COLEMAN

National Fish Hatchery
California
Intake Alternatives Study

U.S.
FISH & WILDLIFE
SERVICE
DEPARTMENT OF THE INTERIOR

Final Report

INTAKE ALTERNATIVES STUDY

FOR

COLEMAN NATIONAL FISH HATCHERY

Final Report

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By:

Sverdrup

and

Tetra Tech/KCM, Inc.

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EXECUTIVE SUMMARY

The following study reviews and assesses the water intake diversion and supply system for Coleman National Fish Hatchery (CNFH) and alternatives for improving it to meet the current fish protection standards. CNFH is located in Shasta County, California, on the north bank of Battle Creek. Battle Creek has long been recognized as one of the three remaining Sacramento River Tributaries in which natural spring-run and winter-run chinook salmon, and steelhead trout continue to exist. Hydroelectric development and hatchery operations have seriously reduced annual runs of naturally reproducing anadromous fish in Battle Creek. Efforts are currently under way to enhance habitat conditions and restore naturally reproducing anadromous salmonids to portions of Battle Creek upstream of the CNFH.

As part of the restoration effort, it is required that CNFH intakes conform to all National Marine Fisheries Service (NMFS) and State of California guidelines for the protection of salmonids at water diversions. This study includes an assessment the water supply requirements, a review of the existing intake system, ten alternatives for making improvements to it, and recommendation including selected alternatives to be considered for final design.

The assessment of the existing system concluded that a number of deficiencies existed that required remediation. The evaluation of the hatchery water supply requirements determined that to meet potential future increases in hatchery water demands, any new facilities or upgrades to existing facilities should provide a total of 70,000 gpm to the hatchery with 6,000 gpm going to meet downstream water rights on the hatchery canal.

The ten intake alternatives were developed by the Coleman Intake Working Group (a group consisting of hatchery personnel, USF&WS biological and engineering personnel, National Marine Fisheries Service, California Department of Fish and Game, and U.S. Bureau of Reclamation representatives, and design engineers from the Sverdrup Civil design team.) Although the alternatives utilize various approaches and intake locations, they are each designed to meet the flow and fish protection requirements discussed above. Eight evaluation criteria were developed to guide the design and assessment of each of the alternatives. These criteria are discussed in detail in Section 3.0 of the report and include Water Quality and Quantity, System Reliability, Redundancy, Access, Fish Protection, Maintenance, Long-Term Performance, and Water Rights Issues. Section 6.0 of the report includes descriptions of each of the ten alternatives and assessments of each alternative relative to these criteria.

After development of the ten alternatives, a meeting of the Intake Working Group was held to select the alternatives which best fit the requirements of the hatchery and the goals of the Battle Creek salmon restoration objectives. Details of the selection process and the four alternatives selected for further consideration are discussed in

Section 7.0 and Appendix C of the report. A brief description of the four selected alternatives in the order of preference is as follows:

Alternative 10 (preferred alternative):

Intake 1, located on the Coleman Powerhouse tailrace, would be expanded so as to have a capacity of 70,000 gpm. This increase would be accomplished by continued use of the existing intake, which supplies up to 40,000 gpm gravity flow to the hatchery canal. A new intake would be constructed adjacent to the existing intake and would be designed to supply up to 30,000 gpm gravity flow to the hatchery's existing sand settling basins. Use of this expanded Intake 1 as the primary water source for the hatchery would maximize the use of the high quality water available in the powerhouse tailrace. The existing weir located at Intake 1 is in poor condition and would be replaced with a new structure. Additionally, a new tailrace fish barrier would be located just upstream of the tailrace confluence with Battle Creek. The presence of the powerhouse at the upstream end of the tailrace, and this new fish barrier at the downstream end, will preclude fish from being in the tailrace and thereby eliminate the need to provide fish screening protection at Intake 1.

A powerhouse bypass system would be constructed consisting of a new intake on the Coleman Powerhouse forebay and a bypass pipe capable of supplying up to 40,000 gpm directly to the tailrace (and thereby to Intake 1) during periods when the powerhouse is not operating. This feature is described in the report in Section 6.9, with respect to Alternative 7, and was added to this alternative during the final selection process to further maximize the availability of the high quality tailrace water. Although the powerhouse bypass feature does add increased flexibility and reliability to the alternative as a whole, it is not absolutely required for the overall functionality of this alternative and should be viewed somewhat as an optional feature.

The existing unscreened Intake 2 on the left bank of Battle Creek would be abandoned, and a new emergency intake (back-up for Intake 1) would be constructed on the right bank near the location of the Coleman Powerhouse. This new intake would include fish screens designed to comply with all federal and state guidelines for fish protection. The emergency intake would be capable of supplying up to 40,000 gpm gravity flow to the hatchery canal, and would only be used during conditions when water was not available in the tailrace.

The existing Intake 3 and its associated weir and fish ladder structure would be removed. The removal of this weir is viewed as a habitat improvement measure which will help with the overall Battle Creek restoration efforts.

Estimated Construction Cost: $5,515,400 (1999 dollars)
Estimated Annual O&M Costs: $41,800

Alternative 3:

Intake 1 would be essentially maintained as it currently exists and would supply up to 40,000 gpm gravity flow to the hatchery canal. Improvements would include the new Intake 1 weir structure and the tailrace fish barrier described for Alternative 10. Additionally, the 40,000 gpm powerhouse bypass system would be included to maximize availability of the high quality tailrace water.

The existing intake 2 would be abandoned and replaced with a new right bank emergency intake as described for Alternative 10. However, with this alternative the Intake 3 structures (intake, weir and fish ladder) would remain in place and be reconstructed to comply with all federal and state fish screening criteria. The screening facility would be sized so that Intake 3 could provide up to 32,000 gpm gravity flow to the existing sand settling basins.

Estimated Construction Cost: $5,765,600 (1999 dollars)
Estimated Annual O&M Costs: $79,400

<u>Alternative 7:</u>
Intake 1 would be essentially maintained as it currently exists and would supply up to 40,000 gpm gravity flow to the hatchery canal. Improvements would include the new Intake 1 weir structure and the tailrace fish barrier described for Alternative 10. Additionally, the 40,000 gpm powerhouse bypass system would be included.

Intake 2 would be abandoned but, unlike the previous two alternatives described, no new Battle Creek intake would be constructed to replace it. Therefore, the powerhouse bypass system, which maximizes the availability of tailrace water, is more beneficial in this alternative than the others.

Intake 3 structures (intake, weir and fish ladder) would remain in place and be reconstructed to comply with all federal and state fish screening criteria. The screening facility would be sized so that Intake 3 could provide up to 32,000 gpm gravity flow to the existing sand settling basins. Two pumps would also be included with this facility to boost this flow as high as 40,000 gpm for emergency conditions when flow is not available in the powerhouse tailrace. These pumps could be considered somewhat optional in that if an emergency action plan were developed for the hatchery which defined a method allowing the hatchery to operate on a short-term basis with the 32,000 gpm gravity flow available from Intake 3, then the pumps at Intake 3 would not be required. Of course, a more detailed evaluation of the short-term flow requirements that resulted in a design emergency flow rate of less than 40,000 gpm, would likely result in some amount of savings in any of the alternatives described in this report.

Estimated Construction Cost: $3,725,700 (1999 dollars)
Estimated Annual O&M Costs: $49,300

<u>Alternative 9:</u>

Alternative 9 is identical to the description above for Alternative 10, except that the replacement intake for the abandoned Intake 2 would not be located upstream near the Coleman Powerhouse, as in Alternative 10, but rather on the hatchery grounds immediately upstream of the existing hatchery barrier weir. This would be an emergency intake, and would only be used when flow was not available in the powerhouse tailrace. Placing the emergency intake at this location will require that pumps be utilized to lift the flow from the creek up to the sand settling basins.

Estimated Construction Cost: $5,540,700 (1999 dollars)
Estimated Annual O&M Costs: $41,800

The Coleman Intake Working Group selected Alternative 10 as the preferred alternative since it best met the hatchery needs and goals of the Battle Creek restoration efforts. The other three alternatives were determined to be reasonable alternatives to be included in the environmental review process. The construction cost estimates given in the descriptions above do not include costs of permitting or land acquisition.

A probable schedule was prepared for the permitting, design and construction of Alternative 10 which estimates the entire project to take approximately three years from a decision to proceed. Any of the other three selected alternatives would likely require a similar schedule.

1.0 INTRODUCTION AND BACKGROUND

1.1 General

This study is submitted in fulfillment of Contract No. 14-48-001-93044, Work Order No. 53 between U.S. Fish and Wildlife Service (Service) and Sverdrup Civil, Inc.

The study reviews and assesses the water diversion and supply system for Coleman National Fish Hatchery (CNFH). This includes an assessment of the water supply requirements, a review of the existing intake system, and alternatives for making improvements to it.

1.2 Coleman NFH and the Battle Creek Drainage

CNFH was constructed in 1942 as part of the mitigation measures to help preserve significant runs of chinook salmon threatened by the loss of natural spawning areas resulting from the construction of Shasta Dam on the Sacramento River. Construction of the facility was authorized as an integral part of the Central Valley Project (CVP). The CVP was authorized and established under the provisions of the Emergency Relief Appropriation Act of 1935 (49 Stat.115), the First Deficiency Appropriation Act, Fiscal Year 1936 (49 Stat.1622), and the River and Harbor Act of 1935 (49 Stat.1028,1083).

CNFH is located in Shasta County, California, on a relatively flat parcel of land on the north bank of Battle Creek approximately 3 miles east of the Sacramento River and 17 miles southeast of the city of Redding, see Figure 1.1. Ground elevations on the hatchery property vary from a low of approximately 405 feet in the creek bed at the west boundary to a high of approximately 480 feet along the north property line. Small valleys and sharp breaks in the land have been produced by numerous seasonal streams draining the area.

Battle Creek, a tributary of the upper Sacramento River, flows along the southern edge of the property before entering the Sacramento River approximately 3 miles to the southwest. Battle Creek is approximately 45 miles long and encompasses a watershed of 357 square miles, fed by rainfall and snowmelt on the western slopes of the Cascade Range. Battle Creek is made up principally of two forks: North Fork Battle Creek and South Fork Battle Creek, each contributing approximately 50% of the total flow in the drainage. The two forks converge about 11 miles upstream of the hatchery to form Battle Creek. The drainage is characterized by steady flowing cold water flowing through deep gorges providing relatively high flows even during dry seasons. Between 1961 and 1996, the average daily flows in Battle Creek as measured at the gaging station just below CNFH ranged between approximately 250 cfs in summer and early fall to approximately 900 cfs in winter [1]. The maximum recorded instantaneous peak flow between 1961 and 1996 was approximately 25,000

[1] USGS Gage for Battle Creek below Coleman NFH near Cottonwood (No. 11376550)

cfs (January, 1970), and the minimum average daily flow recorded was about 100 cfs. An in-depth discussion of Battle Creek hydrology is presented in Section 6.2.

1.3 Hydroelectric Operations on Battle Creek

Battle Creek has been transformed into a complex hydraulic system, developed during the early 1900s into a highly efficient hydroelectric system. Owned and operated by Pacific Gas and Electric (PG&E) since the early 1930s, the Battle Creek Hydroelectric Project (FERC License No. 1121) today consists of five powerhouses, two storage reservoirs, six Battle Creek diversions, a number of small tributary diversions, and a complex network of canals, pipelines, flumes, and tunnels. PG&E's current FERC license to operate the project expires in 2026.

Of particular relevance to CNFH is Coleman powerhouse. Coleman powerhouse is the final hydroelectric generating facility in the system, supplied by the combined flows from all the upstream diversions. At approximately 12 MW, Coleman is the largest of the five powerhouses in the system with a hydraulic capacity of approximately 350 cfs. Powerhouse flow is discharged into the Coleman tailrace before it returns to Battle Creek just upstream of CNFH. Operations at the powerhouse affects operation of the CNFH water supply system by influencing the availability of water at Intake 1 located on the tailrace (see Plate 2). During sporadic shutdowns of the water supply to the powerhouse, and consequently the tailrace, CNFH is forced to modify intake operations, relying on an emergency intake on Battle Creek (Intake 2) which takes over from Intake 1. As a part of its operating license, PG&E is required to provide a minimum flow of 150 cfs below the confluence of Battle Creek and the tailrace. This is both for CNFH water supply considerations as well as in-stream fishery considerations. [2]

Coleman powerhouse operates under four scenarios. The first is the normal operating condition of the facility which involves the discharge of flow from the Coleman forebay through the penstocks and through the single Francis-type turbine before being discharged into the tailrace. The second scenario represents a non-typical operating condition caused by a turbine trip event during which normal flow through the powerhouse is diverted from the turbine and is bypassed through a Howell-Bunger valve discharging into the tailrace. Approximately 75% of all non-typical operating conditions results in flow being bypassed through this valve and into the tailrace, not affecting CNFH operations [3]. The other approximately 25% of turbine trip events, representing the third operational scenario, results in flow being diverted from the powerhouse altogether resulting in backing up of flow from the forebay up the power canal and into a bypass ditch which cascades into Battle Creek approximately 1 mile upstream of the powerhouse. For the normal powerhouse flow to return to the area of the CNFH intakes usually involves a period of time of about one-half hour. Since flow is

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[2] FERC License, Project No. 1121, Issued August 13, 1976

[3] Personal communication between Gene Terry (PG&E) and Rolf Wielick (Sverdrup) on 12/10/98.

not available at Intake 1 on the tailrace, Intake 2 on Battle Creek automatically assumes a portion of the water supply duties.

The fourth and final scenario involves events which prevent flow from reaching either the forebay or the bypass ditch. This would be caused by a failure of the Coleman Power Canal itself (feeding the forebay) and may be caused by a slide or other catastrophic failure. In this scenario, the gates at the Coleman diversion dam several miles upstream would be closed and the flow would be diverted back into Battle Creek. It is estimated that a failure such as this will cause a delay of as much as eight hours from the time the powerhouse shuts down and the full river flow is realized in the reaches of Battle Creek near CNFH. In the past six to eight years, one such event has occurred.

1.4 Battle Creek Fisheries Restoration Efforts

Battle Creek has long been recognized as one of the three remaining Sacramento River Tributaries in which natural spring-run and winter-run chinook salmon, and steelhead trout continue to exist. Past hydroelectric development and hatchery operations have seriously reduced annual runs of naturally reproducing anadromous fish in Battle Creek. CNFH's need for a broodstock collection facility and the need for a disease-free water source led to partial blockage of upstream migrating adult fish above the CNFH barrier weir. Additionally, inadequate minimum in-stream flow provisions in the FERC license, reflecting the lower priority that naturally reproducing fish were given in the drainage due to the role of CNFH, at times resulted in sections of the creek with too little flow in the creek to sustain healthy fish runs [4].

In 1993, construction began on water supply treatment facilities at CNFH to control persistent disease problems encountered at the hatchery. Subsequent operation of these facilities, which utilizes ozone as a disinfectant, began in 1994. Expansion of the treatment plant from about 10,000 gpm (22 cfs) to 30,000 gpm (67 cfs) is currently under construction and is scheduled to be completed in late 1999. With the completion of these facilities, opportunities will exist for restoring naturally reproducing fish runs in upper Battle Creek after a few years of monitoring, as the need for a disease-free water source becomes less critical at the hatchery.

Taking advantage of these new opportunities, the Battle Creek Working Group, a group consisting of representatives from the state and federal agencies, and fishery, environmental, local, agricultural, power and urban stakeholder communities, was formed in 1997 to share technical information regarding the progress being made on restoration activities in the Battle Creek Watershed. Issues of concern included the opening up of the 42 miles of Battle Creek above CNFH to winter and spring-run chinook, and steelhead. This will require correcting fishery passage issues associated with six diversion dams due to ineffective ladders, unscreened diversions and inadequate stream flows. Correction of these problems would provide enormous potential for restoring salmonid populations. To this end, the Battle Creek Working

[4] Personal communication between Harry Rectenwald (CDF&G) and Rolf Wielick (Sverdrup) on 10/6/98.

Group, PG&E, state and federal resource agencies, as well as other interested parties, have been working on solutions to existing deficiencies to improve conditions in the watershed. In early 1999, a settlement agreement was negotiated regarding removal of several diversion dams on Battle Creek and increases in the minimum flow rates above CNFH. In light of these developments and following AFRP (Anadromous Fish Restoration Program) Actions 5 and 8, CNFH has undertaken a review of its intake system, which consists of existing diversions within the watershed. AFRP Action 5 requires screening of the Coleman Powerhouse tailrace to eliminate attraction of adult chinook salmon and steelhead while Action 8 requires screening of CNFH Intakes 2 and 3 to prevent entrainment of juvenile chinook salmon and steelhead. [5]

1.5 CNFH Water Diversions

CNFH is a non-consumptive water user drawing water to support hatchery operations from three distinct locations in the watershed. As noted earlier, Intake 1 draws from the Coleman Powerhouse tailrace which enters Battle Creek approximately 1.6 miles upstream of the hatchery property. Intake 2, an emergency backup to Intake 1, draws from Battle Creek near Intake 1 when flow in the tailrace is interrupted, while Intake 3 draws from Battle Creek approximately 0.4 miles downstream from Intake 2, approximately 1.2 miles upstream of the hatchery. In response to and in support of the Battle Creek Working Group objectives, the Service initiated a review of its water diversions. This study, the CNFH Intake Alternatives Study, commissioned to review the long-term water intake system needs and alternatives at CNFH, represents only a portion of the efforts undertaken by the Service to ensure compliance with fish protection measures at it diversions. The CNFH Intake Working Group, convened in early 1998 to examine the long-term water supply system needs, also executed a number of interim improvements to the CNFH intake system to protect the existing fishery resource in Battle Creek. These interim measures included installation of a flap gate at Intake 2 to block this unscreened intake except under emergency conditions (when Intake 1 is not operational), installation of a finer temporary screen on the existing screen structure at Intake 3, and installation of an experimental stream-bed mounted auxiliary screen system at Intake 3 which, as a prototype screen, is being evaluated for conformance to current fish screening criteria, as well as other operational characteristics at this site. These measures will be discussed in greater detail in Section 5.0. The identification and selection of appropriate long-term improvements to replace these temporary measures is the goal of this study.

[5] "Revised Draft Restoration Plan for the Anadromous Fish Restoration Program" USF&WS, May 30, 1997.

2.0 HATCHERY WATER SYSTEM

2.1 Description of Hatchery Water System

The principle features of CNFH include the water treatment and delivery systems, hatchery building, 8 x 80 and 15 x 150 raceways, and the broodstock building.[6] A plan of the hatchery facilities is depicted on Plate 1. A plan of the overall hatchery and intake system is depicted on Plate 2. The hatchery water delivery system consists of two major diversion and conveyance systems, the Intake 1 and 2 system and the Intake 3 system. The Intake 1 and 2 system withdraws water from the tailrace of the Coleman powerhouse and Battle Creek , respectively, and conveys it to the hatchery site in a pipe and canal system (see Figure 6.4). A 30,000 gpm (67 cfs) canal pump station located on the hatchery canal (currently under construction) will lift water from the canal to the water treatment system for filtering and disinfection. Should it be required, the pump station has been designed to incorporate three additional pumps which would increase its capacity to a maximum of 45,000 gpm (100 cfs). The Intake 3 system withdraws water from Battle Creek below its convergence with the powerhouse tailrace, and conveys it to the hatchery site in a separate pipe. At the hatchery site, water from Intake 3 is routed through a sand trap to remove the settlable solids from the water. It is then pumped to the water treatment system by a smaller 20,000 gpm (45 cfs) pumping facility known as the raw water pump station. When the new canal pump station is brought on line, scheduled for late 1999, the raw water pump station will likely take on a backup status. However, the presence of two pump stations will provide for flexibility in operations and the actual balance of pumping from the canal or the sand traps will be an operational decision on the part of the hatchery. Water from the Intake 3 system that is not pumped to the water treatment system flows by gravity to the broodstock pump station where it is pumped into the broodstock facility. The filtered, disinfected water from the water treatment system is then conveyed to the hatchery building, the 8 x 80 raceways and the 15 x 150 raceways (piping to the 15 x 150 raceways from the water treatment facilities is currently under construction). Figure 2.1 is a schematic diagram of the facilities and piping system at CNFH.

As noted earlier, the capacity of the water treatment system at completion of current construction activities will be 30,000 gpm (67 cfs). This is inadequate to treat all of the water required for fish production, however, the broodstock facility does not require disinfected water and untreated water is selectively used to make up the shortfall. The need for additional water treatment capability is currently being assessed and the water treatment system has been designed for expansion to a maximum capacity of 65,000 gpm (145 cfs).

All pipelines and conveyance facilities at the hatchery site have sufficient capacity to meet the current needs of the fish production units they serve. For example, the 15 x

[6] For the purposes of this report, water treatment facilities currently under construction at CNFH are assumed to be complete since completion is scheduled for mid to late 1999. Facilities currently under construction are noted as such in the text.

150 raceways are designed for a total flow of 28,000 gpm (63 cfs) and the pipeline from the water treatment system to these raceways has a corresponding capacity. The canal pump station has a capacity of 30,000 gpm (67 cfs) and the raw water pump station capacity is 20,000 gpm (45 cfs). The capacity of the intakes and their conveyance systems is described in detail in Section 5, but is generally equal to or greater than the water right associated with the intakes.

Because of elevation differences between the two water supply systems, less energy is required to pump water from the Intake 1 and 2 system to the water treatment system than is required to pump from the Intake 3 system to the water treatment system. Each pump station is designed to pump the full capacity of its corresponding diversion and conveyance system. Normal operation (after completion of current construction) will be to maximize the use of water from the Intake 1 and 2 system in the treatment system by pumping from the new canal pump station and to supplement this water with water from the Intake 3 system when necessary.

CNFH has numerous piping interconnections between the facilities. These interconnections allow water to be diverted from the canal to the sand traps, to bypass the treatment system, be reused from the 15 x 150 raceways to the 8 x 80 raceways, and to respond to temporary conditions which occur during construction or emergency conditions. These interconnections will not be described in detail because they are not part of the normal operation of the hatchery.

2.2 Existing Hatchery Water Demand

Hatchery water demand is dictated by a number of factors including the species of fish, number and size of fish to be produced, type of rearing units available at the hatchery, influent water quality, and fish cultural techniques to be employed. At CNFH the current release targets for fish production are approximately 12 million fall chinook, 1 million late-fall chinook, and 600,000 steelhead. Prior to 1998, CNFH also produced winter-run chinook, however this program has been transferred to the recently constructed Livingston Stone National Fish Hatchery located at Shasta Dam.

For each of the three species produced at CNFH the rearing cycle is similar. Eggs from returning adults are taken and fertilized in the spawning building and immediately moved to the incubators in the hatchery building. As the eggs hatch, the fry are transferred to either the start tanks in the hatchery building or directly to the 8 x 80 raceways. Fry which are initially placed in the start tanks are moved outside to the 8 x 80 raceways as necessary to provide suitable rearing conditions. As the fry grow, they are periodically split, or divided, from one raceway into two or more raceways to maintain adequate space and water for healthy rearing conditions. When the fish require more space than is available in the 8 x 80 raceways, they are transferred to the 15 x 150 raceways and finally are released either directly to Battle Creek or are trucked to the Sacramento River. These fish movements are timed to provide optimum use of the available facilities while meeting management requirements at the hatchery and have been developed over the 50 plus years of fish cultural activity at CNFH.

Because the adults return and are spawned at CNFH over a nearly six month time period, the individual facilities are used for more than one species each year. Fall chinook are the earliest returning species with spawning beginning about the first of October and continuing through the end of December. The fall chinook reach their target release size by late April and are then released. Late-fall chinook and steelhead spawning begins in January and continues through mid March. These fish are reared at CNFH until January of the following year when they are released. The timing of their release has been selected to minimize the impact of the hatchery fish upon wild fish production in the Sacramento River system.

Table 2.1 presents the water demand for the current fish production program. This table is broken down by species and rearing unit to assist with understanding the movement of the various species through the hatchery [7]. The flow rates for the raceways are based primarily upon the number of raceways in use and the optimum flow rate for the raceway. Typical flows at CNFH are 500 gallons per minute (gpm) in each 8 x 80 raceway and 1,000 gpm in each 15 x 150 raceway. Lower flows are typically used in the 8 x 80 raceways when the fry are initially placed in them to reduce the water velocity through the raceway. The number of raceways required for each species at any given time is determined either by the space and flow required to maintain good fish cultural conditions or by the need to maintain groups of fish in separate raceways for management or experimental reasons. Additional factors affecting the number of raceways in use and the resulting flow requirements are the number of raceways of each size which are available at any given time and the desire to minimize the number of times the fish are handled.

In addition to the water required for fish cultural purposes relating to the incubation and rearing of juvenile fish, water is required seasonally for operation of the adult holding ponds and the fish ladder. From October 1 through March 15, the flow rate required for these facilities is 10,000 gpm (22 cfs). Finally, between 1,000 and 2,000 gpm is required for "operational spill". This is water which is used for a wide variety of purposes throughout the hatchery such as cooling the ozone production equipment, watering the hatchery grounds, washing down the spawning building during and after spawning, and other housekeeping activities. Another component of operational spill is water which is wasted over weirs at various locations in the piping system to assist with maintaining the hydraulic balance of the piping system and to allow minor adjustments in flow in individual rearing units without upsetting the flows in adjacent units.

Table 2.2 presents the total water requirements for the current facility operations on a semi-monthly basis. The peak flow requirement of 47,550 gpm (106 cfs) occurs in early January immediately before the release of the late-fall chinook and steelhead and the minimum flow requirement of 4,900 gpm (11 cfs) occurs in early May following

[7] USF&WS CNFH, 1998

release of the fall chinook. For the purposes of this study, a current hatchery water demand of 48,000 gpm (107 cfs) will be used.

2.3 Future Hatchery Water Demand

Future water demand at CNFH is largely a matter of speculation. Recent Endangered Species Act listings and concern over impacts of hatchery fish on wild fish have led to a reduction in the number of fish produced at CNFH[8]. Concurrently with this, the need to rear better quality fish in a more natural environment has led to the adoption of lower rearing densities which result in rearing fewer fish in each raceway while maintaining the same water flow. Experimental results generally support the conclusion that lower rearing densities and higher flow indexes result in a higher juvenile survival rate and a higher return rate for adults.

Rather than speculate on what the future holds, this report will simply make the planning assumption that an increase in water demand of one third could occur in the future. This increase may be required as a result of an increase in the number of fish produced, an increase in the duration the fish are reared at CNFH, an increase in the number of species reared at CNFH, changes in rearing techniques which increases the demand for water, or other future events. No specific fish production scenario has been identified as the basis for this assumption, it is just an allowance for the uncertainty that the future may bring. Using the current peak flow of 47,550 gpm (106 cfs) as the base and adding 33% results in a future hatchery water demand of 63,250 gpm (141 cfs). For the purposes of this study, a future hatchery water demand of 64,000 gpm (143 cfs) will be used.

2.4 Hatchery Water Rights

Surface water rights for CNFH were obtained by appropriation with priority dates ranging from 1950 through 1965. The rights total 122 cubic feet per second (cfs) however, under a contract from 1944, 13.13 cfs must be delivered to downstream water users without being used at the hatchery. An additional 9.6 cfs must be delivered for irrigation after use in the hatchery. The 122 cfs total right is allocated among the three existing intakes as follows:

Intake No. 1	39 cfs	17,510 gpm
Intake No. 2	22 cfs	9,880 gpm
Intake Nos. 1 & 2 (Combined right)	11 cfs	4,940 gpm
Intake No. 3	50 cfs	22,450 gpm
Subtotal	122 cfs	54,780 gpm
Downstream right	-13 cfs	-5,840 gpm
Total available for hatchery operations	109 cfs	48,940 gpm

[8] Personal communication between Ed Forner (USF&WS) and Bill Cutting (KCM) on October 5, 1998.

In order to settle protests against their water right applications for the diversions at Intakes 1 and 2, the Service entered into agreements which acknowledged the prior rights of several downstream appropriators.

In addition to the prior appropriation doctrine under which the above mentioned water rights for CNFH were established, California law recognizes riparian surface water use and overlying ground water use inherent in the ownership of land. The rights of each landowner to use surface water on riparian land or ground water on overlying lands are equal and correlative to all other owners similarly situated, but are generally given a higher priority than appropriative water rights. To date, the Service has not claimed a riparian right for CNFH, but this remains an option if water demand increases in the future.

Another option for meeting an increased future water demand is to make application to the State for additional appropriative water rights. Additionally, if a reconfiguration of the intake system is needed as part of a new application or simply to make better use of the water under existing water rights, it will be necessary to petition the State for a change in the point or points of diversion. In either instance, notice of the request will be made and the public will be given an opportunity to protest. If protests are filed it will at a minimum delay a decision by the State, and it could require either negotiations or a hearing to reach a resolution. Because of the non-consumptive nature of CNFH's water use and the low potential for impact on other water users, it is likely that any concerns raised in a protest will be resolvable. For planning purposes, it should be assumed that the process will require at least two years to complete.

If water demand at CNFH increases in the future, then additional water rights will be required. The options mentioned above will be considered along with any other viable options which might be identified. Whether or not additional water is needed in the future, it may be necessary to reconfigure the intake system or reallocate diversion rates between the existing intakes. If this is the case, then the Service will petition the State to make the necessary changes to the existing appropriative water rights.

3.0 INTAKE SYSTEM EVALUATION CRITERIA / ASSUMPTIONS

3.1 General

Prior to the initiation of this study, the Coleman Intake Work Group established a set of intake system evaluation criteria. These criteria were established for the purpose of evaluating potential intake alternatives as to the extent to which they meet the project goals and objectives. The criteria are defined in this section, and subsequently utilized in Section 6.0 to make individual assessments of each alternative. A second set of criteria, referred to as the selection criteria, was established for the purposes of making final selections of recommended alternatives. These criteria are addressed in Section 7.0. In most cases the criteria are the same, however, there are some differences, for example, if every alternative fulfills a particular criterion equally there would be no need to include that criterion in the selection process. Additionally, although cost was not considered an evaluation criterion for the purposes of developing and assessing the alternatives, conceptual level cost estimates were developed for each alternative and would obviously be a consideration in the selection process.

3.2 Evaluation Criteria / Assumptions

The following is a listing of the evaluation criteria used to assess the existing intake system and the alternatives developed for improvement of that system. Assumptions related to these criteria are also presented.

a. **Water quality and quantity.** *The quality and quantity of the water delivered from the intake system shall meet the operational requirements of the hatchery.*

With regards to water quality, it is assumed that water to be used at the hatchery for rearing purposes in critical life-stages will be treated. Otherwise, until water treatment is developed for all the water supply needs of the hatchery, untreated water from Battle Creek is assumed to be adequate for non-critical rearing phases. Obviously, under this scenario, the less disease-prone the water source, the less the risk to the hatchery. For example, due to the lack of access by adult salmon to Coleman Canal water prior to exiting the Coleman powerhouse (both currently and under a restoration plan), this water, the source of water for Intake 1, is assumed to be somewhat less disease-prone than main stem Battle Creek water.

The quantity of water required for current and future hatchery production operations at CNFH (and the locations on the hatchery grounds where this water is required) are as presented in Section 2.0. For the purposes of this study, the combined design water supply capacity for the entire water supply system from all intakes will be 64,000 gpm (143 cfs) plus 6,000 gpm (13 cfs) for downstream water rights for a total supply of 70,000 gpm (156 cfs). The target optimal flow capacity for any single intake will be 40,000 gpm (89 cfs).

b. **System reliability**. *The intakes shall have a high degree of reliability for all reasonably anticipated environmental and operational conditions at the hatchery and with respect to anticipated changes to the water supply configurations in the upper watershed due to the Battle Creek restoration efforts, changes to the hydropower systems and other water resource management proposals*.

System reliability relates not only to the physical integrity of the intakes themselves (resistance to mechanical breakdowns, flooding, erosion, sedimentation, vandalism, etc.), but also to the reliability of the water source supplying these intakes. Issues related to the physical integrity of the intakes are quite predictable and can be effectively planned for during the design process. The reliability of the water source, on the other hand, is much less predictable and is largely beyond the control of the hatchery making planning much more difficult. One issue that affects water source reliability is possible changes in watershed management and operations associated with the Battle Creek Hydroelectric Project. Ongoing deregulation of the power generation and distribution industry has increased this uncertainty, possibly leading to changes in ownership and facility operational goals and objectives. A related issue is the reliability of the hydroelectric project infrastructure to predictably deliver water to the hatchery intakes. This is especially true in light of the many miles of canals, pipelines and numerous mechanical equipment installations required to maintain a steady flow of water through the hydroelectric system. For the purposes of this study, it is assumed that the current configuration and operation of powerhouses (especially Coleman Powerhouse which currently serves as the water source for Intake 1), will remain in place and in operation largely as it does currently, at least until 2026 when the current PG&E license is up for renewal. Turbines at Coleman powerhouse were replaced in 1978 and are assumed to be viable through the term of the current license. It is also assumed that if problems should occur with the hydroelectric project infrastructure, repair of the failed components (for example, failure of the Coleman Power Canal) would be a high priority for PG&E in order to minimize loss of power generation.

