TECHNICAL MEMORANDUM 7-12

Project Effects on Fish Facilities Associated with Daguerre Point Dam

Yuba River Development Project
FERC Project No. 2246

May 2013

TECHNICAL MEMORANDUM 7-12

EXECUTIVE SUMMARY

In 2012, Yuba County Water Agency performed an assessment of the potential effects of the Yuba River Development Project (Project) on the functionality and performance of fish facilities on the Yuba River near the United States Army Corps of Engineers' Daguerre Point Dam. These facilities include: 1) the fish ladders associated with the dam; 2) the Hallwood-Cordua Diversion and fish screen; 3) the South Yuba-Brophy Diversion and rock gabion fish exclusion barrier; and 4) the Browns Valley Irrigation District (BVID) Diversion and fish screen. These four facilities are collectively referred to as the "fish facilities" in this technical memorandum.

The goal of the study was to describe the fish facilities, the Project's Discretionary and Non-Discretionary flow contributions to flows at Daguerre Point Dam, and how those flows potentially affect the functionality and performance of the fish facilities. In addition, the study described the relative contribution of non-Project flows at Daguerre Point Dam, which, in combination with Project Discretionary and Non-Discretionary flows, provided context for the effects of Project flows on the operations of fish facilities at Daguerre Point Dam.

Daguerre Point Dam has two fish ladders, which normally operate year-round. However, these ladders do not operate when lower Yuba River flows exceed 10,000 cubic feet per second (cfs), because the ladders tend to fill up with sand and debris at these river flows. The other fish facilities are associated with agricultural diversions. They operate on a seasonal basis, with greatest diversions occurring from June through August, and some diversions occurring as early as April and as late as December. These facilities are located on the Yuba River near Daguerre Point Dam, with their intakes upstream of the dam.

Results from reviewing previous studies, stage-change relationships, and other existing information support the conclusion that Project Discretionary Releases do not affect Daguerre Point Dam fish facilities except in very rare instances when the Project makes Discretionary Releases to control encroachment into the New Bullards Bar Reservoir United States Army Corps of Engineers flood pool. In those rare instances, these Discretionary Releases are typically followed by much higher flows resulting from flood events. The Project's Non-Discretionary releases either positively support operation of the fish facilities by providing flows within the range of operations of the facilities, or mitigate high flood flows that would negatively affect operations of the fish facilities or damage the fish facilities.

This study was conducted in accordance with the Federal Energy Regulatory Commission-approved Study 7.12, *Project Effects on Fish Facilities Associated with Daguerre Point Dam*, with one variation. The Federal Energy Regulatory Commission-approved study plan provided that phase 1 of the study would be completed in September 2012. Yuba County Water Agency obtained pertinent phase 1 information that delayed completion of the study.

The study is complete.

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PROJECT EFFECTS ON FISH FACILITIES ASSOCIATED WITH DAGUERRE POINT DAM[1]

Yuba County Water Agency's (YCWA) continued operation and maintenance of the Yuba River Development Project, Federal Energy Regulatory Commission (FERC or Commission) Project Number 2246 (Project) affects flows in the Yuba River in the vicinity of the United States Army Corps of Engineer's (USACE) Daguerre Point Dam.[2]

1.0 Goals and Objectives

The goal of the study was to analyze how operation of the Project, including flow timing, magnitude, duration, and rate of change, potentially affects fish facilities (i.e., fish ladders and fish screens) in the vicinity of Daguerre Point Dam.

2.0 Methods

The study included two phases. Phase 1 was a desktop analysis supported by existing information, and included five steps. The purpose of phase 1 was to gather and summarize available information to determine if the Project has an adverse effect on the efficiency or operating periods of the fish facilities in the vicinity of Daguerre Point Dam. The purpose of phase 1 was not to perform an assessment of the efficiency of the fish facilities (e.g., Can the design be improved? Are the fish facilities operating properly?), but only to assess the effects of Project operations on the functioning of the existing facilities.

Phase 2 would be determined following review of phase 1 results with Relicensing Participants. Phase 2 would include field activities, which were not defined in the FERC-approved study, but could include water temperature profiling, hydraulic profiling, and bathymetric profiling.

2.1 Phase 1

Phase 1 of the study included four steps: 1) identify study area; 2) collect and review existing information; 3) analyze existing information; and 4) determine if phase 2 is warranted. The methods for each step are described below.

[1] This technical memorandum presents the results for Study 7.12, *Project Effects on Fish Facilities Associated with Daguerre Point Dam*. FERC required that YCWA develop a plan for this study in its September 30, 2011 Study Plan Determination, and FERC approved the study plan with modifications in its May 14, 2012 Study Determination. There were no modifications to Study 7.12 subsequent to FERC's May 14, 2012 Study Determination.

[2] Daguerre Point Dam, which is about 25 feet high and 575 feet wide, was constructed by the California Debris Commission in 1906 and rebuilt in 1964. The dam is owned by the United States, and is not part of the Project. When the California Debris Commission was decommissioned in 1986, administration of Daguerre Point Dam was passed to the USACE. The primary purpose of the dam when it was constructed was to stabilize the Yuba River channel after it was re-located.

2.1.1 Study Area

The study area was the Yuba River from the Project's Narrows 2 Powerhouse and bypass outlet downstream to Daguerre Point Dam, and included the following non-Project facilities:

- Daguerre Point Dam and associated fish ladders
- Hallwood-Cordua Diversion and fish screen
- South Yuba-Brophy Diversion and rock gabion fish exclusion barrier
- Browns Valley Irrigation District (BVID) Diversion and fish screen

These non-Project facilities are collectively referred to as the "fish facilities" in this technical memorandum.

2.1.2 Collection and Review of Existing Data

YCWA collected data from a number of sources. The Lower Yuba River Accord's (Yuba Accord) River Management Team assimilated a large amount of resources and references during the development of the Yuba Accord, and these resources and references provided a considerable amount of information. Individuals who participated in the development of the Yuba Accord were solicited for additional information, and other information was gathered from YCWA internal records. The United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (Cal Fish and Wildlife),[3] USACE and local irrigation districts also were solicited for information.

2.1.3 Analysis of Collected Data

The evaluation of Project effects on fish facilities associated with Daguerre Point Dam required several study components to be addressed. These components include the following and are addressed within this technical memorandum:

- Characterize and discuss critical anadromous salmonid life history periods and associated potential exposure to the fish ladders and fish screens
- Describe the Daguerre Point Dam fish ladder operations and provide an overview of design and design criteria
- Describe the Hallwood-Cordua Diversion fish screen operations and overview of design and design criteria
- Describe the South Yuba Brophy Diversion and Browns Valley Diversion fish exclusion facilities overviews and designs

[3] Formerly California Department of Fish and Game, or CDFG.

- Describe the operational relationships, minimum flow requirements, and diversion rates at Englebright Reservoir,[4] Narrows 1 and 2 powerhouses, Hallwood-Cordua Diversion, and Daguerre Point Dam
- Characterize the historical operations at Narrows 2 Powerhouse
- Establish a stage/discharge relationship from the existing Yuba Accord River Management Team data to describe how operations may influence the efficiency of the downstream fish facilities
- Assess the range and extent to which Project operations may affect the efficiency of downstream passage routes (e.g., spillway crest and fish ladders) at Daguerre Point Dam

Existing biological data and historical facility records were gathered as part of a review of the lower Yuba River facilities and temporal presence of different lifestages of anadromous salmonids. The review was focused on characterizing the design and operation of facilities and the presence of known anadromous salmonids by lifestage.

To characterize operations of the facilities, historical data were obtained from YCWA or online flow databases such as the California Data Exchange Center. These data provided either operational records that were summarized into tables and figures or previously analyzed data that were presented directly. These data records were previously reviewed for quality.

Stage change data was provided by Dr. Greg Pasternack, University of California at Davis. Dr. Pasternack deployed pressure transducers at Daguerre Point Dam from July 9, 2009 through June 24, 2010 as part of his hydraulic modeling of the Yuba River downstream of Englebright Dam. His data were plotted against historical flow data to display the water stage and discharge relationship.

2.1.4 Determine if Phase 2 Is Warranted

Upon completing all required phase 1 study components, YCWA will review the results of the phase 1 analysis with Relicensing Participants and determine if phase 2 is warranted. The review will identify any findings that could require additional research or were not adequately substantiated from existing data. The review will also investigate whether any findings suggest that operations are affecting the efficiency or operation of fish facilities. Based on this review, if YCWA and Relicensing Participants collaboratively agree that any additional investigation is required, the methods and scope of phase 2 will be collaboratively developed, and YCWA will file the collaboratively-developed study plan with FERC for consideration.

[4] Englebright Dam, which is about 260 feet high and forms Englebright Reservoir, was constructed by the California Debris Commission in 1941. The dam is owned by the United States. When the California Debris Commission was decommissioned in 1986, administration of Englebright Dam and Reservoir passed to the USACE. The primary purpose of the dam is to trap and contain sediment derived from extensive historic hydraulic mining operations in the Yuba River watershed. Englebright Reservoir is about 9 miles long with a surface area of 815 acres. Englebright Reservoir when first constructed had a gross storage capacity of 70,000 ac-ft; however, due to sediment capture, the gross storage capacity today is approximately 50,000 ac-ft (USGS 2003).

2.2 Phase 2

The FERC-approved study stipulated that if YCWA and Relicensing Participants collaboratively agreed that the Project has an adverse effect of the efficiency or operating periods of the fish facilities, as those facilities were designed, the study would move into phase 2. The purpose of phase 2 would be to investigate potential effects identified within phase 1. The FERC-approved study did not identify specific methods for phase 2, but stipulated the methods may include one or more of the following activities:

- Temperature profiles through the Daguerre Point Dam impoundment and upstream and downstream of the dam or the Hallwood-Cordua fish screen to identify thermal refugia and other temperature stratification that may affect adult and juvenile salmonid migrations
- Bathymetry profiles through the Daguerre Point Dam impoundment to identify thermal refugia and other temperature stratification that may affect adult and juvenile salmonid migrations
- Hydraulic profiles of the Daguerre Point Dam impoundment and upstream and downstream of the dam or the Hallwood-Cordua fish screen to describe velocity patterns

The FERC-approved study stated that, if needed, water temperature profiles would be collected by taking vertical measurements with a Hydrolab® or equivalent hardware, bathymetry measurements would be collected in a pre-established gridded pattern using a boat-mounted acoustic depth sounder, and hydraulic profiles would be collected along pre-established transects using an Acoustic Doppler Current Profiler. Standard methodologies would be used, but YCWA would consult with Relicensing Participants to determine the appropriate methods and locations, based on phase 1 results.

