IRRIGATION TRAINING & RESEARCH CENTER

Flathead Indian Irrigation Project

Placid Canal and Jocko Rivers Modernization

U.S. Bureau of Indian Affairs
Branch of Irrigation & Power

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PLACID AND JOCKO RIVER MODERNIZATION

Modernization Plan

The Placid Canal and Jocko River areas are composed of a network of river and stream diversions and storage reservoirs that service irrigated acreage in downstream areas. Figure 1 shows the overview of general modernization changes in the Placid and Jocko River areas. The general modernization changes include:

1. An unnecessary control gate will be removed and a new flow measurement flume will be constructed at the head of the Placid Canal. A SCADA site will also be established to provide remote monitoring and remote manual control of the diversion radial gate position.
2. Vibratory compaction of the entire length of the Placid Canal will decrease canal seepage.
3. Two new SCADA sites will be established to provide remote water level monitoring at the Upper Jocko and Lower Jocko Reservoirs.
4. Three new flow control sluice gates will be installed at the head of the Tabor Feeder Canal at Middle Fork Jocko River to replace existing flashboards and provide improved diversion flow control. Diversion flow measurement will also be improved by constructing a new flow measurement structure. A SCADA site will also be established to remotely monitor and remotely adjust diversion sluice gate openings.
5. A new flow measurement structure will be constructed in the Tabor Feeder Canal to improve flow measurement. A SCADA site will also be established to provide improved flow monitoring and remote manual gate adjustments. The control strategy will also be modified to provide:
    a. Improved diversion flow control for the Tabor Feeder Canal
    b. Improved environmental flow control down the North Fork Jocko River
6. A new control structure will be constructed at the Tabor Feeder Canal and Falls Creek to provide:
    a. Improved flow measurement and flow limiting to maintain safe water conveyance despite large and unexpected runoff inflows
    b. Automatic spill of excess flows down Falls Creek

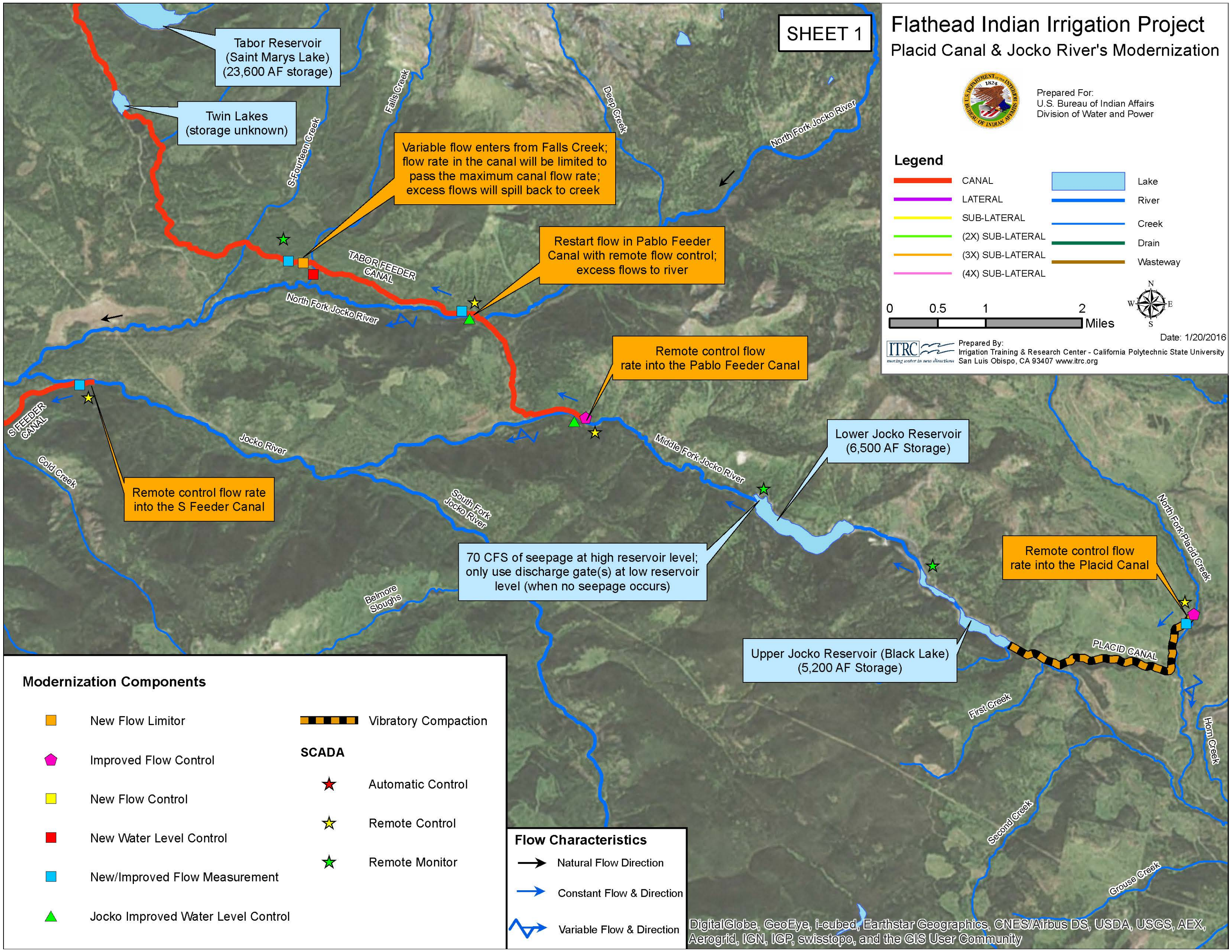


Figure 1. General overview of modernization changes to the Placid Canal as well as North and Middle Jocko Rivers

Placid Canal Improvements

The improvements to the Placid Canal will include:

- Improved control at the Placid Canal Diversion
- Vibratory compaction

Placid Canal Diversion

Figure 2 shows an aerial view of the existing control at the Placid Canal diversion on Placid Creek. Typical diversion flow rates into Placid Canal range from 80-95 CFS.

Figure 2. Aerial view of existing control at the head of the Placid Canal

A 31 foot long sharp-crested weir diversion dam (see Figure 3) raises the upstream Placid Creek water level to facilitate diversions into the Placid Canal. An existing stilling well, pictured in Figure 3, is located upstream of the weir.

Figure 3. Existing Placid Canal diversion dam

As shown in Figure 4, a 10 foot wide radial gate is installed just upstream of an AMIL gate. Additionally, a fish screen is located approximately 100 feet downstream of the existing AMIL gate.

Figure 4. Existing Placid Canal headgate configuration

This configuration of gates is uncommon and the existing control strategy is unclear. Figure 5 shows the existing AMIL gate inside the existing steel box.