The one aspect of the system reliability issue that is in the hatchery's control is risk minimization and mitigation. Intake configurations that minimize risks associated with unforeseen changes in the hydroelectric project operations, or mitigate for them, have advantages in this regard.

Another issue affecting system reliability from a water source perspective is the status of in-stream flow requirements for the various water courses near the hatchery. Changes in in-stream flow requirements for various reaches of Battle Creek may be subject to changes in the future, depending on the priorities established for the drainage. For the purposes of this study, it is assumed that the minimum in-stream flow requirements agreed to in current negotiations with PG&E will be maintained for the foreseeable future. In the main stem of Battle Creek, below the confluence of the North and South Forks of Battle Creek, this minimum in-stream flow is assumed to be 35 to 88 cfs, adjusted seasonally, with current minimum flow obligations of 150 cfs being maintained below the confluence of the Coleman powerhouse tailrace and Battle Creek as required by the PG&E operating license.

c. **Redundancy**. *The water system shall have alternative intakes to allow for Redundancy of operation (including emergency backup)*.

In the development of redundant systems, it is assumed that redundancy applies to the overall intake system and not the individual components such as the conveyance pipe or screening system. Thus, in the context of the existing Intake 1 & 2 system, which shares a common pipeline, these intakes are currently redundant to each other and therefore the system has greater redundancy than the Intake 3 system which has a single intake. Although many hatcheries operate successfully with a single intake supplying 100% of the water demand of the facility, it was agreed by the Intake Working Group during the development of intake criteria that the optimum situation at CNFH will be two largely independent intake systems each with a minimum capacity of approximately 40,000 gpm (89 cfs). Alternatives which have less than 40,000 gpm will still be acceptable, provided that the overall demand of the hatchery is met, but will be considered to have a lower redundancy value than those which meet this criteria.

d. **Access**. *The intakes should be located within reasonable response perimeter from Coleman NFH and shall be easily accessed for maintenance*.

To qualify as being easily accessible, it is assumed that access must be by conventional hatchery vehicle (truck) and that a reasonable response perimeter from Coleman NFH is a distance and location that allows for effective resolution of emergency situations at the intakes without jeopardizing hatchery operations or creating a safety hazard. Locations that are nearer the hatchery are assumed to be more desirable than ones farther away.

e. **Fish Protection.** *The intakes should provide minimum risk to anadromous salmonids and resident species where these are anticipated to be present. Fish screening criteria shall meet or exceed 1998 California Department of Fish and Game (CDF&G) and National Marine Fisheries Service (NMFS) guidelines.*

Protection measures will be designed for anadromous fish. The critical fish species from a facility design and fish protection standpoint is assumed to be steelhead trout which requires the most stringent screen design criteria.

Resident fish and other aquatic biological organisms, if present, are not specifically designed for.

In addition to fish protection at the intakes, compliance to AFRP Action 5 (screening of the Coleman Powerhouse tailrace) is assumed to be included in alternatives which continue to utilize Intake 1. For those alternatives which do not include Intake 1, it is assumed that fish exclusion measures at the tailrace will be constructed, but will be the undertaken by others in conjunction with other fish protection improvements.

f. **Maintenance**. *Both regularly scheduled annual maintenance and the minor routine maintenance activities of either the intake or water conveyance facilities should be easily accommodated and reasonably accomplished.*

Intake system designs which facilitate and minimize maintenance activities are assumed to be more desirable. It is, however, assumed that any screening system will require some degree of maintenance and that this maintenance will be performed as required to ensure the continued protection of in-stream fish and operation of the hatchery.

g. **Long-term performance**. *Major components of the intake system shall have a design life of 50 years*.

Major components are assumed to include those that constitute the greatest value to replace. These include civil works (foundation systems, walls, pipelines, etc.) but are assumed not to include any mechanical systems such as screen cleaner assemblies, water control gates or actuators, screen systems, debris racks, etc. Mechanical systems such as these inherently require rehabilitation and/or replacement.

h. **Water Rights.** *The diversion and water intake system should be designed to fully utilize the hatchery's existing water rights, or expanded rights as deemed necessary. Consolidation or relocation of water rights can be considered*.

Water right issues and assumptions are as discussed in Section 2.0.

4.0 INTAKE SCREEN SYSTEMS

4.1 General

The screening of water intakes for fish and debris has historically been approached by a variety of different methods. Debris screening is accomplished to preclude floating or entrained organic material from entering water supply systems where it can clog filter systems, pipes, and other critical components. These screens vary from coarse debris racks (commonly referred to as "grizzlies") to fine wire mesh screens, perforated plate, or wedge-wire bar screens. Often, coarse debris racks will be installed upstream of more fragile finer screen systems for protection of the more vulnerable equipment downstream.

The other purpose for screening intakes is to prevent fish from entering the intake. At irrigation diversions, entrained fish can end up stranded in canals or pipelines, while at hatchery intakes, they can be injured in the water supply systems or become unwelcomed guests in rearing ponds. For migrating smolts (juvenile fish transitioning biologically from fresh to saltwater phases), the delay associated with entering intakes without timely return to the main river can be fatal. For protected fish, the intentional or unintentional taking of any percentage of fish is unlawful.

The following section discusses various methods that have been employed for screening of both fish and debris. Often both are required at the same location and the same screening system can serve both purposes. Since the screen systems applicable to this study are typically associated with low approach velocities (the preferred standard where possible), screens which have been developed for higher velocity installations are not addressed. Higher velocity installations include penstock or closed conduit screens such as the Eicher screen and the Modular Intake Screen (MIS), and intake diversion screens developed for many of the large hydroelectric projects on, for example, the Columbia and Snake River systems in the Northwest. By contrast, for the river intake systems described herein, screen approach velocities are either 0.33 for on-river installations or 0.4 fps for canal installations with sweeping velocities greater than the screen approach velocity for canal installations (2.0 fps or greater is preferred) and at least two times as great for installations located directly on rivers and streams.

4.2 Screening Criteria and Siting Issues

Screen installations at river diversions occur at three main locations; on-stream, off-stream, and off-site locations. The following comments cite many of the issues and criteria generally applicable to fish screening at these various locations. Fish screening systems shall be in conformance with the latest California Department of Fish and Game (DFG) and National Marine Fisheries Service (NMFS), Southwest Region, screening criteria. For this study, DFG criteria dated April 17, 1998 and NMFS criteria dated January 1997 are applicable. A copy of the current screening criteria is included in the Appendix.

On-Stream Installations

On-stream screen installations are those in which the screening is done at the bank of the river thereby not requiring diversion of fish (or debris) from the main river channel. The primary benefit of this type of design is that it can result in less delay of fish than off-stream installations. Due to their proximity to the river, these types of systems must be able to accommodate wider fluctuations of water surface elevations, water velocities, debris loads, and sediment loads. Sediment sluices are often employed to deal with accumulated sediment. Often, at more remote sites, access to the diversion point may be difficult hampering maintenance of the screen system. Where river flooding involves the mobilization of large amounts of debris, sediment, or rocks, damage to fragile screening components is a concern and should be accounted for in the design.

The screen face at on-stream screen installations should be parallel to the flow and the adjacent bank line with the screen face at or streamward of a line defined by the annual low-flow water's edge. Sweeping velocities (the velocity component that is parallel to the screen face), should be at least twice the allowable screen approach velocity, the velocity component perpendicular to the screen face as measured a distance of 3 inches from the screen face. For on-stream screens, the screen approach velocity shall not exceed 0.33 fps for diversions greater than 40 cfs (fry criteria).

Off-Stream Installations

Off-stream screening installations involve screen systems in a channel or canal where water has already been diverted from the main river channel and are located as close as practical to the point of diversion. Typically, off-stream screens at existing diversions for irrigation or power generation are incorporated into existing canals downstream of existing intake headworks. Off-stream installations should be considered only where on-stream installations are not feasible or desirable. Being somewhat protected from the main river channel by the intake (typically incorporating a coarse debris rack), these types of screen systems generally have greater control of water surface elevation, debris, and sediment loading. Since fish can be diverted from the main river channel at the intake, some delay can be expected. Fish bypass pipes incorporated into the screen designs return diverted fish to the river. In the Battle Creek drainage, off-stream screen installations have been proposed for many existing water diversions making use of existing canal and intake headworks.

From DFG and NMFS criteria, for canals with flowing water, screen approach velocities shall not exceed 0.40 fps with a bypass entrance located every one minute of travel time along the screen face. Screen sweeping velocities shall exceed the approach velocity and should optimally be 2.0 fps or greater. Screens shall be angled to the flow less than 45 degrees.

Off-Site Installations

Off-site screen installations involve the screening of fish remotely from the point of diversion. This can involve great distances from the original diversion point. Installations of this type should be avoided for obvious reasons, although, given the proper circumstances, may be the only viable fish protection strategy. The existing drum screen on the canal and the inclined screen at the sand trap are off-site installations, although neither of these meet the current fish screening criteria.

4.3 Intake Screening Systems

Vertical Plate Screens

Vertical plate screens are a commonly prescribed screening systems within California and is a standard screening strategy prescribed by the California Department of Fish and Game (DFG). Numerous small and large installations can be found and are configured in both single sided systems as well as V-shaped configurations (typically in canals where space is a concern). A typical small vertical plate screen is depicted on Figure 4.1.

The typical installation for these screens includes vertical (or slightly inclined) perforated plates or wedge-wire panels aligned parallel to the flow (for in-stream screens) or angled for canal configurations. An adjustable baffle system is included behind the screen face to ensure proper flow distribution across the screen face. For longer screens, a bypass entrance is required at an intermediate location along the screen face to give fish an additional exit opportunity. The typical cleaning action for these screens involves either a single or multiple vertically oriented brush bars which sweep debris off the face of the screen. To provide positive engagement of the brushes, a screen inclination of 30 degrees is sometimes applied (as is shown in Figure 4.1). For canal installations, a bypass entrance at the end of the screens (or in intermediate locations as required) is provided to allow fish to return to the river channel. For many of the unscreened diversions in the Battle Creek drainage, V-shaped or single face vertical plate screen installations have been proposed.

Rotary Drum Screens

Rotary drum screens are an effective screening system and have been employed with considerable success at both large and small diversions. Typical designs include flow-through and end-delivery systems. A typical end-delivery screen at a hatchery diversion is depicted on Figure 4.2.

In flow-through designs, flow approaches the screen drum structure (at the prescribed angle) and flows through the mesh drum material, exiting the far side of the drum. Debris is entrained on the mesh and passes over as the drum rotates, to be flushed off with the exiting flow. Fish are confined to the upstream face and pass along the face exiting at the terminus of the screen installation much like the vertical plate screens described above. Bottom and side seals prevent fish from passing through the drum screen installation. As was noted, this design does not preclude debris from continuing down the screened flow requiring subsequent debris screening if debris-sensitive components lie downstream where the water is being used.

Where both debris and fish screening is desired, end-delivery drum screens are employed. These screens, like the name suggests, discharge flow through one (or both) ends of the drum rather than exiting on the downstream side. Typically, a spray bar is added to assist in the removal of debris from the turning drum mesh to supplement the draw-off flow on the downstream face of the screen. Numerous end-delivery rotary drum screens have been designed for hatchery water supply systems. Such a screen exists at Screen Chamber No. 1 at CNFH supplying untreated water from the hatchery canal to various hatchery facilities. Because the draw is from the end of the screen, the flow distribution at the face of the screen is not as uniform as with a flow-through configuration. Internal baffling to mitigate this problem is impractical.

These screen systems are more sensitive to fluctuations in water surface. NMFS criteria for submergence on rotary drum screens requires that the design submergence be 75% of the screen diameter and shall not exceed 85% nor be less than 65%. For a 6-foot diameter screen, for example, this means that water surface fluctuations cannot exceed 1.2 feet making on-stream installations impractical where large fluctuations in water surface elevation occur.

For remote screen installations and very small screen installations without electrical power available to drive the small screen drive motors, mechanical paddle wheel drive mechanisms have been designed.

Vertical and Inclined Traveling Screens

Traveling screens operate in much the same manner as the rotary drum screen. Approaching debris and fish are presented with a face of (upwardly) moving screen mesh panels which impinge debris. The debris is either flushed off on the opposite side with the flow as the belt travels in its continuous loop or is flushed off with a spray assembly at the top. A typical vertical traveling screen installation is depicted on Figure 4.3

Commercially available vertical traveling screens as tall as 80-100 feet have been constructed at water intakes for large manufacturing plants and power generation facilities. Optional fish protection measures for these screens have been designed integrally with the screen systems featuring regularly spaced troughs which lift the fish (and a small amount of water) up with the screen to be flushed out into a bypass pipe. For installations in this study, it is assumed that rather than this fish salvage method, the screens would be oriented parallel with the flow for on-stream installations or at an appropriate angle to the flow with a bypass channel for off-stream installations. The fish would remain on the upstream side of the screen to find an exit or continue on downstream. Inclined traveling screens have been successfully installed to control debris but are seen as less advantages for fish protection as the potential for impingement on an upward moving sloping face as the screen clears the water appears more likely than on a vertical face. This characteristic is, of course, why they are successful at removing debris.

Concern expressed by resource agency personnel about fish being in close proximity to the many moving edges, panels which are not flat (causing eddy effects), and mesh panel joints which don't meet the very strict spacing criteria have been a few of the criticisms of the traveling screen design.

Horizontal Plate Screens (Fixed)

Horizontal plate screens are essentially horizontally oriented vertical plate screens which are submerged to depths ranging from as little as 1.5-2 feet to practically no depth limit. The "fixed" designation of this type of screen suggests that development of civil works (concrete or other structures) is required to accommodate the screen and related flow conveyance system. This is in contrast to the "retrievable" screen system described in the following section which is designed with a substantially smaller investment in civil works.

With the entire screen surface submerged, mechanical screen cleaning systems (brushes) on horizontal plate screens are not possible. Rather, these screens rely on air or water jets to clean the screen. High pressure air or water jets located behind the screen face expel impinged material from the face of the screen where it is carried off by the sweeping velocity of the stream. For long screens, the cleaning jets are activated in an upstream to downstream sequence since dislodged debris has a tendency to become re-impinged on downstream screen surfaces. The most challenging design aspects of these screens include the ability to achieve the proper uniform distribution of flow across the face of the screen under varying hydraulic conditions and the ability to balance the screen cleaning jets with the flushing flow. For streams with a high sediment load, the bottom oriented nature of the screen poses additional challenges as large rocks or other debris may damage the screen. The ability of the screen to flush fine sediment is also a design challenge. It may also be necessary to install mechanical cleaning devices to prevent the accumulation of large debris if sweeping velocities are too small.

The development of civil works around the screen (including construction of a training wall on the opposing side of the screen), presents maintenance opportunities allowing the screen to be dewatered through the use of upstream and downstream bulkheads.

Such a screen system is currently employed at Intake 3 at CNFH, although operationally, the screen is somewhat problematic and does not meet current screening criteria. A more thorough discussion of this installation is provided in Section 5.2.

Horizontal Plate Screens (Retrievable)

As was noted above, the distinction of this screen versus the fixed horizontal plate screen is its ability to be retrieved from its installed location in a stream bed and the relatively smaller investment of civil works required to accommodate it. Fairly stated, this screen system is an experimental one which is being tested under the name Universal Stream Bottom, Retrievable (USBR) Flat Plate Screen for which a U.S. Patent has been received. Development of this screen has been through the U.S. Bureau of Reclamation (Reclamation), Northern California Area Office, and testing has been conducted at several locations (including currently at Intake 3 at CNFH) to prove its reliability and effectiveness. A schematic of a typical USBR flat plate screen installation is depicted on Figure 4.4.

Initially developed as a low-cost screening alternative for irrigation diversions, the USBR screen has been proposed as a possible intake for other applications, including fish hatcheries. The USBR screen consists of a streamlined fiberglass shell into which has been developed a horizontally oriented, baffled, wedge-wire bar screen, air-burst cleaning piping, and ballast tanks used to remotely lower and raise the screen module down to and up from the stream bed. An independent remote anchor system is attached to the upstream end to keep the screen from drifting downstream along the stream bed. A specially designed pipe coupling allows the screen to be deployed and retrieved without having to bolt or unbolt the water conveyance piping which delivers the water to on-shore facilities. On-shore “fixed” facilities include the conveyance piping and an air compressor. For pumped diversions, a pump would also be located on the shore. For gravity systems, no pumping is necessary except to prime the system if a siphon design is employed.

Coanda-Effect Screens

This screen type is actually a high velocity screen characterized by weir flow over a steeply inclined wedge-wire bar screen which is oriented perpendicular to flow. The Coanda-effect is actually a hydraulic phenomena that occurs when the water is guided by the orientation of the screen bars (typically tilted about 5 degrees up) leading to very effective dewatering capabilities with little or no roughness perceived by touch of the hand. In a typical application, water would guide over a specially-designed ogee shape onto the steeply inclined screen face, which is about 4 feet high, into a submerged tailwater area. Indications are that a 2-foot high screen would perform as effectively with less dewatering of the screen face. Debris and fish are guided along the screen face while water is effectively removed through the screen to an internal channel before exiting the end of the channel at the shore. Aqua Dyne is a manufacturer of this screen type. It is considered to be experimental in nature and has not been given resource agency approval as a screening device for fish. Testing of this screen at CNFH as a demonstration prototype has occurred over recent years to test the effectiveness and safety of this screen on test fish. Preliminary conclusions have shown some fish injury evidenced on about 20% of tested fish, generally characterized by hemorrhaging of the eyes. Pressure problems rather than abrasion is the suspected cause.

Due to the lack of acceptance of this type of screen system by resource agencies, its immediate applicability as an intake screening system is questionable, although further modifications and testing may yet show potential. A screen system of this type has been installed for the East Fork Irrigation District on the Hood River in Oregon and will be tested in the upcoming year.

Prefabricated Fish Screens

In the category of prefabricated fish screens are a wide array of screening systems that have typically been developed for screening of irrigation diversions, usually as a retrofit installation on an existing withdrawal pipe. Typical of these screens is a T-shaped cylindrical wedge-wire bar screen structure located on the end of a submerged pipe in an irrigation canal or river. Cleaning, when provided, is usually an air or water backwash system. A number of vendors manufacture these screens including Johnson and Hendricks. While well-suited for irrigation diversions, this type of screening system is less commonly found on hatchery intakes. A 30 cfs screen installation has been designed at Horseshoe Bend in Sacramento County, California for the Sherman Island Irrigation District using a pressurized water backwash system. An air burst cleaning system has been used on a cylindrical wedge-wire fish screen on two previously unscreened culverts in the Suisan Wildlife Area in California.

5.0 EXISTING INTAKE SYSTEM ASSESSMENT

5.1 Intake 1 and 2 System

General Description

The Intake 1 and 2 system was the original water supply and conveyance system for Coleman NFH. It was constructed in 1942 with 5 major components, two intake boxes, a 2,700 foot long, 46-inch diameter pipeline, a 3,900 foot long unlined canal and a rotary drum screen at the hatchery site. From the drum screen smaller pipes delivered water to the hatchery building and the 15 x 150 raceways. At the time of its construction, this system was the sole water supply to the hatchery and supplied all the fish production facilities. Intake 1 is an open faced concrete box structure located on the tailrace of the Coleman Powerhouse (see Figure 5.1 and Plate 3). The front of the box has a trash rack to exclude debris larger than about 1 1/2 inches in size. The intake box is 12 feet wide and was originally designed for a minimum submergence of approximately 3 feet. From Intake 1, the 46-inch pipeline crosses under Battle Creek, under the Orrick irrigation ditch and under Battle Creek a second time. The pipeline then terminates at an outlet structure into an unlined canal (see Figure 5.4). Shortly after the pipeline crosses Battle Creek the first time it is joined by a short length of pipe originating at Intake 2. Intake 2 is physically similar to Intake 1 and is located on the left bank of Battle Creek (see Figure 5.2). From the outlet structure, water flows in a trapezoidal earth ditch to the hatchery site. At the hatchery site the water is pumped to the water treatment system by the canal pump station (currently under construction). Gravity flow from the canal to the sand trap on the Intake 3 supply system and from Screen Chamber 1 to the hatchery building or 15 x 150 raceways is also possible. These gravity supply systems bypass the water treatment system and are not normally used.

Because Intake 1 is entirely dependent on flow from the hydroelectric facilities at the Coleman Powerhouse for its water supply, Intake 2 was designed to provide a supplemental and backup source of water to the pipeline at times when water is not available in the powerhouse tailrace (see Figure 6.4). As originally designed, Intakes 1 and 2 worked in combination to deliver water to the 46-inch pipeline with the ability for Intake 2 to deliver all the flow required to operate the hatchery in the event that water was not available in the tailrace. At an unknown date, a low stoplog weir was constructed across the tailrace immediately downstream from Intake 1 (see Figure 5.3). This structure allowed the water surface at Intake 1 to be raised from its original design elevation, increasing the hydraulic capacity of Intake 1 and resulting in a situation where water frequently flowed out of Intake 2 and into Battle Creek. A flap gate was added to Intake 2 in 1998 to prevent water from flowing out of the intake when the water level in Battle Creek is lower than the water level in the pipeline. The addition of the flap gate has the added benefit of further increasing the hydraulic capacity of the intake system due to the additional head that is available in the tailrace. As currently configured, Intake 1 is the primary water supply to the Intake 1 and 2 system. Intake 2 supplies water to the pipeline only when Battle Creek is elevated due to high flow conditions or when flow from the Coleman Powerhouse is shutdown and insufficient flows are available in the powerhouse tailrace. Because the water surface in Battle Creek is normally lower at Intake 2 than the tailrace water surface at Intake 1, and because of the hydraulic constriction caused by the flap gate, Intake 2 has a lower hydraulic capacity than Intake 1 under most conditions. The Intake 1 water surface is reasonably constant due to the steady flow conditions that exist at the powerhouse and the stoplog weir. Intake 2 has a widely varying water surface due to variations in Battle Creek flow and the seasonal presence of a rock cobble diversion dam at the Orrick irrigation diversion downstream of the intake.

The Intake 1 and 2 system was originally designed to deliver 55 cfs (24,700 gpm) to the hatchery site. This is significantly less than the combined water right of 72 cfs (32,300 gpm) which had been granted by 1957, and probably reflects a conservative design. In September 1998 an electronic current meter was used to measure the velocity at the outlet structure from the pipeline to the canal. At the time of the measurement the sluice gates at Intake 1 and the outlet structure were fully open and the sluice gate at Intake 2 was closed. The flow in the tailrace and the elevation of the stoplogs in the tailrace weir were at normal operating levels. The flow was calculated to be approximately 90 cfs (40,400 gpm) based upon a number of individual measurements. Due to the high exit velocity from the pipe and lack of a device to precisely position the current meter, this measurement should be considered to be an approximation and not an absolute value. Based upon the hydraulic characteristics of the intake and pipeline and the water surface conditions which existed at the time of the measurement, it is estimated that Intake 2 has a capacity of approximately 65 cfs (29,200 gpm) under the river conditions present that day. It should be noted that the water surface at Intake 2 was somewhat elevated over its normal late September conditions due to high flows in Battle Creek and the presence of the Orrick irrigation diversion dam downstream of the intake. Under anticipated low water conditions at Intake 2, the capacity of the system would be approximately 58 cfs (26,100 gpm).

Due to its proximity to Battle Creek and the geography of the surrounding bank area, the area around Intake 1 periodically floods, inundating the intake and stoplog weir with several feet of water. Since no electrical or mechanical systems currently exist at the intake, the impact of this flooding typically has been limited to general cleanup of the area and has not affected the ability of the intake to provide water to the hatchery. The most significant problem has been that during flooding, fish have access to the tailrace area above the intake and weir. This causes unintentional delay and stranding of migrating fish and also introduces disease potential above the normally fish-free area above the intake.

Evaluation Against Criteria

Water quality and quantity – Intake 1 provides the best surface water available to CNFH. The extensive canal and reservoir system which delivers water to the Coleman Powerhouse settles out a major portion of the solids which naturally occur in any surface water system. Other than during flood conditions when the dike between Battle Creek and the tailrace is overtopped, all water delivered to Intake 1 has passed through the powerhouse forebay system and thus has a lower suspended solids content and lower turbidity than Battle Creek. Maximum powerhouse flow is approximately 350 cfs, providing an adequate volume at the intake. After satisfying the downstream water right of 13 cfs, Intake 1 can supply up to 77 cfs (34,570 gpm) to meet a substantial portion of the current water demand of the hatchery. When Intake 3 is included there is sufficient withdrawal and conveyance capacity to meet the existing water demand of the hatchery.

Intake 2 functions primarily as a backup intake, providing water to the pipeline when water is not available at Intake 1. Since this flow comes directly off Battle Creek, the suspended solids have not been settled out of the flow entering Intake 2. Thus, the canal acts as a settling basin removing the settlable solids and a portion of the suspended solids from the water supply. The extent of settlement is not as great as that provided by the hydropower diversion system, but it is significant, providing approximately 1 hour of relatively quiescent conditions. Intake 2 generally has a lower capacity than Intake 1 due to the lack of a permanent diversion dam to maintain a minimum water surface at the intake box. Under normal water surface conditions the intake has a capacity of approximately 65 cfs. Under low water conditions this capacity decreases to approximately 58 cfs and during higher water conditions the capacity increases to 72 cfs. Historically, these capacities have been adequate given the backup status of this intake, and the additional capacity available from Intake 3.

System reliability – Intake 1 has served as a highly reliable primary source of water for Coleman for over 55 years. The hydropower diversion and canal system eliminates most of the debris that normally reduces the reliability of surface water intakes by plugging the trashracks. During occasions when flow from the powerhouse shuts down, Intake 2 automatically takes over, supplying a large percentage of the flow provided by Intake 1. Because these shutdowns have generally been brief in duration and frequently occur on a scheduled basis, the impact on hatchery operations of the reduced flow available from Intake 2 has been slight. Only under low flow conditions in Battle Creek is this a significant item of concern. During low flow conditions, Intake 2 often relies in part on a gravel and cobble diversion dam that is pushed up in the creek to divert water to the Orrick irrigation ditch. This diversion dam creates a backwater condition which extends upstream to the Intake 2 site and maintains a sufficient water depth at the intake to allow it to deliver 58 cfs or more at low river stages.

Intake 2 also has a high degree of reliability. It is well sited, at the leading edge of an outside bend and has benefited from the activities associated with the irrigation diversion immediately downstream. Prior to the installation of the flap gate in 1998, the intake generally had a slight outflow of water that kept the trash rack clear of debris. The addition of the flapgate has eliminated this "self-cleaning" feature and may increase the need for periodic cleaning to maintain the reliability of the automatic changeover when water is not available at Intake 1. The flap gate will also need to be manually opened periodically to assure that it does not become difficult to open and remain partially or fully closed when Intake 2 is needed.

Redundancy – The Intake 1 and 2 system is both internally redundant, that is Intake 2 is a redundant source of water when Intake 1 is unavailable, and externally redundant. The Intake 1 and 2 system can nearly fully meet the current water supply needs of Coleman if Intake 3 should be unavailable. If Intake 3 were to totally fail, the operational needs of the hatchery during even high demand periods could be met by the Intake 1 and 2 system for an extended period of time with only minor changes to the hatchery operation.

Access – Road access to the Intake 1 site is direct and relatively short, requiring approximately 5 minutes to reach by vehicle from the hatchery. Once at the intake site, the intake itself is reached by foot and requires crossing a walkway on the diversion dam. Direct vehicle or heavy equipment access to the intake is not currently possible. Such access requires either fording the powerhouse tailrace or accessing the site through the powerhouse property and traveling through the trees and brush to reach the site. Access to Intake 2 is more difficult, requiring up to 30 minutes to reach across dirt roads. A cableway provided personnel access from the Intake 1 site for many years, however repeated vandalism problems led to the removal of the cableway a number of years ago.

Fish Protection – Neither Intake 1 or 2 meet the current resource agency requirements for fish screening. Screening at Intake 1 is not considered to be necessary because currently fish would not be likely to survive passage through the penstock and powerhouse, and future plans call for intake screening at the diversions from Battle Creek to the powerhouse canal. Flood conditions can result in fish being stranded in the tailrace above the stoplog weir on a periodic basis, however this is an infrequent event and is associated with extreme conditions when many fish are typically stranded by receding water. Some spawning has occurred in the tailrace above and below the weir and the California Department of Fish and Game plans to install an Alaska picket weir as a temporary exclusion measure at the junction of the tailrace and Battle Creek to prevent the entrance of adults into the tailrace.

Maintenance – Regular maintenance consists of a twice daily visual inspection of the trash racks on the intakes and removal of debris as necessary. This is easily accomplished due to the simple design of the intake structures. The canal is dewatered and cleaned to remove accumulated sediment and vegetation annually. Access along the canal for inspection and cleaning is good.

Long-term Performance – The system is over 55 years old and has required minimal maintenance over this time. From a design life perspective it has reached the end of its economic life. However, based on an inspection of the features that are visible from above ground, the system is in good condition and has many years of life remaining. The concrete intake boxes and outlet structure are in good condition and the canal pump station is new. The trash racks are the original fabricated steel items and should be inspected in detail when they are accessible due to low water conditions. The sluice gates are exercised regularly and appear to be in good condition, however a detailed inspection should be conducted to verify this. The gate hoists also appear to be in good condition but are part of the original installation and should be given a detailed inspection for signs of excessive wear in the gears. The pipeline is an item of significant concern. To the best of our knowledge, it has never been dewatered or inspected and its condition is unknown. The measured velocity is high enough that it is unlikely that any significant volumes of sediment have accumulated in the pipe. During the construction of the experimental flat plate screen at Intake 3, a short section of the pipeline was exposed. Its exterior condition looked good and no visible leakage was identified. If the pipe is to be retained in service for more than 10 years, it should undergo a video inspection of the interior as soon as possible. If any problems or uncertainties are discovered a diver inspection with a video and audio link to an engineer on the surface should be performed. The canal is in good condition with minimal indication of leakage on the downhill side. Restoring the canal to a uniform cross section, including removal of vegetation along the banks, would improve the hydraulic performance of the canal and would be a relatively low cost undertaking. Lining the canal would reduce the cost of annual cleaning, but is not necessary from a performance perspective.

The stoplog weir in the tailrace is another item of significant concern. No drawings of its original construction are known to exist and very little of it is exposed during normal operations making inspection difficult. Although the steel frame members do not show obvious deterioration and the stoplogs are replaced on a regular basis, the foundation of the weir is a significant unknown and could be a source of major problems. Recent visual inspection of the weir (January 1999) showed that at least one of the steel frame support members has come completely free of its foundation on the downstream side of the weir and is oscillating back and forth in the flow, providing no support to the structure. There is serious concerns about the short-term stability of the structure. A temporary repair should be implemented as soon as possible. Based on the evidence available, it is recommended that the weir be demolished and replaced with a new weir structure. The replacement structure should be a concrete weir structure with the water level controlled by either stop logs or a mechanical crest gate.

Water rights – The present water rights limit the maximum withdrawal from Intake 1 to 50 cfs (22,500 gpm) and Intake 2 to 33 cfs (14,820 gpm) or a combined total of 72 cfs (32,330 gpm) provided that the individual withdrawals do not exceed the 50 and 33 cfs limits. At a minimum, it would be desirable to revise these rights to allow up to 72 cfs to be withdrawn from either intake. This would provide a secure water source under the current operating conditions. If hatchery operations are revised in the future to require additional water, additional rights should be obtained to allow full utilization of the 90 cfs (40,410 gpm) hydraulic capacity of the system.

Conclusions

The Intake 1 and 2 system is an outstanding water supply. It has served CNFH well for over 50 years with minimal maintenance and repair other than annual dredging of the canal and daily inspection and debris removal at the intake boxes. The system provides a high degree of reliability without the need for the hatchery staff to take action. Access to Intake 2 is difficult, however a bridge or other fixed crossing could easily remedy the problem. Intake 2 is not in compliance with current state and federal fish screening criteria and cannot be easily renovated to meet them. Maintenance is easily accomplished and does not require an excessive amount of time. The pipeline has never been dewatered or inspected and should be inspected by video camera to ensure that no major problems exist. The stoplog weir in the tailrace should be replaced. The sluice gates and gate hoists in the two intakes and the outlet structure to the canal should also receive a detailed inspection. The water rights should be revised to allow diversion of the existing total right from either of the intakes or a combination of the two.

5.2 Intake 3 System

The Intake 3 system was constructed in about 1963 to supply water to the 8 x 80 raceways and an outdoor broodstock holding pond which was constructed about the same year. The intake is located about 2,500 feet downstream of Intakes 1 and 2. The system originally included an intake box, 3,900 feet of 48-inch diameter pipeline and an inclined screen box at the hatchery site. Intake 3 is an open faced concrete box structure located on the right bank of Battle Creek (see Figure 5.5 and Plate 4). The front of the box has a trash rack to exclude debris larger than about 1 1/2 inches in size. The intake box is 12 feet wide and was originally designed for a minimum submergence of approximately 2 feet. The intake was constructed without a permanent diversion dam. For many years a low rock, riprap dam was maintained in Battle Creek to divert water to the intake box and deliver the required flow to the pipeline. At the hatchery, screen 2 excluded fish and debris greater than ¼ inch in size and a pipe network delivered the screened water to the 8 x 80 raceways and the broodstock holding ponds. Excess water overflowed Screen 2 and returned to Battle Creek via a drain ditch (see Figure 2.1).

