

# Appendix H. Operational Procedures for Willow Slough Weir and Weir No. 2

## Part 1: Operational Procedures for Willow Slough Weir

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### 1. Introduction

Willow Slough Weir is located in Sutter County along the East Borrow Canal (EBC) of the Sutter Bypass at its junction with Willow Slough, just downstream of the Sacramento Avenue Bridge over the EBC.

Willow Slough Weir is owned and operated by the Department of Water Resources (DWR). The purpose of the weir is to maintain the necessary water surface elevation in the EBC required for irrigation. Willow Slough Weir is designed as an earthen dam with four 60-inch corrugated metal pipe culverts and a Pool and Chute fish ladder with slide gates that control flow from the lower end of the EBC into Willow Slough (figure H1).

The Pool and Chute fish ladder design features a 4-foot wide rectangular weir in the center of each baffle and two 20-inch square orifices located at the bottom of each baffle (figure H2). The entire fish ladder is 89 feet long and consists of 9 baffles and a headgate structure. The fish ladder headgate structure consists of two 4-foot wide by 6-foot tall slide gates located symmetrically on each side of the headwall and one 5-foot wide by 7-foot tall weir located in the center (figure H3).

### 2. Objective

The primary objectives of the Operational Criteria are to provide for fisheries protection and maintain high fish passage efficiency. Willow Slough Weir maintains a water surface elevation in the EBC ranging between 27.5 feet and 29.5 feet U.S. Engineering Datum (USED).

The primary operations for the fish ladder will be to maintain a maximum of a 1-foot drop between pools. Adjustments can be made by removing or replacing boards in the weir sections, adjusting the headgate configuration and/or closing the orifices. Both headgates should be operated in tandem to minimize turbulence in the fish ladder. However, operating one headgate is acceptable as the flows decrease and both headgates have been lowered to a minimum of 12 inches, as per DFG and NOAA Fisheries recommendation.

The very first and last adjustments will be made at the fish ladder. When the headgates are wide open and the stage in the EBC continues to rise, further adjustments will be made with the culverts. As the stage in the EBC lowers, the culverts will be closed off and both headgates can be lowered to a minimum

opening of 12 inches which provides a flow of approximately 45 cfs. As the stage continues to lower, one headgate will be closed and the other headgate will remain open 12 inches for a flow of approximately 23 cfs. As the flows are further reduced, both headgates are closed completely and the 5-foot wide center weir in the headgate structure will provide flow of about 17 cfs down to 6 cfs into the fish ladder.

As the flow decreases from approximately 100 cfs down to 40 cfs through the fish ladder, flashboards will be placed in the 4-foot wide weirs in each of the 9 baffles in order to maintain a maximum of 1-foot drop per pool. As the flow in the fish ladder drops below 40 cfs or plunging flow over the weir crest becomes less than .5-feet deep, orifices need to be closed. With the orifices closed, the fish ladder operates as a step pool style fishway instead of a Pool and Chute fishway. Under most flow conditions, most of the fish passage likely occurs in the orifices; therefore, closing the orifices should be the last adjustments made to the fish ladder.

### 3. Basis of Operating Criteria

The operational schedule is set by the run timing of salmonids into the Lower Butte Creek system. Spring-run Chinook salmon adults enter and migrate through the system anytime from January through June, with the peak of the run from early February through early May. Fall-run Chinook salmon adults are in the system anytime from summer to late fall with the peak run from September through November. Adult Central Valley steelhead are likely to migrate into and through the system anytime from fall through spring. In summary, salmon and steelhead adults are most likely present in the system from September through June.

Juvenile salmon and steelhead travel downstream through the Lower Butte Creek system from November through June. In order to provide safe downstream fish passage during this time, the 5-foot wide center weir in the headgate structure should be left open.

#### 4. Operation Criteria

The primary operation criterion is to maintain a maximum of 1-foot head differential between pools by adjusting boards in the 4-foot wide center weirs.

##### Steps to take for High Water (greater than 29.5 ft USED)

- The first adjustments to be made are at the fish ladder
- With the fish ladder headgates and orifices wide open, adjustments thereafter are first at culvert gates 3, 2, 4 then 1.

