US Army Corps
of Engineers
Sacramento District

Yuba River Ecosystem Restoration Section 905(b) Analysis


Source: J.D. Richey

October 2014

This page left blank intentionally.

October 2014
Sacramento District

SECTION 905(b) (WRDA 86) ANALYSIS
YUBA RIVER ECOSYSTEM RESTORATION

Introduction

The Yuba River is one of California's signature rivers. Since the Gold Rush, prior to California statehood, the Yuba River has been a source of life-sustaining water for native peoples, farmers and ranchers, as well as for salmon, steelhead and other fish and wildlife.

The United States Army Corps of Engineers (USACE) has a long history of involvement with the Yuba River. With the advent of the California gold rush in the mid-1800s, hydraulic mining washed away entire sections of the upper Yuba River Watershed. The release of incredible amounts of sediment and contaminated mining debris threatened nearby cities, farms and the river itself. The United States Congress directed the Federal California Debris Commission (CDC) to manage this dangerous mining sediment. In 1906 construction was completed on Daguerre Point Dam, and then the 260-foot tall Englebright Dam was completed in 1941, both to impound mining debris. These dams continue to contain this contaminated mining debris, with an estimated 28 million cubic yards (yd^3) impounded behind Englebright Dam and 4 million yd^3 behind Daguerre Point Dam. Upon Congressional decommissioning of the CDC in 1986, administration of Daguerre Point Dam and Englebright Dam and Lake was assumed by USACE.

1. Study Authorities

Ecosystem restoration, or environmental protection, became a mission of USACE by the Water Resources Development Act (WRDA) of 1990, Public Law (P.L.) 101- 640, Section 306, which reads:

> *(a) GENERAL RULE.—The Secretary shall include environmental protection as one of the primary missions of the Corps of Engineers in planning, designing, constructing, operating, and maintaining water resources projects.*
> *(b) LIMITATION.—Nothing in this section affects—*
> *(1) existing Corps of Engineers' authorities, including its authorities with respect to navigation and flood control;*
> *(2) pending Corps of Engineers permit applications or pending lawsuits involving permits or water resources projects; or*
> *(3) the application of public interest review procedures for Corps of Engineers permits.*

WRDA1996, P.L. 104-303, Section 210 established cost-sharing for ecosystem protection/restoration:

(a) In General.--Section 103(c) of the Water Resources Development Act of 1986 (33 U.S.C. (c); 100 Stat. 4085) is amended--

(1) by striking ``and'' at the end of paragraph (5);

(2) by striking the period at the end of paragraph (6) and inserting ``; and''; and

(3) by inserting after paragraph (6) the following: ``(7) environmental protection and restoration: 35 percent; except that nothing in this paragraph shall affect or limit
the applicability of section 906.''.

The authority to study the Sacramento River Basin for flood control and allied purposes, including ecosystem restoration, was granted in the Rivers and Harbors Act of 1962, P.L. 87-874, Section 209, which reads:

The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities: Provided, that after the regular or formal reports made on any survey are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law except that the Secretary of the Army may cause a review of any examination or survey to be made and a report thereon submitted to Congress, if such review is required by national defense or by changed physical or economic conditions: Provided further, that the Government shall not be deemed to have entered upon any project for the improvement of any waterway or harbor mentioned in this title until the project for the proposed work shall have been adopted by law:

Sacramento River Basin and streams in northern California draining into the Pacific Ocean for the purposes of developing, where feasible, multi-purpose water resource projects, particularly those which would be eligible under the provisions of title III of Public Law 85-500.

(Title III of Public Law 85-500 concerns water supply.)

The authority to review completed USACE projects was granted in the Flood Control Act of 1970, P.L. 91-611, Section 216, which reads:

The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corp of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due (to) the significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest.

Under Section 216 authority, the United States Army Corps of Engineers Sacramento District prepared an Initial Appraisal Report (IAR) in 2005. The report recommended a

cost-shared feasibility study to determine the Federal interest in fish passage improvement, restoration of fisheries, restoration of aquatic habitat, and flood damage reduction associated with Daguerre Point Dam. (Daguerre Point Dam provides limited flood risk management by creating a backwater effect in the river, which causes some floodwaters to flow out and be detained in the Goldfields.) A Continuing Authorities Program (CAP) Section 1135 study was not recommended because alternative costs to address aquatic ecosystem problems along the Yuba River were expected to exceed the CAP limit.

The Energy and Water Development Appropriations Act, 2014, Division D of Public Law 113-76, the Consolidated Appropriations Act, 2014 initiated the reconnaissance study:

> *That the Secretary may initiate up to but no more than nine new reconnaissance study starts during fiscal year 2014: Provided further, That the new reconnaissance study starts will consist of three studies where the majority of the benefits are derived from navigation transportation savings, three studies where the majority of the benefits are derived from flood and storm damage reduction, and three studies where the majority of the benefits are derived from environmental restoration: Provided further, That the number of environmental restoration studies selected shall be limited to no more than the lessor (sic) of the number of navigation studies or the number of flood and storm damage reduction studies selected: Provided further, That the Secretary shall not deviate from the new starts proposed in the work plan…*

The Act's accompanying Statement of Managers report designated specified programs, projects, and activities. Based on the categories and criteria provided in the Statement of Managers, USACE identified studies in the 2014 Work Plan. One of those studies was the Yuba River Ecosystem Restoration study, listed as Yuba River Fish Passage, California (Englebright and Daguerre Point Dams).

2. Study Purpose

The purpose of a Section 905(b) analysis, also known as a reconnaissance report, is to address the requirements of Section 905(b) of the Water Resources Development Act (WRDA) of 1986, as amended. The purpose of this 905(b) analysis is to determine whether there is a Federal interest in participating in a cost-shared feasibility study to investigate ecosystem restoration in the Yuba River watershed in the interest of water resource development opportunities. The analysis uses existing data to determine Federal interest, develop preliminary costs and benefits, and estimate the cost of preparing the feasibility report. Additionally, per Planning Bulletin 2014-02: SMART Planning in the Reconnaissance Phase, the analysis describes areas of risk and remaining uncertainties that affect feasibility-phase assumptions. The analysis includes a description of the existing problem(s) in the Yuba River watershed, identification of Federal interest, and potential solution(s) that would result in a policy-consistent study with a willing and capable sponsor. The sponsor for the feasibility study is the Yuba County Water Agency (YCWA).

3. Recommendation/Finding of Federal Interest

Based on consistency with Army and budgetary policies and the likelihood of a project

meeting criteria for Federal participation in implementation, the Sacramento District recommends continuing with a feasibility study. There is Federal interest in proceeding to the feasibility phase of this study to further analyze and evaluate ecosystem restoration in the Yuba River watershed. Preliminary data indicate that there are significant National Ecosystem Restoration (NER) benefits associated with restoration of structures, functions, and processes in the Yuba River.

Federal interest in ecosystem restoration is based on the national significance of the ecosystem resources. The significant resources within the Yuba River watershed are spring-run Chinook salmon and steelhead trout. Significance is composed of institutional significance, technical significance, or public significance.

- Institutional significance means that the importance of an ecosystem resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. In the Yuba River, there are currently three fish species listed as threatened under the ESA: 1) spring-run Chinook salmon; 2) steelhead; and 3) green sturgeon. The lower Yuba River is designated critical habitat for each of these species. The July 2014 NOAA Fisheries "Recovery Plan for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead" seeks to recover these ecological values. In 1998, the Ecosystem Restoration Program Plan of CALFED recommended a program to evaluate the feasibility of returning steelhead and spring-run Chinook salmon to the Upper Yuba River upstream of Englebright Dam. Spring-run Chinook salmon are also listed as threatened under the State of California's Endangered Species Act. The Yuba Accord Fisheries Agreement, which provides assurances that instream flows will be maintained for the benefit of fish species, is another example of a formal plan. The State of California's Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988 states that it is a policy of the State to significantly increase the natural production of salmon and steelhead. Sierra County, through which the North Yuba flows, states in Element 13 of its General Plan that, "It is the County's goal to protect and defend its abundant and diverse plant and animal species."

- Technical significance means that the importance of ecosystem resources is based on the scientific or technical knowledge or judgment of critical resource characteristics. Technical significance is shown because the ESA listing of spring-run Chinook salmon and steelhead is based on scientific and technical knowledge and is well-documented in scientific literature.

- Public significance means that some segment of the general public recognizes the importance of an ecosystem resource. Members of the public have formed organizations based on their interest in fishing and the continuation of salmonid populations in the Yuba River. One such organization is SYRCL; their Yuba Salmon Now campaign aims to restore salmon habitat in the lower Yuba River and ultimately get salmon past Englebright Dam into the upper Yuba River. Another organization is American Rivers; in 2011, they named the Yuba as one of America's Most Endangered Rivers, primarily because of the lack of fish passage.

This 905(b) analysis includes a description of the existing problems, evidence of Federal

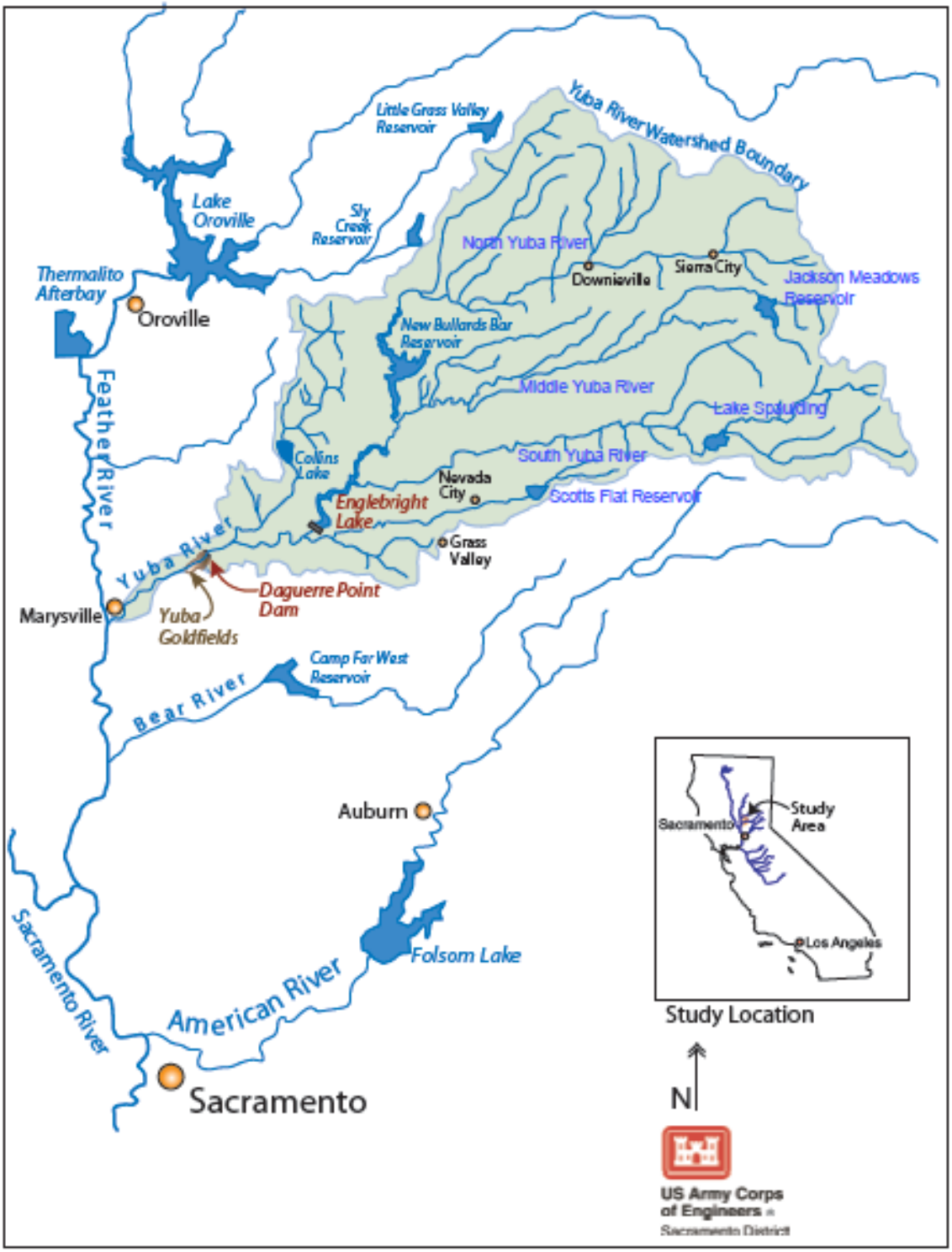
interest, a commitment from willing and capable sponsors, and that there is strong potential to implement a viable ecosystem restoration study. The feasibility report will be completed in accordance with SMART planning principles and risk-informed decision- making.

4. Study Area

The Yuba River Watershed (Figure 1) encompasses 1,340 square miles on the western slopes of the Sierra Nevada Mountain Range, and is located in portions of Sierra, Placer, Yuba, and Nevada counties (Reynolds et al. 1993). The Yuba River is a tributary of the Feather River which, in turn, flows into the Sacramento River near the town of Verona, California.

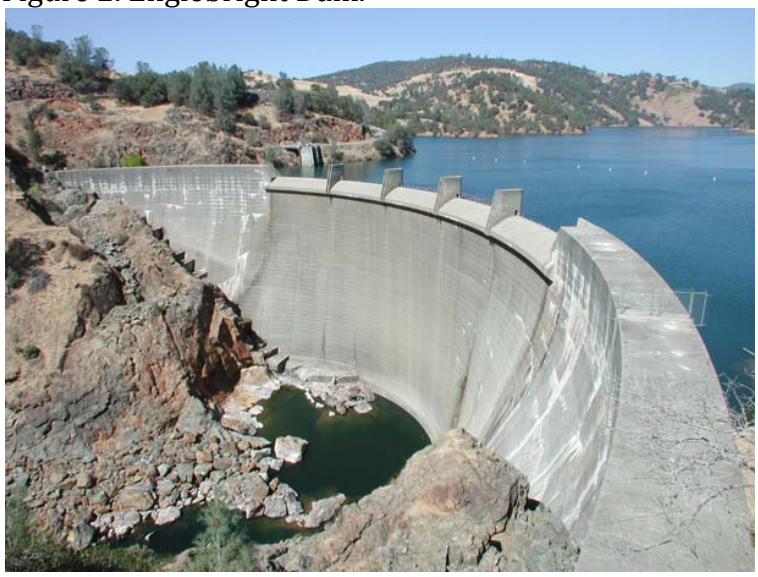
The Yuba River flows through forest, foothill chaparral, and agricultural lands. Levees are absent from most of its course except for near the river's confluence with the Feather River. At that point, the Yuba River is bounded by setback levees for approximately six miles.

