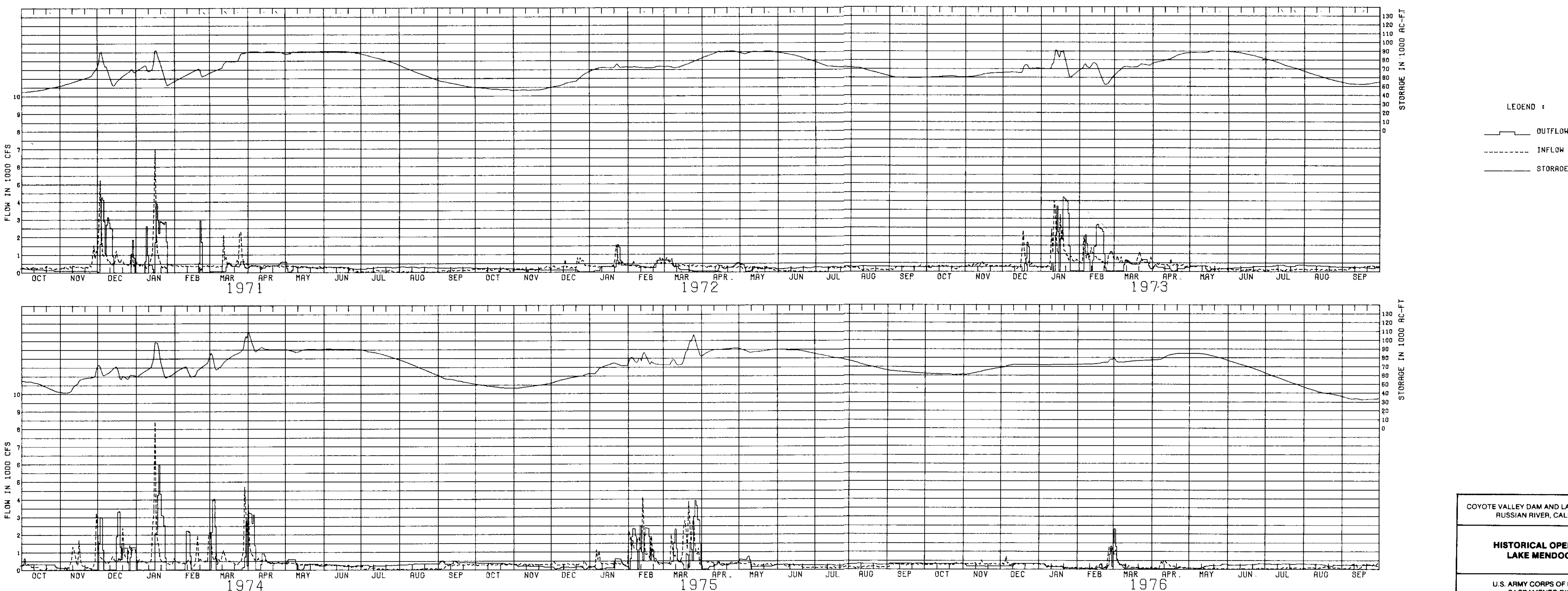
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

HISTORICAL OPERATION
LAKE MENDOCINO

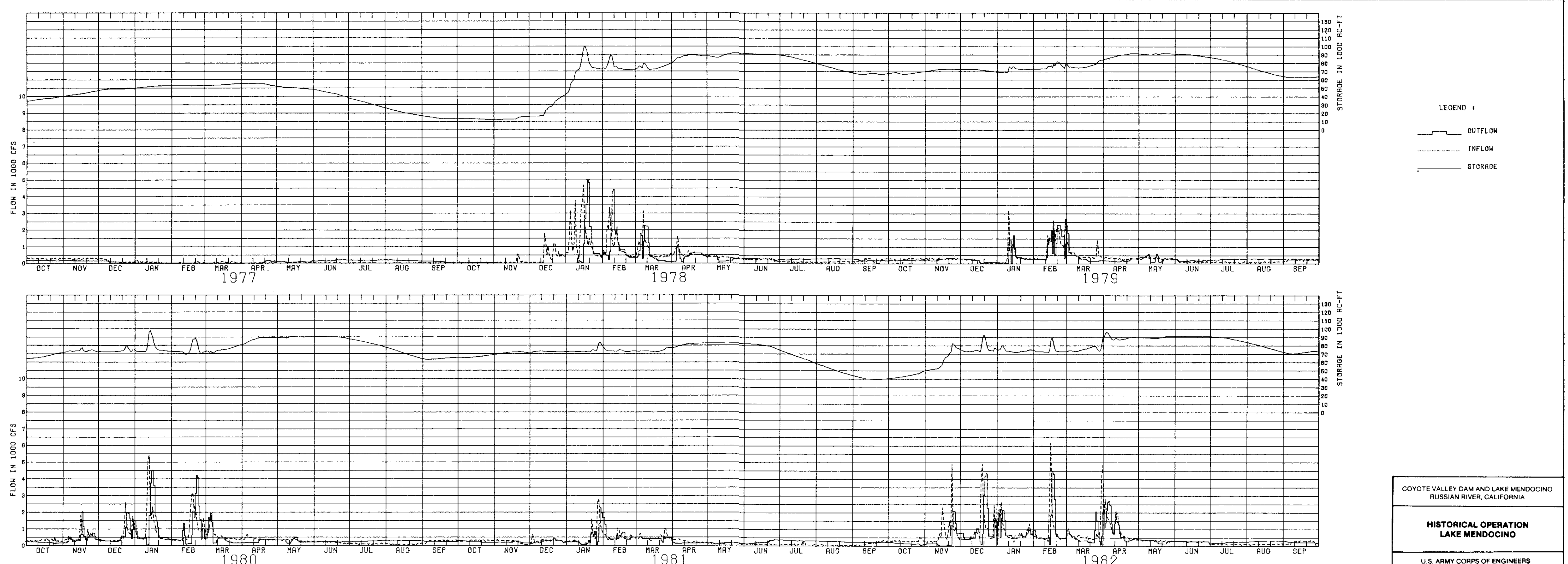
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

HISTORICAL OPERATION
LAKE MENDOCINO

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

HISTORICAL OPERATION
LAKE MENDOCINO

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

COYOTE VALLEY DAM
AND
LAKE MENDOCINO

RUSSIAN RIVER, CALIFORNIA

WATER CONTROL MANUAL

AUGUST 1986

EXHIBIT A

STANDING INSTRUCTIONS TO DAMTENDERS

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

EXHIBIT A

STANDING OPERATING INSTRUCTIONS TO DAMTENDERS
TO
COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

CONTENTS

Personnel Concerned in Flood Control
Operation of Coyote Valley Dam and Lake Mendocino

CHARTS

COYOTE VALLEY DAM
AND
LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA
WATER CONTROL MANUAL
EXHIBIT A

STANDING OPERATING INSTRUCTIONS TO DAMTENDERS

1. GENERAL

This exhibit is prepared in accordance with instructions contained in EM 1110-2-3600, paragraph 4-07, (Standing Instructions to Damtenders), and ETL 1110-2-251 and pertains to duties and responsibilities of the damtenders in connection with the operation of Coyote Valley Dam and the reporting of required hydrologic data.

Operational instructions to the damtenders are outlined with specific emphasis on flood emergencies when communication facilities between the damtender and the Reservoir Control Section have been disrupted. This exhibit is designed to be used independently as a flood control guide or in conjunction with the rest of the water control manual. Charts required for emergency flood control operation of Coyote Valley Dam are included in this exhibit.

2. FLOOD CONTROL OPERATION REQUIREMENTS

Coyote Valley Dam is operated for flood control according to the Flood Control Diagram (Chart A-10). The flood control objective for Coyote Valley Dam is to minimize flood damage downstream from the dam and insofar as practicable, to avoid causing damage that would not have occurred without the project.

Storage space of 50,000 acre-feet including sediment allocation shall be reserved in Lake Mendocino for flood control. Whenever encroachment into the flood control space occurs, water is released in accordance with the schedules shown on the Flood Control Diagram.

3. LIMITATIONS ON STORAGE

Operational limitations on storage in Lake Mendocino are specified on the Flood Control Diagram. There are no legal limitations on storage as most of the project boundary is above the maximum operating level, and flowage and storage easements cover the rest.

4. LIMITATIONS ON RELEASES

The power plant is operated generally in two modes; the power generation mode and the flood control mode. The power generation mode is in operation when the required releases are between zero and 4,375 cfs inclusive, and the flood pool is at or below elevation 755 feet MSL. The flood control mode is in operation when required releases exceed 4,375 cfs, the flood pool exceeds elevation 755 feet MSL; or the conservation pool exceeds elevation 762 feet MSL. See Exhibit B to this Manual (Construction, Operation and Maintenance for Coyote Dam Power Project) agreement between Corps of Engineers, Sacramento District, and City of Ukiah for additional information.

The transition procedure from power generation mode to flood control mode is presented below.

Transition Procedure
From Power Mode Generation to Flood Control Mode

Event		Time Required
*1.	Operator dispatched from City, alerts Corps to begin transition.	15 Minutes
2.	Reduction of flow through turbines and fixed cone valves to zero. Corps closes service side gates.	30 Minutes
3.	Air vent valves are opened by Corps and the system is depressurized.	5 Minutes
4.	Operator moves to downstream tainter valve. Gate is fully opened and fixed into position. The outlet conduit is drained.	25 Minutes
5.	Corps alerted that the service slide gates can be reopened.	30 Minutes
6.	Corps increases outflow to 4,000 cfs	4 Hours
	Total Time:	5 hours 45 Minutes

*When reservoir elevation reaches 755 feet or required outflow is greater than 4,200 cfs.

The transition procedure from flood control mode to power generation mode is presented on page A-3.

Releases from Coyote Valley Dam will not change more than 1,000 cfs per hour when the pool elevation is at or below 764.8 feet MSL. Releases which will contribute to flows greater than 8,000 cfs at Hopland will not be made. Whenever the pool elevation rises above 764.8 MSL, the damtender shall refer to the Emergency Release Schedule shown on the Flood Control Diagram, Chart A-10.

Transition Procedure
From Flood Control Mode to Power Generation Mode

Event	Time Required
1. When required control releases are less than 4,200 cfs and reservoir elevation reaches 737.5 feet, the releases can be accomplished through the powerhouse, the Corps closes service slide gates. Operator from City is alerted and dispatched to powerhouse.	4 hours
2. The downstream tainter valve is closed.	20 Minutes
3. Operator alerts Corps that system is closed. Corps closes two air vent valves. Corps partially opens one slide gate. Conduit is 98% filled. Corps closes the slide gate and air vent valve. Corps opens conduit fill line valve. Outlet system is pressurized. Corps closes conduit fill line valve and fully opens service slide gates.	50 Minutes
4. Powerhouse valves opened and turbines started to meet the required release requirement.	20 Minutes
Total Time:	5 hours 30 Minutes

5. STANDING INSTRUCTIONS DURING FLOOD EMERGENCY

Flood control operation is under the direction of the Reservoir Control Section, Corps of Engineers, Sacramento District. During flood periods, close contact will be maintained between operating personnel at Coyote Valley Dam and the Reservoir Control Section in Sacramento. During power generation the City of Ukiah's personnel will physically operate the power plant. However, during emergency situations, as determined by the Corps, the Corps will advise the City of Ukiah of the situation and may take appropriate action, including shutting down the power units and assuming control of the appropriate outlet gates and valves. The Corps will not be held liable for damage to the City's facilities that results from the Corps operation of the power facilities during emergency situations. Corps personnel will be trained to operate all aspects of the proposed power bypass facility in case of an emergency. See Exhibit B to this Manual for additional information.

If communication is broken between the operating personnel and the Reservoir Control Section, continue releases in accordance with the last instructions from the Reservoir Control Section and make every attempt to reestablish communications. If communication cannot be reestablished, make releases in accordance with the Flood Control Diagram, Chart A-10.

6. **OPERATIONAL RESPONSIBILITIES**

The primary responsibilities for operating Coyote Valley Dam are delegated to units of the Engineering Division and Construction-Operations Division of the Sacramento District, U.S. Army Corps of Engineers. Names and telephone numbers for the individuals whose responsibilities are outlined below are given at the front of this exhibit and at the front of this manual.

a. **The Hydrology Section, Engineering Division.**

(1) Obtain current hydrometeorological data and weather forecasts for the region.

(2) Maintain hydrologic equipment and supervise its operation.

(3) Supervise a program of water quality and sediment measurement.

b. **The Reservoir Control Section, Engineering Division.**

(1) Analyze current reservoir and hydrologic data, determine schedule under which the reservoir shall be operated, and issue appropriate operating instructions to the reservoir operator (except for day-to-day conservation operation).

(2) Prepare monthly operation and other special reports relative to the operation of the reservoir.

(3) Advise the District Engineer whenever there has been an unavoidable departure from these operating rules, or when there is a need for making temporary modification of these operating rules.

(4) Make and distribute the necessary revisions to this Water Control Manual.

c. **The Park Manager, Construction-Operations Division.**

(1) Keep well informed of the operating rules contained in this Water Control Manual and bring to the attention of the Reservoir Control Section any feature of the manual that may require clarification or revision.

(2) Keep familiar with the operation of all recording and communication equipment.

(3) Accomplish the physical operation of the reservoir in accordance with instructions contained in the Water Control Manual or issued by the Reservoir Control Section.

(4) Calculate and maintain a record of inflows, outflows, storage, weather data, and other data specified by the Reservoir Control Section.

(5) Report data required in Paragraph 10 to the Reservoir Control Section each work day or as required.

(6) Report to the Reservoir Control Section any unusual conditions which might interfere with the planned operation of the reservoir.

(7) Maintain a log of gate or valve operations to include the date, time, and water surface elevation when such changes were made, and initials of the individual making the change.

(8) Make and record weekly checks on reservoir and outflow gage readings to assure proper operation of all recording equipment.

(9) Obtain samples for water quality and sedimentation analysis as required.

(10) Immediately after the end of each month, transmit to the Reservoir Control Section forms specified in Paragraph 9.

(11) Make emergency gate changes when contact with the Reservoir Control Section is broken and a clearly defined change occurs that warrants immediate action.

(12) Maintain a record of instructions received from Reservoir Control Section, and requests received from the Sonoma County Water Agency.

d. City of Ukiah.

(1) The City's personnel will remotely and/or locally operate the power facilities.

(2) Based upon the flow requirements provided by the Corps and Sonoma County Water Agency determine and set the respective flow rates through the turbines and bypass valves.

(3) Maintenance of the Lake Mendocino Power Plant structures.

e. Sonoma County Water Agency.

(1) Determine conservation releases.

7. COMPUTATION OF HYDROLOGIC DATA

During conservation operation, computations are made daily by the damtender to determine mean daily reservoir outflow, inflow and evaporation. During flood control operations, these computations may be made more frequently as directed by the Reservoir Control Section.

Procedures to determine the required information are as follows:

a. Mean Daily Outflow from the Reservoir.

(1) Check punch tape for errors in time and gage height. Time is corrected to the current 15 minutes; gage height to the nearest .01 foot.

(2) Tabulate correct gage height readings at odd hours, starting with 0100 hours. Punch tape correction, if any, should be noted.

(3) Enter current outlet works streamgage rating table, using shifts as applicable, determine and list flow at each odd hour.

(4) When calculating discharge from gage height with a (-) shift correction, enter rating table below the actual height, i.e., if observed gage height is a 4.86 and shift is -.02, enter rating table at 4.84 to obtain discharge. For (+) shift, enter rating table above observed gage height.

(5) Total the 12 flow readings obtained and divide be 12. This is the mean daily flow.

(6) Mean daily flow will be listed to nearest 0.1 cfs for flows up to 10 cfs, and to the nearest 1 cfs for flows above 10 cfs.

b. Evaporation from the Reservoir.

Lake evaporation in feet is equal to the pan evaporation in inches multiplied by the evaporation coefficient B shown on Chart A-9. For this computation pan evaporation measured at 0700 hours is used to compute lake evaporation for the previous day. Lake evaporation in cfs is computed using the following formula:

Lake evaporation (cfs) = Pan evaporation (inches) x evaporation coefficient B x lake area (acres)

Lake area used when computing evaporation will be the average area for the day obtained by averaging the midnight areas at the beginning and ending of the period being computed.

c. Inflow to the Reservoir.

Computed mean daily inflow to the lake will be taken as the algebraic sum of the mean outflow, change in the lake storage and evaporation from the lake water surface.

8. GATE AND VALVE OPERATION

During the power generation mode, the City of Ukiah's personnel will operate the power facilities. These power facilities include two generating units, 18-inch gate valve, 54-inch fixed cone valve, 108-inch fixed cone valve and 11-foot by 16-foot tainter valve. The Corps will operate the air vent valves and associated equipment located in the intake tower. Under normal operating conditions the City of Ukiah will operate the tainter valve. The Corps will be instructed how to operate the tainter valve in the event of an emergency. During power generation, the air vent valves will be closed and up to 4,375 cfs can be released.

When the reservoir pool reaches elevation 755 feet MSL, or the release rate exceeds about 4,375 cfs, or when the Corps requires the units to get off line, the power facility will operate for flood control. The tainter valve will be locked in the open position and the air vent valves will be fully opened. The Corps slide gates are used to regulate the flow. The powerhouse units and valves will be closed down.

9. NORMAL OPERATION PROCEDURES

a. Water Supply.

All inflow in excess of releases required for downstream needs and for hydropower will be stored to the extent that conservation storage space is available. Release of water for conservation purposes will be made only at the request of the Sonoma County Water Agency.

b. Flood Control Operation.

A Flood Control Diagram for flood control operations is presented on Chart A-10. Flood control release schedules associated with the Flood Control Diagram are also presented on Chart A-10. A brief description of the schedules is presented in the following paragraphs.

Schedules 1, 2 and 3 are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1) the discharge that does not cause the flow at Russian River near Hopland to exceed 8,000 cfs and (2) the discharge that results in flow at Hopland being less than that reached during the previous storm. In addition releases will be limited to (1) between 2,000 and 4,000 cfs if the reservoir pool did not reach elevation 746 feet MSL, (2) 4,000 cfs if the highest reservoir pool level reached was between elevation 746 and 755 feet MSL, and (3) 6,400 cfs if the pool level exceeded elevation 755 feet MSL. Schedules 1, 2 and 3 are used only if no significant rainfall is predicted.

If significant rainfall is forecasted (one inch in 24 hours or 0.5 inch in any six hour period) maximum releases are limited to 2,000 cfs so that the reservoir releases can be reduced to 25 cfs within 1 1/2 hours if necessary. Also when flow in the West Fork of the Russian River at Ukiah exceeds 2,500 cfs and is rising, releases from the reservoir will be reduced to 25 cfs.

Outlet works gates may be used when the pool level is above the spillway crest (elevation 764.8 MSL) for Flood Control Schedule 3 releases, however the sum of the spill and the releases must not exceed 6,400 cfs.

The Emergency Release Schedule (see Chart A-10) is used between elevation 764.7 and 773 feet MSL, at which stage the flood control gates are fully open. The flood control gates remain fully open until the reservoir pool has receeded to elevation 773 feet MSL, at which time the Emergency Release Schedule is implemented. When the reservoir pool has receeded to elevation 764.7 feet MSL, release schedule 3 is maintained.

10. REPORTS

The damtender shall report the following data via the Hydrologic Automatic Data Acquisition Network to the Reservoir Control Section each work day:

a. Reservoir stage as of midnight.

b. Pan evaporation as of 0700 hours.

c. Mean daily flows (ending at midnight).

d. Daily precipitation at the dam as measured at 0700 hours.

When conditions do not warrant weekend or holiday reports, complete reports for each day will be made on the first day following the non-reporting period. More frequent reports of the above information and reports of other data will be made in the same manner when requested by the Reservoir Control Section. Forms furnished to the operators are to be used in computing the above information.

Immediately after the end of each month, the damtender will send to the Reservoir Control Section all original forms used for observations and computations.

11. SPECIAL WATER AND FLOOD REPORTS

During the flood season from 1 October to 1 May, the damtender shall call the Reservoir Control Section whenever any of the following occurs:

a. One inch or more of rainfall at the project during any 6 hour period or 1.5 inches or more of rainfall during any 24 hour period.

b. Inflow to the reservoir exceeds 2,500 cfs.

d. Discharge at the U.S.G.S. streamgaging station "Russian River near Hopland" exceeds 8,000 cfs.

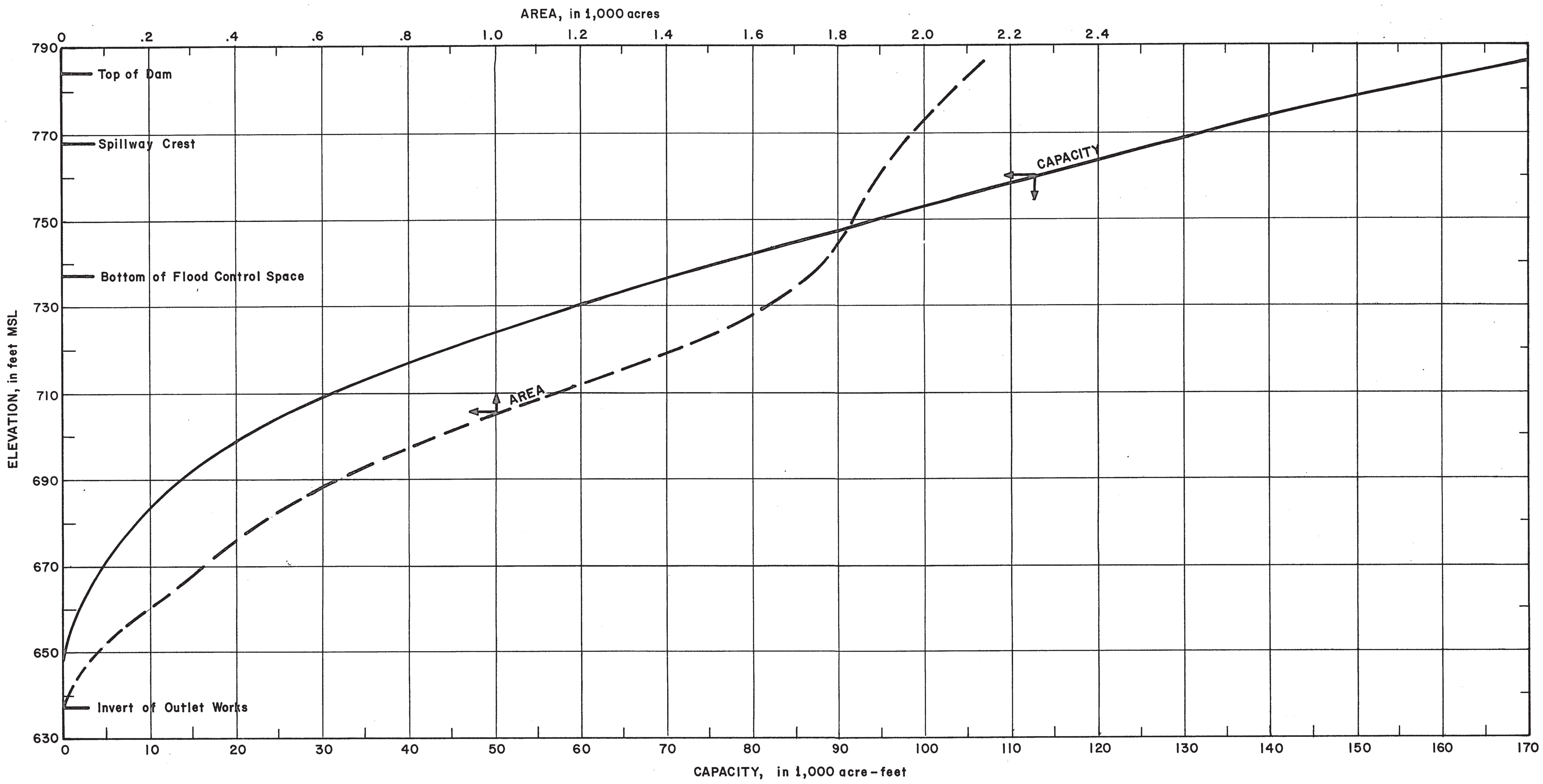
On non-working days or at night, these special reports should be telephoned directly to the Chief of the Reservoir Control Section or his designated representative.

12. EMERGENCY NOTIFICATION

For serious emergencies such as iminent dam failure, an emergency notification plan is maintained at the Coyote Valley Dam Project Office. The park manager is responsible for implementing the emergency notification plan; however, such notification should be coordinated with the Reservoir Control Section, if possible.

13. MODIFICATION OF REGULATIONS

The damtender may make emergency departures from the regulations in this manual as required by operating equipment failures, accidents such as drownings or other emergencies that require immediate action. The Reservoir Control Section should be notified of such departures as soon as possible. The District Engineer, Sacramento District, Corps of Engineers, may make temporary modifications to these regulations. Permanent changes are subject to approval by the Division Engineer, South Pacific Division, U.S. Army Corps of Engineers.



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

LAKE MENDOCINO
AREA AND CAPACITY

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

LAKE MENDOCINO
AREA AND CAPACITY TABLE

CAPACITIES OF LAKE MENDOCINO – RUSSIAN RIVER, CALIFORNIA

ELEVATION *(Feet)*	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	DIFFERENCE
					(Acre-Feet)						
640.0	14	15	16	17	18	19	20	22	23	24	11
641.0	25	27	28	30	31	33	34	36	37	39	16
642.0	41	43	45	46	48	50	52	54	57	59	20
643.0	61	63	66	68	71	73	76	78	81	84	26
644.0	87	89	92	95	98	101	105	108	111	115	31
645.0	118	122	125	129	132	136	140	144	148	152	38
646.0	156	160	165	169	174	178	183	187	192	197	46
647.0	202	207	212	217	222	228	233	239	244	250	54
648.0	256	261	267	273	280	286	292	298	305	311	62
649.0	318	325	332	339	346	353	360	367	375	382	72
650.0	390	398	406	414	422	430	438	446	455	463	82
651.0	472	481	490	499	508	517	526	536	545	555	93
652.0	565	574	584	594	605	615	625	636	646	657	103
653.0	668	679	690	701	713	724	735	747	759	771	115
654.0	783	795	807	820	832	845	857	870	883	896	126
655.0	909	923	936	950	964	977	991	1005	1019	1034	139
656.0	1048	1063	1077	1092	1107	1122	1137	1153	1168	1184	151
657.0	1199	1215	1231	1247	1263	1280	1296	1313	1329	1346	164
658.0	1363	1380	1397	1414	1432	1450	1467	1485	1503	1521	176
659.0	1539	1558	1576	1595	1613	1632	1651	1670	1690	1709	190
660.0	1729	1748	1768	1788	1808	1828	1848	1869	1889	1910	202
661.0	1931	1952	1973	1994	2015	2037	2058	2080	2102	2124	215
662.0	2146	2168	2190	2213	2235	2258	2281	2304	2327	2350	228
663.0	2374	2397	2421	2445	2469	2493	2517	2541	2566	2590	241
664.0	2615	2640	2665	2690	2715	2741	2766	2792	2817	2843	254
665.0	2869	2895	2922	2948	2975	3001	3028	3055	3082	3109	268
666.0	3137	3164	3192	3219	3247	3275	3303	3331	3360	3388	280
667.0	3417	3446	3474	3503	3533	3562	3591	3621	3650	3680	293
668.0	3710	3740	3770	3801	3831	3862	3892	3923	3954	3985	307
669.0	4017	4048	4079	4111	4143	4175	4207	4239	4271	4303	319
670.0	4336	4369	4402	4434	4468	4501	4534	4568	4601	4635	333
671.0	4669	4703	4737	4771	4805	4840	4875	4909	4944	4979	345
672.0	5014	5050	5085	5121	5156	5192	5228	5264	4301	5337	360
673.0	5374	5410	5447	5484	5521	5558	5595	5633	5670	5708	372
674.0	5746	5784	5822	5860	5899	5937	5976	6015	6054	6093	386
675.0	6132	6171	6211	6251	6290	6330	6370	6410	6451	6491	400
676.0	6532	6573	6613	6654	6696	6737	6778	6820	6862	6904	414
677.0	6946	6988	7030	7072	7115	7158	7201	7244	7287	7330	428
678.0	7374	7417	7461	7505	7549	7593	7637	7682	7726	7771	442
679.0	7816	7861	7906	7951	7997	8042	8088	8134	8180	8227	473
680.0	8273	8320	8366	8413	8460	8508	8555	8602	8650	8698	473
681.0	8746	8794	8842	8890	8939	8988	9036	9086	9135	9184	488
682.0	9234	9283	9333	9383	9433	9484	9534	9585	9635	9686	504
683.0	9738	9789	9840	9892	9944	9996	10048	10100	10153	10205	520
684.0	10258	10311	10364	10417	10471	10525	10578	10632	10687	10741	537
685.0	10795	10850	10905	10960	11015	11071	11126	11182	11238	11294	555
686.0	11350	11407	11463	11520	11577	11634	11692	11749	11807	11865	573
687.0	11923	11981	12040	12099	12157	12217	12276	12335	12395	12455	592
688.0	12515	12575	12635	12696	12756	12817	12879	12940	13001	13063	610
689.0	13125	13187	13250	13312	13375	13438	13501	13564	13628	13691	630
690.9	13755	13820	13884	13948	14013	14078	14143	14209	14274	14340	651
691.0	14406	14472	14539	14605	14672	14739	14806	14874	14942	15010	672
692.0	15078	15146	15215	15283	15352	15422	15491	15561	15630	15700	693
693.0	15771	15841	15912	15983	16054	16126	16197	16269	16341	16414	715
694.0	16486	16559	16632	16705	16779	16852	16926	17000	17075	17149	738
695.0	17224	17299	17375	17450	17526	17602	17678	17755	17831	17908	762
696.0	17986	18063	18141	18219	18297	18375	18454	18533	18612	18691	785
697.0	18771	18851	18931	19011	19092	19173	19254	19335	19417	19499	810
698.0	19581	19663	19746	19828	19912	19995	20079	20163	20247	20331	835
699.0	20416	20500	20586	20671	20757	20843	20929	21015	21102	21189	860
700.0	21276	21363	21451	21539	21627	21716	21805	21894	21983	22073	887

LAKE MENDOCINO
AREA AND CAPACITY TABLE

CAPACITIES OF LAKE MENDOCINO - RUSSIAN RIVER, CALIFORNIA

(Continued)