##### Steps to take for Low Water (lower than 27.5 ft USED)

- The first adjustments to be made are at the culverts. Culvert gates 1, 4, 2 then 3 will be closed.
- With the all the culvert gates closed, adjustments thereafter are at the fish ladder.
  - Both headgates will be operated in tandem. Headgates can be closed to a minimum opening of 12 inches.
  - With both headgates open 12 inches, close all orifices to maintain adequate pool depths.
  - With orifices closed, close one headgate and leave other headgate open 12 inches.
  - With one headgate closed, open 5-foot wide weir and close other headgate.

Figure H1. Plan View of Willow Slough Weir Structure

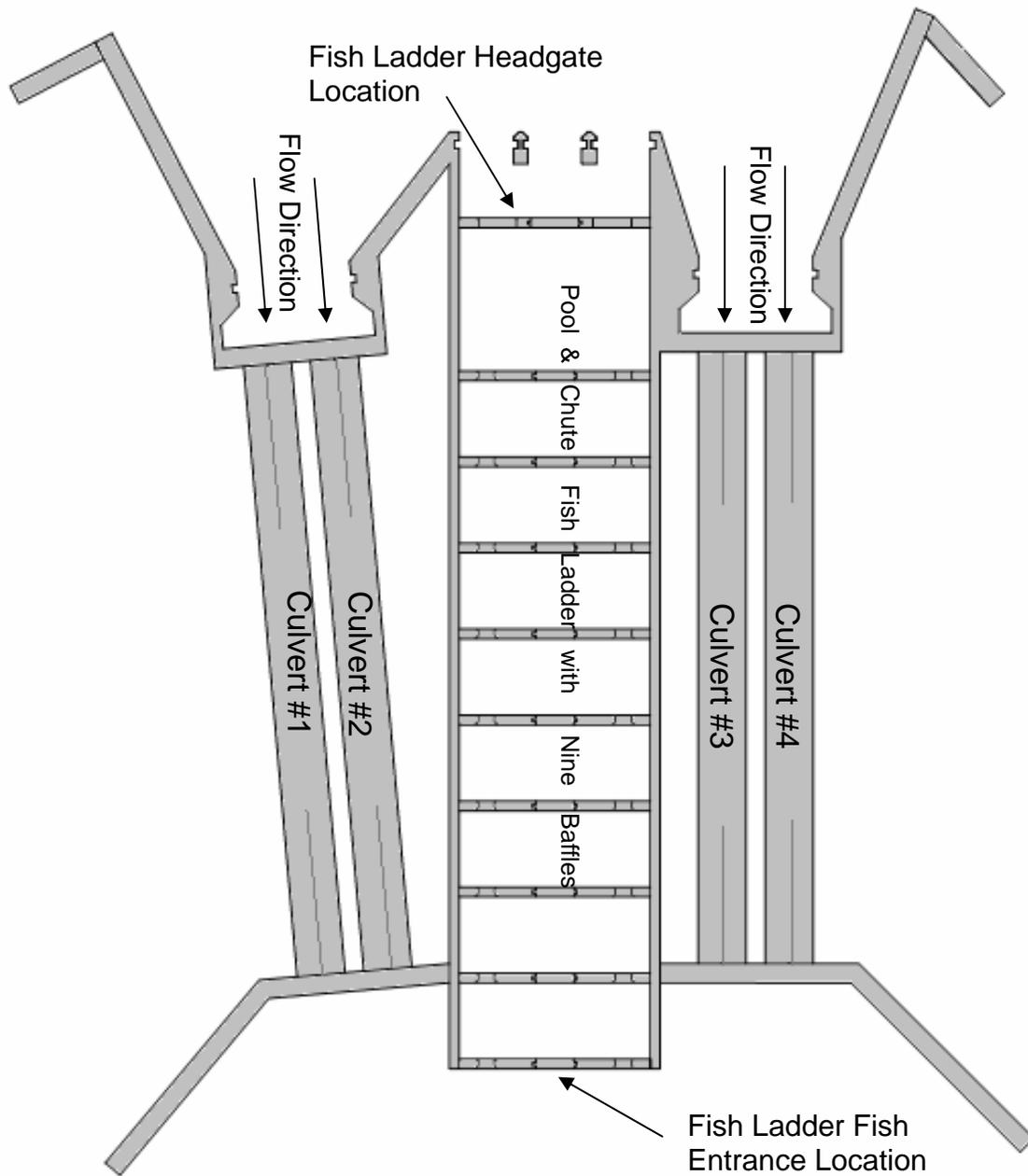


Figure H2. Pool and Chute Baffle Design

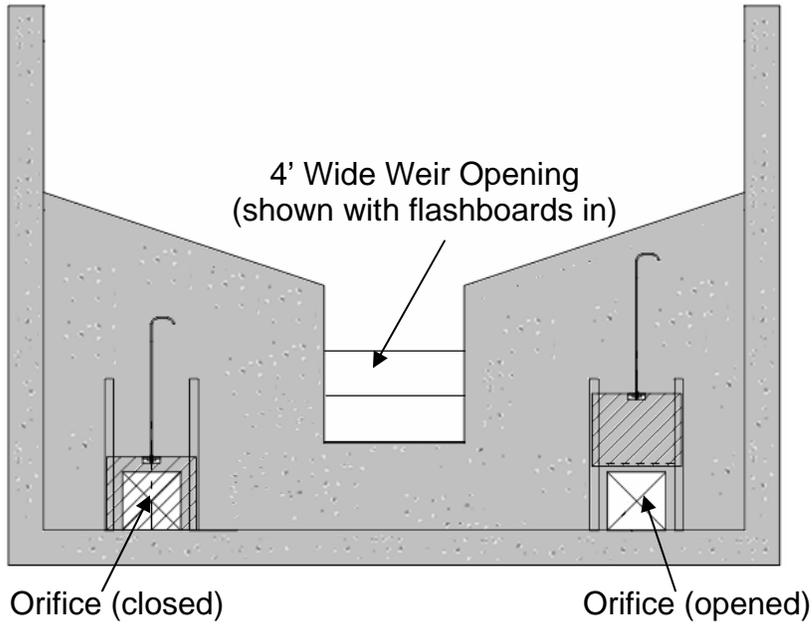
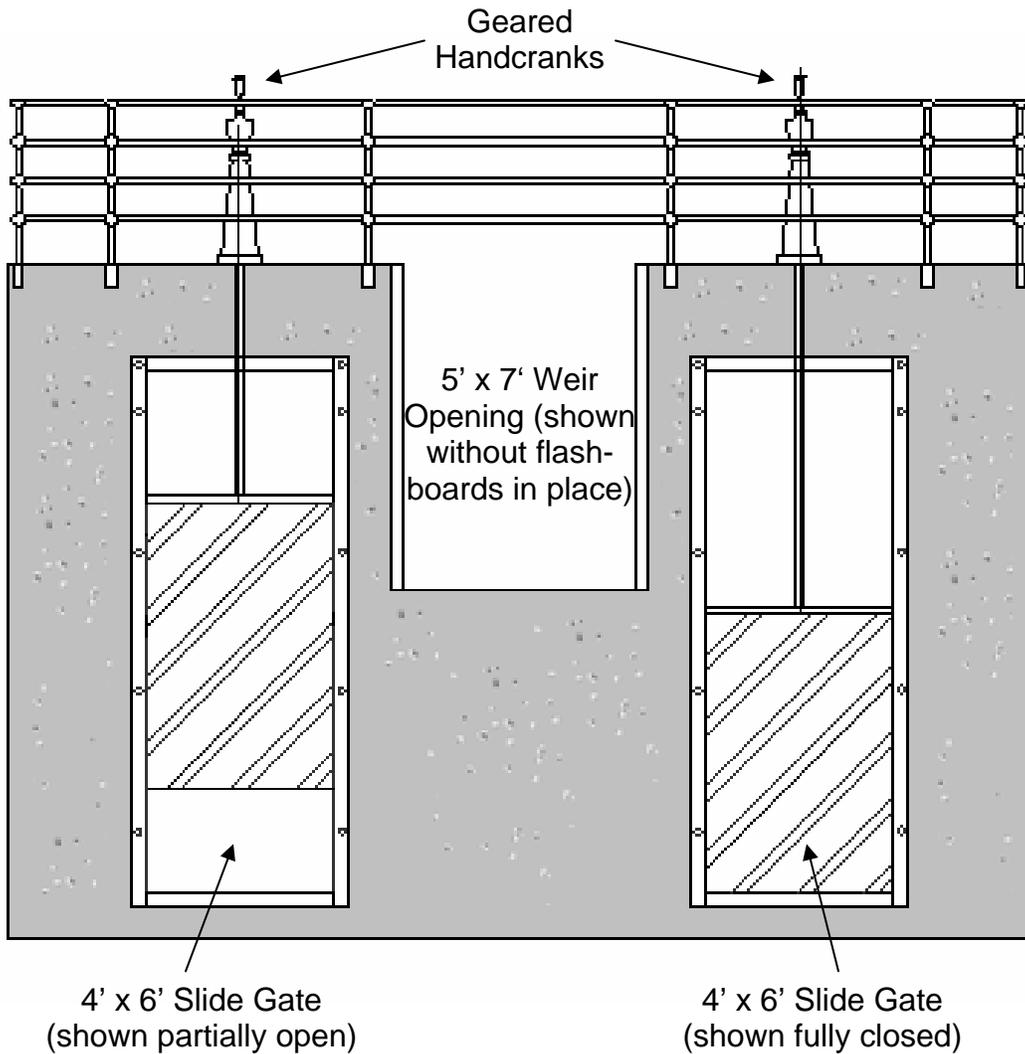