Figure 5. Existing AMIL gate downstream of the existing radial gate

Some of the existing operational issues at this site include:

- Large floating debris such as logs and trees can be encountered, but there is no existing trash rack or grating to stop the debris from fouling gate operations.
- Ice accumulation can stop gate operation until the ice has thawed or has been manually cleared.

Control Improvements at the Head of the Placid Canal

As shown in Figure 6, the proposed control improvements are:

1. Remove the existing AMIL gate and steel box.
2. Install a new flow measurement structure approximately 50 feet downstream of the existing fish screen.
3. Install a trash deflection structure in Placid Creek just upstream of the Placid Canal to deflect large debris away from the existing Placid Canal radial gate.
4. Install an electronic actuator on the existing radial gate gear reduction unit.
5. Establish a SCADA site to provide remote manual gate control for the existing radial gate and flow rate monitoring of the following:
    a. Placid Canal flow rate as measured by the new flow measurement structure downstream of the existing fish screen
    b. Placid Creek flow rate over the weir

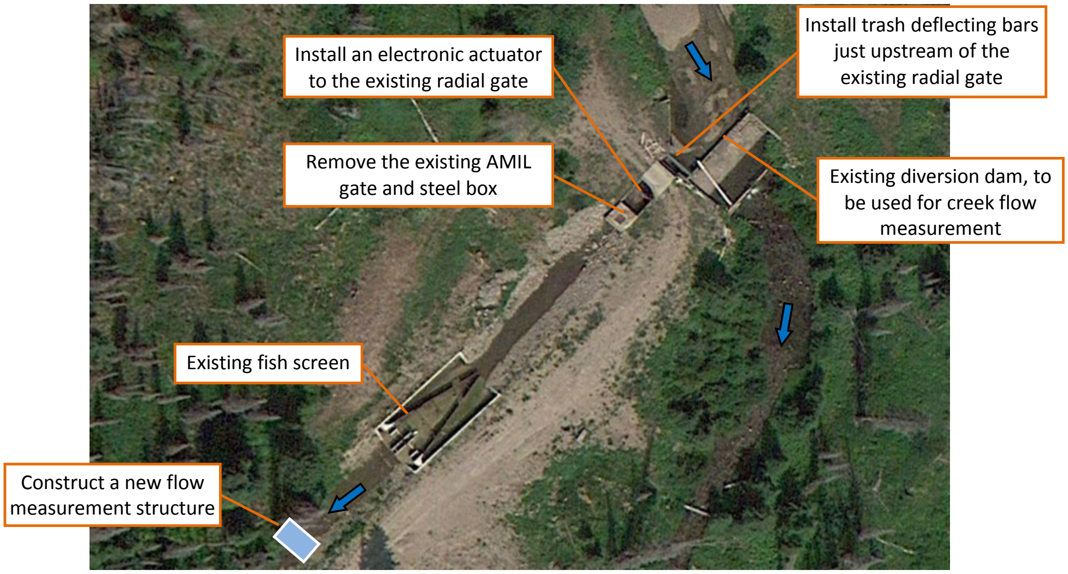


Figure 6. Placid Canal heading modernization components

A conceptual drawing of the proposed deflecting bars is shown in Figure 7.

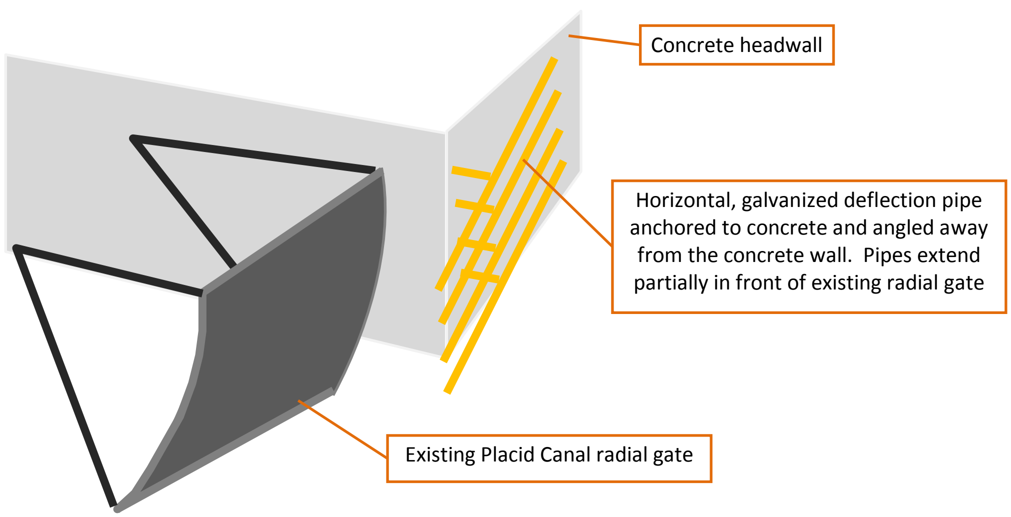


Figure 7. Conceptual drawing of proposed debris deflecting bars. Isometric view.

In addition to the hydraulic control and monitoring improvements, it is anticipated that installing the new flow measurement structure will raise the water depth at the fish screen, which should improve fish screening operations.

Vibratory Compaction

Vibratory compaction is a cost-effective method of decreasing seepage along earth-lined open channels. Although a soils analysis has not been completed, it is recommended to:

- First remove rocks and large gravel from the existing Placid Canal channel.
- Try vibratory compaction along the entire Placid Canal alignment (Refer to Figure 1).

Upper and Lower Jocko Reservoir Improvements

The Upper and Lower Jocko Reservoirs have a combined storage capacity of 11,700 acre-feet. The reservoirs are used to store diverted river and stream flows for redistribution in the late irrigation season.

Upper Jocko Reservoir

Upper Jocko Reservoir is a 5,200 acre-foot storage reservoir along the Middle Fork Jocko River. Upper Jocko Lake discharges directly into the Lower Jocko Reservoir. The Upper Jocko Reservoir was not visited by ITRC, so no critical issues have been identified.

Control Improvements at the Upper Jocko Reservoir

It is recommended that a SCADA site be established to remotely monitor reservoir water levels due to the reservoir's remote location.

Lower Jocko Reservoir

The Lower Jocko Reservoir, shown in Figure 8, has a capacity of about 6,500 acre-feet. In the beginning of each irrigation season, the outlet gates are closed and the reservoir water levels are typically high. Despite having the gates closed, an accumulation of uncontrolled leaks discharge about 70 CFS downstream, which is sufficient to meet minimum required environmental flows.

Figure 8. Lower Jocko Reservoir outlet gate and control building

As the reservoir water level drops, the leaks decrease and the reservoir outlet gates are opened to meet downstream irrigation and environmental demands.

Control Improvements at Lower Jocko Reservoir

It is recommended that a SCADA site be established to remotely monitor reservoir water levels due to the reservoir's remote location.

