Appendix C
Section 1: Voluntary / Involuntary Spill
Section 2: Dworshak temperature releases

Voluntary / Involuntary Spill

The National Marine Fisheries (NMFS) 1995 Biological Opinion and 1998 Supplemental Biological Opinion outline spill programs for the mainstem Columbia and Snake Rivers. The spill program is identified as a means to pass migrant fish past projects with less exposure to the potential effects of turbines by spilling water through the project spill bays. During the spill season, April through September, the amount of water spilled at each project is based upon the guidance provided in the NMFS documents with in-season spill adjustments to maintain the Total Dissolved Gas (TDG) levels below the state Clean Water Act standards in the tailwaters and forebays.

During the remainder of the year the projects are operated with a focus on issues other than fish passage, such as power generation and flood control. The TDG levels in the mainstem Columbia and Snake Rivers are monitored. The projects are operated in a manner to not exceed the state standards, if possible. Typical situations where meeting state standards might not be possible would be during fall or winter rain events or spring run-off events when the river volume exceeds the project powerhouse capacity.

The following graphs contain data extracted from the Columbia River Operational Hydrologic and Meteorological System (CROHMS) along with calculated values for involuntary spill. This information was calculated and compiled by BPA. The definition for involuntary spill, total flow and total spill for these graphs is:

Involuntary Spill
- Equal to sum of flow (spill) above turbine capacity plus lack-of-market spill where lack-of-market spill is
    - Spilled water that could have been passed through the turbines to generate power if a load/market had existed for that additional generation.

Total Flow
- Total volume of water passing a project.
- Observed value retrieved from CROHMS.

Total Spill
- Volume of water passing a project through the spill bays.
- Observed value retrieved from CROHMS.