In the late 1980's a sand trap was constructed on the pipeline near Screen 2 to remove settlable solids from the water. The outlet structure from the sand trap included an inclined screen system to remove debris and juvenile fish from the water and return them to Battle Creek. In 1990 a low diversion dam was constructed across Battle Creek at the intake to improve the reliability of the intake by establishing control of the minimum water surface at the intake. A horizontal screen system was constructed in front of the intake to prevent the entrainment of juvenile fish in the system and steel plates were bolted to the face of the trash rack to prevent unscreened water from entering the trash rack. The horizontal screen was provided with an air burst cleaning system however due to poor hydraulic conditions and a low sweeping velocity, the air burst system was not effective in keeping the screen clean. Additionally, the screen is undersized to meet the current fish protection criteria and does not have a uniform approach velocity. After several attempts to solve the operational problems with the horizontal screen, the majority of the plates were removed from the trash rack to return the intake to its original operating condition.

Intake 3 and the surrounding bank area (including the area around the small equipment building) have historically been susceptible to flooding during significant flow events in Battle Creek. Since the original fish screening system has been disabled by the removal of the plates (as was noted above), this has not had a major impact on the hatchery from a water supply standpoint. Flooding of the building, however, where critical mechanical and electrical equipment are housed, is troublesome and is a maintenance problem.

In 1993 the raw water pump station was constructed on the outlet pipe from the sand trap to pump water from the Intake 3 water supply system to the water treatment system. The pump station has a design capacity of 20,000 gpm (45 cfs) and includes one spare pump for a total capacity of 25,000 gpm (56 cfs) with no redundancy. In 1998 an experimental horizontal plate screen system was constructed in the pool upstream of the diversion dam and the discharge pipe from this addition was connected to the pipeline to the hatchery site. The screen system consists of two 25 cfs modules of the USBR Flat Plate Screen with certain modifications to suit the conditions present in Battle Creek. Specifically, the modules are partially buried in the creek bed in order to provide a minimum of 12-inches of water over the screen panels. This makes the screen system non-retrievable and places the screen faces closer to the creek bed than the prototype model was developed to be. An extensive monitoring program is planned to evaluate the physical and biological performance of the screens. Also in 1998, the coarse trash rack on the front of the original intake box was retrofitted with perforated plate screen panels. The screen slots are 0.125 inch (3.175 mm) wide, rather than the 0.0689 inch (1.75 mm) criteria for steelhead trout fry and the average approach velocity based on the submerged screen area exceeds the 0.33 fps criteria under all but flood conditions. The lower panels can be raised to remove them from the flow path and no cleaning system is provided. The retrofit was made as an interim, low cost method of providing some degree of fish exclusion while allowing the intake to be used as an emergency water source during evaluation of the experimental horizontal screen system.

Gravity flow from the sand trap to the 8 x 80 raceways and the broodstock facility is possible. This is normally not done because it bypasses the water treatment facilities in the case of the supply to the 8 x 80 raceways. Water for the broodstock facility is normally delivered by pumping untreated water from the sand trap overflow channel to the broodstock facility since the adult fish do not require treated water.

The Intake 3 system has a water right of 50 cfs (22,500 gpm) and is capable of delivering as much as 70 to 75 cfs (31,400 to 33,700 gpm)

Evaluation Against Criteria

Water quality and quantity – Water from the Intake 3 supply system has a higher total solids concentration than the Intake 1 and 2 system. Although the sand trap removes nearly the entire settlable solids content, suspended solids as measured by weight and turbidity are typically slightly higher in the Intake 3 system than the Intake 1 and 2 system. Intake 3 also has a much greater exposure to reaches of Battle Creek that contain anadromous fish. This may result in a greater possibility of pathogens and disease organisms being present in water from Intake 3 than would be present in water from Intake 1. Intake 3 is located downstream of the confluence of the Coleman Powerhouse tailrace and Battle Creek. This results in minimum stream flows that substantially exceed the capacity of the intake and an adequate availability of water under all conditions. The hydraulic capacity of the Intake 3 supply system is between 70 and 75 cfs (31,430 to 33,670 gpm). This exceeds the design capacity of the sand trap and the raw water pump station as well as the water right. In combination with the Intake 1 and 2 system, Intake 3 provides adequate quantity to meet the existing water demand of the hatchery. With minor improvements to the Intake 3 system, the combined systems could provide adequate capacity for the future needs of the hatchery.

System reliability – Intake 3 has been a reliable source of water from the perspective of the availability of an adequate supply, the ability of the intake to divert the supply and the reliability of the system to convey the water to the hatchery site. The addition of the diversion dam greatly reduced the low flow diversion problems that previously existed and improved the overall reliability of the system. Attempts to develop an effective fish and debris screening system at the intake have not been successful and have reduced the reliability of the intake to the point that the intake box has been returned to its original configuration.

The recent installation of the modified USBR Flat Plate Screen in combination with movable plate screens on the front of the intake box has an unknown impact upon the reliability of the system. Until the system has been evaluated and tested it must be assumed that the reliability of the intake system has been decreased as a result of the installation of these features. The USBR screen has never been field tested in conditions similar to those that exist in Battle Creek. The relatively shallow water depth available upstream of the diversion dam may increase the accumulation of floating or semi-floating debris on the screens. Also because the screens are semi-buried in the bed of Battle Creek, they may be susceptible to sedimentation or entrainment of bed load. Operational experience will be necessary to provide answers to these concerns. The plate screens on the intake box are intended to provide a source of screened water as a backup supply to the USBR screens. Normally no water will be provided through these screens and they do not have an automatic cleaning system. Based on previous experience with static screens, they will require a large amount of effort to keep clean, particularly when leaves are present in Battle Creek. Because the bottom sections are on guides, they can easily be removed from the front of the intake, returning it to its original configuration.

Redundancy – The current configuration of the Intake 3 supply system provides a limited degree of redundancy by virtue of having both the USBR screen and the original intake box in place. Additionally, as noted previously, the presence of two independent water supply systems provides a level of redundancy that a single system cannot accomplish. Should the Intake 1 and 2 system fail totally, the Intake 3 system could provide up to 25,000 gpm (56 cfs) to the water treatment system for an extended period of time. Additional water could be provided to operate the broodstock facilities if necessary.

Access – Vehicle access to Intake 3 is extremely good, with the site requiring less that 3 minutes to reach by paved road from the hatchery. Direct heavy equipment access to the intake and appurtenances is available. The pipeline, sand trap and raw water pump station are directly accessible by vehicle. The pipeline route has not been maintained in a driveable condition but access could be easily established.

Fish Protection – Based on laboratory and prototype testing the USBR screens can be operated to meet current resource agency criteria for fish protection with regard to opening size and velocities. The 5 minute cleaning frequency requirement cannot be met by the existing compressor system and either a change in equipment or a modification of the standard may be necessary. The plate screens on the intake box do not meet agency criteria, and were installed as an interim improvement over the unscreened conditions that previously existed. These screens are planned for use only under emergency conditions such as failure of the USBR screens.

Maintenance – Maintenance on the USBR screens will be difficult. The screens have been installed in a non-retrievable manner due to the low water depths available at the site. If significant damage to the screens were to occur, repairs would have to wait until low water conditions are present and the screens can be removed by excavation and disassembly using heavy equipment or repaired by a diver. Alternatively sheet piling would have to be driven around the screens and the enclosure dewatered to provide access.

Long-term Performance – Although not as old as the Intake 1 and 2 system, the Intake 3 system is approaching an age where major repairs are not uncommon. The pipeline in particular is an item of concern. Based on a visual inspection of the portion of pipe that was removed during connection of the USBR screen, it appears that the pipe material is welded steel with a coal tar exterior coating. The interior appeared to be uncoated steel. This inspection did not reveal a significant loss of pipe wall thickness, however no thickness measurements were made for comparison with the original pipe wall thickness because the original design thickness is unknown. A comprehensive inspection of the pipe would require excavation of the pipe in a number of locations and the determination of the remaining pipe wall thickness in several places around the circumference of the pipe. With this information an estimate of the remaining pipe life could be made. Lacking this information, it is reasonable to assume that the pipe has approximately 25 years of life remaining based on the condition of the removed pipe section. The original intake box is in good condition with only minor deterioration of the concrete noted. The sluice gates and gate hoists are in fair condition and are exercised on a regular basis. The gates and hoists should be given a detailed inspection for excessive wear and general deterioration when the intake is dewatered. All other components of the system are less than 10 years old and are in good condition.

Water rights – The Intake 3 system is capable of fully utilizing the water right of 50 cfs (22,450 gpm) associated with it. If hatchery operations are revised in the future to require additional water, additional rights should be obtained to allow full utilization of the 70 to 75 cfs (31,430 to 33,670 gpm) hydraulic capacity of the system.

Conclusions

Intake 3 has historically provided a reliable source of water for hatchery operations. Attempts at meeting fish protection criteria have not been successful to date, however the location and accessibility of the intake for inspection has avoided major problems as a result of the increased attention required to maintain its reliability. The installation of the experimental USBR Flat Plate Screen may have a negative impact of unknown extent on the reliability of the Intake 3 system. In the worst case, the original intake box can be returned to its original configuration by raising the plate screen panels and the system will revert to its original operation with only coarse screening at the intake. The USBR screen should meet the current fish protection criteria, however access to the screens for inspection or repair will be impossible during much of the year, and difficult during the remainder of the year. An extensive evaluation of the USBR screen is planned to validate its compliance with the current fish protection criteria. Other than the pipeline, the system is in good condition and has many years of life left. The remaining life of the pipeline is uncertain, but could be more accurately estimated with minimal additional inspection efforts. The intake system has adequate water rights for current hatchery operations and since CNFH is non-consumptive user of water, sufficient rights could likely be obtained to meet future operations if needed.

The USBR screen is an experimental design at this writing and its performance history has never been demonstrated outside of short term test installations. As part of the experimental installation at CNFH an extensive monitoring program is planned to evaluate the hydraulic and fish protection performance aspects of the screen system. In addition to determining if the screen will meet the resource agency criteria for fish protection, the monitoring program will also assist with evaluating the suitability of the screen for a hatchery intake where very high reliability is required. The installation at Intake 3 is significantly different than the conditions for which the screen was developed. The screen housing is partially buried in the creek bed and this may increase the intake of fine sediment during period of high bed load movement. During low stream flows, the screen is not submerged to the depth of previous tests and this may affect the hydraulic performance and increase the rate of debris fouling when floating or semi-submerged debris is present in Battle Creek. The results of the monitoring program should assist with the resolution of these concerns.

6.0 INTAKE SYSTEM ALTERNATIVES

6.1 General

Alternative Development Methodology

Development of alternatives for investigation in this report was a cooperative process initiated by the Coleman Intake Working Group during the Spring of 1998. This group was comprised of various representatives from the resource agencies including NMFS and CDF&G, representatives from the CNFH staff, Service staff from the Northern Central Valley Fish & Wildlife Office in Red Bluff , the Service engineering office in Portland, Service staff from the CVPIA Office in Sacramento, Reclamation representatives from the Northern California Area office, and other interested parties. A brainstorming process during a series of meetings was undertaken where a number of ideas and concepts were proposed for consideration. After a screening process undertaken by the group which eliminated ideas deemed to be unfeasible or unreasonable, a final group of six alternatives was selected. These alternatives, Alternatives 1 through 6, were refined by the group for further investigation. Responsibility for development of three additional alternatives was given to the engineering consultants preparing this report and are presented as Alternatives 7 through 9. A final alternative, Alternative 10, was developed as a result of a project review meeting where various features of two different alternatives were combined. A summary of the various alternatives is presented in Table 6.1 on the following page.

Review of each alternative includes a description of the alternative which describes the physical features and operations of the system. To enhance clarity, sketches showing the layout of physical features associated with each alternative are provided. Following the description is an evaluation of the alternative against the criteria developed for the project, as described in Section 3.0. A final recommended alternative (with selected back-up alternatives) is provided in Section 7.0.

Cost Estimates

Construction Cost Estimates

Since the alternatives presented in this study are conceptual level designs, developed without a high degree of design detail, the probable construction cost estimates were consequently developed to a similar conceptual level of detail using estimated unit costs derived from the actual construction costs of similar facilities, vendor input for large components, and standard industry cost guides. This method was used since adequate detail is not included in these designs to perform a detailed cost estimate based on exact material quantity and fabrication/installation labor expenses. Separate cost estimates have been prepared for each alternative. A cost summary is provided with each of the alternative descriptions. A more detailed accounting of specific cost items is provided for each alternative in the Appendix. Because of the conceptual nature of the designs, a construction

Table 6.1 – Intake System Alternatives Summary

(Flows shown are hatchery supply flows. Intake flows at screened intakes would be slightly greater to accommodate fish bypass pipe flows)

Intake Alternative	Status of Intake in Alternative					Max. Total System Flow [5]
	Intake 1	Intake 2	Intake 3	New Intake	New Intake	
1	**"As Is"** [1] (40,000 gpm)	**"As Is"** (26,000 gpm-Emerg.)	**Reconstruct** [2, 6] (32,000 gpm)	--	--	**70,000 gpm** (Norm.) **58,000 gpm** (Emerg.)
2	**"As Is"** (40,000 gpm)	**Reconstruct** [6] (26,000 gpm-Emerg.)	**Reconstruct** [6] (32,000 gpm)	--	--	**70,000 gpm** (Norm.) **58,000 gpm** (Emerg.)
3	**"As Is"** (40,000 gpm)	**Abandon**	**Reconstruct** [6] (32,000 gpm)	**Relocate Intake 2 to Right Bank of Battle Creek** [6] (40,000 gpm – Emerg.)	--	**70,000 gpm** (Norm.) **70,000 gpm** (Emerg.)
4	**"As Is"** (40,000 gpm)	**Abandon**	**Increase Cap. & Reconst.** [3, 6] (32,000 gpm Norm. – 40,000 gpm Emerg.)	--	--	**70,000 gpm** (Norm.) **40,000 gpm** (Emerg.)
5	**Increase Capacity** (70,000 gpm)	**Abandon**	**Abandon**	**Battle Creek Gravity Intake to Sand Filters** [6] (40,000 gpm – Emerg.)	--	**70,000 gpm** (Norm.) **40,000 gpm** (Emerg.)
6	**Abandon**	**Abandon**	**Abandon**	**Coleman Forebay Gravity Intake to Filters** (70,000 gpm)	**Battle Creek Gravity Intake to Sand Filters** [6] (40,000 gpm – Emerg.)	**70,000 gpm** (Norm.) **40,000 gpm** (Emerg.)
7	**"As Is" with Power-house Bypass** [4] (40,000 gpm)	**Abandon**	**Increase Cap. & Reconst.** [6] (32,000 gpm Norm. – 40,000 gpm Emerg.)	--	--	**70,000 gpm** (Norm.) **40,000 gpm** (Emerg.)
8	**Abandon**	**Abandon**	**Gravity to Settling Basins & Pumped to Hatchery Canal** [6] (70,000 gpm)	--	--	**70,000 gpm** (Norm.)
9	**Increase Capacity** (70,000 gpm)	**Abandon**	**Abandon**	**Pumped Intake At Barrier Weir** [6] (40,000 gpm – Emerg.)	--	**70,000 gpm** (Norm.) **40,000 gpm** (Emerg.)
10	**Increase Capacity** (70,000 gpm)	**Abandon**	**Abandon**	**Relocate Intake 2 to Right Bank of Battle Creek** [6] (40,000 gpm – Emerg.)	--	**70,000 gpm** (Norm.) **40,000 gpm** (Emerg.)

Notes:

1) "As Is" means that the intake will remain substantially as currently configured. Improvements may be required to ensure long-term viability or improve performance. A tailrace barrier structure would be constructed to preclude movement of fish up the tailrace. All alternatives which use Intake 1 will include a tailrace barrier.
2) "Reconstruct" means that the intake must be reconfigured or otherwise re-built to meet operational, fish protection, and other criteria.
3) "Increase Capacity and Reconstruct" means that the existing intake must be reconfigured or re-built to meet operational, fish protection, and other criteria and that the total flow through the intake must be increased.

4) "As Is with Powerhouse Bypass" means that the existing intake would remain essentially as is (see note 1) and a new bypass pipe would be constructed around the Coleman powerhouse to improve reliability of supply to Intake 1 during powerhouse outages.

5) Total System Flows shown are the capacities of the combined intakes limited to sum of the hatchery demand (64,000 gpm) plus downstream water rights (6,000 gpm) for normal operating conditions (non-emergency intakes are functioning normally). Under emergency conditions (water is not available at an intake due to hydroelectric system operational problems), emergency or "backup" intakes are operated. Total system flow under these conditions may or may not meet the target flow of 70,000 gpm. If a combination of intakes taken separately can provide more than the total system target flow, the assumption is that the intakes would be throttled back to obtain the target system maximum of 70,000 gpm. Intake capacities shown may exceed current water rights. (See Section 2.4)

6) Screened intake. The total flow shown is 90% of the total diverted amount of flow from the river. The remaining 10% is used for fish bypass flow and is returned to the river downstream.

contingency of 25% has been added to all cost estimates. Additionally, a 12% planning and engineering line item has been included. A construction management cost of 12.5% is also added to each cost estimate. Costs for property or right-of-way procurement and costs for permitting are not included. Costs are presented in 1999 dollars.

Operations and Maintenance Costs

The facilities described in the alternatives are, by design, relatively simplistic in nature with the goal of minimizing the amount of maintenance necessary by hatchery personnel. This type of approach increases the overall system reliability, especially under adverse conditions. Intakes where screens systems are present will naturally require, on an annual basis, a higher degree of maintenance than those intakes with just a simple bar rack. However, even intakes with bar racks will require daily inspection and attention as necessary to ensure a clear water passage into the water delivery system. For emergency intakes (intakes used only as a backup to other intakes), there is typically no flow entering into the system thus reducing maintenance needs even further.

Because the degree of mechanical complexity is relatively low for these systems (relatively simple technologies are applied) and because the degree of automation is relatively high (automated gate controllers, screen cleaners, and monitoring equipment), the need for daily attention to the facilities, except to physically remove debris from intake bar racks, should be relatively low. Annual maintenance (maintenance performed annually on a scheduled basis during which time the system is off-line) can be expected at intakes with screening systems to remove accumulated sediment, maintain screen panels and cleaner systems, service gates, etc.

For the purpose of generating an estimate of O&M costs for the alternatives, it is apparent that the greatest single cost will be associated with the labor requirements for these daily inspections and annual maintenance. Obviously, the greater the number of facilities to visit, and the more extensive the facilities, the higher this labor cost is.

Another aspect of O&M costs is the cost for replacing equipment that wears out over time. In general, for these alternatives, this is generally limited to the screens and screen cleaning equipment found in facilities with fish screens, the electrical generation and control equipment, pumps, and other motorized devices such as the gate actuators. The annualized replacement cost for these items is estimated at approximately 6% of the original equipment cost. Features assumed to not need replacing during the lifetime of the project include concrete structures, bar racks, water control gates, water piping, etc. These facilities are not assigned an annual replacement cost.

For facilities with full-time pumping (not including emergency intakes with pumps), costs for power are included. Electrical costs for these major draw items are based on an assumed power cost of $0.02/kwh. The actual cost of the power supplied to the hatchery is somewhat dependant upon one's point of view. Power is supplied to the hatchery by the Bureau of Reclamation and is accounted for in the Bureau's budget based on the wheeling costs of producing the power (approximately $0.002/kwh). However, if the hatchery was not using the power it could be sold at wholesale by the Bureau at a much higher rate. This rate would be variable and hard to predict over the life of this project. The use of $0.02/kwh would appear reasonable for estimating purposes (being ten times the approximate wheeling cost), and the power costs given in the O&M estimates could certainly be adjusted by anyone wishing to assess these costs at some other rate.

Separate O&M cost estimates have been prepared for each alternative and are presented along with the construction cost estimates

6.2 Battle Creek Hydraulic Design Issues and Parameters

To support this evaluation of intake system alternatives at CNFH, a hydraulic analysis of Battle Creek was performed to establish appropriate design flows and water surface profiles, review sediment transport issues, and assess the long-term stability of Battle Creek from an intake siting viewpoint [9].

Design Flows and Water Surface Profiles

A bathymetric survey of approximately 2 miles of Battle Creek, starting at the barrier weir near the hatchery, was conducted to support the analysis. By use of historical flow records of Battle Creek from the USGS gaging station located below CNFH and one-dimensional HEC-RAS and HEC-6 computer modeling, a statistical analysis of the data was performed to determine flood flows of various frequencies. Historical Battle Creek flow data is presented in Figures 6.1, 6.2, and 6.3. From the hydraulic analysis, the resulting water surface profiles were plotted for the various flood frequencies as follows:

Battle Creek Flood Peak Estimates

Flood Freq. (Years)	**Q_1**	**Q_2**	**Q_5**	**Q_{10}**	**Q_{25}**	**Q_{50}**	**Q_{100}**	**Q_{200}**
Flow (Cfs)	855	6,094	10,850	14,500	19,560	23,620	27,890	32,390

Using the results of hydraulic analysis, the appropriate flood frequencies were established for the purpose of developing appropriate design water surface elevations at the intakes. Key issues included protection of critical components of the intake systems from flooding (screening equipment, motors, monitoring equipment, pumps, etc.) as well as access to the facilities during flood events. The central issue, however, is to preserve the ability of the intakes to deliver water to the hatchery.

To establish the appropriate maximum design water surface elevations at the intakes, the peak historical flows for Battle Creek (Figure 6.2) were compared to the peak flood estimates. The maximum recorded peak flow event during the period of 1961 to 1996 was approximately 24,300 cfs. This corresponds closely to the Q_{50} event of 23,620 cfs. This flow was thus established as the maximum flood design flow for the project. Flows below this level would not compromise the critical components. Flows above this level would, in any event, not affect the ability of the hatchery to obtain water, but the functionality of the critical components or systems might be compromised as a consequence. The drawings for the various alternatives refer to the water surface elevation corresponding to this flow as the *maximum flood* design elevation.

The other relevant design water surface elevations are what are referred to in the text and drawings as the *normal minimum* and *normal maximum* design water surface

[9] *Hydraulic Analysis of Battle Creek – Coleman NFH*, March, 1999, ENSR Corporation

elevations. This is a range of elevations expected to be seen during a typical year. Based on historical information for average flows in Battle Creek (Figure 6.1), the normal maximum river flow is approximately 900 cfs while the normal minimum river flow is approximately 250 cfs. The upper limit of this range corresponds relatively closely to the Q_1 flood event of 855 cfs. The lower limit is the critical low water surface elevation for which intakes located on Battle Creek would be designed to supply the design flow to the hatchery. The relevant river design stages and flows are summarized below:

Design River Stage	Flow (cfs)
Normal Minimum	250
Normal Maximum	900
Maximum Flood	23,620

As can be seen in Figure 6.3, flow in Battle Creek has historically been as low as 102 cfs during the 35-year period between 1961 and 1996. Although this flow occurred during the month of October, flows as low as 152 cfs or lower have occurred during months of July, August, and September. In fact, daily river flows below the normal minimum design flow have occurred at some time in the 35-year period during all 12 months. River elevations at these flows would produce less than the design discharge for intakes directly on Battle Creek due to the absence of sufficient driving head through the system. Additionally, these conditions may require the discharge through any intake to be artificially limited to a predetermined amount in order to meet minimum in-stream flow requirements for Battle Creek. These would be considered to be non-typical operating conditions and the appropriate response to these conditions would be defined in a hatchery emergency action plan.

Erosion and River Channel Stability Issues

Battle Creek is an active, powerful creek during major flood events, as witnessed by the large quantities of sediments, rocks, boulders, and debris transported down the river periodically causing damage to natural and constructed features in the river. The barrier weir at the hatchery, for example, was replaced in 1993 as a result of severe erosion due to high water. Despite the presence of the sand settling basins located on the Intake 3 supply line, which were constructed to reduce sediment load on the hatchery facilities, the sand filters for the water treatment system are often choked with suspended sediments during floods; a testimony to the seriousness of this issue as it relates to the operation of the hatchery.

The objective of reviewing the erosional and channel stability characteristics of Battle Creek in the hydraulic analysis was to establish the critical issues related to different intake designs and intake locations to better anticipate maintenance problems and long-term performance of the systems. These issues should be considered from a planning perspective and should be taken into account during the final design phase at any prospective intake site.

Battle Creek, in the length of the study reach, can be classified as an S-9 stream, associated with the bankfull width of 150 to 250 feet. The depositional patterns easily observed along the creek are point bars in the downstream reach, and point bars with a few mid-channel bars upstream. The channel is characterized by an irregular meander pattern and shows a historical tendency to lateral migration of the channel. Based on the channel evaluation method employed, Battle Creek can be classified as having good channel stability in the study reach with low to medium erosion potential except in discrete sections including the existing site of Intake 2 (see discussion below).

Based on the results of the analysis, the depositional and erosional characteristics of the stream bed vary throughout the reach. The bed upstream of the barrier weir (proposed location for the emergency intake in Alternative 9) and the reach near the proposed emergency intake near the powerhouse for a number of alternatives, appear to be the most stable after passage of bankfull (2.3-year) and 100-year floods. The rate of erosion of the bed appears to be most active near Intake 2 while deposition is anticipated upstream of the weir at Intake 3 and the barrier weir. Quantitative assessments of bed erosion and deposition were not possible due to the limited scope of the analysis, however, the qualitative results provide relative rates of bed erosion and deposition and are nonetheless meaningful from a planning standpoint.

The lateral stability of the river was evaluated based on the Rosgen Stream Classification Systems (RSCS) method utilizing visual evidence at the site, and by interpretation of results from the HEC model runs.

Based on this methodology, visual evidence at the existing location of Intake 2 suggests a high degree of stability of the bank due to the protection from trees and grasses, however, during extreme flood events the high estimated velocities (9 to 10 fps) along the left bank (looking downstream), suggest that streambank erosion potential could be quite high. Although, it should be noted that the intake structure at Intake 2 was constructed in the 1940s and shows little evidence of distress due to bank erosion.

The medium angled bank at the proposed emergency intake site near the powerhouse (Alternatives 3 and 10), is sparsely populated with trees although the bank is protected by small to large boulders and cobbles. Because of the sparseness of the vegetation, it is possible that bank erosion may take place during very high flows as observed on the opposite side of the creek during the site visit. However, the vegetation that is observed in the area along the stream bank is characterized by brush and mature trees suggesting a degree of stability in this reach of the river.

The river channel at the upper Battle Creek intake sites (Alternatives 5 and 6) was evaluated by ENSR only from photographic evidence since this area was not originally considered for intake siting. However, the assessment is that the right bank (the bank with proposed intake) is more stable than the left and is fortified by deeply rooted trees and dense brush. This reach of the river is directly following a sharp bend in the river, and high creek velocities are discernible in the creek. Evaluation of this stretch of the creek suggests that it should be rated as fair to good with the right bank erosion potential low because of the tree factor.

The bank of the section of the river upstream of the barrier weir (at the proposed location for an emergency intake for Alternative 9) is slightly sloped and fortified with tall vegetation and small brush. The lower bank is fortified with large cobbles. The floodplain just above the bank is protected only with sparse vegetation, and would likely erode if overtopped. During normal flows, the streambank erosion potential is small.

It is apparent from the analysis that local conditions at the proposed intake sites vary considerably. The proposed intake sites do, however, appear to exhibit a reasonable degree of stability, although protection from erosion (riprap, etc.) would be considered as a prudent mitigation measure for future erosion.

6.3 Alternative 1

General Description

Intake system Alternative 1 can be characterized as the "least action" alternative because it involves the fewest number of improvements to meet criteria objectives. In this alternative, the existing intakes at Intake 1 and 2 remain essentially as they are currently configured while Intake 3 is reconstructed to meet current fish protection requirements. A fish barrier is constructed on the tailrace at the confluence of the tailrace and Battle Creek to exclude adult fish from entering the tailrace to prevent stranding during periods when the powerhouse flow is interrupted and to preclude movement of fish to areas above Intake 1 in the tailrace (see Figure 6.4 on the following page). Sketches showing proposed improvements associated with Alternative 1 are depicted on Plates 5, 6 and 7.[10]

Intake 1 Improvements

Proposed improvements at and around Intake 1 are intended primarily to extend the life of the intake to meet the 50-year design life and to block movement of fish up the tailrace and around Intake 1. As was noted in Section 5.2, the physical features of Intake 1 are in reasonably good condition. They are, however, over 55 years old and several mechanical system items should be inspected and rehabilitated or replaced as necessary to extend the intake life for another 50 years. Discharge through the intake remains at approximately 40,000 gpm (89 cfs) at the design discharge in the tailrace of 350 cfs.

Proposed improvements to Intake 1 include the following:

- *Rehabilitation or replacement in-kind of the existing manually operated water control gate and operator*
- *Rehabilitation or replacement in-kind of the existing steel trash rack*
- *Construction of new concrete wing walls on either side of the intake to eliminate the flow of water around the intake (see Figure 5.1)*
- *Replacement of the security fencing at the intake*

Proposed improvements in the tailrace include the following:

- *Replacement of the existing stoplog weir adjacent to the intake*. The existing structure, shown on Figure 5.3, is fabricated of steel members and includes stop logs for water level control and a walkway grating and handrail. As was noted in Section 5.1, the structure is in eminent danger of collapse and should be replaced as soon as possible. A reasonable and functional replacement structure would

[10] During the final selection process, the powerhouse bypass pipe as described for Alternative 7 was added to Alternative 1. See Section 7.0 of the report for details concerning this addition.

involve construction of a new stoplog weir structure supported by a concrete foundation adjacent to the existing intake. The overflow weir would be formed by removable wood or steel stop logs. Since water level control adjustments are not made frequently at the structure, this type of structure would be appropriate. If greater operator convenience is desired, a new hydraulically (or manually) operated steel crest gate could be constructed rather than the removable stop log-type design.

For the purposes of this study, a new stoplog weir structure is assumed since it meets the operational needs of the hatchery and would be a lower cost and maintenance installation compared to more elaborate fabricated gate designs. A plan and section of the weir is shown on Plate 6. A grated walkway across the weir would be constructed to gain access to the intake on the far side of the tailrace. To accommodate fluctuating pool elevations and prevent local flooding caused by changes in hatchery intake operations and powerhouse discharges, the embankments around the pool would be raised slightly. A small low-level gate would be incorporated into the structure to offer greater control over the pool water surface and to allow for easy draining of the pool for maintenance purposes.

- *Construction of a fish barrier structure on the tailrace about 20-30 feet upstream of the confluence of the tailrace and Battle Creek*. The proposed barrier structure would be constructed as a low (1 foot high) sloping concrete weir across the tailrace with concrete abutment walls extending approximately 8 feet high on either bank. A series of sloping hinged bar racks supported by a steel truss would be constructed on top of the walls extending between the concrete wall abutments. Little or no impounding of water is anticipated behind the structure so no significant embankment protection measures are anticipated adjacent to the structure. The bar spacing on the racks would be sized to exclude the target species and would be about 1-inch.
- *Roadway access improvements to the fish barrier structure*. Existing unimproved dirt tracks lead near the proposed fish barrier location. Improvements would include grading and application of a crushed gravel surfacing.

<u>Intake 2 Improvements</u>

In this alternative and as currently is the case with the existing system, Intake 2 functions as an unscreened emergency backup to Intake 1 and supplies approximately 26,000 gpm (58 cfs) at low river flows as was noted in Section 5.1.

Proposed improvements at Intake 2 are intended primarily to extend the life of the intake to meet the 50-year design life. They include the following:

- *Rehabilitation or replacement in-kind of the existing manually operated water control gate and operator*
- *Rehabilitation or replacement in-kind of the existing steel trash rack*
- *Replacement of the existing security fencing at the intake*

Intake 1 and 2 Water Conveyance System Improvements

Proposed improvements to the water conveyance system (pipeline, canal water control structure, and canal) are intended primarily to extend the life of the system to meet the 50-year design life. They include the following:

- *Remote or visual inspection of the supply pipeline.* As was noted in Section 5.1, the existing 46-inch hand-cast reinforced concrete water supply pipe which conveys water from Intakes 1 and 2 is about 55 years old and there is no evidence that that pipe has ever been inspected. A prudent first measure to prepare for another 50 years of service for this 2,700-foot long pipe would be to perform an inspection of all or parts of the pipe to confirm the integrity of the pipe structure and condition of the interior finish. Evidence from hydraulic calculations and field measurements suggest that the pipe is very efficient leading to the conclusion that no major deterioration of the interior of the pipe has occurred. Inspections could be performed by remote camera or a diver to confirm this. A diver inspection for this pipe has been estimated to cost approximately $25,000. Alternatively, if desired, the pipe could be dewatered by pumping and bulkheading to allow for a complete visual inspection.