Tabor Feeder Canal Improvements

Tabor Feeder Canal modernization components include control improvements at the following sites:

- Middle Fork Jocko River
- North Fork Jocko River
- Falls Creek

The locations of these three sites are shown in Figure 9. Diversions from natural rivers and streams into the Tabor Feeder Canal occur at each of these locations. Diverted water is stored at Tabor Reservoir to meet a portion of the irrigation demands in the FIIP Mission and Post Canal units.

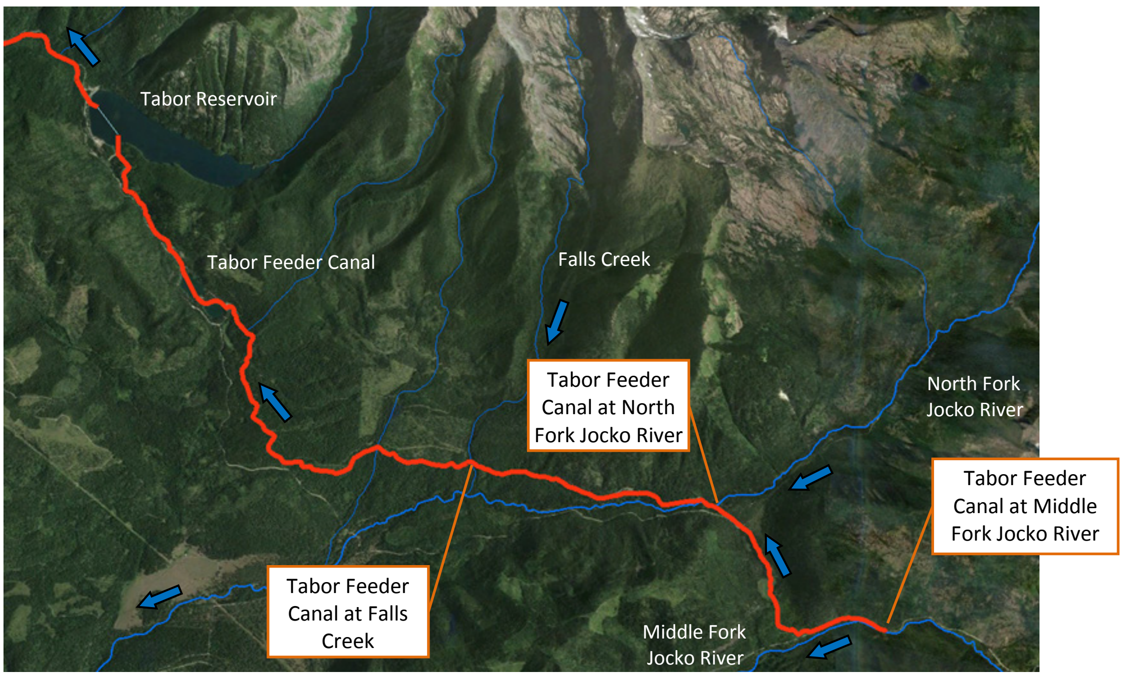


Figure 9. Tabor Feeder Canal improvement locations

Tabor Feeder Canal Diversion – Middle Fork Jocko River Diversion

The head of the Tabor Feeder Canal is located at its confluence with the Middle Fork Jocko River. Existing infrastructure at the site includes:

- Five (5×) 6 foot wide slotted bays with flashboards in the Middle Fork Jocko River are used to raise the upstream water level to facilitate diversions into the Tabor Feeder Canal.
- A fish ladder installed parallel to the river flashboard bays provides a path for fish to travel upstream.
- River water is diverted through five (5×) 6 foot wide slotted bays with individual trash grates.
- An existing fish screen is located just downstream of the diversion bays.
- An existing gauging station is located downstream of the fish screen.

The existing site conditions are shown in Figure 10 through Figure 12.

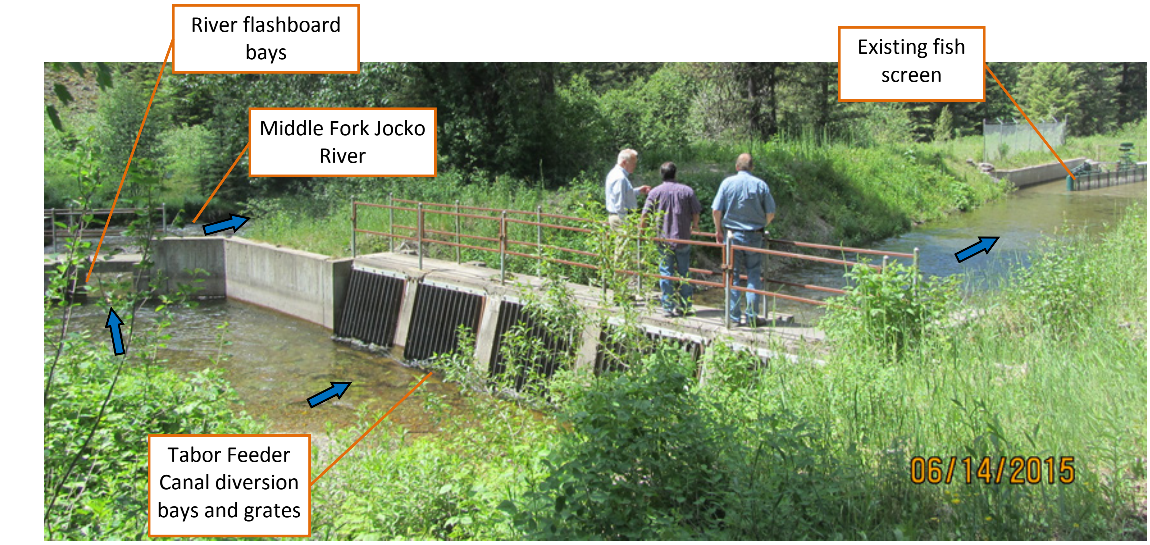


Figure 10. Existing infrastructure at the head of the Tabor Feeder Canal at Middle Fork Jocko River looking downstream

Figure 11. Existing Middle Fork Jocko River structures at the head of the Tabor Feeder Canal

Figure 12. Existing Middle Fork Jocko River fish ladder – looking downstream

Issues with the existing infrastructure include:

- It is currently difficult to maintain a target diversion flow rate because:
    - The upstream water level is not maintained at a reasonable depth. Even small fluctuations in the upstream river water level will have a significant effect on the diversion flow rate
    - The existing flashboards are poor choices for diversion flow control.
- The existing fish screen is operated with very little water depth.