Figure 1. Study Area Map (not to scale).



The primary watercourses of the upper Yuba River Watershed are the South, Middle, and North Yuba rivers. The South Yuba river flows into Englebright Lake. The Middle Yuba River flows into the North Yuba River and together they are referred to as the upper Yuba River. Beginning at the confluence of the North Yuba and the Middle Yuba rivers, the mainstem upper Yuba River flows approximately 7.8 miles downstream to Englebright Dam. Englebright Dam's reservoir extends approximately 8 miles from its high water surface elevation at RM 32.2 to the Englebright Dam at RM 24 (YSF 2013). Below Englebright Dam, the lower Yuba River reach extends approximately an additional 24 miles downstream to the confluence with the Feather River. The study area begins in the city of Marysville and extends upstream approximately 90 miles, past Sierra City, California, in Sierra County.

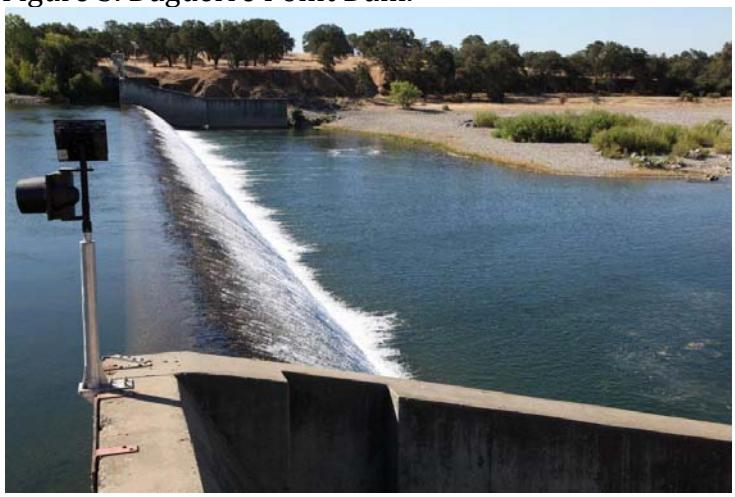
Figure 2. Englebright Dam.



Source: US Geological Survey

Daguerre Point Dam is located on the lower Yuba River approximately 11.5 river miles (RM) upstream from the confluence of the lower Yuba and lower Feather rivers near Marysville (USACE 2013). Owned by USACE, Daguerre Point Dam is a 25 feet (ft) tall, low-head dam across the lower Yuba River and there is no reservoir associated with the dam. Englebright Dam, located approximately 12.3 miles upstream of Daguerre Point Dam, is a 260-ft tall concrete dam also owned by USACE. Located on the Yuba River approximately 18 miles upstream of Englebright Dam, the 645 ft high New Bullards Bar Dam (owned by YCWA) is the tallest man-made structure in the Yuba River Watershed.

Figure 3. Daguerre Point Dam.



Source: USACE

Figure 4. New Bullards Bar Dam.

Source: Trails.com

Aquatic and Riparian Habitat

According to the National Marine Fisheries Service (NMFS) and numerous studies, at least 80% of historic riparian habitat has been lost in the Western United States (NMFS 2014; Krueper 1993). Riparian habitats support the greatest diversity of wildlife species of any habitat type in California (CALFED 2000 as cited in RMT 2013). Riparian habitat is linked to aquatic habitat both by flood waters as well as being a source of invertebrate prey, temperature-controlling shade, and structural refuge in the form of large woody debris (CDFW 2010).

The Yuba River flows through a rural area, so urban development has not contributed to habitat loss. However, habitat along portions of the Yuba River is reduced due to past mining practices and dam construction. Although the amount of habitat along the lower Yuba River has been altered from pristine conditions, it has been assessed as healthy and recovering from historical disturbance (YCWA 2013).

Riparian vegetation along the lower Yuba River is composed largely of willow shrubs, cottonwood and other hardwood species, with a simple understory of Himalayan blackberry or blue elderberry shrubs (YCWA 2013). Field observations reported that woody species in various life stages are present throughout the lower Yuba River. In the upper part of the Yuba River watershed, alders and quaking aspen become more common, in addition to cottonwoods and willows (Potter 2005). Riparian habitat in both the lower and higher elevations supports the little willow flycatcher (*Empidonax traillii brewsterii)*, a California endangered subspecies of willow flycatchers (USFS 2014).

Whereas riparian habitat generally borders rivers and streams, aquatic habitat is composed of the plants and animals within the water. For the Yuba River, fish species include Chinook salmon, steelhead, green sturgeon, Sacramento pikeminnow (*Ptychocheilus grandis*), common carp (*Cyprinus carpio*), Sacramento sucker (*Catostomus occidentalis*), channel catfish (*Ictalurus punctatus*), brown bullhead (*Ictalurus nebulosus*), bluegill (*Lepomis macrochirus*), and green sunfish (*Lepomis cyanellus*). These species depend on clean water of the appropriate temperature, adequate dissolved oxygen, appropriate streambed substrate, food, and areas to rest.

Because of the mountain snowmelt and cold water outflows from New Bullards Bar Dam, the Yuba River is suitable for cold-water fish species such as salmonids and trout. NMFS designated the Yuba River from Marysville to Englebright Dam as critical habitat for spring-run Chinook salmon and steelhead.

In the Central Valley of California, an estimated 72% of the historic Chinook salmon spawning and holding habitat is no longer available (Yoshiyama et al. 2001). The amount of steelhead habitat lost is probably much higher than that for Chinook salmon, because steelhead were more extensively distributed in the past (NMFS 2014). Many of these losses are from urban development, agriculture, and water supply facilities.

Historical Gold Mining

Extensive hydraulic mining occurred in the Yuba River watershed during the late 1800s. In hydraulic mining, water cannons shot high-pressure flows out to wash away hillsides. The material that was dislodged was then sluiced to expose the gold. Gilbert (1917), as cited in Yoshiyama et al. (2001), estimated that "…during the period 1849-1909, 684 million cubic yards of gravel and debris due to hydraulic mining were washed into the Yuba River system – more than triple the volume of earth excavated during the construction of the Panama Canal." Beak Consultants, Inc. (1989) stated, "the debris plain ranged from approximately 700 feet wide and up to 150 feet thick near the edge of the foothills to nearly 3 miles wide and 26 feet tall near Marysville." This debris field is still mined for residual gold deposits and gravel. Hydraulic mining in the Yuba River accounted for 40 percent of all the mining debris that washed into the Central Valley (Mount 1995).

In addition to eliminating much of the riparian vegetation corridor (either by burying it, by retarding its regeneration, or by its use as raw material for constructing brush dams to contain sediment) along the lower Yuba River (NMFS 2005), the hydraulic mining debris probably had devastating impacts on salmonids. This is because the sediments in the debris

would have suffocated incubating eggs and pre-emergent fry (NMFS 2002). Even by the 1870s and 1880s, the Yuba River salmon runs had been greatly diminished by hydraulic mining debris effects (Yoshiyama et al. 2001). Historically, the Yuba River Watershed supported large numbers of spring-run Chinook salmon, fall-run Chinook salmon, and steelhead, and was a major contributor to anadromous salmonids stocks in the Central Valley of California. Loss of historic spawning and rearing habitat in the upper basin likely had particularly severe impacts on spring-run Chinook salmon and steelhead populations, which depended on the upper basin for successful summer holding and rearing (Yoshiyama et al. 1998; 2001).

Along with hydraulic mining, mercury was used to process gold deposits. According to the US Geological Survey, hundreds of pounds of liquid mercury were added to the typical sluice box. Gold sank to the bottom of the sluice, while sand and gravel passed over the high-density mercury, allowing gold to separate and sink to the bottom. In the Sierra Nevada, up to 9 million pounds of mercury were lost in this manner to the environment (Churchill 2000). In the Yuba River study area, much of this left over mercury is contained in sediment held behind the debris dams. Although most of the mercury is not biologically available, enough has methylized in Englebright Lake that it is bioaccumulating in the larger predatory fish. Mercury levels in the larger predatory fish are high enough that the California Office of Environmental Health Hazard Assessment issued a safe-eating advisory for Englebright Lake. Guidelines advise women ages 18-45 and children ages 1-17 to avoid eating largemouth, smallmouth, or spotted bass.

The Yuba Goldfields, located from approximately 8 to 16 miles upstream of Marysville, are dominated by approximately 20,000 acres of dredger tailings that were reworked from hydraulic mine waste. Dredging of gold from the hydraulic waste in the Goldfields began in 1902, and by 1910, 15 dredges were operating in the lower Yuba River. The area has been dredged and re-dredged intermittently throughout the years, and dredging continues today.

Figure 5. Yuba Goldfields.

Source: ENGEO

Hydraulic mining resulted in torrents of sediment being transported downslope to the valley

and caused rapid aggradation and exacerbation of flooding along valley rivers, including the lower Yuba River (James and Singer 2008). Two major debris dams (i.e., Daguerre Point Dam in 1906 and Englebright Dam in 1941) were constructed on the Yuba River to prevent continuing movement of sediment into the Feather and Sacramento rivers, and ultimately the Bay-Delta.

Dams

During the late 1800s and early 1900s, development of the upper Yuba River Watershed for hydropower and water supply was in progress. Most of the dams and diversions that were used primarily for gold mining were in place during this period, but they were being replaced or removed as developmental emphasis in the watershed shifted from gold mining to flood control, water supply and hydropower generation. Debris dams also were in place or being added at several locations throughout the middle to lower elevations of the watershed.

The presence, operation and maintenance of dams can hinder or preclude fish access to upstream sub-basins, which historically provided holding, spawning, incubation and rearing habitats (NMFS 2014a). In addition to the effects of harvest, hatcheries, predation, and habitat degradation, the effects of hydropower dams and other water and sediment control facilities have contributed to the significant decline of Central Valley salmon since the mid-1800s, including the Yuba River (NMFS 2014). Although other, smaller dams are present in the watershed, Englebright Dam is the first barrier to salmonids, while New Bullards Bar dam is the second on the North Yuba.

As documented in the 2013 biological assessment on Daguerre Point Dam, USACE implemented protective and voluntary conservation measures for listed species under its obligation to Section 7(a)(1) of the Endangered Species Act and several voluntary conservation measures in accordance with USACE's Environmental Stewardship and Maintenance Guidance and Procedures, respectively. USACE is in compliance with the Endangered Species Act.

4.1. Species Addressed by the Section 905(b) Analysis

Detailed descriptions of the fish species, including their life histories and habitat utilization in the Yuba River, are provided in the Biological Assessment addressing the Operations and Maintenance of Existing Fish Passage Facilities at Daguerre Point Dam (USACE 2013). Much of that information was based upon the Yuba Accord River Management Team (RMT) 2013 report on the fish resources of the lower Yuba River through review of previously conducted studies, as well as recent and currently ongoing data collection activities of their Monitoring and Evaluation (M&E) Program. Brief descriptions are provided below for context in this analysis.

Spring-run Chinook Salmon (*Oncorhynchus tshawytscha*)

Listing Status and Critical Habitat

On September 16, 1999, NMFS listed the Central Valley Evolutionarily Significant Unit (ESU) of spring-run Chinook salmon as a "threatened" species under the ESA (64 FR 50394). In

August 2011, NMFS completed a 5-year status review of the spring-run Chinook salmon ESU. Based on a review of the available information, NMFS (2011a) recommended that the spring-run Chinook salmon ESU remain classified as a threatened species. NMFS' review also indicates that the biological status of the ESU has declined since the previous status review in 2005.

Critical habitat was designated for the Central Valley spring-run Chinook salmon ESU on September 2, 2005 (70 FR 52488). On the Yuba River, critical habitat is designated from the confluence with the Feather River upstream to Englebright Dam. The dam blocks all upstream passage, however, the Central Valley spring-run Chinook salmon ESU can swim upstream of Daguerre Point Dam by using the fish ladders.

Life History and Habitat Utilization

Adult Immigration and Holding
Spring-run Chinook salmon previously have been reported to migrate immediately to areas upstream of the Highway 20 Bridge after entering the Yuba River from March through October (Vogel and Marine 1991; YCWA et al. 2007), and then over-summer in deep pools located downstream of the Narrows 1 and 2 powerhouses, or further downstream in the Narrows Reach through the reported spawning period of September through November (CDFG 1991a; SWRCB 2003).

The results from the RMT's M&E Program, including the VAKI Riverwatcher™ monitoring and particularly the three-year acoustic telemetry study, found past characterizations of temporal and spatial distributions to be largely unsupported. Tagged phenotypic adult spring-run Chinook salmon in the lower Yuba River actually migrated upstream of Daguerre Point Dam from May through September, and utilized a broad expanse of the lower Yuba River during the summer holding period, including areas as far downstream as Simpson Lane Bridge (i.e., ~RM 3.2), and as far upstream as the area just below Englebright Dam.

The majority of tagged spring-run Chinook salmon were detected in the plunge pool located immediately downstream of Daguerre Point Dam from the onset of tagging in May/June, through the over-summer holding period as late as September. Periods of occupation in the Daguerre Point Dam pool during the study ranged from 0 to 116 days. There are no definitive explanations for this observation, but it is possible that Daguerre Point Dam represented a passage impediment, or that these fish over-summered in the Daguerre Point Dam pool due to suitable habitat conditions available below the dam (e.g., favorable water depths, cover, water temperatures and proximity to spawning gravels). Chinook salmon passage was observed over a variety of flow conditions. Flow thresholds prohibiting passage of Chinook salmon through the ladders at Daguerre Point Dam were not apparent in the data.