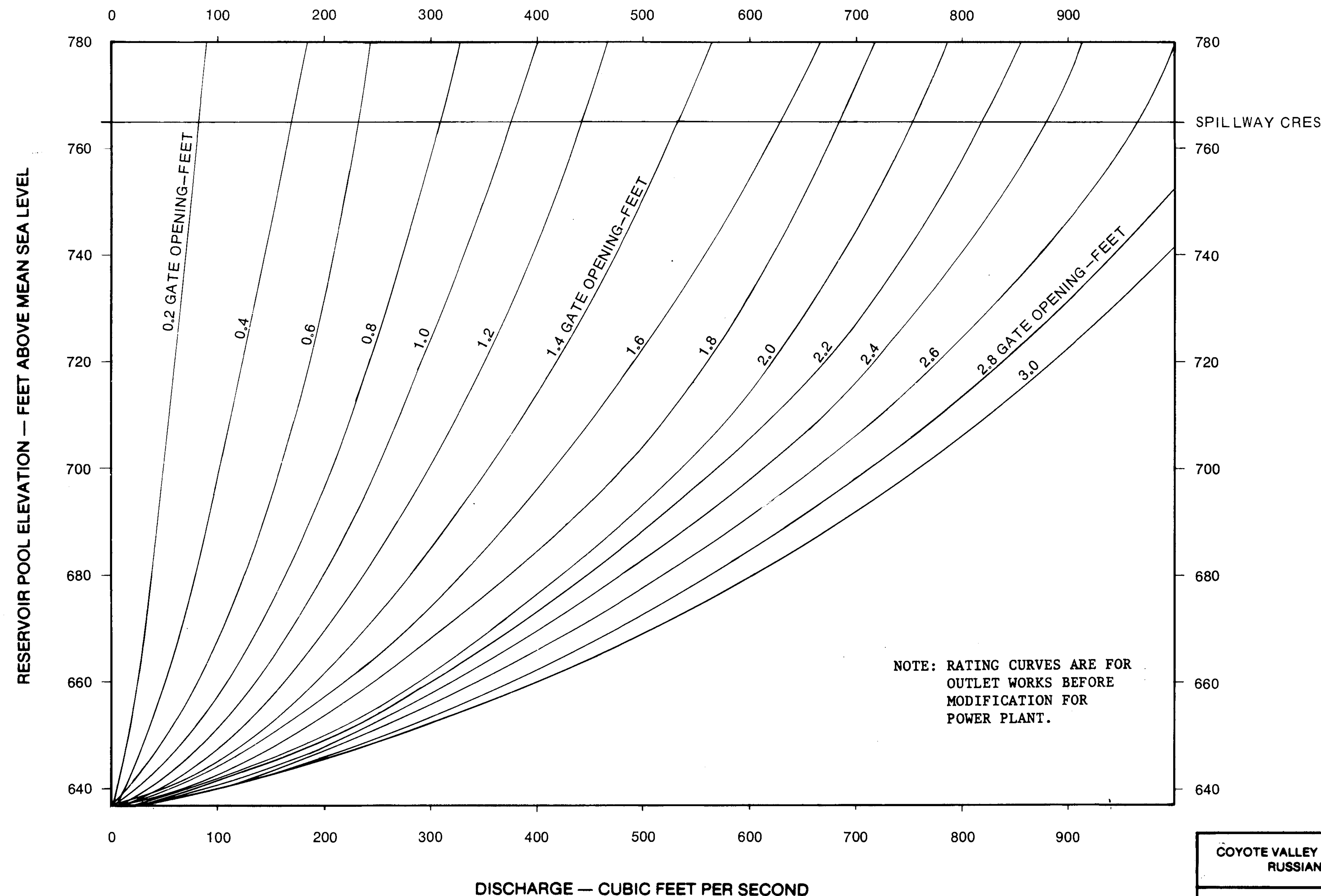
ELEVATION (*Feet*)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	DIFFERENCE
					(*Acre-Feet*)						
701.0	22163	22253	22343	22433	22524	22616	22707	22799	22891	22983	912
702.0	23075	23168	23261	23354	23448	23542	23636	23730	23825	23920	940
703.0	24015	24110	24206	24302	24399	24495	24592	24689	24786	24884	967
704.0	24982	25080	25179	25277	25376	25476	25575	25675	25775	25876	995
705.0	25977	26077	26179	26280	26382	26484	26586	26689	26792	26895	1022
706.0	26999	27102	27207	27311	27415	27520	27625	27731	27837	27943	1050
707.0	28049	28155	28262	28369	28477	28585	28693	28801	28909	29018	1078
708.0	29127	29237	29346	29456	29567	29677	29788	29899	30010	30122	1107
709.0	30234	30346	30459	30571	30685	30798	30912	31026	31140	31254	1135
710.0	31369	31484	31599	31715	31831	31947	32064	32180	32297	32415	1163
711.0	32532	32650	32768	32887	33006	33125	33244	33363	33483	33603	1192
712.0	33724	33845	33966	34087	34208	34330	34452	34575	34697	34820	1220
713.0	34944	35067	35191	35315	35439	35564	35689	35815	35939	36065	1247
714.0	36191	36317	36444	36571	36698	36825	36953	37081	37209	37338	1276
715.0	37467	37595	37725	37854	37984	38114	38245	38375	38506	38638	1302
716.0	38769	38901	39033	39165	39298	39431	39564	39697	39831	39965	1330
717.0	40099	40233	40368	40503	40638	40774	40909	41045	41182	41318	1356
718.0	41455	41592	41730	41867	42005	42143	42281	42420	42559	42698	1383
719.0	42838	42977	43117	43257	43398	43538	43679	43821	43962	44104	1408
720.0	44246	44388	44530	44673	44816	44959	45102	45246	45390	45534	1433
721.0	45679	45823	45968	46113	46259	46405	46550	46696	46843	46989	1457
722.0	47136	47283	47431	47578	47726	47874	48022	48171	48319	48468	1482
723.0	48618	48767	48916	49066	49216	49367	49517	49668	49819	49970	1504
724.0	50122	50273	50425	50577	50730	50882	51035	51188	51341	51495	1526
725.0	51648	51802	51956	52110	52265	52420	52575	52730	52885	53041	1549
726.0	53197	53352	53509	53665	53822	53978	54135	54293	54450	54608	1568
727.0	54765	54923	55082	55240	55398	55557	55716	55875	56035	56194	1589
728.0	56354	56514	56674	56834	56995	57156	57316	57478	57639	57800	1608
729.0	57962	58124	58286	58448	58610	58773	58935	59098	59261	59425	1626
730.0	59588	59751	59915	60079	60243	60408	60572	60737	60901	61066	1643
731.0	61231	61396	61562	61727	61893	62059	62225	62392	62558	62724	1660
732.0	62891	63058	63225	63392	63559	63727	63894	64062	64230	64398	1676
733.0	64567	64735	64903	65072	65241	65410	65579	65748	65917	66087	1690
734.0	66257	66426	66596	65766	66936	67107	67277	64448	67618	67789	1704
735.0	67961	68131	68303	68474	68646	68817	68989	69161	69333	69505	1716
736.0	69677	69850	70022	70195	70368	70541	70713	70887	71059	71233	1730
737.0	71407	71580	71754	71927	72101	72275	72449	72624	72798	72972	1740
738.0	73147	73321	73496	73671	73846	74021	74196	74372	74547	74722	1751
739.0	74898	75073	75249	75425	75601	75777	75953	76130	76306	76482	1761
740.0	76659	76835	77012	77189	77366	77543	77720	77897	78074	78251	1770
741.0	78429	78606	78784	78961	79139	79317	79495	79673	79851	80029	1779
742.0	80208	80386	80564	80743	80921	81100	81278	81457	81636	81815	1786
743.0	81994	82173	82352	82531	82711	82890	83069	83249	83428	83608	1794
744.0	83788	83968	84148	84327	84507	84688	84868	85048	85228	85408	1801
745.0	85589	85769	85950	86130	86311	86492	86672	86853	87034	87215	1807
746.0	87396	87577	87758	87939	88120	88302	88483	88665	88846	89027	1813
747.0	89209	89391	89572	89754	89936	90118	90300	90482	90663	90846	1819
748.0	91028	91210	91392	91574	91757	91940	92122	92304	92487	92669	1824
749.0	92852	93035	93218	93400	93583	93766	93949	94132	94315	94498	1830
750.0	94682	94865	95048	95231	95415	95598	95782	95965	96149	96332	1834
751.0	96516	96700	96884	97067	97251	97435	97619	97803	97987	98171	1840
752.0	98356	98540	98724	98908	99093	99277	99462	99646	99831	100015	1844
753.0	100200	100385	100570	100754	100939	101124	101309	101494	101679	101864	1850
754.0	102050	102235	102420	102605	102791	102976	103161	103347	103532	103718	1854
755.0	103904	104089	104275	104461	104647	104833	105019	105205	105391	105577	1860
756.0	105764	105950	106136	106322	106509	106695	106882	107068	107255	107442	1865
757.0	107629	107815	108002	108189	108376	108563	108750	108937	109124	109312	1870
758.0	109499	109686	109874	110061	110249	110437	110624	110812	111000	111188	1877
759.0	111376	111563	111752	111939	112128	112316	112504	112693	112881	113070	1882
760.0	113258	113447	113636	113824	114013	114202	114391	114580	114769	114958	1890

LAKE MENDOCINO
AREA AND CAPACITY TABLE

CAPACITIES OF LAKE MENDOCINO - RUSSIAN RIVER, CALIFORNIA

(Continued)

ELEVATION (Feet)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	DIFFERENCE
	(Acre-Feet)										
761.0	115148	115337	115526	115715	115905	116095	116284	116474	116663	116854	1896
762.0	117044	117233	117424	117614	117804	117994	118185	118375	118565	118756	1903
763.0	118947	119138	119329	119519	119710	119902	120092	120284	120475	120666	1911
764.0	120858	121049	121241	121433	121625	121817	122008	122201	122392	122585	1919
765.0	122777	122969	123162	123354	123547	123740	123933	124126	124318	124512	1928
766.0	124705	124898	125091	125285	125478	125672	125865	126059	126253	126447	1936
767.0	126641	126835	127030	127224	127418	127613	127807	128002	128197	128392	1946
768.0	128587	128782	128977	129172	129368	129563	129759	129955	130150	130346	1955
769.0	130542	130738	130934	131130	131327	131524	131720	131917	132113	132310	1965
770.0	132507	132704	132902	133098	133296	133494	133691	133889	134086	134284	1976
771.0	134483	134680	134879	135077	135275	135474	135672	135871	136070	136269	1985
772.0	136468	136667	136866	137065	137265	137465	137664	137864	138064	138264	1996
773.0	138464	138664	138864	139065	139265	139466	139666	139867	140068	140269	2007
774.0	140471	140672	140873	141074	141276	141478	141679	141881	142083	142285	2017
775.0	142488	142690	142892	143094	143297	143500	143703	143906	144108	144312	2027
776.0	144515	144718	144922	145125	145329	145533	145736	145941	146144	146349	2038
777.0	146553	146757	146962	147166	147371	147576	147780	147986	148190	148396	2048
778.0	148601	148806	149012	149217	149423	149629	149834	150041	150246	150453	2058
779.0	150659	150865	151072	151278	151485	151692	151898	152105	152312	152519	2068



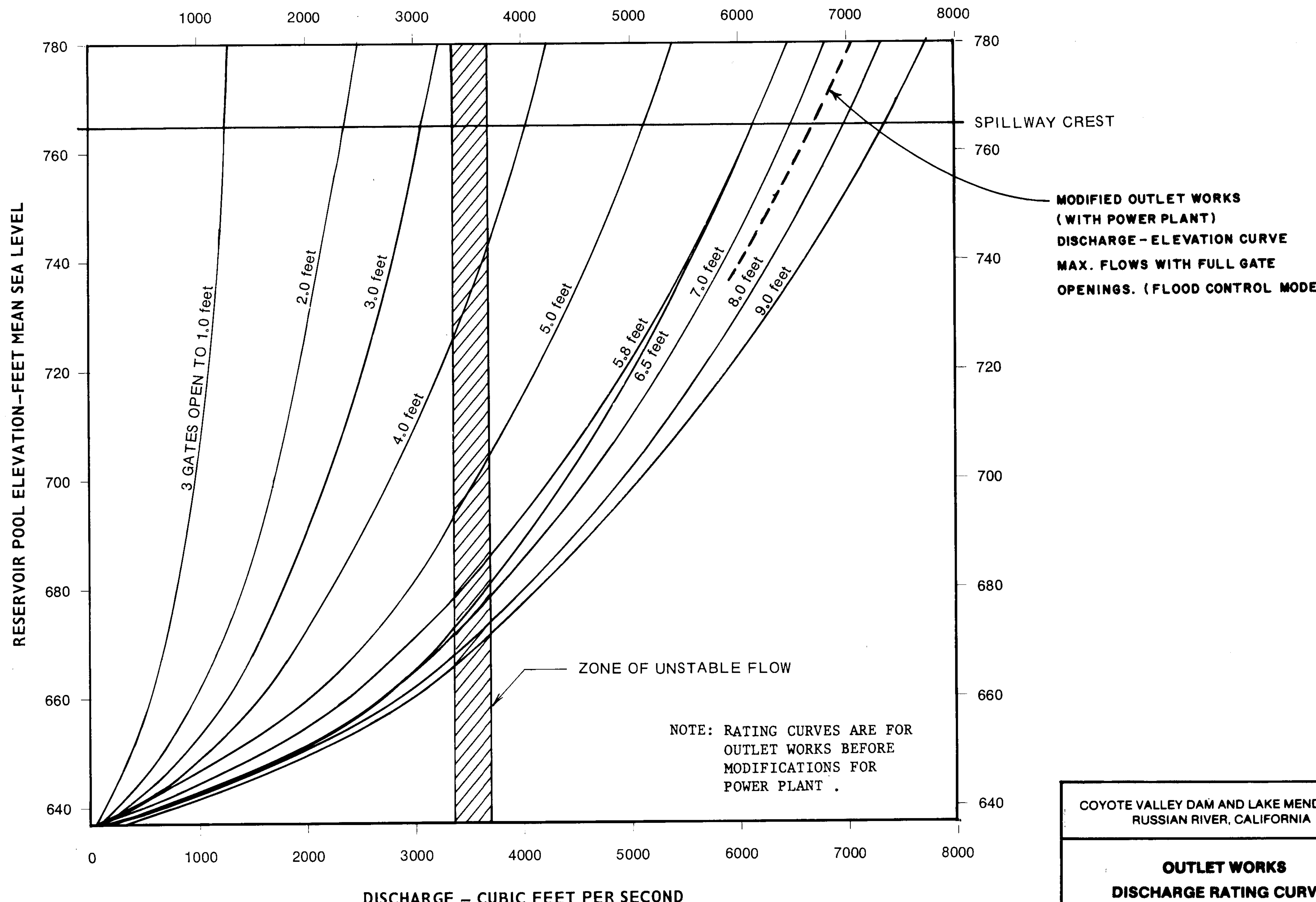
SINGLE GATE DISCHARGE — COYOTE DAM LAKE MENDOCINO

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

OUTLET WORKS

DISCHARGE RATING CURVES

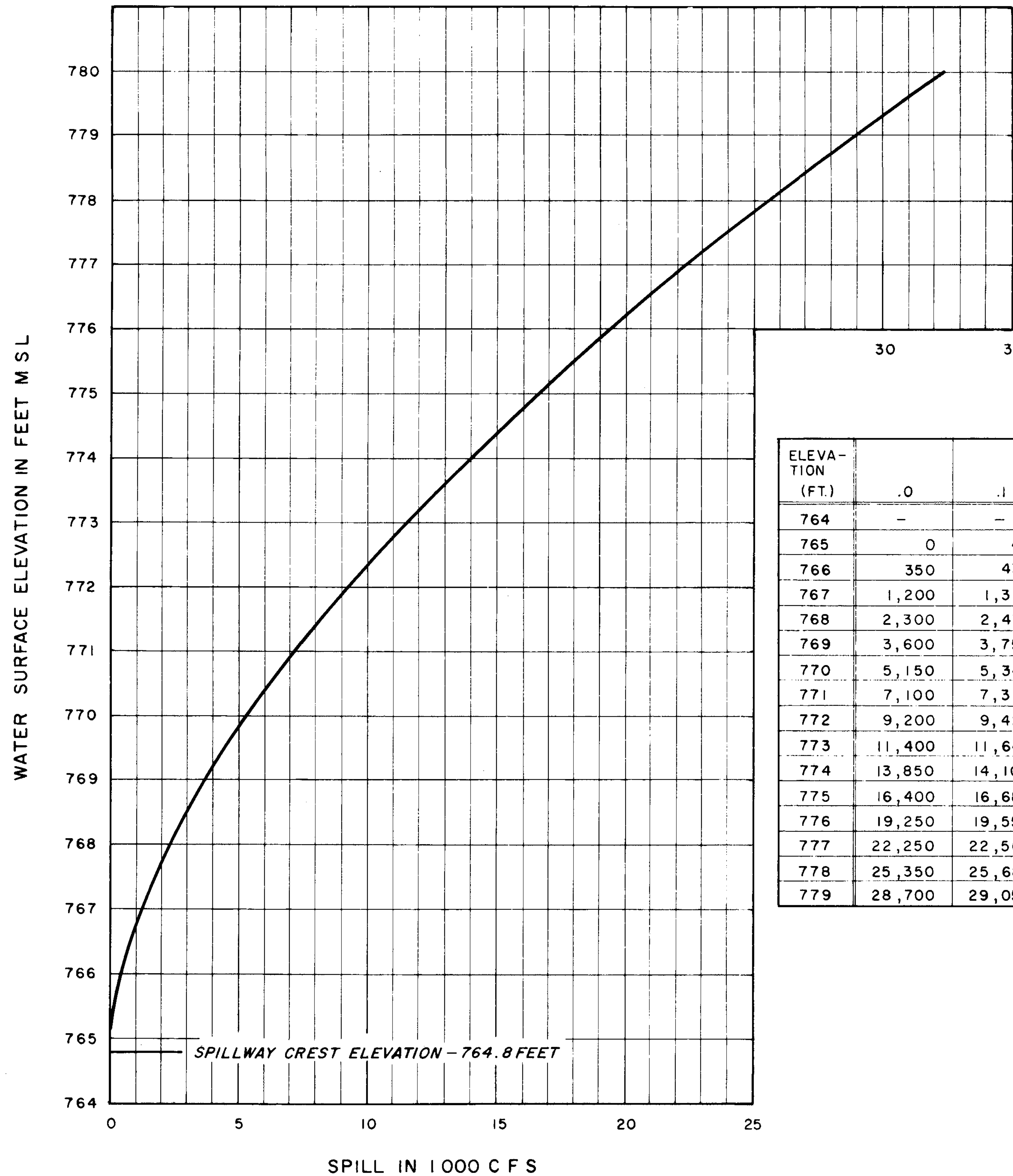
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

OUTLET WORKS
DISCHARGE RATING CURVES

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



NOTE:
Spillway rating curve based on a 200 foot bottom width approach channel with 1 on 1½ side slopes and a 200 foot rectangular spillway crest section.

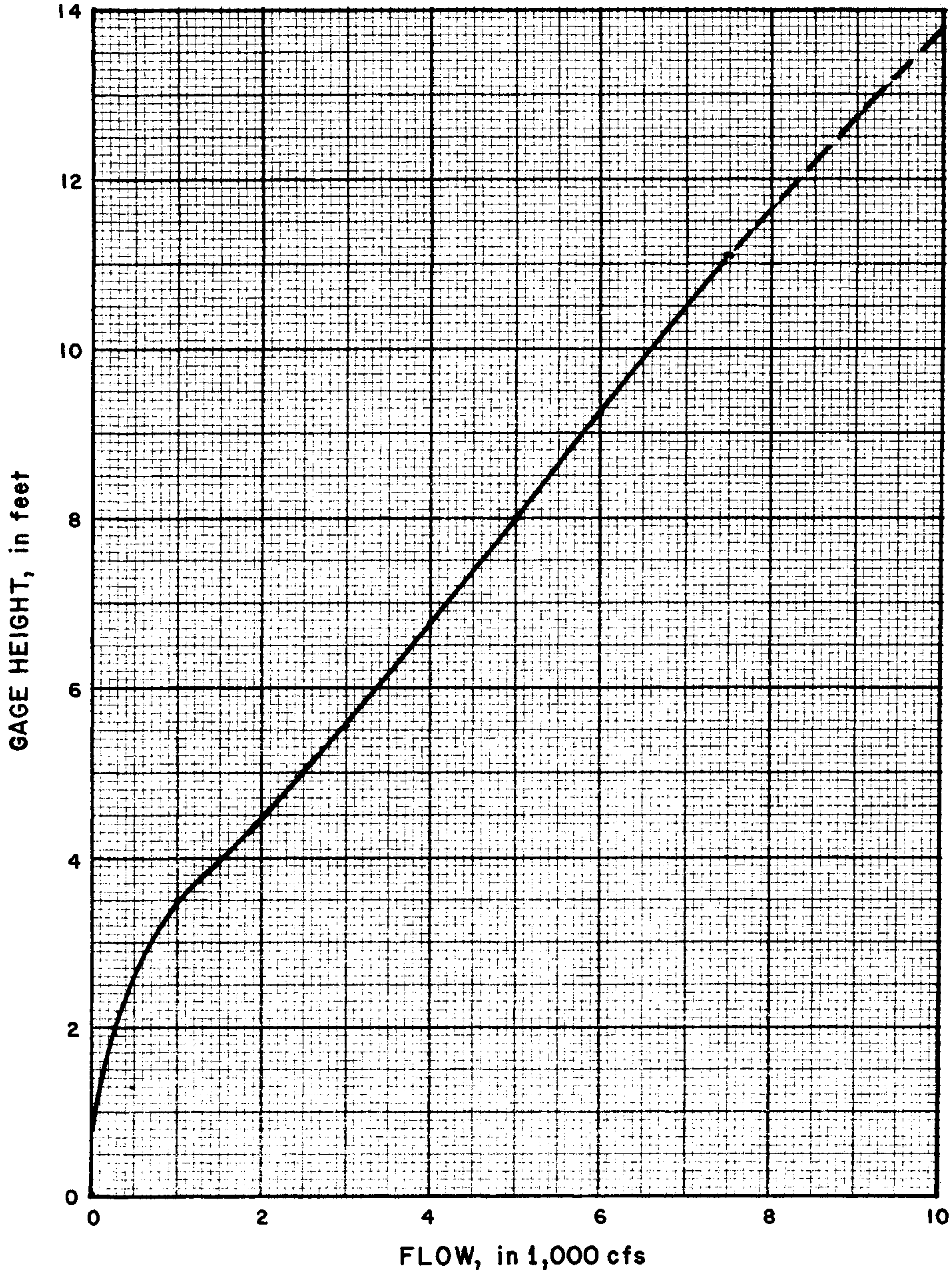
SPILLWAY RATING TABLE

ELEVATION (FT.)	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
764	–	–	–	–	–	–	–	–	0	0
765	0	45	90	120	150	180	210	250	290	320
766	350	430	510	590	670	750	840	930	1,020	1,110
767	1,200	1,310	1,420	1,530	1,640	1,750	1,860	1,970	2,080	2,190
768	2,300	2,430	2,560	2,690	2,820	2,950	3,080	3,210	3,340	3,470
769	3,600	3,750	3,900	4,050	4,200	4,350	4,510	4,670	4,830	4,990
770	5,150	5,340	5,530	5,720	5,910	6,100	6,300	6,500	6,700	6,900
771	7,100	7,310	7,520	7,730	7,940	8,150	8,360	8,570	8,780	8,990
772	9,200	9,420	9,640	9,860	10,080	10,300	10,520	10,740	10,960	11,180
773	11,400	11,640	11,880	12,120	12,360	12,600	12,850	13,100	13,350	13,600
774	13,850	14,100	14,350	14,600	14,850	15,100	15,360	15,620	15,880	16,140
775	16,400	16,680	16,960	17,240	17,520	17,800	18,090	18,380	18,670	18,960
776	19,250	19,550	19,850	20,150	20,450	20,750	21,050	21,350	21,650	21,950
777	22,250	22,560	22,870	23,180	23,490	23,800	24,110	24,420	24,730	25,040
778	25,350	25,680	26,010	26,340	26,670	27,000	27,340	27,680	28,020	28,360
779	28,700	29,050	29,400	29,750	30,100	30,450	30,800	31,150	31,500	31,850

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

SPILLWAY RATING CURVE

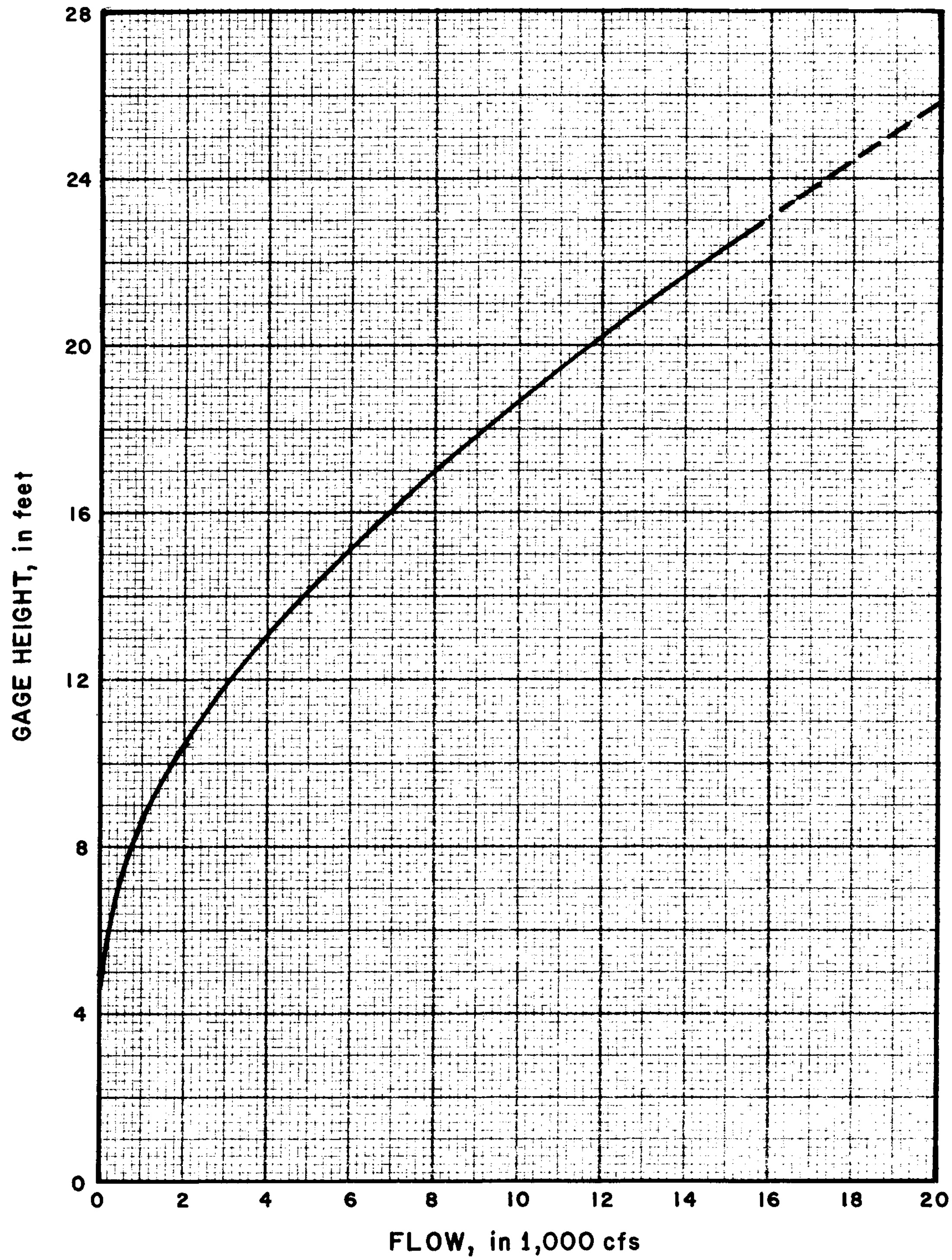
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