Control Improvements at the Tabor Feeder Canal at Middle Fork Jocko River

The recommended improvements are:

1. Construct a new flow measurement flume approximately 500 feet downstream of the existing fish screen in the Tabor Feeder Canal.
2. Install three new sluice gates with electronic actuators to replace three of the existing flashboard sections at the head of the Tabor Feeder Canal. The remaining two flashboard bays will be left as-is.
3. Insert more flashboards in the river bays to raise the upstream water level by about one foot.
4. Establish a SCADA site to provide remote manual control of the new Tabor Feeder Canal sluice gate positions and monitoring of Tabor Feeder Canal flow rates.

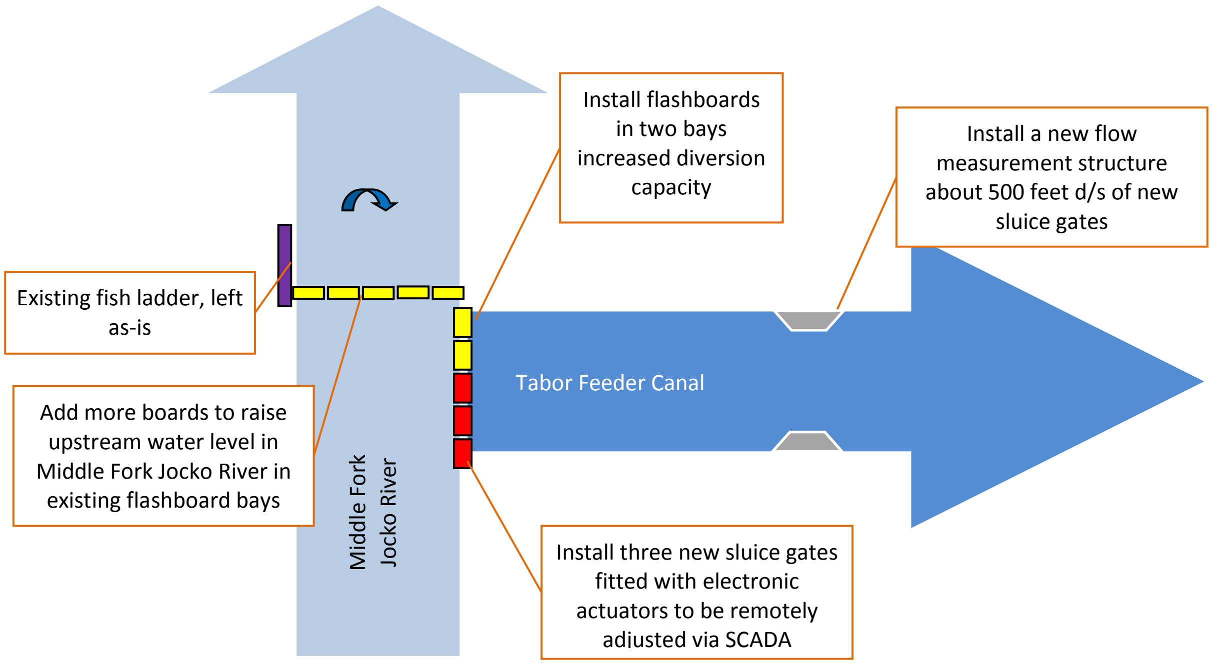


Figure 13. Recommended modifications to Tabor Feeder Canal at Middle Fork Jocko River

The new operational strategy would be as follows:
- Maintain a higher upstream Middle Fork Jocko River water level by adding or removing flashboards as needed, perhaps on a weekly basis.
- Two to three times a week or as necessary, remotely adjust the sluice gate positions to maintain a relatively constant target diversion flow rate into the Tabor Feeder Canal. It is recommended that all gates be kept at roughly the same opening over time.

Tabor Feeder Canal Diversion – North Fork Jocko River Diversion

The existing infrastructure is described below:
- An approximately 60 foot long weir dam raises the upstream water level in the North Fork Jocko River for diversions into the Tabor Feeder Canal.
- An approximately 10 foot wide radial gate is installed in parallel with the weir dam to manually bypass water.
- An approximately 10 foot radial gate is installed just upstream of the long weir dam to divert water into the Tabor Feeder Canal.

Figure 14 and Figure 15 show the existing infrastructure at the Tabor Feeder Canal diversion at North Fork Jocko River. A schematic of the existing site and operations is shown in Figure 16.

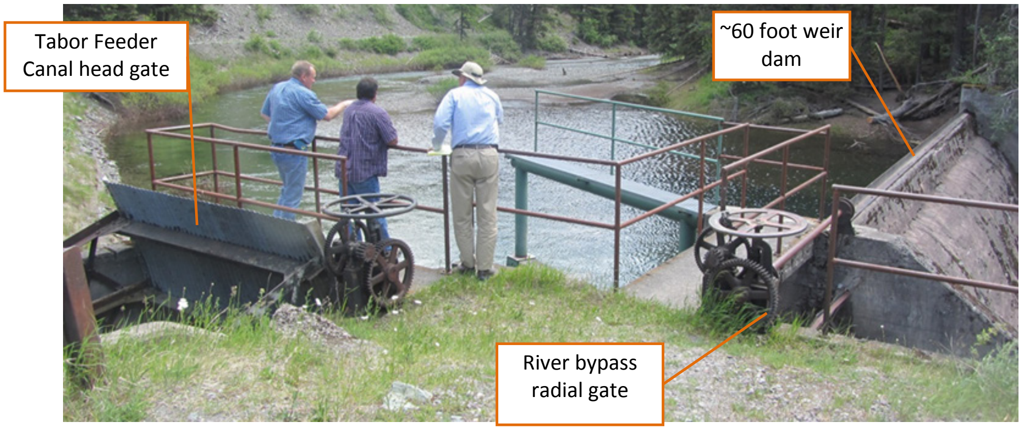


Figure 14. Existing infrastructure at the Tabor Feeder Canal diversion looking upstream at North Fork Jocko River

Figure 15. Tabor Feeder Canal diversion at North Fork Jocko River showing long weir dam and river bypass radial gate