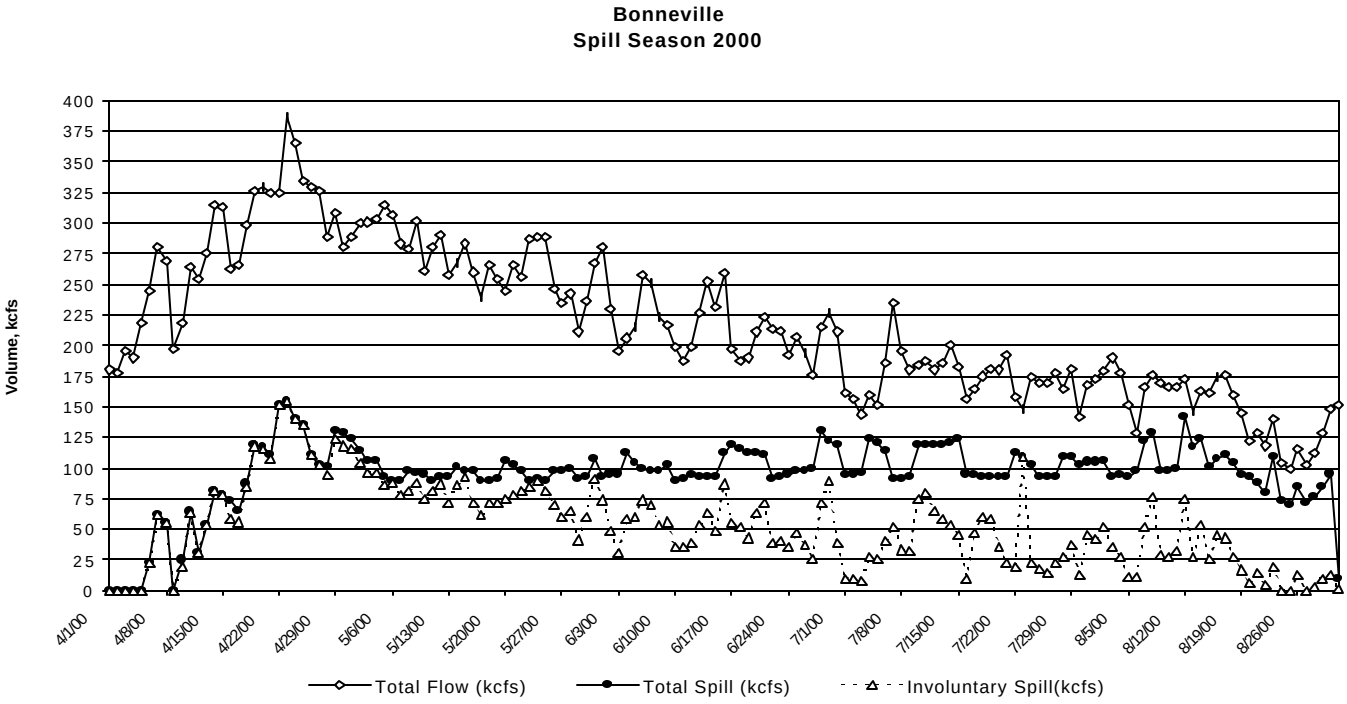


Figure 1 Bonneville – Involuntary Spill

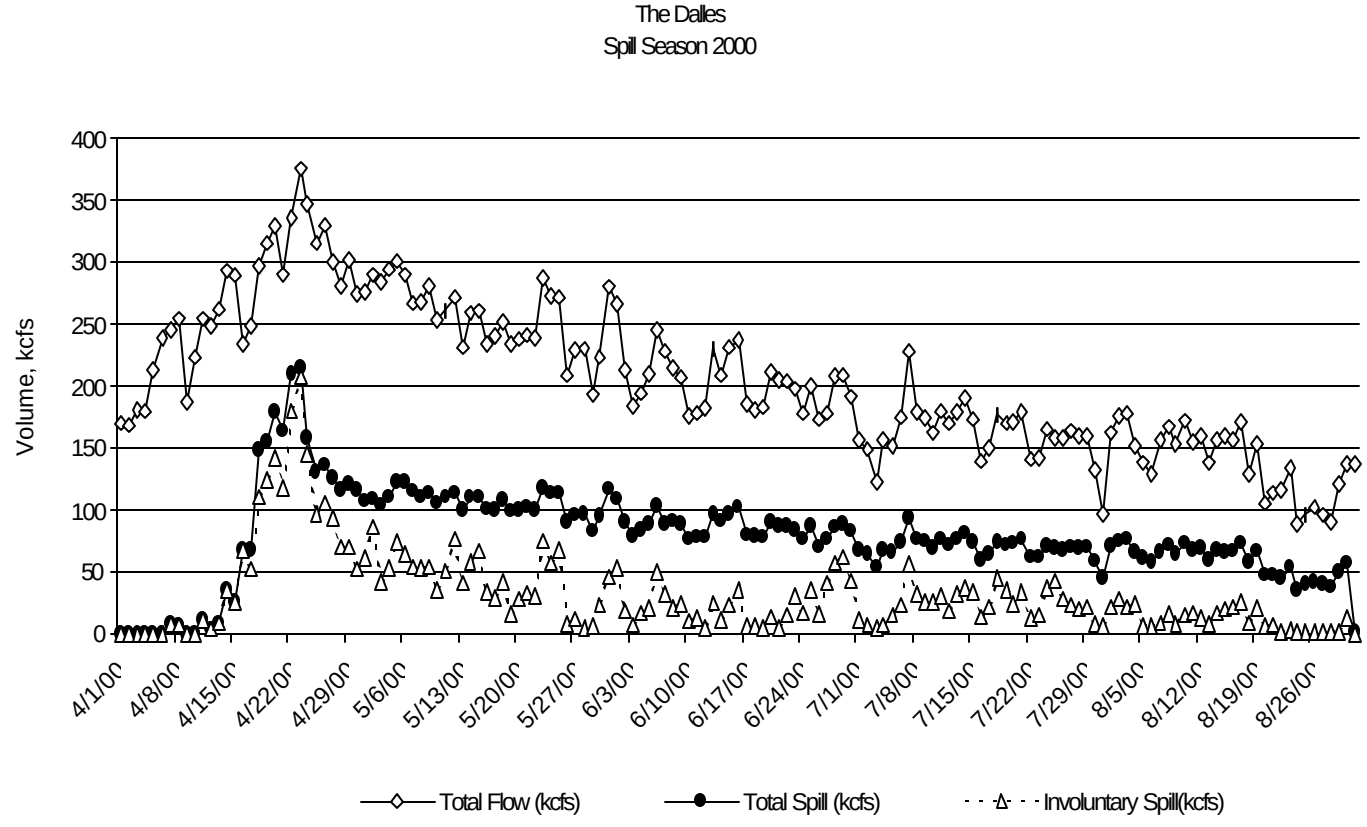


Figure 2 The Dalles – Involuntary Spill

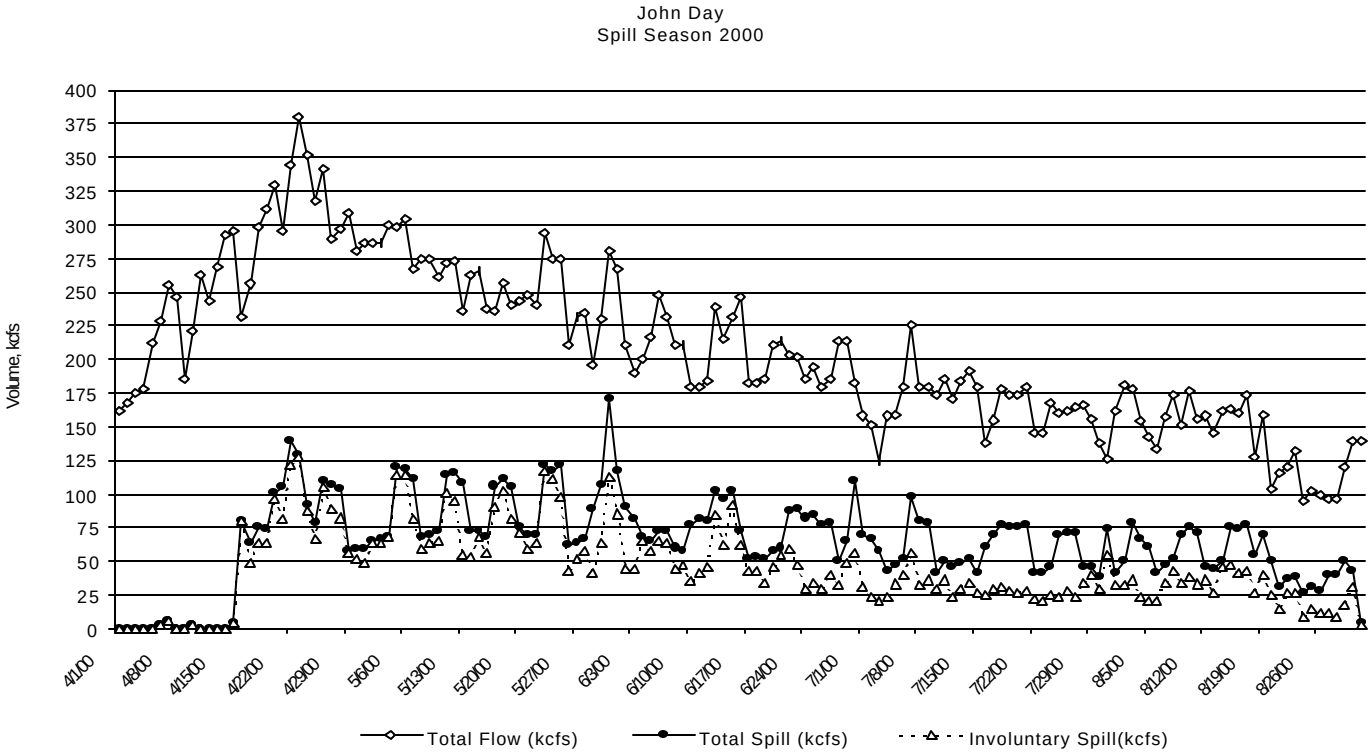


Figure 3 John Day – Involuntary Spill

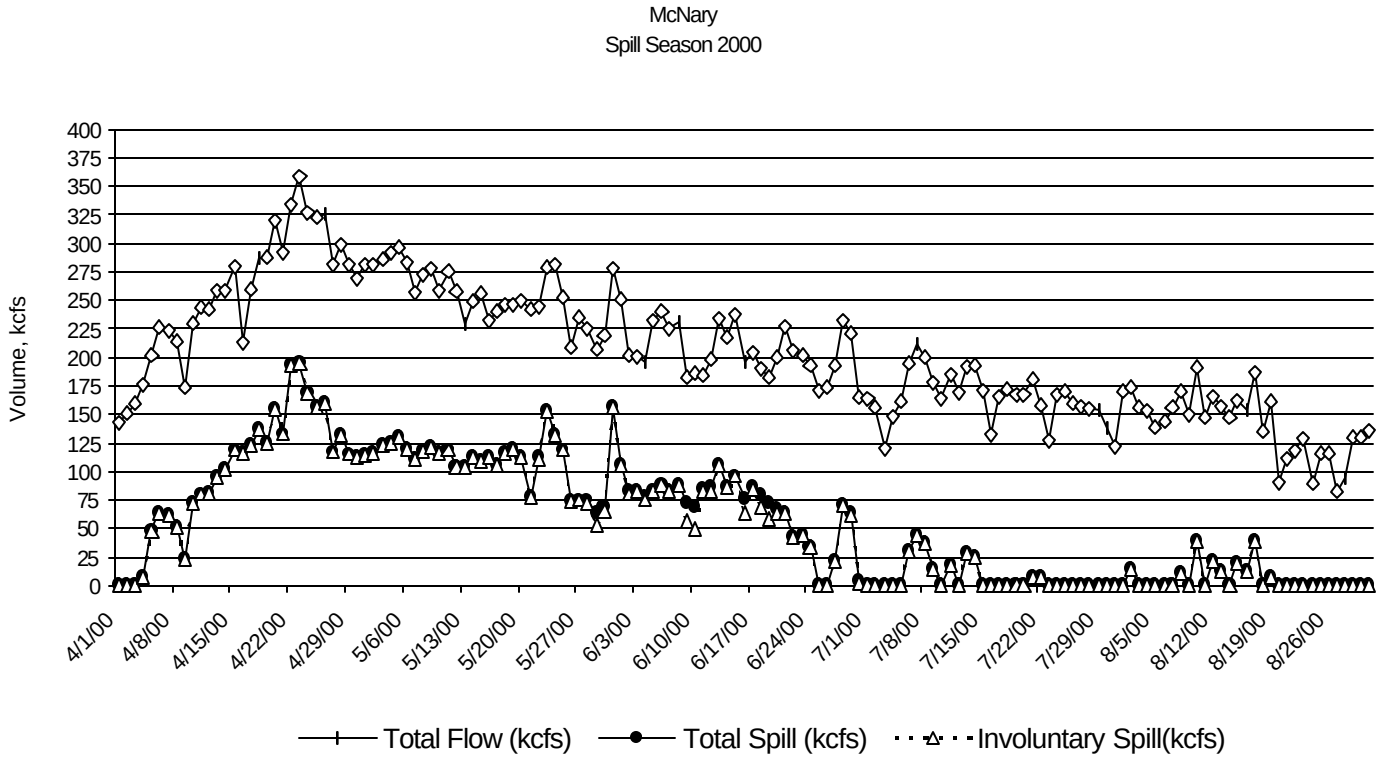


Figure 4 McNary – Involuntary Spill

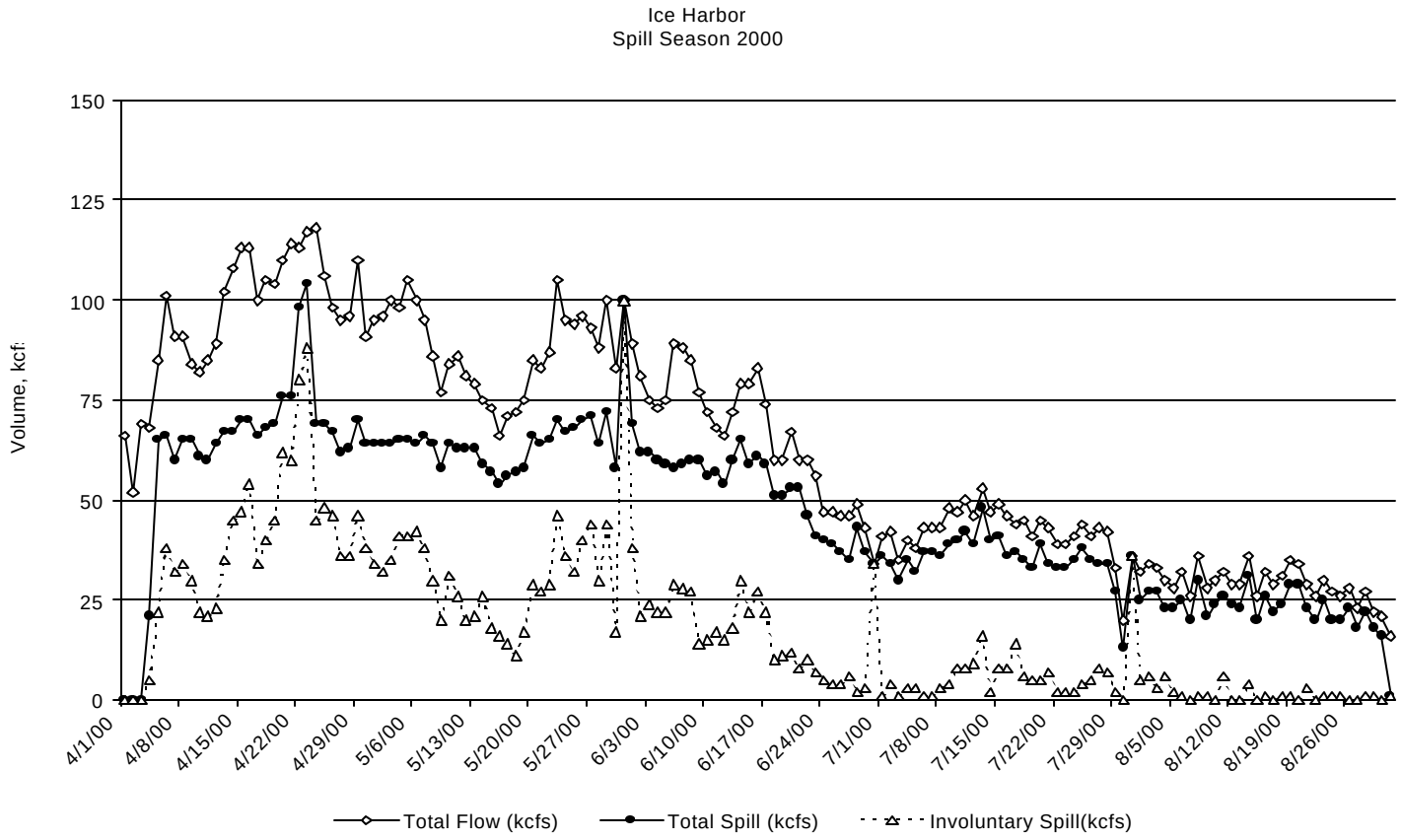


Figure 5 Ice Harbor – Involuntary Spill

