APPENDIX I

Software, Water Supply Forecasts, & Periods-of-Record Used in the Hydroregulation Modeling

APPENDIX I – SOFTWARE, WATER SUPPLY FORECASTS, & PERIODS-OF-RECORD USED IN THE HYDROREGULATION MODELING

The alternatives evaluated in this EIS change the way river flows and reservoir levels fluctuate over time in the Columbia River basin. To support of the EIS, the Corps and Reclamation performed hydroregulation modeling to simulate how the different alternatives would affect river flows and reservoir levels over a range of years, or period-of-record. Software and assumptions were selected to accommodate circumstances unique to the different areas of Corps and Reclamation responsibility and to best address the primary question at hand. This appendix explains the similarities and differences between various hydroregulation modeling efforts, and explains how they inter-relate.

ISSUE 1: Why are there so many hydroregulation models?

There are 4 major hydroregulation modeling efforts:

1) Columbia basin system-wide flood control modeling using SSARR/Autoreg;

2) Kootenai basin modeling using SSARR/Autoreg;

3) Flathead/ Clark Fork/ Pend Oreille modeling using RiverWare™; and

4) Columbia basin system-wide multi-purpose modeling using HYSSR.

If flood-related impacts need to be captured, a daily time-step model like SSARR/Autoreg (modeling efforts 1 and 2) or RiverWare™ (modeling effort 3) should be used. The Corps of performed daily modeling for the Kootenai basin, and system-wide flood control modeling for the Columbia basin as a whole. For the Kootenai basin, the Corps' SSARR program (with Autoreg pre-/post-processor) has a built-in ability to simulate special rules relating to Kootenay Lake. Likewise, SSARR (with Autoreg) was used for flood control modeling of the entire Columbia basin because of its built-in ability simulate US and Canadian reservoirs in accordance with the Columbia River Treaty Flood Control Operating Plan. The Bureau of Reclamation performed daily modeling for the Flathead/ Clark Fork/ Pend Oreille basins using a software package called RiverWare™, a general river basin modeling tool developed by CADSWES University of Colorado, Boulder. RiverWare™ is a widely-used and accepted simulation model.

Modeling effort 1 was conducted in support of the Environmental Assessment for interim implementation of VARQ (Corps 2002), and remains valid for its purpose of reporting system flood control impacts as part of this EIS. The SSARR/Autoreg simulations for modeling effort 1 provided daily conditions at the primary system flood control points of Birchbank, The Dalles, and Portland/Vancouver and relied on the assumption that Hungry Horse and Libby Dams would begin refilling on May 1 every year under VARQ operations. The May 1 assumption is acceptable on a system-wide basis, but local impacts (such as in the Kootenai or Flathead basin)

can be sensitive to this assumption. Likewise, local basin impacts can be quite sensitive to the water supply forecast used to determine flood storage needs. This is explained in the response to Issue 2.

Modeling efforts 2 and 3 were performed to best portray the local effects of the different alternatives. These efforts were consistent with the regional modeling done for the system flood control analysis (modeling effort 1) and incorporated some aspects of Libby and Hungry Horse operations that were not captured in the system flood control analysis.

The dams in the entire Columbia system do much more than provide flood protection -- they are multi-purpose dams with hydropower, fish and wildlife, recreational, and other uses. To capture the broader multi-purpose operations of Columbia system as a whole, the Corps' HYSSR model was used. HYSSR operates on about a monthly time step (14 periods per year) and is traditionally used to model power output from dams. However, it also incorporates flood control rules and accommodates user-defined operations such as providing flow augmentation from certain dams.

The information obtained from modeling efforts 2 and 3 listed above was used as input to modeling effort 4. For example, daily modeling results for Hungry Horse and Libby Dams were used to tell the HYSSR model what to do. Basically, the HYSSR model targeted the end-of-month reservoir elevations that were achieved in daily modeling (for Libby, the daily modeling was used as HYSSR inputs from May through August; for Hungry Horse, the daily modeling provided the HYSSR inputs for the entire year. Although the HYSSR model doesn't report conditions on a day-by-day basis, the end-of-month conditions it does report are consistent with the daily Libby and Hungry Horse operations.

ISSUE 2: Why are there different water supply forecasts and simulation periods?

Seasonal storage requirements for many dams in the Columbia system are based on water supply forecasts. The forecasting technique for a basin changes with time as data collection and tools for analysis improve. Modeling efforts 1-4 listed above all required some set of assumed water supply forecasts, which are shown for comparison in the Figure I-1.

All of the modeling studies simulated river and reservoir conditions over a period of record with a wide range of water supply conditions. However, the periods of record for the different modeling studies differed based primarily on the availability of the specific water supply forecasts available as model inputs.

For system flood control studies, the Corps has customarily used the Kuehl-Moffitt forecasts and the 61-year period from 1929-1989 (note that the last several years in the 1980s use the forecasts that were actually made and used during those years, including the Wortman-Morrow forecasts for Libby Dam). The Kuehl-Moffitt forecasts are preferred because there can be consistency and comparability with previous flood control studies.