  Local deterioration, if found, could be repaired by a number of concrete repair systems. Extensive, severely deteriorated piping lining can be repaired by casting of a new liner using a resin-impregnated tube which is applied to the interior of the pipe with the pipe in place. Insituform Technologies, Inc. is a vendor that utilizes this repair technology. This approach is applicable to pipes up to 96 inches in diameter. It does not seem reasonable or justifiable to contemplate replacement of this pipeline unless severe structural problems are observed.
- *Rehabilitation or replacement of the existing manually operated water control gate and operator at the canal water control structure.* Like the intake structure, the water control gate at this structure, located at the end of the 46-inch pipe (where it discharges into the hatchery canal), requires attention to ensure continued adequate performance. Despite its relatively good condition by visual inspection, a thorough inspection of all mechanical items (bushings, operator, guides, etc.) should be performed and repaired or replaced as necessary. For future considerations, it has become a goal at the hatchery to eventually automate this gate to enable remote control of the gate from the ozone production building and thus integrating it into the water treatment system control system. To accomplish this, an electric actuator with wireless control features would be required. Power would be obtained from existing electrical panels at Intake 3. It is recommended that this automation upgrade be performed at this time also.
- *Rehabilitation of the hatchery canal.* The hatchery canal has over the years evolved into a nominally uniform channel with somewhat irregular sides and bottom. To improve the hydraulic capacity of the canal, it is recommended that the canal be deepened slightly, re-graded and cleared of bank vegetation to restore it to a uniform cross section.

Intake 3 Improvements

The deficiencies at Intake 3 are primarily in the area of fish-protection as was noted in Section 5.2. Temporary modifications recently made to the existing intake to improve fish-protection (addition of the experimental USBR screen and modifications to the existing intake rack) are not felt to be adequate for long-term protection purposes.

In reconstructing Intake 3, no increase in supply to the hatchery is proposed since the combined supply capacities of all the intakes in this alternative during normal operations and at low river design flows is about 72,000 gpm (160 cfs), representing approximately 40,000 gpm from Intake 1 and approximately 32,000 gpm from Intake 3. This exceeds the maximum total system flow requirement of 70,000 gpm (156 cfs) representing the hatchery demand of 64,000 gpm (143 cfs) plus the downstream rights of 6,000 gpm (13 cfs). Under emergency operations, with Intake 2 operating rather than Intake 1, the total capacity is approximately 58,000 gpm (129 cfs) at low flow (26,000 gpm from Intake 2 and 32,000 gpm from Intake 3). While Intake 3 does not meet the per intake target capacity of 40,000 gpm (89 cfs) at minimum river flows (see Section 5.2), this is felt to be an acceptable long-term configuration since overall hatchery water needs during normal operations would be met adequately. Details showing proposed improvements at Intake 3 are shown on Plate 7.

Proposed improvements at Intake 3 include the following:

- *Partial demolition of existing concrete structure at Intake 3 including downstream headwall at connection to 48-inch pipe, downstream control gate on headwall, and existing debris racks and fish screens on intake.*
- *Demolition/removal of the existing temporary USBR intake screen installation and demolition or abandonment in place of existing 48-inch piping from a location at USBR screens and existing intake to end of new fish screening structure.*
- *Construction of a new off-stream fish screening structure and transition channel from the existing intake structure to the new screening structure*. The transition channel would be incorporated into the end of the existing intake structure and would route flow to the new fish screening structure which would roughly follow the alignment of the demolished 48-inch pipe section. To ensure proper flow approach conditions to the screens, flow baffles or other fish-friendly flow straightening measures may be required in the transition channel. Additionally, the length of the transition channel would need to be determined to optimize the hydraulics. These issues would best be resolved in a physical model during final design.

  Based on a screened flow of 32,000 gpm (71 cfs), representing approximately 90% of the total intake flow, the screen in the screening structure would be a 75-foot long single-faced vertical plate screen with screen depths varying from approximately 4.5 feet to 1.25 feet deep in the structure (upstream to downstream). Screen approach velocities would be less than 0.4 fps and screen sweeping velocities would vary between 2.0 fps and 2.9 fps, with the higher velocities near the downstream end. The average sweeping velocity would be approximately 2.25 fps. A horizontally moving multi-arm vertical brush bar system would sweep debris off the screen face and down the fish bypass pipe. The discharge pipe from the screening structure would be connected to the existing supply pipeline to the sand settling basins. Since the transit time through the structure would be about 35 seconds, a single fish bypass entrance and fish bypass pipe would be located at the end of the screens and would return diverted fish to the river. The fish bypass pipe outfall location shown on Plate 5 is an approximate location and is based on the need to ensure that there is sufficient hydraulic drop to operate the bypass under design flows. Final design for the system would investigate the optimum location for the outfall taking into consideration predation from other fish, water depth, velocity requirements, and the need to be far enough downstream that increases in river stage at the outfall would not back up the bypass pipe to the level where it would interfere with the operation of the screening facility. This is true for all bypass outfall locations depicted in this report.

Total flow diverted into the intake would be approximately 35,600 gpm (79 cfs) with 90% (32,000 gpm) supplied to the hatchery. Approximately 10% (3,600 gpm) of the total intake flow would be diverted back to the river as fish bypass flow. The minimum design river water surface elevation for the screening system would be approximately 439.9 feet at the intake entrance. Flow into the structure would be controlled by an automated control gate at the intake structure to maintain the design flow and water level through the structure at higher river elevations.

The selection of an off-stream screening system, as opposed to an on-stream system, was made due to concerns about potential damage to fragile screens and screen cleaning equipment from debris during flood events. Also, there is very little depth (about 12 – 18 inches) available for screens under low flow conditions in the main river channel making screens excessively long. Finally, the advantageous location of the existing intake relative to the existing adjacent ladder and sluice structures, makes continued use of the intake attractive as a supply point for an off-stream screening structure.

Selection of a vertical plate screen system was based primarily on its suitability to the site, good reliability through its simplicity of design, ease of maintenance relative to other screening systems and good performance history at other sites. Rotary drum screen systems, another screening option, do not conveniently screen both fish and debris from the supply pipeline as is required in this application except in an end-delivery configuration which is not optimal from an approach flow uniformity viewpoint as was noted in Section 4.3.

The retrievable horizontal plate screen (USBR screen) currently installed as a temporary screening measure, was not felt to be appropriate because of its experimental status, uncertainties about its long-term performance characteristics, and shallowness of the river during low flow. Likewise, a new fixed horizontal screen, similar to the screen system currently installed at the intake, is more problematic from a maintenance viewpoint than shore-based systems that have better maintenance access. Because of the shallowness of the river during low flow, prefabricated fish screens as described in Section 4.3 were also deemed to be inappropriate.

Although not depicted on the drawings, a fish trapping facility could easily be incorporated in the final design should that be desired. A gate or removable panel placed in the flow path at the end of the screens could be used to divert fish to either a fish trap or to the bypass pipe depending upon research or operational requirements.

A safety feature that could be included in the screening structure to increase system reliability would be a fused panel that would be designed to fail open under excessive water differential across the fish screens. This panel would provide a way for water to be delivered to the hatchery in the event that flow through the screens was blocked, presumably due to the failure of the screen cleaners. This fused panel, however, would be a "last resort" measure. The existing hatchery alarm system, expanded as required to include critical systems at the intakes, would provide a first indication to hatchery personnel that excessive differential head has been experienced at the screens and that water supply problems are imminent. This would allow for hand cleaning of the screens to alleviate the problem while the cleaner system was investigated. This alarm and fuse pin feature could be included on any of the screened intake designs in the various alternatives.

- *Rehabilitation of the existing right bank sediment sluice.* Integral with the existing intake, weir and fish ladder is a sluicing section located adjacent to the entrance of the existing intake. This sluice would be rehabilitated by filling with concrete the area currently used for screening in the floor of the sluice. Modifications would include replacement of the existing vertical sluice gate to allow for an overflow weir condition at low river flow to allow downstream migrants an opportunity to pass by the intake entrance. The actuator would also be replaced as necessary.
- *Demolition and reconstruction of the existing air-compressor/equipment building.* The new building would be sited on the new elevated area of the bank to protect against flooding. The building layout and design would be suited for the emergency electrical generator, electrical distribution panels, and control systems required for the new screening system. The generator, which would handle electrical power requirements in the event of the loss of commercial power, would be sized to handle loads from the screen cleaning systems at the intake, other small motors, lighting, and gate actuators at this intake as well as at the water control gate on the hatchery canal water control structure described earlier.
- *Bank improvements to stabilize the right bank around the intake and bank filling to elevate critical structures and components against flooding.* The bank would be protected with rip rap upstream and downstream of the intake. The fill areas would be limited to areas adjacent to the screen structure, equipment building and intake control gate. Access to the facilities would need to be preserved during flood events.

Intake 3 Water Pipeline Improvements

Proposed improvements to the 3,500-foot long, 48-inch pipeline from Intake 3 to the sand settling basins are intended primarily to extend the life of the system to meet the 50-year design life. They include the following:

- *Remote or visual inspection of the supply pipeline.* As was noted in Section 5.2, the existing steel pipe, from visual inspection of a short exposed section, did not reveal any obvious signs of significant degradation of pipe wall thickness. However, a more extensive evaluation of the pipeline would be prudent to assess the long-term performance capabilities of the pipe. Should significant deterioration be found, replacement of the pipeline, or relining as described in the discussions for the Intake 1 and 2 pipeline, would be required. Lacking detailed information from this inspection, it is reasonable to assume that the pipe has approximately 25 years of service life remaining after which replacement of the pipeline would be required. This assumption is carried in this report.

Evaluation Against Criteria

Water quality and quantity –

The location and configuration of the intakes in Alternative 1 is essentially identical to that of the existing intake system. Consequently, the quality of water supplied by the system will remain essentially the same. The water supplied to Intake 1 provides the best quality surface water available to CNFH because of its isolation from adult fish contamination (except during flooding events when the dike between Battle Creek and the tailrace is overtopped) and because of its lower suspended solids content and turbidity. Water supplied through Intakes 2 and 3, drawn directly from Battle Creek, is more disease prone because of contamination of the water source from adult fish in the river and is more turbid since no settling potential exists prior to being drawn into the water supply system. Water quality issues and mitigation measures would remain essentially the same for the hatchery. It should be noted, however, that with completion of water treatment construction at the hatchery, disease concerns in the water source will become less of an operational concern for the hatchery, except when the treatment system is down for maintenance or for hatchery processes not normally utilizing treated water.

The quantity of water supplied by the intake configuration described for Alternative 1 meets the target water demand of the hatchery of 64,000 gpm (143 cfs) plus 6,000 gpm (13 cfs) for downstream water rights through the combined use of Intakes 1 and 3. During emergency operations when Intake 2 replaces Intake 1, the total available water supply becomes dependant upon river stage but is approximately 58,000 gpm (129 cfs) at the normal minimum river design flow defined in Section 6.2 This falls short of the target 70,000 gpm, however, meets the current maximum hatchery demand. Should demand increase to flows in excess of this amount, a mitigation measure defined in the emergency action plan at the hatchery would have to be developed to prioritize water use during these conditions.

Under unusually low flow conditions in Battle Creek, the creek flow has been as low as 102 cfs in early fall and as low as 197 cfs in winter, as shown in Figure 6.3. During these periods, the hatchery water supply target of 64,000 gpm (143 cfs) will not be met, especially in light of minimum in-stream flow requirements as described in Section 3.2. This would be the case, in fact, for any alternative relying on surface water from Battle Creek. As during other emergency events, a hatchery emergency action plan would need to address the prioritization of water use during these periods.

System reliability –

A major issue related to system reliability for Alternative 1, and any alternative relying on flow from the Coleman powerhouse tailrace, is the future of the hydroelectric system in the Battle Creek watershed. A permanent (or protracted) shutdown of the Coleman powerhouse caused by an abandonment of the hydroelectric system or other major configurational change would rob Intake 1 of its water source, drastically impacting the hatchery. As was discussed in Section 3.2, the assumption in this report, however, is that the current operational configuration of the hydroelectric system will remain intact at least until the year 2026, coinciding with the relicensing of the Battle Creek Hydroelectric Project. Continued operation beyond 2026 is likely assuming the continued fiscal attractiveness of the system and no major changes in regulatory requirements in the watershed. Nonetheless, this is a risk carried by the continued use of Intake 1.

Other reliability issues relate to the physical features of the intakes and supply system components. Since Intakes 1 and 2 are effectively being adopted "as is", their reliability is as described in Section 5.1. Reliability for these intakes is rated highly because of their simplicity of operation, having only bar racks for debris and no screens, and lack of other automated control features. Because of the recent addition of the flap gate on Intake 2, installed to preclude fish from swimming into the intake or being attracted to the water coming from it, the self-cleaning feature of the intake has been eliminated, theoretically reducing its reliability somewhat in emergency situations as debris may accumulate on the debris rack at inopportune times.

As in all of the alternatives which utilize Intake 1, the small, deteriorating stoplog weir located adjacent to the intake on the tailrace will be replaced with a new structure. This will ensure a continued adequate depth of water at the intake for proper supply of water through the system. The supply pipes from Intakes 1 and 2 and from Intake 3 would be inspected as part of the overall system improvement. However, they are expected to continue to serve reliably for many years.

In Alternative 1, Intake 3 would be been reconstructed with a vertical plate screening system to preclude fish from the supply line. This type of system has extensive operational history at many sites in the West and has proven to be very reliable when properly designed and maintained. Emergency electrical power, supplied by a dedicated emergency generator located in the new equipment building, should provide a high degree of reliability for proper operation of the electrical systems (screen cleaners, etc.). The bank area surrounding the intake screening area and support facilities have been raised in the proposed design to an elevation above the 50-year design flood, thus eliminating the flooding problems found at the existing intake. Thus, overall reliability is judged to be quite high for this intake.

Redundancy –

Since the intake configuration proposed for Alternative 1 is identical to that of the existing system, the redundancy characteristics are also identical. Intake 2 provides internal redundancy for Intake 1 should it go down, while the Intake 3 system can be considered to be externally redundant with the Intake 1-2 system and visa versa. Although not all of the target water supply flow of 64,000 gpm could be met with just one of the two systems operating (approximately 40,000 gpm from the Intake 1-2 system and approximately 32,000 gpm from the Intake 3 system), most if not all of the critical water supply requirements of the hatchery could be met for an extended period of time. The prioritization and planning for these events would be addressed in the hatchery emergency action plan.

Access –

Access to the intakes for this alternative is the same as for the existing system. Intake 3 is approximately three minutes drive from the hatchery by vehicle with access to Intake 1 about two minutes further. Intake 2 access is more difficult requiring up to 30 minutes to reach by vehicle across dirt roads.

Fish Protection –

Since fish will have no access to Intake 1 because of the proposed tailrace barrier (in conformance with AFRP Action 5) and because of the proposed screened diversions upstream of the powerhouse, no fish protection measures are required at this intake. The exception is during flood events when it is theoretically possible for fish to reach the intake. These occurrences are quite unusual and are not considered to be a design issue for this intake.

Intake 2, which is unscreened in this alternative, would not provide adequate protection from entrainment for either adult or juvenile fish. If granted by resource agencies, a permit for incidental taking of fish at this intake would be required [11]. The decision to grant this permit would be based in part on the frequency of use of this intake.

The fish protection measures at Intake 3 are totally revamped in this alternative with the construction of new fish screening facilities conforming to the latest NMFS and CDF&G

[11] Memorandum from John Johnson (NMFS) to Patricia Parker (USF&WS) dated May 11, 1998.

fish screening criteria. These measures will provide adequate protection of both adult and juvenile fish at this intake.

Maintenance –

For Intakes 1 and 2, the maintenance issues associated with Alternative 1 would remain the same as for the existing system. Twice daily inspections of the intakes is anticipated with inspection of Intake 2 being accomplished by a visual inspection from the north bank of the river. Debris has not been, nor is expected to be, a major concern at Intake 1 and since Intake 2 is normally closed, debris accumulation at that intake is not expected to be significant except during flood events when a higher degree of floating material is typically experienced in Battle Creek. A weekly trip to Intake 2 to remove debris may be required since the intake is no longer self-cleaning. This will vary with the debris load in the river.

The bar rack at the fish barrier will require periodic cleaning. Cleaning would consist of swinging the racks clear of the water slightly by use of an electric or manual winch system. Once clear of the water, the debris trapped on the upstream side of the rack would flush under the rack. Some raking may be required to remove entangled debris. Due to the lack of substantial debris sources in the tailrace, the amount of cleaning of this rack is expected to be light. Daily inspections would be prudent, however.

Daily maintenance at Intake 3 is expected to be more significant than at the other intakes due to the presence of the screening facilities. The debris rack on the intake will need daily attention. The screen cleaners, although fully automated and self cleaning, will require inspection to ensure that equipment is operating correctly. Typical minor maintenance activities are expected as part of the daily inspections.

Major annual maintenance activities on the intake systems in Alternative 1 are expected to be concentrated for the most part at the screening systems at Intake 3. It is anticipated that accumulations of sediment in the screening structure will need to be removed, cleaner equipment inspected and serviced as necessary, fish screens removed and cleaned, control equipment and gates inspected, etc. An outage for a period of one week would likely cover all of the major maintenance required at this intake. This outage would likely be scheduled during low water demand periods at the hatchery in May and June.

Long-term Performance –

As was indicated in the evaluation of the existing system in Section 5.1, the major components (concrete structures and water supply pipes) of the Intake 1 and 2 systems are over 55 years old and yet are in very good shape, having operated with a minimum of maintenance over this time. These components are expected to perform well for the next 50 years with little need for major maintenance. The proposed rehabilitation (or replacement as necessary) of the control gates and other miscellaneous metal fittings (racks, etc.) should extend the life of the limited number of mechanical systems at these intakes for many more years to come. Periodic replacement of these mechanical items may be required in the future.

The fish barrier in the tailrace may require periodic rehabilitation or replacement of its mechanical components (bar racks and hoist systems) over its 50-year design life because of damage that might be experienced during major flood events and general exposure to the elements. The major components of the barrier including the weir and the abutment walls, however, will likely provide a minimum of 50 years of service, much like the concrete intake structures at Intakes 1 and 2 have.

The major concrete structures at Intake 3 are expected to provide good service for a minimum of 50 years since most of the structures at Intake 3 are relatively new or would be newly constructed. The mechanical systems associated with the screening facility, on the other hand, are expected to required replacement or major rehabilitation every 10 to 15 years. The electrical components, likewise, will require upgrading and replacement as parts wear out or become obsolete and are no longer serviceable.

The 48-inch supply pipe from Intake 3 to the sand settling basins would be inspected under Alternative 1 and all other alternatives (except Alternative 6 in which the pipe is abandoned). The anticipated life expectancy of the pipe is about 25 more years as was noted in Section 5.2.

Water Rights –

Because the amount of withdrawal has increased for the entire system in this alternative from 122 cfs to 156 cfs (54,780 gpm to 70,000 gpm), the Service will need to petition the State to make the necessary changes to the existing appropriative water rights as was noted in Section 2.4.

Construction and O&M Costs

A summary of construction and O&M costs for Alternative 1 is presented in the following tables. A more detailed breakdown of specific cost items is provided in the Appendix. Direct Costs include a construction contingency of 25%, mobilization, and contractor's overhead and profit. Total Cost includes markups for engineering, planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction Costs:

	Direct	Total

Item Description	Costs	Cost
Intake 1 Area Improvements		
Intake 1 (Rehab)	33,293	**$41,284**
Tailrace Weir at Intake 1 (New)	258,376	**$320,387**
Tailrace Fish Barrier (New)	257,396	**$319,171**
Intake 2 Improvements		
Intake 2 (Rehab)	24,905	**$30,882**
Intake 1 and 2 Water Conveyance System Improvements		
Supply Pipeline, Outlet Structure and Hatchery Canal (Rehab)	114,601	**$142,105**
Intake 3 Improvement		
Intake and Screening Structure (New)	1,085,374	**$1,345,863**
Equipment Building (New)	102,528	**$127,135**
Total Project Cost (1999 Dollars)		**$2,326,827**

Annual O&M Costs:

Item Description	Total Cost
Replacement Cost: (Major Mech./Elect. Equip.)	$26,355
Power Costs: (Major Elect. Equip. Only)	(NA)
Labor Costs: (Assuming $20/hr)	$22,955
Total Annual O&M Costs:	**$49,310**

Conclusions

The lack of appropriate fish protection at Intake 2 is a serious concern for Alternative 1. Despite the possibility that a permit might be secured to allow periodic taking of fish at the intake, this would not appear to be a prudent position for the Service to be in as a resource agency.

Other than concerns about fish protection at Intake 2, Alternative 1 is a very viable alternative, easily meeting the major functional and operational objectives identified in the evaluation criteria in Section 3.0. As compared to the other alternatives, Alternative 1 has a relatively low cost for construction as well as for operation and maintenance. Since most of the major components in the alternative have been incorporated from the existing system, the performance history of the system is well documented and familiar to the hatchery staff. The exceptions to this are the new screening structure at Intake 3 and the new fish barrier on the tailrace.

Because the amount of withdrawal has increased for the entire system in this alternative from 122 cfs to 156 cfs (54,780 gpm to 70,000 gpm), the Service will need to petition the State to make the necessary changes to the existing appropriative water rights as was noted in Section 2.4.

6.4 Alternative 2

General Description

Intake system Alternative 2 is similar to Alternative 1 except that the existing unscreened Intake 2, the emergency backup intake to Intake 1, is reconstructed to meet current fish protection requirements. Aside from Intake 2 improvements, all other features of this alternative are similar to Alternative 1. Intake discharges at Intakes 1 and 3 remain the same as in Alternative 1. Intake 2 discharge, however, would be reduced slightly due to the addition of fish screening facilities (and associated headloss) at the intake. Sketches of improvements associated with Alternative 2 are depicted on Plates 8 and 9.[12]

<u>Intake 1 and Intake 1 Water Supply Conveyance System Improvements</u>

Improvements are the same as for Alternative 1. See Section 6.3.

<u>Intake 2 Improvements</u>

Proposed improvements at Intake 2 include the following:

- *Rehabilitation of intake structure including removal of flap gate, and rehabilitation of water control gate on headwall and existing debris racks.*
- *Construction of a new fish screening structure and transition channel*. From the existing intake, a transition channel would be constructed to a new off-stream fish screening structure. Total flow diverted into the intake would be approximately 28,900 gpm (64 cfs) with 90% (26,000 gpm) supplied to the hatchery, and 10% (2,890 gpm) used for fish bypass flow. The screen in the screening structure would be a 65-foot long single-face vertical plate screen structure similar to the screen system previously described for Intake 3 in Alternative 1. Screen depths would vary from approximately 4.75 feet to 1.25 feet deep in the structure (upstream to downstream). Screen approach velocities would be less than 0.4 fps and screen sweeping velocities would remain approximately constant at about 2.2 fps. A horizontally moving multi-arm vertical brush bar system would sweep debris off the screen face and down the fish bypass pipe. The discharge pipe from the screening structure would be connected to the existing 46-inch supply pipeline from Intake 1 to the hatchery canal. A single fish bypass entrance and pipe located at the end of the screening structure would return diverted fish to the river. Approximately 10% of the total intake flow would be diverted back to the river as a fish bypass flow. The minimum design river water surface elevation for the screening system would be approximately 452.6 feet at the intake entrance. Flow into the structure would be controlled by an automated control gate at the intake structure to maintain the

[12] During the final selection process, the powerhouse bypass pipe as described for Alternative 7 was added to Alternative 2. See Section 7.0 of the report for details concerning this addition.

design flow through the structure at higher river elevations. The normal condition for this intake is for control gate to be closed since it is an emergency backup for Intake 1. Alarms initiated by low water level sensors at Intake 1 would open the gate automatically allowing flow to enter the intake and screening section.

As was the case with Alternative 1, the selection of the vertical plate screen system was based primarily on its suitability to the site, reliability through its simplicity of design, ease of maintenance relative to other screening systems and good performance history at other sites. Other screening systems were not deemed to be appropriate for reasons similar to those identified for Intake 3 in Alternative 1.

- *Construction of a small equipment building at the intake.* The building would house a small emergency generator and control system. The generator, which would handle electrical power requirements in the event of the loss of commercial power, would be sized to handle loads from the screen cleaning systems at the intake, other small motors, lighting, and gate actuators.
- *Electrical power distribution improvements.* Commercial power for operating electrical equipment at the intake would be required. A likely source for this power would be from across Battle Creek requiring power poles, lines, and transformers from the existing power lines along Coleman Fish Hatchery Road.
- *Bank improvements to stabilize the right bank around the new intake.* The bank would be protected with rip rap upstream and downstream of the intake.

<u>Intake 3 and Intake 3 Pipeline Improvements</u>

Improvements are the same as for Alternative 1. See Section 6.3.

Evaluation Against Criteria

Water quality and quantity –

Since Alternative 2 is identical to Alternative 1 from a system configuration viewpoint, the water quality issues, including disease prevalence in and turbidity of the various water sources are identical. The tailrace feeding Intake 1 has the best surface water, while water taken directly from Battle Creek feeding Intakes 2 and 3 are of a lesser quality.

Likewise, the quantity of water supplied through the proposed Alternative 2 system is virtually identical to Alternative 1 with a slight reduction in capacity from Intake 2 due to the presence of the screening facilities and their associated head loss. Thus, the water supplied through the intake configuration for Alternative 2 meets the target water demand of the hatchery of 64,000 gpm (143 cfs) plus 6,000 gpm (13 cfs) for downstream water rights. Emergency operations requiring the use of Intake 2 rather than Intake 1 yields approximately 58,000 gpm (129 cfs), which meets the current maximum water demand of the hatchery. However, as in Alternative 1, this is short of the desired target of 70,000 gpm, and should hatchery demands increase to this flow rate, adjustments to the hatchery operations would be required during emergency conditions.

System reliability –

Like Alternative 1, Alternative 2 relies heavily on the continued long-term operation and viability of Coleman powerhouse which provides water to Intake 1. This is considered to be an acceptable level of risk given the reasonable certainty of continued operation of the hydroelectric system as currently configured.

The introduction of screening facilities at Intake 2 adds a level of uncertainty not found in Alternative 1. Primarily, this has to do with the remoteness of the intake and its function as an emergency intake, an undesirable combination from a system reliability viewpoint. Although the performance of the proposed vertical plate screen system is well documented, the inability to quickly access the facility would add a negative reliability factor.

The continued use of the very reliable intake at Intake 1 (except as impacted by powerhouse operations) and the use of the proposed new screened intake at Intake 3 have the same degree of reliability as judged for Alternative 1.

Redundancy –

Alternative 2 has similar redundancy characteristics as Alternative 1. The Intake 1-2 system is internally redundant, with Intake 2 providing a backup for Intake 1, while Intake 3 is externally redundant with the Intake 1-2 system.

Access –

The remoteness of Intake 2, a screened intake with automated screening equipment, is a negative aspect of Alternative 2. This is somewhat tempered by the fact that as an emergency intake, the degree of daily maintenance required is much reduced from a screened intake which is in operation full time. Nonetheless, regular inspection of the intake and screening facility would be required and the poor access would contribute to a higher operation and maintenance cost. The preparedness of the intake for emergencies might be questionable with less than optimal routine maintenance. Access to Intakes 1 and 3 is good, as was described in Section 6.3.

Fish Protection –

The failings of Intake 2 in Alternative 1 from a fish protection standpoint has been remedied in Alternative 2 with its reconstruction as a screened intake. Adequate fish protection is thus provided for all intakes to which adult and juvenile fish normally have access. Alternative 2 also complies with AFRP Action 5.

Maintenance –

The maintenance issues for Alternative 2 are similar to Alternative 1 except that Intake 2 is now a fully screened intake and would require a higher degree of maintenance than would be required in Alternative 1. The facilities at Intake 2 would be similar to those found at Intake 3 and the maintenance issues would likewise be similar. The frequency of inspection and maintenance would be less than at Intake 3 since the amount of operational time of the screens would be substantially less due to its emergency intake status. Daily inspections of the screens would not be warranted, however, a visual inspection of the intake rack should be performed as was recommended in Alternative 1. This could be performed from the north bank of Battle Creek while inspections of Intake 1 are performed.

Long-term Performance –

The long-term performance of the intake system described in Alternative 2 is similar to those for Alternative 1. Major components would exhibit good performance for as much as 50 years without major maintenance with the exception of the 48-inch pipeline from Intake 3 which would likely require replacement after 25 years. Mechanical and electrical systems would require major rehabilitation or replacement periodically as they wear out or become obsolete.

Water Rights –

As was noted for Alternative 1, the increase in total withdrawal for the intake system from 122 cfs to 156 cfs would require the Service to petition the State to make the necessary changes to the existing appropriative water rights.

Construction and O&M Costs

A summary of construction and O&M costs for Alternative 2 is presented in the following tables. A more detailed breakdown of specific cost items is provided in the Appendix. Direct Costs include a construction contingency of 25%, mobilization, and contractor's overhead and profit. Total Cost includes markups for engineering, planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction Costs:

Item Description	**Direct Costs**	**Total Cost**
Intake 1 Area Improvements		
Intake 1 (Rehab)	92,234	**$114,371**
Tailrace Weir at Intake 1 (New)	258,376	**$320,387**
Tailrace Fish Barrier (New)	257,396	**$319,171**
Intake 2 Improvements		
Intake and Screening Structure (New)	1,000,096	**$1,240,118**
Equipment Building (New)	121,559	**$150,733**
Intake 1 and 2 Water Conveyance System Improvements		
Supply Pipeline, Outlet Structure and Hatchery Canal (Rehab)	114,601	**$142,105**
Intake 3 Improvement		
Intake and Screening Structure (New)	1,085,374	**$1,345,863**
Equipment Building (New)	121,559	**$150,733**
Total Project Cost (1999 Dollars)		**$3,783,481**

Annual O&M Costs:

Item Description	**Total Cost**
Replacement Cost: (Major Mech./Elect. Equip.)	$52,505
Power Costs: (Major Elect. Equip. Only)	(NA)
Labor Costs: (Assuming $20/hr)	$23,342
Total Annual O&M Costs:	**$75,847**

Conclusions

The deficiencies in fish protection at Intake 2 found in Alternative 1 have been rectified in Alternative 2. The siting of this now-screened intake on the opposite bank of Battle Creek from the hatchery is, however, considered to be a negative aspect of some consequence. This especially since it has an emergency intake status.

Other than access issues at Intake 2, this alternative, like Alternative 1, is a viable alternative. It employs most of the components of the existing system, a system with a good performance record. The inclusion of two screening facilities (at Intakes 2 and 3), cannot however be considered to be a positive development from a maintenance and overall system reliability viewpoint.

6.5 Alternative 3

General Description

Alternative 3 is similar to Alternative 2 except that rather than reconstructing Intake 2 at its current location on the left bank of Battle Creek, a new intake would be established on the right bank to replace Intake 2. As with Alternative 2, the new intake would be designed to meet current fish protection requirements. The current Intake 2 installation would be demolished. In function, the new intake would remain an emergency backup to Intake 1. Unlike Alternative 2, the total hatchery supply capacity at the new Intake would be increased to a minimum of 40,000 gpm (89 cfs), matching the discharge of existing Intake 1. Aside from Intake 2 improvements, all other features of this alternative are similar to Alternatives 1 and 2. Sketches of improvements associated with Alternative 3 are depicted on Plates 10 and 11.[13]

The proposed location for the new Intake is on a relatively straight, quiescent stretch of Battle Creek with steeply banked sides. This stretch of the river is backed up by a natural obstruction in the river channel comprised of what appears to be less erodible stream bed materials. The presence of this feature results in a relatively short steep river section separating the slower upstream and downstream river sections. The formation appears to be relatively stable and should provide for long-term impoundment of the upper river section where the intake would be located. The river banks in this area also appear to be relatively stable with mature trees growing close by. The depth of the river in the vicinity of the intake is approximately 12-18 inches at low river flows. No cross-stream weir improvements downstream of the intake location are proposed.

<u>Intake 1 and Intake 1 Water Supply Conveyance System Improvements</u>

Improvements are the same as for Alternative 1. See Section 6.3.

<u>Intake 2 Improvements</u>

Proposed improvements for construction of a new Intake 2 includes the following:

- *Demolition of the existing Intake 2 structure including racks, water control gate, and concrete box.* The bank would be restored to match the surrounding bank line. The 46-inch pipeline from Intake 2 would abandoned in place to the wye at the pipeline from Intake 1.

<u>New Battle Creek Intake</u>

Proposed improvements for construction of the new intake includes the following:

[13] During the final selection process, the powerhouse bypass pipe as described for Alternative 7 was added to Alternative 3. See Section 7.0 of the report for details concerning this addition.