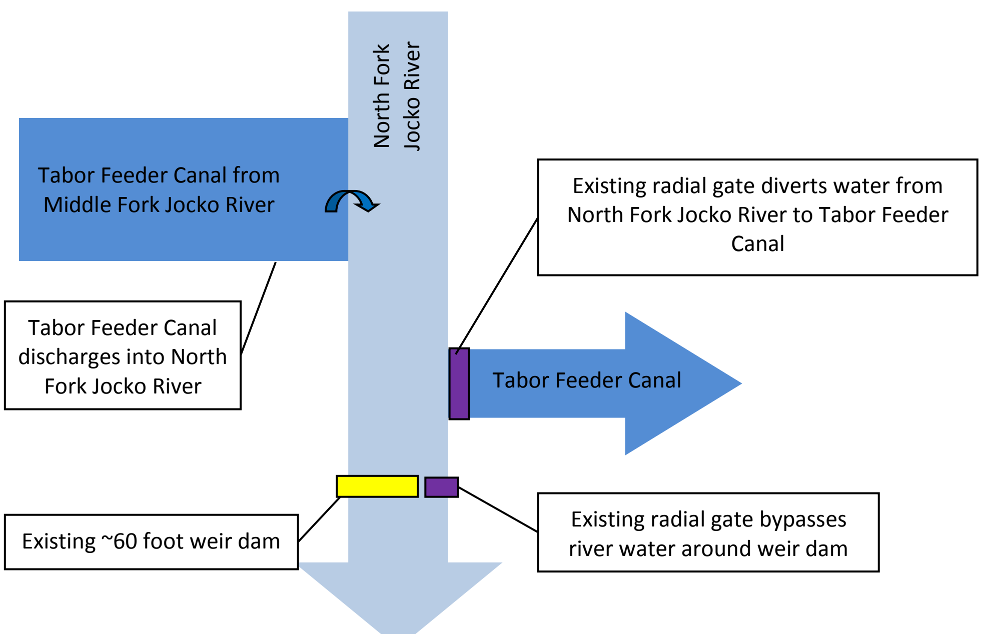


Figure 16. Existing infrastructure and operations schematic of the Tabor Feeder Canal diversion at North Fork Jocko River

Issues with the existing infrastructure and site operation include:

- Fluctuations in the North Fork Jocko River flows significantly affect the Tabor Feeder Canal diversion flow rate and the river bypass flow rate because:
  - The upstream water level is maintained at a relatively low depth.
  - The diversion radial gate is kept above the water surface.
- The site is remote and not easy to access, so it is likely visited infrequently. It is likely that the gates are rarely adjusted.

Control Improvements at the Tabor Feeder Canal Diversion at North Fork Jocko River

The recommended control improvements at the site are as follows:

- Construct a new flow measurement flume in the Tabor Feeder Canal approximately 600 feet downstream of the diversion gates.
- Install an electronic actuator on each existing radial gate.
- Establish a SCADA site to provide remote manual control of both gate positions and monitoring of:
  - Diversion flow rate, measured by the new flow measurement flume
  - River radial gate bypass flow rate, computed using a gate discharge equation
  - River flow rate over the weir using a weir discharge equation and a head measurement upstream of the weir crest
- Implement a new site control strategy:
  - Under normal operating conditions:
    - The river radial gate would be remotely adjusted via manual control commands to maintain about 0.5 feet of head over the weir crest.
    - The Tabor Feeder Canal diversion gate would be remotely adjusted via manual control commands to maintain the target diversion flow rate. It is anticipated that adjusting the diversion gates would be infrequent and normally required only when the diversion target flow rate changes.
  - Under low river flow conditions, the control strategy would be modified:
    - The river radial gate would be remotely adjusted to maintain a minimum river flow rate for environmental purposes.
    - The Tabor Feeder Canal diversion gate would be remotely adjusted to maintain a target upstream river water level at the crest of the weir.

Tabor Feeder Canal at Falls Creek

Figure 17 shows the approximate location of the Tabor Feeder Canal at Falls Creek just northeast of the Jocko Canal Unit.

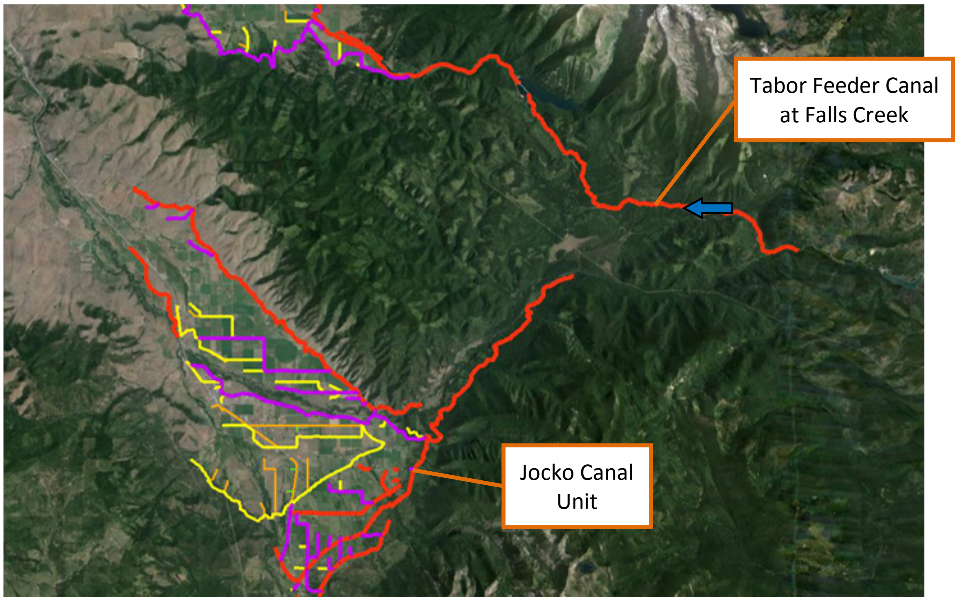


Figure 17. Approximate location of Tabor Feeder at Falls Creek

The existing site infrastructure is described below and shown in Figure 18:

- Falls Creek discharges directly into the Tabor Feeder Canal. Falls Creek inflows pass over a log debris screen and drop into the canal. Large debris is diverted by the log screen to prevent it from entering the canal.
- A depression in the concrete structure at the radial gate (refer to Figure 19) diverts water for deliveries to be made to Falls Creek. The sill of the radial gate is at the same elevation as the floor of the depression.
- An 8 foot wide manual radial gate discharges water to the downstream portion of Falls Creek.
- Two approximately 8 foot wide slotted bays are located in the canal several feet downstream of the radial gate. No flashboards were present in the bays during the field visit.