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 (2007) stated that the angles of the fish ladder entrance

orifices and their proximities to the plunge pool also increase the difficulty for fish to find the entrances to the ladders.

Adult Spawning and Embryo Incubation
The spring-run Chinook salmon spawning period in the lower Yuba River, based upon RMT investigations, extends from approximately September 1 through mid-October. The earliest spawning (presumed to be spring-run Chinook salmon) generally occurs in the upper reaches of the highest quality spawning habitat (i.e., below the Narrows pool) and progressively moves downstream. This spatial trend reflects cooler water temperatures extending farther downstream as the spawning season progresses (RMT 2013).
Spring-run Chinook salmon spawning in the lower Yuba River is believed to occur upstream of Daguerre Point Dam. With the exception of the Englebright Dam Reach, there is an abundance of suitable spawning gravel in the lower Yuba River.

Juvenile Rearing and Outmigration
Snorkel observations conducted by the RMT (2013) indicate that the density of juvenile Chinook salmon was highly variable throughout the lower Yuba River although, with the exception of the upstream-most survey reach (i.e., Englebright Dam Reach) the density of juvenile Chinook salmon generally was higher in the survey reaches located upstream rather than downstream of Daguerre Point Dam. These observations are consistent with previous reports, indicating that .juvenile Chinook salmon collected by electrofishing and observed by snorkeling exhibit higher abundances above Daguerre Point Dam (Beak 1989; CDFG 1991; Kozlowski 2004). This may be due to larger numbers of spawners, greater amounts of more complex, high-quality cover, and lower densities of predators such as striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*), which reportedly are generally restricted to areas below Daguerre Point Dam (YCWA et al. 2007).

The RMT (2013) reported that juvenile Chinook salmon appeared to occupy areas in close proximity to the shore during most survey months and in most survey reaches. The overall findings indicate that juvenile Chinook salmon in the lower Yuba River initially prefer slower, shallower habitat, and move into faster and deeper water as they grow.

Emigration
Recent Rotary Screw Tram (RST) monitoring data indicate that the vast majority of spring-run Chinook salmon emigrate as post-emergent fry during November and December. Overall, most (approximately 84%) of the juvenile Chinook salmon were captured at the Hallwood Boulevard RSTs soon after emergence from November through February, with relatively small numbers continuing to be captured through June. Although not numerous, captures of (over-summer) holdover juvenile Chinook salmon primarily occurred from October through January with a few individuals captured into March (Massa 2005; Massa and McKibbin 2005). These fish likely reared in the river over the previous summer, representing an extended juvenile rearing strategy characteristic of spring-run Chinook salmon (RMT 2013).

Figure 6. Chinook salmon.

Steelhead (*O. mykiss*)

Steelhead exhibits perhaps the most complex suite of life-history traits of any species of Pacific salmonid. Members of this species can be anadromous or freshwater residents and, under some circumstances, members of one form can apparently yield offspring of another form (YCWA 2010).

Listing Status and Critical Habitat

On March 19, 1998 (63 FR 13347) NMFS listed the California Central Valley steelhead ESU as "threatened". On January 5, 2006 NMFS issued a final decision that defined Central Valley steelhead as a Distinct Population Segment (DPS) rather than an ESU, and retained the status of Central Valley steelhead as threatened (71 FR 834). In August 2011, NMFS completed a 5-year status review of the Central Valley steelhead DPS, indicated that the biological status of the DPS has declined since the previous status review in 2005, and recommended that the steelhead DPS remain classified as a threatened species.

On February 16, 2000 (65 FR 7764), NMFS designated critical habitat for Central Valley steelhead including the lower Yuba River upstream to Englebright Dam. NMFS published a final rule designating critical habitat for steelhead on September 2, 2005 (70 FR 52488), which again includes the Yuba River from the confluence with the lower Feather River upstream to Englebright Dam.

Life History and Habitat Utilization

Adult Immigration and Holding
RMT (2010; 2013) examined preliminary data and identified variable annual timing of *O. mykiss* ascending the fish ladders at Daguerre Point Dam since the VAKI Riverwatcher™ began operations in 2003. They identified the period extending from August through March as encompassing the majority of the upstream migration and holding of adult steelhead in the lower Yuba River.

Adult Spawning and Embryo Incubation
Steelhead spawning generally occurs in the lower Yuba River from January through April (RMT 2013). RMT (2013) reported that steelhead redds (egg beds) show a distinctive

pattern spatially throughout the lower Yuba River, with the majority of redds in the upper reaches (Timbuctoo Bend and Parks Bar) of the lower Yuba River. In the lower Yuba River, steelhead have been observed to spawn in side channel areas as well as in mainstem areas (YCWA unpublished data).

Juvenile Rearing and Outmigration
Some juvenile *O. mykiss* may rear in the lower Yuba River for short periods (up to a few months) and exhibit downstream movement from April through September. Others may spend from one to three years rearing in the river. Most juvenile steelhead rearing reportedly occurs above Daguerre Point Dam, with decreasing abundance downstream of Daguerre Point Dam. SWRI et al. (2000) suggested that higher abundances of juvenile *O. mykiss* above Daguerre Point Dam may have been due to larger numbers of spawners, greater amounts of more complex, high quality cover, and lower densities of predators such as striped bass and American shad, which reportedly were restricted to areas below Daguerre Point Dam.

Smolt Emigration
Although not numerous, captures of (over-summer) holdover juvenile *O. mykiss* were observed in the RST captures primarily from October through mid-April (RMT 2013). These fish likely reared in the river over the previous summer, representing an extended juvenile rearing strategy characteristic of holdover juvenile *O. mykiss*. Juvenile *O. mykiss* that exhibit extended rearing in the lower Yuba River are assumed to undergo the smoltification process and volitionally emigrate from the river, and are referred to as yearling+ smolts.

Figure 7. Steelhead.

Source: Oregon DFW

Fall-run Chinook salmon (*O. tshawytscha*)

Listing Status

Central Valley fall- and late fall-run Chinook salmon are considered by NMFS to be the same ESU (64 FR 50394). NMFS determined in 1999 that listing this ESU as a threatened species was not warranted (64 FR 50394), but subsequently classified this ESU as a Federal Species of Concern because of specific risk factors, including population size and hatchery influence in 2004 (69 FR 19975).

In the Central Valley, fall-run Chinook salmon are the most numerous of the four salmon runs, and continue to support commercial and recreational fisheries of significant economic

importance. Because of their commercial importance, all runs (spring- and fall-run Chinook salmon) of Chinook salmon and their designated Essential Fish Habitat (EFH) are managed under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). In the Yuba River Basin, EFH is designated upstream and downstream of Englebright Dam and Reservoir.

Life History and Habitat Utilization

Adult Immigration and Staging
Unlike spring-run Chinook salmon, adult fall-run Chinook salmon do not exhibit an extended over-summer holding period in the lower Yuba River (RMT 2010). Rather, it is believed that they stage for a relatively short period of time prior to spawning, as supported by the recent evaluation by the RMT of the acoustic telemetry monitoring data and the VAKI Riverwatcher™ data (RMT 2013). By contrast to phenotypic adult spring-run Chinook salmon, which exhibited extended periods of holding downstream of Daguerre Point Dam, RMT (2013) found that the acoustically-tagged fall-run adult Chinook salmon held for an average of only approximately 3 days downstream of Daguerre Point Dam prior to passing upstream through the fish ladders.

Spawning and Embryo Incubation
According to RMT (2010), fall-run Chinook salmon are primarily observed spawning during October in the upper reaches of the lower Yuba River upstream of Daguerre Point Dam. Spawning fall-run Chinook salmon begin expanding their spatial distribution further downstream in later fall months as suitable temperatures become available near or downstream of Daguerre Point Dam (RMT 2010).

Juvenile Rearing and Downstream Movement
In the lower Yuba River, most fall-run Chinook salmon reportedly exhibit downstream movement as fry shortly after emergence from gravels, although some individuals rear in the river for a period up to several months and move downstream as juveniles (RMT 2010). Based upon RMT (2013) data review, the phenotypic fall-run Chinook salmon fry rearing period generally extends from mid-December through April, and the juvenile rearing lifestage extends from mid-January through June. Juvenile downstream movement, which includes both fry and larger juveniles as indicated by captures in the Hallwood Boulevard RSTs, generally occurs from mid-December through June.

Green Sturgeon (*Acipenser medirostris*)

Listing Status and Critical Habitat

The Southern DPS of North American green sturgeon (*Acipenser medirostrus*) was listed as a Federally threatened species on April 7, 2006 (71 FR 17757) and includes the green sturgeon population spawning in the Sacramento River and utilizing the Sacramento-San Joaquin River Delta, and San Francisco Estuary.

On October 9, 2009, NMFS (74 FR 52300) designated critical habitat for the Southern DPS of North American green sturgeon. Critical habitat in the lower Yuba River includes the stream

channels to the ordinary high water line extending from the confluence with the mainstem Feather River upstream to Daguerre Point Dam.

Life History and Habitat Utilization

Since the 1970s, numerous surveys of the lower Yuba River downstream of Englebright Dam have been conducted, including annual salmon carcass surveys, snorkel surveys, beach seining, electrofishing, rotary screw trapping, redd surveys, and other monitoring and evaluation activities. Although not specifically designed for green sturgeon, over the many years of these surveys and monitoring of the lower Yuba River, only one confirmed observation of an adult green sturgeon has occurred prior to 2011. Of the three adult or sub-adult sturgeon observed by snorkeling in the Yuba River below Daguerre Point Dam during 2006, only one was confirmed to be a green sturgeon.

As part of ongoing sturgeon monitoring efforts in the Feather River Basin under the Anadromous Fish Restoration Program (AFRP), roving underwater video surveys were conducted in the lower Yuba River. During late May 2011, underwater videographic monitoring observed 4-5 green sturgeon near the center of the channel at the edge of the bubble curtain below Daguerre Point Dam. During 2012 and 2013, underwater videography also was used in an attempt to document the presence of green sturgeon downstream of Daguerre Point Dam, but no observations of green sturgeon were made.

Because green sturgeon have rarely been observed in the lower Yuba River, no site-specific habitat utilization information is available. However, Daguerre Point Dam is acknowledged to be impassible to green sturgeon.

Figure 8. Green Sturgeon.

Source: CA DFW

California Red-Legged Frog (*Rana draytonii*)

Another threatened species that has historic habitat in the study area is the California Red-Legged Frog (CRLF) (Rana draytonii). CRLF historically occupied portions of the western slope of the Sierra Nevada, but populations have been fragmented and nearly eliminated due in large part to habitat loss caused by agriculture, flood infrastructure, and urban development. Such human actions led to the loss of streams and wetlands. The last sightings of the CRLF in Yuba County occurred in the 1960s and were north of the study area, along the North and South Forks of the Feather River.

Figure 9. California Red-Legged Frog.

5. Summary of Applicable Prior Studies, Reports, and Existing Water Projects

5.1. Water Projects

5.1.1. Sacramento-San Joaquin Delta

The Delta is a vast, low-lying inland region located east of the San Francisco Bay Area, at the confluence of the Sacramento and San Joaquin Rivers. The Delta is a complex area that is important to estuarine species, including anadromous fish, agriculture, and production and distribution of California water resources. The Central Valley Project, managed by the US Bureau of Reclamation, and the State Water Project store water and transfer it from the northern part of the state to the drier southern part. While water drawn from the Delta provides for much of California's water needs, including drinking water and agricultural irrigation, fish are impacted by the distribution facilities. The facilities, mainly pumps and water pulled toward the pumps, can alter migratory cues for salmonids traveling out to the ocean. Fish can also be lost in the pumps. To reduce the negative effects to fish, water transfers are highly regulated.

5.1.2. Yuba River Debris Control Project

The Rivers and Harbor Act of June 13, 1902 authorized the construction of the Yuba River Debris Control Project, of which Daguerre Point Dam is a part, at an estimated first cost of $800,000, one-half of which was borne by the U. S. California Debris Commission (CDC) and one-half by the State.

The CDC, consisting of three Army engineers appointed by the President, was established to provide for: resumption of hydraulic mining without injury to navigation or damage to overflow; to restore, as nearly as practicable, navigation conditions as of 1860; and to afford relief in flood time and to provide sufficient water to maintain scouring force in summer to restore channel capacities. The CDC was effective in debris management. Upon decommissioning of the CDC by Section 1106 of WRDA 1986 (P.L. 99-662),, administration Daguerre Point Dam was assumed by USACE.

Daguerre Point Dam

Daguerre Point Dam (**Figure 2**) is located on the Yuba River approximately 11.5 miles upstream of Marysville. Although the dam was completed in May of 1906, the river was not diverted over the dam until 1910 (USACE 2007). Daguerre Point Dam rapidly filled to capacity with sediment and debris that moved downstream during flooding in 1911 (Hunerlach et al. 2004). Daguerre Point Dam was rebuilt in 1965 after it was damaged and breached by floods in 1963 and 1964. The area behind the dam is almost entirely filled with up to 4 million cubic yards of sediment (DWR and USACE 2003) that has accumulated since it was rebuilt. A portion of this sediment next to the upstream face of the dam is removed annually by USACE to facilitate fish passage. Presently, USACE is responsible for the operation and maintenance of Daguerre Point Dam.

Daguerre Point Dam key features include the following (USACE 2012):

- Overflow concrete ogee ("s-shaped") spillway with concrete apron and abutments
- Ogee spillway section is 575 feet wide and 25 feet tall
- Originally designed to retain hydraulic mining debris
- Currently used to facilitate water diversion for irrigation purposes
- Not operated for flood control
- No storage capacity – reservoir filled with hydraulic mining debris and sediments

There are three water diversions associated with Daguerre Point Dam, which utilize the elevated head[1] created by the dam, or the influence of the dam in the prevention of additional river channel incision, to gravity-feed their canals. The three diversions are the Hallwood-Cordua diversion, the South Yuba/Brophy diversion, and the Browns Valley Irrigation District (BVID) diversion, which have a combined capacity of 1,085 cfs. Also, the increased water level created by Daguerre Point Dam significantly enhances groundwater recharge in the Yuba groundwater sub-basins, which is critically important source of water reliability for Yuba County.