Figure H3. Cross-section View of Fish Ladder Headgate Structure



## Part 2: Operational Procedures for Weir No. 2

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### 1. Introduction

Weir No. 2 is located in Sutter County in the East Borrow Canal (EBC) of the Sutter Bypass, just downstream from the mouth of Wadsworth Canal.

Weir No. 2 is owned and operated by Department of Water Resources (DWR). The purpose of Weir No. 2 is to maintain the water surface elevation upstream of the weir from April 1 to October 15 for irrigation purposes and to provide gravity-fed water to the Sutter National Wildlife Refuge (SNWR) owned by U.S. Fish and Wildlife. There are approximately seven private individual pumps that rely on the water surface elevation maintained by Weir No. 2. Without maintaining the current water surface elevation, the SNWR gravity diversion would not be able to function.

The Weir No. 2 structure design is composed of three 12-foot wide automated spillway gates and six 5 ½ -foot wide manual bays and a full Ice-Harbor fish ladder (figure H4). The manual bays will contain bulkheads and flashboards that can be placed or removed. The full Ice-Harbor fish ladder has a flow capacity of 58 cfs and includes two 4-foot wide rectangular weirs and two 20-inch square orifices in each baffle.

### 2. Objective

The primary objective of the Operational Criteria is to provide for fisheries protection. The head difference between pools should be no more than 1 foot. The automated spillway gates will be set to maintain a consistent upstream stage of 38.5 feet U.S Engineering Datum (USED). For this site, NAVD 88 datum is 0.76 feet lower than the USED datum.

### 3. Basis of Operating Criteria

The operational schedule is set by the run timing of salmonids into the Lower Butte Creek system. Spring-run Chinook salmon adults enter and migrate through the system anytime from January through June, with the peak of the run from early February through early May. Fall-run Chinook salmon adults are in the system anytime from summer to late fall with the peak run from September through November. Adult Central Valley steelhead are likely to migrate into and through the system anytime from fall through spring. In summary, salmon and steelhead adults are most likely present in the system from September through June.

Juvenile salmon and steelhead travel downstream through the Lower Butte Creek system from November through June.

### 4. Operation Criteria

During normal stages in the East Borrow Canal (EBC), the primary operational requirement for the fish ladder will be to ensure that proper adjustment of the entrance is maintained to ensure good fish passage. The head difference

between the entrance pool and the water surface elevation in the EBC should be no more than 1 foot. The automated spillway gates will maintain a stage of 38.5 feet USED which should minimize the need for adjustments at the flow entrance of the fish ladder. The trash rack upstream of the fish ladder will need to be cleaned of debris on a regular basis to ensure fish passage.

If the stage upstream of Weir No. 2 drops below the normal operating stage, baffles #1 and #2 on the land side of the fish ladder are adjustable to allow the fish ladder to still operate (figure H5). The uppermost baffle, baffle #1, on the landside can be lowered 2 feet and the next baffle downstream, baffle #2, can be lowered 1 foot. These adjustments will be made by removing the 4-foot wide flashboards and will only be made when the stage upstream has dropped below normal operating stage.