Figure 18. Existing Tabor Feeder Canal structure at Falls Creek

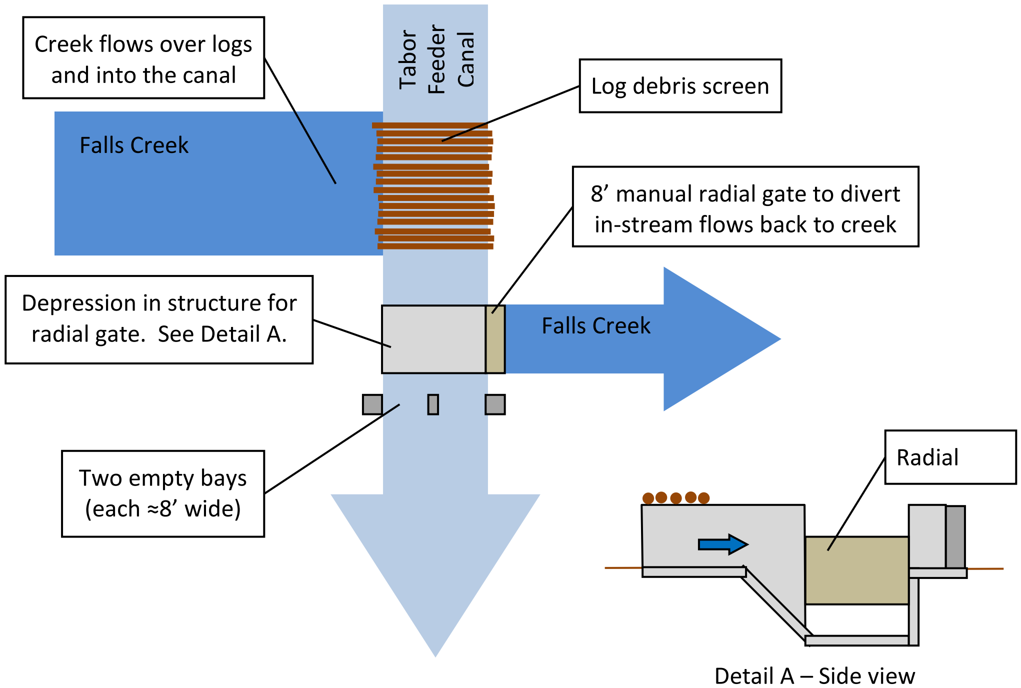


Figure 19. Conceptual sketch of existing control of the Tabor Feeder Canal at Falls Creek (not to scale)

Current Issues

The current canal infrastructure is not capable of handling large flow rate fluctuations from Falls Creek during storm events. During large storm events, an additional 100 CFS frequently discharges into the canal from Falls Creek. The additional surge flow can create a safety risk of either overtopping the Tabor Feeder Canal downstream or possibly causing a canal break.

During storm events, operators are required to drive to the site (sometimes at night) to manually adjust the existing radial gate in order to bypass more flow into the downstream portion of Falls Creek. Accessing the canal site has its own problems:

- The site is remote and not easily accessible.
- A single round trip can take hours.
- The route is not considered safe during storm conditions, especially at night.

Additionally, the existing structures are significantly deteriorated; at minimum the control structures (gates and bays) need to be replaced.

Proposed Control Components

The new control components shown in Figure 20 include:

1. A new radial gate will be installed in the Tabor Feeder Canal to be operated as a flow limiter for the downstream portion of the Tabor Feeder Canal.
2. A new underflow gate (radial or sluice) will be installed to manually control return flows to Falls Creek. The new gate will function similar to the existing radial gate:
    a. During normal operations, the gate will be slightly opened to pass a small amount of flow to meet in-stream flow requirements to Falls Creek.
    b. During the non-irrigation season, the gate will be completely opened to pass all winter flows to the creek.
3. Three new, identical ITRC Flap Gates will be installed to provide automatic upstream water level control in the Tabor Feeder Canal pool. Excess flows will be automatically passed to Falls Creek. Each flap gate will be designed to pass approximately 50 CFS, for a total spill capacity of 150 CFS.
4. A new flow measurement flume will be constructed in the Tabor Feeder Canal approximately 250 ft. downstream of the new canal flow control radial gate.

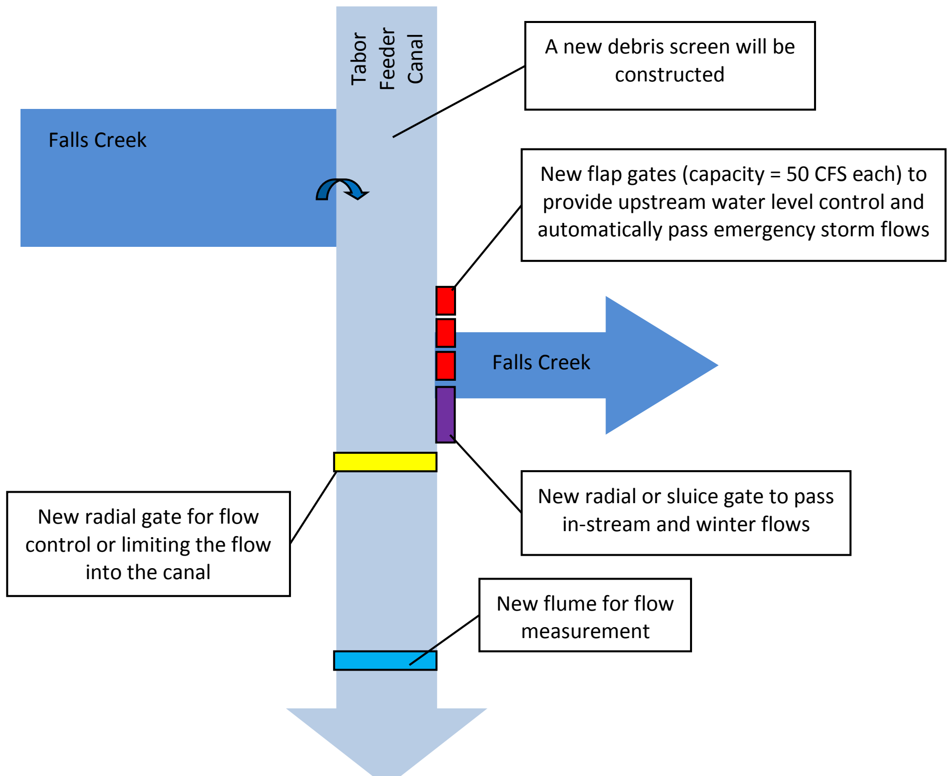


Figure 20. Canal control components to be incorporated into a new Tabor Feeder Canal structure at Falls Creek (not to scale)

It is anticipated that the recommended improvements will provide:

1. Improved normal operational procedures by regulating the downstream canal flow rate
2. Automatic and manual spill capabilities to bypass storm flows and ensure minimum environmental flows

Procedure for Setting Flow Limiting Radial Gate

The procedure for setting the radial gate in the Tabor Feeder Canal to obtain the maximum canal flow is as follows (refer to Figure 21):

1. Enough flow must be diverted at the head of the Tabor Feeder Canal to ensure that the canal flow rate plus the in-stream flow from Falls Creek exceeds the maximum downstream flow rate capacity of the canal.
2. The radial or sluice gate to Falls Creek will be completely closed so that no water is diverted through the gate.
3. The radial gate in the Tabor Feeder Canal will be adjusted until the maximum flow rate is obtained through the flow measurement flume simultaneously while all of the excess flow upstream in the canal begins to spill through the three flap gates.
4. Once the maximum flow rate to the downstream portion of the Tabor Feeder Canal is achieved, the radial gate positions will be permanently marked by making a notch in the gate with a grinder. If the radial gate position is ever changed to achieve a low canal flow rate, operators can easily move the gate back to the marked position to limit the maximum canal flow again.