For the Kootenai basin (modeling effort 2), the Corps used a 52-year time period covering 1948-1999. This period was chosen based on the availability of Wortman-Morrow water supply forecasts for Libby Dam (the Wortman-Morrow forecasts only go back through 1948). The selection of water supply forecasts used for Libby Dam modeling is very important when evaluating local basin impacts. For example, compared to the Kuehl-Moffitt technique, the Wortman-Morrow forecast provides a substantial improvement for the water supply forecast in

1948 (a very wet year) and therefore allows the modeling to provide a more representative estimate of flood impacts in the Kootenai basin. At The Dalles, the improved Libby forecast would have also reduced differences in peak flows between Standard and VARQ FC.

For the Flathead/ Clark Fork/ Pend Oreille basin modeling (effort 3), the Bureau of Reclamation used a combination of forecasts to model the period from 1929 through 2002. In real-time operations, Reclamation operates to Reclamations forecast (as opposed to the Kuehl-Moffitt that was used in the system flood studies).

For the system-wide multipurpose modeling, the 52-year period from 1948-1999 was used because this is the common period between the Flathead/ Clark Fork/ Pend Oreille modeling and the Kootenai Modeling (common period shaded with hatch-mark). Reclamation forecasts were used for Hungry Horse, Wortman-Morrow forecasts were used for Libby, and Kuehl-Moffitt and actual forecasts were used for the remaining projects in the Columbia basin.

ISSUE 3: Why does all of this matter?

The results reported in this EIS are based on several modeling efforts, and together they depict the best information available at this time. There is no single integrated system model, so multiple models must be used together to accomplish the various required purposes. The models provide a tool to evaluate and compare how the alternative dam operations may affect reservoir and river conditions. As with any model, the inputs and assumptions that go into the model will influence the output of the model. Although the various hydroregulation models may differ in terms of water supply forecast inputs and periods of records, they provide a reasonable depiction of the hydrologic effects of the various alternative dam operations.

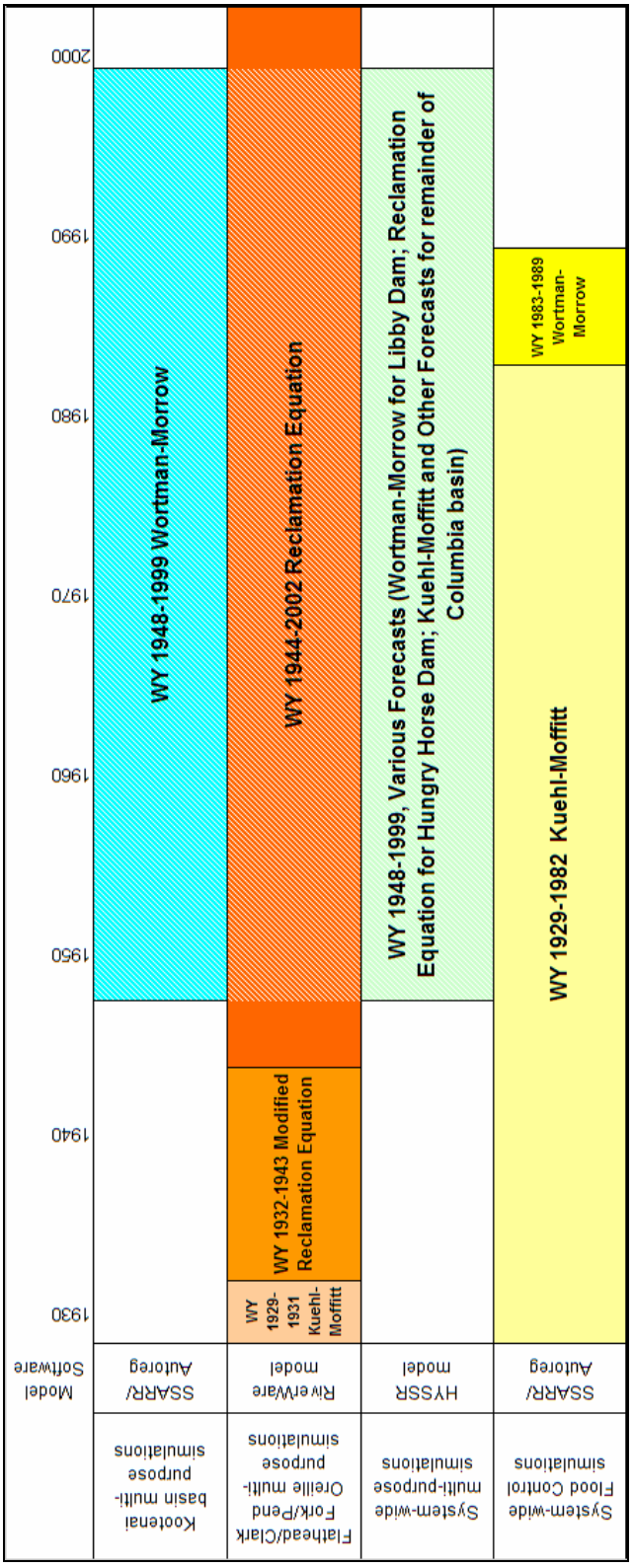

FIGURE I-1. PERIODS OF RECORD, WATER SUPPLY FORECAST, AND MODELING SOFTWARE USED FOR SIMULATIONS IN THIS EIS