DISCHARGE RATING CURVE
EAST FORK RUSSIAN RIVER NEAR UKIAH

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

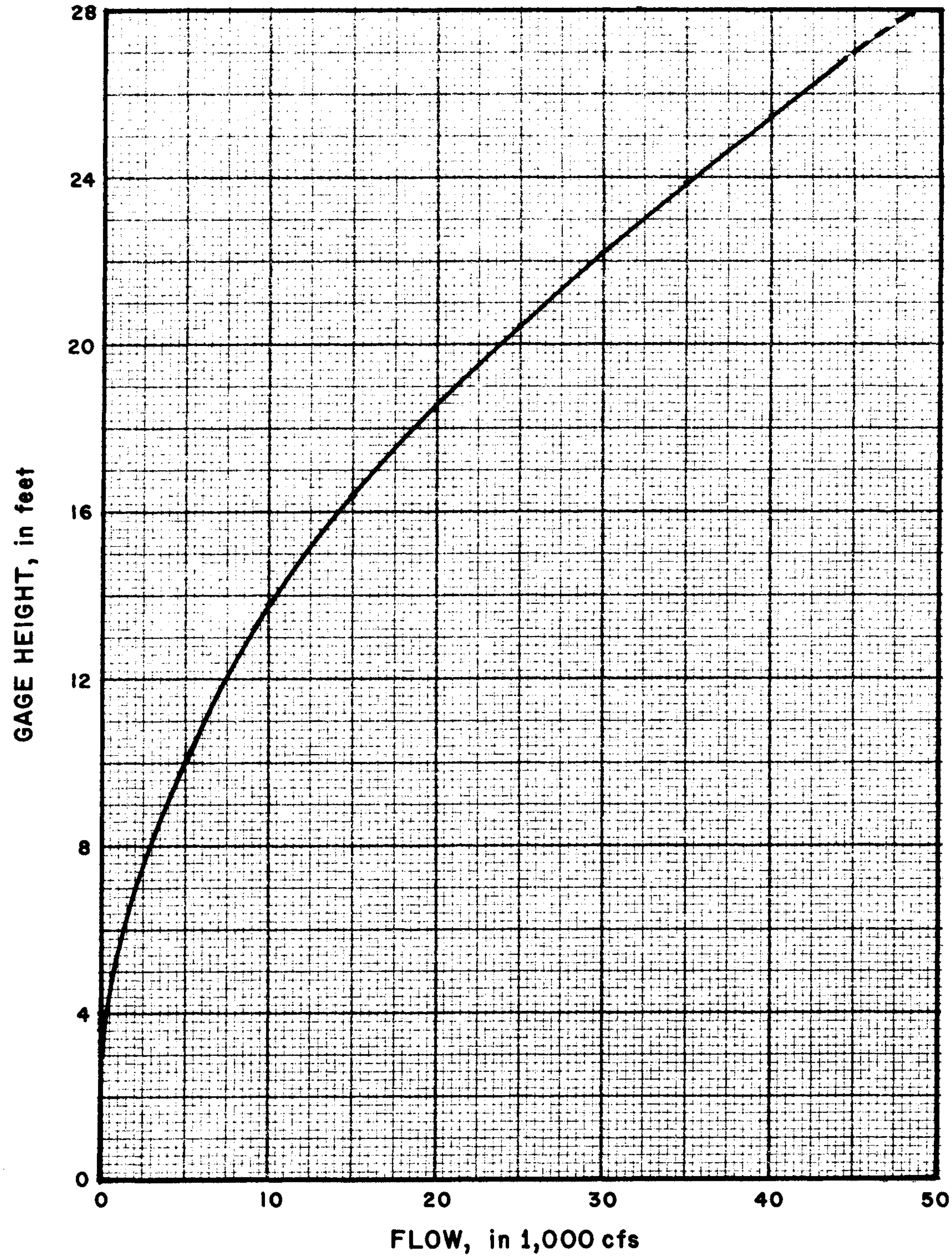


COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

DISCHARGE RATING CURVE
RUSSIAN RIVER NEAR UKIAH

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

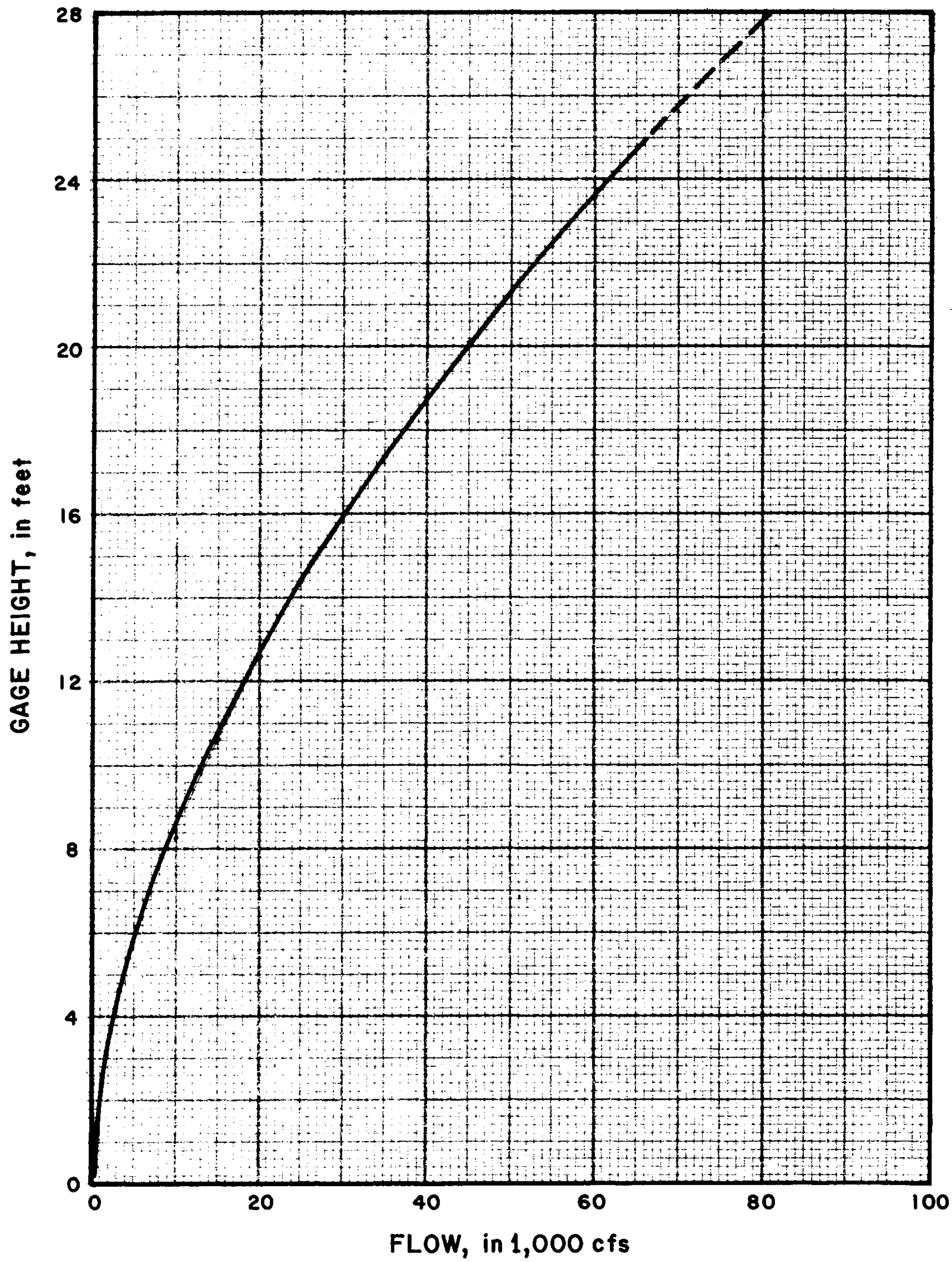
CHART A-6



COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

DISCHARGE RATING CURVE
RUSSIAN RIVER NEAR HOPLAND

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

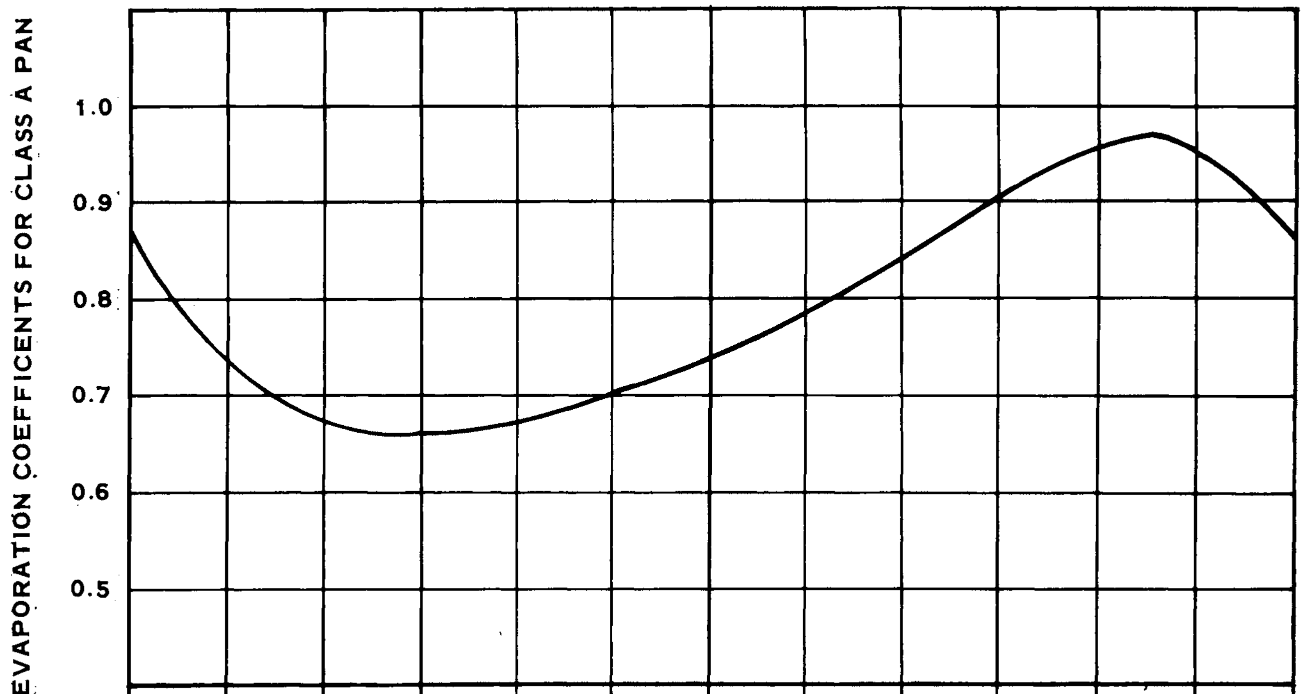


COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

DISCHARGE RATING CURVE
RUSSIAN RIVER NEAR HEALDSBURG

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

CHART A-8



	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
COEF. A	.79	.69	.67	.67	.69	.72	.76	.81	.87	.94	.96	.92
COEF. B	.066	.058	.056	.056	.058	.060	.063	.068	.072	.078	.080	.077

NOTES: COEF. A IS MEAN MONTHLY CLASS A PAN EVAPORATION COEF. TO OBTAIN EVAPORATION FROM THE RESERVOIR IN INCHES, MULTIPLY PAN EVAPORATION BY COEF. A FOR THE APPROPRIATE MONTH.

TO OBTAIN EVAPORATION FROM THE RESERVOIR IN ACRE-FEET, MULTIPLY PAN EVAPORATION BY COEF. B, FOR THE APPROPRIATE MONTH, AND MULTIPLY THE RESULTING PRODUCT BY THE AVERAGE SURFACE AREA OF THE RESERVOIR, IN ACRE-FEET, DURING THE TIME PERIOD FOR WHICH EVAPORATION IS BEING CALCULATED. CLASS A PAN IS STANDARD WEATHER BUREAU PAN, 4 FEET IN DIAMETER AND 10 INCHES DEEP.

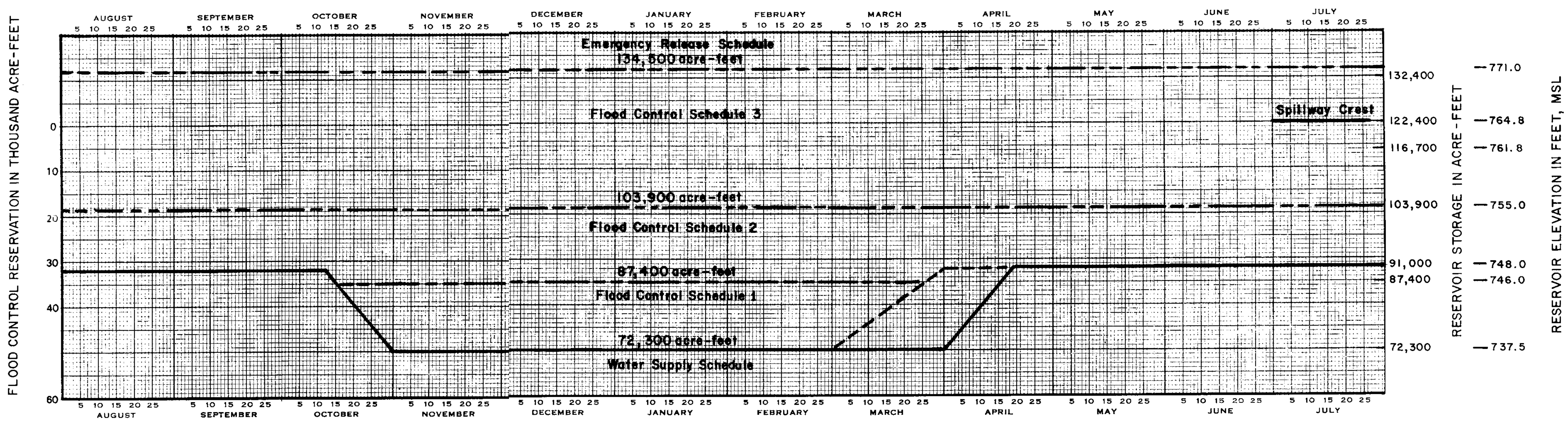
EVAPORATION COEFFICIENTS BASED ON LAKE ELSINORE.

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

EVAPORATION COEFFICIENTS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

CHART A-9



RELEASE SCHEDULES

WATER SUPPLY SCHEDULE
As directed by Sonoma County Water Agency

FLOOD CONTROL SCHEDULE 1
2,000 cfs up to a maximum release of 4,000 cfs depending on antecedent ground conditions, and time of year; subject to limitations 1-3, shown hereon.

FLOOD CONTROL SCHEDULE 2
4,000 cfs subject to limitations 1-3, shown hereon.

FLOOD CONTROL SCHEDULE 3
6,400 cfs subject to limitations 1-3, shown hereon.

Gates may be used when pool is above spillway crest (elevation 764.8) for Flood Control Schedule 3 releases, however the sum of the spill and the releases must not exceed 6,400 cfs (i.e. — outlet discharge is reduced as spillway discharge increases), and should not exceed limitations 1-3, shown hereon, to the extent possible.

NOTES:

1. The Corps of Engineers will reduce the flood control space on the 1st of March if it is determined the flood control functions of the project will not be impaired.
2. Normally, the summer pool elevation will be kept at 748.0 to maximize recreational opportunities at the reservoir. However, Sonoma County Water Agency retains the right to raise the summer pool elevation to 761.8.

USE OF DIAGRAM

1. Releases from the reservoir will be made in accordance with the highest schedule reached during the current flood shown on the accompanying diagram subject to the applicable limitations.
2. The Corps of Engineers may direct that flood releases be increased or decreased from those required by the diagram depending on conditions prevailing at the time.

EMERGENCY RELEASE SCHEDULE

Reservoir Pool Elevation	Gate Releases
771.0	0
771.0-771.3	800
771.3-771.5	1,700
771.5-771.8	2,500
771.8-772.0	3,300
772.0-772.3	4,200
772.3-772.5	5,000
772.5-772.8	5,800
772.8-773.0	6,600
773.0 and above	7,500 (gates 100% open)

LIMITATIONS

1. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour.
2. When flow in the West Fork of the Russian River at Ukiah exceeds 2,500 cfs and is rising, releases from Lake Mendocino will be reduced to 25 cfs, insofar as possible.
3. Flood releases which will contribute to flows greater than 8,000 cfs at Hopland, will not be made, insofar as possible.

COYOTE VALLEY DAM AND LAKE MENDOCINO
RUSSIAN RIVER, CALIFORNIA

FLOOD CONTROL DIAGRAM

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

CHART A-10

COYOTE VALLEY DAM
AND
LAKE MENDOCINO

RUSSIAN RIVER, CALIFORNIA

WATER CONTROL MANUAL

AUGUST 1986

EXHIBIT B

AGREEMENT FOR CONSTRUCTION, OPERATION, AND MAINTENANCE OF LAKE MENDOCINO POWER PROJECT

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

UNITED STATES DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO DISTRICT, CALIFORNIA
AND
CITY OF UKIAH, CALIFORNIA

Agreement between the United States of America and the City of Ukiah, California for Construction, Operation, and Maintenance of Lake Mendocino Power Project at Coyote Dam.

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SF:FIF:AD3:15-TC

AGREEMENT

FOR CONSTRUCTION, OPERATION, AND MAINTENANCE

OF LAKE MENDOCINO POWER PROJECT

THIS AGREEMENT, made this 5th day of April, 1984 ~~1983~~, between the UNITED STATES OF AMERICA, acting through its Corps of Engineers, Department of the Army, hereinafter referred to as the "Corps", and the CITY OF UKIAH, CALIFORNIA hereinafter referred to as the "City", a duly constituted Municipality, duly organized, existing, and acting pursuant to the laws of the State of California, with its principal place of business in Ukiah, California.

WITNESSETH THAT:

WHEREAS, the Corps has constructed Coyote Dam and Lake Mendocino as part of the Russian River Project, including the spillway and outlet works, on the East Fork of Russian River -- for flood control and water conservation for agricultural, municipal, industrial, domestic, and other purposes, and may raise the dam 36 feet at some future time, pursuant to Section 204 of the 1950 Flood Control Act, and acts amendatory thereof or supplementary thereto, and Public Law 404, approved February 10, 1956; and

WHEREAS, the Federal Energy Regulatory Commission (FERC) has issued License No. 2841 (License), dated April 1, 1982 (See Exhibit D), to the City for construction, operation, and maintenance of the Lake Mendocino Power Project which includes, but is not limited to, the powerplant, bypass facilities, switchyard, and dissolved oxygen system at Coyote Dam, in accordance with the Federal Power Act; and

WHEREAS, the City will construct the Lake Mendocino Power Project in two stages; the first stage, to begin immediately, is designed to accomodate the future raising of the dam and includes the Lake Mendocino power plant, bypass facilities, the switchyard, and dissolved oxygen system, with the second stage to include the construction of an extension to the Lake Mendocino power plant when the dam is raised; and

WHEREAS, the Corps has concluded that construction and operation of the power project, as described in the Project Design Report, and the Project Manual and Contract Drawings will not be detrimental to the purposes of the Coyote Dam and Lake Mendocino Project; and

WHEREAS, the License, Article 40 (See Exhibit D), requires the City to enter into an operations agreement with the Corps so as to protect the interests of the Federal Government and to insure the continuity of project operations;

NOW, THEREFORE, the Corps and the City, through the officers signing this Agreement, mutually agree to the construction, operation and maintenance of the power project at Coyote Dam, subject to the terms of FERC License No. 2841 and the conditions hereinafter set forth.

1. Construction

(a) The City shall construct the stage one portion of the power project according to the designs and plans as approved by the Corps and FERC. All design and construction work that will be an integral part of Coyote Dam or that could affect the structural integrity of the dam or operation of Corp facilities shall be reviewed and approved by the Corps, and the City will reimburse the Corps for all inspection and engineering costs in accordance with Article 37 of the FERC License.

(b) The Corps will conduct inspections during the construction of the power project of such work as could affect the integrity of Coyote Dam or operation of Corps facilities and the City will reimburse the Corps for all inspection and engineering costs in accordance with Article 37 of the FERC License (See Exhibit D). The Corps will have the right to direct the City or their designated agent to correct any activity that is detrimental to the integrity or operation of Coyote Dam, including shutting down construction work until such corrections are made.

(c) During the construction phase of the Lake Mendocino Power Project, the City will make provisions so that adequate releases will be pumped from a reservoir depth of approximately 60 feet to meet Sonoma Country Water Agency water needs and to maintain the Russian River flow requirements. The City will be responsible for maintaining a minimum dissolved oxygen level of 7.0 mg/l during the construction phase at the existing U.S.G.S. stream gage (East Fork Russian River, near Ukiah, California) immediately downstream of the proposed tailrace.

(d) During the construction phase of the power project the City will be responsible for, and pay the full cost of grounds security for all lands described as Parcel A and B, and the access road as shown in Exhibits A and B.

(e) Upon completion of construction, the City will remove all construction debris from the site and restore any disturbed areas to conditions existing prior to the construction of the Lake Mendocino Power Project, as approved by the Corps.

(f) The City will be responsible for maintaining the existing access roads in a satisfactory condition during the construction period. The City shall repair any damage to the roads during construction and restore the roads to their original condition upon completion of construction.

(g) The City shall submit to the Corps for approval prior to beginning construction activities its detailed construction schedule including a contingency plan to assure that the required releases can be made as scheduled. In addition, the inspection plan required by FERC will establish the key dates and a procedure such that the Corps inspection team has the opportunity to accept the work before additional work can proceed. The City shall also submit to the Corps any changes in activity dates to the schedule prior to initiation of the activity.

(h) City is to provide the Corps full size reproducible (mylar) as built drawings of the power project. In addition, during the construction phase all revisions to contract drawings are to be provided to the Corps in a timely manner.

(i) The construction shall not interfere with the Corps operation and maintenance of the project.

(j) The City will be responsible to perform and fund repairs of any damage to Corps facilities resulting from (as determined by the Corps) the construction and/or operation of the Lake Mendocino Power Project.

(k) The City may construct the stage two portion of the project, according to the designs and plans as approved by the Corps and FERC, when Coyote Dam is raised. The City will be responsible to fund the additional cost of necessary modifications for stability of the power facility when the dam is raised. The City does not rely on the raising of Coyote Dam for power generation and will not take legal action against the Corps if the dam is not raised.

2. Ownership

(a) Title to the following shall be in the name of the United States.

1. All lands, Coyote Dam, and existing appurtenances and equipment presently in the United States ownership.

2. The plenum chamber, the conduit steel liner installation, all equipment installed in the intake tower, the 108-inch diameter bypass penstock from the plenum chamber to the 108-inch fixed cone valve.

(b) The City shall have title to the Lake Mendocino power plant and appurtenant features: including the turbines and generators, the gates and valves associated with the power plant, the 108-inch fixed cone valve, the plenum tainter valve, the switchyard, the new tailrace channel to be constructed southerly of the existing tailrace channel, the dissolved oxygen facilities, and all other power plant equipment excluding those defined in Article 2(a).

3. <u>Access by Corps</u>

(a) The Corps, its agents, or contractors shall at all times have free and unrestricted access to, through and across all lands and Lake Mendocino Power Project.

(b) Access into the control tower by the City shall only be possible when accompanied by Corps personnel.

4. <u>Operations</u>

(a) All water releases from Coyote Dam will be determined, controlled, and directed by the Corps. The Corps will establish, and transmit to the City, dam flow release schedules (except during flood control operation) at the Coyote Dam for a weekly, daily, or other period as needed, in units of cubic feet per second. The City, after receiving the flow release schedules, shall provide an operations program for that period. The operation program will include the flow distribution through all discharge valves and the power plant necessary to comply with the Corps' release schedules. The Corps will be notified immediately of any revisions to this program. Such revisions may be necessary to increase power plant efficiency or improve valve operation. In no case will such revisions affect the Corps' release schedules. The dam release schedules, operations program and revisions to the program will be transmitted by telephone or radio. Radio communication will be between the City and the Corps located in Sacramento, California on the City's supplied equipment and frequency. The City will fund all costs for the radio communication system.

(b) The City will be responsible for the establishment of new discharge tables for the above mentioned valves and power plant. The City will develop these discharge tables in accordance with procedures approved by the Corps.

(c) During emergency situations, as determined by the Corps, the Corps will advise the City of the situation and may take appropriate action, including shutting down the power units and assuming control of the appropriate outlet gates and valves. The Corps will not be held liable for damage to the City's facilities that results from the Corps operation of the power facilities during emergency situations.

(d) The Lake Mendocino Power Plant will receive flows from the existing outlet conduit. The power plant discharges will be supplemented by the discharge valves, so as to meet and maintain the required dam release into the East Fork of the Russian River.

(e) The power facilities will be locally and remotely operated, and remotely monitored by the City. (See Exhibit C for more information.) In addition, the power plant will have local automatic restart for short duration line trip. Plant operation will be monitored 24 hours per day and may be shut down remotely if required by an emergency.

(f) The City will be responsible for maintaining a minimum dissolved oxygen level of 7.0 mg/l at the existing U.S.G.S. stream gage immediately downstream of the proposed tailrace.

(g) The Lake Mendocino Power Plant and associated facilities will be operated generally in two modes; power generation mode and flood control mode. Power generation mode will be in operation when the required dam releases are between 0 and 4375 cfs, inclusive, and the flood pool is at or below elevation 755 feet. Flood control mode will be in operation when the required dam releases exceed 4375 cfs, the flood pool exceeds elevation 755 feet, or the conservation pool exceeds elevation 762 feet. See Exhibit C of this document for additional information.

(h) When the dam and power plant facilities are operating in the power generation mode, the control gates (three service slide gates and three emergency slide gates in the intake tower) will be fully open, the plenum tainter valve will be fully closed, and the turbines and bypass valves will be opened as necessary to pass the required water release.

(i) When the dam and power plant facilities are operating in the flood control mode the plenum tainter valve will be fully open, the turbines and bypass valves will be fully closed, and the control gates will be opened as necessary to pass the required water release.

(j) The City will be responsible for operating the plenum tainter valve, the turbines, and the bypass valves in cooperation with the Corps to meet the required water releases. The Corps will be responsible for operating all equipment in the intake tower, except the aeration facilities.

(k) The transition from the power generation mode to the flood control mode will proceed in the following general sequence: (1) the turbines will be shut-down, (2) the service slide gates will be closed, (3) the air vent valves will be opened and used to depressurize the outlet conduit, (4) the plenum tainter valve will be opened, and (5) the service slide gates will be opened as necessary to pass the required water release.

(l) The transition from flood control mode to power generation mode will proceed in the following general sequence: (1) the service slide gates will be closed, (2) the air vent valves and the plenum tainter valve will be closed, (3) the outlet conduit pressurized, (4) the service slide gates will be fully opened, and (5) the turbines and bypass valves opened as necessary to pass the required water release.

(m) A detailed start-up testing plan will be developed at a later date by the City, and will be subject to Corps approval.

(n) No change to the Lake Mendocino Power Project, which in the opinion of the Corps is substantial and may affect the structural integrity of Coyote Dam or its operation shall be made by the City without first obtaining the written consent of the Corps.

5. Interruption of Releases

Releases from Coyote Dam, as provided in the daily operation program approved by the Corps, shall not be interrupted, except for transition between power generation and flood control modes, by operation or maintenance of the power plant except with the Corps' prior approval.

6. Maintenance

(a) The City will be responsible for the performance of maintenance and for all costs related thereto, of the following:

1. The Lake Mendocino Power Plant structures as defined under Article 2(a)2 and 2(b).

2. Grounds, care, and security measures of established areas of their facilities.

3. The City's portion of the tailrace channel in compliance with Corps requirements.

4. New access road to the powerhouse and to the satisfaction of the Corps.

(b) The City shall also be responsible for performing and funding 100 percent of the cost for maintenance of the toe of dam access road beginning at Mendocino Drive and ending at the intersection where the road to the power plant begins. The Corps shall be responsible for funding 100 percent of the cost for maintenance of the access road on the crest of the dam.

(c) The City's operation and maintenance activities will not interfere with the maintenance program of Corps facilities and Corps maintenance crews.

(d) The City shall be responsible for reimbursing the Corps for additional costs incurred by the United States that result from installation of the power facilities.

7. Inspection by the Corps after Construction

(a) The Corps shall have the right to inspect the power plant during their periodic and preflood inspections of Coyote Dam to ensure that the power plant is being operated and maintained in a condition which will not endanger the structural integrity of Coyote Dam, or its appurtenances, or the operations of the Corps' Coyote Dam and Lake Mendocino Project. These inspections shall occur on an interval as dictated by the Corps' prevailing policy. Timely notice of these scheduled inspections shall be given to the City by the Corps so as not to conflict with power generating contract provisions.

Copies of all reports shall be provided to the City and to the FERC by the Corps. The City shall reimburse the Corps for the costs of the portions of the inspection associated with the inspection of the power project and for costs of any additional inspections.

(b) The City will promptly correct all deficiencies identified by the Corps. Should the City fail to make necessary repairs in a timely and acceptable manner, the repairs may be made by the Corps and the City will reimburse the Corps for the costs of said repairs.

8. Notices

Any notice, demand, or request authorized or required by this Agreement shall be deemed to have been given, on behalf of the City, when mailed, postage prepaid, or delivered to the District Engineer, Sacramento

District, Corps of Engineers, 650 Capitol Mall, Sacramento, California 95814, and on behalf of the Corps, when mailed, postage prepaid, or delivered to the City of Ukiah, 203 South School Street, Ukiah, California 95482. The designation of the addressee or the address may be changed by notice given in the same manner as provided in this article for other notices.

9. Liability

(a) The City hereby agrees to indemnify and hold harmless the Corps, its agents and employees, from any loss or damage and from any liability on account of personal injury, death or property damage, or claims for personal injury, death, or property damage of any nature whatsoever and by whomsoever made arising out of the City's activities under this Agreement.

(b) Responsibility for the performance and cost of repairing any damage to the Coyote Dam and its appurtenances as a result of the City's deviation from the requirements of this Agreement will be the responsibility of the City.

10. Disagreements

Should any disagreement arise involving the project which cannot be resolved by the parties to this agreement, the disagreement shall be resolved as called for under the terms of License Article 37.

11. Training of Corps Personnel

The City will train three Corps personnel in the emergency shutdown of the entire hydropower system at the City's expense prior to commercial startup of the plant. The City will conduct a refresher course each year thereafter for three Corps personnel to ensure complete familiarity with the hydropower installation.

12. Term of License and Agreement

This Agreement shall become effective on the day when delivered signed by the Corps to the City and shall terminate upon termination or transfer of FERC License No. 2841.

IN WITNESS WHEREOF, the parties have executed this Agreement on the date first above written.

THE UNITED STATES OF AMERICA
USA, Corps of Engineers, South Pacific Division

By ______________________
BRIGADIER GENERAL DONALD J. PALLADINO
Commanding

CITY OF UKIAH

By ______________________
Mayor

Attest:

By ______________________
Secretary

SF:FIF:AD3:15-OMA

EXHIBIT C

TABLE OF CONTENTS

1. GENERAL PROJECT OPERATION

A. Existing Project Operation

The installation of the proposed hydroelectric facilities will not significantly alter the reservoir operation. All releases, except for short durations, will continue to be made as requessted by Sonoma County or the Corps of Engineers, in accordance with procedures given in the U.S. Army Corps of Engineers' document "Operation and Maintenance Manual for Coyote Dam and Lake Mendocino". The Corps will remain in control of the flood control operation of the reservoir; while during the flood free months, the determination of the level of releases are transferred to the Sonoma County Water Agency. The Corps will continue to physically operate the existing outlet works facilities.

The Coyote Dam and Lake Mendocino Project is operated for flood control and water conservation to meet the following objectives:

(a) to prevent flood flows on the East Fork Russian River from contributing to overbank flood stages on the main Russian River below Coyote Dam, insofar as possible;

(b) to provide the maximum amount of water conservation storage without impairment of the flood control functions of the reservoir;

(c) to maintain a normal minimum discharge of 125 cfs at the Russian River near Guerneville stream-gaging station.

When the conservation pool is full, water releases, insofar as possible, are restricted so that the sum of the discharge from the reservoir plus the discharge in the Russian River below the dam is below bankfull stages. Estimated bankfull discharges in critical reaches are (1) Ukiah Valley, 7000 cfs; (2) Hopland Valley, 8,000 cfs; and (3) Alexander Valley, 10,000 cfs. Below Alexander Valley, bankfull discharges are above 20,000 cfs. Under normal conditions, reservoir releases are made to keep the minimum flow at the

Russian River near Guerneville stream-gaging station above 125 cfs. Releases are made to keep the discharge below the confluence of the East Fork Russian River and the Russian River above 150 cfs or the inflow to the reservoir, whichever results in the lower reservoir release. The minimum release from the reservoir under normal operating conditions is 25 cfs. Minimum release from the reservoir when the reservoir pool level is below the flood control pool is governed by an agreement between Sonoma County and the California Department of Fish and Game. In the event of an emergency, the minimum flows can be modified by Sonoma County subject to the concurrence of the California Department of Fish and Game.

The flood control operation plan for Coyote Dam, as stated in the Corps of Engineer's Project document is as follows:

> During the flood season (November 1 to April 1), the reservoir would be operated to provide the highest possible degree of flood protection. Operating procedures would be designed to insure that the entire flood control storage space would be available when needed. During floods, releases would be made from the reservoir only at such times that the releases would not contribute to flood peaks at downstream points. In calculating the total required capacity of the reservoir, it has been assumed that during the flood season the flood control storage space would be kept empty at all times except during floods and that no release would be made from the Coyote Valley Reservoir during a flood.

This plan is still the basic plan for the Project, with the exception that when the reservoir does spill, some releases may be made while stages along the Russian River below the dam are still above bankfull levels.

The plan is based on controlling peak discharges along the Russian River with a single reservoir. To accomplish this plan the reservoir is allowed to fill to the top of the conservation pool (El. 737.5 ft.) each winter. After the reservoir reaches this level, releases are made to hold the pool at this level until the discharge at the stream-gaging station Russian River near Ukiah reaches 2,500 cfs. When the river rises to this level, releases from the reservoir are lowered to 25 cfs until the stage at the stream-gaging station "Russian River near Hopland" falls to bankfull levels. At this point, releases from the reservoir are increased to the level that produces non-

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TABLE 1

LAKE MENDOCINO RESERVOIR OPERATION

STAGE ONE

MONTH	PRESENT OPERATION		POWER PLANT OPERATION
OCT	Flood Control Operation:		Flood Control Pool:
NOV	Pool held at El. 737.5 ft.		Power plant generation is sporadic -- minimum normal release is 30 cfs.
DEC	Maximum Flood Pool Elevation	Maximum Release	Power system must be depressurized if WSEL exceeds 755 feet, and remain so until the pool recedes to El. 737.5 feet.
JAN	<746 ft.	2000 cfs	
FEB	746-755 ft.	4000 cfs	
MAR	755-772.8 ft.	6400 cfs	
APR	Water Supply Operation:		Water Supply Pool:
MAY	Maximum pool is currently held at El. 748.0 ft. The authorized maximum pool elevation is actually 762. ft. Releases made to meet Sonoma County Water Agency's demands of 250 to 250 to 450 cfs.		Power plant generation is firm -- releases and head are relatively constant at peak power plant efficiency.
JUN			
JUL			
AUG			
SEP			

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damaging discharges at the "Russian River near Hopland" stream-gage. Releases continue until the flood control pool is empty, or until another storm that requires closing the gates at the dam occurs. An induced surcharge operation schedule is to be used on the infrequent occasions when flood inflows exceed the capacity of the flood control pool. A brief discussion of the schedules is presented in the following paragraphs.