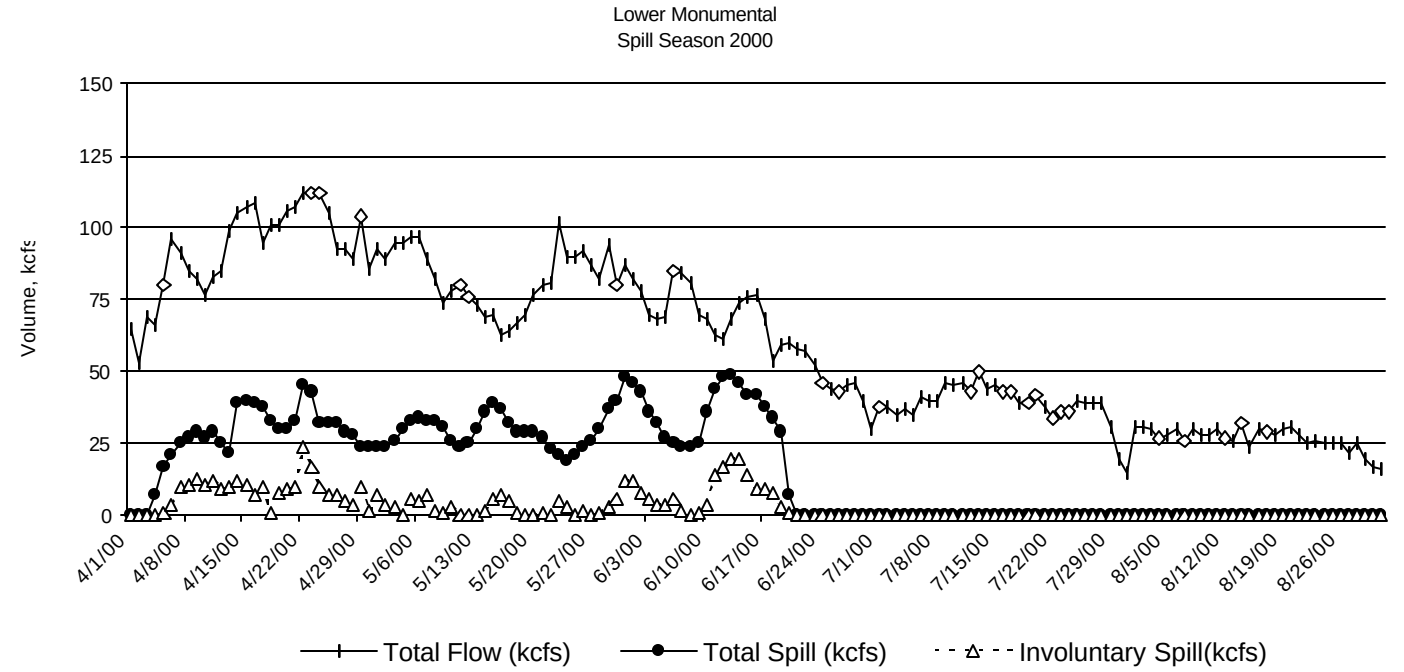


Figure 6 Lower Monumental – Involuntary Spill

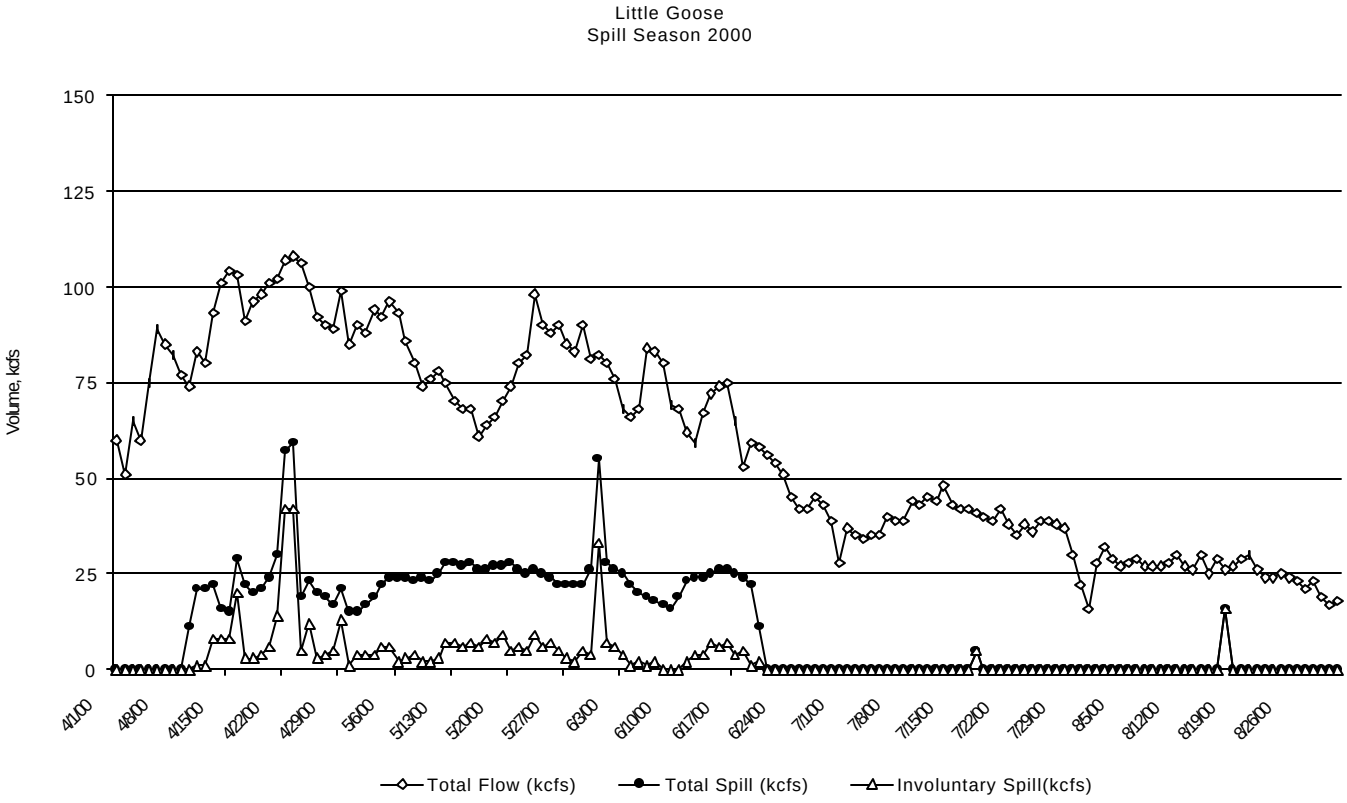


Figure 7 Little Goose – Involuntary Spill

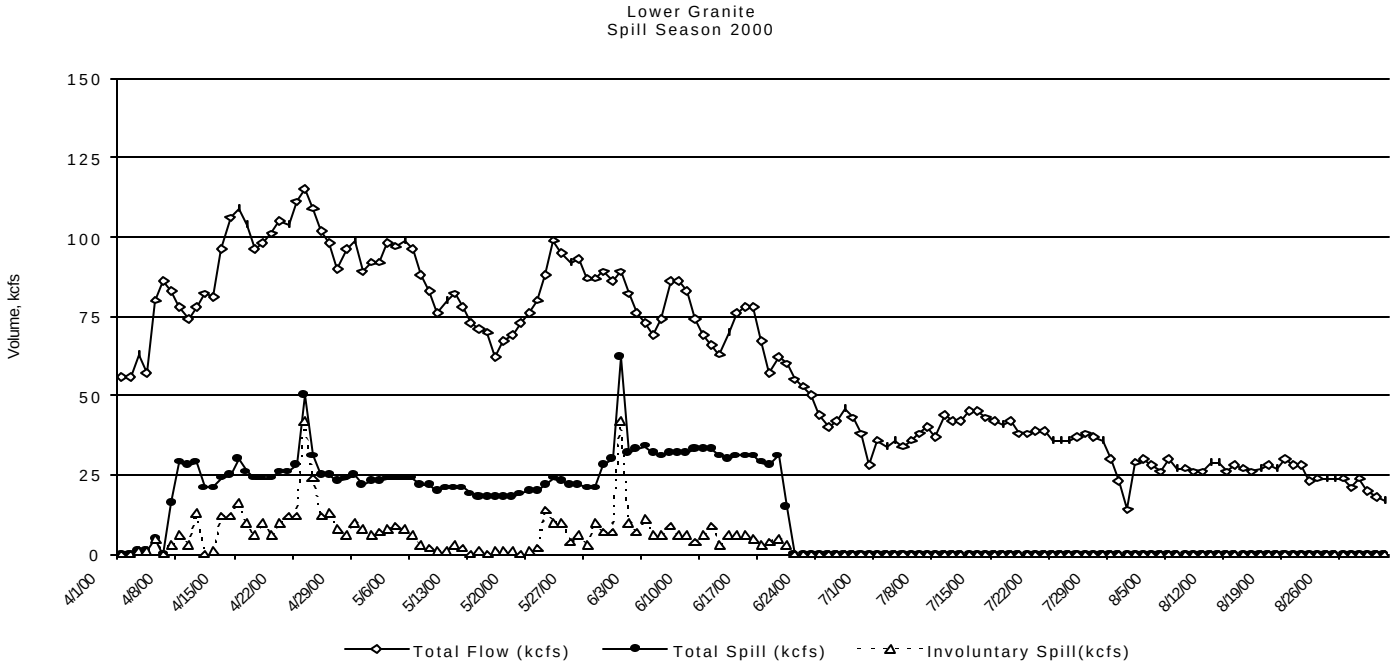
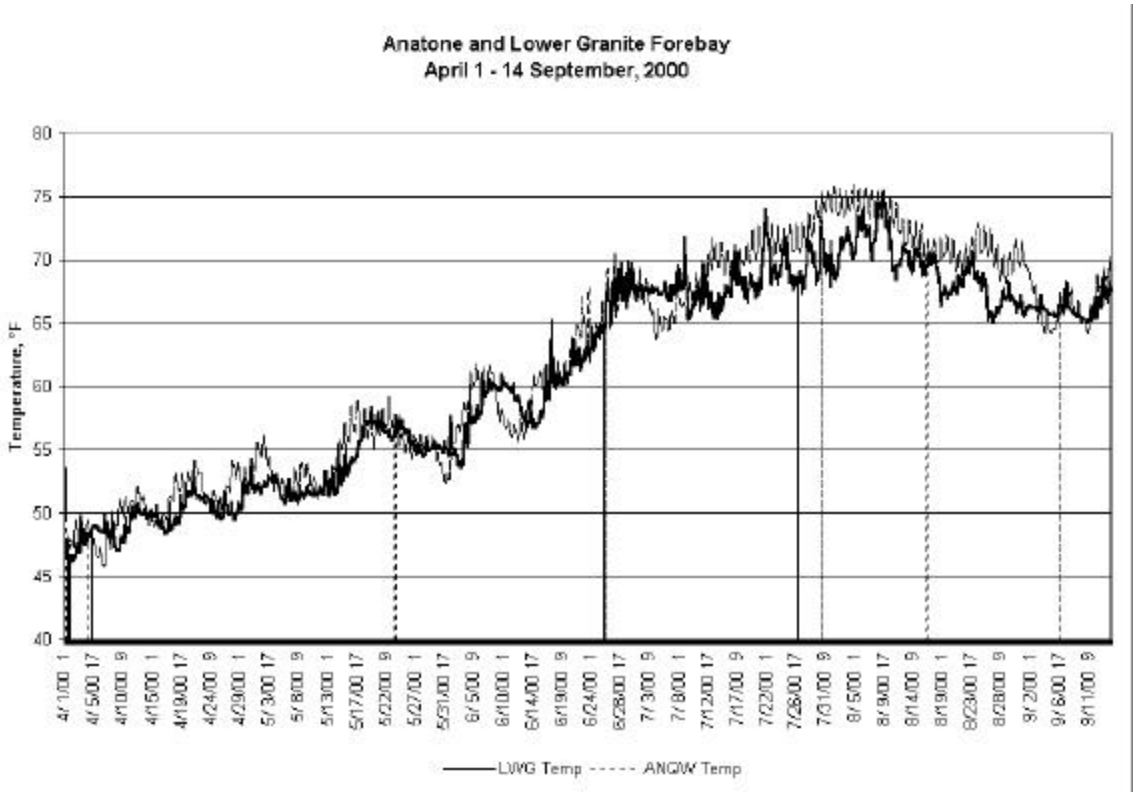


Figure 8 Lower Granite – Involuntary Spill

Dworshak Operations

During the 2000 spill season, cold-water releases from Dworshak reservoir were utilized to maintain cooler water temperatures in the Snake River. Temperature information from resistance thermal devices (RTDs), embedded in the face of the dam at the time of construction, along with an understanding of the overshot and undershot modes of operation of the selector gates were used to determine which elevation of water to release to attain the desired temperature. The temperature profile information was also used to estimate how long temperature control of release water could be maintained before the elevation of the pool was below the selector gate orifices or the warmer, surface layer mixing water was be exhausted.

The following graph contains the temperature data for Anatone and Lower Granite forebay. The reduction in temperature noted between the Anatone station and the Lower Granite forebay station are attributed to the Dworshak cool water releases.