In addition to the dam structure, there are two fish ladders, each with a control gate. The two fish ladders utilize the hydraulic head created by the dam due to the influence of the dam preventing additional channel incision above the dam. The purpose of these two fish ladders is to permit salmon and steelhead access upriver to the seasonal spawning areas. Other native species, pikeminnow and suckers, have also been observed using the ladders. However, the ladders do not meet modern fish passage design standards, and they are not effective in passing all species of concern over a full range of flows (NMFS 2014a). There are no recreation facilities located at Daguerre Point Dam.

Englebright Dam

Originally known as Upper Narrows Reservoir, Harry L. Englebright Dam and Lake is on the

[1] The "elevated head" at Daguerre Point Dam is created by the hydraulic conditions associated with water being impounded behind (i.e., upstream) of the dam. The Corps has no control over the in-river flows, and has no discretionary control over the "head" for local water users in the vicinity of Daguerre Point Dam.

mainstream of the Yuba River (RM 23.9) approximately 20 miles northeast of Marysville. The concrete arch dam and reservoir was authorized by the Rivers and Harbors Act of 1935 as part of the Sacramento River and Tributaries Project. Completed by the CDC in 1941, the project was authorized primarily to contain hydraulic mining sediments originating in upstream areas (USACE 2013). Englebright Dam is 260 feet high (Figure 3), and the storage capacity of the reservoir was 69,700 AF at the time of construction (Childs et al. 2003). However, due to sediment buildup since construction, the gross storage capacity was more recently estimated at approximately 50,000 AF (USGS 2003). The volume of sediment in Englebright Lake is significant and was estimated at approximately 28 million cubic yards in 2003 by the USGS (MWH 2013). Additional details regarding Englebright Dam and Lake are provided below.

- Englebright Dam is a concrete constant angle arch structure.
- Dam crest length of 1,142 feet and the dam top crest width is 21 feet.
- Dam spillway crest elevation is 527 feet msl.
- Maximum spillway design capacity is 108,000 cfs.
- Reservoir water surface elevation generally fluctuates between 517 feet to 525 feet msl on a daily and weekly basis.
- Englebright Reservoir is used as an afterbay for releases from New Bullards Bar Reservoir through the New Colgate Powerhouse and is used as a regulating reservoir to meet recreation and power generation needs and to capture uncontrolled flows from the Middle and South Yuba rivers to manage downstream releases to the lower Yuba River.
- Englebright Lake is approximately 9 miles long.
- Englebright Dam provides the hydraulic head for approximately 67 MW of electric generation at the Narrows 1 and 2 powerhouses.

Water in the reservoir provides for recreational opportunities and for hydroelectric power generation. The reservoir does not have any dedicated flood storage space and only provides incidental flood control benefits. Since the reservoir was constructed for mining debris retention and not for flood control purposes, it does not have a low-level outlet. In fact, the design of the dam allows unregulated flood flows to spill over Englebright Dam during flood events. Since around 1941, controlled releases into the lower Yuba River have been made from the Pacific Gas and Electric Narrows 1 power plant and since 1970 from the YCWA Narrows 2 power plant, both Federal Energy Regulatory Commission (FERC)-licensed facilities. These power plants are just downstream of the dam.

Englebright Dam represents the delineation between the upper and lower Yuba River (USACE 2012). Englebright Lake is currently used for recreation and hydroelectric power generation. Englebright Dam and its associated hydropower facilities are impassable in the upstream direction and therefore represent the upstream limit of anadromous fish migration in the Yuba River (NMFS 2014a).

5.1.3. **New Bullards Bar Dam**

The largest structure on the river, New Bullards Bar Dam, is on the North Yuba River, approximately 18 miles upstream from Englebright. Construction was completed in 1970 by YCWA as part of FERC Project No. 2246 to provide water for power generation, irrigation and

domestic needs, flood control, and recreation (YCWA 2010), and the dam is 645 feet high. Releases from New Bullards Bar Reservoir are made through the New Colgate Powerhouse, through the dam's low-level outlet, or gated spillway (YCWA et al. 2007; YCWA 2014). The reservoir is used heavily for recreation, and it powers two hydroelectric plants. Figure 4 displays New Bullards Bar Dam.

Additional details about New Bullards Bar Dam and Reservoir are as follows (YCWA 2010):

- 1,110-foot radius, double curvature, concrete arch dam.
- Dam height is 645 feet
- Overflow-type spillway with a width of 106 feet.
- Spillway crest elevation of 1,902 feet msl.
- Three 30-foot wide and 54-foot tall Tainter Gates on the spillway.
- Maximum spillway design capacity of 160,000 cfs.
- Provides hydraulic head for 340 MW of hydroelectric peaking power at the Colgate powerhouse.
- The reservoir extends approximately 8.5 miles upstream at the normal maximum water surface elevation (1,956 feet).
- Estimated reservoir storage capacity is 966,103 acre-feet.
- Reservoir maximum depth is 645 feet.
- Normal water level fluctuations of 150 feet

5.1.4. Other Existing Water Projects

Other dams have been constructed in the Yuba River Watershed for irrigation and drinking water supplies. Many of the earlier dams are now used for hydropower in addition to newer dams constructed with hydropower as a purpose. Other hydroelectric projects within the Yuba River watershed are the Yuba-Bear Project managed by the Nevada Irrigation District (a water agency based in Grass Valley, California) and the Drum-Spaulding Project overseen by Pacific Gas and Electric Company.

5.2. Prior Studies

The Yuba River downstream of Englebright Dam is one of the more thoroughly studied rivers in the Central Valley of California. Much of the research is connected to the Federal Energy Regulatory Commission (FERC) relicensing process of YCWA's Yuba River Development Project (YRDP). In Appendix E6 of YCWA's Application for New License, Technical Memorandum 7-8 summarizes the available literature for spring-run Chinook salmon where specifically identified, Chinook salmon in general where runs are not specifically identified, and *O. mykiss* (including steelhead). The technical memorandum summarily describes 21 available field studies and data collection reports, 20 other relevant documents (e.g., plans, policies, historical accounts and regulatory compliance), 14 ongoing data collection, monitoring and evaluation activities for the M&E Program, and 4 other data collection and monitoring programs.

Additional key prior studies and reports are described below.

Assessment of Infrastructure and Related Items to Support Anadromous Fish Passage to the Yuba River Watershed, Prepared by MWH for the Yuba Salmon Forum. March 2013.

The report provided an assessment of infrastructure to support anadromous fish passage to the Yuba River Watershed, including an engineering assessment of the facilities, appurtenances, costs, permitting, and changes to the infrastructure and operations of existing facilities required for the implementation and operations and maintenance (O&M) of an Anadromous Fish Passage Program to locations in the upper Yuba River Watershed, including the North, Middle, and South Yuba rivers.

Biological Assessment for the Application for New FERC License Draft, YCWA, April 2014

The BA identified and evaluated potential effects on threatened and endangered species from the YCWA's power generating activities. It was required as part of the FERC relicensing process.

Biological Assessment for Operation and Maintenance for Daguerre Point Dam on the Yuba River, USACE, October 2013

The BA defined and evaluated the potential effects of USACE's limited ongoing discretionary activities at Daguerre Point Dam on threatened and endangered species and their designated critical habitats in the lower Yuba River. It superseded the January 2012 BA for the Ongoing Operation and Maintenance of Englebright and Daguerre Point Dams.

Biological Assessment for Operation and Maintenance for Englebright Reservoir on the Yuba River, USACE, October 2013

The BA defined and evaluated the potential effects of USACE's ongoing discretionary activities at Englebright Dam and Reservoir on ESA-listed species and their designated critical habitats in the lower Yuba River. It superseded the January 2012 BA for the Ongoing Operation and Maintenance of Englebright and Daguerre Point Dams.

Biological Opinion for Operation and Maintenance of Daguerre Point Dam and Fish Ladders, NMFS, May 2014

The BiOp responded to the 2013 Daguerre Point Dam BA and concluded that implementation of the proposed action is not likely to jeopardize the threatened and endangered species or adversely modify their designated critical habitat. NMFS included Reasonable and Prudent Measures and discretionary terms and conditions that are intended to minimize incidental take associated with the proposed action. The BiOp superseded the February 2012 BiOp for Operation and Maintenance of Englebright and Daguerre Point Dams.

Daguerre Point Dam Fish Passage Improvement Project Alternative Concepts

Evaluation, Wood Rodgers, Inc., Sacramento, CA, September 2003

This evaluation described the potential solutions (and limitations of each) for fish passage improvements at Daguerre Point Dam as recommended by the California Department of Fish and Game (DFG, now the Department of Fish and Wildlife). It provided costs for each solution and compared the impacts to fish passage, water supply interests, and downstream flood protection relative to the cost for implementation.

Interim Monitoring & Evaluation Report Draft, Lower Yuba River Accord, River Management Team, April 2013

The Interim Monitoring and Evaluation (M&E) Report served as both a 'report card' on the Lower Yuba River Accord's RMT's M&E program results regarding the implementation of the Yuba Accord for regulators, stakeholders and the broader scientific community, and to help inform the FERC relicensing process.

Letter of Concurrence for Operation and Maintenance for Englebright Reservoir on the Yuba River, NMFS, May 2014

The letter was responded to the 2013 USACE BiOp for Operation and Maintenance for Englebright Reservoir. In the letter, NMFS concurs with USACE's determination that the project proposed in the BiOp is not likely to adversely affect Central Valley spring-run Chinook salmon and steelhead or green sturgeon or the species' designated critical habitats.

Preliminary Fish Passage Improvement Study, USACE, August 2001

This preliminary study identified potential alternatives for fish passage improvement at Daguerre Point Dam on the Yuba River. It included preliminary plans to reduce fisheries resource problems in the study area. It provided the project status and planned future efforts needed to conduct a feasibility study which would improve fish passage.

Upper Yuba River Watershed Chinook Salmon and Steelhead Habitat Assessment, DWR, 2007

The California Department of Water Resources' (DWR) Upper Yuba River Studies Program conducted this study to determine whether the re- introduction of wild Chinook salmon and steelhead to the upper Yuba River watershed is biologically feasible. The study concluded that the Middle Yuba River could support a small salmon run.

Yuba River, California, Daguerre Point Dam Initial Appraisal Report, USACE, August 2005

This Section 216 study determined that there is Federal interest in proceeding with detailed feasibility-level studies to include fish passage improvement, fisheries restoration, aquatic habitat restoration, and flood damage reduction associated with Daguerre Point Dam.

Yuba River Basin Post Authorization Documentation Report, USACE, December 2012

The Yuba River Basin, California, Post Authorization Documentation Report (PADR) reaffirmed that there is Federal interest in project improvements within the Linda/Olivehurst area of the authorized Yuba River Basin Project. The project, as authorized, includes improvements to strengthen existing levees to provide flood risk management (FRM) benefits to the City of Marysville and to the Reclamation District 784 area.

Yuba Salmon Forum Summary Habitat Analysis, Prepared by Cardno ENTRIX for the Yuba Salmon Forum, September 2013

This report provides a summary assessment of potential anadromous spring-run Chinook salmon and steelhead habitat in the Yuba River Watershed. The summary assessment was designed to provide the YSF with habitat information that can be used to review potential actions that warrant further investigation regarding introduction of Central Valley spring-run Chinook salmon and Central Valley steelhead into the North, Middle, and/or South Yuba rivers and/or portions of the Yuba River. The summary assessment includes a synthesis of data from various sources that includes hydrology, water temperature, upstream migration barriers, and a quantification of migration, holding, spawning, incubation, rearing, and smolt emigration habitat.

5.3 Restoration Projects

Other entities are also working to restore lower Yuba River riparian and aquatic habitat. The South Yuba River Citizen's League (SYRCL) completed the Hammon Bar Riparian Habitat Restoration Project which restored five acres of riparian habitat and 3.5 miles of juvenile rearing aquatic habitat.

6. Scoping

Due to its relationship to ESA-listed species, this study is important to many stakeholders as well as Federal, state, county, and local governmental agencies, and conservation groups which are actively working to bring salmon back to the upper parts of the river. The Yuba Salmon Forum, of which USACE is a part, convened in 2009 to address reintroduction planning in a collaborative forum with broad representation and a charter. This analysis incorporates some of the consensus reached by that group.

The Yuba Accord is a 2008 settlement agreement representing nearly three years of intense negotiations among 17 stakeholders, including local irrigation districts, state and Federal resource agencies and conservation groups. The settlement provides for higher flow requirements that are protective of the salmonid fishery. Also, the settlement created the River Management Team, which performs fishery and restoration studies on the lower Yuba River and provides input to YCWA on flow management decisions.

On August 6, 2014, Corps staff met with representatives from NMFS and FWS to brief them on the reconnaissance study and the process leading to a feasibility study. The staff heard about other similar projects and studies, such as NFMS' "RIPPLE reports." FWS asked USACE to investigate amphibian habitat, particularly for the foothill yellow-legged frog (*Rana boylii*),

along tributaries to the Yuba River. This feedback will be researched and possibly incorporated into the feasibility study, and USACE will continue to dialogue with the NMFS and FWS representatives.

Over the course of preparation of this analysis, USACE met with representatives from potential non-federal sponsors for this study (DWR and YCWA). Cooperating agencies and stakeholders in addition to the sponsors for this study include, but are not limited to: NMFS, FWS, California Department of Fish & Wildlife (CDFW), the Tahoe National Forest, public recreation groups, irrigation districts, the South Yuba River Citizens League (SYRCL), and Trout Unlimited. USACE will consult with the Native American tribes of the area.