See Table 1 for the Existing vs. Proposed reservoir operation description.

B. Power Project Operation Overview

The power plant and associated facilities at Lake Mendocino can be operated in basically two modes; the power generation mode and the flood control mode. The power generation mode occurs when the downstream releases are in the range of 0 to 4,375 cfs, and with the outlet conduit under full reservoir pressure. The flood control mode occurs when the release rate exceeds 4,375 cfs., and with the outlet conduit under open channel flow conditions. See Section 2 for detailed operation procedures.

B.1. Power Generation Mode

The outlet system generally consists of the original three sets of tandem slide gates (three service gates and three emergency gates), the powerhouse and bypass valve takeoffs, and the plenum tainter valve. Also involved in this operation are the three air vent valves in the intake tower. Under the power generation mode the three sets of tandem slide gates will be 100% open; the tainter valve will be fully closed; the air vent valves will be closed; and the turbines plus bypass valves will be opened as necessary. Table 2 shows the flow ranges through the powerhouse and bypass valves.

B.2. Flood Control Mode

The flood control mode occurs infrequently during the winter months when the flood control pool exceeds elevation 755 ft., and when the Corps anticipates high runoff from a storm in excess of 4000 cfs. During the flood control mode, the three service slide gates are used to regulate the flow; the tainter valve is 100% open; the air vent valves are open; and the powerhouse and bypass valves are shut down.

The maximum flood release rate through the outlet works is decreased by the installation of the power project from the existing 7,700 cfs capacity to approximately 7,080 cfs capacity. The Corps has determined that the effect of this lost capacity on flood control protection can be accommodated.

C. Proposed Power Project Construction Schedule

As shown on Table 3 the Notice to Proceed for Construction of the Lake Mendocino Power Project is scheduled to be issued on October 1, 1983. The construction completion date is scheduled to be April 15, 1985, with the start-up of commercial operation to begin on June 15, 1985. Only routine maintenance procedures would be required after the start-up of the plant. A brief description of the proposed construction activities is discussed in the following paragraphs.

The construction of the tailace, energy dissipator, switchyard and powerhouse, scheduled to take place between January 1984 and April 1985, would involve only routine construction practices. The critical construction period involves installing the steel liner in the existing outlet conduit, along with its associated tainter valve and plenum chamber.

During March and April, 1984, the preparation work for the construction in the outlet works will take place. This will include on-site delivery of the tested and approved liner sections, any pre-assembly of the liner prior to insertion into the outlet works, installation of the pumping system which will divert the required downstream releases over the dam, and on-site delivery and assembly of the tainter valve.

Construction work in the existing outlet conduit will begin on May 1, 1984, and be completed by September 1984. It is anticipated that crews will be working 24-hours per day, and 7-days per week in order to complete this work.

TABLE 2

LAKE MENDOCINO POWER PROJECT

PROPOSED RELEASE SCHEDULE

Reservoir WSEL (feet)	Downstream Release (cfs)	Flow through Component (cfs)					
		1000 kW Unit	2500 kW Unit	108" Fixed-Cone Valve	54" Fixed-Cone Valve	18" Gate Valve	Plenum Taintor Valve
746	0-21	-	-	-	-	0-21	-
	22-112	22-112	-	-	-	-	-
	113-272	-	113-272	-	-	-	-
	273-382	110	163-272	-	-	-	-
	383-500	110	272-271	-	-	1-119	-
	501-1267	110-107	271-260	-	*120-900	-	-
	1268-1322	107	260	-	900-865	1-90	-
	1323-3707	107-90	260-220	956-3397	-	-	-
	3708-3770	90	220-215	3397-3370	-	1-95	-
	3771-4175	90-80	215-190	3370-3155	*96-675	1-75	-
	4176-7200	-	-	-	-	-	4176-7200
755	0-21	-	-	-	-	0-21	-
	22-117	22-117	-	-	-	-	-
	118-282	-	118-282	-	-	-	-
	286-397	116	170-281	-	-	-	-
	398-518	116-115	281-280	-	-	1-123	-
	519-1313	115-111	280-269	-	*124-933	-	-
	1314-1370	111-110	269	-	933-897	1-94	-
	1371-3902	110-96	269-231	992-3575	-	-	-
	3903-3964	96-94	231-227	3575-3542	-	1-101	-
	3964-4373	94-80	227-193	3542-3325	*101-701	1-74	-
	4374-7200	-	-	-	-	-	4374-7200

* Operation of this valve at these low flows may cause cavitation.

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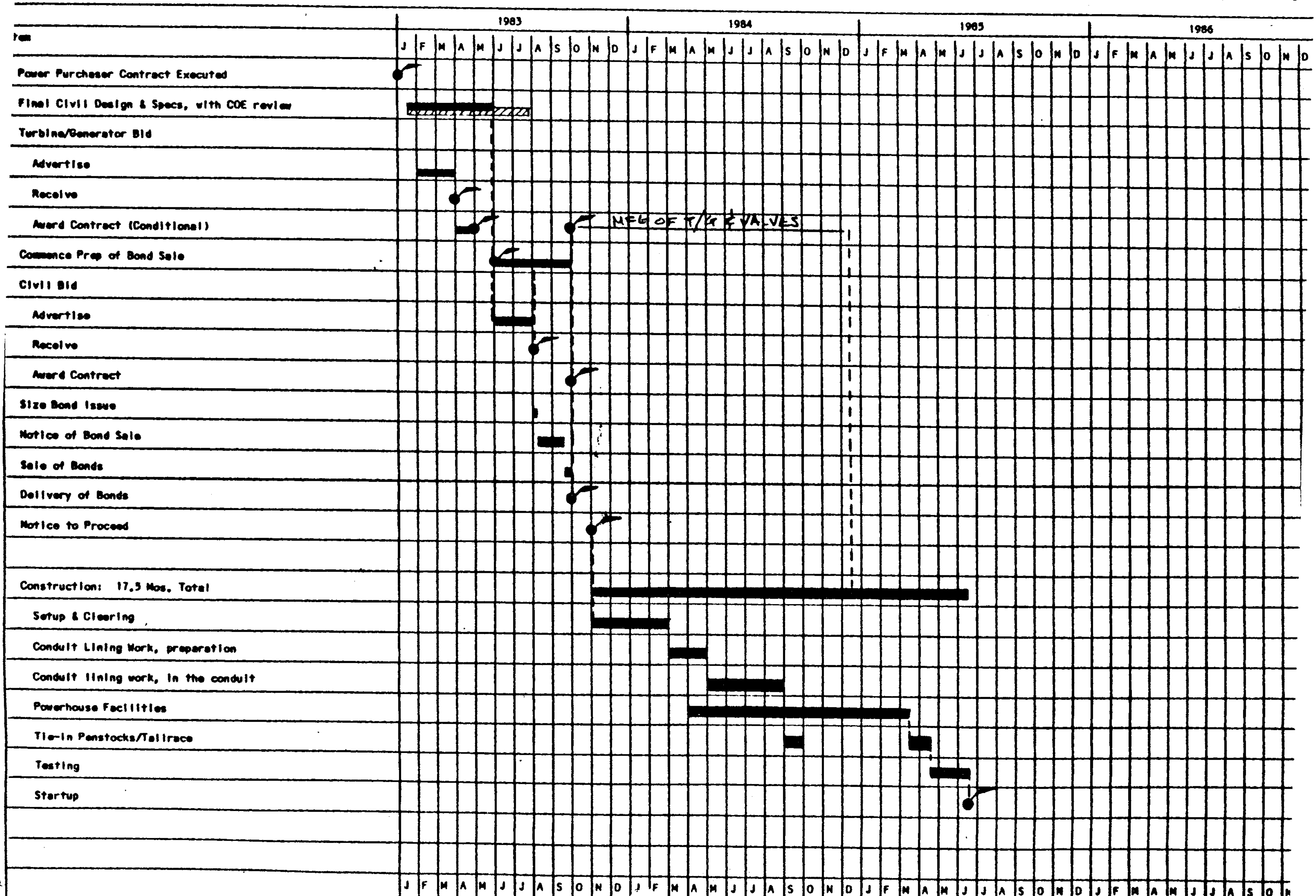
During the work in the outlet conduit, flows would be passed over the dam at rates specified by Sonoma County Water Agency, and which would maintain the Russian River requirements of: (1) 125 cfs at Guerneville, (2) 150 cfs at the Forks, or the inflow to Lake Mendocino, whichever is less, and (3) 25 cfs in the East Fork Russian River. If flood releases must be made during the period when the outlet conduit is closed for construction, then such flood releases will be made as directed by the Corps. The Corps will not be held liable for claims resulting either for damages or lost time due to this action.

The major water rights holder along the Russian River is the Sonoma County Water Agency (SCWA). The SCWA's main intake to their water distribution system is the Wohler Pumping Plant located near Healdsburg about ten miles upstream of Guerneville. SCWA has specified a maximum pumping capacity of 400 cfs. This requirement has been specified in the Project's Plans and Specifications. SCWA reviewed the pumping system and their comments and requirements were incorporated into the plans and specifications.

TABLE 3
LAKE MENDOCINO POWER PROJECT
CONSTRUCTION SCHEDULE

REV. 3 SCS 11/8/83
REV. 2 SCS 4/22/83
REV. 1 SCS 1/26/83



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2. PROPOSED POWER PLANT OPERATION

The installation of the Lake Mendocino Power Project will change the physical operation that the local Corps Project Team must do to operate the reservoir. During normal power generation mode operation, the downstream releases will be regulated by the power facility. The Corps will continue to dictate the amount of releases, but the City's personnel will physically operate the facility, except in emergency. In an emergency the Corps will operate the facilities as necessary. The City's personnel will physically operate the power facility to meet the release requirement. During flood control operation, the Corps will physically operate the dam facility to regulate the flows.

Maintenance of the powerhouse facility including penstocks, the 18-inch gate valve, 54-inch fixed cone valve, tainter valve and oxygen system can be accomplished without interrupting the reservoir releases. Maintenance of 108-inch fixed cone valve may result in a short term disruption of flow, on the order of 2 hours. Maintenance of the outlet conduit liner will essentially incur the same outlet conduit shutdown as is now required for maintenance of the unlined conduit. The powerhouse and bypass facilities will be shut down as necessary to give adequate time for maintenance.

The power facility can be operated in basically two modes, the power generation mode (PGM), and the flood control mode (FCM). Table 4 shows the normal, steady state operation of the power facility for the entire range of flows from 0 to 7080 cfs. In order to change from the PGM to FCM, a series of operations must be made. Table 5 shows the mode transition under normal operating conditions, from PGM to FCM, based on maintaining the Corps flow adjustment limitations of 1000 cfs per hour, and operating all power facility components as designed. An additional series of operations must be made to change from the FCM to the PGM. Table 6 shows the mode transition under normal operating conditions, from FCM to PGM, based on maintaining the Corps' flow adjustment limitations, and operating all power facility components as designed.

Under certain circumstances, the Corps may perform a mode transition operation disregarding the 1000 cfs per hour flow adjustment limitation. Table 7 shows four transition procedures which are based on the specific equipment designed operating times and ignores the flow adjustment constraints. These four transitions, two "normal" conditions and two emergency - equipment failure conditions, represent the quickest transition time while operating the equipment as designed under a "normal" operation, i.e., the tainter valve is opened with the outlet conduit drained.

Table 8 represents the mode transition, from PGM to FCM, in the event of an emergency which would require a rapid mode transition in less than one hour. The Corps flow adjustment limitation would be ignored and some component operations would occur simultaneously. The air vents will be exposed to the reservoir head, the slide gates will be closed where they control the outflow, and the tainter valve will be opened with the outlet conduit full of water. See the following text and tables for a complete description.

A. Normal Operation

As briefly mentioned the power plant can operate in two modes; the power generation mode (PGM) and the flood control mode (FCM). The power facility would be operating in the flood control mode less than 2 weeks out of the average year.

A.1. Power Generation Mode

During the PGM, the City's personnel will remotely and/or locally operate the power facilities. These power facilities include two generating units, 18-inch gate valve, 54-inch fixed cone valve, 108-inch fixed cone valve and 11-foot by 16-foot tainter valve. The air vent valves and associated equipment located in the intake tower will be operated by the Corps.

Supervisory Control System — Supervisory Control and Monitoring will be provided by a Master Station located at the City of Ukiah's Electrical Department Office for remote operation of the power plant and two

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TABLE 4

LAKE MENDOCINO POWER PROJECT

FLOW CONTROL COMPONENT SELECTION

Case	Flow From	Flow To	Components Utilized	Automatic Bypass to
1.	0 Flow	Min. for 1MW	18" Gate Valve	NA
2.	Min. for 1 MW	Max. for 1MW	1MW Unit	18" Gate Valve
3.	Max. for 1 MW	Max for 2.5MW	2.5MW Unit	54" Fixed Cone Valve
4.	Max. for 2.5MW	Max. for 1MW + 2.5MW	1MW and 2.5MW operated to produce max. power	54" Fixed Cone Valve
5.	Max. for 1MW + 2.5MW	Max. for 1MW + 2.5MW + 18" Gate V.	1MW full capacity 2.5MW full capacity 18" Gate V. remainder	54" Fixed Cone Valve
6.	Max. for 1MW + 2.5MW + 18" Gate V.	Max. for 54" fixed cone valve	1MW full capacity 2.5MW full capacity 54" Valve remainder	54" Fixed Cone Valve
7.	Max. for 54" Fixed Cone Valve	Max. for 54" + 108 valves	1MW full capacity 2.5MW full capacity 54" between zero and max valve of Case 6 108" remainder, added in 10% increments	54" Fixed Cone Valve
8.	Max for 54" + 108" Valves	Max. for 54" + 108" + 1MW + 2.5MW	1MW full capacity 2.5MW full capacity 108" full capacity 54" remainder	54" Fixed Cone Valve (partial opening)
9.	Max. for 54" + 108" + 1MW + 2.5MW	Plenum Tainter Valve	Use Plenum Tainter Valve	None

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distribution substations. A few of the Control, Telemetry and Alarm monitoring functions which will be provided as follows: (A complete listing appears in the Project Design Criteria.)

	Power Plant		City Control Room	
	Capability	Reading	Capability	Reading
a. Bypass Valves				
1. 18-inch Gate Valve	Monitor & Control	Valve Pos	Monitor & Control	Valve Pos
2. 54-inch Fixed Cone Valve	Monitor & Control	Valve Pos	Monitor & Control	Valve Pos
3. 108-inch Fixed Cone Valve	Monitor	Valve Pos	Monitor	Valve Pos
b. Each unit - control and telementry				
1. Unit start/stop	Control	on/off	Control	on/off
2. Turbine gate control	Control	Gate Pos	Control	Gate Pos.

The Corps will operate the air vent valves and associated equipment. Under normal operating conditions the City will operate the Tainter valve. The Corps will be instructed how to operate the Tainter valve in the event of an emergency. During heavy runoff condition, the initiation of the closure of the 108-inch fixed cone valve must occur within 15 minutes after notification by Corps personnel. The City of Ukiah powerplant operators will be available within 15 minutes to operate the 108-inch valve. See Table 4 for a

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description of the powerhouse flow control component selection. During the PGM, the powerhouse units and valves will be operated as shown in Table 4, and the air vent valves will be closed. Up to 4375 cfs can be released under the PGM.

As shown in Table 4, Case 1, during the periods of low reservoir releases, less than about 25 cfs, the generating units are out of the range of operation and the flow is bypassed through the 18-inch gate valve. This flow regime typically occurs during the flood control season between flood releases, and during a drought.

In Case 2 (Table 4), the reservoir releases will be between about 25 cfs and 100 cfs. Only the 1.0 MW unit will operate at these flows, with the automatic bypass component being the 18-inch gate valve. The 18-inch gate valve will automatically open in one to three minutes after load rejection of the unit; and, if open, will automatically close upon startup of the 1 MW unit.

Cases 3 through 8 (Table 4), represent the "normal" operating condition for the power facilities. The reservoir releases are between about 100 cfs and 4375 cfs. Either the 2.5 MW unit alone, or both the 1 MW and 2.5 MW units are generating power at peak efficiency, and the bypass valves are opened as necessary to maintain the required releases. During this operation, the 54-inch fixed cone valve is used to automatically bypass the flows from the operating units. The 54-inch valve will open in 3 to 5 minutes, or less, upon load rejection of the unit(s). In order to ensure this, a "reserve" capacity equal to the generating unit(s) flow, is set aside from the 54-inch valve's maximum capacity. For example, the maximum flow through the 54-inch valve is approximately 1,000 cfs. With both generating units operating at maximum capacity, about 400 cfs is used to generate power. Under these conditions, the maximum flow through the 54-inch valve will be limited to 600 cfs, with the remaining bypass flows being released through the 18-inch and/or 108-inch valves. The power facility is therefor able to maintain the required release rates independent of the power unit's operating status.

When the reservoir release rate exceeds the generating unit's capacity, plus the 18-inch and 108-inch valve's capacity, plus the 54-inch valve minus the

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reserve capacity, then the power facility will be shut down and the tainter valve opened. This represents Case 9 in Table 4, when the reservoir releases exceed about 4375 cfs. This operation is defined under the Flood Control Mode.

Turbine Operating Criteria

a. Normal Start-up

The turbine shutoff valves are opened under balanced or unbalanced pressure. Flow through the turbines is controlled by the wicket gates. Flow is stopped by closure of the wicket gates or turbine shutoff valves.

b. Normal Shutdown

The flow through the turbines is stopped by a slow closure of the wicket gates either under the control of the hydraulic controller or under manual control. The turbine shutoff valves may or may not be closed after the flow has stopped. To maintain river flows, the 54-inch fixed cone automatic bypass valve opens when the 2500 kW turbine shuts down. The 18-inch gate automatic bypass valve and/or the 54-inch fixed cone automatic bypass valve opens when the 1000 kW turbine is shut down.

c. Normal Emergency Shutdown

Upon load rejection due to grid fault the 2500 kW turbine wicket gates will close rapidly (within six seconds) to minimize generator overspeed and the 54-inch fixed cone automatic bypass valve will open to approximately the discharge flow rate of the turbine when the load rejection was initated. The 54-inch automatic bypass valve will have an electric motor actuator. When the 1000 kW unit shuts down the 18-inch electric motor actuated gate automatic bypass valve and/or 54-inch automatic bypass valve opens.

d. Equipment Malfunction Emergency Shutdown

An emergency shutdown is necessary in the event of an equipment failure. If wicket gate closure is activated by other equipment malfunction, the normal emergency shutdown process occurs. If the wicket gate malfunctions, the turbine shut-off valve closes and the turbine shut-off valve bypass valve actuators cause the bypass valves to operate.

A.3. Flood Control Mode

When the reservoir pool reaches elevation 755 feet, or the release rate exceeds about 4,375 cfs, or when the Corps requires the units to get off line, the power facility will operate under the FCM. Under this mode, the tainter valve will be locked in the open position and the air vent valves will be fully opened. The Corps slide gates are used to regulate the flow. The powerhouse units and valves will be closed down.

A.4. Transition from PGM to FCM

In order to make the transition from the power generation mode to the flood control mode, a series of operations will be made. First, the turbines will be shut down and the three service slide gates closed. The air vent valves will be opened, the outlet conduit will be depressurized, and the conduit drained as the tainter valve is being raised to the fully open position. Vacuum breaker/air relief valves are provided in the air vent system in order to dewater and pressurize the outlet conduit. Once the tainter valve is secured in the open position, the three service slide gates will be opened as necessary by the Corps to regulate the releases. During the transitory period, the release rate will be determined by the Corps. The sequence the timing of this procedure are shown on Table 5. The sequence shown in Table 5 maintains the Corps normal operation criteria of limiting the change of flow to 1000 cfs or less per hour increments.

TABLE 5

SEQUENCE AND TIMING OF TRANSITION

FROM POWER GENERATION TO FLOOD CONTROL

DURING FLOOD CONTROL SEASON

NORMAL OPERATION - MAINTAINING CORPS FLOW ADJUSTMENT LIMITATIONS

	EVENT	TIME REQUIRED
*1.	Operator dispatched from City, alerts Corps to begin transition.	15 MINUTES
2.	Reduction of flow through turbines and fixed cone valve(s) to zero (Normal reservoir release ranges from 0 to 500 cfs reduced at Corps Requirement (Δ Q)max=1000 cfs/hr.) Corps closes service slide gates.	30 MINUTES
3.	Air vent valves are opened by Corps and the system is depressurized.	5 MINUTES
4.	Operator moves to downstream tainter valve. Gate is fully opened and fixed into position. The outlet conduit is drained.	25 MINUTES
5.	Corps alerted that the service slide gates can be reopened.	30 MINUTES
6.	Corps increases flow to 4000 cfs (WORST CASE)	4 HOURS
	TOTAL TIME	5 HOURS-45 MINUTES

* When reservoir elevation reaches 755 feet or required outflow is greater than 4200 cfs.

A.5. Transition from FCM to PGM

A similar series of operations is required to make the normal operating transition from the flood control mode to the power generation mode. Once the reservoir pool falls below elevation 737.5 feet and the release rate falls below 4,375 cfs, the three service slide gates will be closed down. Two of the air vent valves will be closed. The tainter valve is lowered and one slide gate partially opened. (The open air vent will be above the opened slide gate.) The slide gate is closed when the conduit fills to 98%. The air vent valve is closed and the outlet conduit is pressurized using the conduit fill line. Four air relief valves are provided in the air vent system and in the crown of the powerhouse penstock to bleed air from the conduits. The powerhouse turbines and valves will be opened as necessary to release the required downstream flow. Under no circumstances will the tainter valve be used to regulate the flow. The sequence and timing of this procedure are shown on Table 6.

Several Normal and Emergency Operation procedures for making the mode transitions are shown in Table 7. The information in Table 7 represents the quickest transition times ignoring the Corps flow adjustment limitations. These transition times are based on the equipment operating times.

The Corps and Sonoma County Water Agency (SCWA) will establish the required downstream releases. Based upon the flow requirements provided by the Corps, Ukiah staff will determine and set the respective flow rates through the turbines and bypass valves.

B. Emergency Operation

Several safety features have been designed into this power facility in case of emergencies. All bypass flow components in the proposed installation have a manual, battery, or gas powered backup system in case of a loss of electrical power. The 18-inch gate valve and 54-inch fixed cone valve have batteries as the primary backup system. The 18-inch gate valve, 54-inch and 108-inch fixed

TABLE 6

SEQUENCE AND TIMING OF TRANSITION

FROM FLOOD CONTROL TO POWER GENERATION

DURING FLOOD CONTROL SEASON

NORMAL OPERATION - MAINTAINING CORPS FLOW ADJUSTMENT LIMITATIONS

	EVENT	TIME REQUIRED
1.	When flow is less than 4200 cfs and Reservoir Elevation reaches* 737.5 feet, Corps closes service slide gates. Operator from City is alerted and dispatched to Powerhouse.	4 HOURS
2.	The downstream tainter valve is closed.	20 MINUTES
3.	Operator alerts COE that system is closed. Corps closes two air vent valves. Corps partially opens one slide gate. Conduit is 98% filled. Corps closes the slide gate and air vent valve. Corps opens conduit fill line valve. Outlet system is pressurized. Corps closes conduit fill line valve and fully opens service slide gates.	50 MINUTES
4.	Powerhouse valve(s) opened and turbines started to meet the required release requirement.	20 MINUTES
	TOTAL TIME	5 HOURS- 30 MINUTES

* Bottom of flood control pool is elevation 737.5 - existing dam height.

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TABLE 7
LAKE MENDOCINO POWER PROJECT
PROJECT OPERATION
DISREGARDING THE CORPS FLOW ADJUSTMENT LIMITATIONS

COMPONENT NORMAL OPERATION TIME PARAMETERS - FULLY CLOSED TO FULLY OPEN, OR VICE VERSA

Component	Approximate Time
1,000 kW Unit, automatic	5 seconds
2,500 kW Unit, automatic	5 seconds
Turbine Shutoff Valve	5 minutes
18-inch Bypass Gate Valve	3 minutes
54-inch fixed cone valve	5 minutes
108-inch fixed cone valve	31 minutes
11-foot by 16-foot tainter valve, valve operation only	11 minutes
11-foot by 16-foot tainter valve, lock into up position	4 minutes
Existing Slide Gate (one)	9 minutes
Existing Slide Gates - all three service gates	27 minutes
36-inch air vent butterfly valve, electric operator	1 minute each
6-inch conduit fill line valve, manual	1 minute
4-inch air vent bypass line valve, manual	30 seconds each

Notes:

1. The operation times shown assume the City and the Corps has one operator each to perform the specified task.

2. The times shown to shut down the power facilities, or raise the slide gates are dependent on the initial/final total flow rate through the facility.

3. In Emergency cases III and IV, the conduit drain time depends on the extent of valve malfunction, and which alternate valve will be used as a bypass.

4. The exact filling procedure will be "field tested and adjusted" once the power facilities are constructed. The pressure rise resulting from the conduit filling process can be measured with pressure taps located in the downstream liner and plenum sections. A pressure tap will also be installed in the air vent system to measure pressure variances at the slide gates. The overall mode transition time and acceptable pressure rise can be optimized during this field testing.

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TABLE 7
- continued -

I NORMAL OPERATION - POWER GENERATION MODE TO FLOOD CONTROL MODE:

Initial Operating Status: PGM - Flow range: 1 to 4375 cfs

1. Powerhouse turbine(s), bypass valve(s) are open.
2. Tainter valve closed 100%.
3. Slide gates (3) opened 100%.
4. Air vent valves (3) closed 100%.
5. Air vent bypass line valves, conduit fill line valve, and drain line valves closed 100%.

Transition Procedure:	TIME
1. Corps requires powerhouse to shut down.	0.
2. Powerhouse turbine(s), bypass valves(s) are closed 100% by City personnel. Outflow = 0 cfs. Conduit is pressurized.	5 sec. for Q = 400 cfs to 31 min. for Q = 4300 cfs*
3. All three slide gates are fully closed by Corps personnel.	27 min.
4. The air vent valves are opened by Corps to depressurize the outlet conduit system.	5 min.
5. Tainter valve is opened 100% and dogged into place. Outlet conduit is drained. Powerhouse penstock may or may not be drained through penstock drain line by the City.	15 min.
6. All three slide gates are opened as necessary by the Corps.	3 to 27 min.*

* Time shown does not consider the Corps 1,000 cfs/hr flow adjustment limitation.

TABLE 7
- continued -

Resulting Operating Status: FCM

1. Powerhouse turbines, bypass valves are closed.
2. Tainter valve is open and dogged up.
3. Slide gates are opened as necessary to release flows.
4. Air vent valves are open.
5. Air vent bypass line valves, conduit fill line valve, and drain line valves are closed.

II NORMAL OPERATION - FLOOD CONTROL MODE TO POWER GENERATION MODE:

Initial Operating Status: FCM - Flow range (normal): 4,375 to 7,080 cfs

1. Powerhouse turbines, bypass valves are closed.
2. Tainter valve is open and dogged up.
3. Slide gates are opened as necessary to release flows.
4. Air vent valves are open.
5. Air vent bypass line valves, conduit fill line valve, and drain line valves are closed.

Transition Procedure:	TIME
1. The Corps will close all three slide gates. The outlet conduit rapidly drains.	3 to 27 min.*
2. Two air vent valves are closed by the Corps.	5 min.
3. The tainter valve is lowered by City staff.	15 min.

* Time shown does not consider the Corps 1,000 cfs/hr flow adjustment limitation.

TABLE 7
- continued -

		TIME
4.	A single slide gate, corresponding to the open air vent, is opened by the Corps to 0.6 feet open (discharge is approximately 220 cfs.) for about 10 minutes, and closed. The outlet conduit is approximately 98% full of water (water surface elevation in the conduit is at 642 feet. A conduit water surface measuring device will be provided to aid in this filling procedure.) The one open air vent valve above the slide gate is closed by the Corps.	15 min.
5.	The Corps opens the conduit fill line valve. Water completely fills the outlet conduit, at a flow rate of 6 to 7 cfs, in about 7 minutes. The outlet conduit becomes pressurized and the four air relief valves automatically bleed the air from the outlet conduit. The Corps closes the conduit fill line valve.	10 min.
6.	The Corps fully opens all three slide gates.	27 min.
7.	City staff starts the turbine(s) and opens bypass valve(s) as necessary.	1 to 31 min.*

Resulting Operating Status: PGM

1. Powerhouse turbine(s), bypass valve(s) are open.
2. Tainter valve closed 100%.
3. Slide gates (3) opened 100%.
4. Air vent valves (3) closed.
5. Air vent bypass line valves, conduit fill line valve, and drain line valves closed.

* Time shown does not consider the Corps 1,000 cfs/hr flow adjustment limitation.

TABLE 7
- continued -

III EMERGENCY OPERATION - POWER GENERATION MODE TO FLOOD CONTROL MODE WITH THE 108-INCH BYPASS VALVE INOPERATIVE AND OPEN.

Initial Operating Status: PGM - Flow range: 0 to 4375 cfs

1. Powerhouse turbine(s), bypass valve(s) are open.
2. The 108-inch fixed cone valve is inoperative and open.
3. Tainter valve closed.
4. Slide gates (3) opened 100%.
5. Air vent valves (3) closed.
6. Air vent bypass line valves, conduit fill line valve, and drain line valves closed.

Transition Procedure:	TIME
1. Corps requires powerhouse to shut down.	0.
2. Powerhouse turbine(s), bypass valve(s) are closed by City personnel. Outflow is still occurring through 108" valve. Conduit is still pressurized.	5 sec. to 5 min.*
3. The air vent bypass line valves are opened by the Corps to equalize the pressure on the air vent valves. The Corps opens all three air vent valves. A column of water stands in the air vents.	5 min.
4. The three slide gates are closed by the Corps until the slide gates control the outflow. The column of water in the air vent system falls and the conduit is depressurized.	27 min.
5. The Corps closes the air vent bypass valves.	1 min.

* Time shown does not consider the Corps 1,000 cfs/hr flow adjustment limitation.

TIME

6. The tainter valve is opened and dogged into place. The outlet conduit is drained. — 15 min.
7. All three slide gates are opened as necessary by the Corps. The malfunctioning valve will be repaired or replaced when the outflows permit a short term closure of the outlet conduit. — 3 to 27 min.*

Resulting Operating Status: FCM

1. Powerhouse turbines, bypass valves are closed as much as practicable.
2. Tainter valve is opened and dogged up.
3. Slide gates are opened as necessary to release flows.
4. Air vent valves are opened.
5. Air vent bypass line valves, conduit fill line valve, and drain line valves are closed.

