A History of the Operational and Structural Changes to the State Fish Salvage Facility from 1968 - 2010

Draft Report

by

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ABSTRACT

The John E. Skinner Delta Fish Protective Facility (SDFPF) is one of two large fish salvage facilities located in the south Sacramento-San Joaquin Delta. The facility is operated by the Department of Water Resources (DWR) and plays a major role in the State Water Project (SWP). Completed in 1968, the purpose of the SDFPF is to salvage fish entrained by the export of water through the SWP and return them safely back to the Delta away from the immediate vicinity of the SWP's Harvey O. Banks Pumping Plant (Banks Pumping Plant) and the Central Valley Project's (CVP) Jones Pumping Plant. Over the past 40 years, the SDFPF has undergone a variety of both operational and structural changes. Many of these changes may have impacted the reported number of salvaged fish at the facility.

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ACKNOWLEDGEMENTS

I would like to thank Dan Odenweller, Paul Raquel, and Dennis McEwan for their willingness to be interviewed and providing historical information on the SDFPF. The Department of Water Resources Delta Field Division provided information on historical repairs to the SDFPF within the past decade and allowed access to historical maintenance logs kept at the facility. Also thanks to Robert Fujimura and Marty Gingras for reviewing and providing valuable comments during the report-writing phase.

A. INTRODUCTION

The SDFPF has been salvaging fish and collecting data on fish entrained by the export of water through the SWP since 1968. Throughout its history, the facility has undergone a number of changes; both operational and structural. Today, the fisheries data collected at the facility is being used by various agency groups. Many who use the data are unaware of the history associated with the data. The purpose of this document is to give a general overview on the SDFPF, to document the historical changes that have occurred at the facility throughout its existence, and to list those changes which may have impacted the reported number of salvaged fish at the facility.

B. METHODS

Various resources were used in researching the historical changes that have occurred at the SDFPF. The California Department of Fish and Game's (DFG) Fish Facilities files and reports stored at the Stockton Bay Delta Region office were the primary reference sources used for this document. Other sources of historical information were acquired through personal interviews conducted with current and previous DFG employees who conducted studies and provided oversight at the SDFPF. Information on SDFPF repairs and equipment changes during the past decade was acquired from DWR's Delta Field Division and SDFPF blue prints and daily maintenance logs.

C. STATE FISH FACILITY

I. OVERVIEW OF THE SDFPF

The SDFPF was designed and constructed by DWR in the late 1960's and is an integral part of the SWP. The facility is located near Byron, California in Contra Costa County and is operated and maintained by the Delta Field Division of DWR (Figure 1). The facility is situated along an intake channel between Clifton Court Forebay (CCF) and the Harvey O. Banks Pumping Plant (Figure 1). The primary purpose of the facility is to salvage fish entrained by the export of water and return them back to the Delta away from the immediate vicinity of the SWP and Central Valley Project (CVP) pumping plants. The SDFPF was originally designed to salvage Chinook salmon, striped bass, white catfish, and threadfin shad of at least 1-inch in length.

Delta water from the Old River and West Canal first enters CCF through a series of 5 radial gates located at the southeast corner of the forebay (Figure 2). The surface area of CCF is 2,180 acres and the storage capacity of the forebay is approximately 31,260 acre-ft (DWR 1997). The current storage capacity of CCF has decreased due to the influx of sediment into the forebay from export operations over the years. The radial gates are normally operated on a daily basis and are opened on the highest high tide when the greatest head differential occurs between the river and forebay elevations. The gates remain in the open position until DWR reaches their daily allotment of water to export.

Water pumped by the Banks Pumping Plant flows out of CCF and enters an intake channel on the west side of the forebay before heading towards the SDFPF (Figure 3). A trash boom located near the entrance of the SDFPF deflects large floating

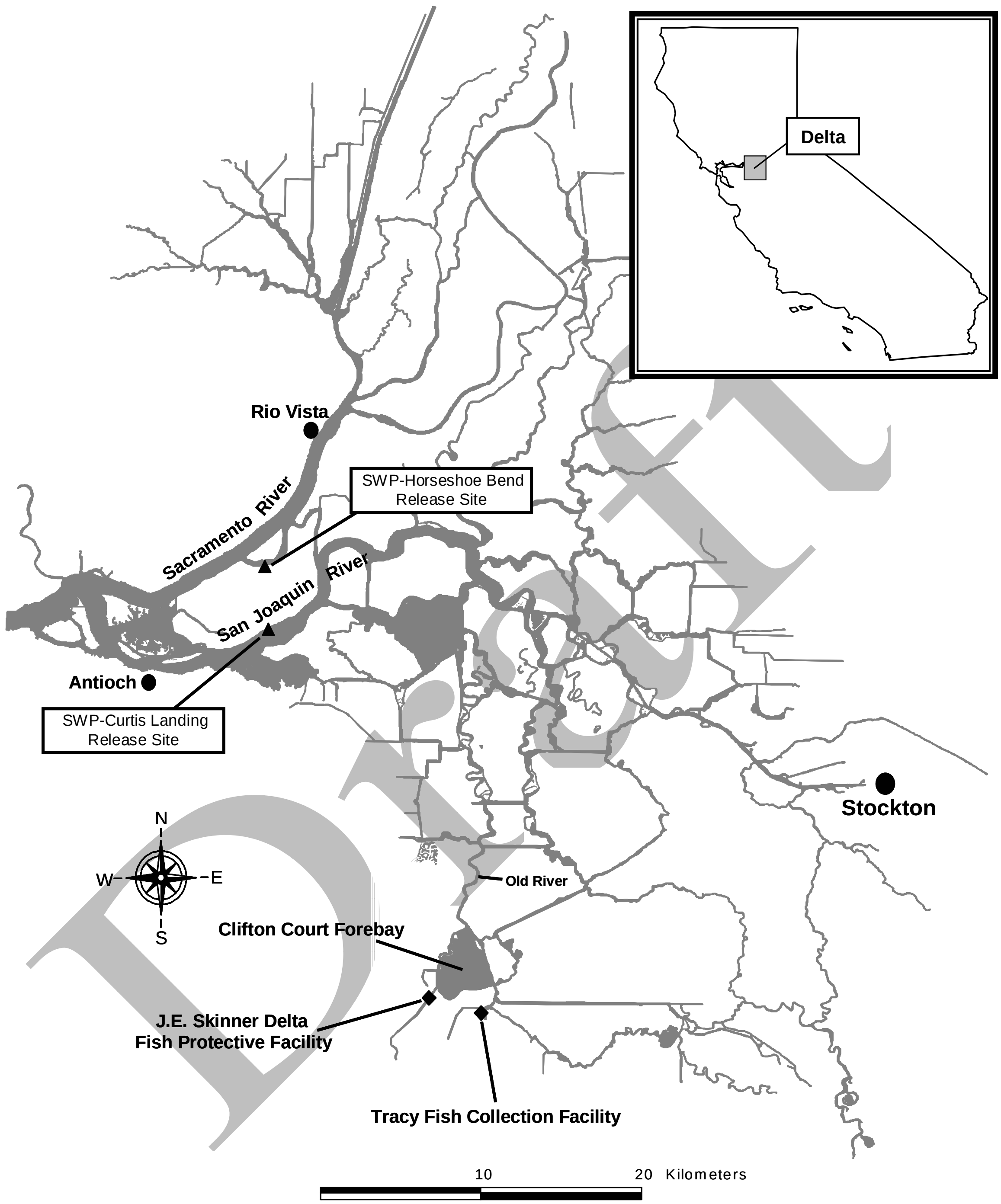

Figure 1 Map of the Delta showing the location of the SDFPF and the SWP fish release sites

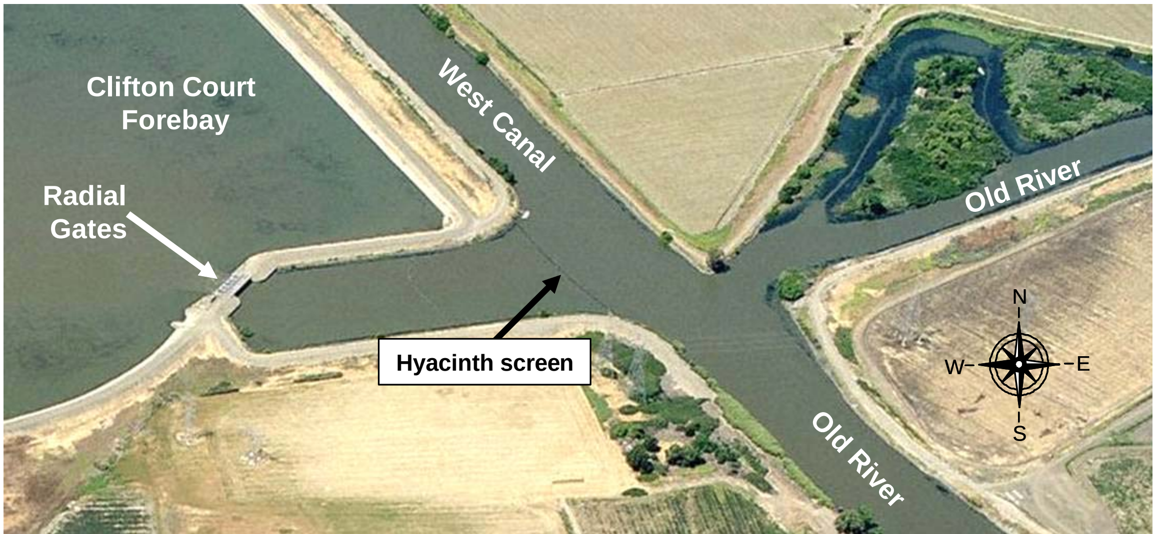

Figure 2 Location of radial gates at the southeast corner of Clifton Court Forebay