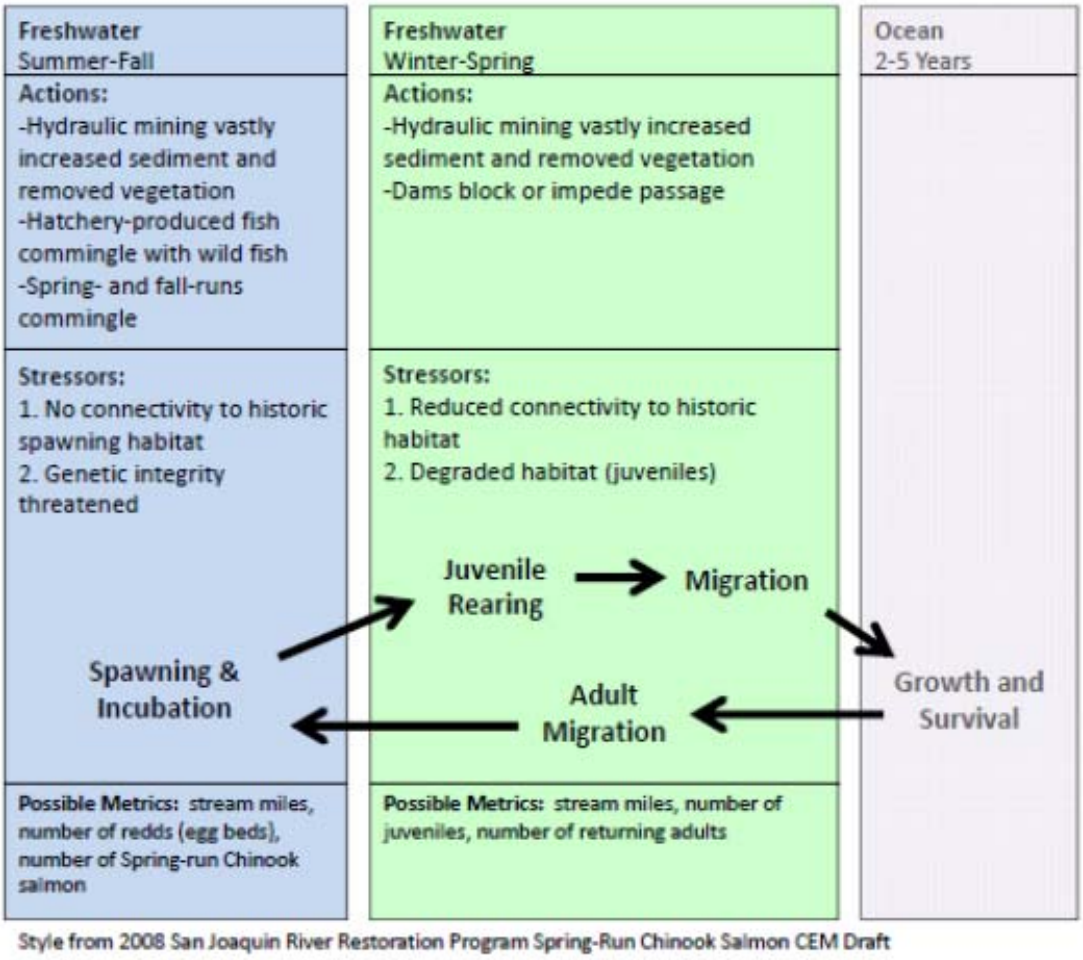
7. Problems, Opportunities, and Future Without-Project Conditions

Problems are undesirable conditions to be changed through the implementation of an alternative plan. Opportunities are positive conditions to be improved by an alternative plan. The difference between problems and opportunities is often simply a matter of perspective.

Because habitats of the Yuba River are healthy and recovering from historical disturbances (YCWA 2013), the largest remaining problem is the loss of habitat connectivity for anadromous fish species, which are nationally significant resources. Fish cannot access upstream habitat because of the presence of dams or effective fish passage mechanisms.

Conceptual models are helpful during the first steps of the planning process, as they provide a key link between early planning (e.g., an effective statement of problem, need, opportunity, and constraint) and later evaluation and implementation. For this 905(b) analysis, the following conceptual model (Figure 10) was developed, which explores the salmonid lifecycle and its connection to the Yuba River.

Figure 10. Salmonid Life Cycle Conceptual Model.



Style from 2008 San Joaquin River Restoration Program Spring-Run Chinook Salmon CEM Draft

7.1. Problems

The conceptual model assists in understanding the anadromous salmonids' lifecycles and functional relationships in the Yuba River, as summarized below.

1. Aquatic habitat connectivity has been lost. In particular, anadromous fish cannot access historic spawning habitat above Englebright Dam.

   Daguerre Point Dam may, under certain conditions, be an impediment to anadromous fish passage—salmonids can't use the fish ladders under some flow conditions, and sturgeon can't use the ladders at all. Additionally, fish may become injured as they pass downstream over Daguerre Point Dam. Englebright Dam blocks all anadromous fish passage.

2. The quality and quantity of aquatic, riparian, and general floodplain habitat has been diminished. In particular, anadromous fish spawning gravel has been reduced throughout the Yuba River, and juvenile rearing habitat has been reduced in the lower Yuba River.

In addition to what has been lost upstream of the dams, habitat loss, especially for juvenile anadromous fish, has contributed to reduced populations of native fish in the Yuba River. Although USACE's gravel augmentation program has increased the amount of spawning habitat downstream of Englebright Dam, high quality, complex and diverse juvenile rearing habitat is lacking, as is floodplain habitat.

3. Salmonid genetic diversity has declined throughout the study area and world-wide.

   The limited availability of spawning habitat and impeded passage can result in overlap of different spawning runs in the same spawning area during the same period, which reduces genetic integrity. Also, hatchery fish stray into the lower Yuba River from the Feather River and other systems and interbreed with the native fish as well as compete with native-spawned Yuba River fish for spawning habitat and other resources.

Anadromous salmonid populations in the Yuba River watershed have endured nearly 150 years of intense human degradation of their riverine habitat, starting with hydraulic gold mining in the mid-nineteenth century, and continuing through the construction of dams, including the two Corps dams - Englebright and Daguerre Point. Numerous stressors, several of which are associated with past hydraulic mining practices and these two dams, continue to affect the fishery resources in the Yuba River. Many of the most important stressors affecting anadromous salmonids in the Yuba River include passage impediments and barriers, physical habitat alteration, loss of riparian habitat and instream cover (e.g., riparian vegetation, instream woody material), loss of natural river morphology and function, loss of floodplain habitat, entrainment, predation, and hatchery effects. The key limiting factors, threats and stressors affecting spring- and fall-run Chinook salmon, as well as steelhead, are thoroughly discussed in USACE's 2013 BAs and are briefly summarized below.

The geomorphic conditions caused by hydraulic and dredge mining since the mid-1800s, and the construction of Englebright Dam, which affects the transport of nutrients, fine and coarse sediments and, to a lesser degree, woody material from upstream sources to the lower river, continue to limit habitat complexity and diversity, particularly for juvenile salmonids rearing in the lower Yuba River. Restricted availability of complex, diverse habitats such as multiple braided channels and side channels associated with the loss of natural river morphology and function also presently continues to be a relatively high stressor to Yuba River anadromous salmonids. Riparian vegetation and large woody material (LWM) play an important role in habitat complexity and diversity. The abundance and distribution of these physical habitat characteristics potentially limits the productivity of juvenile salmonids in the lower Yuba River. Also, the lower Yuba River floodplain is comprised of unconsolidated alluvium without an abundance of characteristics associated with increased juvenile salmonid growth. Englebright Dam is an impassable barrier to the upstream migration of anadromous salmonids, and marks the upstream extent of currently accessible Chinook salmon and steelhead habitat in the lower Yuba River. According to NMFS (2007, 2009, 2014), the greatest impact to listed anadromous salmonids in the Yuba River Watershed is the complete blockage of access for these species to their historical spawning and rearing habitat above Englebright Dam. Because of the loss of historical spawning and rearing habitat above Englebright Dam,

resultant loss of reproductive isolation and subsequent hybridization with fall-run Chinook salmon, restriction of spatial structure and associated vulnerability to catastrophic events, the existence of Englebright Dam is a very high stressor to Yuba River spring-run Chinook salmon, as well as to steelhead.

In addition to Englebright Dam, there are numerous issues associated with anadromous fish passage at USACE's Daguerre Point Dam. NMFS (2014) stated that passage conditions at Daguerre Point Dam are considered to be inadequate for Chinook salmon and steelhead throughout much of the year due to the design of the existing ladders. When high flow conditions occur during winter and spring, adult spring-run Chinook salmon and steelhead reportedly 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 (USACE 2013). In addition, NMFS (2014) stated that the angles of the fish ladder entrance orifices and their proximities to the plunge pool also increase the difficulty for fish to find the entrances to the ladders. Other configuration and design features of the fish ladders and passage facilities that reportedly could either delay or impede anadromous salmonid access to spawning and rearing areas above the dam include: (1) the control gate, acting as a submerged orifice, is only passable at low flows (actual flow data are unavailable) during the summer and fall; (2) "masking" of the entrances to the ladders when flow over the spillway occurs; (3) the ladders become clogged with debris; (4) unfavorable within-bay hydraulic characteristics, particularly associated with debris collection; (5) unfavorable fish ladder geometric configurations; and (6) sedimentation and unfavorable habitat conditions associated with egress from the fish ladders.

NMFS (2014) and other documents (NMFS 2002; CALFED and YCWA 2005) suggest that juvenile salmonids also may be adversely affected by Daguerre Point Dam on their downstream migrations, because Daguerre Point Dam creates a large plunge pool at its base, which provides ambush habitat for predatory fish in an area where emigrating juvenile salmonids may be injured or disoriented after plunging over the face of the dam into the deep pool below. The introduced predatory striped bass and American shad have been observed in this pool (CALFED and YCWA 2005).

7.2. Opportunities

According to USDOI (2010), some of the factors responsible for reductions in Chinook salmon populations can be minimized through restoration actions. Opportunities exist to significantly improve aquatic habitat connectivity, habitat quality and quantity, and genetic diversity, and to lessen stressors affecting anadromous salmonids in the Yuba River Watershed over the period of analysis.

1. There is an opportunity to reintroduce anadromous salmonids into the upper Yuba River Watershed.

Reintroduction of target populations (e.g., spring-run Chinook salmon and steelhead) into the highest quality, most available and persistent habitat in the upper Yuba River Watershed would be expected to expand the geographic distribution of anadromous salmonids, increase the overall amount of habitat available by reconnecting access to

previously blocked habitat, decrease the possibility of catastrophic decline, and increase the attributes of spatial structure and diversity. All of these factors decrease the extinction risk and thereby contribute to recovery.

2. There is an opportunity to restore side-channel habitat in the lower Yuba River.

In the lower Yuba River, opportunities exist to implement side-channel habitat restoration actions, shallow water rearing improvement actions, riparian habitat improvements and off-channel rearing actions. Habitat improvement actions in the lower Yuba River also would be expected to increase the productivity of Yuba River origin juveniles. Lower Yuba River habitat improvement actions could increase the carrying capacity of spawning habitat and, correspondingly, initial year class strength of spring-run Chinook salmon. Perhaps more importantly, it is anticipated that the lower Yuba River habitat improvement actions would focus on juvenile rearing and contribute to the overall goal of increasing productivity and survival of juvenile anadromous salmonids which subsequently return as adults to the lower Yuba River.

3. There is an opportunity to consider recreation in conjunction with any recommended ecosystem restoration features.

4. There may be an opportunity to re-establish a California red-legged frog population, not only along the Yuba River, but also in tributaries.

Opportunities will be explored further during the feasibility study.

7.3. **Future Without-Project Conditions**

If no Federal action is taken, the fisheries-related problems described above are expected to continue, and the stressors will persist and potentially become exacerbated. Incremental improvements to currently accessible habitat may be made by other entities. Populations of Chinook salmon and steelhead, while stabilizing, will be less than what an increase in connected habitat could support. Also, populations will not be as resilient to changing conditions due to the lack of access to upstream habitat as well as genetic homogenization.

Mining will continue in the Goldfields, and the tailings will remain. Restoration opportunities may be present in the Goldfields, however, due to the tremendous volume of gravel tailings and inability of those tailings to support much vegetation, this analysis does not include any recommendations for the Goldfields.

Restoration actions by other entities will continue. The US Bureau of Reclamation's Central Valley Basin Fisheries Programs has two projects in the planning phase, the Narrows Channel Restoration and the Daguerre Alley Floodplain Restoration Projects. The Yuba River Narrows Channel Restoration Project will restore up to 0.5 miles of in-channel spawning habitat by restoring and replenishing gravel and removing shot rock debris from the Narrows Reach, which is below Englebright Dam. The Daguerre Alley Floodplain Restoration Project will restore up to 180 acres of floodplain habitat and approximately

2.5 miles of side-channel habitat, which is particularly beneficial to juvenile salmonids.

The number of salmonids returning from the ocean will continue to fluctuate due to various stressors, such as fishing and ocean conditions. Because of management actions by the Pacific Fishery Management Council, such as seasonal commercial and recreational fishing bans when salmonid numbers are low, it is expected that returning salmonid populations will be sufficient to utilize available spawning and rearing habitat in the Yuba River.

Over the next 50 years, climate change is expected to be a stressor for anadromous salmonids in the Yuba River, and climate change in general poses an additional risk to the survival of salmonids in the Central Valley (NMFS 2014). According to National Oceanic and Atmospheric Administration (NOAA) research, under the expected warming of around 5°C, substantial habitat in the Central Valley would be lost, although significant amounts of habitat could remain, primarily in the Feather and Yuba rivers (Lindley et al. 2007). Literature suggests that by the year 2100, mean summer temperatures in the Central Valley may increase by 2 to 8°C, precipitation will likely shift to more rain and less snow, with significant declines in total precipitation possible, hydrographs will likely change, and Chinook salmon and steelhead will be more thermally stressed by stream warming at the southern ends of their ranges (e.g., Central Valley Domain) (NMFS 2014).

NMFS (2014) has prioritized the upper Yuba River (upstream of Englebright Dam) as a primary area to re-establish viable populations of spring-run Chinook salmon and steelhead. Recent studies conducted by YSF (2013) demonstrate that of all rivers/reaches in the Yuba River Watershed, the North Yuba River upstream of New Bullards Bar Reservoir and the lower Yuba River downstream of Englebright Dam provide the most thermally suitable amounts of habitat in the watershed. The North Yuba River, because of the lack of storage reservoirs and water management infrastructure, most closely approximates unimpaired conditions.