If the stage continues to recede, and flows get low enough that adequate depth cannot be maintained in the ladder, then one set of orifices (one orifice in each baffle) will be closed by using the stop gates. If depth is still not maintained, the other set of orifices will be closed using the stop gates. The fish ladder will operate as a pool and weir fishway with both sets of orifices closed. This configuration will only be employed during extremely low flow events where depth in the pools cannot be maintained.

As seasonal flooding begins to occur, the handrails on the fish ladder that are perpendicular to water flow will be set to their collapsed position so they are not damaged by debris. When flows recede, the handrails will be positioned back to their upright position and debris will be removed from the working platform covering the fish ladder.

The fish ladder will be closed off seasonally when fish passage is not required to allow removal of gravel and sediments that have accumulated in pools.

Figure H4. Plan View of Weir No. 2 Structure

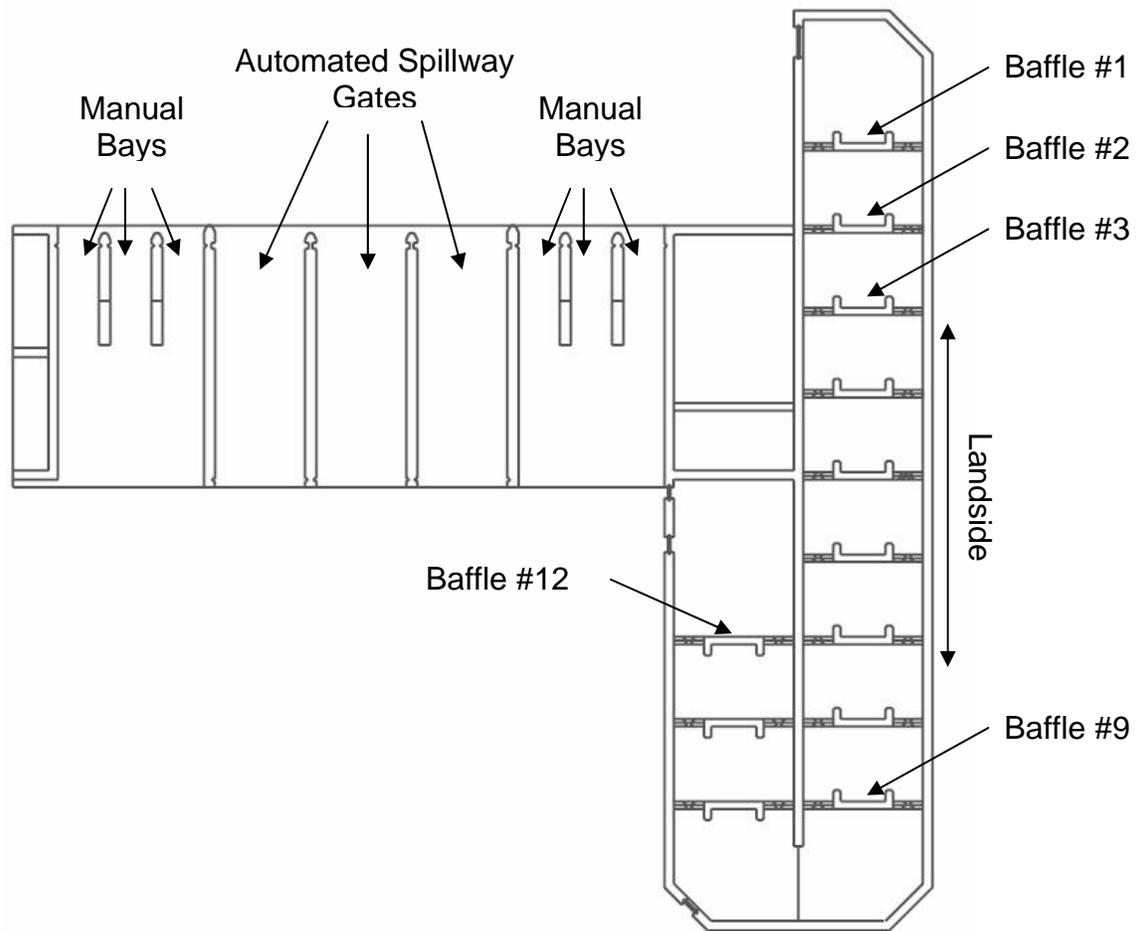


Figure H5. Cross-section View of Baffles in Full Ice Harbor Fish Ladder (looking downstream).