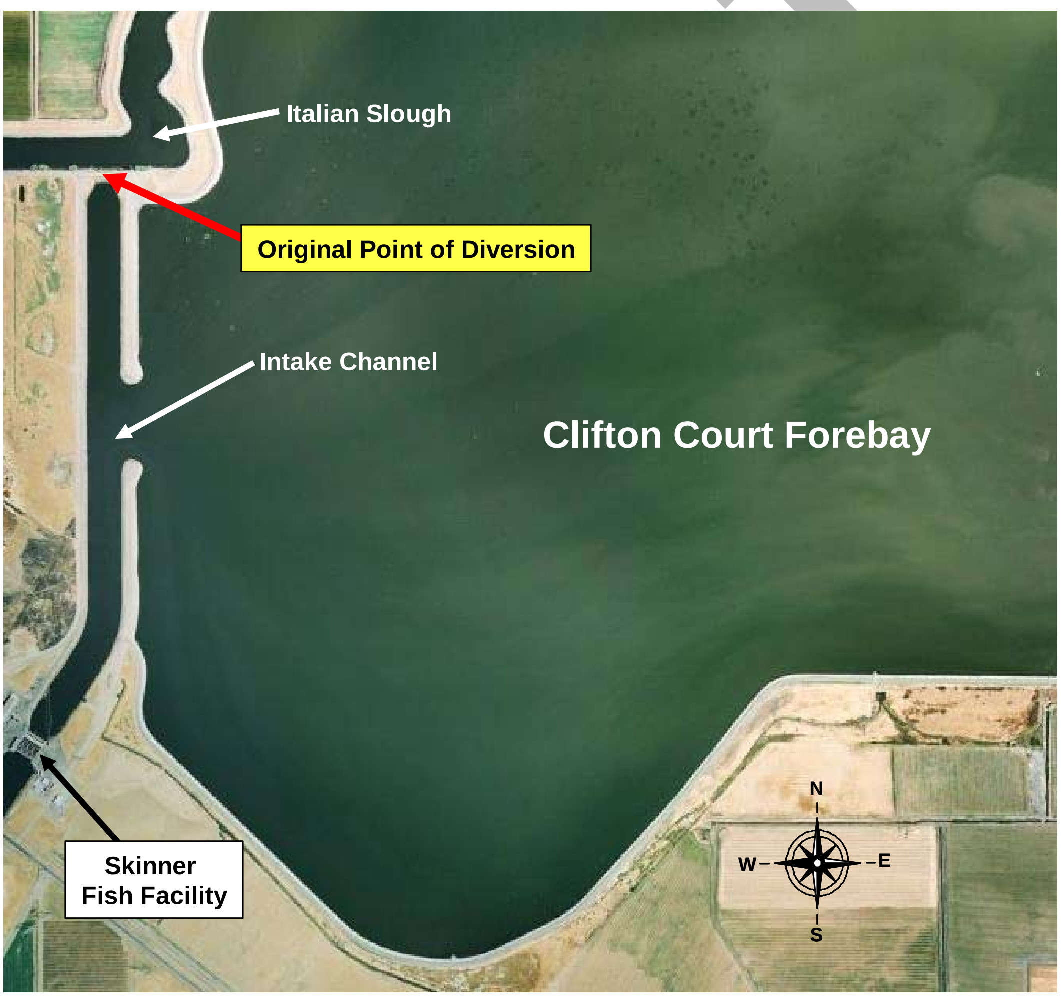

Figure 3 Aerial view of Clifton Court Forebay showing the intake channel leading to the SDFPF and the original diversion point for exporting water

debris (e.g. logs, hyacinth) at the top of the water column towards a conveyor for disposal on the south side of the intake channel (Figure 4). The trash boom is a floating structure with a leading edge extending 0.5 meters below the water surface. Therefore, the trash boom is not considered to be a major barrier to fish movement towards the SDFPF. Fish moving with the flow of water towards the SDFPF first encounter the trash rack. The trash rack is a large structure constructed of vertical grating that spans the entire width of the intake channel at the entrance to the SDFPF (Figure 5). Large fish and debris are prevented from entering the facility through the trash rack's vertical 5.1 cm wide openings. An automated cleaner is used to remove debris collected on the face of the trash rack and deposits the debris into trash containers on each side of the channel.

Fish that successfully pass through the trash rack enter the primary louver section of the SDFPF (Figure 4). This section uses the louver-and-bypass concept for fish guidance and collection (DFG 1969). The intake channel narrows and is divided into 3 large bays and 1 smaller bay. A series of wing gates located at the upstream end of each bay in front of the primary louvers are used to regulate the velocity of the water approaching the louvers (Figure 6). A series of louver panels are arranged in a v-shaped configuration to guide fish into bypasses located at the apex of the configuration (Figure 7). Unlike positive barrier screens, the louvers rely on the behavior of the fish to avoid passing through them. Each bank of louvers consists of adjoining sections (2.4 x 4 m) stacked vertically (DFG 1969). The louver sections consist of vertical members spaced 2.5 cm apart that are oriented 15 degrees relative to the direction of water flow. This orientation creates turbulence along the face of the louvers to elicit an avoidance reaction and encourages fish movement towards the bypasses. Concrete splitter walls were installed in the center of 3 of the larger bays to help guide fish into the bypasses (Figure 4). The center walls divide the channel into 7 smaller bays.

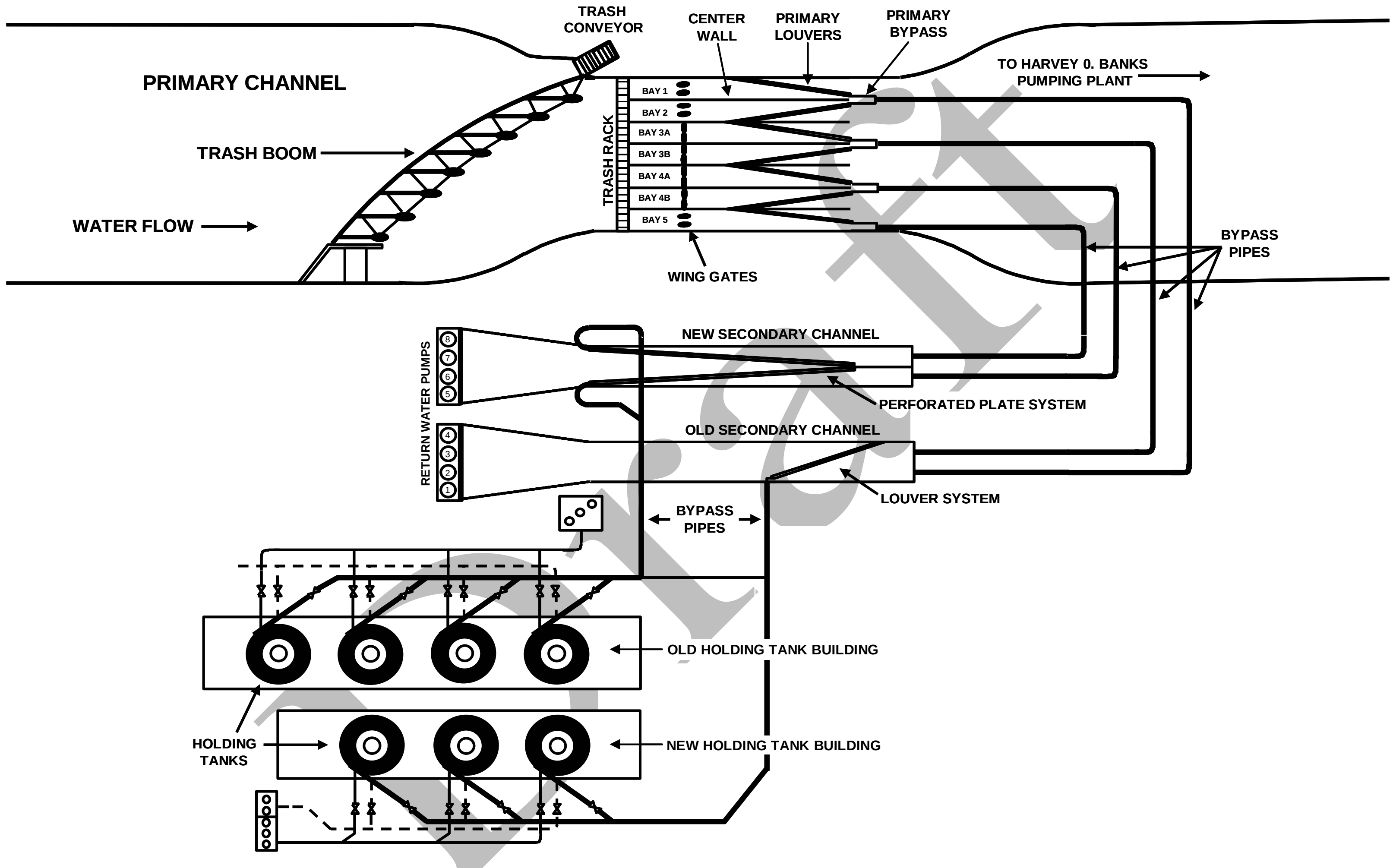

Figure 4 Schematic of the State Water Project's SDFPF (features not to scale)

Figure 5 View of the new SDFPF trash rack and automated cleaner

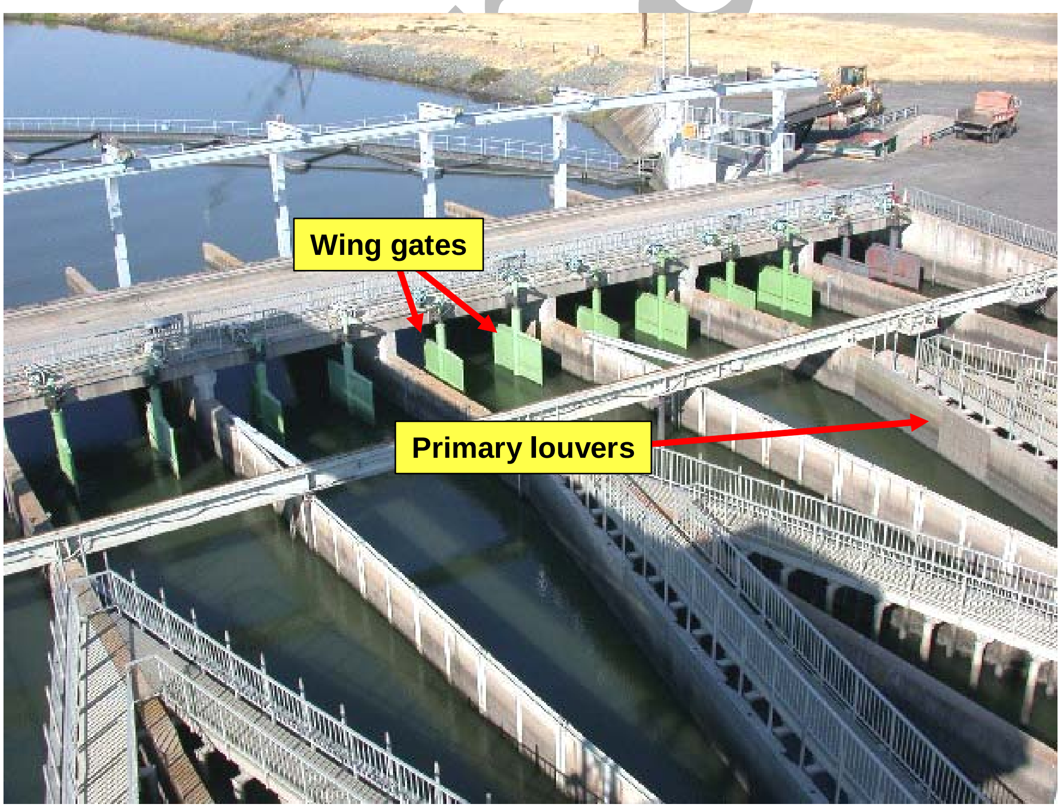

Figure 6 Overhead view of the primary louvers showing the location of the wing gates