3.0 Results

3.1 Salmonid Periodicity and Exposure to Fish Ladders and Screens

Spring-run Chinook (*Oncorhynchus tshawytscha)*, fall-run Chinook and steelhead (*O. mykiss*) were historically and are currently present within the Yuba River downstream of Englebright Dam. Each run has a specific life history that requires unique conditions for optimal run success. Each species requires a pathway to immigrate to the ocean and to migrate back to spawning grounds. The critical periods of movement into and out of the river vary by species or run.[5]

A monthly summary of lifestages and run timing (USACE 2001) for each species or run shows that movement within the river occurs year-round (Table 3.1-1). The variation of migration and immigration run timing between fall- and spring-run Chinook salmon alone covers the entire 12-month calendar. In addition, steelhead rearing and emigration can occur throughout the year.

[5] Green sturgeon (*Acipenser medirostris*) is also present in the lower Yuba River below Englebright Dam, but assessing this species was not within the scope of the FERC-approved study.

Table 3.1-1. Chinook salmon and steelhead life history periodicities in the Yuba River downstream of Englebright Dam.

Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SPRING-RUN CHINOOK SALMON												
Adult Immigration & Holding												
Spawning												
Embryo Incubation												
Fry Rearing												
Juvenile Rearing												
Juvenile Downstream Movement												
Smolt (Yearling+) Emigration												
FALL-RUN CHINOOK SALMON												
Adult Immigration & Staging												
Spawning												
Embryo Incubation												
Fry Rearing												
Juvenile Rearing												
Juvenile Downstream Movement												
STEELHEAD												
Adult Immigration & Holding												
Spawning												
Embryo Incubation												
Fry Rearing												
Juvenile Rearing												
Juvenile Downstream Movement												
Smolt (Yearling+) Emigration												

Seasonally high flows occur from January through May and can result in spill events at Englebright Dam that can exceed 100,000 cubic feet per second (cfs). Adult salmonids commonly return from the ocean during this high flow period. The primary irrigation diversion season generally begins in May and extends through August. During this period, it is common for juvenile salmonids to be immigrating downstream to the ocean and potentially to be exposed to agricultural diversions, fish exclusion facilities, fish ladders, and passage over Daguerre Point Dam.

3.2 Fish Facilities Overview

The following section provides a description of the fish facilities. Figure 3.2-1 provides a timeline of significant events in the Yuba River downstream of Englebright Dam.

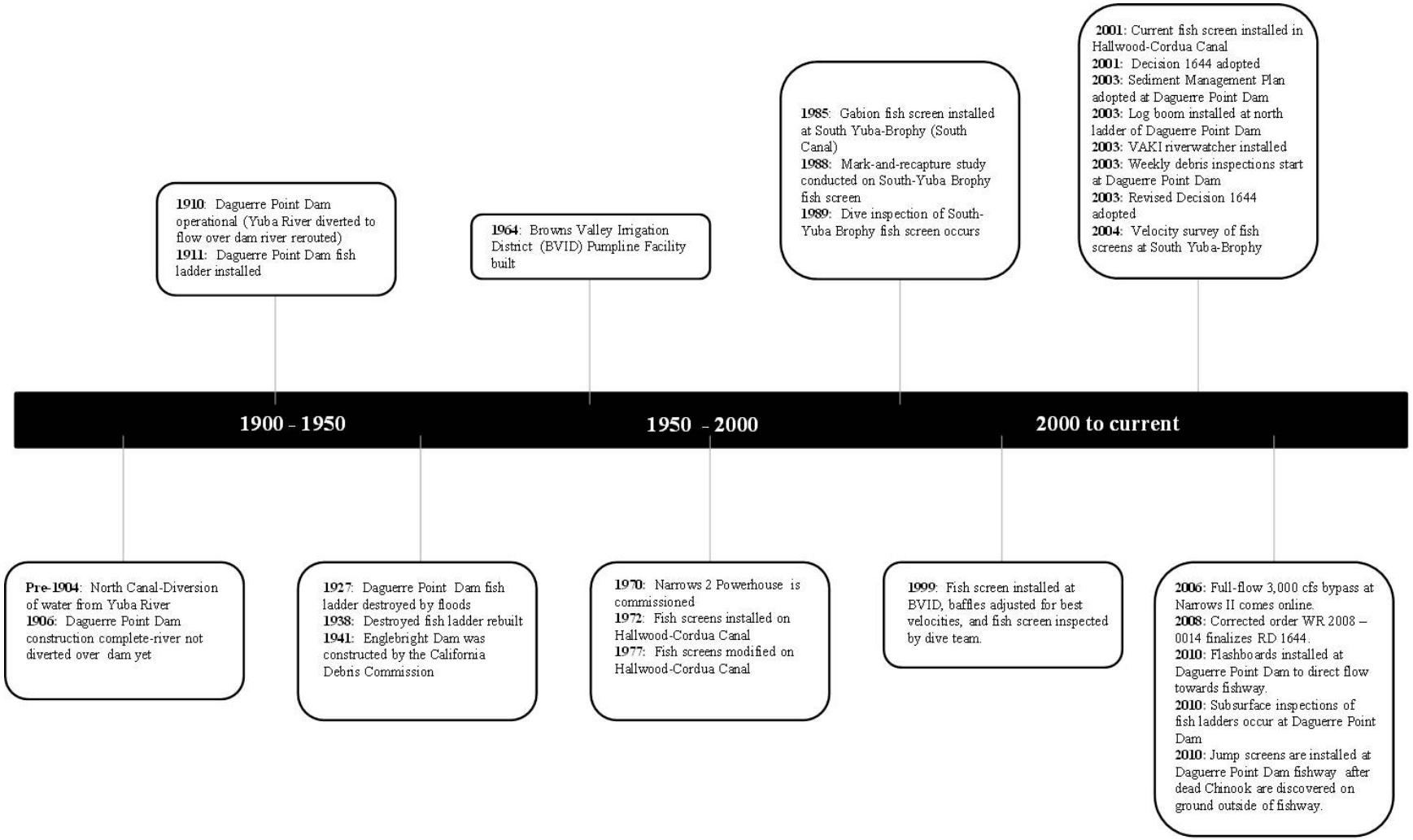
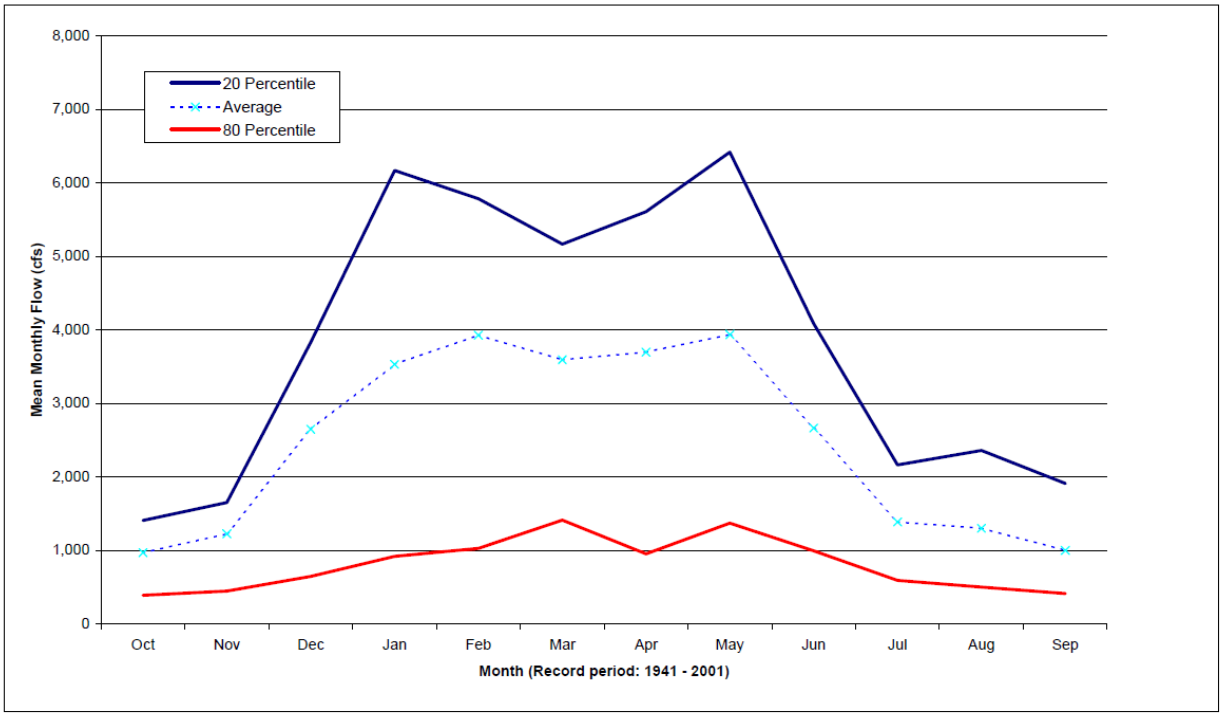


Figure 3.2-1. Timeline overview of significant events.

3.2.1 Overview of Flow and Diversion

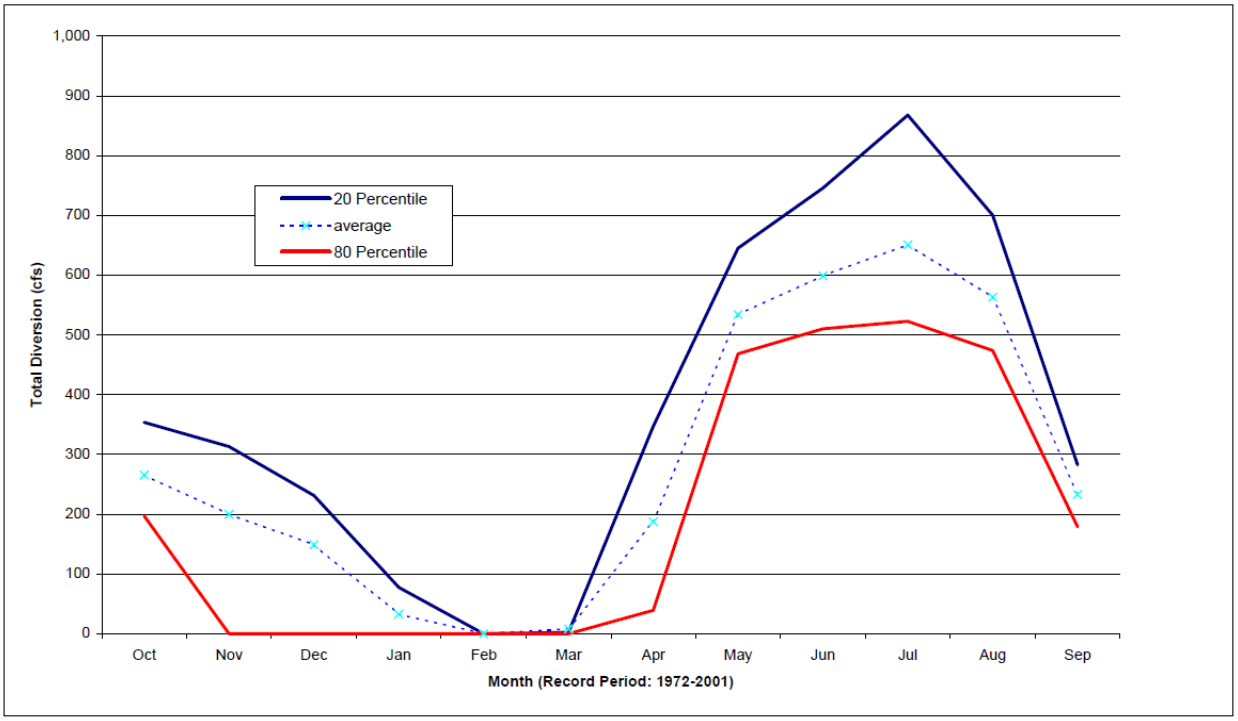
Flow in the Yuba River is either passed over Daguerre Point Dam or through its associated fish ladders, or is diverted by one of the three independently operated proximal agricultural diversion facilities. A study conducted by Entrix (2003) assessed several aspects of flow and diversion in the Yuba River near Daguerre Point Dam. Historical monthly flow data show that, for the period of 1941 to 2001, flows above Daguerre Point Dam were highest in January through May for both the 20 and 80 percentiles and the average monthly flows (Figure 3.2-2). (Note that these data do not account for accretion from tributaries, runoff or losses in the river reach from Englebright Dam to Daguerre Point Dam.) The average monthly flow exceeded 1,000 cfs from January through May approximately 80 percent of the time, and 5,000 cfs about 20 percent of the time.