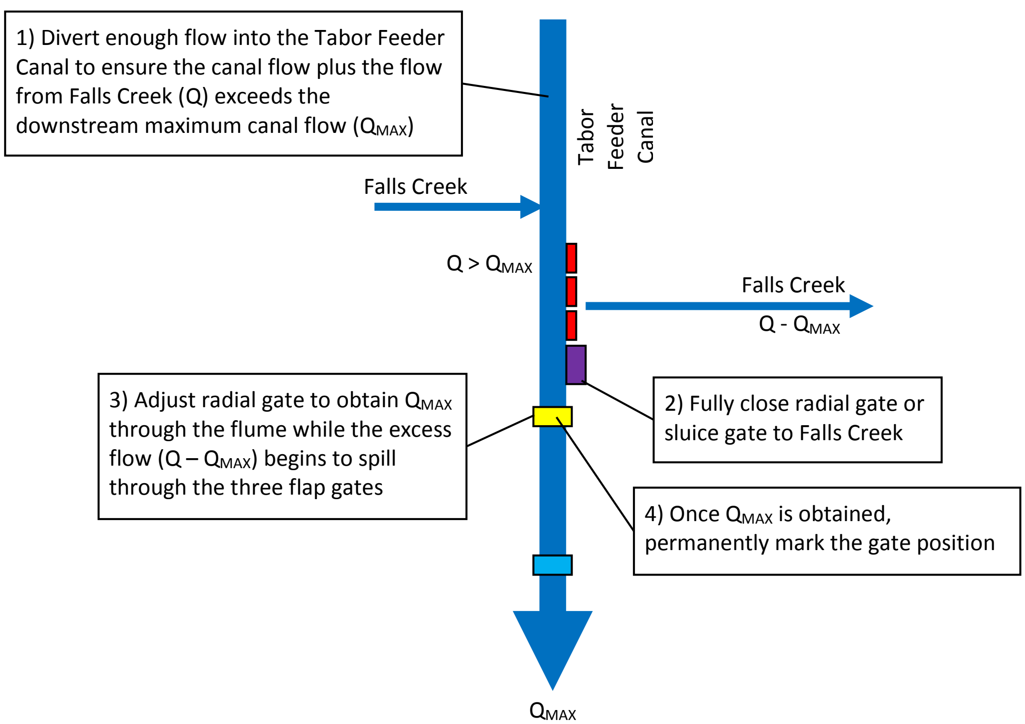


Figure 21. Conceptual procedure for setting the maximum flow rate for the downstream portion of the Tabor Feeder Canal (not to scale)

Flap Gate Design

Figure 22 and Figure 23 show the conceptual design of the three new flap gates. Each flap gate will be designed to pass approximately 50 CFS. The three flap gates will automatically maintain a fairly constant upstream water level in the canal over a wide range of flow rate fluctuations in the Tabor Feeder Canal.

It is highly recommended that ITRC design, construct, and ship the three gates, because it will be the first such gate in the project. This is the typical process with districts. Hundreds of these gates are in use, and are typically manufactured in irrigation district shops by irrigation district personnel.

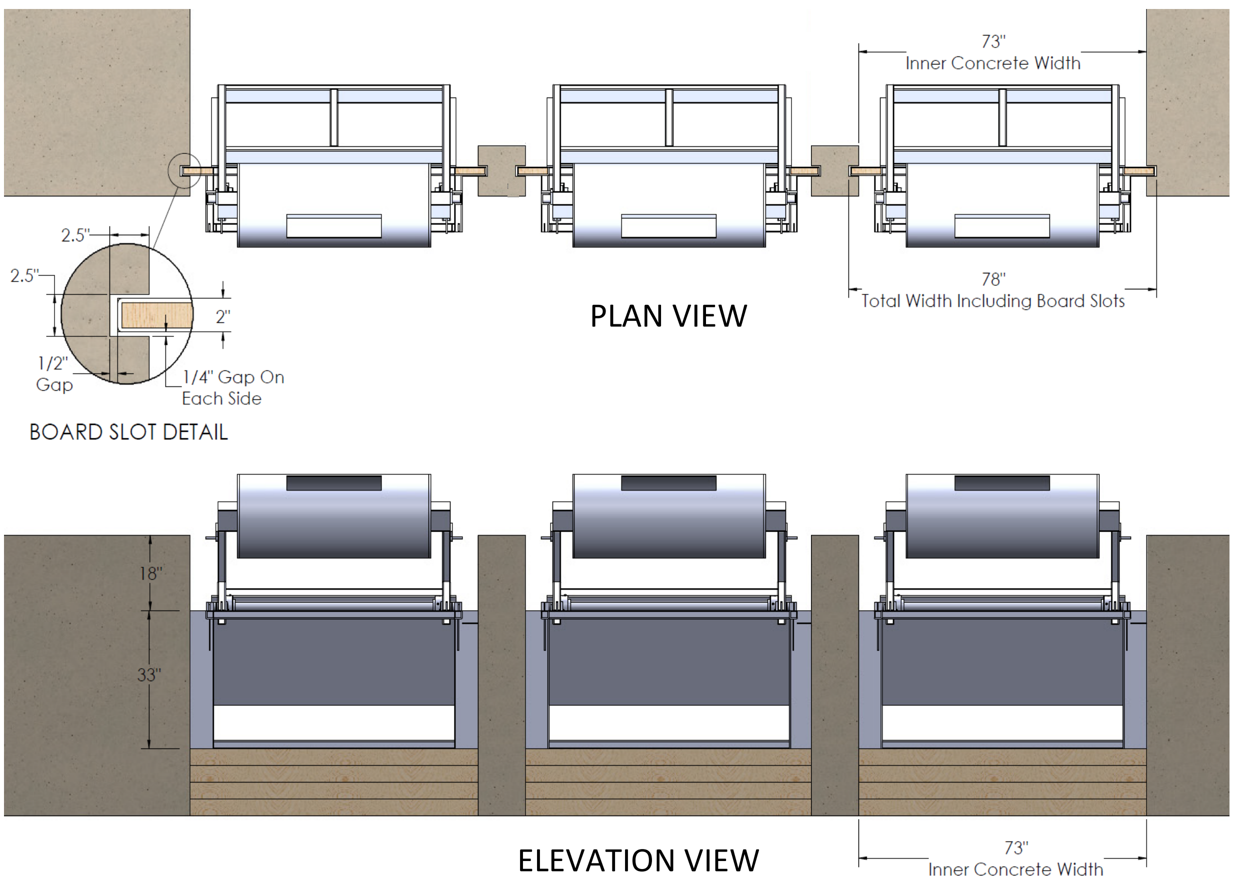
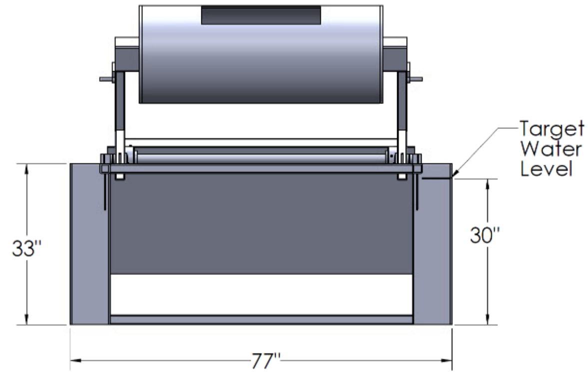
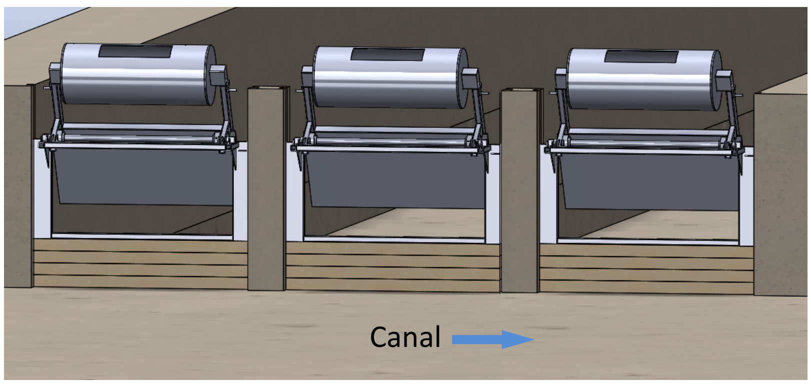