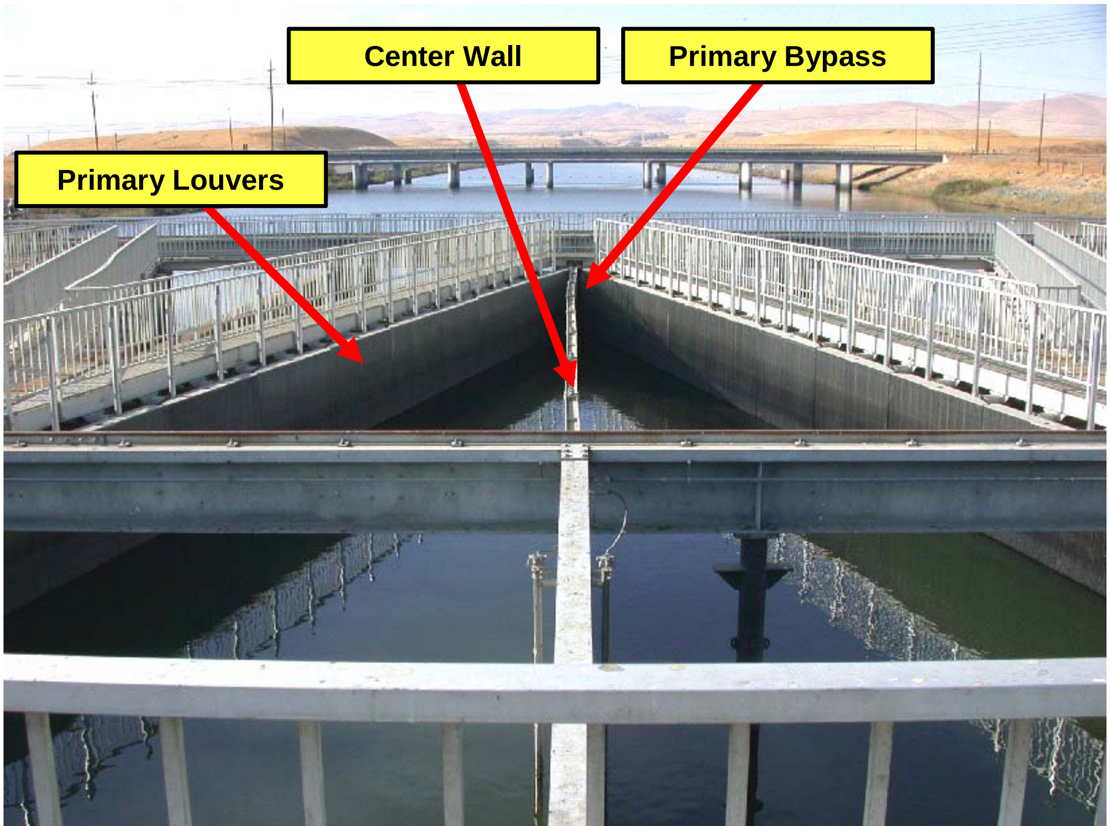

Figure 7 View showing the v-shaped configuration of the primary louvers

After entering the bypass, fish are transported to the secondary system of the SDFPF through 122 cm diameter bypass pipes. Fish leave the bypass pipes and enter 1 or more secondary channels (Figure 4). The secondary channels are used to reduce the volume of water, concentrate the fish, and guide the fish into the secondary bypasses.

The SDFPF was constructed in 2 phases. The original (old) secondary channel uses a series of louver panels identical to the primary louvers to guide fish into the bypass (Figure 8). A screened water system was incorporated into the original design of the old secondary channel to reduce the amount of larger debris entering the holding tanks. The system effectively kept larger debris from the holding tanks, but it was not good for the efficiency of fish entering the secondary bypass (Dan Odenweller, personal communication, 2010). The screened water system was removed from service as part of the Phase II expansion of the SDFPF in the mid-1980's. The old secondary channel has been in use since the SDFPF started salvaging fish in 1968. The newer (new) secondary channel uses a system of 2 bays consisting of panels of perforated plate (4 mm openings) to guide fish into 2 bypasses (IESP 1986). DWR started using the new secondary channel in the early 1990's (Figure 9).

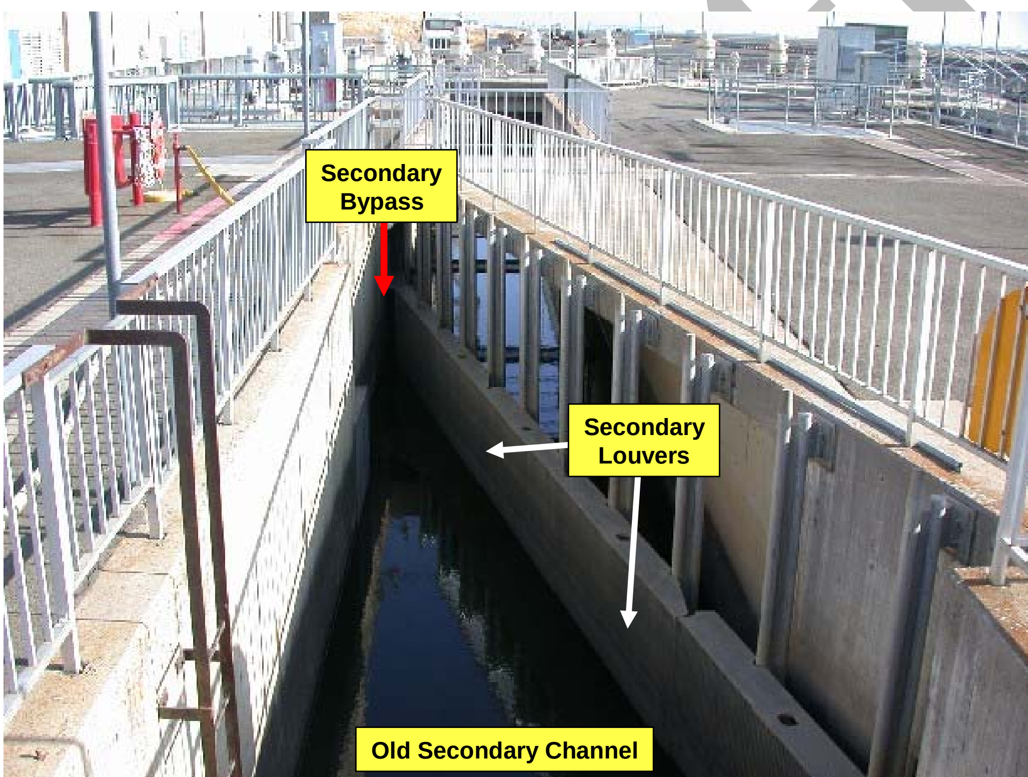

Figure 8 View of the louver system in the old secondary channel

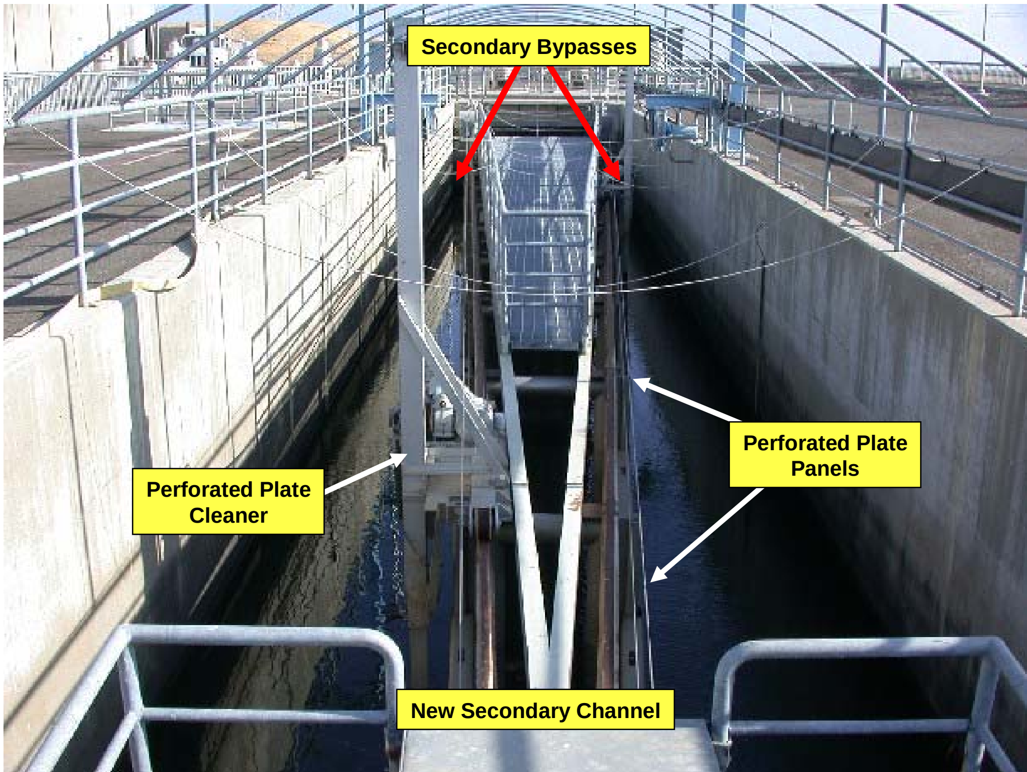

Figure 9 View of the perforated plate system in the new secondary channel

Fish entering the secondary bypasses are directed into 1 or more holding tank buildings through bypass pipes (Figure 4). The original (old) building has 4 recessed holding tanks; 1 tank is only used for fish counts and 3 tanks are used for holding salvaged fish. Each tank is approximately 6.1 m in depth and 6.1 m in diameter. Water and fish enter the holding tanks from a pipe located at the bottom outside edge of the tank. A cylindrical holding tank screen 2.7 m in diameter in the center of the holding tanks retains fish between the screen and the outside wall of the tank away from the drain (Figure 10). The new holding tank building was first used for fish salvage in May 1992. The new building has 3 recessed holding tanks; 1 tank is only used for fish counts and 2 tanks are used for holding salvaged fish. The holding tanks and center screens in the new holding tank building are similar in size to those in the old building.