- *Construction of a new concrete intake and fish screening structure on the right bank*. Total flow diverted into the new intake would be approximately 44,500 gpm (99 cfs) with 90% (40,000 gpm) supplied to the hatchery, and 10% (4,500 gpm) used for fish bypass flow. The intake would include a course debris rack and water control gate located on the right bank approximately 2,000 feet upstream of the current Intake 2 location on Battle Creek. The intake box would feed a new off-stream screening structure. Based on a screened flow of 40,000 gpm (89 cfs), representing approximately 90% of the total intake flow, the screen in the screening structure would be an 80-foot long, single-faced vertical plate fish screening structure similar to the screening structures proposed for Intake 3 in Alternatives 1 and 2 and for Intake 2 in Alternative 2. Screen depths would vary from approximately 5.0 feet to 1.5 feet deep in the structure (upstream to downstream). Screen approach velocities would be less than 0.4 fps and screen sweeping velocities would remain approximately constant at about 2.4 fps. A horizontally moving multi-arm vertical brush bar system would sweep debris off the screen face and down the fish bypass pipe. A new 66-inch discharge pipe from the screening structure would be constructed connecting at a new wye in the existing 46-inch supply pipeline from Intake 1 approximately 1,200 feet downstream of the new screening structure and approximately 350 feet downstream of the Intake 1 structure. Since the transit time through the structure would be about 35 seconds, a single fish bypass entrance is located at the end of the screening structure. Fish would exit the structure into a bypass pipe which would return diverted fish to the river about 1,200 feet downstream. Approximately 10% of the total intake flow would be diverted back to the river as fish bypass flow. The minimum design river water surface elevation for the screening system would be approximately 458.6 feet at the intake entrance. Control of flow through the system would be with the intake control gate which would throttle flow into the intake and screening system.

  As was the case with Alternatives 1 and 2, the selection of the vertical plate screen system was based on its suitability to the site, reliability through its simplicity of design, ease of maintenance relative to other screening systems and good performance history at other sites. Other screening systems were not deemed to be appropriate for reasons similar to those identified for Intake 3 in Alternative 1.

- *Construction of a small equipment building at the intake.* Like Intake 2 in Alternative 2, the building would house a small emergency generator and control system. The generator, which would handle electrical power requirements in the event of the loss of commercial power, would be sized to handle loads from the screen cleaning systems at the intake, other small motors, lighting, and gate actuators.

- *Electrical power distribution improvements.* Commercial power for operating electrical equipment at the intake would be required. A likely source for this power would be from existing power lines along Coleman Fish Hatchery Road.

- *Access road construction from Coleman Powerhouse to the new intake.* Approximately 300 feet of access road would be constructed to the new intake from the existing access road and parking area near the Coleman Powerhouse. Grading and some fill material would be required followed by application of a crushed gravel surfacing.

- *Bank improvements to stabilize the right bank around the new intake.* The bank would be protected with rip rap upstream and downstream of the intake.
- *Acquisition of easements or purchase of property.* The property at the proposed intake location and along the pipeline route is by owned by PG&E [14]. Purchase or easement agreements for the property would have to be secured.
- *Construction of security fencing at the intake.*

<u>Intake 3 and Intake 3 Pipeline Improvements</u>

Improvements are the same as for Alternative 1. See Section 6.3.

Evaluation Against Criteria

Water quality and quantity –

The water quality issues for Alternative 3 are the same as for Alternatives 1 and 2 with Intake 1 drawing from the Coleman powerhouse tailrace, and Intake 3 and the new Battle Creek intake (which replaces Intake 2) both drawing from Battle Creek. Once again, the highest quality water is being drawn through Intake 1 with more turbid and more disease-prone water being drawn through the Battle Creek intakes.

The quantity of water supplied through Alternative 3, however, is greater than for the first 2 alternatives. The full 70,000 gpm (156 cfs) can be delivered under both normal *and* emergency operating conditions. This is accomplished by having selected an upstream site for the new emergency intake on the north bank of Battle Creek to take advantage of the available hydraulic head. Consequently, should future hatchery operations require 70,000 gpm and Intake 1 were to lose its water source, no adjustment in hatchery operations would be required.

System reliability –

Like Alternatives 1 and 2, Alternative 3 relies on the continued long-term operation of the Coleman powerhouse to provide water to Intake 1. Unlike these first 2 alternatives, however, should the powerhouse be shut down for long periods of time, or even indefinitely, the total quantity of flow to the hatchery would not be adversely impacted. This is due to the fact that the new emergency intake on Battle Creek, which is screened, combined with Intake 3, can meet all of the projected water needs for hatchery for the long term. This feature of Alternative 3 improves the reliability of the system significantly in terms of long-term planning. Should the hydroelectric system continue functioning as predicted for at least 50 years, Intake 1 would be the primary

[14] Personal communication between Rolf Wielick (Sverdrup) and Tom Nelson (CNFH) on March 8, 1999.

water source for the Intake 1-2 system. Should the powerhouse be abandoned, the new intake on Battle Creek would become the sole water source on the Intake 1-2 system with Intake 1 being abandoned. Only the redundancy characteristics of the Intake 1-2 system and possibly water quality would be compromised.

The reliability of the overall system is better for Alternative 3 than for Alternative 2 since the screened emergency intake is now on the north bank (hatchery side) of Battle Creek and readily accessible for inspection and maintenance. The proposed vertical plate screening systems at Intake 3 and the new emergency intake are judged to be highly reliable, although compared to the unscreened intake at Intake 1, the reliability is obviously somewhat less.

Redundancy –

As was noted above and as was the case for Alternatives 1 and 2, the Intake 1-2 system is internally redundant while the Intake 3 and Intake 1-2 systems are externally redundant with each other. Since neither the Intake 3 or Intake 1-2 systems by themselves can provide the total projected future hatchery water demand of 70,000 gpm (156 cfs), the hatchery would need to prioritize water usage in a hatchery emergency action plan for periods when the full 70,000 gpm were required. However, the need to describe emergency measures in an emergency action plan in response to reduced flow is less likely with Alternative 3 since the new Battle Creek intake proposed has a greater capacity than the existing Intake 2.

Access –

Access features of Alternative 3 are much improved over Alternatives 1 and 2 since the emergency intake has been placed on the hatchery side of Battle Creek and is only two minutes beyond the Intake 1 site by vehicle. Currently, public access to the proposed site for the new emergency intake is restricted since the road to the site is also the access road to the Coleman powerhouse, a private facility. The hatchery would have to acquire keys to the gate from PG&E. This has not been investigated but would appear to be feasible.

Fish Protection –

Fish protection afforded by the intakes in Alternative 3 is the same as for Alternative 2 and meets all current fish protection criteria and complies with AFRP Action 5.

Maintenance –

The maintenance issues for Alternative 3 are the same as for Alternative 2 except that access for maintenance is improved for the new emergency intake, resulting in more consistent maintenance opportunities. Once again, the unscreened intake at Intake 1 will be significantly less maintenance intensive than Intake 3 which is screened and is a full-time facility. Maintenance for the new (screened) emergency intake will be less intensive than Intake 3 since the facility will not normally operate.

Long-term Performance –

The long-term performance of the intake system described in Alternative 3 is similar to those for Alternatives 1 and 2. Major components would exhibit good performance for as much as 50 years without major maintenance with the exception of the 48-inch pipeline from Intake 3 which would likely require replacement after 25 years. Mechanical and electrical systems would require major rehabilitation or replacement periodically as they wear out or become obsolete.

Water Rights –

Moving the withdrawal location of the emergency intake to a point upstream on Battle Creek has in effect established a new diversion point on the river. This, combined with the fact that the amount of withdrawal has increased for the entire system (from 122 cfs to 156 cfs) in this alternative, would require the Service to petition the State to make the necessary changes to the existing appropriative water rights.

Construction and O&M Costs

A summary of construction and O&M costs for Alternative 3 is presented in the following tables. A more detailed breakdown of specific cost items is provided in the Appendix. Direct Costs include a construction contingency of 25%, mobilization, and contractor's overhead and profit. Total Cost includes markups for engineering, planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction Costs:

Item Description	Direct Costs	Total Cost
Intake 1 Area Improvements		
Intake 1 (Rehab)	92,234	**$114,371**
Tailrace Weir at Intake 1 (New)	258,376	**$320,387**
Tailrace Fish Barrier (New)	257,396	**$319,171**
Intake 2 Improvements		
Intake (Demolish)	42,694	**$52,940**
New Battle Creek Intake Improvements		
Intake and Screening Structure (New)	1,030,682	**$1,278,046**
Equipment Building (New)	118,036	**$146,365**
66" Supply Pipe and 30" Fish Bypass Pipe (New)	641,808	**$795,842**
Intake 1 and 2 Water Conveyance System Improvements		
Supply Pipeline, Outlet Structure and Hatchery Canal (Rehab)	114,601	**$142,105**
Intake 3 Improvement		
Intake and Screening Structure (New)	1,085,374	**$1,345,863**
Equipment Building (New)	102,528	**$127,135**
Total Project Cost (1999 Dollars)		**$4,642,226**

Annual O&M Costs:

Item Description	Total Cost
Replacement Cost: (Major Mech./Elect. Equip.)	$52,505
Power Costs: (Major Elect. Equip. Only)	(NA)
Labor Costs: (Assuming $20/hr)	$23,050
Total Annual O&M Costs:	**$75,555**

Conclusions

With the relocation of Intake 2 to the north bank of Battle Creek, access and maintenance issues for Alternative 3 have been significantly improved over either Alternative 1 or 2. Additionally, moving the emergency intake further upstream results in a new emergency intake capable of the full hydraulic capacity of Intake 1. As in Alternative 2, the inclusion of two screened intakes is not seen to be an advantage for operational reliability or maintenance costs.

6.6 Alternative 4

General Description

Alternative 4 is similar to Alternatives 1, 2 and 3 in that Intake 1 would continue to be used essentially "as is" with improvements being made to the intake, tailrace stoplog weir, tailrace fish barrier, and conveyance pipeline as described in Section 6.3. Unlike the previous alternatives, however, Intake 2 is completely abandoned and no longer provides an emergency backup to Intake 1 from either the left or right bank. Rather, if Intake 1 goes down due to interruptions in water supply to the Coleman tailrace, Intake 3 must supply all the hatchery water needs during emergencies. Consequently, in addition to reconstructing the intake to provide appropriate fish protection modifications, the discharge capacity of Intake 3 is increased over that described for Alternatives 1 through 3 to provide additional capacity during emergencies. In this alternative, the minimum supply to the hatchery at Intake 3 is increased from approximately 32,000 gpm (71 cfs) to approximately 40,000 gpm (89 cfs), but only under emergency conditions. Thus, under normal operations at low river flow, the total supply capability to the hatchery would be approximately 72,000 gpm (160 cfs), representing 40,000 gpm from Intake 1 and 32,000 gpm from Intake 3, and approximately 40,000 gpm (89 cfs) from Intake 3 during emergency operations when Intake 1 is down. The assumption therefore, is that the hatchery would be operated under "emergency" conditions in such a way that total water demand would be 40,000 gpm (89 cfs) or less. Sketches depicting improvements for Alternative 4 are depicted on Plates 12 and 13.

<u>Intake 1 and Intake 1 Water Supply Conveyance System Improvements</u>

Improvements are the same as for Alternative 1. See Section 6.3.

<u>Intake 2 Improvements</u>

Intake 2 will be abandoned in this alternative. Work at Intake 2 thus would involve abandoning the existing facilities and restoring the site to match surrounding terrain. Proposed improvements at Intake 2 include the following:

- *Demolition of the existing Intake 2 structure including racks, water control gate, and concrete box.* The bank would be restored to match the surrounding bank line. The 46-inch pipeline from Intake 2 would abandoned in place to the wye at the pipeline from Intake 1.

<u>Intake 3 Improvements</u>

The objective at Intake 3, as in Alternatives 1, 2 and 3, is to make improvements to the facilities to provide fish protection consistent with current fish screening criteria. Unlike the previous alternatives, the total hatchery supply capacity at Intake 3 would be increased by about 8,000 gpm (18 cfs). This will require a larger screening structure than described in the earlier alternatives. More importantly, however is the need to increase the capacity of the system as a whole to accommodate the increased flow. As was noted in Section 5.2, at low river flows, the existing Intake 3 system is limited in capacity to approximately 32,000 gpm (71 cfs). There are four ways to increase the capacity of the system. These are to 1) increase the hydraulic head on the system (water level in the river) at low flow by increasing the height of the weir; 2) increase the size of the existing pipeline to reduce friction losses (the source of most of the losses in the system); 3) construct addition pipeline capacity parallel to the existing 48-inch pipe; or 4) install low-head pumps downstream of the screen structure to provide additional driving head during periods when the additional flow is required.

The first option, increasing the weir height, would require an increase in weir height of approximately 4 feet. This would introduce a much more significant barrier in the river than currently exists and although the fish ladder could be extended to accommodate this, it would be a significantly greater detriment to upstream fish passage. Since Battle Creek restoration goals include improving passage and habitat conditions in Battle Creek, this does not seem to be an action which would be consistent with those goals. Additionally, raising the height of the weir would result in a loss of riparian habitat which would need to be mitigated.

The second option, increasing the size of the existing pipe, would involve the removal or abandonment of the existing 48-inch pipe and replacement with a 54-inch or larger pipe thereby reducing pipeline velocities, and consequently, headloss due to friction. While this would certainly allow for replacement of the aging existing pipe, it is felt that the cost of this would be quite high and would not take advantage of the remaining life in the existing pipeline which is estimated to be as much as 25 years (see Section 5.2). Construction of pipelines of this size is a significantly greater undertaking, both from a construction viewpoint as well as a cost viewpoint ($1.5 million or more).

The third option, constructing a smaller parallel pipeline, would have the net effect of reducing headloss in the system due to reduced pipeline velocities much like installing a large replacement pipe. In this option, a 3,500-foot long, 30-inch or larger pipe would be constructed parallel to the existing pipeline. This pipe would reconnect at a new wye in the existing pipeline at the upstream and downstream end of the 48-inch pipe. Construction costs for this new pipeline would be substantial ($750,000 or more) but would appear to be less intrusive than the first option, and less expensive than the second.

The fourth option, installing low-head pumps downstream of the screen structure to increase driving head on the pipeline, would have the equivalent effect of increasing the weir height. For this option, the downstream end of the screen structure would be designed with a pump sump area. Two 20,000 gpm (45 cfs) low-head axial flow submersible propeller pumps would be located in the sump on either side of the control gate into the existing 48-inch pipe. Under normal operations, when additional flow would not be required, the gate would be open and the pumps would be off. When additional flow is required, the gate would be closed and the pumps would be turned on pumping directly into the 48-inch pipe downstream of the gate. The new emergency generator located in the existing equipment building would be sized for the pumps in addition to other screening system loads in event of a loss of commercial power at the site. This option has the least cost for increasing capacity (less than $200,000 for the pumps, manifold piping, valving, and increased structure for the pump sump area). This fourth option is seen to be the most feasible option and is has been adopted for this alternative.

Proposed improvements at Intake 3 therefore include the following:

- *Partial demolition of existing concrete structure at Intake 3 including downstream headwall at the connection to 48-inch pipe, downstream control gate on headwall, and existing debris racks and fish screens on intake.*
- *Demolition/removal of the existing temporary USBR intake screen installation and demolition or abandonment in place of existing 48-inch piping from a location at USBR screens and existing intake to end of new fish screening structure.*
- *Construction of a new off-stream fish screening structure and transition channel from the existing intake structure to the new screening structure*. Like the previous alternatives, the transition channel would be incorporated into the end of the existing intake structure and would route flow to the new off-stream fish screening structure (see Plate 13). During normal operations, the total flow diverted into the intake would be approximately 35,600 gpm (79 cfs) with 90% (32,000 gpm) supplied to the hatchery, and 10% (3,600 gpm) used for fish bypass flow. During emergency operations, total flow diverted into the intake would be approximately 44,500 gpm (99 cfs) with 90% (40,000 gpm) supplied to the hatchery, and 10% (4,500 gpm) used for fish bypass flow. Because of the increased flow requirements, and because the structure operates under two distinctly different conditions (normal and emergency), the screens would be designed for both flow rates. To accommodate this design, a screening structure with a single-face vertical plate screen approximately 80 feet long would be constructed. Screen depths would vary from approximately 5.0 feet to 1.5 feet deep in the structure (upstream to downstream). When operating at the higher flow rate, screen approach velocities would be about 0.4 fps and screen sweeping velocities would remain approximately constant at about 2.4 fps. For the lower normal operating flow rate, screen approach velocities would be about 0.3 fps and screen sweeping velocities would remain approximately constant at almost 2.0 fps. A horizontally moving multi-arm vertical brush bar system would sweep debris off the screen face and down the fish bypass pipe.

  Since the transit time through the structure would be about 40 seconds, a single fish bypass entrance and fish bypass pipe would be located at the end of the screens and would return diverted fish to the river. The screening system would be designed for a minimum design river elevation of approximately 439.9 feet at the intake entrance. Flow into the structure would be controlled by an automated control gate at the intake structure to maintain the design flow through the structure at higher river elevations.

The discharge from the screening structure would be routed via an open channel to a sump area just downstream of the screening area. As described above, two 20,000 gpm (45 cfs) low-head propeller pumps would be located on either side of a 48-inch water control gate at the entrance to the 48-inch pipe. The discharge pipe on each pump would be connected to the 48-inch pipe downstream of the gate. The gate would normally be open and would allow a discharge of about 32,000 gpm (71 cfs). During emergency operations (or when 40,000 gpm (89 cfs) was desired), the gate would be closed and the pumps would be turned on.

- *Rehabilitation of the existing right bank sediment sluice.* (See Section 6.3 for discussion)
- *Demolition of the existing air-compressor/equipment building and construction of a new equipment building.* The new building would be sited on the new elevated area of the bank to protect against flooding. The building layout and design would be suited for the emergency electrical generator, electrical distribution panels, and control systems required for the new screening system. The generator, which would handle electrical power requirements in the event of the loss of commercial power, would be sized to handle loads from the screen cleaning systems at the intake, other small motors, lighting, and gate actuators at this intake as well as at the water control gate on the hatchery canal water control structure described earlier.
- *Bank improvements to stabilize the right bank around the intake and bank filling to elevate critical structures and components against flooding.* (See Section 6.3 for discussion).

<u>Intake 3 Water Pipeline Improvements</u>

Proposed improvements for the pipeline are the same as for Alternatives 1, 2, and 3 and are described in Section 6.3. As a part of the water supply improvement features for this pipeline, the manifold piping leading from the distribution box to the sand settling basins, and the distribution box and settling basins themselves, may need to be increased in size to accommodate increased flow from the intake during emergency operations. This would be the case for any alternative supplying more than the 32,000 gpm (71 cfs) currently delivered to the sand settling basins via this pipeline.

Evaluation Against Criteria

Water quality and quantity –

The primary difference between Alternative 4 and the previous three alternatives is lack of a separate emergency backup intake for Intake 1. Rather, the capacity of Intake 3 is expanded during emergency conditions (when Intake 1 is down) and becomes the only water supply for the hatchery. The quality of the water is therefore comparable to the other alternatives since Intake 1 still draws for the best water source, the Coleman tailrace, and Intake 3 draws from Battle Creek, a more disease-prone and turbid water source during higher river flows. Like the other alternatives, during emergency operations, the lower quality Battle Creek water is the sole water source for the hatchery.

The configuration depicted for Alternative 4 provides up to 70,000 gpm (156 cfs) of water to the hatchery under normal operating conditions, meeting the target hatchery water demand. During emergency operations, this amount is reduced to 40,000 gpm (89 cfs).

Unlike the previous alternatives, delivery of the emergency water to the hatchery is quite different for Alternative 4. Since all the water during emergency operations is drawn through Intake 3, no water is directed to the hatchery canal, and consequently the canal pump station. Nor is it directly available to downstream water users on the canal. All water to be treated would need to be pumped to the water treatment system through the existing raw water pump station located near the sand settling basins. This is limited to about 20,000 gpm (45 cfs) leaving the water treatment system almost 15,000 gpm (33.4 cfs) short of its capacity. With the other alternatives, the full capacity of the treatment system could be utilized, even under emergency operation conditions. This is not seen as an optimum configuration. To remedy this, the raw water pump station could be expanded to increase the amount of water available to the treatment system. Since this is an optional improvement only affecting emergency conditions, the cost estimate for Alternative 4 assumes no expansion for the existing raw water pump station.

System reliability –

The reliability issues for Intake 1 are the same as in the previous alternatives and involves the continued use of the Coleman powerhouse. Intake 3, with its reliance on water directly from Battle Creek, is not impacted by the future of operations at Coleman powerhouse and the Battle Creek Hydroelectric system.

The elimination of one screened intake is seen as a positive feature of Alternative 4 from a reliability standpoint since fewer screened facilities must be maintained. From the perspective of redundancy (see below), the reliability of Alternative 4 could be viewed as somewhat reduced due to the reduced number of water sources from three intakes to two.

Redundancy –

As was noted previously, the elimination of a separate emergency backup intake for Intake 1 has reduced the redundancy of the system to a degree. No longer is Intake 1 on an internally redundant system. Rather, it is only externally redundant with the Intake 3 system, and visa versa. Moreover, during emergency operations, Intake 3 no longer has a redundant system, making proper functioning of Intake 3 and outages at the

Coleman powerhouse that much more critical. Although a reduction in redundancy can be seen as less desirable, the elimination of a third intake has distinct advantages from a maintenance and overall facility cost viewpoint.

Access –

Access to the intakes is good with travel time to Intake 3 requiring about three minutes by vehicle and further to Intake 1 requiring an additional two minutes.

Fish Protection –

Fish protection afforded at the intakes in Alternative 4 meets all current fish protection criteria and complies with AFRP Action 5.

Maintenance –

Because Alternative 4 has one less screened intake than Alternatives 2 and 3, the amount of total maintenance required for the intake system will be reduced. Maintenance at Intakes 1 and 3 will be as described in these earlier alternatives with the exception of two low-head pumps which have been included in the design of Intake 3. These pumps, which are only engaged during emergency operations, will require periodic maintenance. Due to their infrequent usage, however, major maintenance on the pumps will likewise be required infrequently.

Another positive maintenance consequence of eliminating the emergency intake from the Intake 1 system is the elimination of the more turbid Battle Creek water from the hatchery canal during emergency operations. This will reduce the annual dredging requirements for the canal somewhat.

Long-term Performance –

Long-term performance characteristics of Alternative 4 will be similar to those of the previous alternatives.

Water Rights –

Elimination of the emergency intake on Battle Creek in this alternative may also improved conditions in Battle Creek upstream of the confluence with the tailrace by reducing the fluctuations in the river water levels to some degree due to the elimination of this diversion point. This potential benefit would be tempered by the realization that fluctuations in in-stream flows will continue to be present as a result of operations of the hydropower system and fluctuations in Coleman powerhouse discharge. As in the previous alternatives, because the amount of withdrawal has increased for the entire system in this alternative, the Service will need to petition the State to make the necessary changes to the existing appropriative water rights.

Construction and O&M Costs

A summary of construction and O&M costs for Alternative 4 is presented in the following tables. A more detailed breakdown of specific cost items is provided in the Appendix. Direct Costs include a construction contingency of 25%, mobilization, and contractor's overhead and profit. Total Cost includes markups for engineering, planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction Costs:

Item Description	**Direct Costs**	**Total Cost**
Intake 1 Area Improvements		
Intake 1 (Rehab)	92,234	**$114,371**
Tailrace Weir at Intake 1 (New)	258,376	**$320,387**
Tailrace Fish Barrier (New)	257,396	**$319,171**
Intake 2 Improvements		
Intake (Demolish)	42,694	**$52,940**
Intake 1 and 2 Water Conveyance System Improvements		
Supply Pipeline, Outlet Structure and Hatchery Canal (Rehab)	114,601	**$142,105**
Intake 3 Improvement		
Intake and Screening Structure (New)	1,194,661	**$1,481,379**
Equipment Building (New)	138,676	**$171,958**
Total Project Cost (1999 Dollars)		**$2,602,310**

Annual O&M Costs:

Item Description	**Total Cost**
Replacement Cost: (Major Mech./Elect. Equip.)	$26,355
Power Costs: (Major Elect. Equip. Only)	(NA)
Labor Costs: (Assuming $20/hr)	$19,145
Total Annual O&M Costs:	**$45,500**

Conclusions

The high degree of redundancy found in Alternatives 1, 2 and 3 has been reduced somewhat in Alternative 4 with the elimination of the separate emergency intake on Battle Creek. The resulting system is still judged to have an acceptable level of reliability. In fact, with the elimination of the third intake, the amount of maintenance has been reduced as has the reliance on remote emergency systems. Once again, the reliance on the continued long-term operation of the Coleman powerhouse is a risk factor to be considered in this alternative.

Operational flexibility during emergency operations is reduced with Alternative 4 due to the elimination of water supplied to the hatchery canal, although this could be remedied with construction of additional pumping facilities.

6.7 Alternative 5

General Description

Alternative 5 increases the capacity of flow through Intake 1 from 40,000 gpm (89 cfs) to 70,000 gpm (156 cfs) to meet all of the future projected flow requirements for the hatchery and downstream water rights. Intake 2 is abandoned. Intake 3 is also abandoned, but the existing pipeline from Intake 3 to the sand settling basins is preserved. The additional 30,000 gpm (67 cfs) added to the capacity at Intake 1 is routed to this pipeline, replacing the flow from Intake 3. To provide an emergency backup to Intake 1 when the tailrace is dry, a new intake is established on Battle Creek that will allow gravity flow to the water treatment system sand filters located on the north bank of the hatchery canal near the canal pump station, eliminating the need to pump water into the water treatment system. The sand filters are the highest hydraulic point on the hatchery and all parts of the hatchery can be supplied by gravity from this point. Since the new intake is an emergency intake and would be operated infrequently, the amount of hatchery supply capacity at the intake is set at 40,000 gpm (89 cfs). It is anticipated that use of the emergency intake would likely be for periods of up to approximately one week. Like Alternative 4, the assumption is that the hatchery would be operated under "emergency" conditions in such a way that total water demand would be 40,000 gpm (89 cfs) or less. Proposed improvements for Alternative 5 are depicted on Plates 14 and 15.[15]

<u>Intake 1 Improvements</u>

The limiting factors for increased capacity at Intake 1 are similar to those at Intake 3 for Alternative 4. Namely, too much headloss in the existing 46-inch pipe from Intake 1 due to friction and other form losses when more water is pushed through the system without raising the head on the intake. Like Intake 3 in Alternative 4, the possible solutions are to increase the head on the intake, to increase the size of the pipe (or add another pipe in the system) to reduce the headloss under increased flow while maintaining the existing head, or to increase head on the system artificially by pumping water into the pipe thereby overcoming the additional headloss. Since in the proposed configuration, the additional pipe capacity requirement occurs between Intake 1 and where the pipe would branch off at the 48-inch pipe to the settling basins, only 1,900 feet of the total 2,700-foot long pipe is affected.

As noted above, one way to increase flow through the system is to raise the hydraulic head on the system. To accomplish this, the tailrace water surface would have to be raised approximately 10 feet. This is not feasible due to site constraints resulting in no feasible impoundment capacity to this depth and interference with powerhouse operations due to flooding of the tailrace area on the powerhouse.

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[15] During the final selection process, the powerhouse bypass pipe as described for Alternative 7 was added to Alternative 5. See Section 7.0 of the report for details concerning this addition.

Enlargement of the existing pipeline to a 56-inch or larger pipe would provide sufficient capacity without raising the head on the intake. This, however, is seen as an extremely expensive option with an estimated cost of as much $1.5 million or more. Rather than replacing the existing pipe, a second parallel pipe could be constructed. A 36-inch or larger pipe would meet the capacity requirements. The pipe would be tied directly to the existing 48-inch pipe at the former location of Intake 3. Costs for this pipeline could range from $500,000 to $750,000. In both cases, replacement of the existing pipeline or construction of a second pipe, construction would be through relatively flat areas but would require crossing of Battle Creek two times. Routing of the pipe to the north around the bend in the river would eliminate the need to cross the river but would be difficult as the terrain in this area is quite steep. The pipelines routed this way would also need to be almost 500 feet longer resulting in bigger pipes and higher costs.

The last alternative would be to pump the water through the pipe. Three 24,000 gpm (53 cfs) low-head axial flow submersible propeller pumps would be employed to pump water out of the tailrace from a new larger intake box and into the 46-inch pipe. For hatchery flow demands up to 40,000 gpm (89 cfs), the pumps would not be used and the water control gate at the head end of the pipe would be opened allowing gravity flow through the pipeline. Beyond 40,000 gpm (89 cfs), the gate would be closed and the pumps would pump into the pipeline.

Because of the attractiveness of not pumping from a remote location (Intake 1) and the susceptibility of the site to periodic flooding, the proposed design for Alternative 5 is to construct the smaller parallel pipe from Intake 1 to the former location of Intake 3 and reconnect the pipe to the existing pipeline to the sand settling basins.

Proposed improvements to Intake 1 include the following:

- *Rehabilitation of existing intake structure including racks and control gate*
- *Construction of a new intake structure for the new 36-inch pipe adjacent to the location of the existing intake structure.* The new intake would be similar in design to the existing intake. A plan and section view of the intake (and new stoplog weir) is provided on Plate 15.
- *Construction of new security fencing at the intake.*

Proposed improvements in the tailrace include the following:

- *Demolition of the existing weir adjacent to the intake and construction of a new replacement weir structure*. As was noted in Section 5.1, the existing weir is in poor condition and should be replaced. It is proposed that the existing weir structure be replaced with a concrete structure with stop logs as described in Section 6.3.

- *Construction of a fish barrier structure on the tailrace about 20-30 feet upstream of the confluence of the tailrace and Battle Creek*. (See discussion in Section 6.3).
- *Roadway access improvements to the fish barrier structure*. (See discussion in Section 6.3).

Intake 2 Improvements

Intake 2, as was noted above, will be abandoned in this alternative. Work at Intake 2 thus would involve abandoning the existing facilities and restoring the site to match surrounding terrain. Proposed improvements at Intake 2 include the following:

- *Demolition of the existing Intake 2 structure including racks, water control gate, and concrete box.* The bank would be restored to match the surrounding bank line. The 46-inch pipeline from Intake 2 would abandoned in place to the wye at the pipeline from Intake 1.

Intake 1 Water Conveyance System Improvements

Proposed improvements to the water conveyance system (pipeline, canal water control structure, and canal) are intended primarily to extend the life of the system to meet the 50-year design life and to add additional capacity to the system as discussed above. They include the following:

- *Remote or visual inspection of the existing supply pipeline.* (See discussion in Section 6.3).
- *Rehabilitation or replacement of the existing manually operated water control gate and operator at the canal water control structure.* (See discussion in Section 6.3).
- *Rehabilitation of the hatchery canal.* (See discussion in Section 6.3).
- *Construction of a new 36-inch pipeline parallel to the existing 46-inch pipeline.* The pipe would extend from Intake 1 to the approximate location of Intake 3 (to be demolished in this alternative, see following discussions) and would be connected to the existing 48-inch pipeline at a location near Intake 3.

Intake 3 Improvements

Intake 3 would be demolished in this alternative. Because the existing weir at Intake 3 impounds water for Intake 3, it too could be demolished. This would remove one more obstruction on the river to fish passage. Improvements at Intake 3 would therefore include:

- *Demolition of Intake 3 structure including the sediment sluice, fish ladder and weir.* The bank would be restored to match the surrounding bank line. The 48-inch pipeline from Intake 3 would be demolished up to where it is reconnected to the new

36-inch line from Intake 1. The existing equipment building can be left in place as a storage building or it can be demolished. The report assumes that it will be left in place as is with the equipment salvaged.

Intake 3 Water Pipeline Improvements

As in the other alternatives which continue the use of the existing 48-inch pipeline from Intake 3 to the sand settling basins, the issues for this alternative are the same. Improvements include the following:

- *Remote or visual inspection of the supply pipeline.* (See Section 6.3 for discussion)

New Intake on Battle Creek

The new intake described in this section is to be an emergency backup for Intake 1. Since flow at Intake 1 is dependant on flow from the Coleman powerhouse and therefore susceptible to periodic interruption, and since Intakes 2 and 3 are demolished in this alternative, no other means of obtaining water is available. The goal in the design of the new intake was to utilize gravity (rather than pumping) to supply water from Battle Creek to the hatchery, and the target location for delivery was to the sand filters. Currently, all water supplied to the sand filters must be pumped, either from the hatchery canal (fed by Intake 1) through use of the canal pump station or from the raw water pump station (formerly fed by Intake 3, but now also fed by Intake 1 in this alternative). Emergency flow requirements for the intake are assumed to be 40,000 gpm (89 cfs).

The normal operating water level in the sand filters is nominally at El. 460 feet. By contrast, the water surface at Intake 1, one mile distant, is approximately El. 458.5 feet. Thus, it becomes apparent that some location upstream of Intake 1 on Battle Creek would be required to accomplish a gravity feed into the filters. To maintain the maximum flow in Battle Creek, the most upstream location for an intake should be below where the PG&E bypass ditch from the power canal enters Battle Creek, approximately one mile upstream of the Coleman powerhouse. This is to take advantage of the water that would be diverted from the tailrace and back into Battle Creek when flow through the powerhouse and penstocks is interrupted as explained in Section 1.3. A preliminary hydraulic analysis of a 40,000 gpm (89 cfs) pipeline routed up Battle Creek was performed and it was determined that to meet this criteria, a 62-inch pipe would be required starting at a location approximately 3,200 feet upstream of the Coleman powerhouse at a river water surface elevation of 470 feet. A 9,500-foot pipe (approximately) would be required to reach from an intake at this location to the sand filters. Alternatively, at approximately 2,000 feet upstream of this location at elevation 480 feet in the river, a 54-inch pipe would be required. An 11,500-foot pipe (approximately) would be required to reach from the intake at this location to the sand filters. Because the shorter pipe involves less construction and fewer river crossings and since access to either is about the same, for the purposes of this study, the shorter pipe is assumed. Pipe material costs for the shorter pipe would approach $3 million. This would not include installation costs. Because of poor access and difficult construction conditions, installation costs are expected to be significantly higher than normal. Material costs for the longer (smaller) pipe would be slightly less but installation costs would be higher. An intake and screening structure similar to the one previously described for Intake 2 in Alternative 3 would be constructed at the intake location.