According to YCWA (2010), because of specific physical factors, hydrologic factors, and flows negotiated under the Yuba Accord the lower Yuba River is expected to continue to provide the most suitable water temperature conditions for anadromous salmonids of all Central Valley floor rivers, even if there are long-term climate changes. This is because New Bullards Bar Reservoir is a deep, steep-sloped reservoir with ample coldwater pool reserves that will continue to be available to provide sustained, relatively cold flows of water into the lower Yuba River during the late spring, summer and fall of each year (YCWA 2010).

Urban development along the Yuba River will be negligible. Most of the upper watershed is national forest land. The towns along the upper portions of the Yuba River are over an hour's drive from job centers, so they are not expected to grow significantly. Areas along the lower Yuba River are expected to remain rural; indeed, Yuba County's current general plan, from 1996, states that, "the Yuba County watershed will be conserved and protected through careful management of growth, development and timber harvesting within the watershed."

A preliminary permit for a proposed 3 mega-watt hydroelectric project on the south side of Daguerre Point Dam is currently undergoing a preliminary FERC proceeding (P-14432) (NMFS 2014a). However, no actions are planned at this time. It is assumed for this analysis that the

project would be required to mitigate its own impacts, if permitted.

Authorized Functions - Daguerre Point Dam

Under the Daguerre Point Dam project authority, USACE is responsible for various discretionary and non-discretionary functions. The discretionary functions include, but are not limited to, the timing and frequency of monitoring and clearing debris from the fish ladders, and managing sediment buildup across the upstream face of the dam. Future gravel injections and the Large Woody Material Management Plan are anticipated as components of USACE's voluntary conservation measures associated with the recent ESA consultation. USACE's Gravel Augmentation Implementation Plan contains guidance for a long-term gravel injection program to provide spring-run Chinook salmon spawning habitat in the bedrock canyon downstream of Englebright Dam. Non-discretionary functions include the inspection and maintenance of the dam structure and fish ladders to ensure they remain in good repair.

Authorized Functions - Englebright Dam

Under the Englebright Dam project authority, USACE is responsible for various discretionary and non-discretionary functions. The discretionary functions include activities related to the manner and frequency of maintaining the recreational facilities at the dam. Non-discretionary functions include the inspection and maintenance of the dam structure to ensure it remains in good repair. As a debris dam, USACE does not conduct any water control operations or releases.

8. Planning Goals and Objectives

Ecosystem restoration is one of the primary missions of USACE's Civil Works program. The ecosystem restoration planning objective is to contribute to national ecosystem restoration (NER). Contributions to NER outputs are increases in the net quantity and/or quality of desired ecosystem resources over the period of analysis (often 50 years). Measurement of NER, which is based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity, is expressed quantitatively in physical units, also known as metrics. The NER Plan is the alternative plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective.

Specific planning objectives will be developed with the non-Federal sponsor and study stakeholders during the feasibility study. The objectives will identify how the plan can reduce the risk of continued undesired outcomes, such as steelhead population declines, and/or increase the likelihood of desired outcomes, such as miles of accessible riparian habitat. Metrics will be developed in order to assess the outputs and effects of the alternatives. These metrics will likely be based on the anadromous fish species as indicator species.

Salmon are an effective indicator species because they are fairly easy to observe and they occupy the entire river ecosystem. They are sensitive to a variety of factors: water quality, food webs, river flows and processes, turbidity, and water temperature. Generally, if the quality of the watershed ecosystem declines, salmon populations will

decline. Also, salmon serve a key role in bringing nutrients from the ocean, such as nitrogen, into inland areas. These nutrients nourish countless other organisms.

One way to identify objectives is to use an example of a functioning habitat. For river ecosystem restoration projects, such an example is often called a "reference reach." One has not yet been identified along the Yuba River, partly because the Upper Yuba can't easily be compared to the Lower Yuba. During the feasibility study, possible reference reaches in other waterways will be investigated, such as along the Cosumnes River, the only undammed river draining west out of the Sierra, and the Trinity River or Battle Creek, which are undergoing restoration efforts.

For the reconnaissance study, the following preliminary objectives were identified. These objectives address three broader categories of problems and opportunities: 1) connectivity, 2) habitat quality and quantity, and 3) genetic integrity. Alternatives that meet these objectives will increase anadromous fish species' resiliency to withstand climate change as well as catastrophic events such as wildfires.

Appropriate, limited recreation, in conjunction with ecosystem restoration features, will be considered, consistent with USACE policy.

All of the objectives are throughout the study area over the period of analysis, which is expected to be 50 years.

Connectivity:

- Improve or provide access to habitat for anadromous salmonids within the Yuba River watershed.
- Improve upstream and downstream passage for green sturgeon in the lower Yuba River to provide access to suitable habitat.

Habitat Restoration

- Restore rearing habitat of juvenile anadromous salmonids.
- Restore spawning habitat of spring-run Chinook downstream of Englebright Dam.

Genetic Integrity

- Preserve genetic diversity of anadromous salmonids, particularly spring-run Chinook salmon.

Recreation

- Provide recreation opportunities in conjunction with ecosystem restoration features where recreation use would not detract from ecosystem outputs.

Meeting the above objectives will increase the resiliency of salmonids and green sturgeon. Increasing the availability and quality of spawning and rearing habitat will increase the likelihood that nationally-significant salmonids could continue to reproduce. Preserving genetic diversity protects the ability of a species to withstand diseases or changing conditions.

9. Planning Constraints and Key Considerations

During the feasibility study, specific study objectives and constraints will be addressed with the non-federal sponsor and study stakeholders.

At this time, no absolute constraints have been identified. However, a key limitation on the formulation process is that the study will not recommend any action that is legally required of another entity or USACE O&M. For instance, according to the Planning Guidance Notebook Appendix E, USACE will not propose any restoration projects or features that would result in treating or otherwise abating pollution problems caused by other parties where the other parties have, or are likely to have, a legal responsibility for remediation or other compliance responsibility. Any such actions will become part of the without-project condition.

The following considerations were recognized. They are not constraints, as they will not preclude consideration or selection of any potential measures or alternatives. However, the feasibility study will seek to identify measures and alternatives that address these considerations to the extent practicable.

- Avoid or minimize where practicable providing upstream passage for non-native fish.
- Avoid or minimize where practicable features that would require additional water rights.
- Avoid or minimize adverse effects on the downstream water users' diversions at Daguerre Point Dam.
- Avoid or minimize where practicable increasing flood risk.
- Avoid or minimize where practicable impeding navigation.
- Avoid or minimize where practicable impacts to groundwater recharge.
- Avoid or minimize where practicable impeding green sturgeon recovery efforts.
- Avoid or minimize where practicable impeding CRLF recovery efforts.
- Avoid or minimize where practicable impeding public access as currently allowed.

An outstanding challenge is and will remain the presence of significant quantities of toxic sediments behind Englebright and Daguerre Point Dams (including mercury, arsenic, chromium, copper, and nickel) deposited from past mining. Responsibilities for any hazardous clean up would be determined in accordance with applicable laws, regulations, and policies.

10. Fish and Wildlife Resources Considerations

10.1. Resource Significance

Ecosystem restoration is a priority mission of USACE. In contrast to more traditional study outputs, many of the outputs of ecosystem restoration projects cannot be measured in monetary terms. Without the option of quantifying ecosystem outputs in monetary terms, other criteria must be considered for evaluating and justifying ecosystem restoration projects. One such criterion is the "significance" of the ecosystem resource(s) associated with such projects. For this purpose, resource significance can be described in terms of institutional, public, and technical considerations as reflected in Section 3.

10.2. **Environmental Compliance**

The study must be compliant with all applicable laws and regulatory requirements. During the feasibility study, an environmental document will be prepared to evaluate potential impacts of an ecosystem restoration study on the existing environment. Factors addressed by the evaluation include, but are not limited to, public safety, water quality, wetlands, threatened and endangered species, noise, economics, fish, and wildlife. The National Environmental Policy Act (NEPA) review process will be completed, pursuant to requirements in 33 CFR Part 230. This process includes demonstrating compliance with all applicable laws and regulations to include the ESA, Clean Water Act, National Historic Preservation Act, Fish and Wildlife Coordination Act, Noise Control Act, Magnuson-Stevens Act, Executive Order 11988 on Floodplain Management, and Executive Order 11990 on the Protection of Wetlands.

10.3. **Surveys Needed for Feasibility Study**

There have been many studies and surveys in the Yuba River Watershed. Recently, efforts have increased to understand portions of this system, primarily the lower Yuba River, resulting from the Lower Yuba River Accord and FERC relicensing efforts for the hydropower facilities associated with Englebright Dam and New Bullards Bar Dam. In addition to the lower Yuba River studies, there have been habitat surveys and modeling of habitat in the Upper Yuba River Watershed to identify quantity and quality of habitat for salmon in the event that passage is restored to allow fish to access these reaches. Many of these studies and models have been focused on water temperature, which is likely a limiting factor for much of the watershed. However, there may be structural opportunities that need to be evaluated which would require additional evaluation of current habitat conditions.

While there has been a significant effort to understand this system and its processes, there will likely be additional surveys and studies for supporting the feasibility study. Much of this effort will likely build on the previous and ongoing efforts, but may need to be site-specific or build upon or continue efforts that were performed previously, but are not currently ongoing. There may be new studies looking at the predator populations and movements in the lower Yuba River and perhaps additional habitat evaluations in the upper Yuba River. Also, hydraulic evaluations of areas in the watershed may be necessary to identify feasible locations for collecting fish if relocation is considered in the alternatives. Surveys of tributary habitats should be considered to help to determine the extent of opportunity to restore habitat for fish, amphibians and other riparian habitat-associated animals. Since much of the existing habitat work has been focused on salmon and steelhead, it may require additional effort to identify and evaluate opportunities for other ESA-listed species such as the CRLF.

Some specific studies might include use of acoustic telemetry and snorkel surveys to monitor fish movement and habitat use. Continued surveys of redds, gravel movement, and channel complexity might also be necessary to help develop alternatives and better identify future-without-project conditions.

11. Historical and Cultural Resources Considerations

Historical Resources

YCWA conducted archaeological and historical architecture studies as part of the FERC relicensing process. The FERC Project Area of Potential Effects (APE) lies within the reconnaissance study area. The APE encompasses approximately 9,600 acres, and YCWA received the California State Historic Preservation Office's (SHPO's) concurrence on the APE in a letter dated February 5, 2013.

In 2009, YCWA performed records searches at the Northeast Information Center at California State University, Chico and the North Central Information center at California State University, Sacramento. It was determined that approximately 2000 acres of the APE had been previously surveyed. One hundred and fifty-six (156) previously recorded archaeological sites are within the FERC Project Boundary and 0.25-mile buffer. Of these, 26 sites were inside the APE and the remaining 130 sites are within the 0.25-mile buffer outside the APE. No previously recorded sites were identified for the Sierra County portion of the FERC Project. None of the previously recorded sites within the APE had been formally evaluated for the National Register of Historic Places (NRHP) at the time of the 2009 records search. Since the records searches are over five years old, a new records search will be conducted for the APE during the feasibility study. The feasibility study will have its own APE separate from the FERC APE.

In 2011 and 2012, YCWA conducted field surveys within the entire expanded FERC Project APE which were coordinated with US Forest Service archaeologists. Because the previous surveys were more than ten years old, it was decided that the entire APE should be resurveyed. An additional 31 sites were recorded. The study identified a total of 57 archaeological sites within the APE. Of the 57 sites identified within the APE, twenty-three were prehistoric archaeological sites. Sixteen prehistoric sites were previously recorded prior to the 2011- 2012 surveys. Thirty-two historic sites were identified within the APE. Of the historic sites identified in the APE, eight were previously recorded. A total of two previously recorded multicomponent sites were identified within the FERC Project APE. Additionally, the archaeological survey identified 13 isolated artifacts.

YCWA evaluated both previously recorded and newly identified archaeological sites and built environment resources for their eligibility for listing on the NRHP when those resources could be evaluated at the inventory level. As a result, 10 archaeological sites and 16 built environment resources were evaluated as ineligible for listing on the NRHP and will require no further management upon SHPO NRHP eligibility concurrence with eligibility determinations. The New Colgate Powerhouse and Penstock are recommend as eligible for listing on the NRHP and will require SHPO NRHP eligibility concurrence. Of the 57 archaeological sites identified in the APE, 47 sites remain unevaluated for NRHP eligibility.

In 2000, USACE evaluated Daguerre Point Dam as not eligible for inclusion to the NRHP. The ineligibility determination was based on four criteria: A) the dam's insignificance with respect to important historical events, namely the California gold rush, B) the lack of association with significant persons, C) the lack of unique construction methods or

style, and D) the dam is not likely to yield important information. Also, the dam lacks overall integrity, since it is a 1965 replacement structure. The SHPO was not consulted regarding the previous NRHP eligibility determination. This, along with the results and recommendations from the pedestrian survey, need to be coordinated with the SHPO prior to proceeding with any actual construction or ground-disturbing activities.

Native American Resources

YCWA contacted the Native American Heritage Commission in 2009 to determine which Native American Tribes could have interest in the Project Area. It is recommended that a new Tribal contact list be obtained from the Native American Heritage Commission to ensure that all interested Tribes have been contacted. YCWA conducted a Native American Traditional Cultural Properties (TCP) study to determine if the proposed study had the potential to have an adverse effect on historic properties, including traditional cultural properties (TCP) and ethnographic resources that qualify for listing on the National Register of Historic Places (NRHP). The APE for this FERC study was approximately 4,300 acres and which overlaps most of the reconnaissance study area. Since the TCP study was completed in 2012, YCWA expanded the APE to 9,600 acres, which was concurred with by the SHPO in 2013. YCWA conducted several consultation meetings with tribes and agencies beginning in 2009 and continuing into 2012. The study did not identify any TCPs within or near the FERC Project APE.