IV EMERGENCY OPERATION - POWER GENERATION MODE TO FLOOD CONTROL MODE WITH THE 108-INCH VALVE INOPERATIVE AND CLOSED.

Initial Operating Status: PGM - Flow range: 0 to 4375 cfs

1. Powerhouse turbine(s), bypass valve(s) are opened. The 108-inch fixed cone valve is closed and inoperative, or a dished head is in place blocking the 108-inch outlet.
2. Tainter valve closed 100%.
3. Slide gates (3) opened 100%.
4. Air vent valves (3) closed 100%.

* Time shown does not consider the Corps 1,000 cfs/hr flow adjustment limitation.

TABLE 7
- continued -

5. Air vent bypass line valves, conduit fill line valve and drain line valves closed 100%.
6. Sump pump valve in intake tower is opened.

Transition Procedure:		TIME
1.	Corps requires powerhouse to shut down.	0.
2.	Powerhouse turbine(s), bypass valve(s) are closed 100% by City personnel. Outflow = 0 cfs. Conduit is pressurized.	5 sec. to 5 min.*
3.	All three slide gates are fully closed by the Corps.	27 min.
4.	The air vent valves are opened by Corps. The outlet conduit is depressurized.	5 min.
5.	The tainter valve is opened by City personnel. The outlet conduit is drained, and the tainter valve is dogged into place at 100% open.	15 min.
6.	All three slide gates are opened as necessary by the Corps.	3 to 27 min.*

Resulting Operating Status: FCM

1. Powerhouse turbines, bypass valves are closed.
2. Tainter valve is opened.
3. Slide gates are opened as necessary.
4. Air vent valves are opened.
5. Air vent bypass line valves, conduit fill line valve, and drain line valves are closed.

* Time shown does not consider the Corps 1,000 cfs/hr flow adjustment limitation.

cone valves also have manual handwheels as the backup. The tainter valve is equipped with a gas driven pump to recharge the hydraulic oil accumulators and operating system in case of a line fault.

Normal operation of all bypass facilities for one full stroke (full open to full close, or vice versa) can be accomplished in less than 5 minutes except for the 108-inch fixed cone valve. Full stroke movement for the 108-inch valve takes 31 minutes to accomplish. All automatic bypass and the 108-inch valve operators/motors are rated for continuous, modulating operation without over-heating the motors. The critical bypass facilities, the 108-inch and 54-inch valves, can undergo one full stroke of operation in 31 and 5 minutes respectively under an emergency (loss of electrical power) condition.

In case one of the bypass valves malfunction and is locked in the open position (see Table 7, condition III), the air vents in the intake tower can be exposed to full reservoir head, without damage to the air vents, and used to help depressurize the system. In the event of an emergency, the mode transition from PGM to FCM can be accomplished in less than 1 hour. The exact operation sequence is shown in Table 8.

TABLE 8

LAKE MENDOCINO POWER PROJECT

EMERGENCY PROJECT OPERATION AT THE DIRECTION OF THE CORPS*

POWER GENERATION MODE TO FLOOD CONTROL MODE

TRANSITION IN LESS THAN ONE HOUR

a. The powerhouse and bypass valves would begin to shut down. (Maximum time 31 minutes.)

b. As the power facilities are being shut down, the air vent valves would be opened simultaneously with the closure of the slide gates. The slide gates would be closed to the position where they control the outflow. Maximum total time for steps a. and b. is 31 minutes.

c. All turbines and bypass valves are closed. The City opens the tainter valve and secures it in the up position (15 minutes).

d. The slide gates are used to regulate the flow in 46 minutes after initiation of the mode transition. If slide gates are not fully closed, so that some amount of flow is occurring, then less time is required.

Corps personnel will be trained to operate all aspects of the proposed power/bypass facility in case of an emergency.

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*This emergency operation will override the operation modes as shown in Table 7, III and IV, when directed by the Corps.

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

City of Ukiah, California) Project No. 2841-001

ORDER ISSUING LICENSE (MAJOR)

(Issued April 1, 1982)

On April 13, 1981, the City of Ukiah, California (Applicant) filed an application for a major license under Part I of the Federal Power Act (Act) to construct, operate, and maintain the Lake Mendocino Power Project No. 2841. 1/ The proposed project would be located at, and develop the water power potential of, the United States Army Corps of Engineers' (Corps) Coyote Dam 2/ located on the East Fork of the Russian River in Mendocino County, California. The project would affect lands of the United States under the Corps' administration.

Notice of the application has been published and comments have been received from interested Federal, State, and local agencies. The California Department of Fish and Game and Sonoma County Water Agency sought, and were granted, intervention in this proceeding. The significant concerns of the commenting agencies and the intervenors are discussed under appropriate headings.

Project Description

The proposed project would consist of the existing outlet works of Coyote Dam, a 12-foot diameter steel penstock to be constructed in the existing 12.5-foot diameter outlet tunnel, a powerhouse with an installed capacity of 3.5 MW, and the appurtenant facilities. The project is more fully described in ordering paragraph (B) of this license.

1/ Authority to act on this matter is delegated to the Acting Director, Office of Electric Power Regulation under 18 C.F.R. §375.308 (1981).

2/ The Coyote Dam, constructed by the Corps between 1956 and 1958 is an earth embankment structure 160 feet high and 3,500 feet long. The dam was built to provide flood control, water supply, and augmentation of low summer flows in the Russian River. The dam impounds a reservoir with a maximum storage capacity of 122,500 acre-feet and a surface area of 1,960 acres.

Safety of Structures

The Corps, in commenting on the application, stated that its concerns are related to: (1) reduction of outlet tunnel discharge capacity due to construction of the penstock; (2) development of hydraulically and structurally sound outlet facilities; (3) a safe operational system; and (4) adequate project maintenance. Article 37 of this license requires that the Licensee obtain approval of the Corps for those project facilities that would affect the structural integrity of Coyote Dam and to coordinate its activities with the Corps so that the Corps may maintain operational and safety control over the Coyote Dam Project. Article 46 of this license requires that a copy of the final plans and specifications be filed with the Commission's Regional Engineer in San Francisco, California for review, 60 days prior to the start of construction.

The proposed project would be safe and adequate if constructed in accordance with sound engineering practice. The safety of the Coyote Dam and the adequacy of its spillway are the responsibility of the Corps.

Economic Analysis

Economic analysis of the Lake Mendocino Power Project shows that for the early years of operation the estimated annual cost of the project would exceed the Applicant's cost of purchasing power from Pacific Gas and Electric Company (PG&E). Life cycle analysis of the project shows that the project is economically feasible but would experience a negative cash flow for the first four years of operation (up to 1987) with repayment of those losses by the ninth year of project operation.

The project, with its average annual generation of 17,660,000 kWh, will utilize a renewable resource that will save the equivalent of approximately 29,000 barrels of oil or 8,200 tons of coal per year.

Annual Charges

Section 10(e) of the Act 3/ requires the Commission to fix a reasonable annual charge to be paid to the United States for the use of a government dam. The Applicant has requested that the Commission waive the payment of this annual charge, stating that the waiver "would provide a firm basis for financing the project..." The Applicant contends that uncertainties "regarding the financial matters could adversely affect bond bids to the detriment of the project."

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3/ 16 U.S.C. Section 803(e)(1976).

The method used historically to arrive at a charge for the use of a government dam has been the "sharing of the net benefits method." Kings River Conservation District, Project No. 2741, Order Issuing License (Major) (issued September 25, 1979). As the Commission has applied it, this method involves calculating the difference between the cost to the Licensee of developing power at the proposed hydroelectric project and the hypothetical cost to the Licensee of obtaining an equivalent amount of power from the least expensive alternative. This difference is the net benefit to be derived from developing the power potential of the government dam. Half of this figure is then assessed as the annual charge for use of the government dam, thus dividing the value of the net benefit equally between the Licensee and the United States.

The Commission's Staff, however, is currently reassessing comprehensively the subject of suitable annual charges for use of government dams for the purpose of making recommendations to the Commission for any appropriate changes in its policies and regulations. Consequently, a final determination on the annual charge for the use of the Coyote Dam will be reserved. Article 41 provides for a final determination of that charge, which shall not be more than the figure calculated by the "sharing of the net benefit" method.

Sonoma County Water Agency (Sonoma) in its petition to intervene argued that since 60% of the cost of construction of Coyote Dam was paid by Sonoma, Sonoma should share in any reimbursement made to the United States for the use of the Coyote Dam. Sonoma is already receiving the bargained-for benefits of its investment in the construction of the dam in the form of water supply storage capability within Lake Mendocino, and is entitled to no more. Article 40 of this license ensures that Sonoma's interests in the Lake Mendocino reservoir will not be disturbed by issuance of this license. Sonoma is not, therefore, entitled to any reimbursement for the use of the Coyote Dam for hydropower purposes.

Approximately 65% of the releases at Coyote Dam are derived from the Eel River through PG&E's licensed Potter Valley Project No. 77. The Applicant has also requested that any charges for headwater benefits under Section 10(f) of the Act 4/ be waived. This issue cannot be addressed until the Applicant and PG&E have filed the data necessary to determine the headwater benefits, or until the parties have agreed on the amount of annual payments

4/ 16 U.S.C. Section 803(f) (1976).

or a waiver thereof. 5/ Article 11 of this license specifies that this data be filed with the Commission. 6/ Therefore, the Applicant's request for a waiver of payments under Section 10(f) of the Act is rejected.

Water Quality and Quantity

The drainage basin for Lake Mendocino comprises 101.9 square miles. Releases are made through a conduit that withdraws water from near the bottom of the reservoir. Project construction would include the installation of a steel lining in the existing outlet works, which would require shutting down of the outlet tunnel during May, June, and July of one construction year. During this period, downstream releases would be maintained by pumping water over the dam.

The California Department of Fish and Game (DFG) indicated a concern for the maintenance of downstream aquatic habitat related to: (1) the possible failure of pumps or their power supply resulting in dewatering of the East Fork of the Russian River; (2) the discharge of warm surface water, eliminating cold water habitat; (3) the discharge of water, low in dissolved oxygen stressing downstream reaches; and (4) the inadequacy of pumping capacity to meet discharge requirements. Intervenor Sonoma stated that the application does not include a description of the pumping plant, its power source and reliability, standby power or standby pumping capacity and that the Applicant's proposed pumping capacity of 295 cubic feet per second (cfs) is inadequate for Sonoma's flow requirements. The Corps commented that failure to meet minimum flow requirements and water supply needs during construction would have adverse impact on the Coyote Dam Project purposes.

The Applicant reported it has met with Sonoma and has agreed on a pumping system that would include: (1) a backup pump and an emergency backup power source; (2) a barge-based intake structure to maintain an intake depth of 60 feet; (3) an unspecified aeration device to maintain a dissolved oxygen level of 7 milligrams per liter (mg/l) in the discharge, the State of California's minimum dissolved oxygen requirement for the Russian River; and (4) sufficient capacity to deliver 400 cfs in 1982 or 450 cfs in 1983, depending upon which year the steel penstock is to be installed, to meet DFG requirements as well as Sonoma's irrigation requirements.

5/ PG&E, in commenting on the application, stated that it should be entitled to headwater benefits from its Potter Valley Project.

6/ See Also, 18 C.F.R. Section 11.26 (1981).

The proposed pumping system effectively addresses the concerns of Sonoma, DFG, and the Corps. In addition, Article 33 requires the Licensee, in consultation with the DFG, to prepare an aquatic habitat maintenance plan for the construction period.

Project operation would reduce dissolved oxygen levels downstream of the dam. Dissolved oxygen levels are increased by as much as 7 mg/l under current operation procedures. The U.S. Department of the Interior (Interior) and DFG request that specific aeration measures be provided by the Applicant. Interior contends that maintenance of the 7 mg/l state minimum requirement would reduce existing dissolved oxygen levels by 16 to 20 percent, thereby adversely affecting the downstream salmonid fishery. The Applicant has agreed to provide an unspecified aeration system to maintain dissolved oxygen levels of 7 mg/l, which the Applicant argues is adequate for the downstream aquatic habitat.

The State of California's water quality requirements for the Russian River include a minimum dissolved oxygen level of 7 mg/l, and also a level of 7.5 mg/l, which must be exceeded 90 percent of the time. In addition, a 10 mg/l monthly median value must be maintained for the calendar year. These dissolved oxygen requirements must be met in order to protect the downstream aquatic resources. This license, therefore, includes Article 34, which ensures that a specific aeration method will be developed, after consultation with Interior and DFG, to comply with the State of California water quality standards.

The California Regional Water Quality Control Board has waived the requirement for a water quality certificate for this project, in accordance with Section 401 of the Federal Water Pollution Control Act.

Fish and Wildlife Resources

DFG recommends that the license include conditions designed to protect the fish and wildlife resources of the area. DFG contends that operation of the turbines may increase the current fish mortality associated with passage from Lake Mendocino to the East Fork of the Russian River. Currently, fish passage is hindered by the depth of the intake structure and the low dissolved oxygen levels at this depth. Interior states that turbine fish mortality cannot be determined precisely until a study is conducted after installation of the turbine. The Applicant maintains that fish mortalities will not be significantly increased. Article 35 requires the Licensee after consultation with Interior and DFG, to prepare a plan of study that will determine project-related fish mortality and develop appropriate mitigation measures.

Recreation

The Corps has developed seven recreational areas around Lake Mendocino providing facilities for camping, picnicking, swimming, fishing, hiking and boating. These areas received approximately 1.8 million visitors in 1979. The Applicant does not propose any additional recreational facilities at the site. Article 17 reserves the Commission authority to require the Licensee to construct additional facilities if the need arises in the future.

The Report on Recreational Resources adequately describes the recreational facilities provided by others at the reservoir. Because the report does not provide for further recreational development at the project, it is not approved herein.

Biological Resources

The Report on Fish, Wildlife, and Botanical Resources adequately describes the resources in the vicinity of the project and the impact of the project on these resources. Articles 33, 34, 35, and 36, included herein, require the Licensee to file, for Commission approval, specific mitigation plans.

Environmental Considerations

Traffic to and from the project would increase during the construction period. Dust and exhaust emissions would increase during construction but would be minor in nature and of short-term duration.

The installation of the powerhouse, modification of the outlet works and construction of a tailrace channel would require excavation. While the existing outlet tunnel is being modified, the required releases would be pumped over the dam. Failure of the pumping system would result in dewatering downstream; however, back-up facilities are proposed. Furthermore, the temperature and dissolved oxygen content of waters pumped from the reservoir could be significantly different than existing releases and thus, stress the downstream aquatic habitat. The Applicant proposes measures to protect the downstream habitat but additional information would be required to determine if these measures would sufficiently protect these resources. Some siltation would result from construction activities, but an erosion control plan filed with the Commission would ensure that resulting sedimentation would be kept to a minimum. Although water would be withdrawn from the depth of the existing outlet structure, project operation would result in the loss of hypolimnetic discharge aeration that now occurs at the outlet release valve and through the outlet tunnel. The Applicant proposes to mitigate this loss by installing oxygen injection facilities or modifying other project structures and would be required by Article 34 to file specific proposals to ensure compliance with the state standards.

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Fish mortalities may increase from passage through turbines, either from mechanical or pressure-induced injuries. Because of insufficient data, fish losses under existing conditions and from turbine passage are not quantifiable; hence, Article 35 requires that the Licensee conduct appropriate studies and develop adequate mitigation measures.

Clearing of land for construction of the powerhouse and related facilities would eliminate a small amount of wildlife habitat. Noise levels during construction would result in short-term adverse effects on wildlife communities.

The Corps conducted archeological surveys of all lands within the proposed project boundary prior to constructing Coyote Dam. No significant cultural resources were identified by this survey. The State Historic Preservation Officer, after reviewing the Corps' findings, concurred with the finding of no effect on cultural resources.

Recreation areas would not be disturbed during construction, but increased noise levels might affect nearby recreation areas.

The proposed project would involve minimal land disturbance and water quality would be protected by adequate mitigation measures.

On the basis of the record, including agency and intervenor comments and the staff's independent analysis, issuance of this license, as conditioned, is not a major Federal action significantly affecting the quality of the human environment.

Comprehensive Development

The proposed Lake Mendocino Power Project would develop the head created by the Coyote Dam and use flows released from the reservoir which are not now used to generate power. The Corps, at some future time, plans to raise the dam by 36 feet, at which time the Applicant plans to amend its license for Lake Mendocino Power Project to install an additional 3 MW of installed capacity. The proposed project would use a non-polluting, renewable resource to produce energy and would not be in conflict with any planned development of the East Fork of the Russian River.

It is concluded that, as conditioned in this license, Project No. 2841 is best adapted to a comprehensive plan for development of the Northern California Coastal Basins for beneficial public uses.

<u>It is ordered that:</u>

(A) This license is issued to the City of Ukiah, California (Licensee), under Part I of the Federal Power Act (Act) for a period of 50 years, effective the first day of the month in which this order is issued, for the construction operation, and maintenance of the Lake Mendocino Power Project No. 2841, located in Mendocino County, California, on the East Fork of the Russian River and using the Coyote Dam of the United States and appurtenant lands administered by the U.S. Army Corps of Engineers. This license is subject to the terms and conditions of the Act, which is incorporated by reference as part of this license, and subject to the regulations the Commission issues under the provisions of the Act.

(B) The Lake Mendocino Power Project No. 2841 consists of:

(1) All lands, to the extent of the Licensee's interests in those lands, constituting the project area and enclosed by the project boundary. The project area and boundary are shown and described by certain exhibits that form part of the application for license and that are designated and described as:

Exhibit	FERC No.	Titled
G-1	2841-5	Vicinity Map and Site Plan - Electrical One-Line Diagram

(2) Project works consisting of: (1) the existing intake structures; (2) the existing 12.5-foot diameter concrete tunnel, to be modified by installing a 900-foot long, 12-foot diameter steel penstock to accommodate power production and a Howell Bunger valve; (3) a powerhouse to contain one Francis-type, turbine-generating unit with a rated capacity of 3 MW and one Francis or Turgo-type, turbine-generating unit with a rated capacity of 0.5 MW; (4) a 200-foot long riprapped tailrace channel; (5) a switchyard, integral with the powerhouse; (6) two generator leads, 5-kV switch gear, a 2.4/12-kV main step-up transformer; (7) a 200-foot long, 12-kV transmission line; and (8) appurtenant facilities.

The location, nature, and character of these project works are generally shown and described by the exhibits cited above and more specifically shown and described by certain other exhibits that also form a part of the application for license and that are designated and described as:

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Exhibit	FERC No.	Titled
F-1	2841-2	Existing Dam and Water Conduit; Penstock Steel Lining
F-2	2841-3	Outlet Chute and Power Plant; Sheet 1
F-3	2841-4	Outlet Chute and Power Plant; Sheet 2

(3) All of the structures, fixtures, equipment, or facilities used or useful in the operation or maintenance of the project and located within the project boundary, all portable property that may be employed in connection with the project, located within or outside the project boundary, as approved by the Commission, and all riparian or other rights that are necessary or appropriate in the operation or maintenance of the project.

(C) Exhibits G-1, F-1, F-2 and F-3, designated in ordering paragraph (B) above, are approved and made a part of the license only to the extent that they show the general location, description, and layout of the project works.

(D) This license is also subject to the terms and conditions 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 to and made a part of this license. The license is also subject to the following additional articles:

Article 33. Licensee shall, after consultation with the California Department of Fish and Game, and the U.S. Fish and Wildlife Service, and at least 30 days prior to beginning of construction, prepare and file for Commission approval a plan for protecting the fish and wildlife resources of the East Fork of the Russian River downstream from Lake Mendocino during periods when the existing reservoir outlet structure is closed for project construction purposes. The plan shall include specific provisions for: (1) the possible failure of any pumps and/or power supply necessary for providing releases of water from Lake Mendocino during the construction period; (2) maintenance of necessary dissolved oxygen and temperature levels in any discharge from Lake Mendocino; (3) sufficient pumping capacity to provide for downstream requirements; and (4) documentation of consultation with the above listed agencies. Copies of this plan shall be sent to the agencies consulted when the plan is filed with the Commission.

Article 34. Licensee shall, after consultation with the California Department of Fish and Game and the U.S. Fish and Wildlife Service, and within 1 year from the date of issuance of this license, prepare and file for Commission approval a plan for maintaining the State of California's dissolved oxygen standards for the East Fork of the Russian River during project operations. The plan shall provide specific proposals for the aeration of project discharges, to include design drawings and aeration capabilities, sufficient to ensure compliance with State standards. Further, the plan shall include a dissolved oxygen monitoring program to determine the effectiveness of the aeration device. Documentation of consultation shall be included in any plan filed, and copies of the plan shall be sent to the consulted agencies coincident to the Commission filing.

Article 35. Licensee shall, after consultation with the California Department of Fish and Game and the U.S Fish and Wildlife Service, and within 1 year from the date of this license, prepare and file for Commission approval a plan of study to determine the effect of the project's operation, if any, on the passage of fish from Lake Mendocino to the East Fork of the Russian River. The study shall assess any increase in fish mortality which may be associated with turbine passage, relative to pre-project conditions. The plan shall include a schedule for completion of the study and documentation of agency consultation. Within 3 months of completing the above study, Licensee shall, in cooperation with the above listed agencies, review the effects of project operations on the downstream passage of fish, and file a report for Commission approval containing recommendations to mitigate any project-related adverse effects. Copies of the report shall be filed with the consulted agencies at the same time.

Article 36. The Licensee, in consultation with the U.S. Fish and Wildlife Service, the California Department of Fish and Game, and the U.S. Army Corps of Engineers, shall prepare and file with the Commission's Regional Engineer in San Francisco, California, and the Director, Office of Electric Power Regulation, within 6 months from the date of issuance of this license, a detailed plan to control soil erosion, dust, and slope stability, and to minimize the quantity of inorganic sediment or other potential water pollutants resulting from construction and operation of project facilities. This plan shall include an implementation schedule, maintenance program, and evidence of agency consultation. The Director, Office of Electric Power Regulation, may require changes in the plan to minimize erosion, dust, sedimentation, water pollution, or slope stability problems.

Article 37. The design and construction of only those facilities that will be an integral part of or that could affect the structural integrity of Coyote Dam shall be done in consultation with and subject to the review and approval of the U.S. Army Corps of Engineers (Corps), District Engineer, San Francisco, California. Licensee shall also coordinate its activities with the Corps in order that the Corps may maintain operational and safety control over the Coyote Dam - Lake Mendocino Project. The Commission reserves the right to resolve any disagreement between the Licensee and the District Engineer in these regards. Licensee shall reimburse the Corps for costs they incur in the review and approval of the design and construction of project works directly related to the structural integrity of Coyote Dam.

Article 38. The Licensee shall commence construction of the project works within two years from the effective date of this license and in good faith and with due diligence shall prosecute and complete construction of the project works within five years from the start of construction.

Article 39. The Licensee shall hold and save the United States of America free from any and all claims and damages resulting from construction, operation, and use of the Coyote Dam and facilities for power purposes.

Article 40. The Licensee, prior to initiation of power operation, shall enter into an agreement with the U.S. Army Corps of Engineers, District Engineer, San Francisco, California, providing for operating the project so as to protect Federal and Sonoma County Water Agency interests in the Lake Mendocino Reservoir.

Article 41. The Licensee shall pay the United States the following annual charges, effective the first day of the month in which this license is issued:

(a) For the purpose of reimbursing the United States for the cost of administration of Part I of the Act, a reasonable amount as determined in accordance with the provisions of the Commission's regulations in effect from time to time. The authorized installed capacity for that purpose is 4,667 horsepower.

(b) For the purpose of recompensing the United States for the use, occupancy, and enjoyment of approximately 7 acres of its lands, a reasonable amount as determined in accordance with the provisions of the Commission's regulations in effect from time to time. The exact acreage of U.S. lands for this purpose will be determined after submission of as-built exhibits for approval. The Licensee will be charged any back charges or given credit against future charges, as appropriate.

(c) For the purpose of recompensing the United States for the use of surplus water or water power from the Coyote Dam or lands in connection therewith, an amount to be hereafter determined by the Commission. Such an amount will not exceed that derived from the sharing of the net power benefits.

Article 42. The Licensee shall enter into an agreement to coordinate its plans with the U.S. Army Corps of Engineers (Corps) for access to and site activities on lands and property administered by the Corps so that the authorized purposes, including operation of the Federal facilities, are protected. In general, the agreement shall not be redundant with the Commission's requirements contained in this license and shall identify the facility, and the study and construction activities, as applicable, and terms and conditions under which studies and construction will be conducted. The agreement shall be composed mainly of the following items: (1) reasonable arrangements for access to the Corps site to conduct studies and construction activities, such access rights to be conditioned by the Corps as may be necessary to protect the Federally authorized project purposes and operations; (2) charges to be paid by the Licensee to the Corps (a) for technical studies by the Corps that relate solely to the structural integrity of the Corps facility associated with power plant development, and (b) for review of designs including plans and specifications, and for construction inspections based on personnel costs, where such review and inspections are directly related to the structural integrity of the Coyote Dam; and (3) charges to be paid by the Licensee to the Corps for copies of reports, drawings and similar data based on printing and mailing costs, provided that charges shall not be assessed for information, services, or relationships that would normally be provided to the public. Should the Licensee and the Corps fail to reach an agreement, the Licensee shall refer the matter to the Commission for resolution.

Article 43. The Licensee shall review and approve the design and construction procedures for contractor-designed cofferdams and deep excavations prior to the start of construction. The Licensee shall file with the Commission's Regional Engineer and Director, Office of Electric Power Regulation, one copy of the approved construction drawings and specifications, and a copy of the letter of approval.

Article 44. Within 90 days from the date of commencement of operation of the project, the Licensee shall file for approval as-built Exhibits F and G drawings to show the project as finally constructed and located and the exact amount of U.S. lands occupied by it.

Article 45. The Licensee shall file with the Commission's Regional Engineer in San Francisco, California, and the Director, Office of Electric Power Regulation, one copy each of the contract drawings and specifications at least 60 days prior to the start of construction. The Director, Office of Electric Power Regulation, may require changes in the plans and specifications to assure a safe and adequate project. The Licensee shall also furnish the Commission's Regional Engineer copies of all correspondence between the Licensee and the Corps of Engineers regarding the schedule of progress of the design review and approval.

Article 46. The Licensee shall have no claim under this license against the United States arising from the effects of any changes made in the pool levels of Lake Mendocino.

Article 47. (a) In accordance with the provisions of this article, the Licensee shall have the authority to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain other types of use and occupancy, without prior Commission approval. The Licensee may exercise the authority only if the proposed use and occupancy are consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. For those purposes, the Licensee shall also have continuing responsibility to supervise and control the uses and occupancies for which it grants permission, and to monitor the use of, and ensure compliance with the covenants of the instrument of conveyance for, any interests that it has conveyed under this article. If a permitted use and occupancy violates any condition of this article or any other condition imposed by the Licensee for protection and enhancement of the project's scenic, recreational, or other environmental values, or if a covenant of a conveyance made under the authority of this article is violated, the Licensee shall take any lawful action necessary to correct the violation. For a permitted use or occupancy, that action includes, if necessary, cancelling the permission to use and occupy the project lands and waters and requiring the removal of any non-complying structures and facilities.

(b) The types of use and occupancy of project lands and waters for which the Licensee may grant permission without prior Commission approval are: (1) landscape plantings; (2) non-commercial piers, landings, boat docks, or similar structures and facilities; and (3) embankments, bulkheads, retaining walls, or similar structures for erosion control to protect the existing shoreline. To the extent feasible and desirable to protect and enhance the project's scenic, recreational, and other environmental values, the Licensee shall require multiple use and occupancy of facilities for access to project lands or waters. The Licensee shall also ensure, to the satisfaction of the Commission's authorized representative, that the uses and occupancies for which it grants permission are maintained in good repair and comply with applicable State and local health and safety requirements. Before granting permission for construction of bulkheads or retaining walls, the Licensee shall: (1) inspect the site of the proposed construction, (2) consider whether the planting of vegetation or the use of riprap would be adequate to control erosion at the site, and (3) determine that the proposed construction is needed and would not change the basic contour of the reservoir shoreline. To implement this paragraph (b), the Licensee may, among other things, establish a program for issuing permits for the specified types of use and occupancy of project lands and waters, which may be subject to the payment of a reasonable fee to cover the Licensee's costs of administering the permit program. The Commission reserves the right to require the Licensee to file a description of its standards, guidelines, and procedures for implementing this paragraph (b) and to require modification of those standards, guidelines, or procedures.

(c) The Licensee may convey easements or rights-of-way across, or leases of, project lands for: (1) replacement, expansion, realignment, or maintenance of bridges and roads for which all necessary State and Federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas, and electric utility distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kV or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project reservoir. No later than January 31 of each year, the Licensee shall file three copies of a report briefly describing for each conveyance made under this paragraph (c) during the prior calendar year, the type of interest conveyed, the location of the lands subject to the conveyance, and the nature of the use for which the interest was conveyed.

(d) The Licensee may convey fee title to, easements or rights-of-way across, or leases of project lands for: (1) construction of new bridges or roads for which all necessary State and Federal approvals have been obtained; (2) sewer or effluent lines that discharge into project waters, for which all necessary Federal and State water quality certificates or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric transmission lines that require erection of support structures within the project boundary, for which all necessary Federal and State approvals have been obtained; (5)

private or public marinas that can accommodate no more than 10 watercraft at a time and are located at least one-half mile from any other private or public marina; (6) recreational development consistent with an approved Exhibit R or approved report on recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed for a particular use is five acres or less; (ii) all of the land conveyed is located at least 75 feet, measured horizontally, from the edge of the project reservoir at normal maximum surface elevation; and (iii) no more than 50 total acres of project lands for each project development are conveyed under this clause (d)(7) in any calendar year. At least 45 days before conveying any interest in project lands under this paragraph (d), the Licensee must file a letter to the Director, Office of Electric Power Regulation, stating its intent to convey the interest and briefly describing the type of interest and location of the lands to be conveyed (a marked Exhibit G or K map may be used), the nature of the proposed use, the identity of any Federal or State agency official consulted, and any Federal or State approvals required for the proposed use. Unless the Director, within 45 days from the filing date, requires the Licensee to file an application for prior approval, the Licensee may convey the intended interest at the end of that period.

(e) The following additional conditions apply to any intended conveyance under paragraphs (c) or (d) of this article:

(1) Before conveying the interest, the Licensee shall consult with Federal and State fish and wildlife or recreation agencies, as appropriate, and the State Historic Preservation Officer.

(2) Before conveying the interest, the Licensee shall determine that the proposed use of the lands to be conveyed is not inconsistent with any approved Exhibit R or approved report on recreational resources of an Exhibit E; or, if the project does not have an approved Exhibit R or approved report on recreational resources, that the lands to be conveyed do not have recreational value.