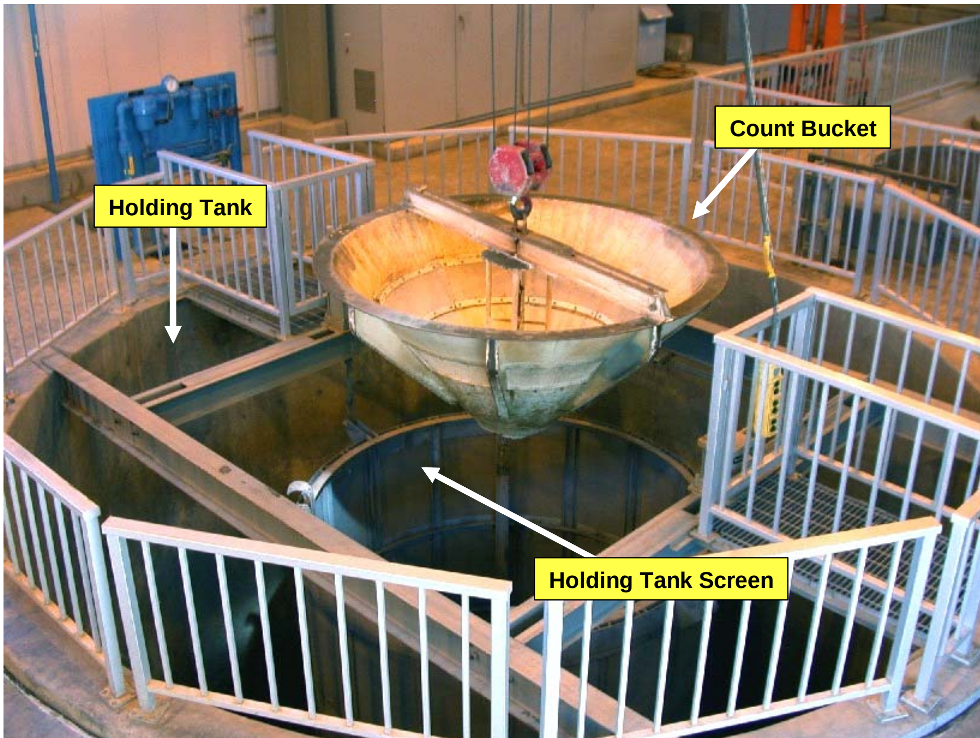

Figure 10 View showing a holding tank at the SDFPF with center holding tank screen and count bucket

Fish counts are normally conducted at the SDFPF every 2 hours whenever DWR is exporting water at the Banks Pumping Plant. Fish counts may be conducted as frequently as every hour whenever flow changes (changes in pumping rates) occur at the pumping plant. Each fish count sub-samples a specific time period (1 hour, 2 hours, etc.) that the facility is salvaging fish.

The length of time fish are held in the holding tanks at the SDFPF varies according to species of fish, numbers of fish, size of fish, and water temperature, but the maximum holding period does not exceeds 24 hours. Fish are trucked and returned to the Delta at 2 SWP release sites located on Sherman Island outside the immediate influence of the SWP and CVP pumps. The Horseshoe Bend release site is located in Horseshoe

Bend off of the Sacramento River and the Curtis Landing release site is located on the San Joaquin River east of Antioch (Figure 1).

The pumping rate at the Banks Pumping Plant in addition to the season of the year determines how the SDFPF operates. Historically, many factors have affected the pumping rates at the Banks Pumping Plant including water storage and availability, water demand, and water quality standards. Since 1993, regulatory standards (Biological Opinions, incidental take permits, etc.) have influenced operations at the SWP, especially during normal entrainment periods of ESA-listed fish at the SDFPF. Pumping rates at the Banks Pumping Plant can range from as low as 375 cfs to as high as 10,300 cfs.

II. OPERATIONAL CHANGES THAT HAVE TAKEN PLACE FROM 1968 TO 2009

Point of Diversion

The SDFPF first began salvaging fish in March 1968 (DFG 1969). At that time, DWR exported water directly from Italian Slough (Figure 3). Shortly after operating the Banks Pumping Plant off of the Italian Slough diversion, it was apparent that tidal influence impacted continuous operation of the pumping plant. Exporting water directly from Italian Slough also adversely affected the agricultural diversions in the South Delta. Plans were developed to construct CCF as a storage reservoir to supply water to the Banks Pumping Plant for continuous pumping. Once CCF was completed, DWR discontinued exporting water from Italian Slough and began exporting water directly through CCF. The CCF levee was breeched in November 1969 (DFG 1970). DWR has used CCF since 1969 as a storage reservoir and water supply for the Banks Pumping Plant.

Operating Criteria

State Water Resources Control Board Decision 1485

In August 1978, the State Water Resources Control Board (SWRCB) issued their Water Rights Decision 1485 (D1485). This decision 1) amended the water rights permits for DWR's SWP and United States Bureau of Reclamation's (USBR) CVP facilities, 2) exercised its jurisdiction to set terms for protection of fish and wildlife, and 3) coordinated the terms for both facilities. This decision requires standards to be maintained for the protection of fish and wildlife as a condition of all SWP and CVP permits (SWRCB 1978).

Table II (Appendix A) of the decision established standards for the operation of the SDFPF. The most relevant standards are listed below:

"Maintain appropriate records of the numbers, size, kind of fish salvaged and of the water export rates and facility operations."

Established two seasonal operational periods with specific fish protection standards or conditions.

1. Chinook (King) Salmon Criteria: November 1 to May 14
    a. Primary and secondary channel approach velocities = 3.0 to 3.5 feet per second (fps)
    b. Primary and secondary bypass ratios = 1.2:1.0 to 1.6:1.0

2. Striped Bass and White Catfish Criteria: May 15 to October 31

a. Primary and secondary channel approach velocities = 1.0 fps (preferred); 2.5 fps maximum
b. Primary bypass ratio = 1.2:1.0 to 1.5:1.0
c. Secondary channel bypass ratio = 1.2:1.0

Based on Table II requirements, holding tank flows are not to exceed 10 cfs. The old holding tank building can salvage fish into as many as 3 holding tanks. Whenever multiple tanks are being used, the average flow for all tanks in use must not exceed 10 cfs. Therefore, if 3 holding tanks are being used to salvage fish, the total flow into the old holding tank building must not exceed 30 cfs (10 cfs per tank).   The SDFPF can salvage fish into 1 holding tank in the new holding tank building without violating the 10 cfs per tank criteria.

<u>Regulatory Standards</u>

In February 1993, the National Marine Fisheries Service (NMFS) issued the *Biological Opinion for the Operation of the Federal Central Valley Project and the California State Water Project* (NMFS 1993). The Biological Opinion listed specific terms and conditions that DWR needed to comply with to minimize the take of winter-run Chinook salmon from October 31 through May 31. The most relevant requirements of the Biological Opinion were:

1. Monitoring the incidental take of winter-run Chinook salmon associated with the operation of the SDFPF.
2. Ensuring that the SDFPF was fully staffed and all water passing through the facility was screened.

3. In coordination with USBR, submitting daily, weekly, and annual reports to NMFS regarding operations of project facilities, temperature and hydrological conditions, and the results of the salvage monitoring programs.

In March 1995, the U.S. Fish and Wildlife Service (USFWS) issued a Biological Opinion entitled *Formal Consultation and Conference on the Long-Term Operation of the Central Valley Project and the State Water Project on the Threatened Delta Smelt , Delta Smelt Critical Habitat, and Proposed Threatened Sacramento Splittail* (USFWS 1995). The Biological Opinion listed specific terms and conditions that DWR needed to comply with to minimize the take of delta smelt. The most relevant requirements of the Biological Opinion were:

1. Transporting delta smelt in 8-ppt salinity water to a new release site whenever the number of adult delta smelt in a salvage count preceding a fish haul exceeds 0.5 adult delta smelt per count minute.
2. Not holding salvaged fish longer than 8 hours at the SDFPF before transporting to a release site whenever delta smelt were present.
3. Immediately reporting take or suspected take of delta smelt and splittail and sending weekly reports to USFWS when delta smelt and splittail were present.

In March 2000, NMFS issued a Biological Opinion entitled *Operation of the Federal Central Valley Project and the California State Water Project from December 1, 1999 through March 31, 2000* (NMFS 2000). The Biological Opinion listed specific terms and conditions that DWR needed to comply with to minimize the take of Central Valley spring-run Chinook salmon and Central Valley steelhead. The most relevant requirements of the Biological Opinion were:

1. Operating the SDFPF to intercept fish before they reached the Banks Pumping Plant.
2. Conducting fish counts of no less than 10 minutes every 2 hours.
3. Identifying to species, measuring, examining for marks and tags, and transporting all salmon and steelhead live to the release sites.
4. Operating the SDFPF to salmon criteria from November 1 through May 14.
5. Using coded-wire tagged fall-run Chinook salmon and unmarked juvenile steelhead collected at the SWP and CVP as triggers for agency consultation.
6. Collecting tissue samples from juvenile spring-run Chinook salmon and steelhead at the SDFPF for genetic analysis.

In 2000, the Vernalis Adaptive Management Plan (VAMP) was initiated as part of the SWRCB Decision 1641. VAMP was designed to protect juvenile Chinook salmon migrating from the San Joaquin River through the Sacramento-San Joaquin Delta. The long-term plan utilizes a 31-day pulse flow period during April and May in the San Joaquin River near Vernalis, and includes decreased export pumping at the SWP and CVP for salmon protection. During the annual VAMP period each year, the SDFPF does not salvage many fish due to limited pumping and/or shutting down the facility for maintenance.

In December 2008, USFWS issued a Biological Opinion on the Long-Term Operational Criteria and Plan (OCAP) for coordination of the Central Valley Project and the State Water Project. The most relevant requirements of the Biological Opinion were:

1. During the months of December through July, when water is being diverted, Reclamation and DWR shall ensure that the frequency of sampling for delta smelt at the Banks and Jones will be at least 25 percent of the time.
2. Reclamation and DWR shall develop a methodology for larval quantitative monitoring at Banks and Jones to help refine triggers for the Actions in the Reasonable and Prudent Alternatives.

In February 2009, DFG issued a California Endangered Species Act Longfin Smelt Incidental Take Permit No. 2081 for DWR's SWP Delta facilities and operations. The most relevant requirements of the incidental take permit were:

1. Minimize entrainment of adult and juvenile longfin smelt at the SDFPF.
2. Meet the Old and Middle River flow requirements in order to protect adult longfin smelt migration and spawning during the December through February period and protect larval and juvenile longfin smelt during the January through June period.

<u>DWR/DFG Four Pumps Agreement</u>

In December 1986, DFG and DWR signed an interagency agreement titled *Agreement Between the Department of Water Resources and the Department of Fish and Game to Offset Direct Fish Losses in Relation to the Harvey O. Banks Delta Pumping Plant* (DFG and DWR 1986). The agreement acknowledged fish losses caused by the export of water through the SWP and established measures to offset impacts to Chinook salmon, striped bass and steelhead. The most relevant operational procedures of the agreement were:

1. DWR must maintain records of the numbers, sizes, and kinds of fish salvaged, water export rates, and SDFPF operations.
2. DWR must notify DFG well in advance of any scheduled outages, and at the time of unscheduled outages, if such outages might affect the effectiveness of the screens (louvers) at the SDFPF.
3. DWR will stop exporting water through the Banks Pumping Plant if the screens at the SDFPF become inoperative, unless there is an emergency situation and water is not available from any other source for direct deliveries or unless DFG determines that the adverse impact on fish is not sufficient to stop the pumping.
4. The SDFPF will be operated in conformance with mutually acceptable criteria to maximize protection of the Delta fishery.

<u>DWR/DFG Operations Agreement</u>

The DWR/DFG operations agreement for work conducted at the SDFPF has changed several times since the inception of the facility. When the SDFPF started salvage operations in 1968, DFG personnel implemented and directed all phases of the salvage operation (Hamilton 1971). Under the agreement, DFG's responsibilities included:

1. Overseeing the frequency and methods of collecting and counting.
2. Establishing methods and capacities for fish transport.

3. Selection and modification of fish release locations and equipment.
4. Sampling procedures
5. Record maintenance
6. Implementation of efficient flow velocities, volumes, and ratios.