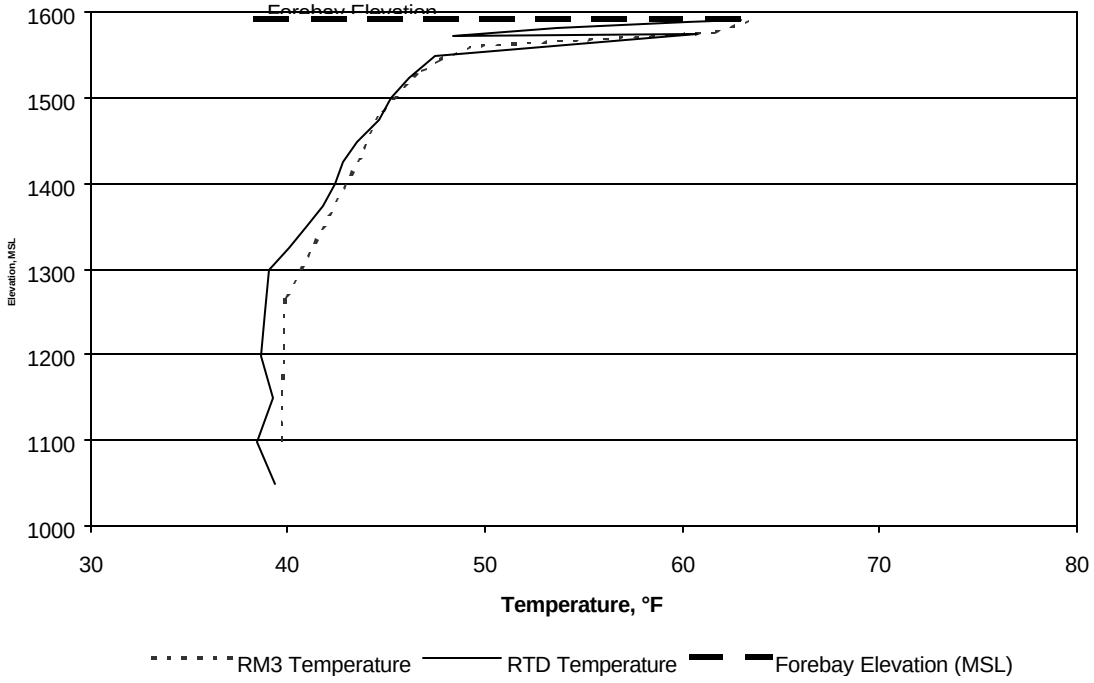
Since the RTDs were installed at the time of construction and are not routinely calibrated there was some concern as to their accuracy. The following 3 graphs include temperature data for 12 June, 17 July and 18 Aug 2000. These graphs contain the RTD data along with data collected at river mile 3 (RM3) of the north fork of the Clearwater River. RM3 is located in the Dworshak Dam forebay, approximately 0.5 miles from the face of Dworshak Dam.

Review of in-season decision-making and these temperature comparison graphs indicate that the accuracy of the RTDs is sufficient for determining forebay elevation releases.

Dworshak Temperature Profile Comparison

12Jun 2000

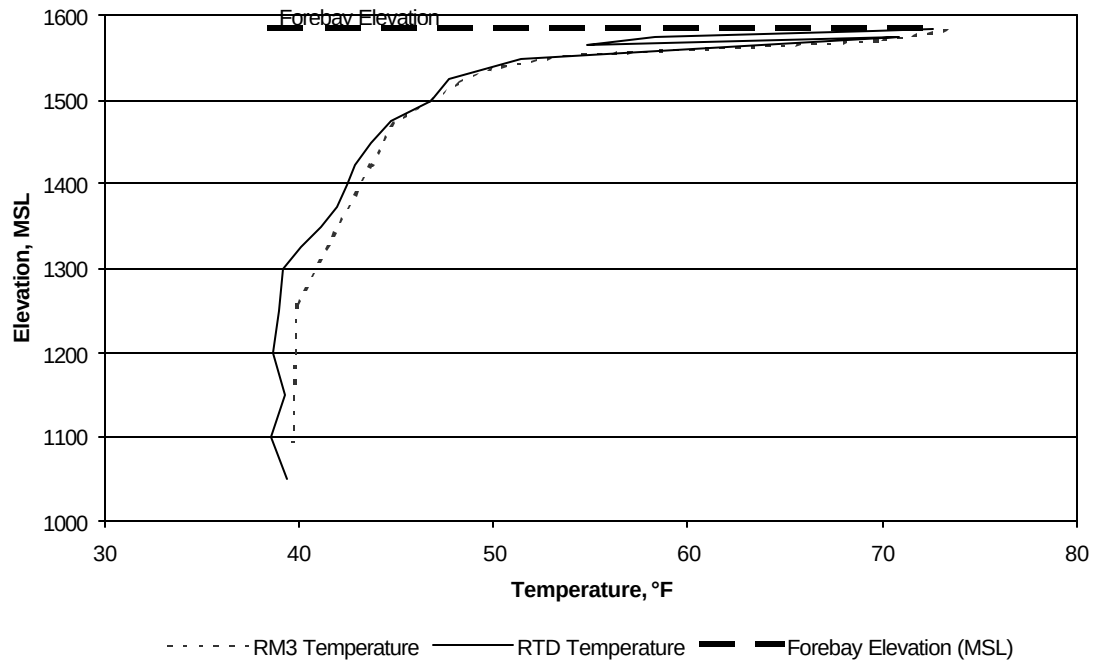
Resistance Thermal Devices (RTDs) and River Mile 3 (RM3)

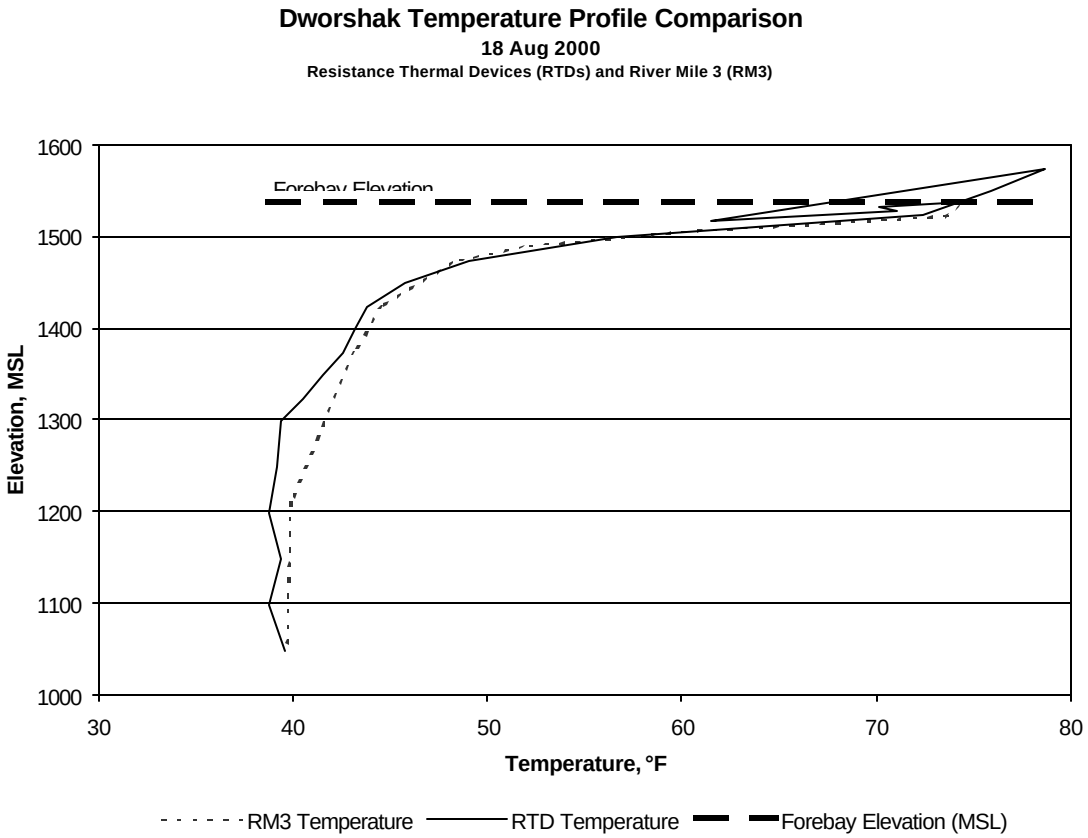


Dworshak Temperature Profile Comparison

17 Jul 2000

Resistance Thermal Devices (RTDs) and River Mile 3 (RM3)





Included next are a side view of the spillway and regulating outlet and side and front view schematics of the selector gates at Dworshak Dam.