(3) The instrument of conveyance must include covenants running with the land adequate to ensure that: (i) the use of the lands conveyed shall not endanger health, create a nuisance, or otherwise be incompatible with overall project recreational use; and (ii) the grantee shall take all reasonable precautions to ensure that the construction, operation, and maintenance of structures or facilities on the conveyed lands will occur in a manner that will protect the scenic, recreational, and environmental values of the project.

(4) The Commission reserves the right to require the Licensee to take reasonable remedial action to correct any violation of the terms and conditions of this article, for the protection and enhancement of the project's scenic, recreational, and other environmental values.

(f) The conveyance of an interest in project lands under this article does not in itself change the project boundaries. The project boundaries may be changed to exclude land conveyed under this article only upon approval of revised Exhibit G or K drawings (project boundary maps) reflecting exclusion of that land. Lands conveyed under this article will be excluded from the project only upon a determination that the lands are not necessary for project purposes, such as operation and maintenance, flowage, recreation, public access, protection of environmental resources, and shoreline control, including shoreline aesthetic values. Absent extraordinary circumstances, proposals to exclude lands conveyed under this article from the project shall be consolidated for consideration when revised Exhibit G or K drawings would be filed for approval for other purposes.

(E) This order is final unless a petition appealing it to the Commission is filed within 30 days from the date of its issuance, as provided in Section 1.7(d) of the Commission's regulations, 18 C.F.R. Section 1.7(d) (1981). The filing of a petition appealing this order to the Commission or an application for rehearing as provided in Section 313(a) of the Act does not operate as a stay of the effective date of this license or of any other date specified in this order, except as specifically ordered by the Commission. The Licensee's failure to file a petition appealing this order to the Commission shall constitute acceptance of this license. In acknowledgment of acceptance of this license and its terms and conditions, it shall be signed by the Licensee and returned to the Commission within 60 days from the date this order is issued.

Robert E. Cackowski

Robert E. Cackowski
Acting Director, Office of
Electric Power Regulation

Project No. 2841-001

IN TESTIMONY of its acknowledgment of acceptance of all of the terms and conditions of this Order, City of Ukiah, California this _____ day of ____________________, 19____, has caused its name to be signed hereto by __________________________, its __________________________ Mayor, and its seal to be affixed hereto and attested by ________________________________ its ____________________________ Secretary, pursuant to a resolution of its City Council duly adopted on the _____ day of ________________________ 19____, a certified copy of the record of which is attached hereto.

By____________________________
Mayor

Attest:

____
Secretary

(Executed in quadruplicate)

44

COYOTE VALLEY DAM
AND
LAKE MENDOCINO

RUSSIAN RIVER, CALIFORNIA

WATER CONTROL MANUAL

AUGUST 1986

EXHIBIT C

1959 AGREEMENT BETWEEN SONOMA COUNTY WATER AGENCY AND CALIFORNIA DEPARTMENT OF FISH AND GAME

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

BEFORE THE STATE WATER RIGHTS BOARD

OF THE STATE OF CALIFORNIA

In the Matter of Applications 12919A, 12920A, etc. SONOMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, et al., Applicants; CALIFORNIA DEPARTMENT OF FISH AND GAME, et al., Protestants.	<u>STIPULATION</u> <u>AND</u> <u>AGREEMENT</u>

WHEREAS, the UNITED STATES ARMY CORPS OF ENGINEERS has constructed a Dam and Reservoir known as Coyote Dam and Lake Mendocino, together with related works in and across the East Fork of the Russian River at a point upstream from Ukiah, California; and

WHEREAS, the SONOMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT proposes to store water existing in the East Fork of the Russian River behind Coyote Dam and to divert water existing in the Russian River at numerous points between Coyote Dam and the mouth of said river for reasonable and beneficial uses and purposes, one of such uses and purposes being sustained flow of water for recreational use; and

WHEREAS, The people of the State of California acting by and through the CALIFORNIA DEPARTMENT OF FISH AND GAME, seek to have minimum flows of water of suitable quality maintained in the channel of the East Fork of the Russian River and the Russian River from Coyote Dam to the mouth of the Russian River, for the protection, preservation and enhancement of the fish, wildlife, and recreational resources existing in and around said River; and

WHEREAS, the State Water Rights Board of the State of California is now considering Applications 12919A, 12920A, 15736, 15737, and 15779, of the SONOMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, to appropriate water, in which proceedings the CALIFORNIA DEPARTMENT OF FISH AND GAME is appearing as a protestant,

WHEREAS, said parties are in accord as to the operation of Coyote Dam and Lake Mendocino which, subject to certain conditions, will in their opinion result in the best possible utilization thereof in the public interest, and it is the desire of said parties to reduce the same to writing and to settle and adjust any and all differences which might exist or arise out of misunderstanding between them so that definite assurances can be had as nearly as practicable that the public interest will be served without jeopardy arising out of conflict between said parties;

NOW, THEREFORE, the SONOMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, hereinafter called "District" and the People of the State of California acting by and through the

CALIFORNIA DEPARTMENT OF FISH AND GAME, hereinafter called "Department", stipulate and agree as follows:

1. This Stipulation shall be filed and become part of the record in the current proceeding before the State Water Rights Board to be relied upon by and to be recognized as affecting respective rights, powers, privileges and duties between these parties only, to wit: District and Department--no third party beneficiary, and the provisions of this Agreement may be included by way of reference or otherwise, in any permit or license issued by the State Water Rights Board of the State of California, pursuant to the aforesaid applications, and if said permit or licenses are conditioned upon the terms of this Agreement, the Protest of the Department to District's said applications may be considered withdrawn and may be dismissed.

2. As between these parties District and Department propose and agree, to the extent of District's control thereover and over waters referred to herein, to the operation or to the causing of Coyote Valley Dam to be operated and waters to be released from or allowed to pass through, around, or over Coyote Valley Dam into the natural channel of the East Fork of the Russian River immediately below Coyote Valley Dam (any or all of which shall be deemed included in the meaning of the term "release" or "releases" as the same is hereinafter used unless another intention is apparent) subject to the following conditions and in accordance with the following criteria therefor:

CONDITIONS:

A. The State Water Rights Board, or any successor to the jurisdiction of said Board, as between the parties hereto, shall have continuing primary authority and jurisdiction over the subject of releases for minimum flows of water herein provided to be maintained in the channel of the Russian River for the protection, preservation and enhancement of fish and wildlife, to modify the same in accordance with law and equities between these parties in the interest of the public welfare to prevent waste, unreasonable or inequitable use, unreasonable or inequitable method of use or unreasonable or inequitable method of diversion of water.

B. To the extent of their control thereover District shall make no reductions in releases as hereinafter specified for the purpose of maintaining minimum flows except as may become warranted by higher priority use or to achieve maximum beneficial use of appropriated water and then only after notice in writing to Department of intention so to do, except in the event of true emergency. Any such reduction shall be subject to hearing before the State Water Rights Board, or any successor to the jurisdiction thereof, and appeal to court or any other appellate agency of competent jurisdiction.

C. That reduction in District's commitment hereunder shall be allowed corresponding to any reduction in the permit issued in said proceedings under Applications Nos. 12919A and 12920A in the amount of water applied for for direct diversion to beneficial use or diversion to storage to the extent that such reduction may affect District's ability to perform hereunder without encroachment upon other beneficial uses proposed by District in said applications.

D. That reduction in District's commitment hereunder shall be allowed corresponding to any reduction in District's entitlement under the permit issued by State Water Rights Board resulting from allocation or reservation to the county of origin, Mendocino County or Mendocino County Russian River Flood Control and Water Conservation Improvement District of a greater quantity of water covered by said applications to beneficial use in Mendocino County than is provided for in the Assignment dated November 14, 1955, of State Applications (12919A and 12920A) to the extent that such reduction may affect District's ability to perform hereunder without encroachment upon other beneficial uses proposed by District in said applications. These parties simultaneously herewith and by the act of filing this stipulation petition the State Water Rights Board to make its order or provide in the permit issued under Applications Nos. 12919A and 12920A that the Mendocino County District, subject to notice and hearing and continuing jurisdiction of said Board, make up any deficiency in the minimum flows herein provided for to the extent that waters so allocated or reserved to the county of origin, Mendocino County or Mendocino County Russian River Flood Control and Water Conservation

Improvement District in excess of the quantities provided for in the Assignment dated November 14, 1955, of State Applications (12919A and 12920A) affect Sonoma County District's ability to perform hereunder without encroachment upon beneficial uses other than sustained minimum flows for protection, preservation and enhancement of fish, wildlife and recreational resources existing in and around the Russian River.

E. That reduction in District's commitment hereunder shall be allowed corresponding to any reduction in quantities and at times substantially as have existed since 1950 in Eel River water importation into the Russian River Basin to the extent that such reduction may affect District's ability to perform hereunder without encroachment upon beneficial uses other than sustained minimum flows for protection, preservation and enhancement of fish, wildlife and recreational resources existing in and around Russian River.

PROPOSED CRITERIA FOR OPERATION:

As between these parties District shall, to the extent of District's control thereover and over waters referred to herein and subject to the foregoing conditions, operate or cause Coyote Valley Dam to be operated and waters to be released from or allowed to pass through, around, or over Coyote Valley Dam into the natural channel of the East Fork of the Russian River immediately below Coyote Valley Dam as follows:

A. For beneficial usage of District and Department, District shall release a quantity of water sufficient to maintain a minimum continuous flow of 25 c.f.s. immediately below Coyote Valley Dam.

B. For beneficial usage of District and Department, District shall either release a quantity of water sufficient to maintain a minimum continuous flow of 150 c.f.s. at the junction between the east and west forks of the Russian River, or District shall release the existing natural flow of the East Fork of the Russian River reaching said dam as augmented by the existing flow of diversions of Eel River water reaching said dam, whichever is less. Within the foregoing limitations said releases shall be in excess of releases required by law to be made to supply the beneficial usage of diverters under established riparian rights thereto and whose rightful riparian diversions are not supplied by other sources and releases required by law to be made to supply the beneficial usage of diverters who have vested rights prior in origin to 1914 or appropriative rights with a priority date earlier than 10:47 A.M., January 28, 1949, and whose diversions under such rights with such priority are not supplied by other sources.

C. For beneficial usage of Sonoma County Flood Control and Water Conservation District Zone 5 and Department, District shall release sufficient quantities of water to maintain a minimum continuous flow of 125 c.f.s. in the channel of the Russian River throughout said Zone 5. Said releases shall be in excess of releases required by law to be made to supply the beneficial usage of diverters under established riparian rights thereto and whose rightful riparian diversions are not supplied by other sources and releases required by law to be made to supply the beneficial usage of diverters who have vested rights prior in origin to 1914 or appropriative rights with a priority date earlier than 10:47 A.M., January 28, 1949, and whose diversions under such rights with such priority are not supplied by other sources.

3. District may but shall not be obligated to assert and enforce rights to minimum flows herein provided for benefit of Department.

DATED: 8-21, 1959

SONOMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

By ______________________
Chairman, Board of Directors

ATTEST:

____
Clerk

CALIFORNIA DEPARTMENT OF FISH AND GAME

By ______________________
Director

APPROVED:

____
RICHARD H. RAMSEY, County Counsel
Attorney for Applicant Sonoma County Flood Control and Water Conservation District

STANLEY MOSK, Attorney General

By ______________________
J.M. SANDERSON, Deputy Attorney General
Attorney for Protestant CALIFORNIA DEPARTMENT OF FISH AND GAME.

APPENDIX E PRELIMINARY CONSIDERATIONS FOR DEVELOPING FIRO EVALUATION CRITERIA

Flood control – Goal is to not increase risk to the dam or downstream occupants. Hence increase in water storage would be temporary in nature and may well be a deviation per policy. For example if additional 10,000 acre feet of water is retained just before March the rule curve allows increased water storage starting 1 March. By 18 March the allowed increase would account for the 10,000 acre feet.

Recreation at CVD - As showed in 8.1 FIRO might be able to help recoup economic lost if additional 10,000 Ac ft of water is captured. This increased water could potentially place the lake level on par with the level of the lake during a normal dry year, significantly increasing visitation. (Note: Water flowing into CVD from the PVP is not a straight forward impact on visitation as winter pool levels were maintained based on rule curve. Hence additional water was released from CVD prior to 2005 as flood releases).

Water Supply criteria –The water supply reliability of CVD/Lake Mendocino has resulted in the Water Agency having to file a number of Temporary Urgency Change Petitions (TUCP) to its water rights with the SWRCB since 2006 to reduce minimum in-stream flow requirements due to inadequate water supply storage in Lake Mendocino. As a requirement to approving a TUCP filed by the Water Agency in May of 2013, the State Board required the Water Agency to perform an analysis evaluating the water supply reliability of Lake Mendocino and the Upper Russian River. The Lake Mendocino Water Supply Reliability Study was submitted to the SWRCB in April 2015 (Lake Mendocino Water Supply Reliability Study). The following lists some of the scenarios evaluated using a water balance model of the Upper Russian River:

- Current water demand using historical hydrologic data (1910-2013): *"Current Conditions"*;
- Low projected water demand at 2045 using historical hydrologic data (1910-2013);
- High projected water demand at 2045 using historical hydrologic data (1910-20130;
- High projected water demand at 2045 using wet climate change future; and
- High projected water demand at 2045 using dry climate change future.

Figures G.1 and G.2 summarizes the results of these model scenarios. As can be seen, the current reliability (Current Condition scenario) of CVD/Lake Mendocino, as evaluated by modeling, is lower than observed water storage between 1984 to 2006, the period of time when the Russian River was managed by both CVD and Warm Springs Dam and before the reduced PVP diversions. In addition, the modeling results indicate a decline in future water supply reliability compared to the Current Condition scenario. Consequently, the management of Lake Mendocino for water supply will be more challenging in the future as its reliability declines due to increased demand and projected climate change. The results of the Lake Mendocino Water Supply Reliability Study should be used as criteria in evaluating the viability of FIRO to improve the water supply performance of the facility.

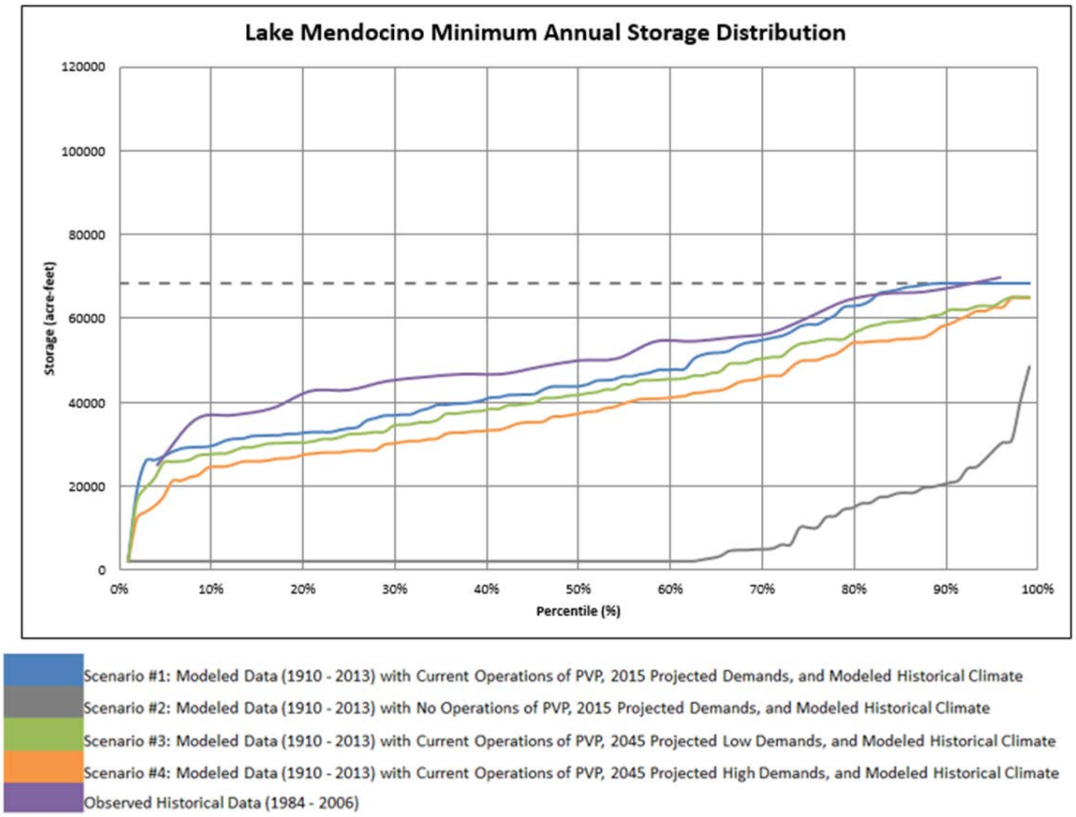


Figure G.1. Graph illustrating minimal annual storage in Lake Mendocino with historical climate data, a variety of demands and current and no operations of Potter Valley Diversion Project.

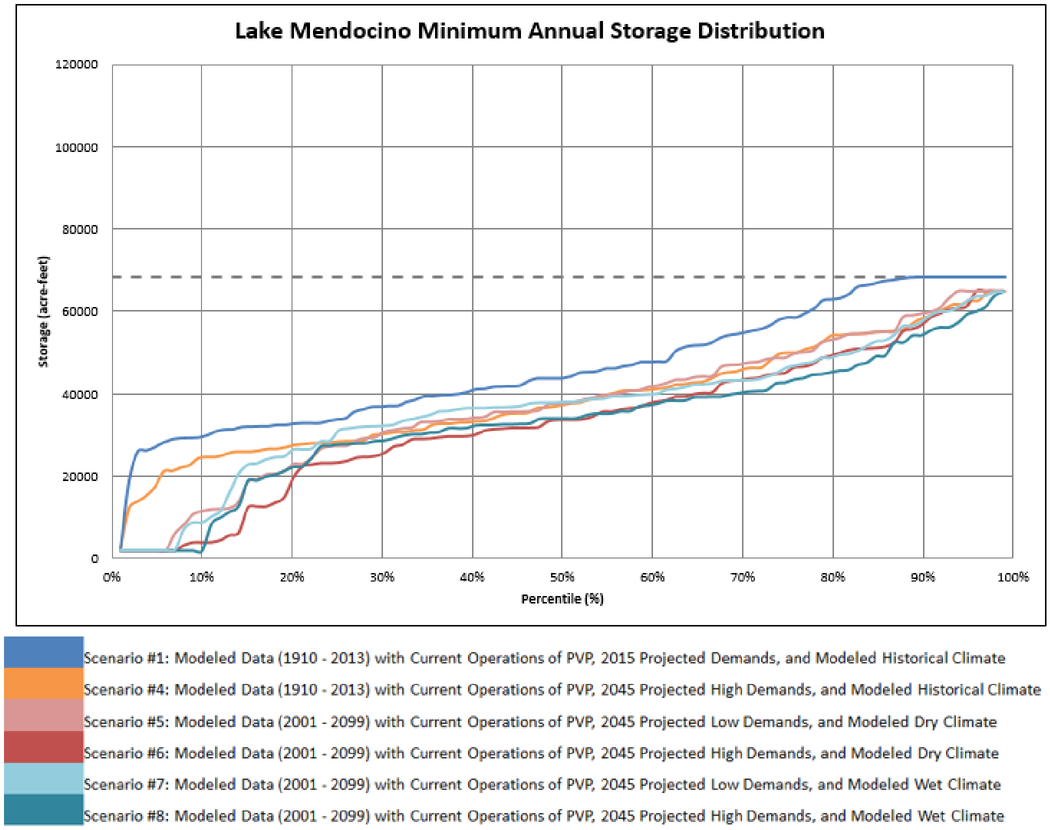


Figure G.2. Graph illustrating modeled Lake Mendocino storage with historic, dry and wet climate scenarios and a variety of demands.

Environmental Criteria

The 2008 Russian River Biological Opinion includes CVD flood and water supply operations and the potential of these actions to impact threatened Central Coast Chinook salmon and California Central Coast steelhead trout. The three specific areas identified as potentially impacting ESA-listed salmonids in the Russian River Biological Opinion associated with CVD includes elevated summer stream flows (D1610), ramping rates, and turbidity. The current salmonid criteria related to each of these areas are as follows:

1) Elevated summer streamflows (Permanent Changes to D1610):
    a. Normal water years: Reduce the minimum flow requirements in the Russian River from the East Fork to Dry Creek from 185 cfs to 125 cfs between June 1 and August 31; and from 150 cfs to 125 cfs between September 1 and October 31.
    b. Dry water years: Reduce the minimum flow requirements between the mouth of Dry Creek and the mouth of the Russian River from 85 cfs to 70 cfs.
2) CVD Operations (Ramping rates):

a. Ramp-up: (1) discharge 0-250 cfs, max ramp-up 1000 cfs/hour; (2) discharge 250-1000 cfs, max ramp-up 1000 cfs/hour; (3) discharge >1000 cfs, max ramp-up 2000 cfs/hour.
b. Ramp-down: (1) discharge 0-250 cfs, max ramp-down 25 cfs/hour; (2) discharge 250-1000 cfs, max ramp-down 250 cfs/hour; (3) discharge >1000 cfs, max ramp-down 2000 cfs/hour.
c. RPM3 (p. 320): Undertake measures to ensure that harm and mortality to listed salmonids from ramping procedures at CVD are low.

3) Turbidity:
   a. "Turbidity from Coyote Valley Dam may be causing harm to eggs and alevins, and limiting rearing opportunities by reducing feeding, displacing rearing juveniles downstream, reducing growth rates for rearing salmonids, and reducing their food supply (p.122)".
   b. RPM4 (p. 321): Undertake measures to assist NMFS in determining the amount of take resulting from turbidity releases at Coyote Valley Dam.

Water temperature impairments associated with reduce cold water storage in Lake Mendocino was not presented as a specific impact to juvenile steelhead or adult Chinook salmon, but was mentioned in the Russian River Biological Opinion: *"Main stem flow releases required to maintain current D1610 requirements cause the cold water pool in Lake Mendocino to become depleted by late August or early September, reducing the quality of rearing habitat in the upper main stem Russian River (p. 121)".*

APPENDIX F SHORT PROJECT DESCRIPTIONS

Enhanced Monitoring of Flow & Turbidity

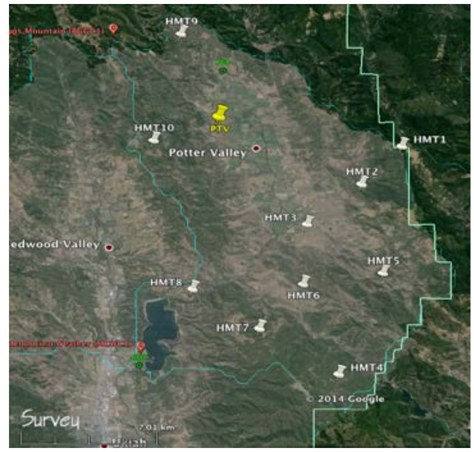
In effort to better quantify seasonal changes in Lake Mendocino limnology and pervasive issues with high turbidity associated with reservoir releases, the following additions to existing monitoring are recommended:

1) Monitoring of turbidity of inflow into Lake Mendocino at the USGS Calpella gage;
2) Monitoring of temperature, dissolved oxygen and turbidity at the outlet structure with the deployment of a vertical array of 3 to 5 instruments to monitor conditions at discrete depths below water surface; and
3) Monitoring of temperature, dissolved oxygen, and turbidity just downstream of the outfall of the outlet structure.

Data collected under these monitoring recommendations can be used to better understand the seasonal temperature and dissolved oxygen stratification and turnover of the reservoir as well as the ongoing issue of turbid releases which result in degraded habitat conditions downstream. These data will be used to support and validate future comprehensive modeling efforts.

NOTE: SEE APPENDIX G, ESTABLISHING FISHERIES BENEFITS ASSOCIATE WITH FIRO, FOR A DISCUSSION OF ENHANCED MONITORING OF FLOW AND TURBIDTY AND OF RAMPING RATES.

Precipitation and Soil Moisture Monitoring in the Russian-Napa Watersheds



Proposed HMT sites (white) in upper Russian. Existing HMT (yellow), CNRFC (red), and other precipitation gauge sites (green).

The precipitation and soil moisture monitoring program in both the Russian and Napa rivers watersheds is a collaborative project between ESRL-PSD, DWR, SCWA, USGS, and USACE. ESRL-PSD will install rain gauge and soil moisture monitoring sites above Lake Mendocino to monitor watershed conditions and augment the existing ESRL-PSD network in the Russian. The soil moisture data will be used by the USGS to determine soil storage capacity to estimate runoff into the reservoir. Rain gauge data will be used together with the S-PROF radars to improve precipitation monitoring in the watershed, especially above Lake Mendocino. Retrospective analyses of QPE during extreme precipitation events will be conducted and data sets provided to USACE for design study analysis. A NOAA P-3 research aircraft will be deployed during the 2014-15 winter season for the CalWater 2 field program, and an experimental flight track over the S-PROF network will be evaluated.

Tasks:

1. Install 4 SPROF sites (PSD, SCWA)
2. Install 10 soil moisture/rain gauge sites (PSD, SCWA)
3. Collect data during precipitation events, QC data, and make available to partners (PSD, USGS, SCWA, ACE, DWR)
4. Conduct retrospective analyses of QPE and soil moisture (PSD, USGS, ACE, SCWA, DWR)

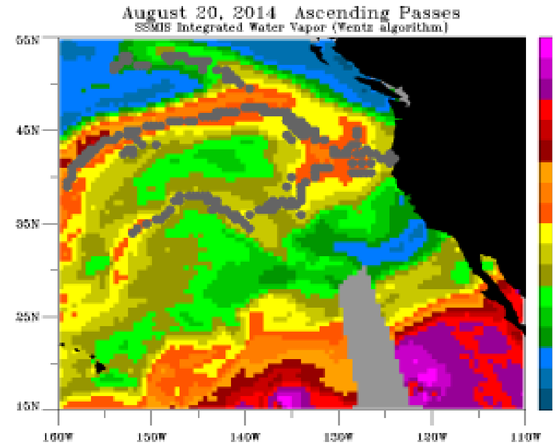
Schedule:

1. Installations: Fall-Winter 2014-2015
2. Data collection: Winter 2014-2015 and 2015-2016
3. Retrospective analyses: Spring 2015-Spring 2016

Budget:

Collaborators: ESRL-PSD, DWR, SCWA, USGS, ACE

Detecting and Tracking Atmospheric Rivers over the Pacific Ocean



NOAA ESRL PSD has developed automated satellite monitoring tools to detect and track ARs across the Pacific.

This is a collaborative project between ESRL-PSD, Scripps, DWR, and the Water Agency. NOAA's ESRL-PSD has developed satellite-based atmospheric river detection and tracking tools which have been automated and operate continuously. Passive microwave data from the Special Sensor Microwave Imager (SSM/I) and Special Sensor Microwave Imager Sounder (SSMIS) enable retrieval of the total integrated water vapor (IWV) content over the oceans. The combination of SSM/I and SSMIS data provides an IWV climate record of over 20 years. Work at developed a mapping of SSMIS brightness temperatures to SSM/I to extend the record. Initial criteria were developed to identify atmospheric river events in IWV imagery and forecast fields. These techniques were expanded to enable fully automated detection of the events and have been applied to the verification of forecasts of the events. http://www.esrl.noaa.gov/psd/psd2/coastal/satres/data/html/ESRL-PSD_sat.html

An Atmospheric River Detection Tool (ARDT) has been developed that compares model (GFS) analyses IWV with satellite observations and shows forecasts of integrated vapor transport (IVT) out to one week (http://www.esrl.noaa.gov/psd/psd2/coastal/satres/ar_detect.html; Wick et al 2013).

It is intended to continue to operate the IWV detection and tracking system, and to work to improve the system through integration with large-scale numerical weather models so that the location of AR landfall, intensity and duration can be better forecast. In addition it is intended to add additional models (e.g., ECMWF and NAM) to the ARDT so that forecasters can compare model performance and help inform prediction of landfalling ARs.

Tasks:

1. Incorporate other NWP models to compare with GFS (PSD, Scripps)
2. Improve decision support tool as needed (PSD, Scripps, DWR, SCWA)

Schedule:

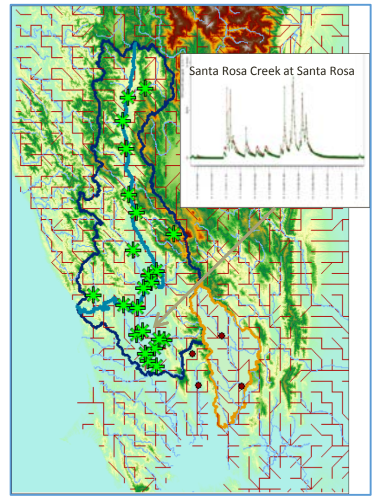
1. Incorporate additional NWP guidance: Year 1
2. Improve decision support tool: Year 2

Budget:

Collaborators: ESRL-PSD, Scripps, Cal DWR, SCWA

Distributed Hydrologic Modeling

This is a collaborative project between ESRL-PSD, NWS, USGS, SCWA, ACE, and DWR. NOAA's ESRL-PSD has been involved in piloting the NWS OHD Distributed Hydrologic Model (DHM) to support future forecast operations, which can address tributary flash flood and environmental low flows. The higher resolution gridded model can provide forecasts for smaller basins, as well as account for spatially variable rainfall and soil moisture dynamics, which the current CNRFC model does not do.



Distributed hydrologic model (DHM) is being piloted in the Russian-Napa Rivers to support NWS forecast operations for flash floods and environmental services.

The DHM has been calibrated for the Russian River tributaries and performs well for flood peaks and reasonably well for low flows. The Russian River DHM is being prototyped for real-time operations by ESRL-PSD and the NWS WFO-MTR using the CHPS-FEWS platform. It is now capable of importing a number of QPE and QPF precipitation field for retrospective and real-time forecasting applications. It is being prototyped to examine model performance and concept-of-operations aspects, and it is expected to be applied to the entire WFO-MTR San Francisco Bay area domain. The CHPS-FEWS-DHM is available to be implemented at Scripps in the mid- to long-term.

Tasks:

1. Calibrate and verify the DHM: Calibration complete except for soil moisture data assimilation. (Hsu et al 2014 (in prep)).
2. RDHM/CHPS forcing with various precipitation fields (i.e. HEFS, reforecasts, XREF, HRRR): This is on-going development. (ESRL-PSD, CNRFC, OHD)
3. Interface to CNRFC Sac Model: Coordination with the CNRFC main stem river forecasts is to be accomplished; the DHM will focus on tributaries for flash floods. (ESRL-PSD, CNRFC, WFO-MTR)
4. Interface to USACE CWMS: The imported and processed precipitation fields for retrospective and real-time events can be provided to the Corps CWMS platform as needed. (ESRL-PSD, USACE, CNRFC)
5. Implement CHPS-FEWS with DHM at Scripps: The CHPS-FEWS platform could be implemented at Scripps to support state-wide implementation of the DHM.