After obtaining a current list of Tribes with interest in the study area, USACE will continue to consult about the feasibility study within the feasibility study APE.

12. Formulating Alternative Plans

12.1. Preliminary Measures

A measure is a feature or an activity that can be implemented at a specific geographic location to address one or more planning objectives. Generally, measures are components that are grouped together to form alternative plans. Based on published reports, site visits, Corps operations and maintenance (O&M) actions, and communication with the likely non-federal sponsor and stakeholders, below is a preliminary list of measures arranged by objective for the Yuba River.

These preliminary measures have been identified as being conceptually representative of a range of measures for the restoration of anadromous fish populations and/or their habitat within the Yuba River Watershed. The final form of a measure may be different than what is listed below. However, regardless of the form of any specific measure, two overarching considerations will be assessed when further describing and/or examining any potential measure during the feasibility study: (1) any significant reduction in the quality of existing anadromous fisheries habitat below Englebright Dam is to be avoided, as it would potentially represent a degradation of existing populations; and (2) given the high flood risk that currently exists in most of the Sacramento River Basin and the extensive efforts (and tremendous costs) currently being expended to improve flood protection, any significant reduction in flood management capability of the lower Yuba, Feather, or Sacramento rivers

should be considered unacceptable. This would include avoiding release of large quantities of sediment from behind Englebright Dam.

Aquatic Habitat Connectivity

- Remove Daguerre Point Dam
- Remove Englebright Dam
- Construct step pools up to Daguerre Point Dam
- Construct a second dam as step to Englebright Dam
- Reconstruct fish ladders at Daguerre Point Dam
- Install a full fish ladder at Englebright Dam
- Notch Englebright Dam and install a partial fish ladder
- Construct a fish bypass around Daguerre Point Dam
- Construct a fish bypass around Englebright Dam
- Collect and haul around Englebright Dam
- Collect and haul around New Bullards Bar Dam
- Hallwood-Cordua fish screen improvement
- South Yuba/Brophy fish screen improvement

Habitat Restoration

- Sinoro Bar shot-rock removal, gravel placement
- Shot-rock stabilization
- Deer Creek gravel augmentation
- Gravel placement
- Upper Rose Bar improvement with local gravel
- Native riparian vegetation planting
- Predator control at Daguerre Point Dam and in general
- Daguerre Alley side-channel
- Other/various side-channel construction
- Rice field rearing
- Floodplain rearing habitat restoration
- Natural habitat features (such as root wads, whole trees, and wood jams) installation
- Engineered riffles or boulder fields to reduce velocities and restore channel complexity
- Bioengineering features to facilitate vegetation establishment
- Install new security features or reconstruct existing barriers, etc. to limit public access (where access is currently prohibited) at Daguerre Point Dam to reduce poaching.

Genetic Integrity

- Segregation structure (weir or gate) for spring- and fall-run Chinook salmon downstream of Englebright Dam
- Segregation structure for wild and hatchery fish
- Collect and haul around Englebright Dam
- Collect and haul around New Bullards Bar Dam and Reservoir
- Coordinated management with Feather River operations and hatchery

12.1.1. **Screening of Measures**

A preliminary screening of the identified measures was done in an attempt to reduce the

number of candidate measures before combining them into preliminary alternatives. For example, the removal of New Bullards Bar Dam was screened out because dam removal would eliminate 170,000 acre-feet of dedicated flood storage, thus significantly increasing flood risk. Measures had to address at least one objective and be practicable. For example, wetland restoration and vernal pool protection were considered but screened out because they do not address one of the three main objectives of fish habitat connectivity, riverine aquatic habitat restoration, or salmonid genetic integrity. Measures targeting the Goldfields were not retained due to practicability; at this time, techniques are lacking to restore large amounts of cobble into riparian habitat. Installation of a hatchery was screened out because it conflicts with the objective of maintaining genetic integrity. During the feasibility study, the measures listed above, as well as any additional measures yet to be identified, will be screened to determine whether each measure should be retained for use in the formulation of the alternative plans. Screening criteria during the feasibility phase will likely include cost effectiveness, whether the measure meets multiple objectives, how well the measure has performed at other projects (likelihood of success), and whether the measure is expected to be constructed by another entity. Also, the four planning criteria of completeness, efficiency, effectiveness, and acceptability will be employed to screen measures and formulate alternatives.

12.2. **Alternative Formulation Strategies**

An alternative formulation strategy is a method for grouping measures into alternatives. For the reconnaissance study, a formulation strategy based on fish passage barriers to salmonids, classes of aquatic habitat restoration, and river reaches was used. Barriers to salmonids are the dams, and because the dams are large structures and the causes of the major problem on the river (fish passage), it was logical that alternatives should be formulated to address problems posed by those structures. Classes of aquatic habitat restoration were focused on salmonid life phase: spawning or juvenile rearing. Lastly, river reaches were included in the formulation strategy simply to organize features by location.

The alternative formulation strategy will be finalized during the feasibility phase of the study. During the feasibility study, the formulation strategy or strategies will be developed based on scoping. Through scoping, stakeholder input will be sought. Some of the preliminary alternatives presented in this analysis may be modified, some may be eliminated, and still other additional alternatives may be added.

13. Array of Alternatives

For the purposes of this analysis, nine potential alternatives were considered, including the No Action alternative. The alternatives are intended to demonstrate minimum and maximum connectivity levels along the reaches from Daguerre Point Dam to Englebright Dam, from Daguerre Point Dam to New Bullards Bar Dam, and from Daguerre Point Dam to the North Yuba River upstream of New Bullards Bar Dam. Operation of the collect-and-haul measure would be an O&M requirement, and thus undertaken by the non-federal sponsor. Quantifiable metrics to evaluate alternative benefits/outputs will be identified during the feasibility study. The preliminary array of alternatives along with their expected outputs is shown in Table 1.

The preliminary alternatives were developed based on several assumptions. One was assuming that screening of measures done by other groups, such as the YSF was consistent with the process USACE will follow, so that USACE would reach the same conclusions. For instance, complete removal of Englebright Dam was not included, as earlier studies have indicated it would be cost-prohibitive, especially with respect to disposing of the toxic contaminated sediment behind it.

Table 1. Preliminary Potential Alternatives.

Alternative	**Description**	**Benefits/Outputs**	**Preliminary Construction Cost Estimate[1]**
No Action	USACE will not construct a restoration project.	0	$0
1 – Daguerre to Englebright, Minimum Connectivity	□Plant riparian vegetation and place LWM. □Reconstruct the Daguerre fish ladders.	□Minimal increase in connectivity □12 miles of juvenile habitat □No increase in genetic integrity	$30-40M
2 – Daguerre to Englebright, Minimum Connectivity plus Segregation Facility	Same as above with the addition of: □segregation structure to sort spring and fall runs, hatchery fish, and wild salmonids	□Minimal increase in connectivity □12 miles of juvenile habitat □Increase in genetic integrity	$35-50M
3a – Daguerre to Englebright, Maximum Connectivity	□Plant riparian vegetation and place LWM. □Construct bypass channel at Daguerre (for green sturgeon). □Construct step-pools for fish passage at Daguerre.	□Moderate increase in connectivity □12 miles of juvenile habitat □No increase in genetic integrity	$30-60M
3b – Daguerre to Englebright, Maximum Connectivity plus Segregation Facility	□Plant riparian vegetation and place LWM. □Construct bypass channel at Daguerre (for green sturgeon). □Construct step-pools for fish passage at Daguerre. □Install a segregation structure.	□Moderate increase in connectivity □12 miles of juvenile habitat □Increase in genetic integrity	$30-65M
3c – Daguerre to Englebright, Maximum Connectivity, Remove Daguerre	□Plant riparian vegetation and place LWM. □Remove Daguerre Point Dam (and relocate diversions).	□Moderate increase in connectivity □12 miles of juvenile habitat □No increase in genetic integrity	$125-150M
4a – Daguerre to New Bullards Bar, Maximum Connectivity plus Segregation Facility	Same as 3b plus: □notching Englebright Dam and constructing a partial ladder	□Moderate increase in connectivity □30 miles of juvenile habitat □No increase in genetic integrity	$100-150M
4b – Daguerre to New Bullards Bar, Maximum Connectivity, Remove Daguerre plus Segregation Facility	Same as 3c with the additions of: □segregation structure □notching Englebright Dam and constructing a partial ladder	□Moderate increase in connectivity □30 miles of juvenile habitat □Increase in genetic integrity	$2.6-2.7B

Alternative	Description	Benefits/Outputs	Preliminary Construction Cost Estimate[1]
5a – Daguerre to Upper Yuba[2], Maximum Connectivity plus	Same as 3a with the additions of: collecting and hauling migrating salmonids segregation structure	Maximum increase in connectivity 40+ miles of juvenile habitat Increase in genetic integrity	$270 - 305M
5b – Daguerre to Upper Yuba[1], Maximum Connectivity, Daguerre	Same as 3c with the additions of: collecting and hauling migrating salmonids segregation structure	Maximum increase in connectivity 40+ miles of juvenile habitat Increase in genetic integrity	$300-500M

1 These cost estimates are generally prepared based on very limited information, and they have wide accuracy ranges. They are only presented in this analysis to convey relative costs among alternatives. Actual cost estimates will be developed during the feasibility study.

2 Upper Yuba extends past New Bullards Bar Reservoir.

The cost range of the preliminary action alternatives is estimated to be $30 million to $2.7 billion. Preliminary costs were based on other Yuba River studies, such as the 2013 YSF Fish Passage Infrastructure Report, other Corps estimates for different restoration projects, US Forest Service river restoration costs, and local restoration projects like construction of a side channel along the Green River in Kent, Washington.

In order to evaluate the alternatives for the feasibility study, results of monitoring of the Yuba River habitat repair work already underway by USACE as part of its O&M activities will be reviewed. Other comparison and evaluation criteria in addition to that used to screen measures may include how much an alternative plan reduces predation and whether it adds to water temperature management capability.

Any alternative that has the potential to release mercury through ground- or streambed-disturbing activities will need to be investigated further. Attempts will be made to formulate alternatives that avoid actions that could make mercury biologically available. However, if remediation is required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), financial responsibility for such remediation will be determined in accordance with the requirements of CERCLA, applicable regulations and Corps policy as described in Engineer Regulation 1165-2-132.

Additionally, several ecosystem restoration models will be used. USACE's Engineer Research and Development Center (ERDC) has a connectivity model to evaluate fish passage barriers. The Forest Service's FishXing software can be used to design aquatic organism passage facilities. USACE's Institute for Water Resources (IWR) is developing a salmon- specific model for larger fish passage projects. Greg Pasternak with the University of California, Davis developed an ecohydraulic 2-dimensional model using SRH-2D of the lower Yuba River. A US Fish and Wildlife Service (FWS) Habitat Evaluation Procedure (HEP) model for Chinook salmon may be used. IWR Plan, the Cost Effectiveness/Incremental Cost Analysis (CE/ICA) software from the IWR Planning Suite, will be used to evaluate and compare alternatives.

13.1. **Environmental Impacts**

The relative levels of potential environmental impacts for the preliminary alternatives were estimated based on the amount of ground- or streambed-disturbing work that each alternative would entail. Clearly, potential environmental impacts need to be quantified and analyzed during the feasibility study. Table 2 displays the alternatives and the preliminarily expected level of impact by category—"highs" are bolded.

Most impacts would be temporary due to construction, including impacts to biological resources; some wildlife could be affected during construction in and along the river. Negative effects will be minimized by scheduling work around protective windows, employing best management practices and adhering to Federal and applicable state regulations. Modifications to Englebright Dam would likely affect hydroelectric facilities, so those effects would have to be fully explored, evaluated, and addressed during the feasibility study.

Table 2. Preliminary Environmental Impact Assessment.

Alternative	**Impact Category**									
	Soils	Land	Air Qualit	Water Quality	Biological Resource	Cultural Resource	Traffic	Noise	Recreation	Aesthetics
No Action	None	None	None	None	None	None	None	None	None	None
1 – Daguerre to Englebright, Minimum	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
2 – Daguerre to Englebright, Minimum Connectivity plus	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
3a – Daguerre to Englebright, Maximum	**High**	Low	Low	**High**	**High**	Low	**High**	Low	Low	Low
3b – Daguerre to Englebright, Maximum Connectivity plus	**High**	Low	Low	**High**	**High**	Low	**High**	Low	Low	Low
3c – Daguerre to Englebright, Maximum Connectivity, Remove	**High**	Low	Low	**High**	**High**	Low	**High**	Low	Low	Low
4a – Daguerre to New Bullards Bar, Maximum Connectivity plus Segregation Facility	**High**	Low	Low	**High**	**High**	Low	**High**	**High**	**High**	Low
4b – Daguerre to New Bullards Bar, Maximum Connectivity, Remove Daguerre plus Segregation	**High**	Low	Low	**High**	**High**	Low	**High**	**High**	**High**	Low
5a – Daguerre to Upper Yuba, Maximum Connectivity plus	**High**	**High**	**High**	**High**	**High**	Low	**High**	**High**	**High**	Low
5b – Daguerre to Upper Yuba, Maximum Connectivity, Daguerre Point Dam Removal plus Segregation	**High**	**High**	**High**	**High**	**High**	Low	**High**	**High**	**High**	Low

14. Key Assumptions and Uncertainties

In order to scope the feasibility study, the following assumptions were made and uncertainties identified. The scope of the feasibility study will be based on these assumptions as well as any others identified during Project Management Plan (PMP) development. Uncertainties are items or activities that may significantly impact the feasibility study; they can change, or details are not yet known. These will be refined further during development of the PMP and will be documented and qualified in a risk register.