All mechanical maintenance and operations at the facility were handled by DWR personnel. In 1977, DWR began taking complete responsibility for data gathering at the facility (DFG 1978). DFG retained responsibility for data storage, data analysis, publication of monthly and annual reports, monitoring the salvage program, and recommending changes needed to optimize efficiency at the facility.

In 1990, DFG and DWR began discussions and developed a proposal for DFG to assume responsibility for fish sampling and transporting fish at the SDFPF (IESP 1991). The primary reasons for these actions were that the quality of data from the program was inadequate, and the sampling level was going to double once the new holding tank building began operating. DWR did not have adequate staffing for the increased sampling. In 1992, DFG once again assumed all aspects of the sampling operations at the SDFPF, included transporting salvaged fish to release sites. DWR personnel were responsible for all mechanical maintenance and operations at the facility.

In 2000, DFG was experiencing problems of maintaining a full staff to conduct the sampling operations at the SDFPF. In early 2001, the DWR/DFG Operations Agreement was modified and the sampling operations were redirected to DWR. DWR assumed responsibility for all aspects of the sampling operation in addition to their responsibilities for all mechanical maintenance and operations at the facility. DFG continued to provide oversight and retained responsibility for the salvage data and reporting.

Standard Operating Procedures

The SDFPF uses a variety of pumps to maintain proper velocities, flows, and bypass velocity ratios in compliance with D1485 operational criteria. The Banks Pumping Plant controls the amount of flow passing through the primary channel, but the primary approach velocities at the primary louvers can be regulated by opening or closing bays through the use of the wing gates (Figure 4). The primary bypass velocity ratios are adjusted by using the return water pumps located at the downstream end of the secondary channels. The pumps are used to increase or decrease the flow in the secondary channels which at the same time adjusts the water velocity at the primary bypasses resulting in changes to the primary bypass velocity ratios. Similar operating procedures are used to change the secondary bypass velocity ratios, except effluent pumps at the holding tank buildings are used to adjust the flows into the holding tanks and the water velocity at the secondary bypasses.

Until the early 1990's all of the mechanical equipment (pumps, wing gates, bypasses, etc.) were controlled in the DWR SDFPF office through the use of a schematic control panel. The control panel had a schematic diagram of the water flow through the facility. The control panel was equipped with control buttons, control knobs, and gauges for operating the various types of mechanical equipment. From the early 1990's until present, the DWR workers have been operating the facility through a personal computer. Various computer screens are used to adjust pumps, control bypasses, and view the water depths, flows, and velocities. Primary approach velocities and primary bypass velocity ratios are automatically calculated once the primary flow (Banks pumping rate) is entered into the computer.

Salvage Estimation Process

The SDFPF salvages fish whenever the Banks Pumping Plant is exporting water. The facility can salvage fish into the old holding tank building, the new holding tank building or both buildings at the same time (Figure 4). If both building are being used, fish counts are conducted simultaneously in both buildings.

Routine fish counts are conducted every 2 hours and on the odd hour (0100, 0300, 0500, etc.). Not until the early 1990’s were fish counts conducted after every flow change in addition to the routine odd hour counts. Flow-change counts are necessary to accurately estimate the number of fish salvaged whenever there is an increase or decrease in the volume of water being pumped. Therefore, hourly counts at the SDFPF are not unusual and it is conceivable to conduct as many as 10 or 11 fish counts within a 12-hour period.

Fish counts are a sub-sample of a specific time period (1 hour, 2 hours, etc.) that the SDFPF salvages fish. Salvage estimates are calculated by multiplying the total number of fish (by species) by an expansion factor. The expansion factor is the value calculated by dividing the time interval salvaging fish by the sample time length. When both holding tank buildings are operating, the expansion factor is applied to fish counts in each building. The total salvage estimate is equal to the sum of the salvage estimates from each building. An example of estimating salvage for a 30-minute fish count conducted within a 2-hour period is calculated in the following example:

Time interval salvaging fish = 2 hours or 120 minutes

Sample time length = 30 minutes

$$\text{Expansion factor} = \frac{\text{Time interval salvaging fish}}{\text{Sample time length}} = \frac{120 \text{ minutes}}{30 \text{ minutes}} = 4$$

Total number of species # 1 = 45 x 4 (expansion factor) = 180
Estimated salvage of species # 1 = 180 fish

Total number of species # 2 = 170 x 4 (expansion factor) = 680
Estimated salvage of species # 2 = 680 fish

<u>Sample Time Length</u>

The sample time lengths have varied significantly. Sample time length has varied from 10 seconds when large numbers of fish were being salvaged to 24-hour counts (total count) in the winter months when fish abundance was extremely low. At one point in January 1972, the sample time length was changed from a 10 minute base to a 6 minute base to eliminate rounding off and yield salvage estimates in multiples of 10 (DFG 1973). In 1976, David Hughes (Department of Mathematics at the University of the Pacific) was asked to establish a minimum level of sampling effort required to achieve and maintain a desired level of precision (Dan Odenweller, personal communication, 2009). The minimum level of effort established was to sample 6.5 minutes during every 12 hours of salvaging fish to yield estimates with confidence intervals of ± 50 to 100% of the total fish salvage estimate, at the 80% confidence level (McEwan and Collins 1990). DFG initiated protocols for the sampling program in 1977, which required that the sample time length was no less than 1 minute and the total duration for all fish counts within a 12-hour period was no less than 6.5 minutes. From 1992 to 2001, DFG staff conducted fish counts ranging from as short as 1-minute when salvaging up to 100,000 fish per hour to as long as 6 hours when salvaging less than 1 fish per hour. Starting in 2001, DWR staff normally conducted 20-minute fish counts until 2008 when the USFWS Biological Opinion on the Long-Term OCAP required sampling a minimum 25% of the time from December through June for delta smelt. Currently, DWR staff normally samples 25% of the time throughout the calendar year.

<u>Fish Species Counts</u>

Currently, all fish collected during the routine fish counts at the SDFPF are identified to species. This has not always been the case. From 1968 to 1978, all fish were identified to species in each fish count. From 1978 to July 1992, fish species counts were routinely scheduled twice a day at the 0100 and 1300-hour fish counts. During that time period, fish species counts were also conducted at some flow changes (changes in pumping rates) and sometimes at other miscellaneous fish counts. If a particular fish species was collected outside of a fish species count, it was not recorded as being salvaged on that day. From July 1992 to the present, fish have been identified to species at every routine fish count.

<u>Fish Length Measurements and Frequency</u>

Over the past 40 years, the method by which fish length data has been recorded has changed significantly. Initially, all fish salvaged at the SDFPF were measured by total length and in 0.5 inch increments (0.5 inch and larger). In January 1973, measurements switched to the metric system. In 1975, fish continued to be measured by total length, but measurements were in millimeters and grouped in the following intervals:

10.0 mm, 10.0 – 12.5 mm, 12.5 – 15.0 mm, 15.0 – 17.5 mm, 17.5 – 20.0 mm, 20 – 25 mm, 25 – 30 mm, 30 – 40 mm, 40 – 50 mm, 50 – 75 mm, 75 – 100 mm, 100 – 125 mm, 125 – 150 mm, > 150 mm (DFG 1981).

Beginning in 1977, all fish length data were recorded as individual total lengths in millimeters. From the 1980's to the present, all fish length data were recorded as individual fork length measurements in millimeters. Until July 1992, fish length measurements were taken twice a day at 0100 and 1300 hours. From July 1992 to the present, fish measurements have been taken 4 times a day at 0300, 0900, 1500, and 2100 hours. During each length count, every salmon and steelhead is measured (mm FL) and checked for origin (wild or hatchery) by the presence or absence of the adipose fin. All delta smelt and longfin smelt are also measured. Up to 24 of all other fish species collected in the length count are also measured (mm FL).

Since the start of the SDFPF, DFG has been responsible for providing fish identification (ID) training, ID references, and fish ID QA/QC. Assistance with fish ID at the facility has included memo notifications of new species, keeping a collection of preserved fish specimens onsite, fish ID classes, and fish ID posters and handouts. DFG records show fish identification quality control samples taken by facility staff were checked from 1987 to 1990 and from 1993 to present. No records of quality control checks were found prior to 1987 in the available historical resources. Following the formal listing of delta smelt in 1995, much of the focus has been on proper identification of that species. Since 1995, delta smelt QAQC at the facility has ranged from verifying a sub-sample of all delta smelt collected during routine fish counts to verifying every delta smelt collected during routine fish counts.

Cleaning

DWR has a floating screen secured across the inlet to CCF where water is first diverted from West Canal and the Old River (Figure 2). Because of this screen, very little hyacinth ever enters the forebay. Any hyacinth or large floating debris that enters CCF and ends up at the SDFPF is deflected by the trash boom to the south side of the intake channel. DWR workers manually operate the conveyor which picks up the debris and deposits it into a trash container.

The trash rack collects debris (aquatic vegetation and smaller debris that passes under the trash boom) before it enters the SDFPF. Heavy accumulations of debris on the trash rack can lead to a number of problems. If heavy debris is not removed it could impede fish passage into the facility and it could create velocity problems within the primary channel.

The SDFPF utilized the same basic design of trash rack and cleaning system from 1968 until 2004. A DWR worker manually cleaned the trash rack using a cleaner that moved along a track across the bridge over the primary channel (Figure 10). During periods of heavy debris, it would take a worker (or 2 workers) several hours to clean the entire trash rack. These situations sometimes resulted in missed or postponed fish counts, because cleaning the trash rack to keep the facility operating took precedence over conducting fish counts.

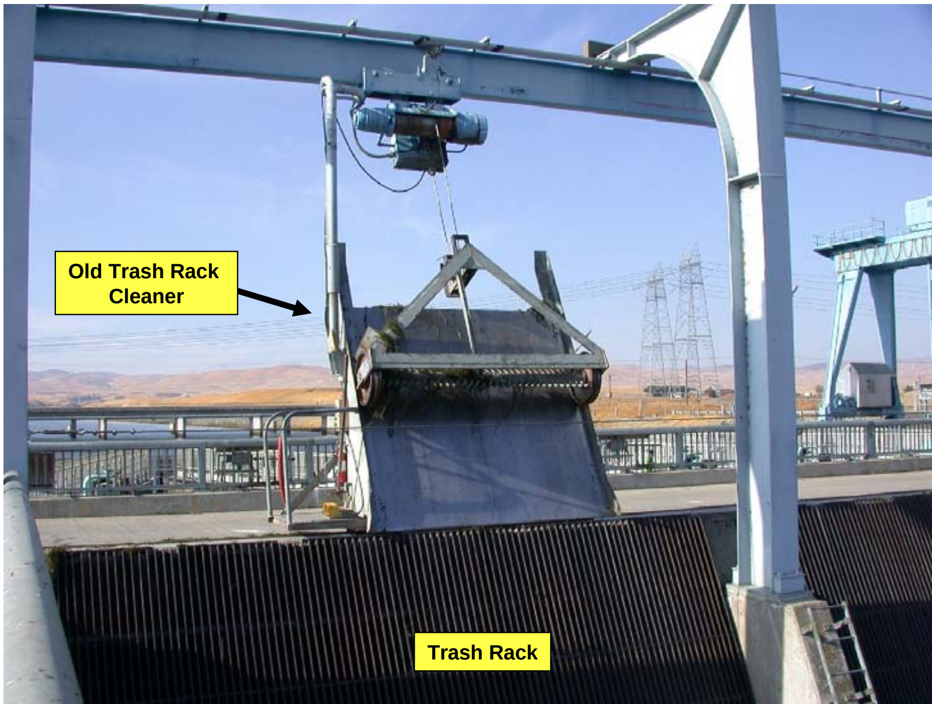

Figure 11 View of the old trash rack cleaner and old trash rack

In early 2004, DWR removed the old trash rack and cleaning system and contracted the installation of a new trash rack and automated cleaning system at the SDFPF (Figure 5). The automated cleaner can be set to clean continuously, on a timer, or at a set head differential on the trash rack. The cleaner is a dual system which uses 2 separate rake cleaners that move along an overhead track along the face of the trash rack. The rakes clean one bay at a time by grabbing the debris collected on the trash rack, lifting the debris above the trash rack, then depositing the debris into trash containers located on each side of the channel. The new automated system is a vast improvement over the old system, because it does not require a worker to be present and manually operating the cleaner.