It should be noted that no specific intake siting study has been performed although a visual inspection of the area has been performed. Many issues would be involved including suitability of the site for construction, accessibility to the site, whether sufficient water depth is available in the river and if not, if construction of a weir across the river is feasible. Also, since electrical power is required, whether a feasible source of power is available. For the purposes of this study, it is assumed that sufficient water depth is available in the vicinity of the intake location proposed without construction of a weir. Reasonable access to the river at this location appears to be possible from the north side of the river, however construction of a one-half mile long gravel access road from the area of the Coleman powerhouse would be required. Access to the river from the south is questionable because of the great distance from the hatchery to the site and the questions about the integrity of the dirt roads in the area, both during good and bad weather. Moreover, the south bank appears to be part of a flood plain and not particularly well suited for an intake and screening structure. Consequently, it is assumed that the intake would be constructed on the north bank of the river. Power should be available from the area of the Coleman powerhouse and would be routed along the new access road.

The following improvements for the new intake would be required:

- *Acquisition of easements or purchase of property.* The property at the proposed intake location and along the pipeline route is by owned by PG&E and private landowners [16]. Purchase or easement agreements for the property would have to be secured. Also, easements for the construction of an access road from the Coleman powerhouse would need to be secured.
- *Construction of a 9,500-foot long, 62-inch buried pipe from the proposed intake location to the sand filters at the hatchery.* Based on a preliminary layout, three river crossing would be required.
- *Construction of a new intake and off-stream fish screening structure.* The intake and screening structure would be similar to that depicted for Intake 2 in Alternative 3 and would supply 40,000 gpm (89 cfs) to the hatchery.
- *Construction of access roads to the site.* Grading and surfacing would be required to provide for an all-weather surface.
- *Local site improvements.* The area of the intake is vegetated and would have to be improved to accommodate the new facilities. Grading and surfacing, construction

[16] Personal communication between Rolf Wielick (Sverdrup) and Tom Nelson (CNFH) on March 8, 1999.

of power distribution facilities, construction of a small equipment/generator building, and installation of security fencing are among the items that would be required.

- *Modifications at sand filters for new 62-inch pipe.* Connection to the existing 54-inch supply piping from the canal pump station would be accomplished to supply the filters.

Evaluation Against Criteria

Water quality and quantity –

In Alternative 5, the primary source of water for the hatchery would be through the higher quality water found in the flow from the Coleman powerhouse via Intake 1. The new intake, located on Battle Creek, would function for the most part as an emergency intake. There could be rare cases where the powerhouse is discharging less than 70,000 gpm and the hatchery demand requires that the new intake make up the difference. The use of this higher quality water will have a positive impact on the amount of sediment handled by the hatchery in its settling basins and will provide the least disease-prone water to the hatchery, an advantage during periods when the treatment system is down or for non-treated water uses.

The quantity of water supplied through Alternative 5 for normal operating conditions meets the target water demand for the hatchery of 70,000 gpm (156 cfs), all from Intake 1 on the Coleman powerhouse tailrace. During emergency conditions when Intake 1 is down, the emergency intake located on Battle Creek would supply up to 40,000 gpm (89 cfs), which is less than the target water demand. As in the other alternatives where this potential deficiency exists, the hatchery emergency action plan would prioritize water usage.

System reliability –

Because Intake 1 normally supplies 100% of the water in this alternative, the reliability of the intake system is heavily dependant on the ability of the Coleman powerhouse to supply water to the intake, both short term and long term. As has been noted earlier, this is judged to be a relatively secure water source and thus is quite reliable.

The elimination of Intake 3 in this alternative, proposed to be a full-time screened intake in previous alternatives, is an improvement from a reliability standpoint. This, because it is judged to be beneficial to reduce the number of mechanical/electrical systems associated with the water supply, regardless of the overall relative advantages of one screening system versus another.

The emergency intake depicted for this alternative, which is located on Battle Creek approximately one-half mile upstream of the powerhouse, is configured as a screened gravity intake, able to provide water to the sand filters without any pumping. This gravity feature increases the reliability of the water source, since mechanical pumping systems would not be required to provide treated water to the hatchery. Also, the gravity feature of the system would decrease the pumping costs for the hatchery (a savings of about $4.5 per hour at $0.02/kwh). Being an emergency intake, the estimated savings could run about $1,400 per year assuming that the intake operates for a total of 2 weeks per year (conservative).

A consequence of the desire to include a gravity intake in this alternative with the ability to provide gravity flow to the sand filters, was the need to locate the intake approximately one-half mile upstream from Intake 1 to gain sufficient hydraulic head on the system. This would require that an access road be constructed to ensure maintenance access and reliability.

Redundancy –

Despite the fact that Intake 3 has been eliminated in this alternative, there continues to be an externally redundant system to the Intake 1 system in the presence of two separate pipes from Intake 1 to the hatchery and two separate intakes at Intake 1. The failure of one of the pipes from Intake 1, for example, would not cut the hatchery water supply off completely but only reduce it to the capacity of one of the two pipelines (approximately one-half total capacity of Intake 1 or about 30,000 – 40,000 gpm). Also, for an added level of redundancy, the new emergency intake is not only a backup to Intake 1 during emergencies, but also is a completely separate system (as is the case for Alternative 9 discussed later).

Access –

Access to Intake 1 and tailrace improvements is good. Access to the new gravity intake is comparable to the new intake location described in Alternative 3 since to reach it, hatchery personnel must go through locked gates at the Coleman powerhouse entrance road. It is about a mile further upstream so a slightly longer travel time would be required.

Fish Protection –

All current fish screening criteria are met with this alternative and AFRP Action 5 requirements are satisfied by the presence of the tailrace barrier. It should be noted that because normal operations for this alternative do not involve fish screening (no fish screening is required at Intake 1), the impact on fish is perhaps the smallest for this alternative (and those similarly configured such as Alternatives 9 and 10). Also, since the weir at Intake 3 has been eliminated, upstream passage on Battle Creek is improved for adults through adoption of this alternative.

Maintenance –

Because Intake 1 is the normal intake for water supply in this alternative, and since this intake requires very little routine maintenance (very little debris, no fish screens, etc.), the maintenance aspects of this alternative are very good. The screened emergency intake will require a relatively low level of maintenance since it is not normally used. Regular inspection of the intake racks (not inclined to attract debris since the intake is not normally operating), and of the fish screening systems will be required as a part of normal maintenance.

One maintenance aspect of this alternative that is less desirable is the direct connection of the emergency intake to the sand filters with no pre-settling capacity in the system. This will have the effect of further reducing the filtration capabilities of the filters during turbid water events in Battle Creek, perhaps to a critical level. As it is, during flooding, the sand filter capacity is significantly reduced, even with the good level of pre-settling provided by the existing sand settling basins. A settling basin similar to the existing one at Intake 3 could be incorporated into the design of this alternative, but the cost would be quite excessive, and since the emergency intake is operated only rarely, and even more rarely during turbid water events, the cost cannot be justified. The result of reducing the filtration capabilities is that unless significant overcapacity is built into the sand filter system, which seems unjustified, the actual level of water available to the water treatment system may be considerably less than the 40,000 gpm (89 cfs) the intake is designed to deliver.

Long-term Performance –

Long-term performance characteristics of this alternative would be similar to other similarly configured alternatives providing at least 50 years for major components (except for the 48-inch pipe near Intake 3) and 10-15 years for most mechanical/electrical system before major rehabilitation or replacement is required.

Water Rights –

Like Alternative 3, the new intake located upstream on Battle Creek would be a new diversion point. Also, the total withdrawal has increased as in the other alternatives. Consequently, the Service will need to petition the State to make the necessary changes to the existing appropriative water rights.

Construction and O&M Costs

A summary of construction and O&M costs for Alternative 5 is presented in the following tables. A more detailed breakdown of specific cost items is provided in the Appendix. Direct Costs include a construction contingency of 25%, mobilization, and contractor's overhead and profit. Total Cost includes markups for engineering, planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction Costs:

Item Description	**Direct Costs**	**Total Cost**
Intake 1 Area Improvements		
Intake 1 (Expand)	157,382	**$195,153**
Tailrace Weir at Intake 1 (New)	258,376	**$320,387**
Tailrace Fish Barrier (New)	257,396	**$319,171**
Intake 2 Improvements		
Intake (Demolish)	42,694	**$52,940**
Intake 1 and 2 Water Conveyance System Improvements		
Supply Pipelines, Outlet Structure and Hatchery Canal (Rehab and Expand)	799,973	**$991,967**
Intake 3 Improvement		
Intake and Weir (Demolish)	219,414	**$272,074**
Equipment Building (Demolish)	16,192	**$20,078**
New Battle Creek Gravity Intake Improvements		
Intake and Screening Structure (New)	1,078,120	**$1,336,869**
Equipment Building (New)	297,670	**$369,111**
62" Supply Pipe and 24" Fish Bypass Pipe (New)	3,601,424	**$4,465,766**
Total Project Cost (1999 Dollars)		**$8,343,515**

Annual O&M Costs:

Item Description	**Total Cost**
Replacement Cost: (Major Mech./Elect. Equip.)	$26,149
Power Costs: (Major Elect. Equip. Only)	(NA)
Labor Costs: (Assuming $20/hr)	$11,845
Total Annual O&M Costs:	**$37,994**

Conclusions

Alternative 5 provides a number of advantages over the preceding alternatives including the most desirable maintenance characteristics since normal water supply is provided through an unscreened (expanded) intake at Intake 1, a very low maintenance installation. It also has, like Alternatives 9 and 10 to follow, minimal fish protection issues since fish are not diverted into any intakes (screened or otherwise) except under emergency conditions when the screened emergency intake is employed. Also, and since the weir at Intake 3 is removed, upstream passage conditions in the river are also improved. The completely separate emergency supply pipe from the emergency intake provides the same level of redundancy found in other alternatives utilizing the separate supply system provided by Intake 3, but without the added cost and maintenance issues associated with a full-time screened intake.

The gravity features of this alternative, as manifested by the new emergency gravity intake on Battle Creek, are on the other hand, not seen to have significant benefit considering the extreme cost for the separate pipeline. The cost savings to the hatchery in terms of pumping costs is negligible and the increase in reliability to the hatchery through not having to rely on pumps is not seen as being significant. It is suggested that the very positive operational benefits afforded by the adoption of Intake 1 for all normal water supply functions be considered separately from the desire to provide a gravity intake as the emergency backup. The extreme cost associated with the gravity system prescribed for the emergency intake could likely rule this alternative out without due consideration given to its positive aspects. Alternatives 9 and 10, (discussed later) attempt to address this issue.

6.8 Alternative 6

General Description

The goal of Alternative 6 is to provide gravity water supply to the sand filters under both normal operating and emergency operating conditions. This is unlike Alternative 5, in which only the emergency backup intake for Intake 1 provides gravity flow to the sand filters, the highest point on the hatchery property hydraulically. Proposed improvements for Alternative 6 are depicted on Plate 16.

Gravity flow to the sand filters, which are at El. 460, is feasible from two sources. These are 1) upriver on Battle Creek above El. 470, and 2) from the Coleman forebay which is at El. 930 (±). Since the Coleman forebay is part of the Battle Creek hydro system and is subject to periodic outages (see Section 1.3), it makes a reasonably reliable source of good quality water, but needs an emergency backup so that hatchery operations are not negatively impacted. Battle Creek, as was noted in Alternative 5, can provide a reliable source of water downstream of the PG&E canal bypass ditch when water is interrupted to the Coleman forebay. With this in mind, Alternative 6 proposes to locate a new intake on Coleman forebay for normal hatchery operating conditions and an emergency intake on Battle Creek below the bypass ditch but above El. 470 on the river. The forebay intake would be unscreened and would provide 70,000 gpm (156 cfs) flow to meet the target hatchery water demand, while the Battle Creek intake would be screened and would provide 40,000 gpm (89 cfs) on an emergency basis during the infrequent occasions when the forebay intake is down. Alternatively, it may be possible to tap into one of the two penstocks just upstream of the turbine at the Coleman powerhouse. This might result in a lower initial cost since the total length of pipe would be shorter and no intake facilities would have to be constructed on the forebay, but this configuration would put more reliance on an aging penstock system and would be subject to interruptions due to facility operations at the Coleman hydroelectric facilities. This is felt to be less desirable than a separate supply system.

It should be noted that water diverted by the new forebay intake (or through a penstock tap) would not be available for power generation. The value of this water to PG&E could be over $11,500 per day assuming 466 feet of head, 85% turbine efficiency and $0.10 per kilowatt hour, and represents over 40% of the total capacity of the Coleman Powerhouse. Obviously, there are serious issues associated with this which would need to be addressed. One of these is that because locating a new intake on the Coleman forebay would affect operations of the hydroelectric system (reducing flow to the Coleman powerhouse), FERC and licensee approval would be required as well as a possible amendment to the existing FERC license.

<u>New Intake on Battle Creek</u>

For the Battle Creek emergency intake, the same intake and screening structure design proposed for Alternative 5 is proposed (see Section 6.7). It would be located about 3,800 feet upstream from the current location of Intakes 1 and 2 at El. 470 and would be connected to the sand filters by a 9,500-foot long 62-inch buried pipe. It would only be operated when flow from the Coleman power canal is bypassed down the bypass ditch and into Battle Creek upstream of the intake. The improvements described for this intake in Alternative 5 would be applicable here also.

New Intake on Coleman Forebay

For the Coleman forebay intake, a simple intake box located on the banks of the forebay with a debris rack would be appropriate since fish are excluded from the power canal by screens at diversion structures upstream [17]. Since the location of the forebay is relatively close to the proposed Battle Creek emergency intake in the valley below, a 3,600-foot, 30-inch pipe would be routed down from the forebay intake and is connected to the proposed 62-inch line from the emergency intake to the sand filters. The pipe would either be buried or could be routed above grade, supported by concrete pipe supports and thrust anchors. A valve at the bottom of the 30-inch pipe would ensure that the 62-inch pipe would not be over pressurized. Other safety provisions could be included to limit the pressure on the larger pipe. Improvements would include:

- *Construction of an unscreened intake on the Coleman forebay.* A simple concrete box structure with a debris rack and water control gate would be adequate. The control gate would be automated.
- *Construction of a 3,600-foot, 30-inch buried or above-grade pipeline to join the 62-inch pipe at the emergency intake on Battle Creek.*
- *Installation of security fencing around the intake.*
- *Construction of power distribution facilities for the water control gate.* Power might be obtained from the existing PG&E intake facilities located nearby.
- *Construction of an access road to the intake.* Good access to nearby PG&E facilities is available and road improvements may not be substantial. Improvements may be limited to minimal grading and application of gravel surfacing.

Intake 1 Improvements

Intake 1 would be abandoned. The following improvements are proposed:

- *Demolition of existing intake and adjacent stoplog weir.*
- *Restoration of intake area.*

[17] In reality, at the writing of this report, not all diversions into the power canal are screened. However, long-term plans for Battle Creek restoration, as noted in the AFRP, include full screening of all diversions on Battle Creek.

Intake 2 Improvements

Intake 2 would be abandoned. Improvements would be as described for Alternative 3 in Section 6.5.

Intake 1 and 2 Water Conveyance System Improvements (Pipe and Canal)

Since the Intakes 1 and 2 are no longer required, the supply pipeline and canal would be abandoned. The following improvements are proposed:

- *Abandonment of existing 46-inch pipeline from intake.* The pipeline would be plugged and abandoned in place.
- *Demolition of pipe outlet structure at hatchery canal.*
- *Partial abandonment of hatchery canal.* A large portion of the canal, extending from the canal outlet structure to near the canal pump station, would no longer be required. A small portion of the canal would be required to pass water to downstream water users and could be used as an emergency distribution canal in case the sand filters would need to be bypassed. The abandoned section of the canal could be left dry or backfilled with earth. It is proposed that the canal be left dry.
- *Demolition of canal pump station.* The pump station would not be required and would be demolished.

Intake 3 and Intake 3 Pipeline Improvements

Intake 3 would be abandoned. Improvements would be as described for Alternative 5 except would include abandonment of the 48-inch pipeline to the sand settling basins.

Evaluation Against Criteria

Water quality and quantity –

The positive water quality characteristics of this alternative for normal water supply to the hatchery are identical to those of Alternative 5 since the source of water is the Coleman forebay which feeds the Coleman powerhouse (and Intake 1 in Alternative 5). The water quality of the emergency intake is the same as that for Alternative 5 since the same gravity intake on Battle Creek is used.

The quantity of water provided is the same as that of Alternative 5 with the full target flow of 70,000 gpm (156 cfs) provided under normal operating conditions and a reduced flow of 40,000 gpm (89 cfs) provided under emergency conditions, necessitating operational adjustments at the hatchery during rare emergency operating conditions. One positive aspect of this alternative is the elimination of the need to utilize pumps for water supply to the hatchery because of the gravity features of both the forebay intake and the Battle Creek intake. This would result in a savings to the hatchery of approximately $5.50 per hour (based on a cost of $0.02/kwh), assuming that 45,000 gpm would normally be pumped from the canal pump station to the sand filters, and that overall pump efficiency is approximately 63%. Assuming that this rate of pumping were required for about half the year and that a rate of about half of that were required for the balance of the year, total cost savings to the hatchery in reduced power consumption would be approximately $36,000 per year. This compares to the estimated electrical cost for operating the ozone water treatment facilities at CNFH of $250,000 per year for water treatment at 45,000 gpm[18]. It must also be compared to the lost power generation revenue at the Coleman powerhouse of $11,500 per day, as discussed earlier, which totals over $3,000,000 per year at the assumed value to PG&E of $0.10 per kwh. While this cost could be recovered in a turbine located on the water supply line, the issues of reliability of the generating equipment (similar to those currently experienced at Coleman powerhouse) would once again be faced by the hatchery.

System reliability –

Because the normal supply of water is directly from the Coleman forebay in this alternative, the reliability of the water supply is enhanced in this alternative compared to alternatives that utilize Intake 1. This is because the operational status of Coleman powerhouse is not a factor in determining the availability of flow to the new forebay intake. As was noted in Section 1.3, flow to the Coleman forebay has been interrupted only once in the past six to eight years, a very good performance record. This would suggest that except for failure of the new forebay intake or its pipeline down to the gravity intake, (or maintenance of these facilities), the Battle Creek emergency intake, as proposed in this alternative, would only have been used once in that period of time.

Like all the alternatives relying on the continued operation of the Battle Creek Hydroelectric system, this alternative is similarly burdened. As has been noted previously, however, this risk is not judged to be very great.

Redundancy –

This alternative is only internally redundant in that both the forebay intake and its emergency backup intake are on the same pipeline, the latter performing a redundant withdrawal opportunity for the former. Failure of the pipeline from the intakes, however, would result in complete loss of water to the hatchery. The risk of this type of failure is judged to be comparable to that of many hatcheries with a single main water supply line and is considered to be acceptable, although not as good as alternatives with externally redundant systems.

[18] "Coleman NFH Water Treatment System Cost Study and Alternatives Analysis", USF&WS, March 1997

Access –

Access to the Coleman forebay is good, however does require a 10 minute drive up a poorly maintained dirt road. Negotiating this road during very poor weather is not seen as a positive characteristic of this alternative. On the other hand, other major facilities are located near the proposed intake (including the intake for the penstocks for Coleman powerhouse), and the access issues for this facility are similar and apparently acceptable to PG&E.

Access to the gravity intake on Battle Creek is as described in Alternative 5 and involves gaining access to the locked access road to the Coleman powerhouse and construction of a one-half mile access road from there to the intake. As with Alternative 5, this would require that ownership of, or easements rights through, this property be obtained. Otherwise, the location is more remote than some Battle Creek sites but not as poor as others.

Fish Protection –

Since there are no fish present in the forebay (or won't be when screening of all the Battle Creek diversions is completed) no fish protection at the new forebay intake will be required. Fish protection of the new gravity intake on Battle Creek is provided by vertical plate screens as described in earlier discussions and will meet all relevant fish screening criteria. Since the Service would not have a hatchery intake on the Coleman tailrace, no tailrace barrier has been shown for the tailrace. It is assumed other entities would be responsible for addressing the exclusion of fish from the tailrace so that requirements of Action 5 of the AFRP would be met.

Maintenance –

Maintenance issues for this alternative are comparable to those of Alternative 5 except that the daily inspections and maintenance of the debris racks at the intake on the Coleman forebay would require a substantially longer trip compared to the short trip to Intake 1. Because the emergency intake would be rarely used, the actual maintenance of this intake would be reduced to levels below that of Alternative 5. It is possible that equipment would be run periodically just to ensure that it was still in working order. Because of the rarity of use, the entrainment of sediment from the emergency intake into the sand filters (a concern discussed in Alternative 5) is not considered to be an issue for this alternative.

Long-term Performance –

Long-term performance of the improvements described for this system are similar to those of Alternative 5 except that a new intake at the forebay would replace the expanded existing intake at Intake 1, potentially increasing the longevity of the intake since all construction is new.

Water Rights –

The increase in total withdrawal and the establishment of the new diversion point on Battle Creek described in Alternative 6 would require the Service to petition the State to make the necessary changes to the existing appropriative water rights.

Construction and O&M Costs

A summary of construction and O&M costs for Alternative 6 is presented in the following tables. A more detailed breakdown of specific cost items is provided in the Appendix. Direct Costs include a construction contingency of 25%, mobilization, and contractor's overhead and profit. Total Cost includes markups for engineering, planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction Costs:

Item Description	Direct Costs	Total Cost
Intake 1 Area Improvements		
Intake 1 and Weir (Demolish)	40,101	**$49,725**
Intake 2 Improvements		
Intake (Demolish)	42,694	**$52,940**
Intake 1 and 2 Water Conveyance System Improvements		
Supply Pipelines, Outlet Struct. and Hatchery Canal (Abandon)		
Intake 3 Improvement		
Intake and Weir (Demolish)	219,414	**$272,074**
Equipment Building (Demolish)	16,192	**$20,078**
New Battle Creek Gravity Intake Improvements		
Intake and Screening Structure (New)	1,078,120	**$1,336,869**
Equipment Building (New)	297,670	**$369,111**
62" Supply Pipe and 24" Fish Bypass Pipe (New)	3,931,589	**$4,875,170**
New Coleman Forebay Gravity Intake Improvements		
Intake (New)	166,253	**$206,153**
30" Supply Pipe to Battle Creek (New)	844,970	**$1,047,763**
Total Project Cost (1999 Dollars)		**$8,229,883**

Annual O&M Costs:

Item Description	Total Cost
Replacement Cost: (Major Mech./Elect. Equip.)	$26,149
Power Costs: (Major Elect. Equip. Only)	(NA)
Labor Costs: (Assuming $20/hr)	$7,715
Total Annual O&M Costs:	**$33,864**

(Note: O&M costs shown do not include lost power generation costs at Coleman powerhouse nor reductions in pumping costs at CNFH)

Conclusions

Despite the apparent attractiveness of a gravity intake system for the hatchery (no pumping for any hatchery water supplied to the treatment system or other non-treated water uses), the extreme costs associated with construction of the pipelines and the cost of lost power production at the Coleman powerhouse, combined with the unlikeliness that PG&E and the FERC would approve of this configuration, makes this alternative unrealistic.

6.9 Alternative 7

General Description

Alternative 7 is almost the same as Alternative 4 in that it uses the existing intake system at Intake 1, abandons Intake 2, and reconstructs Intake 3 which is expanded in flow capacity during emergency conditions. In this alternative however, a powerhouse bypass pipe has been added to increase the reliability of flow to Intake 1 to reduce the occasions when the hatchery would have to go to emergency operations conditions due to reduced water availability. To supply water to the bypass pipe, a new unscreened intake would be located on the Coleman forebay. From the forebay, the bypass pipe would be routed parallel to the existing penstocks and into the Coleman tailrace upstream of Intake 1, bypassing Coleman Powerhouse. The pipe would be designed for 40,000 gpm (89 cfs). Intake 3 would be designed to supply 32,000 gpm (71 cfs) during normal operating conditions. During emergencies (when Intake 1 is dry), flow from Intake 3 would be increased to 40,000 gpm (89 cfs). Sketches of improvements associated with Alternative 7 are depicted on Plate 17.

<u>Powerhouse Bypass Pipe Improvements</u>

Proposed improvements for construction of a new powerhouse bypass pipe includes the following:

- *Construction of an unscreened intake on the Coleman forebay.* A simple concrete box structure like that for Intakes 1 or 2 with a debris rack and water control gate would be adequate. The control gate would be automated.
- *Construction of a 4,700-foot, 26-inch buried or above-grade pipeline parallel to the existing penstocks with an outlet structure on the tailrace.* The outlet structure would be a concrete structure and would discharge freely into the tailrace through a Howell-Bunger valve or equivalent. Discharging into the tailrace rather than directly connecting to the Intake 1 pipe protects the Intake 1 pipe from over-pressure and also de-couples the discharge down the bypass pipe from the supply requirements at the hatchery. Also, no modifications at Intake 1 would be required to accommodate the bypass pipe.
- *Installation of security fencing around the intake.*
- *Construction of power distribution facilities for the water control gate.* Power might be obtained from the existing PG&E intake facilities located nearby.
- *Construction of access road to the intake.* Good access to nearby PG&E facilities is available and road improvements may not be substantial. Improvements may be limited to minimal grading and application of gravel surfacing.

Other improvements for this alternative would be as described for Alternative 4 in Section 6.6.

Evaluation Against Criteria

Water quality and quantity –

The quantity and quality of water available through the adoption of Alternative 7 would be same as for Alternative 4 except that the number of times the higher quality water found at Intake 1 would be interrupted would be decreased substantially due to the presence of the new powerhouse bypass pipe.

System reliability –

As was noted in Section 1.3, the occasions where flow from Coleman Powerhouse is interrupted are relatively infrequent because of the presence of existing bypass piping in the powerhouse routing flow around the turbines. Thus, the existing system is quite reliable. However, approximately 25% of powerhouse turbine trips result in flow being stopped completely. The separate bypass pipe proposed for this alternative would eliminate this, thereby increasing the overall reliability of Intake 1. Moreover, water supplied to Intake 1 would no longer by subject to Coleman powerhouse outages. This is desirable both for the hatchery and for PG&E since PG&E would no longer have to account for the hatchery water supply needs in their scheduling for maintenance of the powerhouse, etc.

Nonetheless, the overall reliability of the intake system would once again hinge on the long-term viability of the hydroelectric system. As note previously, this is judged to be a low-risk issue.

The reliability of the screened intake at Intake 3 is as has been discussed in earlier alternatives and is judged to be very good. The presence of the pumps, which are engaged during emergency conditions to provide the full 40,000 gpm flow to the hatchery, introduces a mechanical component which would only be used very infrequently. These pumps are considered to be very reliable and coupled with the emergency power supply provided by the new emergency generators, should function dependably.

Redundancy –

The elimination of the separate emergency intake on Battle Creek has reduced the redundancy of the overall system somewhat. The intake system is still externally redundant since two separate supply systems are present in the Intake 1 and the Intake 3 systems, however, the internal redundancy of Intake 1 has been reduced. The bypass pipe upstream of Intake 1, however, does provided almost the same level of redundancy as the emergency backup intakes described for other alternatives. It will not, of course, be operational if water to the forebay is stopped due to a catastrophic failure of the supply system to the forebay and is therefore not a totally redundant water supply feature. Also, in the event the Intake 1 structure itself should become inoperable, these is not an internally redundant intake on the same supply pipe.

Access –

Access to the various intakes (including the intake on the forebay for the bypass pipe) is comparable to other alternatives with access to the forebay intake being the least convenient.

Fish Protection –

Fish protection at the intakes complies with all the relevant screening criteria and the proposed tailrace barrier meets the requirements of AFRP Action 5.

Maintenance –

Maintenance of the intakes described in this alternative is similar to that described for Alternative 4 except with the addition of the forebay intake, which is an unscreened intake. The forebay intake will require daily inspection to ensure that it is free of debris. Since it is not normally functioning, the degree of debris impingement should be quite low. However, since it is an emergency facility, it will need to be regularly monitored and maintained. The pumps at Intake 3 are mechanical items which will require a routine level of maintenance, as will the other mechanical/electrical systems at the intake.

Long-term Performance –

The long-term performance characteristics of this alternative are similar to those of the other alternatives with major concrete structures and pipelines exhibiting design lives of at least 50 years (with the exception of the 48-inch pipeline) and mechanical/electrical components such as screen cleaners, small motors, etc. typically requiring major rehabilitation or replacement after 10 to 15 years. Because the pumps at Intake 3 will be infrequently used, normal routine maintenance should keep this equipment functional for many years without major work.

Water Rights –

Except for the forebay intake, which functions only during periods when the powerhouse is down and the construction of which would require FERC and PG&E approval, the water rights issues for Alternative 7 are the same as for Alternative 4 and includes the need for the Service to apply to the State for an increase in appropriate rights since the total withdrawal has been increased from 122 cfs to 156 cfs. No new diversions are proposed (except the forebay intake), therefore, this aspect of the water rights issue is simplified.

Construction and O&M Costs

A summary of construction and O&M costs for Alternative 7 is presented in the following tables. A more detailed breakdown of specific cost items is provided in the Appendix. Direct Costs include a construction contingency of 25%, mobilization, and contractor's overhead and profit. Total Cost includes markups for engineering, planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction Costs:

Item Description	Direct Costs	Total Cost
Intake 1 Area Improvements		
Intake 1 (Rehab)	92,234	**$114,371**
Tailrace Weir at Intake 1 (New)	258,376	**$320,387**
Tailrace Fish Barrier (New)	257,396	**$319,171**
Intake 2 Improvements		
Intake (Demolish)	42,694	**$52,940**
Intake 1 and 2 Water Conveyance System Improvements		
Supply Pipeline, Outlet Struct. and Hatchery Canal (Rehab)	114,601	**$142,105**
New Coleman Forebay Intake Improvements		
Intake (New)	164,355	**$203,800**
26" Supply Pipe to Coleman Tailrace (New)	741,593	**$919,575**
Intake 3 Improvement		
Intake and Screening Structure New)	1,194,661	**$1,481,379**
Equipment Building (New)	138,676	**$171,958**
Total Project Cost (1999 Dollars)		**$3,725,686**

Annual O&M Costs:

Item Description	Total Cost
Replacement Cost: (Major Mech./Elect. Equip.)	$26,355
Power Costs: (Major Elect. Equip. Only)	(NA)
Labor Costs: (Assuming $20/hr)	$22,955
Total Annual O&M Costs:	**$49,310**

Conclusions

The primary beneficial aspect of Alternative 4 (only one Battle Creek diversion) is also present in Alternative 7, while one of the more negative aspects, a loss in the redundancy of Intake 1, has been improved dramatically with the addition of the powerhouse bypass pipe. With only one documented occurrence of flow being interrupted to the forebay in eight years, it can be said that this system would be extremely reliable. In fact, it is likely that the emergency pumping system at Intake 3 would almost never be used because of the powerhouse bypass pipe proposed for this alternative. If the hatchery could survive in the short-term (during an emergency outage of the Intake 1 system) with the normal 32,000 gpm capacity of Intake 3, it could be argued that the emergency pumps at Intake 3, which bring the intake up to 40,000 gpm, could be eliminated.

6.10 Alternative 8

General Description

Alternative 8 is the simplest approach of the various alternatives using a single intake rather than two or three (including emergency backups). In this alternative, Intakes 1 and 2 are abandoned (including the 46-inch supply pipe up to Intake 3) while Intake 3 is reconstructed to meet fish protection requirements and to meet water supply demands of 70,000 gpm (156 cfs) for the hatchery and downstream water rights. After entering a new intake structure at Intake 3 and passing through a new fish screening structure, flow would be routed by gravity through the existing 48-inch pipe to the sand settling basins. It would also be pumped to the existing hatchery canal through a pipe connecting to the remaining section of the existing 46-inch pipe terminating at the existing hatchery canal outlet structure. Depending on the hatchery water demand, the flow through the gravity system would be a maximum of about 32,000 gpm (71 cfs) while the balance of the flow would be pumped (about 38,000 gpm). Alternatively, as much as 40,000 gpm (89 cfs) could be pumped, leaving 30,000 gpm (67 cfs) for the gravity system to the sand settling basins. Because Intake 3 is not dependant on Coleman powerhouse operations, no emergency or backup intake system is proposed. Proposed improvements for Alternative 8 are depicted on Plates 18 and 19.

<u>Intake 1 Improvements</u>

Intake 1 would be abandoned. The following improvements are proposed:

- *Demolition of existing intake and adjacent stoplog weir.*
- *Restoration of intake area.*

<u>Intake 2 Improvements</u>

Intake 2 would be abandoned. Improvements would be as described for Alternative 3 in Section 6.5.