Source: Entrix 2003

Figure 3.2-2. Average monthly flow of the Yuba River above Daguerre Point Dam from Water Year (WY) 1941 to WY 2001.

Entrix (2003) also presented an overview of the rates of diversion for the three diversions from 1971 to 2001 (Figure 3.2-3), and found that diversion amounts differed among the three facilities. The Hallwood-Cordua Canal diverted the largest monthly average, 12,314 acre-feet (ac-ft), and BVID diverted the smallest monthly average, 1,059 ac-ft. Diversions typically occurred from April through December with a peak diversion rate in July that averaged a total of approximately 650 cfs.



Source: Entrix 2003

Figure 3.2-3. Average monthly total diversion rate upstream of Daguerre Point Dam from WY 1971 through WY 2001.

3.2.2 Daguerre Point Dam and Associated Fish Ladders

The California Debris Commission began construction of the original Daguerre Point Dam in 1904 as part of the Yuba River Debris Control Project (USACE 2001). Dam construction was completed in May 1906, but the Yuba River did not flow over the dam until 1910, when the location of river channel was changed (USACE 2007). Figures 3.2-4 and 3.2-5 provide aerial views of Daguerre Point Dam and associated fish ladders.

Figure 3.2-4. Daguerre Point Dam and associated north and south fish ladders.

Figure 3.2-5. The Daguerre Point Dam north (on left) and south (on right) fish ladders.

The current configuration of Daguerre Point Dam is a reinforced, overflow concrete ogee ("s-shaped") spillway with concrete apron and concrete abutments. The ogee spillway section is 575 feet (ft) wide and 25 ft tall (USACE 1966, NMFS 2007 and 2012). Due to full sedimentation of the space behind the dam shortly after construction, the dam does not hold any storage and the dam has no low-level outlet or spill gates. Therefore, there are no operations for storage or flow at the dam.

Fish ladders were added to Daguerre Point Dam in 1911 to permit salmon and steelhead to travel upriver to the seasonal spawning areas. However, the first ladders were quickly destroyed by floods, and the ladders have been redesigned and rebuilt numerous times since then.[6]

Currently, the dam has two fish ladders that were constructed by USACE and Cal Fish and Wildlife. Each ladder has a control gate at the upstream exit of the ladder. The ladders are composed of a combination of 8 feet (ft) by 10 ft and 6 ft by 10 ft concrete bays on either side of the dam with 1 ft steps (USACE 1966). The ladders were designed for salmonid fish passage and are monitored with infrared VAKI® Riverwatcher scanners year-round. The ladders have a hydraulic capacity that is estimated to be 6 cfs per ladder (USACE 2001). However, according to USACE operators of the fish ladders, the capacity of each ladder actually is closer to 15 cfs to 25 cfs per ladder, depending upon the forebay water surface elevation.

USACE's Daguerre Point Dam Operations and Maintenance Manual requires that the fish ladders be physically closed when water elevations reach 130 ft at a local onsite staff gage, which corresponds to river flows of slightly less than 10,000 cfs (USACE 1966, SWRCB 2003). Once closed, the ladders are kept closed until the water elevation recedes to 127 ft, at which point USACE re-opens the ladders (USACE 1966, CALFED and YCWA 2005).[7] However, USACE is collaborating with resource agencies to improve salmonid fish passage and current operational practices, and to keep the ladders open at water elevations near 130 ft.

Management of the existing fish ladders is coordinated by several parties. Cal Fish and Wildlife has removed large woody material that may clog the ladders, and sometimes adjusts flashboards in the lowest bay to improve attraction flows. USACE operates the gates, and clears sediment at the tops of and exits from the fish ladders.

Anadromous salmonid passage at Daguerre Point Dam can occur year-round because, as demonstrated in Table 3.1-1, either adults are passing upstream or juveniles are passing downstream throughout the year. For example, adult spring-run Chinook salmon immigration and holding extends from April through September, adult fall-run Chinook salmon immigration occurs from July through December, and most juvenile Chinook salmon, including spring-run and fall-run Chinook salmon, emigration occurs from late-December through late-April.

Adult fish passage is potentially impaired when rain or snowmelt runoff produces high flow conditions at the dam, which may be during the same time periods that spring-run Chinook salmon and steelhead are attempting to migrate upstream to spawning areas in the Yuba River. The 2007 NMFS' Biological Opinion for Daguerre Point Dam (NMFS 2007) stated that when high flow conditions occur during winter and spring, adult spring-run Chinook salmon and steelhead can experience difficulty in finding the entrances to the ladders because of the relatively low amount of attraction flows exiting the fish ladders, compared to the magnitude of the sheet-flow spilling over the top of Daguerre Point Dam. In addition, NMFS's 2007 Biological Opinion (NMFS 2007) stated that the angles of the fish ladder entrance orifices and

[6] Fish ladders were reconstructed by the State of California after flood washouts in 1942, 1949, 1952, 1954 and 1964 (USACE 2005).

[7] All elevation data are in United States Department of Commerce, National Oceanic and Atmospheric Association, National Geodetic Survey Vertical Datum of 1983.

their proximities to the plunge pool increase the difficulty for fish to find the entrances to the ladders.[8]

In addition, flooding causes periodic obstruction of the ladders by large woody material and sediment deposition around the ladder entrances, exits and ladder bays.

The USACE has installed a log boom at the exit of the north ladder and implemented a sediment management program since 2003 to minimize obstructions to fish passage. Upstream passage at Daguerre Point Dam can potentially be adversely impacted when sediment builds up near the upstream exits of the fish ladders. When gravel builds up on the upstream side of the dam, it can impede flows into the ladders, thereby reducing the ability of fish to climb the ladders and reducing the attraction flows coming out at the base of the ladders. In addition, the gravel bars could potentially build up to the point where they could reduce access to the main channel for fish that have exited the ladders and are attempting to continue their upstream migration. Ongoing maintenance removes sediment from the forebay side of the fish ladders (USACE 2009).

The USACE (2001) stated that juvenile fish passage is impeded at Daguerre Point Dam. It identified four potential issues: 1) unsuitable habitat due to pool habitat created by the dam; 2) injury or disorientation to fish passing over the dam face; 3) potential injury or entrainment to fish at diversion canals; and 4) impeded passage at low river flows.

Low river flow conditions at Daguerre Point Dam were mentioned by the USACE as a possible issue for juvenile emigration over the dam. The USACE did not define what range of river flows were considered to be low flow conditions or the potential issues created by such low flows. Issues associated with low river flows could include longer migration times, increased water temperatures, and increased exposure to predators; however, most of these issues relate directly to the physical arrangement of facilities and the resulting habitat created by Daguerre Point Dam. The magnitudes of releases from Narrows 2 Powerhouse reaching Daguerre Point Dam are directly affected by available upstream storage and Yuba Accord minimum streamflow requirements, which are measured at the Smartsville Gage upstream and downstream of Daguerre Point Dam, and must be maintained regardless of agricultural diversion rates. In addition, these flows were designed to maintain optimum water temperatures in most years for key salmonid lifestages during the hotter seasons, so water temperatures due to Project operations would not be expected to affect the ability of salmonids to navigate the Daguerre Point Dam fish ladders.

Specific studies identifying the success of migration pathways over the dam or through the fish ladders were not identified. The passage of juvenile fish over Daguerre Point Dam was identified by USACE, CALFED Bay-Delta Program (CALFED) and YCWA (CALFED; YCWA 2005) to potentially disorient or injure fish, but the USACE discussed the shape of the dam as the primary factor affecting that possible issue.

[8] In addition to problems with adult salmonid passage, the ladders are not capable of passing the adult sturgeon (i.e., presumably green sturgeon) that occasionally migrate to the base of the dam (Cramer Fish Sciences 2011).

3.2.3 Hallwood-Cordua Diversion and Fish Screen

The Hallwood-Cordua Diversion, a gravity flow diversion facility located on the north bank of the Yuba River upstream of Daguerre Point Dam, has a diversion capacity of 625 cfs (SWRCB 2001). At the headworks of the diversion, gate valves allow water to flow into the intake channel. Water then flows a distance of approximately 1,500 ft to the fish screen facility. At the screen, water levels are manually controlled year round by board weirs. Minimum water levels are maintained to ensure conditions are adequate for any user to divert water when needed (SWRI et al. 2000). Although water elevations in these primary conveyances remain relatively constant, the flow rates through the conveyances may change with changes in agricultural demands.

In 2001, the modified original fish screen was replaced with a flat-plate stainless steel fish screen designed in collaboration with Cal Fish and Wildlife and NMFS that more closely conformed to Cal Fish and Wildlife's and NMFS' fish screening criteria (Figure 3.2-6). The screen is at the same location as the original screen and has a fish collection system, appropriate-sized openings and sweeping and approach velocities to facilitate direct return of screened fish back to the river below Daguerre Point Dam (NMFS 2007). Exact dimensions and design were not available to YCWA, but Cal Fish and Wildlife has inspected the screen, and NMFS annually inspects it, and, to date, has approved operation of the screen (Barton 2011). The diversion channel was also inspected and approved by both agencies for operation.

Figure 3.2-6. Hallwood-Cordua Diversion. Image on the left shows the control gate headworks on the north abutment of Daguerre Point Dam. Image on the right shows the current v-shaped screen.

The fish screen is operated during the entire diversion season (NMFS 2002).

High spill flow events over Daguerre Point Dam previously posed an issue for the diversion because there was overtopping into the diversion channel; however, now flow is controlled by both the headwork gates and flashboards that can be installed by Cordua Irrigation District during periods when overtopping may occur.