The primary louvers are cleaned as needed. The primary louvers are cleaned on a more frequent basis whenever heavy debris loads are being collected on the trash rack. A gantry crane moves horizontally and vertically across the primary channel, and slowly lifts each louver panel one at a time for cleaning. As each panel is lifted, high pressure water jets are used to wash off debris from the louver. The DWR worker operating the gantry crane also uses a scraper to remove sponge material from the louver panel as it is being raised. The wing gates preceding the primary louvers can be closed during the louver cleaning process to reduce the risk of losing incoming fish through the louvers. This action, however, does not prevent large fish from entering the facility from the downstream side of the louvers when they are raised for cleaning.

The protocols for cleaning the secondary channel, secondary louvers (old channel), and secondary perforated plates (new channel) have changed considerably. The secondary channel was drained to a level of about 15 to 20 cm by closing the primary bypass valves and removing water from the channel using the return water pumps. After draining a secondary channel, debris was removed from the louver panels using a fire hose from above. Until the early 2000's, DWR or DFG workers climbed down into a drained secondary channel to remove the debris washed from the louvers. Debris was placed into a trash bucket which was lifted from the channel using a gantry crane. Starting in the early 2000's, the secondary channel was considered a confined space, and only workers trained on confined space were allowed to enter the channel. Necessary safety protocols were established for entrance into the secondary channel. Currently, DWR workers hose down the louvers in the old secondary channel, but do not enter the channel.

Predator Removals – Secondary Channels

Predator removals are currently conducted on a more frequent basis, but they are not as thorough as removals conducted in the past. Prior to the early 2000's, the secondary channel was drained to a level of about 15 to 20 cm by closing the primary bypass valves and removing water from the channel using the return-water pumps. The DWR or DFG workers climbed down into the secondary channels, netted all fish remaining in the channel, and removed the fish from the channel. The collect valve and drain were opened in an empty holding tank in the holding tank building (new building for old secondary and old building for new secondary) before opening the primary bypass valves. Surging water from the bypass pipes flushed fish from the secondary channel into the receiving holding tank for approximately 5 minutes. The collect valve and drain for the receiving holding tank were shut down leaving the flushed fish in the holding tank. The tank was drained and the fish were processed. All fish were identified to species, counted, and up to 50 fish of each species were measured (mm FL).

Starting in the early 2000's, the secondary channels were considered a confined space which changed the predator removal protocols. The basic predator removal procedures remained the same as the past, but workers did not enter the secondary channel to remove fish. Therefore, some of the larger predators which are not removed from the drained channel may have never made it into the receiving holding tank. Large predatory fish have the ability to swim and maintain their position against the high water velocities used to flush fish out of the secondary channels. Currently, all fish are counted in the predator removal, but only predatory fish ≥ 150 mm FL are measured.

III. EQUIPMENT CHANGES

Addition of the New Holding Tank Building

The addition of a second holding tank building was a result of DWR installing four additional pumps at the Banks Pumping Plant. Before the new holding tank building was operable, 6,400 cfs was the highest pumping rate that the Banks Pumping Plant could pump and still have the SDFPF operate within compliance with SWRCB D1485 operating criteria. The new holding tank building was completed and started salvaging fish in May 1992. Once the new holding tank building was added, the Banks Pumping Plant had the potential to pump at a rate of 10,300 cfs.

Trash Boom and Trash Rack

No major changes to the trash boom since the inception of the SDFPF were found while researching the available historical resources. See "Cleaning" section on page 22 for changes in the trash rack and cleaner.

Primary Louvers, Bypass Transition Boxes, and Bypass Pipes

Until 1981, the SDFPF used 2 louver bays (smaller bays 1, 2, 3a, and 3b) in the primary channel to guide fish into 2 primary bypasses (Figure 4). The remaining 2 louver bays (smaller bays 4a, 4b, and 5) were completed as part of the Phase II construction during 1981 (DFG, 1982). Other than adjustments made to the louver panels after installation, there have not been any changes to the louver panels. Following the failure of the center wall between smaller bays 4a and 4b in 2001, all center walls were removed and replaced. No major changes to the primary transition boxes and the primary bypass pipes were found while researching the available historical resources.

Secondary Channels and Louvers/Perforated Plates

The old secondary channel was the first secondary channel to be installed at the SDFPF. The old channel uses a single series of louver panels to guide fish into secondary bypasses. Although the basic design of the louver system has not changed since inception of the facility, a set of specially-fabricated steel flow straighteners was installed in the transition area of the secondary channel in January 1971. The straighteners were used to eliminate turbulence as water passed from a smaller (bypass pipe) to larger (secondary channel) volumetric area (DFG 1972). The old secondary channel was used to direct fish into the old holding tank building until 1992, when the new holding tank building came online. From 1992 until the present, the old secondary channel has been primarily used to direct fish into the new holding tank building.

The new secondary channel was under construction as part of Phase II in 1982 (DFG 1984). The construction included using perforated plate panels instead of louvers to guide fish into the secondary bypasses. The new secondary channel was completed and operable in July 1983 (DFG 1985). During the mid-1980's, DWR used both the new and the old secondary channels at the same time while salvaging fish in the old holding tank building. In 1987, DFG conducted testing to evaluate the effect of operating both secondary channels on fish counts (DFG 1987). Results of the testing showed that the fish counts were inaccurate when using both secondary channels at the same time to guide fish into the old holding tank building. Analysis suggested that the fish counts were underestimating by approximately 25% which could lead to overloading the fish trucks. DFG recommended correcting the salvage estimates for this bias whenever both secondary channels were used at the same time in order to prevent overloading the fish trucks.

Problems with debris (primarily *Egeria densa*) in the early 2000's initiated the need to design and fabricate traveling debris screens for both the old and new secondary channels. The design of the screens was patterned after the experimental crab/debris screen used at the USBR's Tracy Fish Collection Facility. Although the traveling debris screens at the SDFPF were completed in the summer of 2006, they have not been used during normal salvage operations.

De-Watering Pumps and Effluent Pumps

Replacement and refurbishment of de-watering pumps in the secondary channels and effluent and de-watering pumps for the holding tank buildings appears to be a common practice at the SDFPF. This is not unusual for pumps that sometimes operate on a 24/7 basis. DWR maintenance records for the past decade shows such repairs as refurbishment of pumps, replacement of pump motors, and replacement of pump electronic drive units.

Holding Tanks and Holding Tank Screens

The screen for the first holding tank in the old holding tank building was removed for cleaning in November 1971. The galvanized screen mesh was extremely corroded and up to 50% of the mesh openings were blocked. The screen was sandblasted to clean the corrosion and blocked openings. This process not only removed the galvanized coating from the wire mesh cloth, but also removed a significant amount of corroded metal from the sections which had been submerged in water. The loss of the additional amount of metal increased the mesh openings beyond specifications. Therefore, the screen mesh was inverted so that the end of the screen in better condition was on the bottom end submerged in water. The water levels in the holding tanks were maintained below the middle of the screen height under previous normal operating conditions, so the top half of the screen was not submerged in water.

The holding tank screens in the old building were re-screened from 5x5-galvanized wire mesh (0.092-inch diameter wire) to 7x7-galvanized wire mesh (0.054-inch diameter wire) in the spring of 1985 to minimize the losses of small striped bass (Raquel 1986). The change in mesh increased the percent open area for each screen from 29.4% to 38.7%. Holding tank screen evaluations were conducted over a variety of pumping rates, holding tank flows, and depths looking at catch rates of young striped bass (≤ 35 mm FL). Overall, the evaluations resulted in no significant differences between the size and the collection rate of striped bass in the small-mesh and large-mesh cylinder screens (IESP 1987). In the mid-1990's, DWR changed the galvanized screen mesh on all of the holding tank screens in the old building to stainless steel mesh.

DWR began using the new holding tank building in 1992. The holding tank screens in the new building were fabricated using 8x8 stainless steel mesh cloth (0.047-inch diameter wire). The percent open area for each screen in the new building is approximately 38.9%. No changes have been made to the screens since they were installed.

Fish Count Station and Fish Count Bucket

The basic design of the fish count station has essentially remained the same over the years of operation except for the count station screen used to reduce the volume of water and concentrate the fish into the 5-gallon count pan. The original screen design used 5x5 galvanized steel wire mesh wrapped around the perimeter of the screen. Through the years of operation, the screen would periodically collapse from the weight of the count bucket being lowered onto the screen. In an attempt to alleviate this problem, DWR workers replaced the wire mesh screens in both holding tank buildings with sections of PVC pipe. The sections of pipes were perforated by drilling 3.2 mm holes around the perimeter of the pipe for draining. Although the new screens have been more durable than the old screens, the new screens have not been tested for retention of small fish.

The design of the 90-gallon fish count bucket has remained the same since the SDFPF started salvaging fish. Over the years, the solid rubber ball valve used to retain the water and fish in the bucket has had to be re-aligned or replaced whenever the ball valve was not creating a tight seal. Repairs have been made to the upper lip of the count bucket whenever it showed signs of warping.

Load (Haul-Out) Bucket and Fish Trucks

Much like the fish count bucket, the design of the 500-gallon load bucket used to transfer fish into the fish trucks has remained the same over the years. Over the years, the solid rubber ball valve used to retain the water and fish in the load bucket has had to be re-aligned or replaced whenever the ball valve did not create a tight seal. Similar to the count bucket, the load bucket has been repaired periodically whenever the upper lip of the bucket showed signs of warping.