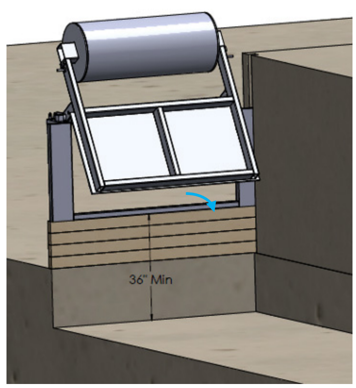
Figure 22. Conceptual plan and side view of new flap gates to be installed in a new structure in the Tabor Feeder Canal at Falls Creek



ELEVATION VIEW – SINGLE FLAP GATE



CANAL VIEW



DOWNSTREAM VIEW - ITRC FLAP GATE

Figure 23. Additional conceptual flap gate figures

Flow Measurement Flume

A new flow measurement flume will be constructed in a straight section of the Tabor Feeder Canal approximately 250 ft. downstream of the current structure. The flume will have a flat-bottom floor with vertical side-contracted walls similar to the example conceptual drawings in Figure 24. The flat-bottom floor design allows for easy sediment passage.

No survey information was taken during the site visit in June 2015 to provide an actual flume design. <u>The dimensions in Figure 24 are only shown as a reference.</u>

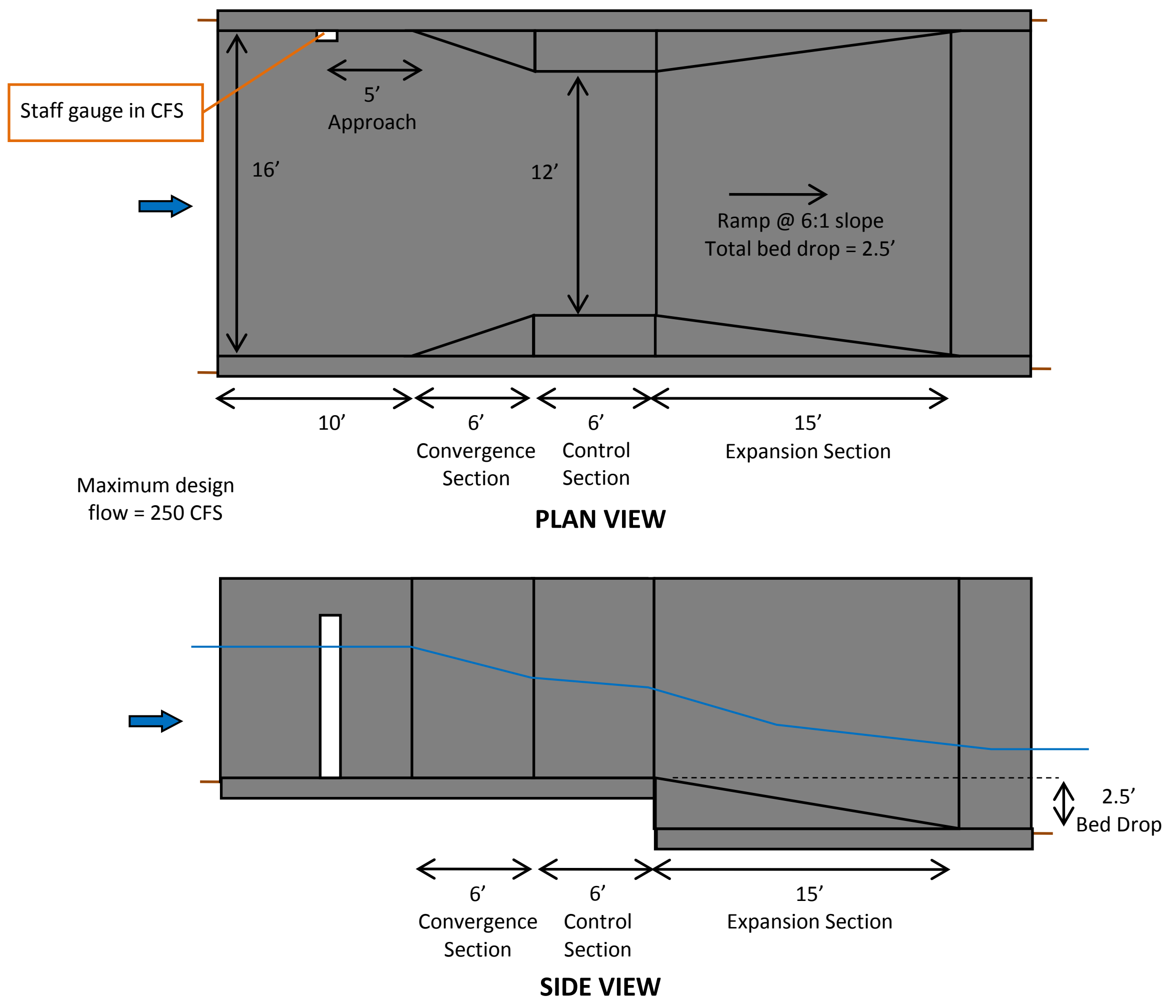


Figure 24. Example conceptual plan and side view of a flat bottom flow measurement flume with contracted side walls designed for a maximum canal flow of 250 CFS (not to scale)