Schedule:

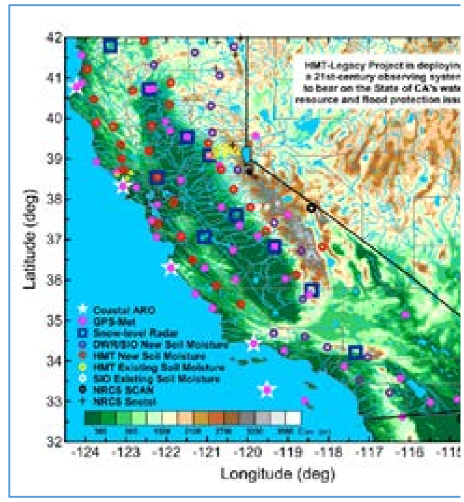
1. Near-term (1 – 2 years):
    a. Calibrate and verify the DHM to assimilate soil moisture observations.
    b. RDHM/CHPS forcing with various precipitation fields Soil moisture flow dynamics:
2. Mid-term (3 – 5 years):
    a. Interface to CNRFC Sac Model
    b. Interface to USACE CWMS
3. Long-term (> 5 years):
    a. Implement CHPS-FEWS with DHM at Scripps

Budget:

Collaborators: ESRL-PSD, NWS CNRFC and WFO-MTR, USGS, SCWA, HEC, DWR, OHD, Scripps

Implementation of Enhanced Hydrometeorological Monitoring Network

The Enhanced Hydrometeorological Monitoring Network is a collaborative project between NOAA-PSD and DWR to install a 21st-century observing network, provide an ensemble numerical weather prediction system, and develop decision support tools to help California deal with water resource and flood protection issues. In addition, the observations network is being densified in the Russian River basin through support of the Water Agency. These instruments are being deployed in stages over a period of years beginning in 2009. Over time, these observations will create an important climate record and datasets to verify model QPF and improve overall forecast skill. Included with the new observations are modeling and display methods and development of decision support tools for extreme precipitation and other hydrologic forcing. The initial water vapor, soil moisture and snow level observations are now operating, while modeling methods, including ensemble and high resolution techniques suited to cool-season orographic precipitation are being tested and the scientific foundations for the decision support tool have been laid around the atmospheric river phenomenon.



Map of California indicating where observing system enhancement projects are being implemented as part of the ESRL PSD HMT-Legacy project.

Tasks:

1. Complete installation of soil moisture and ARO sites (Spring 2015) – PSD, SCWA
2. Maintain sites, QC, manage, and share data (next 5 years) – PSD, DWR, SCWA, USGS

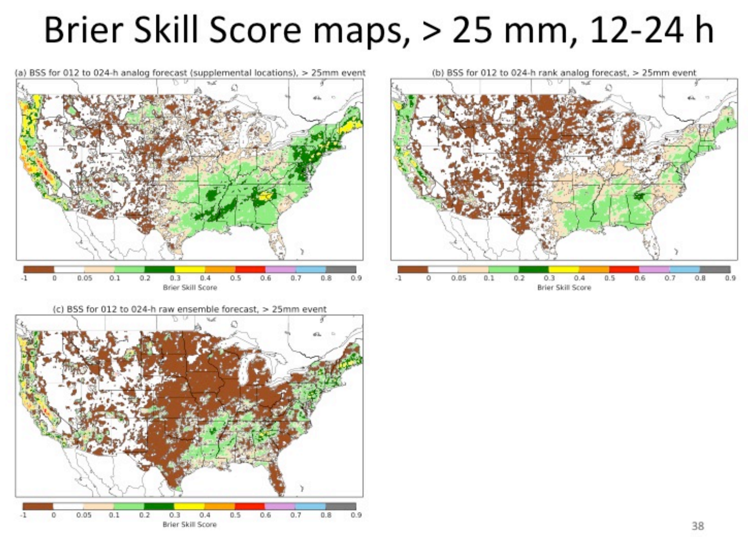
Schedule:

Budget:

Collaborators: ESRL-PSD, Cal DWR, SCWA, USGS

Reforecast Data Set for Improved Precipitation Forecasts

This is a collaborative project between NOAA and CNRFC to develop ensembles of reservoir inflows to be generated by the CNRFC Hydrologic Ensemble Forecast System. The CNFRC predicts unimpaired flows for the Russian River basin using the Hydrologic Ensemble Forecast System. However, before the CNRFC generates the ensemble hydrologic forecasts, it gathers atmospheric ensemble (precipitation, temperature, etc.) forecasts from the NOAA National Centers for Environmental Prediction (NCEP). This project will include demonstration of PSD advanced forecasting tool capabilities in the first year of the project, including evaluation of reforecast data set products (Hamill and Whitaker 2006) for improved atmospheric forecasts in the western U.S.



Brier skill score for 12-24 hour forecast of precipitation exceeding 25 mm using (top left) using reforecast data trained to CPPA with supplemental location technique; (top right) same as top left except using rank analog technique; and (bottom) raw GEFS

The NWS must "pre-process" atmospheric forecasts to produce atmospheric forcing at the space and time scales of the hydrologic forecast models. This includes spatial and temporal downscaling, statistical model bias correction, and an analysis of model hindcasts together with corresponding observations to calibrate the pre-processing algorithms. After the pre-processing is complete, the NWS hydrologic models are initialized with the current basin conditions and the atmospheric ensemble members are run through the hydrologic model one at a time, generating a hydrologic ensemble forecast. Additionally, the NWS forecast ensembles have potential to provide ensemble hydrologic forecasts for future climate change scenarios. The advanced reforecast data set developed by PSD will be integrated with the HEFS and evaluated in Years 2-3 of the project.

Tasks:

1. Evaluation of reforecast data, trained to CPPA (1/8 deg) deg. For cool season precipitation events in California
2. Work with CNRFC to downscale reforecasts to ~4km (HRAP), evaluate, and integrate data set into CNRFC HEFS system
3. Develop experimental 6-10 day probabilistic forecasts of no rain/AR

Schedule:

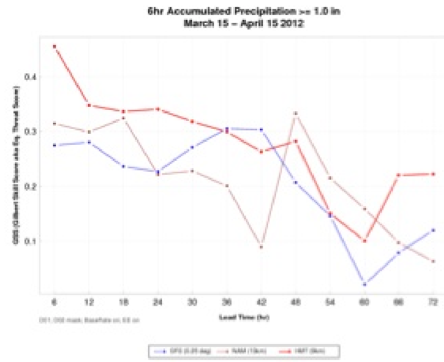
1. Year 1 CPPA evaluation
2. Year 2-3 Integration into HEFS; experimental forecasts

Budget:

Collaborators: ESRL-PSD, CNRFC, OHD

NWP Microphysics Evaluation for Improved Orographic Precipitation

This is a collaborative project between NOAA ESRL-PSD and GSD, NWS, and Scripps. The project will utilize ESRL-PSD S-PROF, wind profiler and other network observations in the Bay Area (including the Russian River watershed) to evaluate different microphysical parameterizations used by high resolution numerical weather prediction models (EXREF, HRRR, West-WRF). Analysis will be done for selected cases studies from extreme precipitation events over a range of forecast lead times. Analysis will include examination of microphysical quantities (e.g., radar reflectivity and particle weighted fall speed) as well as QPF. Tools for the latter include the NWS BoiVer, and ESRL/NCAR tools (MET-MODE) to facilitate model intercomparisons by forecasters.



Gilbert Skill Score for QPF > 1.0" as a function of lead time for 1 month period over west coast domain (March 15-April 15 2012). QPF shown: GFS (blue), NAM (brown), and EXREF(red).

Tasks:

1. Assemble model data sets
2. Re-format data sets as necessary to allow compatibility in AWIPS 2 and MET environments
3. Conduct evaluations of QPF and microphysics for selected case studies
4. Recommend improvements to current microphysical parameterization schemes

Schedule:

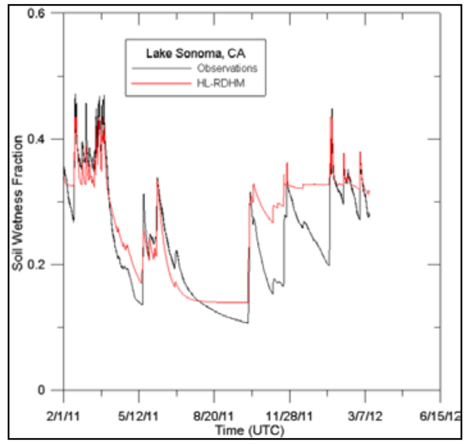
1. Year 1 Identify events for EXREF, HRRR, West WRF evaluation; utilize on-going EXREF evaluation to develop comprehensive methodology for all models (e.g., vertical plus spatial cross section and 3-D analyses)
2. Year 2-3: conduct evaluation on selected case studies. Identify best parameterization for west coast extreme events and make recommendations for improving microphysics parameterizations

Budget:

Collaborators: ESRL-PSD, Scripps, NWS

Soil Moisture Monitoring, Assessment and Data Assimilation

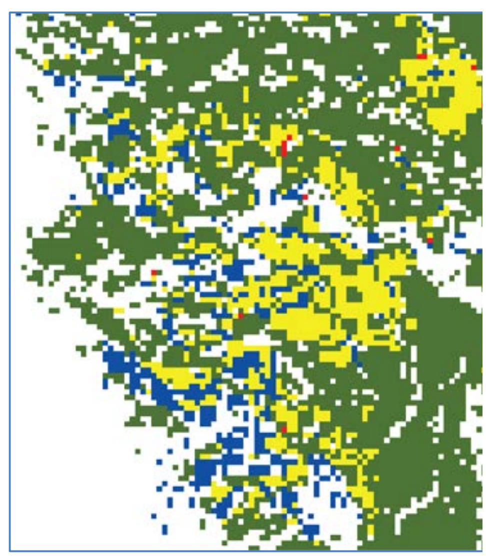
The soil moisture monitoring, assessment and data assimilation is a collaborative project between ESRL/PSD, USGS/CAWSC, SCWA, ACE, DWR, and NWS/OHD. NOAA's ESRL-PSD has been involved with installation and monitoring of soil moisture (SM) in the Russian River basin for a number of years. And several new SM monitoring sites are being added to the E Fk Russian River upstream of Lake Mendocino in order to obtain a better picture of SM conditions and wetting/drying dynamics prior to forecast rain storms. The SM data obtained has been compared to simulated SM values obtained from the NWS DHM (distributed hydrologic model) with varying degrees of success. ESRL/PSD is working with the OHD to advance procedures for assimilating the SM data to establish initial states of the DHM to support improved flow forecasts, esp. for precipitation events occurring after prolonged dry periods.



Correspondence between soil moisture sensor and distributed hydrologic model simulation shows disparities that need to be resolved (i.e. model too wet).

The USGS water balance model, Basin Characterization Model (BCM; Flint et al 2013) has been developed for a daily application at a 270-meter spatial resolution and calibrated for 1910-2013 to Calpella streamflow and reservoir inflows in the Lake Mendocino watershed, to tributaries to the mainstem, including the Lake Sonoma watershed, and all mainstem measured streamflows. The intended application of this model is to develop unimpaired flows for the SCWA RESSEIM water management model. Refinements in the model capability are necessary to better match very dry soil and shallow unsaturated zone conditions and improve consideration of changes in agricultural demand in Potter Valley.

The NWS DHM has been developed at a two resolutions – 4 kilometer and 6 hour, and 1 kilometer and 1 hour to ingest gridded precipitation forecasts and has been calibrated to a four-year period, 2010 – 2013, for total runoff volume, flood peaks and low flows. The DHM is being prototyped within the CHPS-FEWS computing architecture for deployment at WFO-MTR. The CHPS-FEWS implementation involves automatic importing of a variety of precipitation fields from the NWS forecasts systems. Refinement and optimization of both models to represent watershed conditions at the varying spatial scales provides a suite of options for scenario testing and forecasts. The USGS-CAWSC has been examining the ESRL-PSD SM data to better define the dynamics of soil wetting and drying cycles using their BCM model. That activity holds promise for providing better understanding the SM physics and could provide a means for characterizing the initial states for the DHM forecasting model. Calibration of the SM initial states would inform the companion research effort by OHD on


Average climatic water deficit of the current bioclimatic distribution for redwood forest in the Russian River Valley

assimilation of the SM data into the DHM and improve forecast performance. The refined BCM would provide daily scenarios of forecasted hydrologic conditions for testing reservoir operations with the SCWA RESSIM water management model.

The CAWSC has been working with the Sonoma County Water Agency for several years to develop daily hydrologic models for input to their water management models and have soil moisture monitoring in the Russian River watershed. They have been specifically tasked to develop a soil moisture monitoring scheme and hydrologic modeling capability that will serve to establish enough confidence in simulated runoff from a forecasted precipitation event that this information can inform reservoir operations to maintain water in the reservoir under dry antecedent conditions. Confidence will be developed on the basis of demonstrated success with historical conditions especially extreme events, and match to measured watershed and stream flow conditions.

Minimizing uncertainties in the simulations and demonstrating limits to watershed response under several stress test scenarios will increase the support in the use of forecasts to inform reservoir operations and strategically manage the reservoir to optimize this multi-use resource. Once the activities for Lake Mendocino have been developed and tested successfully they will be applied to the remainder of the Russian River basin and particularly the Lake Sonoma watershed for additional improvements to water management on the basis of forecasts of climate and watershed response.

Tasks:

1. Install additional SM sensors (ESRL-PSD, USGS-CAWSC, SCWA): Additional soil moisture gages will be installed (to include an additional sensor at approximately 50 cm) in the West Fork Russian and Lake Sonoma watersheds. These will be co-located with precipitation and temperature gages. Additionally, consideration of additional stream gages in the Lake Mendocino watershed and Dry Creek watershed may be warranted. This collaboration has advanced to the point that the CAWSC has posited criteria for SM sensor siting with detailed mapping, and candidate locations identified. It is anticipated that some of the SM sensors
2. Develop a SM decision support display system (ESRL-PSD, NWS/OHD, NWS/CNRFC/WFO-MTR): The DHM computes the SM conditions for the upper zone (short-term) and lower zone (long-term). The DHM output grids can be visualized as a) anomalies in comparison to expected monthly averages, or b) the percentage full of the upper and lower zones. The gridded displays would be provided through web services deployment in association with the DHM surface runoff grids and channel flows. This is part of DHM prototype deployment to assess SM products in association with CNRFC Flash Flood Guidance at the WFO-MTR.
3. Conduct detailed analysis of soil wetting and drying cycles, and saturated-unsaturated flow dynamics (USGS/CAWSC, ESRL-PSD): The USGS water balance model, Basin Characterization Model (BCM; Flint et al 2013) has been developed for a daily application at a 270-m spatial resolution and calibrated for 1910-2013 to Capella stream flow and reservoir inflows in the Lake Mendocino watershed, to tributaries to the main stem, including the Lake Sonoma watershed, and all main stem measured stream flows. The intended application of this model is to develop unimpaired flows for the SCWA RESSIM water management model. Refinements in the model capability are necessary to better match very dry soil and shallow unsaturated zone conditions and improve consideration of changes in agricultural demand in Potter Valley. The NWS DHM has recently been enhanced by incorporating a heat transfer component (SAC-HT) and vegetation canopy resistance (SAC-HT-CR). Previous advancement of the DHM established an approach to convert the SAC-SMA conceptual storage layer depths to physically-based layers using soil texture information. These aspects of the DHM will be informed by the detailed work being conducted for the BCM soil layers accounting.

4. Develop correspondence between soils saturated-unsaturated flow dynamics with the NWS DHM. (ESRL/PSD, USGS/CAWSC): Refine the BCM to include multiple layers and deep storage reservoir. Correct model dry down calculations as a function of seasonal changes in climatic water deficit for all soil types on the basis of soil moisture measurements throughout the Russian River basin. Calibrate model to historical stream flow data. Establish a conceptual model of the response of the watershed to changes in precipitation under varying soil moisture conditions and how this impacts runoff and inflows to the reservoir.
5. Develop SM data assimilation procedures to relate SM sensor data to DHM SM simulation model. (NWS/OHD, ESRL/PSD, USGS/CAWSC): Soil moisture plays a fundamental role in the partitioning of rainfall into runoff and infiltration inside a catchment. In particular, for a given storm event, different values of initial soil moisture conditions can discriminate between minor or catastrophic flooding effects. Therefore, the assimilation of soil moisture information within rainfall-runoff models can provide improvement for both runoff prediction and forecasting. ESRL/PSD has been examining a nudging scheme incorporating SM observations to establish initial conditions for the DHM in forecasting mode. The USGS/CAWSC has developed detailed mappings of spatial variability of soil conditions. The NWS/OHD is attempting application of advanced variational data assimilation techniques (e.g. Lee at al 2011) to the DHM. These activities will be coordinated using the upper Russian River watersheds (E. Fk. And W. Fk.) as the test areas for assessment of hydrologic model performance.

Schedule:

1. Near-term (1 – 2 years):
    a. Install additional SM sensors in East Fork Russian River
    b. Roll out SM decision support display system and evaluate its utility
    c. Examine SM flow dynamics
2. Mid-term (3 – 5 years):
    a. Install additional SM sensors in tributaries
    b. Adapt SM dynamics to DHM conceptual model; calibrate DHM for wet season start up
3. Long-term (> 5 years):
    a. Install additional SM sensors in Lake Sonoma watershed.
    b. Incorporate SM data assimilation procedure into DHM forecast operations
    c. Long-term – Extend monitoring and modeling to the Lake Sonoma watershed

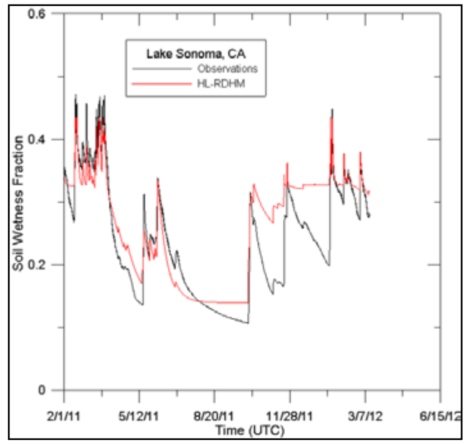
Budget:

Budget details to be determined.

Collaborators: ESRL/PSD, USGS/CAWSC, SCWA, HEC, DWR, OHD, Scripps

Soil Moisture Monitoring, Assessment and Data Assimilation

This collaborative project between PSD, USGS, SCWA, ACE, DWR, and NWS/OHD. NOAA's ESRL-PSD has been underway for several years, and includes installation and monitoring of soil moisture (SM) in the Russian River basin for a number of years. Several new SM monitoring sites are being added to the East Fork Russian River upstream of Lake Mendocino in order to obtain a better picture of SM conditions and wetting/drying dynamics prior to forecast rain storms. The SM data obtained has been compared to simulated SM values obtained from the NWS DHM (distributed hydrologic model) with varying degrees of success. ESRL-PSD is working with the OHD to advance procedures for assimilating the SM data to establish initial states of the DHM to support improved flow forecasts, esp. for precipitation events occurring after prolonged dry periods.



Correspondence between soil moisture sensor and distributed hydrologic model simulation shows disparities that need to be resolved (i.e. model too wet).

The USGS has been examining the ESRL-PSD SM data to better define the dynamics of soil wetting and drying cycles using their BCM model. That activity holds promise for providing better understanding the SM physics and could provide a means for characterizing the initial states for the DHM forecasting model. Calibration of the SM initial states would inform the companion research effort by OHD on assimilation of the SM data into the DHM and improve forecast performance.

Tasks:

6. Install additional SM sensors (ESRL-PSD, USGS, SCWA)
7. Develop a SM decision support display system
8. Conduct detailed analysis of soil wetting and drying cycles, and saturated-unsaturated flow dynamics. (USGS, ESRL-PSD)
9. Develop correspondence between soil saturated-unsaturated flow dynamics with NWS distributed hydrologic model (DHM). (NOAA ESRL-PSD, USGS)
10. Develop SM data assimilation procedures to relate SM sensor data to DHM SM simulation model. (OHD, ESRL-PSD)

Schedule:

4. Near-term (1 – 2 years):
    a. Install additional SM sensors in E. Fk Russian River
    b. Roll out SM decision support display system and evaluate its utility
    c. Examine SM flow dynamics
    d. Long-term Lake Sonoma watershed
5. Mid-term (3 – 5 years):
    a. Install additional SM sensors in tributaries
    b. Adapt SM dynamics to DHM conceptual model; calibrate DHM for wet season start up
6. Long-term (> 5 years):
    a. Install additional SM sensors in Lake Sonoma watershed.
    b. Incorporate SM data assimilation procedure into DHM forecast operations

Budget:

Collaborators: ESRL-PSD, USGS, SCWA, HEC, DWR, OHD, Scripps

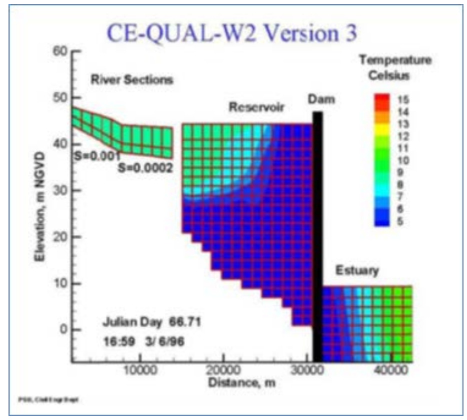
Data Gathering and Synthesis

Implementation of the water quality monitoring recommendations in combination with current monitoring efforts will require data management and information synthesis prior to use in a comprehensive modeling framework targeting water quality forecasting. To do this effectively and ensure all data gaps are addressed a qualified professional(s) will be required to better characterize and improve our understanding of water quality conditions released from Lake Mendocino. This qualified professional(s) will also need to understand and/or conduct water quality forecast modeling that will ultimately inform resource managers of potential impacts and/or benefits of various reservoir operational scenarios to fisheries.

Ultimately, results from these scenarios will provide a decision support tool that will contribute to better coldwater pool management within Lake Mendocino ensuring adequate water temperature conditions for rearing juvenile steelhead and fall-run immigrating adult Chinook salmon during dry and critically dry fall/early winter periods. Perceived chronic turbidity issues associated with Lake Mendocino will also need to be better understood to potentially develop flow release schemes that minimize associated sediment impacts downstream and/or provide justification for modifications to existing Coyote Dam infrastructure. Dissolved oxygen monitoring and modeling will ensure that under severe low storage conditions or during reservoir turnover adequate dissolved oxygen levels are maintain downstream of Coyote Dam for salmonids.

Lake Mendocino Water Quality Modeling

The water quality modeling project is a collaboration between NOAA , Univ. Nevada Reno, USGS, SCWA, and ACE. The project intends to develop reservoir water quality predictive tools to help define release policies to sustain fisheries in the main stem Russian River. Primary emphasis will be on temperature stratification and consequent effects on in-reservoir and downstream fisheries habitat. Other water quality dimensions for sediment, dissolved oxygen and dissolved solids may be addressed as well. Turbidity of release flows and sediment venting near the release gates will also be examined (USGS Minear). This project will integrate the water quality model with the reservoir operations model to provide a fisheries management capability. This approach has recently been applied to the Shasta Reservoir system by Univ. Nevada – Reno's (UN Reno) Saito, et al (2013).



CE-QUAL-W2 Model can be applied for reservoir thermal stratification and water quality (http://www.ce.pdx.edu/w2/).

Collaborators will use available data in collaboration with ongoing efforts to develop a model of Lake Mendocino with CE-QUALW2 (W2), a publically available reservoir hydrodynamic and operations model. W2 will be coupled with a stochastic weather and inflow simulation model that will enable the simulation of extreme climate conditions based on historical observations and climate change projections. The coupled models will help assess the ability of different management options to enhance system resilience for water supplies and fisheries. This information will be vital to stakeholders in effectively using funds for restoration and other activities in the watershed.

Tasks:

1. Use available data in collaboration with ongoing efforts to develop a model of Lake Mendocino with CE-QUALW2 (W2). Identify data gaps and conduct observations to address gaps. (UN Reno (Saito), ESRL-PSD, USGS, SCWA, USACE)
2. Parameterize and calibrate W2 for Lake Mendocino for water quantity, temperature, and turbidity. (UN Reno, ESRL-PSD, USGS, SCWA, USACE)
3. W2 will be coupled with weather and inflow scenarios that will enable the simulation of "stress" conditions. Examine sediment venting and turbidity (UN Reno, ESRL-PSD, USGS, SCWA, USACE)
4. Assess the ability of different management options to enhance system resilience for water supplies and fisheries. (UN Reno, ESRL-PSD, USGS, SCWA, USACE)

Schedule:

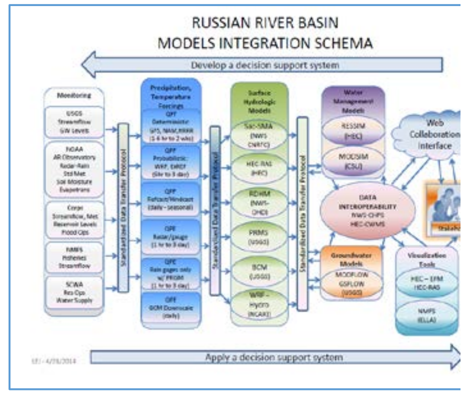
1. Near-term (1 – 2 years):
    a. Collect and analyze available WQ data
    b. Collect additional data
    c. Calibrate W2 for Lake Mendocino
2. Mid-term (3 – 5 years):
    a. Couple W2 to precipitation, temperature and inflow scenarios.
    b. Simulate "stress" conditions and assess resilience
3. Long-term:
    a. Deploy W2 model for continuing operations guidance.

Budget:

Collaborators: ESRL-PSD, UN Reno, USGS, SCWA, USACE, Scripps

Data Coordination and Interoperability

This is a collaborative project between ESRL-PSD, NMFS, PPI, NOS, SCWA, USACE, HEC, DWR, and Scripps. Given the number of project participants and the various data sets and models, there is a need to establish data standards for sharing and exchanges. Improving the interoperability of data and systems is a high priority for the three IWRSS agencies and their cooperators. Current information exchange mechanisms between each water agency are not standardized. There are also concerns about computing capacity and data storage volumes for existing systems of the NWS CNRFC, DWR CDEC, and the other participating agencies. A nascent activity in this regard is the SCWA project on data and interoperability (on-going). Also, the WRF-Hydro architecture could provide guidance on data and models integration scheme.



Integration of data and models across tasks and agencies will require development of project integration concepts and data standards.

It is suggested that a directed effort be made to advance capabilities for data coordination and interoperability. Depending on the vision of need, this task could range from simple data standards to supercomputer hosting of all data and modeling capabilities. The supercomputer at Scripps could provide the capacity required, and the experiences gained from that facility for the CUAHSI program could help in advancing the capabilities desired.

Tasks:

1. Define requirements for data standards and interoperability (ESRL-PSD, USGS, USACE, HEC, SCWA, Scripps)
2. Define a data management and modeling architecture that can sustain the project participants and lead to a continuing capability for operations.
3. Implement the data management and models integration architecture on the Scripps supercomputer. Conduct software prototyping, verification and real-time operations testing.
4. Integrate the FIRO project data and models into the Scripps supercomputer system. Establish real-time links to CDEC, CHPS-FEWS, CWMS, USGS and other data repositories. Implement the various FIRO models on the Scripps supercomputer, perhaps including CHPS-FEWS, CWMS, USGS, XREF and West-WRF, DHM, ResSim and others.
5. Develop a concept of operations for a West Coast Storm Center that would maintain data and modeling capabilities for on-going operations.

Schedule:

1. Near-term (1 – 2 years):
    a. Define requirements for data standards and interoperability.
    b. Define a data management and modeling architecture
2. Mid-term (3 – 5 years):
    a. Implement the data management and models integration architecture at Scripps.
3. Long-term (> 5 years):
    a. Integrate FIRO project data and models at Scripps.
    b. Develop CONOPS for West Coast Storm Center.

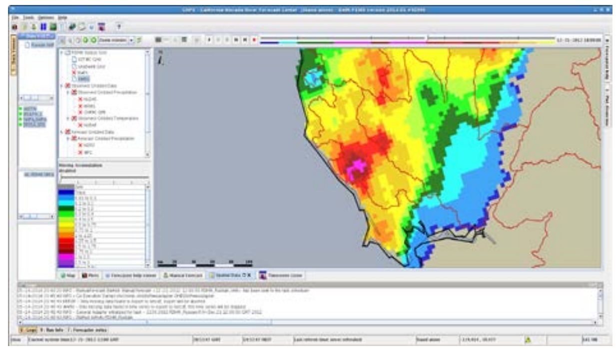
Budget:

Collaborators: ESRL-PSD, NMFS, PPI, NOS, SCWA, USACE, HEC, DWR, Scripps

Identify How Coyote Valley Dam Safety Rating Could Be Improved
The Corps ranks dam safety on a 1-5 scale, with 5 being the safest. Proposed operational changes to dams that are ranked 3 or lower are heavily scrutinized. Coyote Valley Dam is rated a DSAC 3. In the near-term, the FIRO workgroup will identify and describe the factors that make Coyote Valley Dam rated a DSAC 3 facility. In the mid-term, the group will identify what actions/project(s) (and rough costs) would be required to increase the DSAC rating from 3 to 4. This project would only be initiated pending outcome of Tasks 7.2.1, 7.2.2, and 7.2.3 showing potential for some improvement of Lake Mendocino performance via implementation of FIRO.

Task team: **USACE** (lead), SCWA, and RRFCD

Apply DHM for selected "stress test" flood events



CHPS-FEWS implementation of DHM supports import of precipitation and temperature fields, and export of surface runoff and soil moisture grids.

This collaborative project between PSD, USGS, SCWA, ACE, DWR, and NWS uses the NOAA ESRL-PSD distributed hydrologic modeling (DHM) activity, which provides a foundation for assessing the surface runoff and soil moisture (SM) dynamics resulting from a wide variety of precipitation forcing time series. The DHM accounts for the spatial distribution of rainfall and SM dynamics. It can be used to generate the watershed runoff inflows to Lake Mendocino as well as RR tributaries. It has been calibrated for a 3-year period; this calibration will be improved by the soil moisture data assimilation task described above.

The DHM has been implemented within the CHPS-FEWS platform to that it can easily ingest precipitation forcings from a wide variety of QPE and QPF sources, including ensembles of these. The CHPS-FEWS-DHM system is being prototyped for real-time forecast operations by the WFO-MTR. The DHM and its CHPS-FEWS implementation would be used for assessment of the "stress tests" as defined by the companion tasks.

Tasks:

1. Coordinate with companion task activities to define the reservoir operation "stress tests." (PSD, ACE, SCWA, USGS)
2. Ingest the defined "stress tests" precipitation and temperature fields time series and simulate the basin runoff inflows to Lake Mendocino. Export these outputs to task involving assessment of reservoir operations (ACE).
3. Demonstrate that the CHPS-FEWS-DHM system can be used for real-time forecast operations for runoff forecasting for flood and dry period flows (PSD).
4. Implement the CHPS-FEWS-DHM system for continuing forecast operations at the WFO-MTR and Scripps as appropriate (PSD, DWR, Scripps, SCWA, OHD).