Two 1,200-gallon capacity fish trucks were used to transport salvaged fish to the SWP release sites when the SDFPF began salvaging fish in 1968 (DFG 1970). The trucks were equipped with an aeration system (air pump) and a refrigeration system. In 1971, one of the 1,200-gallon fish trucks was replaced with a 2,000-gallon capacity truck also equipped with aeration and refrigeration. The 2,000-gallon capacity fish truck was originally delivered to the facility as a 2,500-gallon capacity truck. Problems with exceeding the legal gross weight limit when the truck tank was at full capacity, resulted in reducing the tank capacity to 2,000 gallons. The refrigeration units on the trucks were removed in 1975 because of problems with acclimating the salvaged fish hauled in the trucks to the receiving waters at the release sites (Dan Odenweller, personal communication, 2009). In the early 1980's, DWR used a 600-gallon capacity fish truck and in 1986, the 2,000-gallon fish truck was replaced with a 1,200-gallon capacity fish truck. In 1989, DWR acquired a new 2,500-gallon fish truck. The truck was designed to also serve as a water truck which later presented problems whenever DWR needed to use the truck as a water truck at the same time that fish needed to be transported. Throughout the 1990's, DWR used the 1,200-gallon capacity fish truck in addition to the 2,500-gallon fish truck to transport fish. DWR purchased a new 2,800-gallon fish truck in 2000 in addition to the existing 2,500-gallon fish truck. Upon arrival of the 2,800-gallon fish truck, the 1,200-gallon fish truck was removed from daily service and only used for emergencies. The SDFPF used the 2,800-gallon fish truck as the primary truck and the 2,500-gallon fish truck as a backup until the spring of 2010. DWR purchased and received two 3,500-gallon fish trucks in November 2009, and began using the new trucks to haul fish in the spring of 2010.

Fish Release Sites

The SDFPF has used 2 primary fish release sites throughout its years of operation to return salvaged fish back to the Delta. The release sites are located on Sherman Island at Horseshoe Bend off the main stem of the Sacramento River and at Curtis Landing which is located on the San Joaquin River east of the Antioch Bridge (Figure 1). In 1969, DWR used 7 alternate sites to release fish during the first half of the year because of the flood on Sherman Island. Unlike the 2 currently used permanent sub-surface release sites, the alternate sites used surface releases because they were primarily boat ramps. From 1968 through the 1980’s, DWR was under a cooperative agreement with USBR to access and use their fish release sites. The fish release sites at Horseshoe Bend and Curtis landing were originally designed whereby the fish truck backed up to the release pipe. The release sites were later modified where the fish trucks parked at a right angle to the release pipe, resulting in releasing fish at a 90° angle. DWR currently releases fish at a 90° angle at both the Horseshoe Bend and Curtis Landing release sites. DWR did not have a cooperative agreement with USBR to use their fish release sites from the 1980’s through 2009. In the spring of 2010 DWR established a cooperative agreement with USBR to use their fish release sites while DWR was modifying the Horseshoe Bend and Curtis Landing release sites to accommodate the new 3,500-gallon fish trucks.

IV. PERSONNEL CHANGES

DWR has always been the agency responsible for all mechanical maintenance and operations at the SDFPF since 1968. Likewise, DFG has always been responsible for data storage, data analysis, publication of monthly and annual reports, and oversight of the fish salvage program. The responsibility for conducting the fish counts and transporting fish has changed hands between DWR and DFG several times. DFG personnel conducted the routine fish counts while DWR personnel transported fish to the release sites from 1968 to 1977. During 1976, the administrative responsibility of the SDFPF was transferred from DFG Region 2 to the Bay-Delta Fishery Project (DFG 1977). DWR took over the responsibilities of the fish counts and transporting fish in October 1977 and continued with those duties before handing back the responsibilities back to DFG in 1992. The routine fish counts and transporting fish were the responsibilities of DFG until 2001. From 2001 until present, DWR has conducted the routine fish counts and transported salvaged fish to the release sites in addition to being responsible for all mechanical maintenance and operations at the facility.

V. TOP 10 CHANGES THAT MAY HAVE IMPACTED SALVAGE COUNTS

Many operational and structural changes have occurred at the SDFPF since it began salvaging fish in 1968. Some of these changes may have impacted the salvage counts. The top 10 changes or factors that may have impacted salvage counts at the SDFPF are listed below:

1. <u>Change in diversion point (intake) – operational change</u>

DWR diverted water from Italian Slough when the SDFPF first started operations in 1968. CCF was constructed and completed as a storage reservoir to supply water to the Banks Pumping Plant for continuous pumping in 1969. The ability to pump continuously has increased the numbers of fish salvaged at the SDFPF. Conversely, the creation of CCF has also affected salvage numbers by increasing pre-screening losses. The forebay created habitat for both fish and avian predators to forage. DFG conducted mark/recapture experiments at CCF using juvenile Chinook salmon and striped bass from October 1976 through November 1993 (Gingras 1997). Pre-screen loss estimates for the series of experiments ranged from 63 to 99%. Although pre-screen loss within the Italian Slough intake channel was never investigated, it is presumed less than the pre-screen loss in CCF.

2. <u>Fish ID</u>

Proper fish identification can affect the estimated salvage of fish (by species) at the SDFPF. The levels of ability to properly identify fish have varied over the years for staff conducting the fish counts at the SDFPF. The facility has been staffed with workers ranging from a maintenance background whose primary responsibility was to keep the facility operating to those with a science background whose primary responsibility was to collect quality data on fish salvaged at the facility.

3. Species counts – Operational change

Changes in the frequency of fish species counts conducted may have affected the reported number of each fish species salvaged at the SDFPF. The frequency of conducting fish species counts has ranged from every fish count down to only 2 fish species counts per day. Obviously, the most accurate method of identifying the fish species salvaged at the facility is to conduct fish species counts at every fish count. When fish species counts were only conducted twice a day, the assumption was made that those 2 fish species counts were representative samples of the fish species salvaged during each 12-hour period. If a particular fish species is collected outside of the 2 fish species counts, there would not be a record of that species ever being salvaged on that day.

4. Fish count duration – operational change

The fish count duration has varied significantly from 1968 to 2009 at the SDFPF. The fish count durations have ranged from as short as 10 seconds to counts as long as a day. Throughout the mid-1970's, 15-, 30-, and 60-second fish counts were common during the summer and early-fall months when fish salvage was high. The longer the fish count, the more accurate the salvage estimate will be, because of the lower expansion factor. Currently, DWR conducts 30-minute fish counts every 2 hours from December through July. Therefore, salvage estimates are calculated by multiplying the fish numbers from the fish count by an expansion factor of 4 (for each holding tank building in use). A 10-second fish count, on the other hand, has an expansion factor of

720. The short fish counts can affect the fish salvage numbers in 2 ways. The large expansion factor can overestimate salvage estimates for abundant species and shorter counts can easily miss rare fish species.

Changes 2-4 listed above can each individually affect the reporting or accuracy of fish salvage estimates, but they can also have an even greater effect when combined. If a fish was misidentified during a 15-second fish count (within a 2-hour period), the misidentified fish would have been multiplied by an expansion factor of 480. If that count happened to be a fish species count when only 2 counts were conducted each day, the misidentified fish would have been expanded proportionally throughout the 12-hour period.

5. <u>Changes in staff levels conducting the sampling and transport of fish</u>

The normal level of staff conducting the fish counts and transporting fish at the SDFPF through 1992 varied from 1 permanent scientific technician and 1 temporary scientific technician conducting fish counts and 1 permanent maintenance worker transporting fish to just 1 permanent scientific technician or permanent maintenance worker conducting fish counts and hauling fish by themselves. When one individual was responsible for fish counts and fish hauls, fish counts were missed from time to time due to the fish haul or multiple hauls. The accuracy of fish counts also suffered when only 1 worker conducted fish counts during peak salvage periods. In the early 1990’s it wasn't unusual for the SDFPF to salvage up to 200,000 fish in 2 hours during the peak summer months. In 1993, DFG started hiring temporary scientific technicians to help the permanent Skinner staff with the fish counts. When the fish salvage duties were redirected to DWR in 2001, each work shift was staffed with a minimum of 2 permanent maintenance workers.

6. <u>Fish collection valve – potential sampling bias</u>

Fish and water are transported from the secondary channels through secondary bypass pipes to the holding tank buildings. The bypass pipes run parallel to the rows of holding tanks in each holding tank building while holding tank influent pipes run off of the bypass pipes into the holding tanks (Figure 12). The valve used to open and close the flow of water into the tank is set back approximately 2 feet from the junction of the main secondary bypass pipe and the holding tank influent pipe (Figure 12). Small fish, during periods of high salvage, can accumulate in the area of dead water between the valve and the secondary bypass pipe. When the valve is opened at the start of a fish count, the fish holding up in this area enter the tank and could bias the count high when used for short count times (McEwan and Collins 1990).

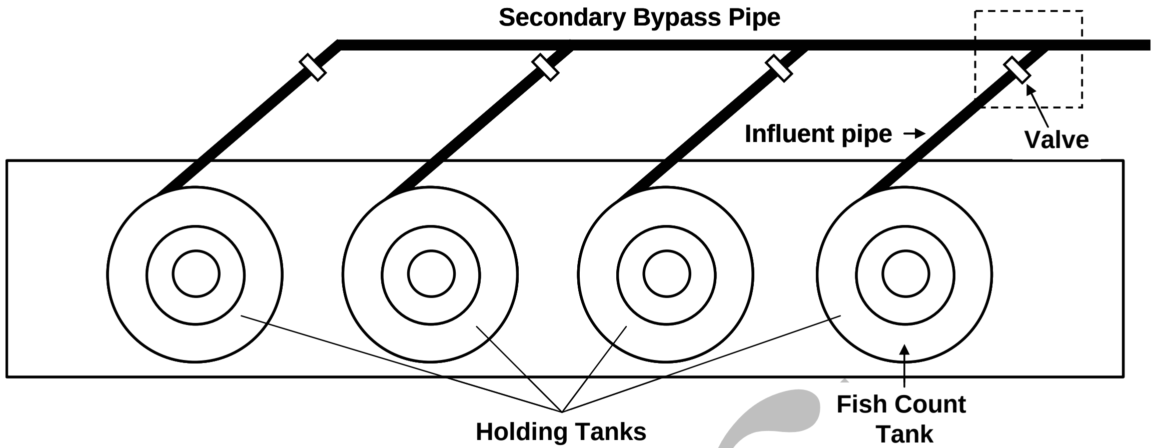

Figure 12 Schematic of the SDFPF's old holding tank building showing location of valve on the holding tank influent pipe (features not to scale)

7. <u>Addition of four pumps to the Banks Pumping Plant – structural change</u>

By 1992, DWR had installed 4 new pumps at the Banks Pumping Plant. The additional pumps increased their pumping capacity from 6,400 to 10,300 cfs. Fish salvage at the SDFPF is normally directly proportional to the pumping rate at the Banks Pumping Plant (more so when pumping at night). Therefore, increasing the pumping rates increases the numbers of fish salvaged. Figure 13 shows a sudden increase in fish salvage at the SDFPF after the 4 new pumps were in operation at the Banks Pumping Plant.

