Appendix 7

Operation and maintenance of the Selective Withdrawal System at Hungry Horse Dam.

Purpose and Need

Hungry Horse Dam was completed in 1953 by the US Bureau of Reclamation (Reclamation), impounding the South Fork of the Flathead River in northwestern Montana. Prior to the installation of a selective withdrawal, temperature control device in 1995 (SWS), water discharged from Hungry Horse Reservoir into the South Fork of the Flathead River remained as cold as 4°C year-round. Discharges from deep in the reservoir chilled the Flathead River downstream from late-June through September and artificially elevated river temperatures during winter. Intermittent dam discharges for power generation caused unnatural seasonal river temperatures and sudden temperature fluctuations as great as 8.3° C (14° F) in the Flathead River downstream. Unnatural flow and temperature fluctuations downstream of the dam decrease aquatic invertebrate species diversity and abundance in the zone of fluctuation (*varial zone*). Fluctuating flows also increase substrate embeddedness, filling habitat between cobbles with sand. Impacts to fish growth and seasonal fish migrations occurred on 8.4 km of the South Fork immediately downstream of the dam and the mainstem Flathead River to Flathead Lake, 64 km downstream.

Native fish species in the Flathead Subbasin include bull tbrout (*Salvelinus confluentus*), listed as threatened under the Endangered Species Act; westslope cutthroat trout (*Oncorhynchus clarkii lewisi*), a Species of Special Concern in Montana; and mountain whitefish (*Prosopium williamsoni*).

The Northwest Power and Conservation Council directed implementation of temperature control at Hungry Horse Dam, with funding provided by Bonneville Power Administration for the SWS design. Reclamation convened a value engineering team at their Denver water lab and completed the design in 1993. A congressional appropriation funded installation of the SWS in 1994, and in 1995 Reclamation completed the SWS retrofit on all four penstocks to direct warmer surface water through the turbines. The SWS operated for approximately one month in 1995, and since 1996 has more closely matched the natural annual thermal cycle in the Flathead River from June through late fall. Before the SWS was installed, Flathead River temperatures only reached the optimal range for trout growth (10° to 15° C) for less than three months annually. Operators can now maintain discharge temperatures within the optimal range for five months or longer each year. Naturalized Flathead River temperatures benefit the entire food web by increasing ecosystem productivity.

Dam operators monitor thermal stratification in the reservoir and adjust the SWS to release water from appropriate depths to meet daily temperature targets during late-June through early November. During SWS operation, warm water flows over adjustable control gates into the turbines. Temperature control ends in late September to early November when the reservoir surface cools and the thermal gradient weakens, and the SWS must be prepared for winter. Winter discharge temperature is approximately 4°C, which artificially warms the Flathead River that naturally cooled to 0°C prior to dam operation. When the SWS ceases operations in late-fall, discharge temperatures can change abruptly. Therefore, Reclamation and Montana Fish, Wildlife & Parks (FWP) developed a plan to minimize sudden temperature changes while ensuring the safety of staff who remove the SWS from service before winter.

The SWS gates and relief panels must be inspected and repaired at a minimum of every three years to ensure uninterrupted temperature control during the months of operation. The control gates slide up or down over stationary gates, which nest with smaller (6-m tall) relief gates located directly in front of the turbine penstocks. To protect the structure, relief gates have shuttered apertures designed to open in the event of excessive hydraulic pressure. When relief panels are open or missing, cold water leaks into the system impacting temperature management. Maintenance must be scheduled prior to annual operation to ensure that the reservoir elevation remains at or below elevation 3526 ft (34 ft below full pool) for a minimum of 14-21 days in April or May.

This agreement between Montana and Reclamation describes our mutual goals for SWS operation and maintenance.

FWP Responsibilities:

Attend an annual SWS Coordination Meeting with Reclamation.

Provide Reclamation with daily temperature targets and minimum/maximum range for the period of SWS operation.

Lead associated fisheries research.

Monitor temperatures at the South Fork Flathead River gauging station and alert Reclamation when river temperatures depart from daily targets. Note: In some years, it may be physically impossible to meet temperature targets during spring, prior to reservoir stratification.

Monitor reservoir thermal structure during thermal stratification and provide advice to operators to manage SWS for optimal effectiveness. Effective monitoring will depend upon Reclamation providing real-time access to thermal data.

Reclamation's Responsibilities:

Convene an annual SWS Coordination Meeting with FWP.

Restore and maintain an array of thermometers on the dam face to monitor reservoir thermal stratification and dam discharge temperature.

Graph the reservoir thermal structure in the control room to help operators position SWS Control Gates at the proper elevation to best achieve discharge temperature targets.

Operators monitor reservoir thermal structure daily during SWS operation and position Control Gates as needed to regulate discharge temperatures and match daily temperature targets provided by FWP. Note: thermal structure in the pool may change daily due to reservoir currents or seiche, which is why temperature targets have a minimum and maximum range. The objective is to the target temperature as closely as possible all season.

After each control gate adjustment, operators check discharge temperature (thermometers in the turbine outlets) to confirm temperature target has been met.

During the in-service season, compare the turbine discharge temperature to the South Fork Flathead River temperature at the gauging station using the HYDROMET data collection system.

Provide on-line data reporting of daily reservoir thermal structure and dam discharge temperature.

When placing the SWS into service, place only one (1) unit into active service per day to minimize abrupt temperature changes downstream. Assuming multiple units are available (penstock flow), raise one (1) Control Gate per day to 30 feet below the reservoir surface (e.g., with only one unit placed in service every 24 hours, the sequence requires 4 days).

When removing SWS from service, only one (1) unit is to be removed from active service per day to minimize temperature effects downstream.

Inspect and repair SWS gates and relief gate panels at least every 3 years (ideally during spring) when the system is not in service (late-fall through May) to prevent impacting temperature control operations during the in-service period (about June - October).

Signatures…