Schedule:

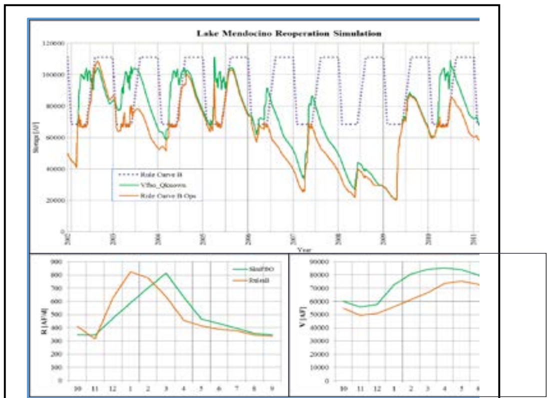
1. Near-term (1 – 2 years):
    a. Coordinate on defining "stress tests."
    b. Ingest "stress tests" precipitation events as developed. Export outputs to reservoir operations tasks.
    c. Long-term Lake Sonoma watershed
2. Mid-term (3 – 5 years):
    a. Demonstrate that the CHPS-FEWS-DHM system for real-time forecast operations.
3. Long-term (>5 years):
    a. Implement the CHPS-FEWS-DHM system for continuing forecast operations at the WFO-MTR and Scripps

Budget:

Collaborators: ESRL-PSD, USGS, SCWA, HEC, DWR, OHD, Scripps

FldOps Reservoir Simulation

This is a collaborative project between ESRL-PSD, USGS, SCWA, ACE, DWR, Scripps, and NWS. A spreadsheet (Excel) reservoir operations simulation model, called “FldOps”, has been developed for the Lake Mendocino system to provide a capability for preliminary assessment of reservoir operations schemes. The FldOps model has been applied to the period 2002 – 2012 to demonstrate its basic functionality, calibration and assessment of alternate operations schemes. The FldOps uses the historic record of inflows and a 10-day look ahead of inflow volumes; effectively characterizing the historic record as “perfect” forecasts.



FldOps simulation model provides an easy to use capability to examine Lake Mendocino operations for various inflow scenarios.

The FldOps simulation results demonstrate that Lake Mendocino can be operated to obtain downstream flows and storage levels that emphasize water supply and fisheries objectives. There are also indications that flood risks can be mitigated through pre-release strategies, however more detailed assessment is required using the ResSim model to confirm this. FldOps is not intended to be a substitute for ResSim but rather an easy to use tool for preliminary assessment of inflow scenarios and alternate operations schemes.

Tasks:

1. Demonstrate FldOps calibration (ESRL-PSD, SCWA, DWR)
2. Extend FldOps application to include selected inflow scenarios for high- (e.g. 1964) and low-flow periods (e.g. 1977). (ESRL-PSD, SCWA, ACE, NWS)
3. Provide training in the use of the FldOps model and provide to interested users. (ESRL-PSD, SCWA, NMFS, Scripps, NWS, ACE, USGS, DWR)

Schedule:

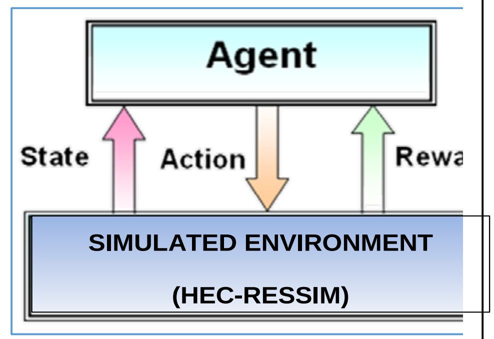
1. Near-term (1 – 2 years):
    a. Demonstrate FldOps
    b. Extend to include 1964 flood scenario
    c. Provide training and distribute to interested users.
2. Mid-term (3 – 5 years):
    a. No mid-term applications of FldOps expected
3. Long-term (>5 years):
    a. No long-term applications of FldOps expected

Budget:

Collaborators: ESRL-PSD, NMFS, USGS, SCWA, HEC, DWR, OHD, Scripps

Agent-Based Reservoir Operations Modeling

This is a collaborative project between ESRL-PSD, USGS, SCWA, ACE, DWR, and NWS. The project intends to leverage off the reservoir operations work that the SCWA has been conducting with the HEC using the ResSim model in developing their revised Hydrologic Index approach to defining operations policies. The entire reservoir operations modeling considered herewith is anticipated to be coordinated and compatible with the ResSim work accomplished to date.



Agent-based approach can be applied to identify optimal reservoir operations policies that emphasize multiple objectives for flood protection, water supply and environmental services.

An agent-based approach will be applied for learning optimal rules for FIRO that involve accounting for weather forecast-based anticipated runoff capture for balancing water supply, aquatic ecosystem preservation and flood control. Several powerful machine learning tools have been successfully applied by these investigators to a wide range of water resource system operational problems, including reinforcement learning (Labadie and Rieker, 2012; Lee and Labadie, 2007), artificial neural networks (Darsono and Labadie, 2007), fuzzy rule-based models (Labadie and Wan, 2010), and evolutionary algorithms (Labadie, et al., 2012). Machine learning, as a branch of artificial intelligence, focuses on development of specific algorithms that allow computerized agents to learn optimal behaviors through interaction with the environment as simulated by models such as HEC RESSIM. This study will investigate the most appropriate approaches for effective FIRO under weather forecast uncertainty using an integration of the HEC-RESSIM with the optimization module. A decision support tool (DST) will be developed to support reservoir operations. The DST will incorporate the agent learning strategy described above and will be designed to maximize reliability and strengthen the ability to make objective, risk-based decisions.

Tasks:

1. Coordinate with ResSim simulation model development (HEC, ESRL-PSD, SCWA)
2. Establish agent-based computing scheme using ResSim (CSU, ESRL-PSD, HEC, SCWA, NMFS)
3. Interface to ensembles of reservoir inflows (CSU, ESRL-PSD, CNRFC, Scripps)
4. Conduct agent-based computer analyses that account for forecast uncertainty (CSU, ESRL-PSD, CNRFC, Scripps)
5. Implement A-B reservoir operations model at Scripps (CSU, Scripps, ESRL-PSD)
6. Coordinate with Risk-Benefit analysis tasks

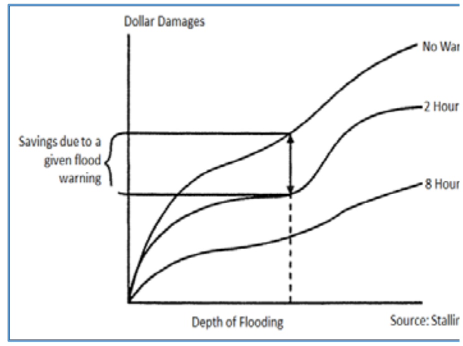
Schedule:

1. Near-term (1 – 2 years):
    a. Coordinate with ResSim
    b. Establish agent-based computing scheme using ResSim
2. Mid-term (3 – 5 years):
    a. Interface to ensembles of reservoir inflows Long-term:
    b. Conduct agent-based computer analyses

Budget:

Collaborators: CSU, ESRL-PSD, USGS, SCWA, HEC, DWR, NWS/OHD, Scripps

Reservoir Operations Benefits Assessment



Stage-damage relations are influenced by flood warning lead times. Damages can be reduced with longer forecast lead times; these reduced damages are benefits.

This is a collaborative project between ESRL-PSD, NMFS, PPI, NOS, SCWA, USACE, DWR, and Scripps. Benefits of reservoir operations can be generally categorized into three accounts, 1) flood damages avoided, 2) water supply, and 3) environmental services (including fisheries and recreation). NOAA's Office of Program Planning and Integration (PPI; http://www.ppi.noaa.gov/economics/) and national Ocean Service (NOS Adkins) have staff who specialize benefits for ecosystem services, as well as other water resources purposes (Adkins). A recent report by ESRL-PSD (Johnson 2014) has developed a regional accounting approach for the three categories and provides a reconnaissance-level characterization of benefits associated with advanced precipitation forecasts. This project will advance that work to provide a more solid basis for benefits accounting supportive to reservoir operations decisions. The approach will involve coordination with the reservoir operations tasks to obtain reservoir storage and river flow time series that can be related to the various benefits categories.

Tasks:

1. Describe benefits to be monetized and existing sources of information. Identify approaches and methods that could be used to monetize benefits; design the benefits assessment methodology. (ESRL-PSD, NMFS, PPI, NOS, SCWA, USACE, HEC, Scripps)
2. Establish operational constraints and criteria for storage levels and releases, and water supply and environmental targets. Collect additional data as appropriate. (ESRL-PSD, NMFS, PPI, NOS, SCWA, USACE, HEC, Scripps)
3. Evaluate flood damage scenarios for reservoir release and tributary flood conditions using the HEC HEC-RAS model. Evaluate water supply and environmental services conditions for high and low flow conditions. (PPI, NOS, SCWA, USACE, HEC)
4. Coordinate with reservoir operations simulation and optimization tasks to characterize benefits for the various "stress test" scenarios. (ESRL-PSD, NMFS, PPI, NOS, SCWA, USACE, HEC, Scripps)
5. Conduct benefits assessment and communicate results. (PPI, NOS, ESRL-PSD, NMFS, SCWA, USACE, HEC, DWR, Scripps)

Schedule:

1. Near-term (1 – 2 years):
    a. Describe benefits and identify approaches for monetization.
    b. Establish operational constraints. Collect additional data to fill gaps.
    c. Evaluate flood damage scenarios using HEC-RAS.
2. Mid-term (2 – 3 years):
    a. Coordinate with reservoir operations simulation and optimization tasks.
    b. Conduct benefits assessment.
3. Long-term (>5 years):
    a. Provide benefits assessment tools for continuing analyses.

Budget:

Collaborators: ESRL-PSD, NMFS, PPI, NOS, SCWA, USACE, HEC, DWR, Scripps

APPENDIX G: EVALUATING FISHERIES BENEFITS ASSOCIATED WITH FIRO

Streamflow and water quality influences the distribution, abundance, and health of salmonids in river ecosystems. Reduced reservoir storage and warming water temperatures from climate change are expected to reduce the remaining anadromous salmonid habitat below dams. As is the case with Lake Mendocino, recent water storage issues have caused concerns regarding the reliability of providing suitable streamflow and associated water quality to important salmonid habitat downstream of the dam during the late summer and fall months. Water quality characterizations can vary widely due to numerous parameters that can be used as indicators or descriptors. For salmonids, the primary water quality parameters of interest as related to Lake Mendocino and FIRO are temperature, dissolved oxygen (DO), and turbidity. Ensuring water storage reliability within Lake Mendocino to meet environmental flow compliance thresholds while achieving higher quality discharged water would prove FIRO as viable option to improve salmonid habitat conditions below Coyote Valley Dam. Below is the following FIRO viability criteria for each of the four flow and water quality parameters described above:

Dry season minimum streamflow requirements:

Throughout California, water supply is highly limited during the summer and early fall. In some years, competing interests for water supply during the dry season can cause adverse conditions for summer rearing steelhead and fall upstream migrating Chinook salmon downstream of Lake Mendocino. Water conservation measures that contribute to elevated water storage in Lake Mendocino will provide greater water supply reliability for fisheries during the dry season. To what extent will FIRO provide water supply certainty during the dry season so that allocated fisheries flows will be preserved; or at minimum provides operational flexibility (i.e., short term releases) that supports the upstream migration of adult Chinook salmon in the fall? This could be measured by quantifying changes in storage with or without the implementation of FIRO.

Water temperatures:

Surface elevation and water storage volumes are important factors influencing the availability of cold water storage (hypolimnion) within reservoirs and subsequently the quantity and quality of salmonid habitat downstream influenced by discharge. For example, in years where Lake Mendocino contains low water storage and the hypolimnion becomes severely depleted, the availability of summer rearing habitat for steelhead downstream can become a water temperature limited area. Conversely, water conservation measures that increase the elevation and water storage volume of Lake Mendocino will increase the likelihood that water temperatures will remain good to excellent for summer rearing juvenile steelhead downstream. Will FIRO result in elevated storage to the extent that a greater volume of cold water (<20°C) is available for downstream salmonids during late summer and fall months? This could be measured by comparing the volume of cold water within Lake Mendocino available for salmonids during select years and during the late summer and fall months with or without additional FIRO stored water.

1) Dissolved oxygen:

Surface elevation, water storage volumes and circulation are important factors influencing dissolved oxygen levels within Lake Mendocino and downstream of Coyote Valley Dam.

Will FIRO result in elevated storage scenarios that contribute to providing quality dissolved oxygen levels (>6.5 mg/L) within and below Coyote Dam? This could be measured by comparing the dissolved oxygen levels within Lake Mendocino and downstream of Coyote Valley Dam in select years during the summer and fall months with or without additional FIRO stored water.

Turbidity:

Chronic turbid flows released from Coyote Valley Dam are thought to impact salmonids and their habitat by prolonging high turbidity flows and increasing sedimentation of riffles and pools in areas below the confluence with the East Branch. These post-storm prolonged releases lengthen the duration salmonids are exposed to high levels of turbidity that can reduce growth rate, delay migration, and cause displacement. Additionally, ramping rates associated with flood control operations have likely exacerbated bank sloughing and channel incision between Ukiah and Hopland resulting in other sources of turbidity and suspended material. Can alternative ramping or discharge rate strategies aligned with FIRO objectives contribute to reducing prolonged chronic turbid flows released from Coyote Valley Dam? This could be evaluated by exploring sediment venting or sluicing in conjunction with high mainstem turbid flows or prior to the onset of heavy rains when flood evacuations are required.

Ramping:

Coyote Valley Dam operations are designed to reduce the magnitude of flood peaks in the mainstem Russian River downstream of the confluence with the East Branch. The ramping rates associated with these operations are most likely to have impacts to salmonids within the five mile stream segment below the confluence of the East Branch. Specific elements of the ramp-up and ramp-down procedures have different implications relative to potential impacts to salmonids.

Ramp-up - Flood control operations affect the natural hydrology in the main stem river below Lake Mendocino by reducing the peak flood discharge and storing runoff and then releasing the storage between storms. Post-storm ramp-up releases from the flood control pool typically extend the periods of high flows when they would be otherwise receding. These potentially longer duration post-storm channel forming flows may impact salmonids by increasing salmonid redd scour and prolonging their exposure to higher than natural turbidity and velocity conditions.

Can FIRO reduce the duration and frequency of ramp-up post-storm channel forming flows; subsequently, reducing potential impacts to salmonids from prolonged exposure to higher turbidity and velocity levels? This could be evaluated by testing the ability of FIRO to operate within the ramp-up criteria provided in the 2008 Russian River Biological Opinion (Appendix F; Table 1) or identifying other ramp-up alternatives that prove to be less impactful to salmonids.

Ramp-down – Ramp-down of flood releases can strand juvenile salmonids on gravel bar surfaces and off-channel habitats by reducing river stage elevations too quickly for juvenile salmonids to follow the receding river elevation. Stranding of juvenile salmonids and dewatering of redds are expected to be most problematic in the mainstem Russian River below Lake Mendocino approximately five miles downstream of the East Fork confluence. Measures are in place to minimize these potential impacts to salmonids; however, investigations are underway that may indicate that stranding could be further minimized or avoided while maintaining flood control operations.

Will the implementation of FIRO reduce or exacerbate potential ramp-down impacts to salmonids? This could be evaluated by testing the current ramp-down criteria (Appendix F; Table 2) at specific locations or developing other ramp-down procedures that prove to further minimize or avoid stranding and dewatering of salmonid redds (e.g., 'natural hydrograph' rate-of-change and shear stress analyses, etc.).

Current Fisheries Criteria Pertaining to FIRO

In 2008, the National Marine Fisheries Service issued the Russian River Biological Opinion (RRBiOp) under the federal Endangered Species Act. The RRBiOp includes Coyote Valley Dam flood and water supply operations and the potential of these actions to impact threatened CC Chinook salmon and CCC steelhead trout. The three specific areas identified as potentially impacting ESA-listed salmonids in the RRBiOp associated with Coyote Valley Dam includes permanent changes to prescribed fisheries flows, ramping rates, and turbidity impacts. The current salmonid criteria related to each of these areas are as follows:

1) ***<u>Future Fisheries Flows</u>***: The Russian River Biological Opinion identifies the following flow ranges to be implemented with the anticipation that Lake Mendocino will have adequate storage to meet these objectives.

Water year classification	River reach	Minimum flow requirement (cfs)	Duration (date)
Normal	East Fork to Dry Creek	125 to 185	June 1 - August 31
		125 to 150	September 1 - October 31
Dry	East Fork to Dry Creek	75	Year round
Critically Dry	East Fork to Dry Creek	25	Year round

2) ***<u>Current Ramping Requirements per the Russian River Biological Opinion</u>***:

Table 1: Ramp-down criteria identified in the Russian River Biological Opinion (2008).

Discharge (cfs)	Max ramp-down (cfs/hr)
0 - 250	25
250 -1000	250
>1000	1000

Table 2: Ramp-up criteria identified in the Russian River Biological Opinion (2008).

Discharge (cfs)	Max ramp-up (cfs/hr)
0 - 250	1000

250 -1000	1000
>1000	2000

1) ***CVD Scour Events*****:** CVD scour events are considered the number of days CVD extends the duration of flows over 4200 cfs in the upper Russian River. CVD scour event limitations are exceeded when:
    a. CVD extends the duration of scour events by more than 32 days or during more than 16 storm events during the next fifteen years; or
    b. CVD in the any one year extends the duration of scour events on more than 5 storms in one year; or
    c. CVD in any one year extends the duration of scour events by more than 14 days in one year.

2) ***CVD Sedimentation Events*****:** CVD sedimentation events are considered the number of days CVD extends the duration of flows over 6000 cfs at Hopland (other than what would occur based on Russian River flows alone). CVD sedimentation event limitations are exceeded when:
    a. CVD releases contribute to more than 31 days of flows > 6000 cfs at Hopland over the course of the next fifteen years; or
    b. CVD releases in any one year contribute to more than 16 days of flows > 6000 cfs at Hopland
    c. CVD releases in any one year contribute to flows > 6000 cfs at Hopland during more than 5 storms.

3) ***Ramping Requirements:*** Undertake measures to ensure that harm and mortality to listed salmonids from ramping procedures at CVD are low.

4) ***Turbidity Requirements:*** Undertake measures to assist NMFS in determining the amount of take resulting from turbidity releases at CVD.

5) ***Temperature Requirements***: Currently no temperature criteria exists for the upper Russian River or for cold water management in Lake Mendocino. However, the benefit of conserving more water in Lake Mendocino is implied in the Russian River Biological opinion: *"Main stem flow releases required to maintain current D1610 requirements cause the cold water pool in Lake Mendocino to become depleted by late August or early September, reducing the quality of rearing habitat in the upper main stem Russian River (p. 121)". Generally, keeping temperatures below 20 degrees Celsius within targeted summer steelhead rearing reaches.*

6) ***Dissolved Oxygen Requirements:*** Currently no dissolved oxygen criteria exists for the upper Russian River or at the outlet of Lake Mendocino. Generally, dissolved oxygen levels over >6 mg/L are good for salmonids.

LAKE MENDOCINO FORECAST INFORMED RESERVOIR OPERATIONS

COMMUNICATIONS MANAGEMENT PLAN

Version 2.0

August 1, 2015

VERSION HISTORY

Version #	Implemented By	Revision Date	Approved By	Approval Date	Reason
1.0	Ann DuBay	06/22/15			
2.0	Ann DuBay	08/01/15			

1.0 INTRODUCTION

1.0.1 Purpose and scope of Communications Management Plan

The purpose of this document is to define the communications goals and strategies of the Lake Mendocino Forecast Informed Reservoir Operations project. These high-level strategies and goals are intended to provide guidance in communicating with internal and external partners, and – where possible -- measuring results of communications efforts.

The Lake Mendocino FIRO Communications Management Plan (CMP) defines the project's structure and methods of information collection, screening, formatting, and distribution of project information. The overall objective of the Communications Management Plan is to promote the success of the project by meeting the information needs of project stakeholders and outline the goals of the communications efforts to reach and inform each group.

Without detailed plans for communications activities that identify the organizational, policy, and material resources needed to carry them out, it will be challenging to secure the support and to coordinate efforts of the Lake Mendocino FIRO project.

1.0.2 Goals and strategies of the communications management plan

The goals of the Lake Mendocino FIRO CMP are threefold:

1. To ensure collaborative, consistent and effective communication among the FIRO Working Group;
2. To provide timely information so that involved agencies can deploy the resources necessary to implement Lake Mendocino FIRO; and
3. To engage and educate policy makers, funding institutions, the media and other interested parties on Lake Mendocino FIRO.

This plan identifies the appropriate level of communication for each stakeholder group (working group, agencies and interested parties), what information should be distributed and the frequency of communications. This plan also includes communication tools (email, face to face meetings, fact sheets, social media, etc).

Lake Mendocino FIRO communications efforts should be based on this explicit, detailed Communications Management Plan, with a matrix of specific actions addressing communications needs of each stakeholder group. Success for project communications should be measured against planned objectives and the communications manager/facilitator should provide regular updates to the Lake Mendocino FIRO Steering Committee on each objective.

The intended audience of the Lake Mendocino FIRO CMP is the Steering Committee, Working Group, involved agencies and any other stakeholders whose support is needed to carry out the project.

STAKEHOLDER IDENTIFICATION AND ANALYSIS

1.0.3 Stakeholders and Goals

Project Communications are Lake Mendocino FIRO's primary tool for promoting cooperation, participation, coordination and an understanding of acceptance between all stakeholders. The project has four primary stakeholder groups and has specific communications goals for each.

Stakeholder Group 1 – Steering Committee and Working Group

The Working Group is comprised of representatives from multiple agencies, including US Army Corps of Engineers (USACE), several divisions of the National Oceanic and Atmospheric

Administration (NOAA), US Geological Survey (USGS), Bureau of Reclamation (BOR), California Department of Water Resources DWR), the Center for Western Water and Weather Extremes at Scripps Institution of Oceanography- UC San Diego (C3WE), Sonoma County Water Agency (Water Agency), and Mendocino County Flood Control and Water Conservation Improvement District (Mendocino Food Control). The Steering Committee includes representatives from these organizations and is supported by staff of the Water Agency, Eastern Research Group (ERG) and Ford Consulting.

The Working Group is an information-sharing venue for FIRO activities and projects, resolves key issues, and makes broad policy decisions about implementation. The Steering Committee makes day-to-day decisions, shepherds the project implementation and provides a forum for updates on FIRO-related activities.

Goals:

- Ensure Steering Committee members have the information needed to make timely, informed decisions about Work Plan implementation.
- Promote ongoing Working Group participation and engagement.
- Increase opportunities for information sharing and cross-agency cooperation among all participants on FIRO-related project, activities, actions and policies.

Objectives:

- Create a platform for document exchange and editing by August 1, 2015.
- Ensure Working Group members are informed and updated on a regular (quarterly) basis.
- Leverage Working Group members as advocates for building agency understanding and awareness of Lake Mendocino FIRO Work Plan and project.
- Develop a process for informing all participants about upcoming meetings on Capitol Hill and with the Administration on FIRO-related projects.

Stakeholder Group Two -- Agencies

The Lake Mendocino FIRO project grew out of the federal Integrated Water Resources Science and Services (IWRSS) initiative and includes federal agencies (listed above) that are actively engaged in water resource issues. DWR is the California agency with responsibility for forecasting and multiple flood and water supply issues. CW3E is embedded in Scripps Center at UC San Diego and is working on cutting edge research. The Water Agency partners with all of the agencies on a variety of forecasting and water supply projects, including NOAA's Russian River Watershed Habitat Blueprint and National Integrated Drought Information System (NIDIS).

With the weight of all these agencies behind it, Lake Mendocino FIRO has a high opportunity for success. However, these agencies have multiple divisions and goals and face funding constraints, making it challenging to get the attention and support of key internal policymakers.

Goals:

- Ensure that agencies continue to work together on Lake Mendocino FIRO.
- Inform and secure commitment from key internal policy makers to support Lake Mendocino FIRO.

Objectives:

- The leadership of all participating agencies are briefed about the Lake Mendocino FIRO Work Plan by November 1, 2015.
- All FIRO agencies commit to participate in the project by October 1, 2016, with appropriate resources, program management, and policies to support their participation.
- Develop communications messages, materials and activities that respond to the needs of the agencies.

Stakeholder Group 3 – Policymakers, including Congressional and California legislative members and staff of relevant appropriations, authorizing, and oversight committees.

Congressional and California legislative members and staff have the ability to bring attention and funding to Lake Mendocino FIRO through committee hearings, appropriations and policy initiatives. These external stakeholders are confronted with multiple interest groups and projects daily, and need succinct, consistent and frequent communications to understand the benefits of Lake Mendocino FIRO.

Goal:

- Inform North Coast congressional and legislative members and staff and key committee staff on the need for Lake Mendocino FIRO, its scope, and progress of implementation.

Objectives:

- Create a sense of urgency for timely development and implementation.
- Report progress to the congressional, legislative and allied stakeholders on a regular basis.

Stakeholder Group 4 – Media and informed interest groups, including water, flood control and sanitation agencies/districts with problems similar to Lake Mendocino or that would benefit from FIRO tools or processes, agriculture (wine grape growers), and environmental advocates.

Industry media and general media can bring attention to the project and educate policymakers and others about its benefits. Media are both looking for interesting stories and beset by continual deadlines and demands, so the Lake Mendocino FIRO project must be described in a way that is compelling – and succinct.

Other western reservoirs face challenges similar to Lake Mendocino, and these water/flood managers could benefit from the information gleaned from and the processes used for Lake Mendocino FIRO. Likewise, many California water, flood control and sanitation districts could benefit from improved forecasting tools implemented for the project. These agencies could become allies, if provided persuasive information about the project and its shared benefits.

Wine grape growers in the upper Russian River watershed could benefit from this project if it improved the reliability of Lake Mendocino and resulted in more reliable summer releases into the Russian River. People who are concerned about the health of Russian River fish and habitat would likely support the project if it preserved a cold water pool in the lake and resulted in more reliable summer releases.

Goals:

- Identify reservoirs with challenges similar to Lake Mendocino and inform relevant water supply and flood control agencies of Lake Mendocino FIRO, its scope and progress.
- Identify North Coast and Bay Area water resource agencies that could benefit from the information developed in support of Lake Mendocino FIRO, and inform them of the project, its scope and progress.
- Educate organizations concerned about the health of the Russian River and salmonid populations and upper Russian River farmers about Lake Mendocino FIRO, its scope and progress.

Objectives:

- Leverage stakeholders as providers of strategic direction and advocates for funding, public understanding, and public support.
- Report progress on a regular basis.

Table H.1 COMMUNICATION GOALS/OBJECTIVES & ASSIGNMENTS

Name	Title	Stakeholder Group	Communications	Vehicle	Comments
Arleen O'Donnell	ERG	1	SC Agenda	email	To be sent out 1 week prior to meetings
Arleen O'Donnell	ERG	1	SC Notes	email	To be distributed within 1 week of meetings
Jay Jasperse	SCWA	1	Co-Chair SC meetings	Conference call	Monthly
Marty Ralph	CW3E	1	Co-Chair SC meetings	Conference call	Monthly
Ann DuBay Marty Ralph	SCWA	1, 2, 3	Quarterly newsletter	email	Distributed to all WG members and elected. First one due 11/1/15.
Cary Talbot		1	Develop a platform for document exchange and editing	Web-based	All SC and WG members have access
Jay Jasperse, Marty Ralph		2, 3	Work Plan	Hard copy, web	Distribute to key agency and legislative staff, 8/1/15
Jay Jasperse, Marty Ralph	SCWA, CW3E	2	Signatory Letter signed by head of all agencies	Hard copy, web	10/1/16 Illustrates commitment to FIRO
Donna Boero	ERG	2,3,4	Distribution list	spreadsheet	Update as needed
Ann DuBay	SCWA	2,3,4	Fact sheets	Hard copy, web	Review & update semi-annually. Distribute to SC & WG
Ann DuBay	SCWA, CW3E	3	Meetings with North Coast reps, staff, committee staff	In person	Organize SC, WG members to attend meetings, with agency representation
SC	ERG	4	Meetings with water districts, reservoir operators	In person	ID similar scenarios; organize SC, WG members to attend meetings

COMMUNICATIONS VEHICLES

1.0.4 Communications Action Matrix for project milestones

Lake Mendocino FIRO project milestones for Years 1-3 include:

- Completion of Work Plan
- Completion of Viability Assessment
- Commitment Letter Signed by All Agencies
- Press Event Releasing Viability Assessment & Commitment Letter

A communications action matrix helps ensure that these milestone documents are completed on time, don't sit unopened on desks, reach the right people, and don't create confusion. The matrix includes the owner responsible for communications products and activities for each project milestone (the person who will shepherd the vehicle through the process); a list of key messages and benefits statements, with an assigned message "owner" as a central point of contact; and a process for vetting communications messages and products.

Table H.2 COMMUNICATIONS ACTION MATRIX FOR MILESTONES

Vehicle	Target	Description Purpose	Frequency	Owner	Distribution Vehicle	Comments
WORK PLAN	All Stakeholders	Provides justification for LM FIRO; project needs; and plan	One time release	Jay Jasperse, Marty Ralph	Email, web, hard copies with cover letter	Release on 8/1/15 with cover letter
WORK PLAN FACT SHEET	2, 3	Provides succinct explanation of LM FIRO and work plan with next steps	One time release	Arleen O'Donnell	Share draft with SC and WG for 1 round of comments via email. Share final draft with SC via email.	Release on 8/1/15 with Work Plan
QUARTERLY NEWSLETTER	All Stakeholders	Provides succinct, graphic update of progress, projects	Quarterly	Ann DuBay, Marty Ralph	Email	11/1/15
VIABILITY ASSESSMENT	All Stakeholders	Determines if LM FIRO is viable, and specific tasks/projects & budget needed to implement	One time release	Jay Jasperse, Marty Ralph	Email, web, hard copies with cover letter	Release on 10/1/16
MOU or MOA	All Stakeholders	MOU or MOA that signifies commitment of all agencies to LM FIRO	One time release	Mike Dillabough	Share draft with SC and WG. Share final draft with SC for distribu-tion to key agency staff for final edits.	Release on 1/1/16
PRESS EVENT	All stakeholders	Formal release of Viability Assessment. Purpose is to inform & educate.	One time event	Ann DuBay	Draft agenda with SC via phone. Share with WG via email.	10/1/16

Table H.3 PROJECT MEETINGS AND RESPONSIBILTY

Meeting	Description Purpose	Frequency	Owner	Internal/ External	Comments/ Participants
SC calls	Communication of project progress and deliverable status	Monthly	Arleen O'Donnell	Internal	Donna Boero will schedule
WG calls	Communication of project progress and status	Quarterly	Arleen O'Donnell	Internal	Donna Boero will schedule
SC face to face	Complete major components of VA; strategic decision making on budget; progress; timeline	Semi-annually	Arleen O'Donnell	Internal	Donna Boero will schedule. Most likely January, 2016.
WG workshop	Complete VA; Share information; develop next steps	Annually	Arleen O'Donnell	Internal	Need to determine convenient location; timing most likely August 2016
Electeds	Educate on LM FIRO; provide progress updates	Annually	Ann DuBay	External	SC & WG members will be included
Selected interested parties	Educate on LM FIRO; provide updates; discuss mutual interests	As needed	Ann DuBay	External	Will work with SC and WG to determine contacts and develop meeting schedule