8. <u>Addition of the new secondary channel and new holding tank building – structural change</u>

The new secondary channel was constructed in 1982 and was tested and ready for use in 1983. The new secondary channel uses series of perforated plates (4 mm openings) to guide fish into the secondary bypasses instead of louvers. Fish are much less likely to pass through the perforated plates than they are with the louver panels. While the new secondary does a better job at retaining fish it has velocity problems which can delay some fish from entering the secondary bypass. While operating under "striped bass criteria" (D1485), fish tend to hold up in the channel, becoming more vulnerable to predation within the channel. The new holding tank building was constructed to salvage fish from newly constructed primary bays as part of the Phase II expansion when 4 new pumps were added to the Banks Pumping Plant. DWR started using the building for salvaging fish in 1992. The new building allowed DWR to export water at higher pumping rates (6,780 to 10,300 cfs) and at the same time comply with D1485 operating criteria. The installation of the new holding tank building has affected total fish salvage by enabling the facility to salvage more fish due to the higher pumping rates.

9. <u>Regulatory standards – operation change</u>

Regulatory standards (i.e. Biological Opinions, incidental take permits, etc.) have affected the numbers of fish salvaged at the SDFPF in different ways. When DWR is taking ESA-listed fish species during the routine fish counts, it affects how DWR operates CCF and the Banks Pumping Plant. The operation of the pumping plant can change whereby the pumping rate is reduced or pumping is shut down entirely. Both cases will affect the numbers of fish salvaged at the SDFPF. DWR will also tend to shift pumping from night to day pumping to avoid take of ESA-listed fish species. This dramatically affects salvage numbers since most fish are salvaged at night and very few are salvaged during the day. Radial gate operations at CCF have also changed during periods when listed fish species are in the south Delta. Rather than opening gates to the fully open position to draw water into the forebay, the gates will at times only be slightly opened. This practice of slowly letting water into the forebay (sipping method) has been used off and on over the past decade.

10. <u>New trash rack and automated cleaner – structural change</u>

The SDFPF used the same trash rack and cleaning system from 1968 until 2004. Until 2004, cleaning the trash rack involved a DWR worker (or multiple workers) manually operating the cleaner and spending from several hours to the better part of a work shift at the trash rack. The more time spent cleaning the trash rack meant less time conducting fish counts. Many times, fish counts would be missed or delayed. Missing or delaying a fish count meant estimating salvage across a longer period of time (more than 2 hours) which lowers the accuracy of the salvage estimate. Debris, such as *Egeria densa*, collected on the face of the trash rack can also inhibit fish from entering the facility which would make them more vulnerable to predation in front of the trash racks. Severe buildup of debris on the trash rack can also affect approach velocities making the primary louvers less efficient. The new automated trash rack cleaner allows the DWR workers more time to conduct fish counts. The new system also has 2 rake cleaners that can clean the face of the trash rack in a shorter period of time than manual cleaning.

VI. TIMELINE OF HISTORICAL EVENTS AT THE SDFPF

Month – Year	**Event or Change**
March 1968	DWR started exporting Delta water through the Italian Slough intake and began salvaging fish at the SDFPF. The facility salvaged fish through 2 primary louver bays and bypasses into 1 secondary channel and 1 holding tank building. Under the DFG/DWR Operations Agreement, DFG staff was responsible for fish salvage and DWR staff was responsible for transport of salvaged fish to release sites and operations and maintenance of the SDFPF. All fish were identified to species in each fish count. All fish were measured by total length and in 0.5-inch increments.
November 1969	DWR breeched the Clifton Court Forebay levee and began exporting Delta waters through the forebay instead of Italian Slough.
January 1972	Fish count duration was changed from a 10-minute base to a 6-minute base to eliminate rounding off and yield salvage estimates in multiples of 10.
January 1973	Fish measurements switched to the metric system.
1975	Fish continued to be measured by total length, but measurements were in millimeters and grouped in intervals from 10 mm to > 150 mm.
October 1977	DWR takes over fish salvage responsibilities at the SDFPF from DFG. DWR continues the responsibility of

	transporting salvaged fish to release sites and operations and maintenance of the facility.
1978	Starting in 1978, fish were identified to species only twice a day at the 0100 and 1300-hour fish counts.
August 1978	State Water Resources Control Board (SWRCB) issued their Water Rights Decision 1485 (D1485). It established operating criteria for the SDFPF.
1981	Two new primary louver bays (including 2 new primary bypasses) were completed as part of the Phase II expansion.
July 1983	The new secondary channel was completed and available for use.
Spring 1985	The holding tank screens in the old building were re-screened from 5x5-galvanized wire mesh (0.092-inch diameter wire) to 7x7-galvanized wire mesh (0.054-inch diameter wire) to minimize the losses of small striped bass.
December 1986	The DWR/DFG Four Pumps Agreement was established to offset impacts to Chinook salmon, striped bass and steelhead caused by the export of water through the SWP.
April 1992	DFG took over fish salvage responsibilities at the SDFPF from DWR including transport of salvaged fish to release sites. DWR continued to be responsible for operations and maintenance of the facility.

June 1992	DWR started using the new holding tank building at the SDFPF.
July 1992	Started identifying fish to species at every routine fish count. Began taking fish measurements 4 times a day at 0300, 0900, 1500, and 2100 hours.
August 1992	DWR began using the 4 new pumps at the Banks Pumping Plant for exporting water.
February 1993	National Marine Fisheries Service (NMFS) issued a Biological Opinion to minimize the take of winter-run Chinook salmon at the water projects. Required fish hauls every 12 hours when salvaging winter-run.
March 1995	U.S. Fish and Wildlife Service (USFWS) issued a Biological Opinion to minimize the take of delta smelt and splittail at the water projects. Required fish hauls every 8 hours when salvaging delta smelt.
Mid – 1990's	DWR replaced galvanized mesh holding tank screens to stainless steel mesh screens in the old holding tank building.
March 2000	NMFS issued a Biological Opinion to minimize the take of Central Valley spring-run Chinook salmon and Central Valley steelhead at the water projects.
April 2000	The Vernalis Adaptive Management Plan was initiated as part of the SWRCB Decision 1641 to protect Chinook salmon migrating from the San Joaquin River through the

	Sacramento-San Joaquin Delta. Resulted in minimal export pumping during VAMP period.
February 2001	DWR took over fish salvage responsibilities at the SDFPF from DFG including transport of salvaged fish to release sites. DWR continued to be responsible for operations and maintenance of the facility.
2004	DWR replaced the old trash rack and manual cleaning system to a new trash rack and automated cleaning system.
December 2008	USFWS issued a Biological Opinion on the Long-Term Operational Criteria and Plan to minimize take of delta smelt at the water projects. Required sampling 25% of time for delta smelt from December through July.
February 2009	DFG issued a California Endangered Species Act Longfin Smelt Incidental Take Permit No. 2081 to minimize take of longfin smelt at the SWP.

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F. GLOSSARY OF TERMS

Approach Velocity - The mean velocity of water in the channel approaching the louvers.

Bypass Velocity Ratio – The value calculated by dividing the velocity of water at the primary or secondary bypass opening by the appropriate approach velocity.

Entrainment - A term used to define organisms, such as fish, that are drawn into the influence of a project (i.e. SWP), and subjected to loss while in the facility.

Fish Count – The actual number of fish counted in the systematic counts. Fish counts are a sub-sample of defined period of time.

Salvage Estimate - The value calculated by multiplying the total number of fish (by species) by an expansion factor. The expansion factor is the value calculated by dividing the total minutes salvaging fish by the length of the fish count.

G. APPENDIXES

Appendix A State Water Resources Control Board Decision 1485 Table II

Table II
DECISION 1485
WATER QUALITY STANDARDS
FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH 1/

FISH PROTECTIVE FACILITIES

Maintain appropriate records of the numbers, sizes, kinds of fish salvaged and of water export rates and fish facility operations.

STATE FISH PROTECTIVE FACILITY

The facility is to be operated to meet the following standards to the extent that they are compatible with water export rates:

(a) King Salmon — from November through May 14, standards shall be as follows:
  (1) Approach Velocity — 3.0 to 3.5 feet per second
  (2) Bypass Ratio — maintain 1.2:1.0 to 1.6:1.0 ratios in both primary and secondary channels
  (3) Primary Bay — not critical but use Bay B as first choice
  (4) Screened Water System — the velocity of water exiting from the screened water system is not to exceed the secondary channel approach velocity. The system may be turned off at the discretion of the operators.

(b) Striped Bass and White Catfish — from May 15 through October, standards shall be as follows:
  (1) Approach Velocity — in both the primary and secondary channels, maintain a velocity as close to 1.0 feet per second as is possible
  (2) Bypass Ratio
    (i) When only Bay A (with center wall) is in operation maintain a 1.2:1.0 ratio
    (ii) When both primary bays are in operation and the approach velocity is less than 2.5 feet per second, the bypass ratio should be 1.5:1.0
    (iii) When only Bay B is operating the bypass ratio should be 1.2:1.0
    (iv) Secondary channel bypass ratio should be 1.2:1.0 for all approach velocities.
  (3) Primary Channel — use Bay A (with center wall) in preference to Bay B
  (4) Screened Water Ratio — if the use of screened water is necessary, the velocity of water exiting the screened water system is not to exceed the secondary channel approach velocity
  (5) Clifton Court Forebay Water Level — maintain at the highest practical level.

TRACY FISH PROTECTIVE FACILITY

The secondary system is to be operated to meet the following standards, to the extent that they are compatible with water export rates:

(a) The secondary velocity should be maintained at 3.0 to 3.5 feet per second whenever possible from February through May while salmon are present

(b) To the extent possible, the secondary velocity should not exceed 2.5 feet per second and preferably 1.5 feet per second between June 1 and August 31, to increase the efficiency for striped bass, catfish, shad, and other fish. Secondary velocities should be reduced even at the expense of bypass ratios in the primary, but the ratio should not be reduced below 1:1.0

(c) The screened water discharge should be kept at the lowest possible level consistent with its purpose of minimizing debris in the holding tanks

(d) The bypass ratio in the secondary should be operated to prevent excessive velocities in the holding tanks, but in no case should the bypass velocity be less than the secondary approach velocity.

FOOTNOTES

1/ Except for flow, all values are for surface zone measurements. Except for flow, all mean daily values are based on at least hourly measurements. All dates are inclusive.

2/ Footnote 2 is set forth on next sheet.

3/ When no date is shown in the adjacent column, EC limit in this column begins on April 1.

4/ If contracts to ensure such facilities and water supplies are not executed by January 1, 1980, the Board will take appropriate enforcement actions to prevent encroachment on riparian rights in the southern Delta.

5/ For the purpose of this provision firm supplies of the Bureau shall be any water the Bureau is legally obligated to deliver under any CVP contract of 10 years or more duration, excluding the Friant Division of the CVP, subject only to dry and critical year deficiencies. Firm supplies of the Department shall be any water the Department would have delivered under Table A entitlements of water supply contracts and under prior right settlements had deficiencies not been imposed in that dry or critical year.

6/ Dry year following a wet, above normal or below normal year.

7/ Dry year following a dry or critical year.

8/ Scheduled water supplies shall be firm supplies for USBR and DWR plus additional water ordered from DWR by a contractor the previous September, and which does not exceed the ultimate annual entitlement for said contractor.

NOTE: EC values are mmhos/cm at 25°C.