Water is released during the spill season at Dworshak Dam for flow augmentation, temperature regulation and power generation. Augmentation water is passed through the powerhouse, over the spillway or through regulating outlets. Typically, above forebay elevation 1545 (the spillway crest), the spillway is used to pass water while maintaining a TDG level below the state standard of 110%. When more volume must be passed and the generation load is already met, water is passed using regulating outlets. Regulating outlets are at elevation 1353 resulting in cold water releases. The water temperature is monitored downstream at the Dworshak National Hatchery. A combination of spillway and/or regulating outlet spill and operating the units in over- or undershot mode is used to regulate the temperature releases.

Notes for the schematic:

- Flow is directed either over (overshot mode) or under (undershot mode) the selector gate, not variable at points in between
- In overshot mode, the top of the gate must be 50 feet below the surface of the forebay. Currently, due to physical limitations at the project, the lowest elevation for the top of the selector gate is 1475 in the overshot mode
- Water can also be released at elevation 1353 through a regulating outlet, bypassing the powerhouse and spillway.
- Water can be passed over the spillway only when the forebay elevation is above 1545.
- The Dworshak National Hatchery uses water directly from the Dworshak releases so releases must be within the range of tolerance for the hatchery

- The Dworshak power house contains 3 turbines: 1900cfs, 2100cfs and 5700cfs.
- Water release temperatures are attained by operating units in overshot or undershot mode to compensate for the spill (spillway or regulating outlet) temperature to achieve a mixture of water that is the desired temperature at the hatchery.
- Unit 2 entrains more air due to the design of the turbine. At low generation capacities this causes TDG levels to be higher than through unit 1.