3.2.4 South Yuba-Brophy Diversion and Fish Exclusion Barrier

The South Yuba-Brophy Irrigation Diversion is located approximately 1,000 ft upstream of Daguerre Point Dam on the south side of the river. The diversion headworks consist of an intake channel and bypass channel, a porous 450-ft long rock gabion fish screen fitted with a fine-mesh barrier within the gabion (USACE 2001), a diversion pond, which is approximately 1-acre in size, and an irrigation canal (Figure 3.2-7). The 450-ft rock gabion is 30 ft wide at its base, narrowing to 10 ft wide at the top. Water flows from the river into the small side channel, where it either is diverted through the gabion or flows through the channel back into the river mainstem. Water entering the diversion pool percolates through the porous cobble-sized rock and flows through mesh. Water can be released from the diversion pond into the main irrigation canal through any of three 5-ft diameter pipes, which are located at the south end of the pond and are regulated by a gate at the head of each pipe. The pipes extend approximately 600 ft underground to the first pond in the Yuba Goldfields, part of the irrigation canal system.

Figure 3.2-7. The South Yuba-Brophy Diversion. The image on the left shows the general location of the diversion (center of picture) relative to Daguerre Point Dam. The image on the right shows an aerial view of the bypass channel, rock gabion, and diversion pool.

Fisheries agencies have questioned the effectiveness of the rock gabion at excluding fish (CDFG 1988). High predation rates within the channel and forebay were also identified as an issue (USFWS 1989). On other occasions, fishery biologists have captured juvenile salmonids that were entrained behind the gabion, having passed either through the gabion or over the top of the gabion during high flows (USFWS 1990, Demko and Cramer 1993). River flows exceeding 20,000 cfs are expected to result in the overtopping of the gabion (USFWS 1990).

3.2.5 Browns Valley Irrigation Diversion and Fish Screen

BVID maintains a screened diversion upstream of the other Daguerre Point Dam diversion facilities (USACE 2001). The facility is located on a small channel that runs parallel to the main channel and rejoins it after approximately 4,000 ft. The facility is composed of a fish screen, a diversion lagoon, and a pumping station. The diversion lagoon is approximately 250 ft long by 70 ft wide (Figure 3.2-8; BVID 2011, 2012). The facility is rated for diverting up to 65 cfs and

BVID may divert up to 9,500 ac-ft per year of water during the months of April to August. The fish screen was installed and became operational in April 1999.

Figure 3.2-8. Browns Valley Diversion. Image shows the screen and diversion forebay.

The screen is composed of fish screen frames and panels, six vertical approach-velocity control flow baffles, and a screen cleaning system (sweeper arm; BVID 2011, 2012). The fish screen frames consist of a 1/8-inch (in) thick stainless steel plate that occupies approximately the top section of the frame and a profile bar screen panel made of stainless steel wedge wire that measures about 81 in by 51 in and occupies approximately the bottom section of the frame. The fish screen panels have slotted openings approximately 1.75 millimeters wide. The openings in each screen panel comprise approximately 43 percent of each screen's surface. Ten fish screen frames slide into guide rails on the diversion-channel side of the fish screen structure and are held in place by gravity. The sweeper arm, consisting of two screen brushes, two brush trolleys mounted on a track system, and a motor to drive the trolleys, provides continuous cleaning.

On July 29, 1999, a crew of engineers from NMFS, United States Department of Interior, Bureau of Reclamation, and State Water Resources Control Board adjusted the fish screen baffles at the facility to achieve acceptable and relatively uniform approach velocities (BVID 2011). The team was able to set an acceptable and uniform approach velocity (approximately 0.33 feet per second [fps]) across the face of the entire set of fish screen panels.

The fish screen also meets NMFS' and Cal Fish and Wildlife's criteria for submerged screen area: the screen area must be at least equal to the quotient of the allowed maximum diversion rate associated with the screen (i.e., 65 cfs), divided by the allowed maximum approach velocity of the water entering the screen (i.e., 0.33 fps). The quotient in this case, 65 cfs divided by 0.33 fps, is 196.97 square feet. This is the minimum required submerged fish screen area. The ten fish screens, with the dimensions stated above, contain 286.9 square feet of area. The entirety of

each fish screen panel is submerged when flow in the Yuba River is at or above 500 cfs, the minimum flow required for BVID to make its maximum diversion of 65 cfs. The barrier on top of the screen protects the screen from overtopping at higher river flows.

In August of 1999, a NMFS dive team inspected the fish screen structure and reported to BVID that the structure was a "*fine structure that promises to provide fish protection for many years*" (BVID 2011).

3.3 Project's Effects on Flows Near Fish Facilities

3.3.1 The Yuba River Development Project

The Project began operating in spring 1970. The Project, which ranges in elevation from about 300 ft to 2,050 ft, consists of three power developments: New Colgate, New Bullards Minimum Flow, and Narrows 2. In total, the Project includes the following major facilities:

- 1 dam and associated storage reservoir – New Bullards Bar
- 2 diversion dams – Our House and Log Cabin
- 2 diversion tunnels – Lohman Ridge and Camptonville
- 2 underground power tunnels – New Colgate and Narrows 2
- 1 above ground penstock – New Colgate
- 3 powerhouses – New Colgate, New Bullards Minimum Flow and Narrows 2
- A Partial Flow Bypass and Full Flow Bypass at Narrows 2 Powerhouse

The Project does not include any other water conveyance facilities (i.e., canals, flumes, or ditches). The Project does not include any water conveyance systems or other facilities, features, or appurtenant structures that are used by YCWA or any other party solely for the purpose of providing consumptive water. The Project does not include the Englebright or Daguerre Point dams. The Project also does not include the Narrows 1 Powerhouse, which is located near Englebright Dam and is part of Pacific Gas and Electric's Narrows Project (FERC Project No. 1403).[9] The Project does not include the fish facilities.

3.3.2 Project Releases[10]

Project releases can be divided into three categories of releases:

- Non-Discretionary Releases. These are Project releases that are made routinely (i.e., as frequently as daily, but at least every few years) to comply with YCWA's FERC License and water right permits and licenses, USACE's *Regulation For Flood Control for New*

[9] The FERC License for PG&E's Narrows Project expires on January 31, 2023.

[10] The discussion in this section does not include very brief periods (i.e., order of minutes) when YCWA is required by FERC or the California Division of Safety of Dams to exercise Project valves. This usually occurs in the spring during high flows.

Bullards Bar Reservoir (i.e., Flood Control Manual), and other requirements, and releases that occur when inflows into Project facilities exceed the facilities' diversion or storage capacities (i.e., spills).

- Emergency Releases. These are Project releases that are made only in the case of emergencies (i.e., potential imminent loss of life or damage to Project facilities).
- Discretionary Releases. These are Project releases that are made for power generation, agricultural diversions at or near Daguerre Point Dam, supplemental instream flows for fisheries purposes (see Section 5.1.7 of the Accord Fisheries Agreement) and water transfers to other entities, and releases that are not specifically required by any regulatory requirements, but are made in anticipation of the need for an imminent Non-Discretionary release, such as releases made in anticipation of water storage in New Bullards Bar Reservoir entering the flood reservation space.

Table 3.3-1 lists each Project facility from which Project releases are made, and the facility's capacity for Non-Discretionary, Emergency and Discretionary releases.

Table 3.3-1. Yuba River Development Project facilities from which Project releases are made and types of releases made at each facility.

Project Facility	Facility	Control Valve/Gate	Estimated Maximum Capacity	Type of Release	Comment
MIDDLE YUBA RIVER					
Our House Diversion Dam[1]	Spillway	None	60,000 cfs	Non-Discretionary	Used to bypass flows in excess of the Lohman Ridge Diversion Tunnel and Our House Diversion Dam - Outlet Valve capacities.
	24-in. Diameter Low-Level Outlet	1 Manually-Operated Gate Valve	60 cfs	Non-Discretionary	Used to make minimum instream flow releases below Our House Diversion Dam.
	60-in. Auxiliary Low-Level Outlet	1 Manually-Operated Slide Gate	800 cfs	Emergency	Used to drain Our House Diversion Dam impoundment in emergencies or for some required maintenance.
Lohman Ridge Diversion Tunnel	12.5 ft by 12.5 ft Tunnel	1 Bulkhead Section Placed into the Upstream End of the Tunnel Using a Boom Truck from Off-Site	860 cfs	Emergency	The tunnel is closed, as required by the Project's Emergency Action Plan, if New Bullards Bar Dam is in imminent danger of overtopping.
OREGON CREEK					
Log Cabin Diversion Dam[1]	Spillway	None	12,000 cfs	Non-Discretionary	Used to bypass flows in excess of the Camptonville Diversion Tunnel and Log Cabin Diversion Dam Outlet Valve capacities.
	18-in. Diameter Low-Level Outlet	1 Manually-Operated Gate Valve	13 cfs	Non-Discretionary	Used to make minimum instream flow releases in Oregon Creek.
	60-in. Auxiliary Low-Level Outlet	1 Manually-Operated Slide Gate	800 cfs	Emergency	Used to drain Log Cabin Diversion Dam impoundment in emergencies or for some required maintenance.

Table 3.3-1. (continued)

Project Facility	Facility	Control Valve/Gate	Estimated Maximum Capacity	Type of Release	Comment
OREGON CREEK (continued)					
Camptonville Diversion Tunnel	14.5 ft by 14.5 ft Tunnel	1 Bulkhead Section Placed into the Upstream End of the Tunnel Using a Boom Truck from Off-Site	1,100 cfs	Emergency	The tunnel is closed, as required by the Project's Emergency Action Plan, if New Bullards Bar Dam is in imminent danger.
NORTH YUBA RIVER					
New Bullards Bar Dam	Spillway	3 Manually-Operated 30 ft by 54 ft Radial Gates	160,000 cfs[2] (at dam crest)	Non-Discretionary	Used to make flood control releases required by the USACE's Flood Control Manual and FERC-required Emergency Action Plan.
				Discretionary	When encroachment into the USACE flood pool is likely, given available forecast information and watershed conditions, anticipatory flood releases up to a maximum of 20,000 or 50,000 cfs (depending on the time of year) can be made for significant flood events.
				Emergency	Releases of greater than 50,000 cfs for dam safety.
	60-in. Low-Level Outlet	1 Locally-Operated Hollow Jet Valve	1,250 cfs[3]	Non-Discretionary	Used for short periods when New Colgate Powerhouse is not in operation and releases are necessary to provide water needed to meet required minimum flows downstream of Narrows 2 Powerhouse.
				Discretionary	When New Colgate Powerhouse is not in operation and minimum flow requirements below Narrows 2 Powerhouse are being met, additional flows may be released from this facility for irrigation water deliveries from the lower Yuba River, water transfers or power generation at Narrows 2 Powerhouse.
	New Bullards Bar Minimum Flow Powerhouse	1 Pelton Turbine	6 cfs	Non-Discretionary	Used to make required minimum instream flow releases.
New Colgate Powerhouse	New Colgate Powerhouse	2 Pelton Turbines/ No Powerhouse Bypass	3,400 cfs	Non-Discretionary	Used to provide water needed to make required minimum flow releases below Narrows 2 Powerhouse.
				Discretionary	Once required minimum flows are met, additional flows may be released from this facility for irrigation water deliveries from the lower Yuba River, water transfers, or power generation at New Colgate Powerhouse and Narrows 2 Powerhouse, or for New Bullards Bar Reservoir water storage management when the USACE Flood Control Manual is not controlling.