<u>Intake 1 and 2 Water Conveyance System Improvements (Pipe and Canal)</u>

Since the Intakes 1 and 2 are no longer required, the supply pipeline up to Intake 3 would be abandoned. The following improvements are proposed:

- *Abandonment of existing 46-inch pipeline from Intakes 1 and 2 up to Intake 3.* The pipeline would be plugged and abandoned in place.
- *Remote or visual inspection of the remaining section of supply pipeline.* Approximately 750 feet of the existing 46-inch pipeline would be salvaged and used for routing of flow from the new pump station at the screen structure to the existing

hatchery canal. Inspection issues for this section would be as described in Section 6.3.

- *Rehabilitation or replacement of the existing manually operated water control gate and operator at the canal water control structure.* Inspection and replacement as needed of guides, bushings, and the actuator would be required.
- *Rehabilitation of the hatchery canal.* Improvements would be as described in Section 6.3 for Alternative 1.

Intake 3 Improvements

Proposed improvements at Intake 3, like the other alternatives using this intake, involve reconstructing to meet fish protection criteria requirements. In this alternative, the supply capacity of the intake to the hatchery is also being increased to 70,000 gpm (156 cfs) as was noted earlier. A portion of the flow would be directed by gravity to the sand settling basins and a portion would be pumped to the hatchery canal.

Proposed improvements at Intake 3 include the following:

- *Demolition of existing concrete intake structure at Intake 3 including water control gates and racks.* Unlike the other Intake 3 reconstruction alternatives, the increase in the quantity of flow and the geometry of the fish screening facility would require that a new intake structure be constructed rather than reconstructing the existing structure.
- *Demolition/removal of the existing temporary USBR intake screen installation and demolition or abandonment in place of existing 48-inch piping from a location at USBR screens and existing intake to end of new fish screening structure.*
- *Construction of a new concrete intake structure*. The new larger intake would be located at the location of the existing intake and would be incorporated into the design of the existing sediment sluice and fish ladder. Total flow diverted into the new intake would be approximately 77,800 gpm (173 cfs) with 90% (70,000 gpm) supplied to the hatchery and downstream users, and 10% (7,800 gpm) used for fish bypass flow. The intake would feature a course debris rack and water control gate.
- *Construction of a new off-stream fish screening structure and transition channel from the new intake structure to the new screening structure*. The transition channel would be incorporated into the end of the new intake structure and would route flow to the new fish screening structure. Based on a screened flow of 70,000 gpm (156 cfs), representing approximately 90% of the total intake flow, the screening structure would include two 60-foot long vertical plate screens oriented in a vee configuration with screens ranging in depth from approximately 5 feet to 2.25 feet (upstream to downstream). Screen approach velocities would be less than 0.4 fps and screen sweeping velocities would remain approximately constant at about 2.9 fps. At a reduced flow of 40,000 gpm (89 cfs), the screen approach velocity would be about 0.25 fps and screen sweeping velocities would be approximately constant at about

1.9 fps. Horizontally moving multi-arm vertical brush bar systems (one on each side) would sweep debris off the screen face and down the fish bypass pipe.

Since the transit time through the structure at a system flow of 70,000 gpm (156 cfs) would be about 20 seconds, a single fish bypass entrance and fish bypass pipe would be located at the end of the screens and would return diverted fish to the river. Approximately 10% of the total intake flow would be diverted back to the river as fish bypass flow. The minimum design river water surface elevation for the screening system would be approximately 439.9 feet at the intake entrance. Flow into the structure would be controlled by an automated control gate at the intake structure to maintain the design flow and water surface elevation through the structure at higher river level.

The discharge from the screening structure would be routed via an open channel to a sump area just downstream of the screening area. Five 10,000 gpm (22 cfs) axial flow propeller pumps (4 active and 1 spare) would be located in the sump along with and adjacent to a 48-inch water control gate at the entrance to the 48-inch pipe. The discharge ends on each pump would be connected to a new short large diameter manifold pipe section which would in turn be connected to the nearby remaining existing section of 46-inch pipe. From there, the existing pipe 46-inch pipe would deliver the flow to the hatchery canal. Under typical operating conditions, the water control gate on the 48-inch pipe would be opened to allow gravity flow to the sand settling basins and the pumps would be operated to pump up to the hatchery canal.

- *Rehabilitation of the existing right bank sediment sluice.* Integral with the existing intake, weir and fish ladder is a sluicing section located adjacent to the entrance of the existing intake. This sluice would be rehabilitated by filling with concrete the area currently used for screening in the floor of the sluice. Modifications would include replacement of the existing vertical sluice gate to allow for an overflow weir condition at low river flow to allow downstream migrants an opportunity to pass by the intake entrance. The actuator would also be replaced as necessary.
- *Demolition of the existing air-compressor/equipment building and construction of a new equipment building.* The new building would be sited on the new elevated area of the bank to protect against flooding. The building layout and design would be suited for the emergency electrical generator, electrical distribution panels, and control systems required for the new screening system and pumps associated with the intake. The generator, which would handle electrical power requirements in the event of the loss of commercial power, would be sized to handle loads from the screen cleaning system and pumps at the intake, as well as other small motors, lighting, and gate actuators at this intake as well as at the water control gate on the hatchery canal water control structure described earlier.
- *Bank improvements to stabilize the right bank around the intake and bank filling to elevate critical structures and components against flooding.* The bank would be protected with rip rap upstream and downstream of the intake. The fill areas would be limited to areas adjacent to the screen structure, equipment building and intake

control gate. Access to the facilities would need to be preserved during flood events.

<u>Intake 3 Water Pipeline Improvements</u>

Proposed improvements to the 3,500-foot long, 48-inch pipeline from Intake 3 to the sand settling basins are intended primarily to extend the life of the system to meet the 50-year design life. They include the following:

- *Remote or visual inspection of the supply pipeline.* (See Section 6.3 for a discussion on this item).

Evaluation Against Criteria

Water quality and quantity –

Since all water delivered to the hatchery in this alternative comes from Intake 3, the water quality will be that found in Battle Creek, which is more disease-prone and more turbid than water from the Coleman tailrace. The disease concerns are an issue primarily if the water treatment facilities at the hatchery are not operational. The turbidity issues are most critical for the portion of the system leading to the canal pump station, which feeds the sand filters and the water treatment system. The overall effect of increased turbidity may be a slight degradation of the sand filter system effectiveness as more suspended solids are likely to clog the filters. This would be due to the fact that the hatchery canal, which is not designed as a settling basin, will be the only solids settling feature. The maintenance of the canal will be more extensive as a consequence. A settling basin could be included in the system by expanding the dimensions of a portion of the canal, but this would be recommended only if this proves to be a serious problem. It should be noted that the current water supply for the water treatment system is also Intake 3. The existing sand settling basin removes the settlable solids leaving rather turbid water at times of the year. Thus, the performance of the sand filters might be expected to be slightly degraded in this alternative, but not significantly so.

The quantity of water meets the projected hatchery demands of 70,000 gpm (156 cfs) and since there is no "emergency" condition (no situations where Coleman powerhouse operations shut down an intake), this quantity of water can be anticipated at all times, river flow permitting.

System reliability –

Alternative 8 is the only alternative that is completely independent of Coleman powerhouse and Battle Creek Hydroelectric project operations. Should the system be temporarily or permanently shut down, water supply to CNFH would not be impacted.

The screening and pumping features at Intake 3 are judged to be very reliable making the overall system very reliable.

Redundancy –

There is no redundancy provided with Alternative 8 except as provided internally in the systems in the intake itself. Except for periods when there is very low flow in Battle Creek (which would impact any alternative), no other external factors except for a catastrophic failure of the weir, the river bank, or the supply pipe, would negatively impact flow capacity and reliability of the system. Therefore, the issue of lack of redundancy appears to be primarily an academic one.

Access –

Access to Intake 3 is very good.

Fish Protection –

Fish protection at the proposed reconstructed Intake 3 meets relevant screening criteria. Since Intake 1 is demolished and not used, the exclusion of fish from the Coleman tailrace is assumed to be accomplished by others.

Maintenance –

With concentration of all maintenance activities at Intake 3, the total amount of time assigned to maintenance of the intake system will be reduced in Alternative 8. The screening is more extensive (about double the amount at other screened intakes), since all 70,000 gpm must be screened at this one facility. Nonetheless, the concentration of activities at only one site will be a savings over two separate screened structures.

Long-term Performance –

The facilities at Intake 3 would largely be reconstructed. Even the intake box itself, rehabilitated in the other alternatives using Intake 3, would be constructed new. Therefore, except for the mechanical/electrical components, which would require periodic replacement, and the 48-inch pipe which has a projected design life of about 25 years, the rest of the facilities at Intake 3 would be expected to see at least 50 years of service.

Water Rights –

The increase in water supply to the hatchery from 122 cfs to 156 cfs would necessitate application by the Service to the State for an increase in appropriative water rights.

Construction and O&M Costs

A summary of construction and O&M costs for Alternative 8 is presented in the following tables. A more detailed breakdown of specific cost items is provided in the Appendix. Direct Costs include a construction contingency of 25%, mobilization, and contractor's overhead and profit. Total Cost includes markups for engineering, planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction Costs:

Item Description	Direct Costs	Total Cost
Intake 1 Area Improvements		
Intake 1 and Weir (Demolish)	40,101	**$49,725**
Intake 2 Improvements		
Intake (Demolish)	42,694	**$52,940**
Intake 1 and 2 Water Conveyance System Improvements		
Supply Pipeline, Outlet Structure and Hatchery Canal (Abandon / Rehab)	76,651	**$95,047**
Intake 3 Improvement		
Intake and Screening Structure (New)	2,004,320	**$2,485,357**
Equipment Building (New)	173,147	**$214,702**
Total Project Cost (1999 Dollars)		**$2,897,771**

Annual O&M Costs:

Item Description	Total Cost
Replacement Cost: (Major Mech./Elect. Equip.)	$66,201
Power Costs: (Major Elect. Equip. Only)	$28,396
Labor Costs: (Assuming $20/hr)	$12,005
Total Annual O&M Costs:	**$106,602**

Conclusions

Alternative 8 has a number of compelling advantages over the previous alternatives. These include the concentration of all water supply withdrawals at one location which would decrease maintenance costs as only one intake would have to be maintained. Also, the separation of the intake system from the operations of the Battle Creek Hydroelectric project and Coleman powerhouse in particular, offers reassurance that but for unforeseen other issues in the watershed, the operation of Intake 3 would be relatively constant and predictable for many years to come. Since there are no “emergency” intakes in this alternative, and since the available water supply would be at a constant 70,000 gpm, one issue related to hatchery operations, that of planning for decreased flow from the intakes, would be eliminated or reduced to scenarios involving failure of the supply system itself.

Reliance on only one intake does reduce the level of comfort (although perhaps only perceived) gained by multiple intake locations. With the normally high quality of maintenance present at CNFH, it is unlikely that maintenance problems would contribute to reliability problems. Nonetheless, this is judged to be a disadvantage of this alternative.

Although the cost of pumping is not excessive totaling about $30,000 per year (assuming $0.02/kwh), the need to pump to the hatchery canal on a continual basis is also judged to be a negative aspect of this alternative. However, since most of the other alternatives similarly rely on some type of pumping (typically from the canal pump station to the sand filters), this issue is really not unique to this alternative. Pumping at CNFH has long been viewed as a reliable method of conveying water.

Finally, the construction costs for this alternative are very attractive being ranked third lowest behind Alternatives 1 and 4.

6.11 Alternative 9

General Description

Alternative 9 is similar to Alternative 5 in that Intake 1 is increased in capacity to 70,000 gpm (156 cfs), Intakes 2 and 3 are abandoned, and a new 40,000 gpm (89 cfs) emergency intake is constructed on Battle Creek to serve as a backup to Intake 1 should flow in the tailrace be shut off. Unlike Alternative 5, however, the emergency intake is located just upstream of the barrier weir near the hatchery rather than upstream of Intake 2 on Battle Creek. Also, as a consequence of this shift in location, the flow from the new emergency intake is pumped to the hatchery rather than gravity fed as in Alternative 5. Proposed improvements for Alternative 9 are depicted on Plates 20 and 21.[19]

<u>Intake 1 Improvements</u>

Improvements at Intake 1 are as described for Alternative 5 in Section 6.7 and would involve the construction of a new intake next to the existing intake and demolition of the existing stoplog weir to be replaced with a new weir adjacent to the intake. A tailrace barrier would also be constructed.

Proposed improvements to Intake 1 include the following:

- *Rehabilitation of existing intake structure including racks and control gate*
- *Construction of a new intake structure for the new 36-inch pipe adjacent to the location of the existing intake structure.*
- *Construction of new security fencing at the intake.*

Proposed improvements in the tailrace include the following:

- *Demolition of the existing weir adjacent to the intake and construction of a new replacement weir structure.*
- *Construction of a fish barrier structure on the tailrace about 20-30 feet upstream of the confluence of the tailrace and Battle Creek. (See discussion in Section 6.3).*
- *Roadway access improvements to the fish barrier structure*.

<u>Intake 2 Improvements</u>

[19] During the final selection process, the powerhouse bypass pipe as described for Alternative 7 was added to Alternative 9. See Section 7.0 of the report for details concerning this addition.

Improvements at Intake 1 are as described for Alternative 5 in Section 6.7 and would involve abandoning the existing facilities and restoring the site to match surrounding terrain. Proposed improvements at Intake 2 include the following:

- *Demolition of the existing Intake 2 structure including racks, water control gate, and concrete box.*

Intake 1 Water Conveyance System Improvements

Proposed improvements to the water conveyance system (pipeline, canal water control structure, and canal) are as described for Alternative 5 in Section 6.7 and are intended primarily to extend the life of the system to meet the 50-year design life and to add additional capacity to the system as discussed above. They include the following:

- *Remote or visual inspection of the existing supply pipeline.*
- *Rehabilitation or replacement of the existing manually operated water control gate and operator at the canal water control structure.*
- *Rehabilitation of the hatchery canal.*
- *Construction of a new 1,900-foot long 36-inch pipeline parallel to the existing 46-inch pipeline terminating at the former location of Intake 3 and connecting with the existing 48-inch pipeline to the sand settling basins..*

Intake 3 Improvements

Intake 3 would be demolished in this alternative. Because the existing weir at Intake 3 impounds water for Intake 3, it too could be demolished. This would remove one more obstruction on the river to fish passage. Improvements at Intake 3 would therefore include:

- *Demolition of Intake 3 structure including the sediment sluice, fish ladder and weir.*

Intake 3 Water Pipeline Improvements

As in the other alternatives which continue the use of the existing 48-inch pipeline from Intake 3 to the sand settling basins, the issues for this alternative are the same. Improvements include the following:

- *Remote or visual inspection of the supply pipeline.*

New Intake on Battle Creek

This intake would be a screened intake and would be located on Battle Creek just upstream of the existing barrier weir and fish ladder. It would be designated as an emergency backup intake for Intake 1 and would supply 40,000 gpm (89 cfs) of water to the hatchery. Because it is at the lowest point at the hatchery, all flow from the intake would have to be pumped. To get the maximum benefit from the existing sand settling basin at the hatchery, it is proposed that all of this flow would be pumped to the existing sand settling basins. Upon exiting the settling basins, it would be pumped up to the sand filters using the existing raw water pump station (20,000 gpm [45 cfs] capacity) and gravity fed to the 8 x 80 raceways and the broodstock facilities.

A direct pipeline could be constructed from the intake to the sand filters, thereby eliminating the need to pump the water twice, however, this would put the burden of elimination of large sediment particles on the sand filters making them all but inoperable during periods of high turbidity in Battle Creek as the filter beds would be choked with the additional sediment loads.

Since water use from the intake is non-consumptive and since the hatchery effluent is returned directly below the barrier weir, the only portion of Battle Creek that is reduced in flow when the intake is operating would be from the intake to just downstream of the weir, a distance of less than 300 feet.

The following improvements for the new intake would be required:

- *Construction of a new intake and off-stream fish screening structure.* The intake and screening structure would be similar to that depicted for Intake 2 in Alternative 3 except with the addition of a pumping station as shown on Plate 21. Total flow diverted into the intake would be approximately 44,500 gpm (99 cfs) with 90% (40,000 gpm) supplied to the hatchery, and 10% (4,500 gpm) used for fish bypass flow. The discharge from the screening structure would be routed open channel to a sump area just downstream of the screening area. Five 10,000 gpm (22 cfs) axial flow propeller pumps (4 active and 1 spare) would be located in the sump. The discharges on each pump would be connected to a large diameter manifold pipe section which would in turn be connected to a pipe to the sand settling basins.

  The fish bypass pipe would be routed either directly to the tailrace area of the weir or could discharge directly into the hatchery ladder to improve attraction flows at the ladder.
- *Construction of a 1,200-foot long, 44-inch buried pipe from the proposed intake location to the surge tower at the sand settling basins.*
- *Construction of a new equipment building.* The new building would be sited on the new elevated area of the bank to protect against flooding. The building layout and design would be suited for the emergency electrical generator, electrical distribution panels, and control systems required for the new screening system and pumps associated with the intake. The generator, which would handle electrical power requirements in the event of the loss of commercial power, would be sized to handle loads from the screen cleaning system and pumps at the intake, as well as other small motors, lighting, and gate actuators at this intake.

- *Modifications at surge tower near the sand settling basins for new 44-inch pipe.* The new pipe would be connected with a new wye fitting to the existing 48-inch pipe from Intake 1 at a location near the surge tower.

Evaluation Against Criteria

Water quality and quantity –

The quality of the water for this alternative, like that of all the alternatives that utilize only Intake 1 for normal water supply to the hatchery, is judged to be very good since only during emergency conditions would water directly from Battle Creek be used.

The target hatchery demand of 70,000 gpm (156 cfs) is met by this alternative for normal operating conditions. During emergency conditions when Intake 1 is down, only 40,000 gpm (89 cfs) is provided through use of the emergency intake. The emergency action plan for the hatchery would need to address the prioritization of water during these relatively rare events.

System reliability –

Like all the alternatives relying on Intake 1, this alternative is susceptible to flow interruptions both at Coleman powerhouse as well as in the larger picture, the continued viability of the hydroelectric system in the watershed. Otherwise, the Intake 1 system is a very reliable water source, and because it has no higher maintenance components (screens, weirs, cleaners, etc.) it is judged to be very reliable.

The screened emergency intake located near the hatchery at the barrier weir has the same level of reliability as the other screened intakes except that the close proximity to the hatchery can only be viewed as a positive development in contributing to reliability. Compared to proposed emergency intakes located upstream of the Coleman powerhouse, as found in many of the alternatives, this intake is rated higher.

The need to pump water from the emergency intake to the hatchery during emergency operating conditions does not increase the reliability aspects of this alternative, but is also not judged to be a serious negative issue.

Redundancy –

Since Intake 1 in this alternative has two supply pipes directed to the hatchery and two separate intake boxes, it can be viewed as having external redundancy in that failure of one system or the other would not prevent flow from reaching the hatchery. Only a loss of water to the intake itself would create a problem. Because it also has an emergency intake located on a completely separate system (the intake is located near the hatchery), it is also externally redundant in that way.

Since the intakes in this alternative are on completely separate systems, with no common components, the intakes are externally redundant to each other.

Access –

Access to both intakes is very good.

Fish Protection –

The fish screening requirements for NMFS and CDF&G are both met in this alternative. Like Alternative 5 and Alternative 10 to follow, no fish are diverted into intakes (screened or otherwise) except under emergency conditions when the screened emergency intake is employed. The tailrace exclusion requirements in AFRP Action 5 are also met. Elimination of the weir at Intake 3 in this alternative can only be seen as an enhancement to upstream passage for adult fish.

Since the emergency intake, the only direct withdrawal from Battle Creek in this alternative, is located just 500 feet or so upstream of where the hatchery returns water to the creek, impacts to Battle Creek in-stream flow are minimal in this alternative.

Maintenance –

Maintenance issues for this alternative are comparable to other alternatives employing both the unscreened intake at Intake 1 and a screened emergency intake. Since the normal condition is for only Intake 1 to be operational, the amount of maintenance is reduced dramatically from those using full-time screened intakes. Also, since the screened emergency intake is close to the hatchery, the level of maintenance effort will be smaller than other intakes since the travel time is reduced substantially. This coupled with only rare use of the intake means that there should be very little effort required to maintain the facility.

Long-term Performance –

The long-term performance issues are similar to other alternatives.

Water Rights –

The increase in water supply to the hatchery from 122 cfs to 156 cfs would necessitate application by the Service to the State for an increase in appropriative water rights and a change in the point of diversion for the emergency intake.

Construction and O&M Costs

A summary of construction and O&M costs for Alternative 9 is presented in the following tables. A more detailed breakdown of specific cost items is provided in the Appendix.

Direct Costs include a construction contingency of 25%, mobilization, and contractor's overhead and profit. Total Cost includes markups for engineering, planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction Costs:

Item Description	**Direct Costs**	**Total Cost**
Intake 1 Area Improvements		
Intake 1 (Expand)	157,382	**$195,153**
Tailrace Weir at Intake 1 (New)	258,376	**$320,387**
Tailrace Fish Barrier (New)	257,396	**$319,171**
Intake 2 Improvements		
Intake (Demolish)	42,694	**$52,940**
Intake 1 and 2 Water Conveyance System Improvements		
Supply Pipelines, Outlet Structure and Hatchery Canal (Rehab and Expand)	799,973	**$991,967**
Intake 3 Improvement		
Intake and Weir (Demolish)	219,414	**$272,074**
Equipment Building (Demolish)	16,192	**$20,078**
New Barrier Weir Intake Improvements		
Intake and Screening Structure (New)	1,325,102	**$1,643,126**
Equipment Building (New)	157,334	**$195,095**
44" Supply Pipe and 24" Fish Bypass Pipe (New)	328,501	**$407,341**
Total Project Cost (1999 Dollars)		**$4,417,332**

Annual O&M Costs:

Item Description	**Total Cost**
Replacement Cost: (Major Mech./Elect. Equip.)	$26,149
Power Costs: (Major Elect. Equip. Only)	(NA)
Labor Costs: (Assuming $20/hr)	$11,845
Total Annual O&M Costs:	**$37,994**

Conclusions

Like Alternative 5, which also uses an expanded Intake 1, this alternative takes very good advantage of the high quality water and the historically very reliable installation at Intake 1. Unlike Alternative 5, however, the emergency intake has been moved to a position very close to the hatchery. Thus, the highest potential maintenance feature, the screened emergency intake, is located closest to the hatchery, while the lowest maintenance feature, the unscreened intake at Intake 1 is farther away. Once again, however, the hatchery would rely heavily on the continued operation of Coleman powerhouse.

Fish protection issues are at a minimum for this alternative since no fish enter any intakes under normal operating conditions and since the weir at Intake 3 is removed eliminating one more upstream passage hurdle on Battle Creek.

The fact that the emergency intake is a pumped intake has little consequence to the overall operating costs of the hatchery or reliability of the intake. Since it provides water to the sand settling basins, the existing sediment management facilities can be used and water can be supplied to any part of the hatchery.

6.12 Alternative 10

General Description

Alternative 10 is similar to Alternatives 5 and 9 in that it utilizes an expanded intake at Intake 1 providing up to 70,000 gpm (156 cfs) split between the hatchery canal and the sand settling basins and functions as the normal supply source for the hatchery. Like Alternatives 5 and 9, a new screened emergency intake is constructed on Battle Creek and operates when flow to Intake 1 is interrupted. This new intake replaces existing Intake 2. However, rather than the new intake being located a half mile upstream of the Coleman powerhouse as depicted in Alternative 5 or at the hatchery as in Alternative 9, it is located almost adjacent to the powerhouse as described in Alternative 3 with its supply pipe connected to the 46-inch pipe from Intake 1. Emergency supply flow is 40,000 gpm (89 cfs). Proposed improvements for Alternative 10 are depicted on Plate 22.[20]

Intake 1 Improvements

Improvements at Intake 1 are as described for Alternative 5 in Section 6.7 and would involve the construction of a new intake next to the existing intake and demolition of the existing weir to be replaced with a new weir adjacent to the intake. A tailrace barrier would also be constructed.

Proposed improvements to Intake 1 include the following:

- *Rehabilitation of existing intake structure including racks and control gate*
- *Construction of a new intake structure for the new 36-inch pipe adjacent to the location of the existing intake structure.*
- *Construction of new security fencing at the intake.*

Proposed improvements in the tailrace include the following:

- *Demolition of the existing weir adjacent to the intake and construction of a new replacement weir structure.*
- *Construction of a fish barrier structure on the tailrace about 20-30 feet upstream of the confluence of the tailrace and Battle Creek. (See discussion in Section 6.3).*
- *Roadway access improvements to the fish barrier structure*.

[20] During the final selection process, the powerhouse bypass pipe as described for Alternative 7 was added to Alternative 10. See Section 7.0 of the report for details concerning this addition.

Intake 2 Improvements

Improvements at Intake 2 are as described for Alternative 5 in Section 6.7 and would involve abandoning the existing facilities and restoring the site to match surrounding terrain. Proposed improvements at Intake 2 include the following:

- *Demolition of the existing Intake 2 structure including racks, water control gate, and concrete box.*

Intake 1 Water Conveyance System Improvements

Proposed improvements to the water conveyance system (pipeline, canal water control structure, and canal) are as described for Alternative 5 in Section 6.7 and are intended primarily to extend the life of the system to meet the 50-year design life and to add additional capacity to the system as discussed above. They include the following:

- *Remote or visual inspection of the existing supply pipeline.*
- *Rehabilitation or replacement of the existing manually operated water control gate and operator at the canal water control structure.*
- *Rehabilitation of the hatchery canal.*
- *Construction of a new 1,900-foot long 36-inch pipeline parallel to the existing 46-inch pipeline terminating at the former location of Intake 3 and connecting with the existing 48-inch pipeline to the sand settling basins..*

Intake 3 Improvements

Intake 3 would be demolished in this alternative. Because the existing weir at Intake 3 impounds water for Intake 3, it too could be demolished. This would remove one more obstruction on the river to fish passage. Improvements at Intake 3 would therefore include:

- *Demolition of Intake 3 structure including the sediment sluice, fish ladder, weir, equipment building and experimental USBR screen.*

Intake 3 Water Pipeline Improvements

As in the other alternatives which continue the use of the existing 48-inch pipeline from Intake 3 to the sand settling basins, the issues for this alternative are the same. Improvements include the following:

- *Remote or visual inspection of the supply pipeline.*

New Battle Creek Intake

Proposed improvements for construction of the new intake are described in Section 6.5 for Alternative 3 and include the following:

- *Construction of a new concrete intake and fish screening structure on the right bank*.
- *Construction of a small equipment building at the intake.*
- *Electrical power distribution improvements.*
- *Access road construction from Coleman Powerhouse to the new intake.*
- *Bank improvements to stabilize the right bank around the new intake.*
- *Acquisition of easements or purchase of property.*
- *Construction of security fencing at the intake.*

Evaluation Against Criteria

Water quality and quantity –

Water quality and quantity issues are identical to those of Alternative 9 which uses only the higher quality water from Intake 1 for normal water supply to the hatchery. The quantity of water supplied during normal and emergency conditions is the same as Alternative 9 and meets the 70,000 gpm (156 cfs) target for the hatchery under normal conditions but falls short of the target during emergency operations.

System reliability –

System reliability for Alternative 9 is impacted by the operations of Coleman powerhouse and the hydroelectric system in the watershed, like all of the alternatives that utilized Intake 1. In this case, and as in Alternatives 5 and 9, the reliance on the continued operation of Coleman powerhouse is even higher than other alternatives since under normal operations, 100% of the flow to the hatchery would come from Intake 1. The actual risks associated with the long-term are judged to be quite low given the stability of the system over the years and the fact that the FERC license for the project, which expires in 2026, would likely be renewed assuming the financial viability of the system remains strong.

Redundancy –

Like Alternatives 5 and 9, Intake 1 has two supply pipes directed to the hatchery and two separate intake boxes, and as such can be viewed as having external redundancy since failure of one system or the other would not prevent flow from reaching the hatchery. Only a loss of water to the intake itself would create a problem. Because it has an emergency intake connected to one of the pipes in the event that flow to Intake 1 is interrupted, it also is internally redundant.

Access –

Access to Intake 1 is very good. Access to the emergency intake, located near the Coleman powerhouse, will require that hatchery staff have keys to the locked gate at the entrance to the Coleman powerhouse access road.

Fish Protection –

All relevant fish screening requirements are met with this alternative. Exclusion of fish from the tailrace is accomplished through the construction of the tailrace barrier. In addition, like Alternatives 5, 6 and 9, the removal of the weir at Intake 3 will improve upstream passage conditions.

Maintenance –

Maintenance issues are similar to those for other alternatives utilizing Intake 1 and a screened emergency intake on Battle Creek. However, like Alternatives 5 and 9, the fact that Intake 1, a low-maintenance unscreened intake, supplies 100% of the water to the hatchery under normal conditions, and the infrequent use of the emergency screened intake located on Battle Creek, make this an attractive alternative from a maintenance standpoint.

Long-term Performance –

Long-term performance issues are similar to other alternatives. The anticipated infrequent use of the emergency intake will reduce the wear of mechanical/electrical components at that intake, extending the useful life of those components.

Water Rights –

The increase in total supply to the hatchery from 122 cfs to 156 cfs will require that the Service make application to the State for an adjustment to their appropriative water rights. As is the case in other alternatives where new intake sites are proposed, because Intake 2 has been relocated upstream and on the opposite bank, this will be viewed as a change in point of diversion.

Construction and O&M Costs

A summary of construction and O&M costs for Alternative 10 is presented in the following tables. A more detailed breakdown of specific cost items is provided in the Appendix. Direct Costs include a construction contingency of 25%, mobilization, and contractor's overhead and profit. Total Cost includes markups for engineering, planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction Costs:

Item Description	**Direct Costs**	**Total Cost**
Intake 1 Area Improvements		
Intake 1 (Expand)	157,382	**$195,153**
Tailrace Weir at Intake 1 (New)	258,376	**$320,387**
Tailrace Fish Barrier (New)	257,396	**$319,171**
Intake 2 Improvements		
Intake (Demolish)	42,694	**$52,940**
Intake 1 and 2 Water Conveyance System Improvements		
Supply Pipelines, Outlet Structure and Hatchery Canal (Rehab and Expand)	799,973	**$991,967**
Intake 3 Improvement		
Intake and Weir (Demolish)	219,414	**$272,074**
Equipment Building (Demolish)	16,192	**$20,078**
New Battle Creek Intake Improvements		
Intake and Screening Structure (New)	1,030,682	**$1,278,046**
Equipment Building (New)	118,036	**$146,365**
66" Supply Pipe and 30" Fish Bypass Pipe (New)	641,808	**$795,842**
Total Project Cost (1999 Dollars)		**$4,392,023**

Annual O&M Costs:

Item Description	**Total Cost**
Replacement Cost: (Major Mech./Elect. Equip.)	$26,149
Power Costs: (Major Elect. Equip. Only)	(NA)
Labor Costs: (Assuming $20/hr)	$11,845
Total Annual O&M Costs:	**$37,994**

Conclusions

This alternative, through the use of the proposed expanded intake at Intake 1, makes use of the best quality water available near the hatchery for 100% of its supply needs during normal operating conditions. Only when flow from the Coleman powerhouse is interrupted would the proposed emergency intake on Battle Creek be engaged.

Like Alternatives 5 and 9, fish protection issues are at a minimum for this alternative since no fish enter any intakes under normal operating conditions and since the weir at Intake 3 is removed improving upstream passage conditions in Battle Creek.

Unlike Alternative 9, which places the emergency intake near the hatchery, this alternative places the intake near the Coleman powerhouse, which is less convenient due to driving distance and the need to gain access through the locked gate at the entrance road to the powerhouse. Unlike Alternative 9, however, no pumps are located at the intake, although pumping is still required (at the canal pump station) to provide water to the water treatment system.

Because no fish screens are normally functioning in this alternative, maintenance issues are reduced dramatically. This is also the case for Alternatives 5 and 9.

6.13 Summary

Construction and O&M Cost Summary

The following is a summary of estimated construction and O&M costs for Alternatives 1 through 10. A more detailed breakdown of specific cost items for each alternative is provided in the Appendix. Construction costs include a construction contingency of 25%, mobilization, contractor's overhead and profit, markups for engineering and planning, and construction management. Costs for property or right-of-way procurement and costs for permitting are not included.

Construction and O&M Costs:

Intake Alternative	**Construction (1999 Dollars)**	**Annual O&M Costs (1999 Dollars)**
Alternative 1	$2,326,827 *	$49,310
Alternative 2	$3,759,883 *	$75,847
Alternative 3	$4,642,226 *	$75,555
Alternative 4	$2,602,310 *	$45,500
Alternative 5	$8,343,515 *	$37,994
Alternative 6	$8,406,194	$33,864
Alternative 7	$3,725,686	$49,310
Alternative 8	$2,897,771	$106,602
Alternative 9	$4,417,332 *	$37,994
Alternative 10	$4,392,023 *	$37,994

***** Note: During the final alternative selection process, the powerhouse bypass pipe described for Alternative 7 was added to these alternatives resulting in an increase in total construction cost for the alternative. See Page 117 in Section 7.0 for adjusted construction costs for these alternatives.