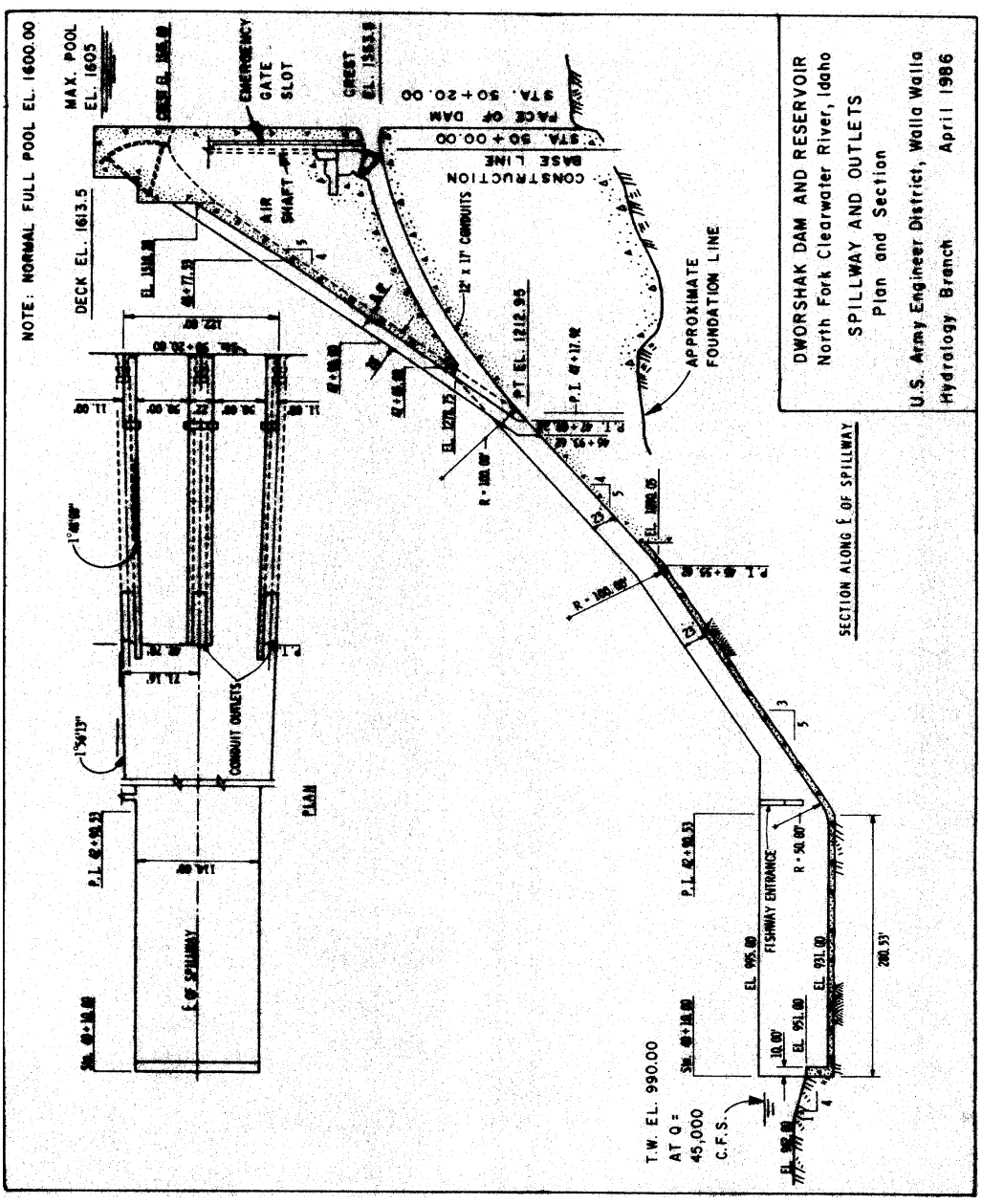


Figure 1. Spillway and Regulating Outlet, Dworshak Dam, Side View

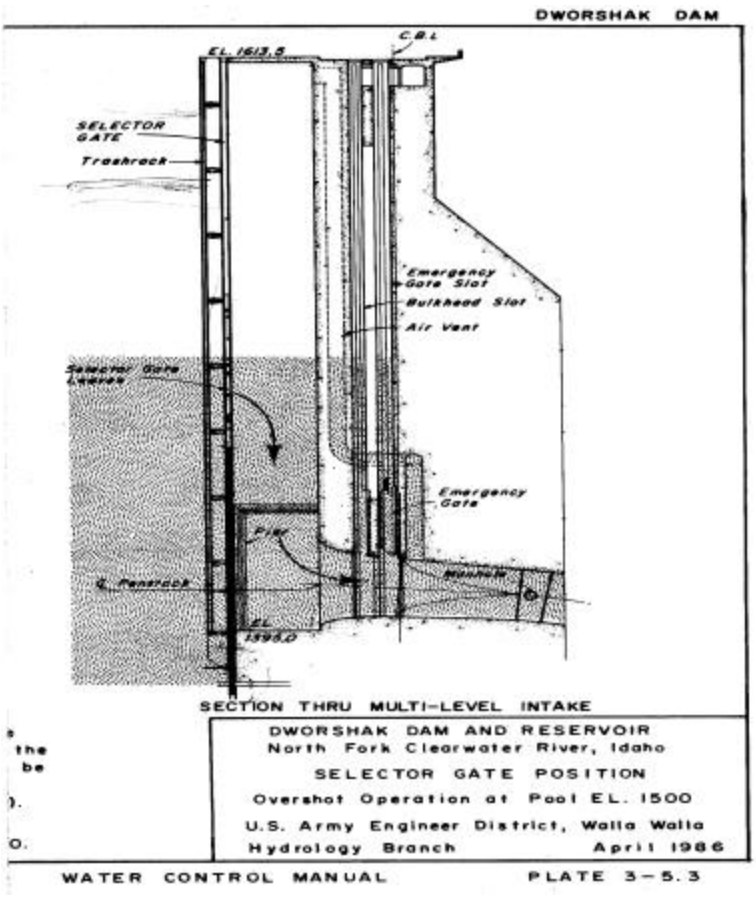


Figure 2. Selector Gate, Overshot Mode, Dworshak Dam, sideview

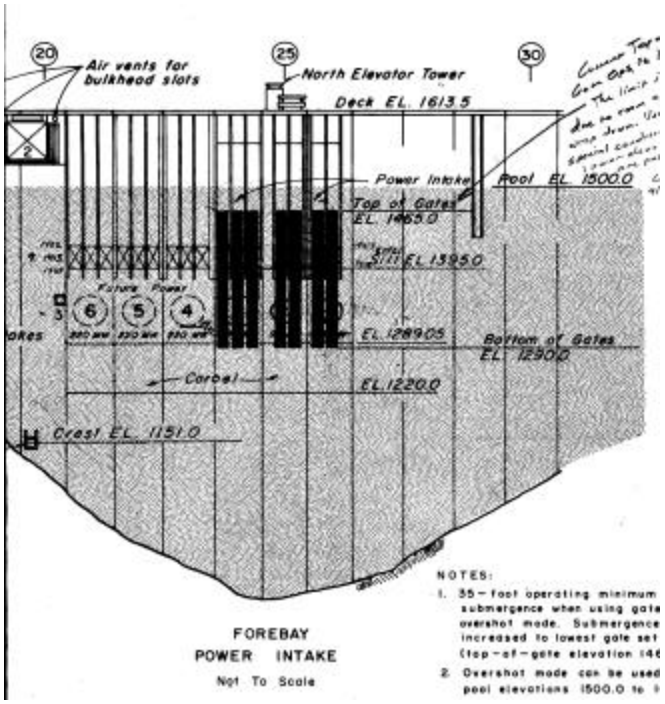


Figure 3. Selector Gate, Overshot Mode, Dworshak Dam, frontview

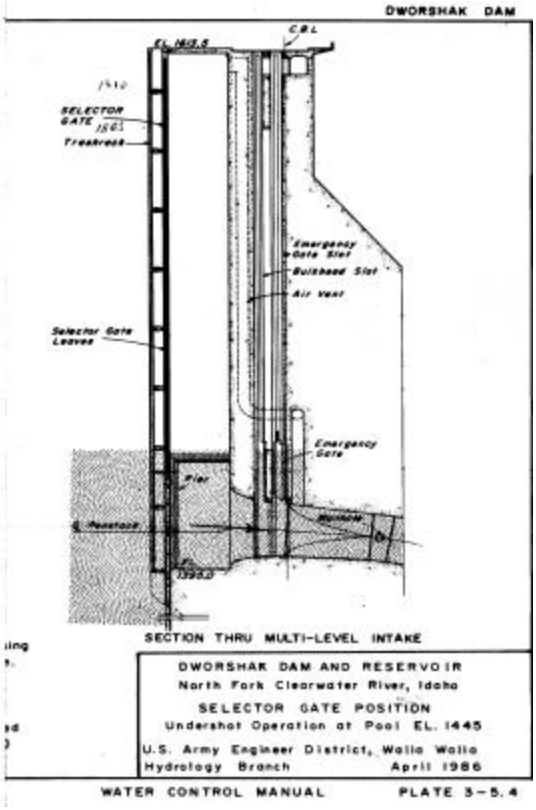


Figure 4. Selector Gate, Undershot Mode, Dworshak Dam, sideview

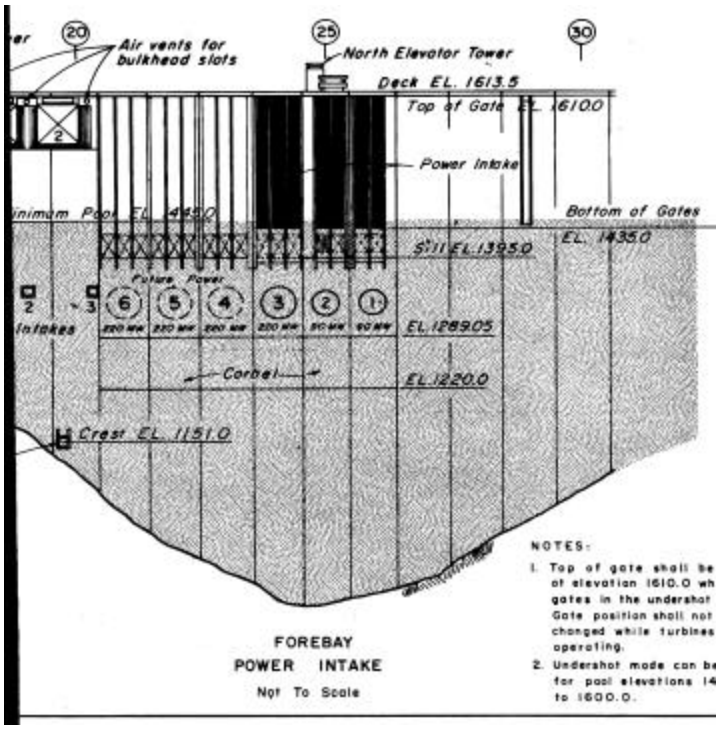


Figure 5. Selector Gate, Undershot Mode, Dworshak Dam, frontview