Table 3.3-1. (continued)

Project Facility	Facility	Control Valve/Gate	Estimated Maximum Capacity	Type of Release	Comment
YUBA RIVER DOWNSTREAM OF ENGLEBRIGHT DAM					
Narrows 2 Powerhouse	Narrows 2 Powerhouse	1 Francis Turbine Powerhouse	3,400 cfs	Non-Discretionary	Used in combination with PG&E's Narrows 1 Powerhouse to make required minimum flow releases.[4]
				Discretionary	Once required minimum flows are met, additional flows may be released from this facility for supplemental fisheries flows, irrigation water deliveries from the lower Yuba River, water transfers or power generation at Narrows 2 Powerhouse.
	Narrows 2 Powerhouse 36-in. Diameter Partial Bypass	1 Locally-Operated Valve	650 cfs	Non-Discretionary	Used in combination with PG&E's Narrows 1 Powerhouse (i.e., maximum capacity of 730 cfs) to make required minimum flow releases less than 900 cfs. The facility does not operate when either the Narrows 2 Powerhouse or Narrows 2 Full Bypass operates.
	Narrows 2 Powerhouse 78-in. Diameter Full Bypass	1 Locally-Operated Valve	3,000 cfs	Non-Discretionary	Used to supplement PG&E's Narrows 1 Powerhouse (i.e., maximum capacity of 730 cfs) to make required minimum flow releases. The facility does not operate when either the Narrows 2 Powerhouse or Narrows 2 Partial Bypass operates.
				Discretionary	Once minimum flows are met, additional flows may be released from this facility for irrigation water deliveries from the lower Yuba River or water transfers.

[1] Our House Diversion Dam and Log Cabin Diversion Dam impoundments have no appreciable storage.

[2] At dam crest.

[3] The designed maximum capacity of the outlet is 3,500 cfs, but actual maximum capacity is 1,250 cfs due to valve vibrations at higher release rates.

[4] The Yuba River Accord minimum flows, as measured at the USGS Smartsville Gage, range from 150 cfs to 2,000 cfs. The lowest end of this range occurs in June, July and August during years when Yuba Accord's Schedule 6 (i.e., critically dry year) is in effect, and if there are no additional flows because of the additional releases of 30,000 ac-ft of water that are associated with groundwater-substitution that is required in Schedule 6 years. (LYRA 2007

3.3.2.1 Non-Discretionary Releases

Table 3.3-1 shows that Non-Discretionary Releases can be made from all of the Project facilities listed in the table except for the Lohman Ridge and Camptonville diversion tunnels. Non-Discretionary Releases from Our House and Log Cabin diversion dams relate to passing flows in excess of those that can be used by the Project (i.e., can be many thousands of cfs during spring runoff), and providing minimum flows required by the FERC License (i.e., from 30 to 50 cfs, or natural inflow, below Our House Diversion Dam and from 8 to 12 cfs, or natural inflow, below Log Cabin Diversion Dam). Non-Discretionary Releases from New Bullards Bar Dam are made for flood control (i.e., when the reservoir enters the USACE's flood control space, and can be many thousands of cfs during spring runoff), and for providing the minimum flow required by the FERC license (i.e., 5 cfs). Non-Discretionary Releases from New Colgate and Narrows 2 powerhouses also are made to provide minimum flows in the lower Yuba River required by YCWA's FERC License and YCWA's water-right permits (i.e., from 150 to 2,000 cfs).

3.3.2.2 Emergency Releases

Emergency Releases can be made from any Project facility listed in Table 3.3-1. Emergency Releases can be at any flow level up to the capacity of the facility, and occur at any time.

3.3.2.3 Discretionary Releases

Table 3.3-1 shows that Discretionary Releases can be made from New Bullards Bar Dam and New Colgate Powerhouse, which are upstream of Englebright Dam; and from Narrows 2 Powerhouse, Narrows 2 Partial Bypass or Narrows 2 Full bypass, located downstream of Englebright Dam.

Discretionary Releases Upstream of Englebright Dam

Upstream of Englebright Dam, Discretionary Releases are made: 1) for supplemental fisheries flows, irrigation water deliveries, water transfers and power generation, which do not result in total releases of more than approximately 3,400 cfs; and 2) to mitigate anticipated flood flows.

The preferred approach for making Discretionary Releases for irrigation water deliveries and water transfers is through New Colgate Powerhouse because this water also generates power. If New Colgate Powerhouse is off-line, these Discretionary Releases can be made through the New Bullards Bar Dam 60-in. low-level outlet. However, this is rarely done: the outlet has been used just once for this purpose since 2000.

Discretionary Releases upstream of Englebright Dam are occasionally made from the New Bullards Bar Dam spillway to avoid encroachment into USACE's flood control pool in the reservoir (i.e., to mitigate anticipated flood event flows or to provide a buffer to the flood pool after evacuating flood space-stored water after a storm). These releases correspond with high flows in the Middle Yuba River and South Yuba Rivers and spills at Englebright Dam. Typically, these Discretionary Releases either immediately follow, or were followed by larger Non-Discretionary Releases from the New Bullards Bar Dam spillway due to encroachment into USACE's flood control pool, along with corresponding large spills at Englebright Dam. This has occurred in 21 of the last 43 years.

Figure 3.3-1 shows Discretionary Spillway Releases upstream of Englebright Dam from Calendar Year 1970 through 2012, flows below Englebright Dam, and the maximum daily flow below Englebright Dam for the year in which the Discretionary Release occurred.

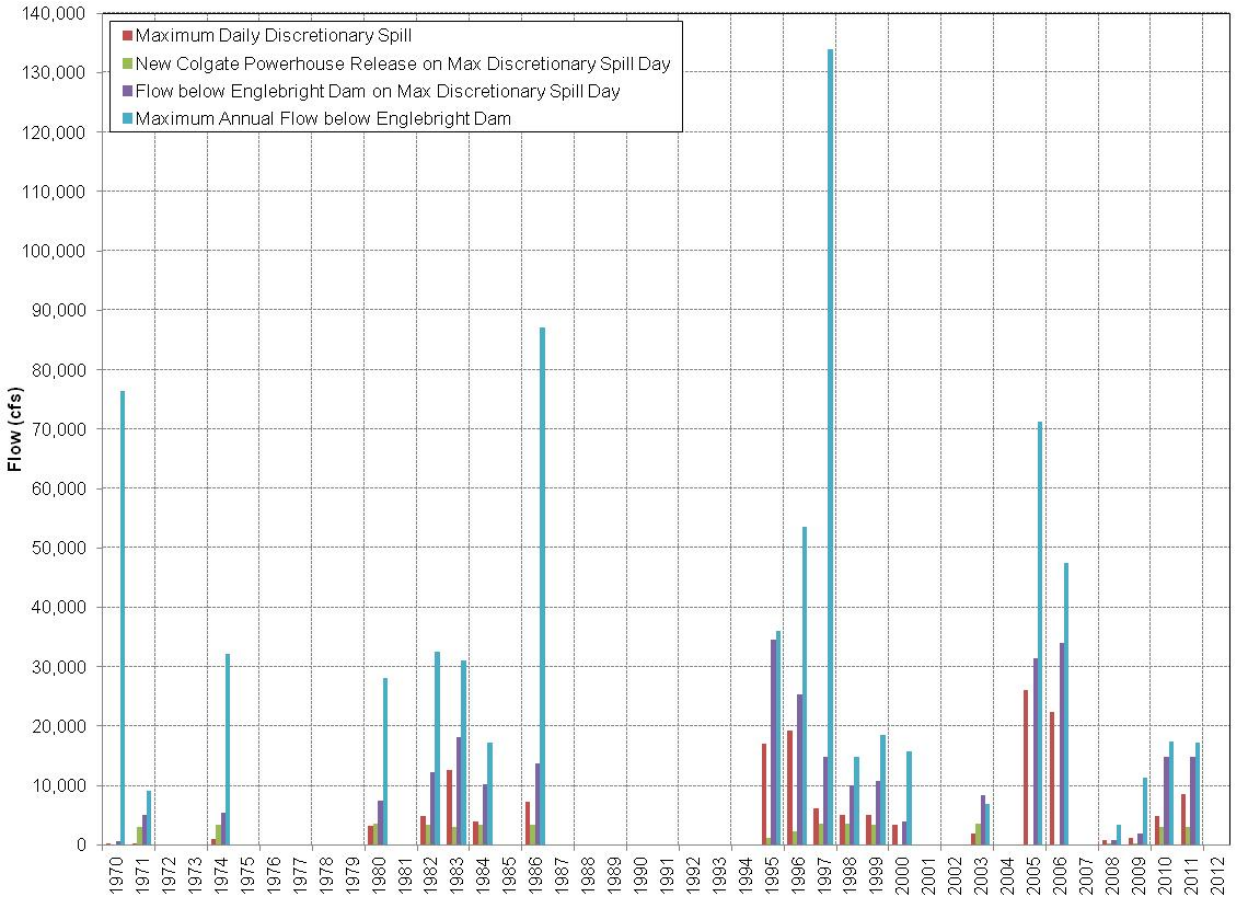


Figure 3.3-1. Historical Maximum Daily Discretionary New Bullards Bar Dam spillway releases and corresponding flows from New Colgate Powerhouse and Englebright Dam, plus maximum daily flow below Englebright Dam.

Figures 3.3-2, 3.3-3 and 3.3-4 show mean daily Discretionary Releases through New Bullards Bar Dam spillway and New Colgate Powerhouse, and total Non-Discretionary Releases from New Bullards Bar Dam spillway and New Colgate Powerhouse from 2006 through 2012. The figures also show the elevation of the New Bullards Bar Reservoir and flood control pool, and flow at United States Geological Survey Smartsville gage.