Assumptions:

- A high degree of study/project management coordination will be needed among the study team, including the non-federal sponsor(s), and the vertical team and stakeholders.
- The non-federal sponsor or other stakeholders will supply some preliminary engineering design work and technical support, which will be reviewed by USACE to verify that it meets Federal standards and requirements.
- Water management with respect to anadromous fish species is being addressed through FERC relicensing and the Yuba River Accord.
- Environmental analysis will be an Environmental Impact Statement (EIS).
- Environmental specialist will need to coordinate with non-federal sponsor on California Environmental Quality Act (CEQA) analysis.
- The decision document will be an integrated feasibility report and NEPA/CEQA document.
- No topographic, bathymetric, or soil surveys will be conducted.
- An MCACES cost estimate will be performed on the selected plan at a level suitable for a feasibility study.
- Preliminary costs are available.
- Data on the likelihood of restoration measure success are available and appropriate.
- Due to significant tribal interest on other projects in the region and not due to any known controversy, consultation efforts could be greater than for similar feasibility studies.

Uncertainties

- Dam safety is not known to be a high risk.
- Details and schedules of other activities, including restoration actions, are not fully known.

15. Feasibility-Phase Cost Estimate and Schedule

The feasibility study will be a Corps SMART Planning study, where SMART stands for Specific, Measurable, Attainable, Risk-Informed, and Timely. As such**,** it will meet the "3x3x3" planning rule: the study will take no longer than three years to result in a signed Chief's Report at a cost no greater than $3 million and involve all three levels of the organization (district, division, headquarters).

The feasibility study is expected to cost approximately $3 million. Out of the $3 million, $150,000 is a 100% Federal cost for IEPR. So the remaining study cost to be cost-shared 50%-50% is $2.85 million. The non-federal sponsor will pay $1.425 million. The Federal government will pay $1.425 million plus the $150,000 for IEPR for a total of $1.575 million. The cost estimate will be refined during PMP development. The cost estimate is broken down by discipline as shown in Table 3 below. (District Quality Control is included with each discipline.)

Table 3. Preliminary feasibility study cost estimate.

Discipline	Cost ($)
Project Management	500,000
Plan Formulation	500,000
Economics	70,000
Dam Safety	15,000
Fish Biology	150,000
Environmental Planning	450,000
Cultural Resources	95,000
Hydraulic Engineering	270,000
Civil Design	100,000
Geotechnical Eng.	100,000
Environmental Eng.	100,000
Real Estate	50,000
Tribal Liaison	50,000
Cost Engineering	120,000
Operations	75,000
Agency Technical Review Team	100,000
IEPR[1]	150,000
Contingency	105,000
Total	3,000,000

[1]Independent External Peer Review

The cost estimate is based on the cost of a similar ecosystem restoration study involving fish habitat connectivity and dams as well as the assumptions listed in Section 14. It will be further refined during the development of the PMP. Although the preliminary overall estimate of the cost of the feasibility study is anticipated to remain as indicated, significant re-allocation among the specific disciplines listed above may be necessary. Additionally, the discipline allocation may change as a result of non-Federal sponsor cost share contributions.

Below is a preliminary schedule based on the availability of full funding, a similar feasibility study, and standard review durations.

Action	Date	Duration
Sign FCSA	Mar 2015	+1 month
Start Feasibility Study	Apr 2015	+6 months
Alternatives Milestone	Oct 2015	+1 year
Tentatively Selected Plan Milestone	Oct 2016	+8 months
Agency Decision Milestone	Jun 2017	+3 months
Final Report Milestone	Sep 2017	+3 months
Civil Works Review Board	Dec 2017	+3 months
Chief's Report	Mar 2018	

16. Letter of Intent

As the non-federal sponsor, YCWA is willing and able to partner in the 50/50 cost-share of the feasibility study and fully understand the responsibilities required of a non-federal sponsor for feasibility studies. The non-federal sponsor is also aware of the cost-sharing requirements for potential project implementation. A Letter of Intent from the non-federal sponsor stating a willingness to purse the feasibility study and to share in its cost, and an understanding of the cost-sharing that is required for project construction, is included as Attachment A.

17. Recommendation

I recommend that the Yuba River Ecosystem Restoration Study proceed into the feasibility phase. This recommendation is based on Federal interest, consistency with Army and budgetary policies, and the likelihood of a project meeting criteria for Federal participation in project implementation.

Date

/S/
Michael J. Farrell
Colonel, U.S. Army
District Commander

Attachment A – Letter of Intent

This page left blank intentionally.

September 9, 2014

Colonel Michael J. Farrell
District Engineer
Sacramento District
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Dear Colonel Farrell:

I am writing to confirm the willingness of the Yuba County Water Agency (YCWA) to pursue the feasibility study and to share in the costs of construction of the U.S. Army Corps of Engineers (Corps) Yuba River Ecosystem Restoration Feasibility Study.

Subject to YCWA's final review of the study and approval by the Board of Directors, YCWA will share in the costs to study, design and construct the project as the Non-Federal Sponsor.

The Yuba River Ecosystem Restoration Study was one of only three ecosystem restoration project studies authorized by the Corps in 2014. Congressional authorization to initiate the Reconnaissance Study was granted through the Energy and Water Development Appropriations Act, 2014, Division D, P.L. 113-76. YCWA, and conservation groups, supported, and continue to support, this study as an invaluable step in the development of a contemporary, science-based assessment of the Yuba River including listed fish species and the two Corps debris retention dams (Daguerre and Englebright), and the evaluation of options to improve Central Valley fisheries habitat.

YCWA has a long history of successful collaboration with the Corps, including the Sacramento District, on flood risk reduction projects throughout Yuba County. This study presents a new opportunity for the Corps and YCWA to become full partners in the development of an important Feasibility Study.

Sincerely,

Curt Aikens

Curt Aikens
General Manager

cc: YCWA Board

Main Office: 1220 F Street • Marysville, CA 95901-4740 • 530.741.5000 • *Fax:* 530.741.6541
Colgate Power House: 12700 Lake Francis Road • P.O. Box 176 • Dobbins, CA 95935-0176 • 530.740.7000 • *Fax:* 530.740.7101
www.ycwa.com

This page left blank intentionally.

Attachment B – Bibliography

This page left blank intentionally.

Yuba River Ecosystem

Section 905(b) Analysis

Bibliography

Adams, P. B., B. Churchill, J. E. Grimes, S. T. Hightower, S. T. Lindley, and M. L. Moser. 2002. NMFS Status Review for North American Green Sturgeon.

Beak Consultants, Inc. 1989. Yuba River Fisheries Investigation, 1986-1988. Summary Report of Technical Studies on the Lower Yuba River, California. Prepared for Sate of California Resources Agency Department of Fish and Game.

Beamesderfer, R. C. P., M. L. Simpson, and G. J. Kopp. 2007. Use of Life History Information in a Population Model for Sacramento Green Sturgeon. Environ. Biol. Fish. DOI 10.1007/s10641-006-9145-x.

CALFED. 2000. Final Programmatic Environmental Impact Statement/Environmental Impact Report. CALFED Bay-Delta Program. Prepared by the CALFED Bay-Delta Program for the U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, Natural Resources Conservation Service, U.S. Army Corps of Engineers, and the California Resources Agency.

CALFED and 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.

CDFG. 1991. Steelhead Restoration Plan for the American River.

CDFG. 1998. Report to the Fish and Game Commission: A Status Review of the Spring-Run Chinook Salmon (*Oncorhynchus tshawytscha*) in the Sacramento River Drainage. Candidate Species Status Report 98-01.

CDFW. 2010. California Salmonid Stream Habitat Restoration Manual. https://www.dfg.ca.gov/fish/resources/habitatmanual.asp. Accessed Sep 2014.

Churchill, R.K. 2000. Contributions of mercury to California's environment from mercury and gold mining activities; Insights from the historical record, *in* Extended abstracts for the U.S. EPA sponsored meeting, Assessing and Managing Mercury from Historic and Current Mining Activities.

DWR. 2004. Evaluation of the Feather River Hatchery Effects on Naturally Spawning Salmonids.

DWR Upper Yuba River Studies Program Study Team. 2007. Upper Yuba River

Watershed Chinook Salmon and Steelhead Habitat Assessment.

Klimley, A. P., P. J. Allen, J. A. Israel, and J. T. Kelly. 2007. The Green Sturgeon and Its Environment: Past, Present, and Future. Environmental Biology of Fishes. Volume 79: 415-421.

Krueper, D. J. 1993. Effects of land use practices on Western riparian ecosystems. Pages 321- 330 in Status and management of Neotropical migratory birds. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Lindley, S. T., R .S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science. Volume 5(1):26 Article 4.

McEwan, D. and T. A. Jackson. 1996. Steelhead Restoration and Management Plan for California. California Department of Fish and Game.

Mount, J.F. 1995. California Rivers and Streams: The Conflict Between Fluvial Process and Land Use. University California Press, Berkeley, California.

Moyle, P. B. 2002. Inland Fishes of California. University of California Press, Berkeley and Los Angeles, California.

NMFS. 2002. Biological Opinion on the Effects of USACE' 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 (*0. mykiss*) and Their Respective Designated Critical Habitats.

NMFS. 2005. Biological Opinion Based on Review of the Proposed Yuba River Development Project License Amendment for Federal Energy Regulatory Commission License Number 2246, Located on the Yuba River in Yuba County, California, and Its Effects on Threatened Central Valley Spring-Run Chinook Salmon (*Oncorhynchus tshawytscha*) and Central Valley Steelhead (*O. mykiss*), in Accordance With Section 7 of the Endangered Species Act of 1973, As Amended.

NMFS. 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.

NMFS. 2009. Endangered and Threatened Wildlife and Plants: Final Rulemaking

To Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon; Final Rule.

NMFS. 2012. Final Biological Opinion on the U.S. Army Corps of Engineers' Continued Operation and Maintenance of Englebright Dam and Reservoir, Daguerre Point Dam, and Recreational Facilities On and Around Englebright Reservoir.

NMFS. 2014. Pacific Salmonids: Major Threats and Impacts. http://www.nmfs.noaa.gov/pr/species/fish/salmon.htm. Accessed August 2014.

NMFS 2014a. Recovery Plan for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

NMFS. 2014b. Final Biological Opinion on the U.S. Army Corps of Engineers' Operation and Maintenance for Daguerre Point Dam on the Yuba River.

NMFS. 2014c. Letter of Concurrence for the U.S. Army Corps of Engineers' Operation and Maintenance for Englebright Reservoir on the Yuba River.

Pasternack, G. B. 2010. Gravel/Cobble Augmentation Implementation Plan (GAIP) for 19 the Englebright Dam Reach of the Lower Yuba River, CA. Prepared for the U.S. 20 Army Corps of Engineers Sacramento District.

Potter, D.A. 2005. Riparian plant community classification: west slope, central and southern Sierra Nevada, California. Gen. Tech. Rep. R5-TP-022. Albany, CA: U.S. Department of Agriculture, Forest Service. Pacific Southwest Region. 630 p.

Reisenbichler, R.R. and S.P. Rubin. 1999. Genetic Changes from Hatchery Propagation Affect Productivity and Viability of Wild Populations. ICES Journal of Marine Science, 56: 459-466.

Reynolds, F.L., Mills, T.J., Benthin, R., and Low, A. 1993. Restoring Central Valley Streams: A Plan for Action. California Department of Fish and Game, Inland Fisheries Division. Sacramento, California.

River Management Team (RMT). 2013. Aquatic Resources of the Lower Yuba River – Past, Present & Future, Yuba Accord Monitoring and Evaluation Program, Draft Interim Report. April 2013.

RMT. 2010. River Management Team Technical Memorandum: Lower Yuba River Water Temperature Objectives. November 2010.

SWRI, JSA, and Bookman-Edmonston Engineering, Inc. 2000. Hearing Exhibit S-YCWA-19.

Expert Testimony on Yuba River Fisheries Issues by Surface Water Resources, Inc., Junes & 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.

USACE. 2013. Biological Assessment for Operation and Maintenance for Daguerre Point Dam on the Yuba River.

USACE. 2013. Biological Assessment for Operation and Maintenance for Englebright Reservoir on the Yuba River.

United States Forest Service (USFS) Tahoe National Forest. 2014. Willow Flycatcher – Introduction. http://www.fs.usda.gov/detail/tahoe/landmanagement/resourcemanagement/?cid=stelprdb5357314

Vogel, D. A. and K. R. Marine. 1991. Guide to Upper Sacramento River Chinook Salmon Life History. U.S. Bureau of Reclamation Central Valley Project.

YCWA, DWR, and Reclamation. 2007. Draft Environmental Impact Report/Environmental Impact Statement for the Proposed Lower Yuba River Accord. State Clearinghouse (SCH) No: 005062111. Prepared by HDR|Surface Water Resources, Inc.

YCWA. 2010. Pre-Application Document, Yuba County Water Agency Yuba River Development Project FERC Project No. 2246.

YCWA. 2012. Technical Memorandum 13-1: Traditional Cultural Properties, Yuba County Water Agency Yuba River Development Project FERC Project No. 2246.

YCWA. 2013. Technical Memorandum 12-1: Historic Properties, Yuba County Water Agency Yuba River Development Project FERC Project No. 2246.

YCWA. 2014. Yuba River Development Project Final License Application for FERC Project No. 2246. April 2014. http://www.ycwa-relicensing.com/Relicensing%20Documents/Forms/AllItems.aspx?RootFolder=%2fRelicensing%20Documents%2fRelicensing%20Documents%2009%20%2d%20Final%20License%20Application&FolderCTID=&View=%7b31B99738%2dB3DA%2d4CD0%2dA63E%2d01898DE55BAB%7d

Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical Abundance and Decline of Chinook Salmon in the Central Valley Region of California. North American Journal of Fisheries Management. Volume 18: 487-521.

Yoshiyama, R. M., E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California. Contributions to the Biology of Central Valley Salmonids. Fish Bulletin 179, Volume 1.

Yuba Salmon Forum (YSF). 2013. Summary Habitat Analysis. Prepared for the Yuba Salmon Forum Technical Working Group. Prepared by Craig Addley, PhD (Cardno ENTRIX), Katie Ross-Smith, PhD (Cardno ENTRIX), and Peter Graf (Cardno ENTRIX. September 2013.

YSF. (2013). Assessment of Infrastructure and Related Items to Support Anadromous Fish Passage to the Yuba River Watershed, Prepared by MWH for the Yuba Salmon Forum. March 2013.