Intake Alternative Evaluation Summary

A summary matrix was developed to summarize the evaluation of the various alternatives performed previously in Sections 6.3 through 6.12. This summary is presented on the following page as Table 6.2. A ranking of "Fair", "Good", and "Excellent" was assigned to the various alternatives for each of the evaluation criteria to indicated the degree to which the alternative met the criteria. In addition to the evaluation criteria, construction and O&M costs were ranked. The comment section in the table provides further information on how the rankings were made for each of the criteria and costs.

Table 6.2 - Intake Alternative Evaluation Summary

Evaluation Criteria	Intake Alternative										Comments
	Alternative 1	***Alternative 2***	***Alternative 3***	***Alternative 4***	***Alternative 5***	***Alternative 6***	***Alternative 7***	***Alternative 8***	***Alternative 9***	***Alternative 10***	
Water Quality	*G*	*G*	*G*	*G*	*E*	*E*	*G*	*F*	*E*	*E*	Alternatives which draw more heavily from higher quality Coleman powerhouse water are rated more highly
Water Quantity	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*E*	*G*	*G*	Alternatives which meet the projected water demand at CNFH of 70,000 gpm more consistently are rated more highly
System Reliability	*G*	*G*	*G*	*G*	*G*	*E*	*E*	*E*	*G*	*G*	Alternatives which do not rely as heavily on operations at Coleman powerhouse are rated more highly
Redundancy	*E*	*E*	*E*	*E*	*E*	*F*	*E*	*F*	*E*	*E*	Alternatives which have greater redundancy are rated more highly
Access	*G*	*F*	*G*	*E*	*G*	*F*	*E*	*E*	*E*	*G*	Alternatives with better overall access are rated more highly. Degree of maintenance at intakes is considered in evaluation.
Fish Protection	*F*	*G*	*G*	*G*	*E*	*E*	*G*	*G*	*E*	*E*	Alternatives meeting fish screening criteria at all intakes are rate "G". Those also reducing in-stream barriers are rated "E"
Maintenance	*G*	*F*	*F*	*G*	*E*	*E*	*G*	*G*	*E*	*E*	Alternatives which exhibit the least amount of daily maintenance are rated highest
Long-Term Performance	*E*	*E*	*E*	*E*	*E*	*E*	*E*	*E*	*E*	*E*	Alternatives which meet the 50-year performance requirements for more components are rated more highly
Water Rights Issues	*E*	*E*	*G*	*E*	*F*	*F*	*E*	*E*	*E*	*G*	Alternatives with fewer water rights issues (diversion points are not changed, etc.) are rated more highly
Construction Costs	*E*	*G*	*G*	*E*	*F*	*F*	*G*	*E*	*G*	*G*	Alternatives with construction costs < $3 million = "E", $3 - $5 million = "G", > $8 million = "F"
O&M Costs	*E*	*G*	*G*	*E*	*E*	*E*	*E*	*F*	*E*	*E*	Alternatives with O&M costs < $50,000 = "E", $50 - $100,000 = "G", > $100,000 = "F"

Rankings: *F* = Fair
G = Good

E = Excellent

7.0 RECOMMENDATIONS

7.1 Alternative Selection Process

The final step in the evaluation of intake alternatives for the Coleman NFH, as presented in Section 6.0, was to make a recommendation as to the most appropriate single (or multiple) alternative based comparisons of the alternatives relative to the criteria. The Coleman Intake Working Group and the Sverdrup Civil, Inc. design team met at the Coleman NFH on April 14 and 15, 1999 for the purpose of reviewing the alternatives and selecting the recommended alternative(s) to be furthered toward the goal of final design and construction. Minutes of this meeting (including a list of meeting participants) are included for reference in Appendix C.

To accomplish this, the group assigned weighting values to each criterion representing its importance relative to the other criteria. Each alternative was then assessed as to how well it fulfilled the requirements of each of these weighted criteria. The result of this procedure was a numerical value for each alternative, which identified how well the team felt the alternative meets the criteria. Although these results provide a useful tool for sorting through the many issues which inevitably arise when comparing multiple alternatives against multiple criteria, the actual numerical value should not be considered the final decision maker in this process. Rather, the results are used to focus conversations on the alternatives which are clearly superior and eliminate some alternatives which are lacking in their adherence to the hatchery requirements.

The intake system evaluation criteria used to develop and assess the ten alternatives were defined in Section 3.0 and include: Water Quality, Water Quantity, System Reliability, Redundancy, Access, Fish Protection, Maintenance, Long-Term Performance, and Water Rights Issues. The intake alternatives tend to satisfy these criteria to varying degrees, with the exception of one of the criterion. Since, long-term performance was defined as having a design life of 50 years, and since all ten alternatives were designed to fully meet this need, there were no discriminating characteristics with which to rank the alternatives relative to this criterion. Therefore, for the purposes of this selection process, the long-term performance criterion was removed from consideration. It was decided that three additional items which were not used specifically as evaluation criteria during the development of the alternatives needed to be included as selection criteria in any comparative assessment of the alternatives. These three criteria were Construction Cost, annual Operations and Maintenance Cost, and the effects the alternative would have on the existing riparian and/or aquatic habitat. In the context of this last new criterion, it was felt that some of the alternatives, especially those which allow for the removal of the weir and intake structure at Intake 3, may actually improve some aspects of the aquatic habitat. With the addition of operations and maintenance cost as a selection criterion it was decided that the maintenance criterion should be clarified as representing only ‘ease of physical maintenance’ issues. This was seen as an important issue above and beyond cost alone. A good example of an undesirable characteristic would be a significant maintenance requirement at a back-up or emergency intake during periods of high flow or power outages when the hatchery staff already had their hands full just keeping the hatchery operating. The final criteria list utilized in this selection process was as follows:

A. Water Quality
B. Water Quantity
C. System Reliability
D. Redundancy
E. Access
F. Fish Protection
G. Ease of Physical Maintenance
H. Effects of Habitat
I. Water Rights Issues
J. Construction Costs
K. O&M Costs

The first step in the selection process was to rate each of the criteria against one another to establish a weighted value for each one. This was done by assigning a value of 1 to both criteria if they were considered equally important, or assigning a value of 2, 3, or 4 to the criterion considered more important, if they were not considered equal. The value of 2 being used for a criterion having a minor preference over another one, 3 for a medium preference, and 4 for a strong preference. The values assigned to each criterion were summed to give a total weighted value. Assigned values and total weights for the criteria are summarized in Figure 7.1. The total weights for the criteria in descending order are; F-29, C-25, A-22, H-21, B-15, D-13, K-9, G-8, E-5, J-2 and I-0. The weight of zero given to Water Rights Issues is not meant to diminish the importance of this criterion, or ignore the complications it may cause in the future, it only results from the fact that the group as a whole did not consider it to be more important than any of the other criteria considered in the selection process.

The next step was to evaluate each of the alternatives in the report against each of the 11 weighted selection criteria. A value of 1 through 5 was assigned to each alternative based on how well it addresses the requirements of each criterion. Assigned values were; 1=Poor, 2=Fair, 3=Good, 4=Very Good, and 5=Excellent. The ten alternatives presented in this report are described in Section 6.0 and summarized in Table 6.1. However, early in the selection process a suggestion was made that the bypass pipe from the forebay to the powerhouse tailrace described for Alternative 7 (see Section 6.9) be included with every alternative which utilizes Intake 1. This addition would increase the reliability of Intake 1, the primary water source for the hatchery. It would also minimize the number of events requiring the use of any emergency intake located on the main stem of Battle Creek. This was viewed as an improvement in water quality, maintenance requirements, and fish protection. One disadvantage might be the need to have the design approved by both PG&E and the FERC in advance of construction. Although this should not present an unachievable obstacle, it will be an additional cost and scheduling requirement. These issues were discussed and the addition was agreed to, which results in the following two modifications to the alternative descriptions provided in Section 6.0:

1. Alternatives 4 and 7 become identical, since the only difference was that Alternative 7 added this bypass pipe. Therefore, Alternative 4 was removed from consideration for the remainder of the evaluation.

2. The construction cost and annual O&M cost of all alternatives (with the exception of Alternatives 6, 7 and 8) are increased by $1,123,376 and $3,810, respectively. This represents the increased costs associated with the addition of the powerhouse bypass pipe and forebay intake structure. It is assumed here that the 40,000-gpm bypass pipe described for Alternative 7 would be adequate for the alternatives which increase the capacity of Intake 1 to 70,000 gpm. During the relatively rare powerhouse outages the available flow could be reduced to 40,000 gpm. This results in a revised summary of construction and O&M costs as shown in the following table.

Revised Construction and O&M Costs (includes powerhouse bypass pipe):

Intake Alternative	**Construction (1999 Dollars)**	**Annual O&M Costs (1999 Dollars)**
Alternative 1	$3,450,203	$53,120
Alternative 2	$4,883,259	$79,657
Alternative 3	$5,765,602	$79,365
Alternative 4 (deleted)[1]		
Alternative 5	$9,466,891	$41,804
Alternative 6 (unchanged)[2]	$8,406,194	$33,864
Alternative 7 (unchanged)[3]	$3,725,686	$49,310
Alternative 8 (unchanged)[2]	$2,897,771	$106,602
Alternative 9	$5,540,708	$41,804
Alternative 10	$5,515,399	$41,804

Notes:
1. Addition of the powerhouse bypass makes Alternative 4 identical to Alternative 7, therefore, Alternative 4 was deleted.
2. No powerhouse bypass added since Intake 1 not used, therefore, cost is unchanged.
3. Original alternative design includes powerhouse bypass, therefore, cost is unchanged.

Figure 7.2 gives the results of the alternative ranking process. Each alternative is assessed relative to each criterion. The number in the upper left corner of each box in Figure 7.2 is the value given to that alternative to describe how well it fulfills the requirements of the particular criterion. The number in the lower right corner of each box is the product of this value multiplied by the criterion weight. The resulting products were added together to obtain a total weighted value for each alternative. Values were assigned to each alternative concerning the group's opinion of the complications involved with water rights issues, even though multiplying these by the criterion weight of zero resulted in no effect on the results. This was done because it may provide useful information to someone in the future who has to deal specifically with this issue. The assigned values and the resulting total weighted values shown in Figure 7.2 represent the collective opinion of the group which met to make the selection recommendations, and would not necessarily correspond to the opinions formed by others who may review this report.

As can be seen in Figure 7.2, the results of this evaluation broke down basically into three groups. Alternatives 9 and 10 scored highest having weighted totals in the mid-600's. Alternatives 1, 2, 3, 5 and 7 had totals in the low to mid-500's, and Alternatives 6 and 8 scored lowest with weighted totals in the mid to high 400's.

7.2 Recommended Alternative and Selected Back-up Alternatives

Based on the discussions during the alternative selection process, and the resulting total weighted values, four alternatives were selected to be furthered into the environmental NEPA process for public and agency review. The selected Alternatives were 3, 7, 9 and 10. Alternatives 10 and 9 ranked first and second, respectively, in the alternative ranking process and clearly fulfilled the selection criteria better than the other alternatives. Alternative 3 ranked third (although significantly below the first two) and represents the alternative which most closely resembles the existing conditions while fully addressing two of the most significant problems with the existing intakes. These two problems were identified as the lack of adequate fish protection at Intakes 2 and 3, and the inaccessibility of Intake 2 on the left bank of Battle Creek. Although Alternative 7 ranked fairly low in the overall list (seventh out of nine) it was viewed as an attractive alternative in that it addressed all the major concerns without construction of an intake at a new location. In this way Alternative 7 is significantly different than the others in its approach and offers a good contrast for the NEPA review. The remaining alternatives were removed from further consideration as either not meeting the criteria requirements as well as the four selected alternatives and/or being unjustifiably expensive with little or no added benefit.

Following the numerical ranking process, advantages and disadvantages of each of the four remaining alternatives were discussed. This resulted in an order of preference of Alternatives 10, 3, 7 and 9, respectively. These discussions included the following points:

<u>Alternative 10</u>:
Advantages:
- By increasing the capacity of Intake 1 so as to supply all current and potential hatchery demands directly from the powerhouse tailrace, the water quality is maximized. *(Same for Alternatives 9 and 10)*
- With the addition of the powerhouse bypass pipe, as discussed in Section 7.1 above, the reliability of this higher quality water source is maximized. *(Included with all four alternatives)*
- Gravity flow to the existing hatchery canal can be supplied under both normal operations and emergency conditions (i.e. when water is not available in the powerhouse tailrace.) However, this may require a low-head sill across the river at the location of the new intake to ensure adequate long-term driving head on the emergency intake. *(Same for Alternatives 3 and 10)*
- The removal of Intake 3, and its associated weir and fish ladder, was viewed as a feature of the alternative which would improve the aquatic habitat conditions in Battle Creek. Although this removal would not have a direct effect on the hatchery operations one way

or the other (except to reduce overall maintenance), the removal of such a structure would appear to be a good position for the Service to be pursuing. *(Same for Alternatives 9 and 10)*

- Other than the expanded Intake 1, which is an unscreened intake on the powerhouse tailrace, only one screened intake is required on Battle Creek and it is used only intermittently for emergency back-up. *(Same for Alternatives 9 and 10)*
- No pumps are required for any of the proposed intakes. *(Same for Alternatives 3 and 10)*

Disadvantages:

- The new pipe installation from Intake 1 (installed to expand the intake capacity) will require two river crossings which will require hydraulic permitting and may result in some negative short-term impact on the aquatic habitat, depending upon construction practices and duration. However, with proper design and installation techniques these impacts could be minimal. *(Same for Alternatives 9 and 10)*
- The new emergency intake is located approximately 9,700 feet (1.8 miles) upstream of the hatchery barrier weir, where the hatchery returns water to Battle Creek. Therefore, when this intake is in operation the flow through this stretch of Battle Creek will be reduced by the quantity of the intake flow, until it is returned to the river near the location of the barrier weir. However, the frequency and length of these occurrences should be minimal since the availability of flow in the powerhouse tailrace is good, and will be increased by the addition of the bypass pipe. Additionally, other than the initial lag time period, the flow which would have been going to the powerhouse would, in this case, be redirected back into the creek supplying adequate flow for this scenario. Given the lag time in flow rates required for the flow from the PG&E diversions upstream to reach the location of the new intake in the event of a power canal failure, emergency action plans for both the hatchery operations and PG&E will need to be established and coordinated to ensure adequate minimal flows to both the hatchery and the creek. *(Inherent to Alternatives 3, 7 and 10, however, length of creek affected varies)*

<u>Alternative 3:</u>

Advantages:

- Continued use of the existing Intake 1 supplies high quality water to the existing hatchery canal. However, since the intake is not expanded (as in Alternative 10) the flow from this intake can not supply all of the hatchery demand. Therefore, the reconstructed Intake 3 will need to supply flow to the sand settling basins, as is currently the case. *(Same for Alternatives 3 and 7)*
- With the addition of the powerhouse bypass pipe, as discussed in Section 7.1 above, the reliability of this higher quality water source is maximized. *(Included with all four alternatives)*
- Gravity flow to the existing hatchery canal can be supplied under both normal operations and emergency conditions (i.e. when water is not available in the powerhouse tailrace.) However, this may require a low-head sill across the river at the location of the new intake to ensure adequate long-term driving head on the emergency intake. *(Same for Alternatives 3 and 10)*

- No pumps are required for any of the proposed intakes. *(Same for Alternatives 3 and 10)*
- Installation of the new supply pipe and fish bypass pipes do not require any river crossings. *(Same for Alternatives 3 and 7)*

Disadvantages:

- In addition to the existing Intake 1, two screened intake facilities would be required, and one of these would operate on a regular basis (Intake 3). This would increase the maintenance requirements and O&M costs, especially during emergency operations. *(Unique to Alternative 3)*
- When flow is not available in the tailrace, and the emergency intake is being used in combination with Intake 3, there is the potential for fish to be exposed to two screening systems. Although the structures would be designed to be fish friendly, it is generally regarded as better to minimize the exposure of fish to any screens if possible. *(Unique to Alternative 3)*
- The location of the new emergency intake approximately 9,700 feet (1.8 miles) upstream of the hatchery barrier weir is the same as stated for Alternative 10. However, the problem associated with this during the initial lag time after a power canal failure could be somewhat reduced, due to the presence of Intake 3 located approximately 5,800 feet (1.0 mile) upstream of the barrier weir. If some or all of the initial emergency flow were taken at Intake 3, the length of creek affected could be reduced. *(Similar to Alternative 10, but potentially over a reduced creek length)*
- This is likely to be the alternative with the greatest water rights issues because there would be three intakes to be addressed. *(Unique to Alternative 3)*

<u>Alternative 7:</u>

Advantages:

- Continued use of the existing Intake 1 supplies high quality water to the existing hatchery canal. However, since the intake is not expanded (as in Alternative 10) the flow from this intake can not supply all of the hatchery demand. Therefore, the reconstructed Intake 3 will need to supply flow to the sand settling basins, as is currently the case. *(Same for Alternatives 3 and 7)*
- With the addition of the powerhouse bypass pipe the reliability of this higher quality water source is maximized. *(Included with all four alternatives)*
- Other than the existing Intake 1, which is an unscreened intake on the powerhouse tailrace, only one screened intake (Intake 3) is required, however, unlike Alternative 10 it would be used on a regular basis rather than only for emergencies as is the case for the emergency intake for Alternative 10. *(Unique to Alternative 7)*
- Installation of new pipes do not require any river crossings. *(Same for Alternatives 3 and 7)*
- No new intakes on Battle Creek need to be constructed. *(Unique to Alternative 7)*

Disadvantages:

- Two new pumps and associated back-up generator equipment and fuel tanks would be required at Intake 3 to increase emergency flow conditions from 32,000 gpm to 40,000 gpm. (However, if an emergency action plan for the hatchery operations were to be established which defined a method by which the hatchery could operate temporarily with 32,000 gpm during the rare periods the powerhouse tailrace was unavailable, then the need for the pumps could be eliminated.) *(Problem less severe than with Alternative 9)*

- Gravity flow can not be supplied directly to the hatchery canal during emergency conditions. *(Same for Alternatives 7 and 9, but more severe for 9)*
- Modifications would likely be required at the sand settling basins, and the associated supply piping from the surge tower, to accommodate the increased flow capacity from Intake 3. *(Same for Alternatives 7 and 9)*
- Intake 3, located approximately 5,800 feet (1.0 mile) upstream of the barrier weir, would be the sole location of the emergency back-up to Intake 1. Although this is shorter than the 9,700 feet described for Alternatives 10 above, emergency action plans for both the hatchery operations and PG&E would still need to be established and coordinated to ensure adequate minimal flows to both the hatchery and this section of the creek during the lag time required to get flow from the upstream diversions down to Intake 3. *(Similar to Alternatives 3 and 10, but over reduced creek length)*

<u>Alternative 9:</u>

Advantages:

- By increasing the capacity of Intake 1, so as to supply all current and potential hatchery demands directly from the powerhouse tailrace, the water quality is maximized. *(Same for Alternatives 9 and 10*)
- With the addition of the powerhouse bypass pipe, as discussed in Section 7.1 above, the reliability of this higher quality water source is maximized. *(Included with all four alternatives)*
- The removal of Intake 3, and its associated weir and fish ladder, was viewed as a feature of the alternative which would improve the aquatic habitat conditions in Battle Creek. Although this removal would not have a direct effect on the hatchery operations one way or the other (except to reduce overall maintenance), the removal of such a structure would appear to be a good position for the Service to be pursuing. *(Same for Alternatives 9 and 10)*
- Other than the expanded Intake 1, which is an unscreened intake on the powerhouse tailrace, only one screened intake is required and it is only used intermittently for emergency back-up. *(Same for Alternatives 9 and 10)*
- During the lag time associated with emergency operations, the intake flow removed from the creek would taken out immediately upstream of where it is released back in downstream of the weir. Therefore, the section of creek which could experience problematic flow reductions is limited only to a short section located at the hatchery barrier weir. *(Unique to Alternative 9)*
- The location of the emergency intake on the hatchery grounds would significantly improve access required for intake monitoring and maintenance, and would minimize the potential for vandalism. *(Unique to Alternative 9)*

Disadvantages:

- The emergency intake can only function through the use of pumps. These pumps would be in addition to other pumps and power needs already required at the hatchery. This could potentially create serious problems if this were to become the only source of water during a prolonged power outage, not the least of which is the large quantity of fuel which would be required to keep the back-up generators operating. During the selection process, representatives from the hatchery expressed the opinion that the potential for complete loss of water with this alternative was too great and suggested removing it from further consideration. The group as a whole, however, chose to keep the alternative for consideration, mostly due to the near zero impact on the aquatic habitat in Battle Creek. *(Unique to Alternative 9)*
- The new pipe installation from Intake 1 will require two river crossings which will require hydraulic permitting and may result in some negative short-term impact on the aquatic habitat, depending upon construction practices and duration. However, with proper design and installation techniques, these impacts could be minimal. *(Same for Alternatives 9 and 10)*
- Modifications would likely be required at the sand settling basins to accommodate the increased flow capacity from the new intake. *(Same for Alternatives 7and 9)*
- The river at the location of the proposed emergency intake tends to be a high siltation area and could be a problem for an intake utilizing pumps. *(Unique to Alternative 9)*
- Gravity flow can not be supplied directly to the hatchery canal during emergency conditions. *(Same for Alternatives 7 and 9, but more severe for 9)*

Based on the advantages and disadvantages discussed, Alternative 10 (with the addition of the powerhouse bypass pipe) was chosen as the alternative which best fit the evaluation criteria and would provide the best design to meet the hatchery's needs. This will be the recommended alternative to be presented in the NEPA documentation, along with the no-action alternative and Alternatives 3, 7 and 9, in that order. The no-action alternative would be included only to fulfill a NEPA requirement and is actually not a realistic alternative because it does not address the requirement for approved fish screening at water diversions on Battle Creek.

Estimated construction costs for Alternatives 10, 3 and 9 are similar at between 5.5 and 5.8 million dollars. Alternative 7 is significantly less expensive at about 3.7 million dollars due to the lack of a replacement intake for the abandoned Intake 2. However, when comparing these costs it should be with the understanding that in Alternative 7 the powerhouse bypass system is more critical to the overall design, in that it replaces much of the function of the abandoned emergency intake. Since in the other three alternatives a new intake is constructed to replace the abandoned Intake 2, the need for the powerhouse bypass system is reduced. If the bypass system is removed from the other alternatives then the estimated costs for all four alternatives become similar. Consideration should also be given to the fact that construction of the bypass system will require considerable effort and expense (and possible project delay) in terms of coordination with PG&E to apply for a FERC license amendment for the Coleman Powerhouse to incorporate the bypass system onto the project property. This cost is somewhat unpredictable and has not been included in the above estimates.

7.3 Project Schedule

A project schedule addressing the preparation of documents, agency and public review periods, design and construction of the selected alternative is presented in this section. This has been prepared based on the assumption that Alternative 10 will be the final selected alternative. This is a reasonable approach because there do not appear to be any compelling reasons for this alternative not to be chosen, and the overall schedule would not be drastically different for any of the four alternatives selected for consideration.

Since no actual time table for starting or completing this project has been established, an arbitrary starting date of January 1, 2000 is used to create a reference point. A conceptual level schedule estimate using this starting date is shown on Figure 7.3. With some exceptions, the schedule can be slid any amount of time to accommodate a different starting date. Exceptions to this involve construction in or around the river which will need to be done during the in-river work period and construction requiring a period of reduced hatchery demand during which time the hatchery would operate on only one of its existing intakes. Although the in-river work period varies slightly from year to year depending upon conditions, it is assumed for the purpose of scheduling that this period is from June 15 to September 15. The period of reduced hatchery demand is assumed to be May 1 to August 31 (see Table 2.2). During the construction phase it should be possible to rearrange individual work items to accommodate this in-river period without significantly changing the overall project time frame. The earlier a decision to proceed can be made, the more likely it will be that construction can begin in time to utilize the earliest available in-river work period.

The first task which will be required to initiate this project is the preparation of permit applications, applications for water rights modifications, and NEPA documentation. The time required for these steps is subject to considerable uncertainty given the potential for protests in both water rights and Corps of Engineers processes. If all proceeds smoothly, about 12 months would be required to acquire the necessary permits. Preparation and filing of all permit and environmental documents would require about six months, given the need for informal consultation on endangered species issues. Public notice and review would consume the bulk of the remainder. NEPA compliance and acquisition of permits could take considerably longer than the 12-month estimate should the water rights changes be protested or the project become controversial.[21]

Assuming all parties are in agreement before the permitting process begins, the documents which will be required include the following:[15]

- Letters from NMFS and FWS concurring with determination of no affect on listed species.
- Environmental Assessment/Initial Study to comply with NEPA and CEQA.

[21] Correspondence with Dr. Buford Holt (U.S. Bureau of Reclamation), 5/19/99.

- Section 404 Permit from the Corps of Engineers.
- Section 401 Permit (water quality) from the Regional Water Quality Control Board.
- Section 1600 Agreement with the California Department of Fish and Game.
- Permits from the Water Resources Control Board for both changes in the points of diversion and the volumes diverted.

If the powerhouse bypass pipe is to be included with the final design, approval of the concept and design from both PG&E and the FERC will be required. This is required because the forebay intake and bypass pipe would be on PG&E project property, and the installation and operation of this facility could potentially impact project power generation, operations, and safety. Additionally, it may require an amendment to the existing license since it affects points of water withdrawal and flow distribution during periods of powerhouse outages. These issues will need to be addressed in a FERC Supporting Design Report which would include a conceptual level design with text description and drawings, a proposed construction plan which ensures the continued safe operation of the forebay and powerhouse, an operating plan for the bypass including required control ties with the Coleman Powerhouse, documentation concerning any modifications this bypass may require to the project's Emergency Action Plan, and all correspondence concerning the bypass. Preparation of this document should be started immediately upon initiation of the project and could occur concurrently with the preparation of the NEPA documentation, since some of the information will be common to both documents. Additionally, if the bypass pipe is deemed to be beneficial, it would likely be included with any of the selected alternatives so there would be no point in waiting for the outcome of the NEPA process. Although the preparation of the FERC Supporting Design Report would presumably be the responsibility of the Service (since the pipe would be for their benefit) the preparation of this report should be done in close coordination with PG&E since as the licensee of the hydro project they will ultimately need to submit it to the FERC for approval. It is assumed for the purposes of this schedule that the preparation of this report would occur concurrently with, and require the same duration as, the preparation of the permit applications and NEPA documentation. It is further assumed that FERC approval could be obtained within the same time frame as the permit approval and the NEPA process. Therefore, although this requirement will add manpower needs and cost to the project it should not significantly affect the overall schedule.

Design of the project is broken out into two phases in Figure 7.3. The initial design would be required at the beginning of the project to support the permit documents. This would include preparation of conceptual level drawings and text to accompany the NEPA documents, EIS, permit applications, and the FERC Supporting Design Report. Considerable progress towards final design could also be made during this phase. However, the actual final design, including preparation of contract documents (drawings, specifications and final engineer's cost estimate) should be put off to near the end of the public and agency review periods so that any modifications made to the proposed action can be incorporated into the final design. The final design may require hydraulic modeling to ensure that the design of the screening structures maximizes hydraulic efficiency and complies with all relevant fish screening criteria. The final design phase is assumed in this estimate to begin about two months before the final receipt of all permits, as by this point it is assumed that any significant modifications resulting from the review process would be identified. Starting this phase prior to receipt of all the permits would be required in order to start construction in time to utilize the 2001 in-river work period. Some relaxation of this requirement could be achieved by initiating the project prior to January 1, 2000.

After completion of the construction documents, the project would be opened for bidding by contractors resulting in a contract award for construction. It is assumed that this process would require approximately 2 months.

The construction schedule is complicated by the limitations of the in-river work period and the requirement that the hatchery be able to meet its water demand at all times. In-river work items can only be performed between June 15 and September 15. Assuming that Alternative 10 is to be constructed, these include the following (items with an asterisk also require that the hatchery operate temporarily on one intake and should be scheduled to end before August 31):

- Installation of a new intake and wing wall adjacent to the existing Intake 1*
- Demolition of the weir at Intake 1 and installation of a new weir structure*
- Installation of a new tailrace fish barrier
- Demolition of Intake 2 and associated pipe connection*
- Two river crossings for the new 36” supply pipe
- Removal of the existing USBR screen at Intake 3
- Demolition of Intake 3 and the associated weir and fish ladder*
- Installation of a new intake structure near the Coleman Powerhouse
- Installation of a fish bypass outfall
- Assorted riprap and other bank improvements

The list above is based on the assumption that the powerhouse bypass installation, including the forebay intake, the bypass pipe, and the tailrace outfall would not be considered in-river work and could be performed anytime. Additional items which would not require in-river work, but would require the hatchery to temporarily operate on a single intake, would need to be scheduled between May 1 and August 31. These items would include:

- Rehabilitation of the control gate and trashrack at the existing Intake 1,
- Inspection of the 46” supply pipe from Intakes 1 and 2,
- Rehabilitate control gate at the hatchery canal and regrade the canal,

Attempting to perform all the items on the lists above in a single season, while ensuring that the three existing intakes are fully operable prior to May 1 and the entire new system is fully operational in time for the hatchery’s autumn water demands, would be an expensive and risky undertaking for the hatchery. Complicating this would be the need to keep one intake operating throughout the entire construction period. Therefore, the construction schedule presented in Figure 7.3 assumes that the work would be spread between two in-river work periods with out-of-river work being performed in the interim. The suggested construction schedule is laid out as follows:

1. Beginning on May 1, prior to the first in-river work period, rehabilitation of the existing Intake 1 and the inspection and improvements of the existing water conveyance system could be initiated.

2. During the first in-river work period, the Intake 1 area improvements would be performed. This would include construction of the new intake adjacent to the existing intake, the 36" pipe from the new intake through the first river crossing, the new tailrace weir, the new tailrace fish barrier, and installation of a connection for a new 66" pipe to the existing 46" pipe. This connection would be capped and left in place for eventual connection to the new Battle Creek intake. During this entire period, Intake 3 would be available to supply the typically reduced hatchery water demands.

3. After the in-river work period concluded, the remainder of the 36" pipe could be installed to a point just before the second river crossing. This crew could then shift to the installation of the 66" supply pipe and the 30" fish bypass pipe associated with the future Battle Creek intake. Also during this interim period, another crew could be installing the powerhouse bypass pipe system (assuming this is to be included.)

4. During the second in-river work period, the timing of work to ensure one intake is always operational will be a little trickier. The approach suggested in this schedule is to take Intake 3 off line as early as possible, leaving the existing Intake 1 to supply the hatchery via the hatchery canal. The second river crossing of the 36" pipe would be completed and the pipe attached to the existing 48" pipe. Meanwhile, construction of the new Battle Creek intake near the Coleman Powerhouse, removal of the existing Intake 3 structures, and installation of the fish bypass outfall structure could be on-going. Once the 36" pipe is connected to the existing 48" pipe, the new intake adjacent to Intake 1 will be available to supply the hatchery via the sand settling basins. At this point, the existing Intake 1 can be taken off line and the connection to the new 66" pipe and the removal of the existing Intake 2 can progress.

Based on this schedule, the entire construction period would be about 17 months, extending from about May 1 to near the end of the following September. Additionally, there would likely be some time before and after this period for contractor's mobilization, demobilization and clean-up. Although work could be initiated at any time of the year, with some of the out-of-river work being performed prior to the first in-river work period, this would be an inefficient use of time since it is assumed that two in-river work periods will still be required regardless of when the project starts. Therefore, initiating the preparation of the permit applications, FERC and NEPA documentation, and water rights applications as early as possible and keeping close track of the early processes (especially the agency and public review periods) to ensure they stay on schedule is critical. If the first available in-river work period is missed, the entire project would be set back by a full year.

The final item on the schedule is the preparation of operating manuals. These would include the Operations & Maintenance Manual for all new equipment and facilities installed, and an Emergency Action Plan (EAP) for the hatchery to describe operations under adverse conditions, such as loss of flow to Intake 1. The EAP should be prepared at the initiation of the project, during the preparation of the permitting documents. Although the EAP could not be fully completed before finalization of the NEPA process, when the final configuration would be approved, significant portions concerning items such as required emergency flow rates will need to be agreed to prior to full engineering design so there is a clear understanding of the required intake facilities which are to be designed and built. The O&M Manual should be compiled at the end of construction so that actual vendor and product information for the installed products can be included.

The entire project from a decision to proceed to end of final construction would be approximately three years. As stated previously, this assumes that the decision to proceed is timely and that schedules are strictly adhered to, otherwise the in-river work period restrictions could easily force the project to slip an additional year.

8.0 PLATES

APPENDIX A

Cost Estimates

- Construction
- Operations and Maintenance

APPENDIX B

Fisheries Design Criteria

- National Marine Fisheries Service (NMFS)
- California Department of Fish and Game (CDFG)

APPENDIX C

- Minutes of the Alternative Selection Meeting (April 14 and 15, 1999)