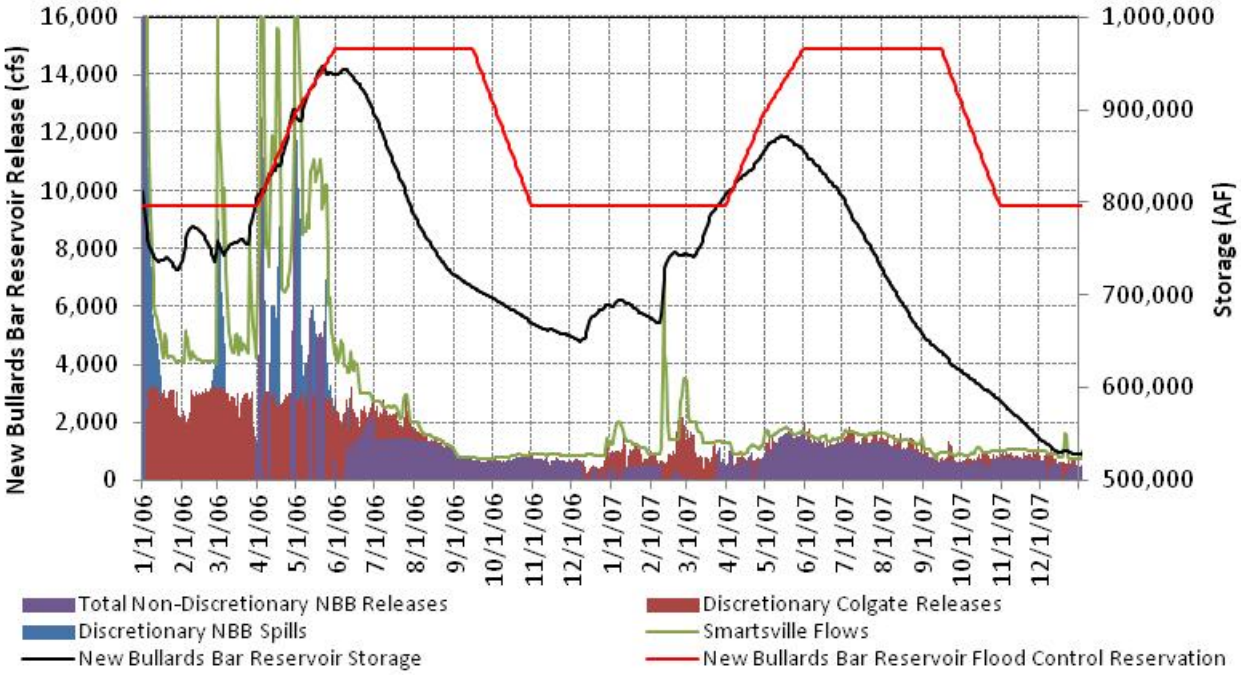


Figure 3.3-2. Historical Discretionary and Non-Discretionary releases from New Bullards Bar Dam – Calendar Years 2006 and 2007.

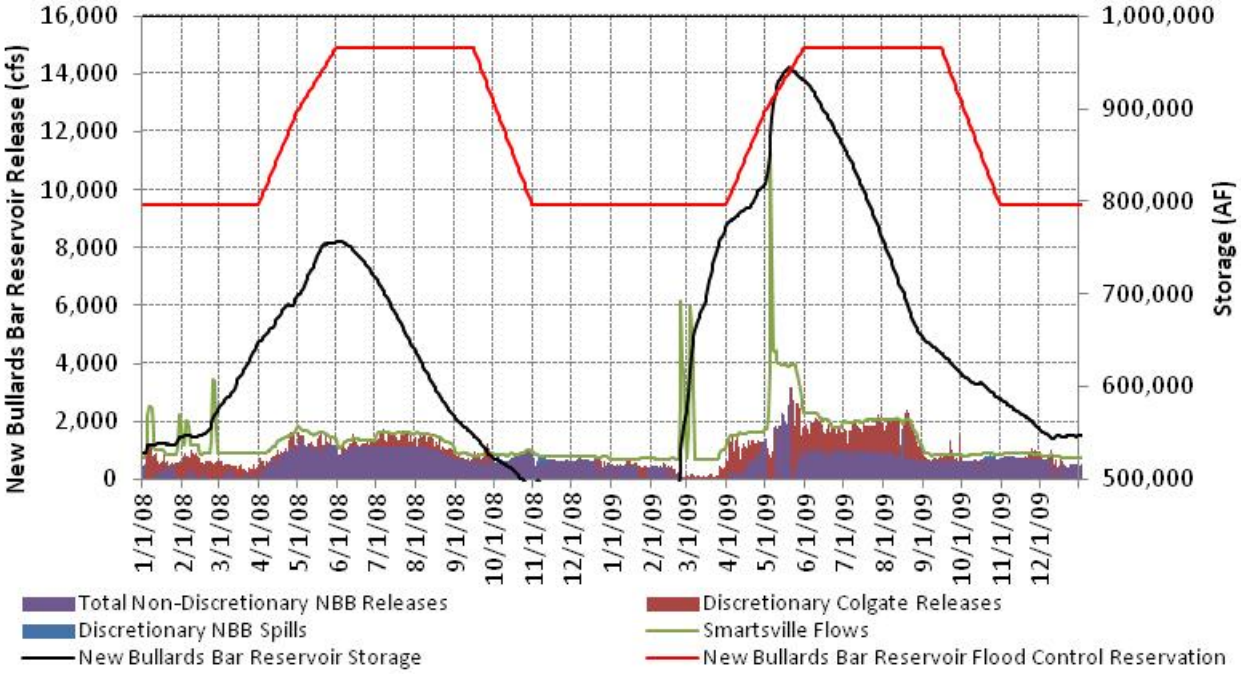


Figure 3.3-3. Historical Discretionary and Non-Discretionary releases from New Bullards Bar Reservoir – Calendar Years 2008 and 2009.

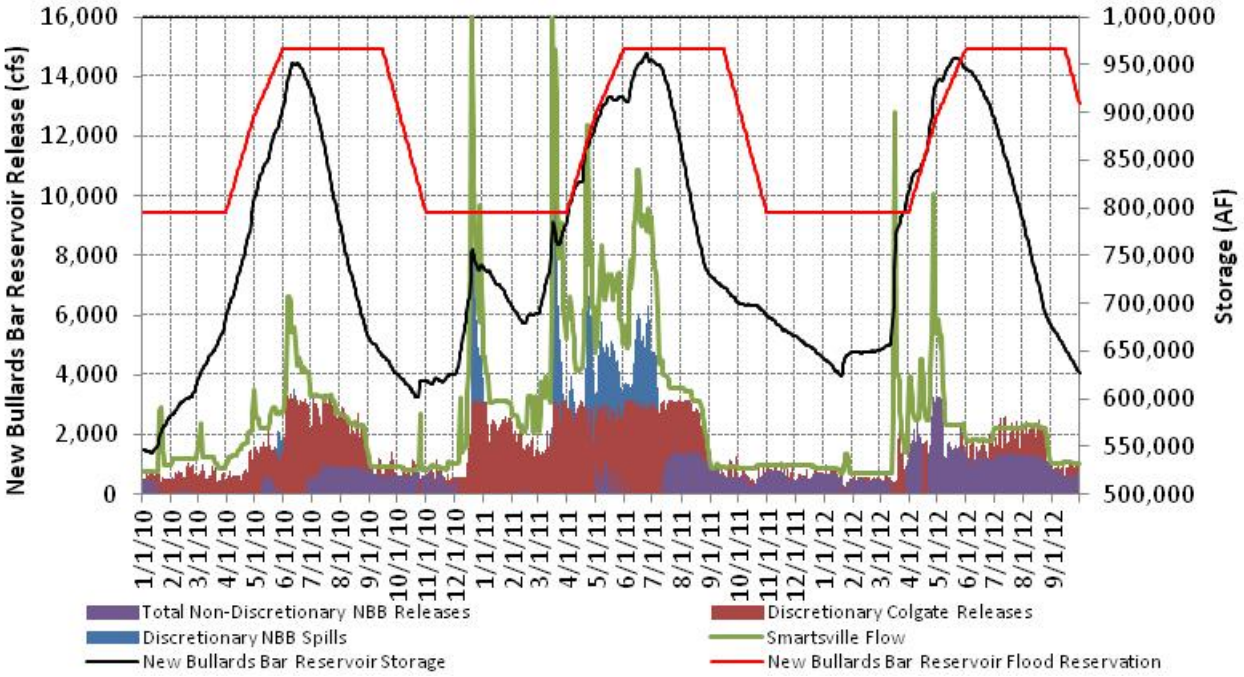


Figure 3.3-4. Historical Discretionary and Non-Discretionary releases from New Bullards Bar Reservoir – Calendar Years 2010 through 2012.

The above figures show that large Discretionary Releases from New Bullards Bar Reservoir are associated with New Bullards Bar Reservoir storage management during potential flood situations, and that non-discretionary spills typically either immediately precede, or immediately follow reservoir storage encroaching into the USACE flood reservation space, and are therefore normally relatively small compared to other flows within the system. Furthermore, without a Discretionary Release from New Bullards Bar Reservoir, a larger non-discretionary spill would otherwise occur a day or two later. These flood-control related Discretionary Releases usually occur on a rising hydrograph to reduce the magnitude and duration of anticipated flood flow, or on the declining limb of a hydrograph to reduce the severity of transition from flood flow to baseline flows. Importantly, these flood control-related releases occur during storm or high runoff conditions, often with rapidly changing or imperfect data on which to base decisions, and almost always occur in consultation with California Department of Water Resources and USACE flood control managers.

The above figures also show that these large Discretionary Releases related to flood pool management are rare. From 2006 through 2012, there have been a total of 28 days out of over 2,500 days with releases from New Bullards Bar Reservoir in excess of the New Colgate Powerhouse capacity of 3,400 cfs. The largest flood control-related Discretionary Release was 22,458 cfs on January 2, 2006, and occurred as part of Project release reduction after a flood event, which greatly exceeded the Discretionary Release. The second and third largest flood control-related Discretionary Releases were 15,996 cfs on January 3, 2006 and 11,167 cfs on January 4, 2006. Figure 3.3-5 shows the exceedance probability of Discretionary Releases from New Bullards Bar Reservoir.

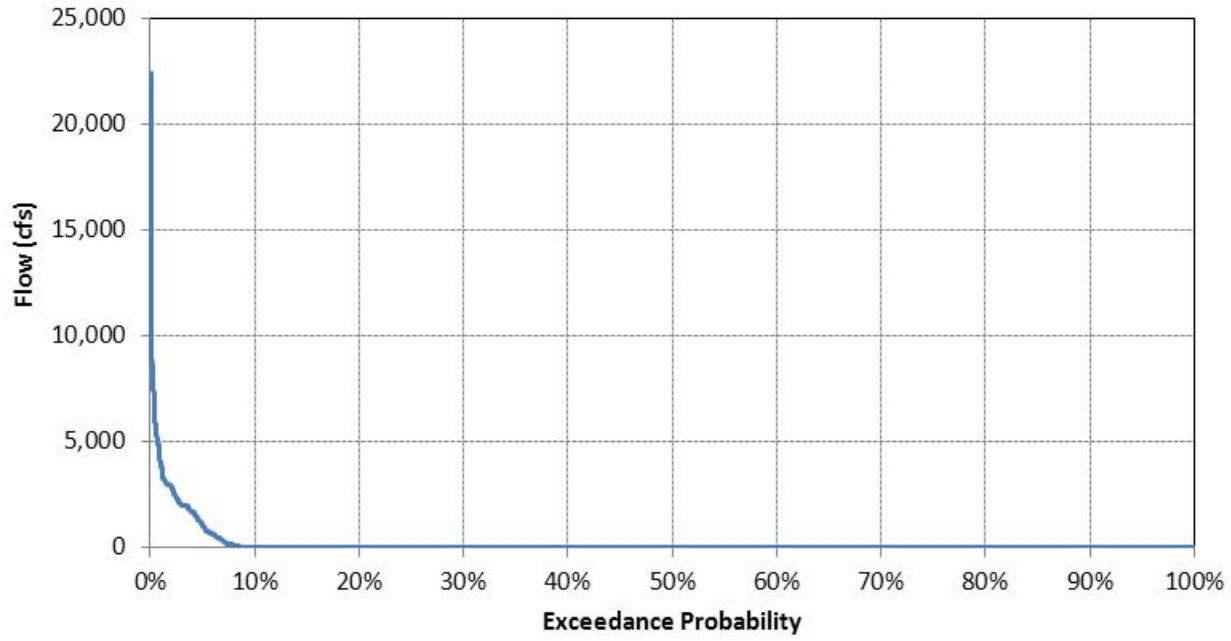


Figure 3.3-5. Exceedance Probability of Historical Mean Daily Discretionary Spills from New Bullards Bar Reservoir.

Discretionary Releases Downstream of Englebright Dam

Project Discretionary Releases downstream of Englebright Dam are made through the Narrows 2 Powerhouse, the Narrows 2 Partial Bypass, and the Narrows 2 Powerhouse Full Bypass. The combined maximum Discretionary Release from these Project facilities is 3,400 cfs, the maximum capacity of the facilities, minus the minimum flow releases, which range from 150 cfs to 2,000 cfs, depending on month and Water Year type.

In addition, any upstream Project Discretionary Release in excess of 3,400 cfs either passes through PG&E's Narrows 1 Powerhouse (maximum capacity of 730 cfs) or spills over Englebright Dam.

3.3.3 Project Effects on Flows at Daguerre Point Dam

Flows in the vicinity of Daguerre Point Dam are determined by the total of releases at Narrows 1 and 2 powerhouses, spills at Englebright Dam, and river inflows and accretions downstream of Englebright Dam, minus the total of the BVID, Hallwood-Cordua and South Yuba-Brophy diversions and net percolation from the river.

The flows passing over Daguerre Point Dam range from the Yuba Accord minimum instream flow requirements (i.e., 150 to 2,000 cfs depending on month and WY type) to storm flood flows (i.e., up to about 150,000 cfs in 1997, which is the highest flow of record). Flows below Daguerre Point Dam are well represented by flows at the United States Geological Survey

Marysville streamflow gage (USGS gage 11421000). During normal (i.e., non-flood management, and with moderate tributary flows from Dry Creek and Deer Creek) flow periods, flows at the Marysville gages are generally within 1,000 cfs less than those at the Smartsville gage, depending on the quantity of agricultural diversions. During flood management periods, flows at the Marysville gage are typically higher, occasionally by more than 5,000 cfs, than those at the Smartsville gage, due to inflows and accretions to the Yuba River below Englebright Dam. Most gains and losses to the Yuba River below Englebright Dam during both flood and non-flood periods occur upstream of Daguerre Point Dam, from Dry Creek and Deer Creek.

3.4 Project Effects on Fish Facilities

The goal of the study was to address whether the operations of the Project have effects on capabilities of the diversions and associated fish facilities at or around Daguerre Point Dam to operate within their design capacities. The following section reviews each facility and addresses Project effects within the capability of the facility. This technical memorandum does not constitute any opinion or stance on the efficiency of existing design, operation, or performance of any diversion and fish exclusion device. This memorandum only provides a review of existing information and discusses whether operation of the Project would potentially positively or negatively influence the efficiency and performance of each facility. Table 3.4-1 summarizes some key information regarding each facility.

Table 3.4-1. Overview of the fish facility, operational characteristics and summary findings in regards to Daguerre Point Dam fish facilities.

Fish Facility	Operator	Constructed	Typical Period of Operations	Capacity	Operational Flow Range	Comments
Daguerre Point Dam Fish Ladders	USACE and Cal Fish and Wildlife	Ladders originally constructed in 1911 and replaced/modified numerous times, with most recent modification in 2003.	Year-round	15 – 25cfs through each ladder	Closed when flows exceed 10,000 cfs	--
Hallwood-Cordua Diversion Fish Screen	Cordua Irrigation District	Updated in 2001	Year-round	625 cfs	Headwork gates and flashboards permit operations at very high flows.	Annually inspected by NMFS and Cal Fish and Wildlife
South Yuba-Brophy Diversion Fish Exclusion Barrier	YCWA (Non-Project)	1985	Year-round	Unknown	River flows over 20,000 cfs may overtop gabion	--
Browns Valley Irrigation Diversion Fish Screen	Browns Valley Irrigation District	Original facility replaced in 1999	April - August	65 cfs	Can divert maximum . capacity when river flows exceed 500 cfs	--

3.4.1 Daguerre Point Dam and Fish Ladders

Daguerre Point Dam and the associated fish ladders have a long history. Flooding and sediment accumulation were persistent problems, and Daguerre Point Dam was part of an attempt to achieve a long-term solution to these problems. Flood flows at the dam were extreme at times

and resulted in numerous iterations of fish ladders being reinstalled, repaired, or modified due to damage. The current facilities have several existing management practices that were developed over time and that include annual sediment removal maintenance at the dam, seasonally installing flashboards to better direct flow at the fish ladders, and limiting operation of the fish ladders when river flows are above 10,000 cfs.

Existing concerns regarding operations and facilities at Daguerre Point Dam include the ability of salmon to find the fish ladders, which are located near the shorelines of the river downstream of Daguerre Point Dam, the ability to operate the ladders at high river flows (i.e., exceeding 10,000 cfs), and the effectiveness of passing juvenile migrants downstream without injury or excessive exposure to predators. Studies, biological opinions, legal proceedings and other reports have contained ideas ranging from modifications of the fish ladders to removal of the entire dam.

Although some of these studies have offered some detail into how the structural design of the dam or the operations of the fish ladders may affect fish passage or survival, none of the studies provided any evidence that specific operations within the capacity of Narrows 2 Powerhouse would provide a substantial benefit to fish passage or survival at Daguerre Point Dam. Releases from the Project are not excessive for upstream passage, as fish ladders become inoperable beyond 10,000 cfs, which is almost three times the Narrows 2 Powerhouse capacity of 3,400 cfs. Operating the Narrows 2 Powerhouse over its entire operational range results in only 2.94 ft of stage change at Daguerre Point Dam. Alterations to the rate of flow (i.e., ramping) at the powerhouse are guided by strict criteria that do not reduce stage by more than 0.21 ft an hour in extreme cases and usually by much less. Minimum flow requirements were thoroughly reviewed as part of the recent proceedings that led to the SWRCB's Decision 1644 and the current flow requirements in the lower Yuba River and based on the Lower Yuba River Accord. These updated flow requirements almost always are higher than the corresponding FERC minimum flow schedule requirements established in 1966. Finally, the potential for predators of juvenile salmonids to be present (potentially at high densities) above or below Daguerre Point Dam is not influenced by operational releases at the Narrows 2 Powerhouse, but rather by the hydraulic control and downstream pool created by the dam.

Overall, the findings from existing data indicate that Project operations (i.e., normal Discretionary Releases) do not affect the Daguerre Point Dam fish ladders operations within their design capability. Project Discretionary Releases have on very rare occasions exceeded 10,000 cfs (for New Bullards Bar flood pool control), and the USACE shuts down the ladders when river flows exceed this rate, but these instances were preceded or followed by river flows well in excess of 10,000 cfs, which are outside of the discretion of the Project and required the USACE to shut down the ladders anyway.

3.4.2 Hallwood-Cordua Diversion and Fish Screen

The Hallwood-Cordua facility at Daguerre Point Dam is a diversion facility composed of control headgates, a diversion channel, and screen facility that were modified several times to improve fish exclusion efficiency. The layout of the diversion begins with headgates that are integrated into the abutment of Daguerre Point Dam. The headgates control flow into the diversion channel

and buffer oncoming upstream releases. This buffer helps to limit changes from upstream release that may affect the timing, rate of change or duration of flows in the river. Water continues through the diversion channel and flows through a v-shaped screen, where water flows are controlled by board weirs. The board weirs adjust the rate of water passing through the screen and into the canal. Fish reaching the screen are diverted into a collection facility and then conveyed back into the lower Yuba River.

In the past, the diversion screen was operated only partially through the year and then removed. In some years the screen was not operated at all. The removal of the screen for part or all of the year resulted in migrating fish being entrained - especially steelhead, which can emigrate throughout the year. In addition, predators moved in from the diversion canal and fed on entrained fish. The facility modification from the removable screen to a newer permanent flat-plate design and the consistent year-round operation of the screen dramatically reduced the potential for entrainment and predation. The most recent flat-plate screen still does not entirely confirm with every Cal Fish and Wildlife and NMFS requirement, but has been inspected numerous times by the agencies. These inspections have resulted in general approval to operate the diversion and the screen.

Even with the screen present, spills from Englebright Dam historically have led to river flows that overtopped the diversion gates and sent fish into the diversion channel resulting in fish entrainment and mortality. Now flashboards are installed near the headgates during Englebright Dam spill events to redirect very high river flows and prevent overtopping of the diversion gates. Also, the river flows during overtopping events were caused by spills at Englebright Dam that greatly exceeded the Discretionary Release capacity of the Project.

The history of modifications associated with the Hallwood-Cordua Diversion is extensive. These updates were all found to be specifically associated with the design and operation of the diversion, unrelated to the operation of the Project. Revisions to the diversion and its operation over time have resulted in the facility appearing to be in a functional state throughout the Discretionary Release capacity of the Project based on existing information.

Overall, the findings from existing data indicate that Project operations do not influence the efficiency or function of this diversion or fish screen.

3.4.3 South Yuba-Brophy Diversion and Fish Exclusion Barrier

The South Yuba-Brophy Diversion facility utilizes a non-traditional fish exclusion barrier that is located on a manmade oxbow upstream of the Daguerre Point Dam. The rock gabion fish barrier has been repeatedly investigated by researchers and agencies to attempt to determine its effectiveness. The interstitial spaces within the barrier are reported to be tight and its initial construction in 1985 included a fabric barrier within the wall to further reduce interstitial spaces between rocks. The current condition of the fabric barrier is unconfirmed.

Results from biological and physical investigations have returned mixed results regarding the effectiveness of the rock gabion. Velocity studies showed that flow across the barrier is not uniform, but irregular. Laminar flows provide the best function for passing fish downstream.

Fish passage studies found that moderate proportions of experimentally released fish were not recovered by downstream nets at the diversion return to the lower Yuba River. Also, spills from Englebright Dam exceeding 20,000 cfs caused river flows that overtopped the barrier and carried fish into the diversion forebay. Fish conveyed into the diversion forebay are directly exposed to the culverts that convey water from the forebay into the Brophy-South Yuba Canal. Studies indicated that few fish were present in the diversion pool when overtopping spills had not occurred.

The study findings indicate that the South Yuba-Brophy Diversion does exclude fish, but may have areas requiring improvement that are not related to Project operations. The irregular flows at the exclusion barrier and potentially low sweeping flows are caused by the gabion's rock composition and the bypass channel configuration. River flows that are sufficiently large to overtop the barrier are infrequent and are more than five times greater than the normal Discretionary Releases of the Project. Overall, the evidence does not suggest that the Project operations affect the performance of this barrier.

3.4.4 Browns Valley Diversion and Fish Screen

The Browns Valley Diversion and associated fish screen is a modern facility that is well-designed and appears not to be significantly affected by the operations of the Narrows 2 Powerhouse. The facility was replaced in 1999 with an updated design that is compliant with Cal Fish and Wildlife and NMFS screening requirements. The facility was inspected and approved by a NMFS dive team in August 1999. To meet these requirements, the facility was designed to meet specific approach and sweeping velocities, and address overtopping and other potential issues based on historical operational data. For instance, the screens are fully wetted at flow greater than 500 cfs within the lower Yuba River. Review of the Smartsville gage showed that from January 2000 to September 2012, the lowest mean daily flow on record was 554 cfs. In addition, the facility is built with a large gabion flow barrier above the screen to protect against overtopping at high flows. Review of existing data and information did not identify any known issues for the facility or suggest that additional improvements were needed.

Given the modern screen design, Cal Fish and Wildlife and NMFS approval of the diversion, and the absence of reports identifying any known issues, it does not appear that Project operations affect the performance of this screen.

4.0 Discussion

Results from reviewing previous studies, stage-change relationships, and other existing information support the conclusion that Project Discretionary Releases do not affect the performance of Daguerre Point Dam fish facilities except in the very rare instances when the Project makes Discretionary Releases to manage encroachment into the New Bullards Bar Reservoir USACE flood pool. In those rare instances, these Discretionary Releases are typically immediately preceding or followed by much higher river flows resulting from flood events. The Project's Non-Discretionary Releases either positively support operation of the fish facilities by

providing flows within the range of operations of the facilities, or mitigate high flood flows that would negatively affect operations of the facilities or damage the fish facilities.

5.0 Study-Specific Consultation

The FERC-approved study included two study-specific consultations, each of which is described below.

5.1 Consult to Obtain Specific Information Regarding Design and Criteria for Fish Screens

The FERC-approved study states:

> YCWA will consult with NMFS, CDFG, USACE, Hallwood Irrigation District and Cordua Irrigation District to obtain specific information, including design criteria, for the fish facilities (Phase 1, Step 1).

YCWA contacted all listed groups through e-mail to solicit information they wished to offer and included specific areas of interest. Cal Fish and Wildlife replied with three resources, which were reviewed and integrated into the technical memorandum. No other responses were received.

5.2 Consult with Relicensing Participants to Determine if Phase 2 Is Needed

The FERC-approved study states:

> YCWA will review the results of the phase 1 analysis with Relicensing Participants and determine if phase 2 is warranted (i.e., if phase 1 indicates that the Project has an adverse effect of the efficiency of the fish facilities as designed). If YCWA and Relicensing Participants collaboratively agree that phase 2 is not warranted, YCWA will move to step 5 of phase 1. If YCWA and Relicensing Participants collaboratively agree that phase 2 is warranted, YCWA will move to phase 2. (Phase 1, Step 4).
>
> YCWA will consult with Relicensing Participants to determine the appropriate methods and locations for phase 2, based on phase 1 results (Phase 2).

YCWA scheduled meetings with Relicensing Participants on March 11 and May 13, 2013 to review the results of Phase 1 and discuss the need for additional data collection. While some agencies expressed a desire to gather additional information regarding the efficiency of the various fish facilities, no specific additional data gathering specific to the study was proposed.

6.0 Variances from FERC-Approved Study

This study was conducted in accordance with the FERC-approved Study 7.12, *Project Effects on Fish Facilities Associated with Daguerre Point Dam*, with one exception. The FERC-approved study plan identified that phase 1 of the study would be completed in September 2012. YCWA obtained pertinent phase 1 information and consulted with Relicensing Participants, which delayed issuance of the final technical memorandum.

7.0 Attachments to this Technical Memorandum

None.

8.0 References Cited

Barton, J. 2011. Letter to David Zezulak, CDFG. August 19, 2011. 8 pgs.

Browns Valley Irrigation District (BVID). 2011. Letter from Walter Cotter, General Manager, to Chad Dibble, California Department of Fish and Game. September 1, 2011.

_____. 2012. John L. Nelson/BVID Fish Screen Project. Available online: <http://www.bvid.org/proj_fsp.html>. Accessed September 1, 2012.

CALFED Bay-Delta Program (CALFED) and Yuba County Water Agency (YCWA). 2005. Draft Implementation Plan for Lower Yuba River Anadromous Fish Habitat Restoration. Multi-Agency Plan to Direct Near-Term Implementation of Prioritized Restoration and Enhancement Actions and Studies to Achieve Long-Term Ecosystem and Watershed Management Goals. Prepared by Lower Yuba River Fisheries Technical Working Group. October 2005.

California Data Exchange Center (CDEC). 2012. Marysville Flow Data. Available online: <http://www.cdec.water.ca.gov/>. Accessed September 4, 2012.

California Department of Fish and Game (CDFG). 1988. Memorandum from Deborah Konoff, Fishery Biologist, Department of Fish and Game to Fred Meyer, Department of Fish and Game regarding the South-Yuba Brophy Study. November 18, 1988.

_____. 1991. Lower Yuba River Fisheries Management Plan. Final Report. Stream Evaluation Report Number 91-1. February 1991.

_____. 2004. Memorandum from G. Heise, Fisheries Engineering, Native Anadromous Fish and Watershed Branch (NAFWB) to B. Curtis, Regional Manager, Sacramento Valley – Central Sierra Region Regarding Water Velocity Measurements at Gravel Dike, South Yuba Brophy Diversion, Yuba River. October 21, 2004.

Cramer Fish Sciences. 2011. Memo: Green Sturgeon Observations at Daguerre Point Dam, Yuba River, California. June 7, 2011. 6 pgs.

Demko, D. B. and S. P. Cramer. 1993. Evaluation of Juvenile Chinook Entrainment at the South Yuba-Brothy Diversion Headworks. Final Report. Prepared by S.P. Cramer & Associates, Inc. Prepared for South Yuba-Brothy and Yuba County Water Agency.

Entrix. 2003. Daguerre Point Dam Fish Passage Improvement Project 2002 Fisheries Studies: Analysis of Potential Benefits to Salmon and Steelhead from Improved Fish Passage at Daguerre Point Dam. Prepared for the California Department of Water Resources. 78 pgs.

Hunerlach, M. P., C. N. Alpers, M. Marvin-DiPasquale, H. E. Taylor, and J. F. De Wild. 2004. Geochemistry of Mercury and Other Trace Elements in Fluvial Tailings Upstream of Daguerre Point Dam, Yuba River, California. August 2001. U.S. Geological Survey Scientific Investigations Report 2004-5165.

Lower Yuba River Accord (LYRA). 2007. Environmental Impact Report/Environmental Impact Statement for the Lower Yuba River Accord. Available online: <http://www.yubaaccordrmt.com/Yuba%20Accord%20Documents/Forms/AllItems.aspx RootFolder=%2fYuba%20Accord%20Documents%2fDraft%20EIR%2dEIS%20for%20the%20Proposed%20Lower%20Yuba%20River%20Accord&FolderCTID=&View=%7B86CA5B0%2d7D95%2d45E5%2dA951%2d795AB3A3A8AF%7d>

Pasternack, G. 2012. Personal Communication. Email from Greg Pasternack to Michael Barclay, Senior Fisheries Scientist, HDR, Inc. May 16, 2012.

South Yuba-Brophy Irrigation District. 2002. Proposed Physical Modification of the Area in Front of the Gabion Fish Barrier and Downstream. 6 pgs.

State Water Resource Control Board (SWRCB). 2001. Decision Regarding Protection of Fishery Resources and Other Issues Relating to Diversion and Use of Water from the Lower Yuba River.

_____. 2003. Revised Water Right Decision 1644 in the Matter of Fishery Resources and Water Right Issues of the Lower Yuba River.

_____. 2008. Corrected Order WR 2008 – 0014 in the Matter of Yuba County Water Agency's Petition to Modify Revised Water Right Decision 1644 related to Water Right Permits 15026, 15027, and 15030 and Petition for Long-Term Transfer of up to 200,000 Acre-Feet of Water Per Year from Yuba County Water Agency to the Department of Water Resources and the United States Bureau of Reclamation under Permit 15026 (Application 5632).

Surface Water Resources Inc. (SWRI), Jones & Stokes Associates (JSA), and Bookman-Edmonston Engineering, Inc. 2000. Hearing Exhibit S YCWA-19. Expert Testimony on Yuba River Fisheries Issues by Surface Water Resources, Inc., Jones & Stokes Associates, and Bookman-Edmonston Engineering, Inc., Aquatic and Engineering Specialists for Yuba County Water Agency. Prepared for the California State Water Resources Control Board Water Rights Hearing on Lower Yuba River February 22-25 and March 6-9, 2000.

United States Army Corps of Engineers (USACE). 1966. Operation and Maintenance Manual, Yuba River Debris Control Project, Yuba River California, Daguerre Point Dam. 60 pgs.

_____. 1972. New Bullards Bar Reservoir Regulation for Flood Control. June 1972

_____. 2001. Daguerre Point Dam, Yuba River California Preliminary Fish Passage Improvement Study. Prepared for the U.S. Fish and Wildlife Service, Anadromous Fish Restoration Program. August 2001.

_____. 2005. Initial Appraisal Report. August 2005. 16 pgs.

_____. 2007. Harry L. Englebright Lake Operational Management Plan. Sacramento District, U.S. Army Corps of Engineers. December 2007.

_____. 2009. Sediment Management Plan. 1 pg.

United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS). 2002. Biological Opinion on the Effects of the Corps' Operation of Englebright Dam and Daguerre Point Dam on the Yuba River, in Yuba and Nevada Counties, California, on the Threatened Central Valley Spring-Run Chinook Salmon (*Oncorhynchus tshawtscha*), the Central Valley Steelhead (*O. mykiss*) and Their Respective Designated Critical Habitats.

_____. 2007. Final Biological Opinion on the Effects of Operation of Englebright and Daguerre Point Dams on the Yuba River, California, on Threatened Central Valley Steelhead, the Respective Designated Critical Habitats for these Salmonid Species, and the Threatened Southern Distinct Population Segment of North American Green Sturgeon. November 2007.

_____. 2012. Final Biological Opinion on the Continued Operation and Maintenance of Englebright Dam and Reservoir, Daguerre Point Dam, and Recreational Facilities On and Around Englebright Reservoir. February 2012.

United States Department of Interior, Fish and Wildlife Service (USFWS). 1989. Letter to Mr. Paul R. Minasian. 5 pgs.

_____. 1990. Fishery Investigations in the Yuba Goldfields Area Near Daguerre Point Dam on the Yuba River in 1989. USFWS Report No. AFFl-FAO-90-9. August 24 1990.

_____. 1994. Planning Aid Report. Restoration Report: Lower Yuba River Investigation, California. Prepared for U.S. Army Corps of Engineers, 27 Sacramento District.