U.S. Army Corps of Engineers

Seattle District
&
Northwestern Division

Update on Implementation of Lessons Learned from the 2006 Spring Flood Event

Kootenai/Kootenay River Basin

April 15, 2008

Table of Contents

Appendices

1. Introduction

The U.S. Army Corps of Engineers (Corps) prepared this update to report on follow-up actions recommended in the Lessons Learned identified in the Corps' After Action Report (AAR) in response to the 2006 Kootenai/Kootenay River flood event (U.S. Army Corps of Engineers 2006).

2. Background

2.1 Description of the After Action Report on the 2006 Kootenai River Flood Event

The Corps' AAR summarized the facts leading up to, during, and following the 2006 flood event. Specifically, it provided information concerning: (1) Libby Dam water management decisions in 2006 prior, during, and after the 2006 flood event; (2) the activation of the Emergency Operations Center (EOC); and (3) the response to requests for emergency assistance in the Kootenai River downstream of Libby Dam.

The AAR also identified certain recommendations in the form of "Lessons Learned" to provide decision-makers with information for future operational decisions. Specifically, the AAR's "Lessons Learned" section identified issues requiring additional follow-up analysis, and/or recommended actions concerning emergency response, public affairs communication, and project operations (such as, improving how the Corps performs risk analysis, reviewing the tools that the Corps utilizes to perform risk assessments, and communicating risk to stakeholders and the public, etc.). Additionally, the Corps committed to assessing the information garnered from the 2006 flood event concerning system and local flood damage reduction, the effects of high flows and spill on resident fish below Libby Dam, and the resulting condition of the local levee system.

2.2 Circumstances since completion of AAR

Since the release of the AAR in 2006, the Corps has been working towards implementation of the recommendations outlined in the Lessons Learned section of the AAR. To date, many of the actions recommended in the AAR have been fully implemented. Certain other recommendations involve processes which have been, and will continue to be implemented in the future, subject to real time management in response to each season's unique conditions. Other recommendations continue to be addressed, but, for reasons such as their dependence on other separate but related actions, are still underway. Section 3.1 provides a summary of the Corps responses to the AAR recommendations.

2.3 Libby Dam operations since the 2006 AAR

Based on an environmental assessment completed in 2002, the Corps began implementation of Variable Discharge (or VARQ, with Q representing engineering shorthand for discharge) flood control on an interim basis at Libby Dam in 2003. VARQ flood control enables the Corps to meet its Endangered Species Act responsibilities and provides more water storage for fish flows, while mimicking a more natural river flow compared to Standard flood control.

The Upper Columbia Alternative Flood Control and Fish Operations EIS, or UCEIS, is intended to be the basis for a long-term operational decision for Libby Dam. The Corps finalized the UCEIS in April 2006 and planned to sign a Record of Decision prior to the January 1, 2007 start of the 2007 flood control operation at Libby. With the Kootenai/Kootenay flood event that occurred in May- June 2006, the AAR process was initiated. Pending completion of the follow-up analyses and actions identified in the AAR, the Corps postponed making a final decision on the long-term flood control operation for Libby Dam.[1]

On January 5, 2007, the Northwestern Division Commander signed a decision document to continue interim implementation of VARQ flood control at Libby Dam for 2007; and again on December 21, 2007, the Corps decided to continue interim implementation VARQ flood control for 2008.

In both years (2007 and 2008), the Corps determined that implementing VARQ flood control operation in strict accordance with its operating procedures and providing fish flows[2] was in the public interest. The decisions were based on the determination that strict application of VARQ flood control provides a reasonable level of flood protection (similar to Standard flood control when fish flows are considered) and included management of flows from Libby Dam to avoid, to the extent practicable, river levels at Bonners Ferry that are higher than the flood stage elevation of 1764 feet (mean sea level). This “strict VARQ” application was also the basis of analysis in the UCEIS.

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[1] In accordance with the National Environmental Policy Act, the UCEIS assesses the effects of various combinations of Libby Dam flood control and fish operations. The preferred alternative for Libby Dam calls for implementation of VARQ flood control with fish flows of up to 10 kcfs higher than powerhouse capacity (for a total of up to 35,000 cubic feet per second, or 35 kcfs). Flows above powerhouse capacity could be released, using spill, subject to appropriate reservoir and inflow conditions. Additionally, dam releases for sturgeon would be timed and optimized to provide for water temperatures of 10°C with no more than a 2°C drop in downstream water temperatures. The Corps plans to sign a record of decision (ROD) in spring 2008 that will apply to Libby Dam operations over the long term.

[2] As called for in *the U.S. Fish and Wildlife Service’s Biological Opinion Regarding the Effects of Libby Dam Operations on the Kootenai River White Sturgeon, Bull Trout, and Kootenai Sturgeon Critical Habitat* dated 18 February 2006 (2006 USFWS Biop); and, the operations contained in the National Marine Fisheries Service (NMFS or NOAA) 2004 NMFS Biop addressing effects of the Federal Columbia River Power System (FCRPS) on listed anadromous species.

3. Reporting

3.1 Status Update - Implementation of AAR Lessons Learned Recommendations

The AAR Lessons Learned[3] were intended to assist the Corps in making future decisions regarding Flood Response (Emergency Management), Public Affairs (PAO), and Libby Dam Operations.

For each of these three categories, the section below summarizes the recommendation from the Lessons Learned section of the AAR, and then provides an update as to the response to the recommendation and the status of its implementation. The format is as follows:

Tab #X AAR Lesson Learned Issue Recommendation: Summary of recommendation from AAR

Issue Status Update
Response to AAR recommendation.

3.1.1 Tab One - Flood Response (Emergency Management) Lessons Learned

Tab One Issue #1 Recommendation– Field Team Readiness: The Corps will continue annual coordination and training activities for District flood teams and continue close coordination with local governments throughout the year.

Issue #1 Status
Complete/On-going: Seattle District and local government flood teams continue to exercise and train together on an annual basis. The most recent exercises/coordination meetings were held in October 2007 for western Washington river basins, in preparation for the Nov-Feb flood season. The effectiveness of this training was demonstrated by the District's successful execution of flood response activities in the December 1 to 15, 2007 flood event in western Washington. Emergency Management assisted the State of Idaho with flood response training during March 2008 and will conduct flood coordination meetings during April 2008. Spring flood preparation activities will be conducted in preparation for the April-June flood season in eastern Washington, northern Idaho, and western Montana. In addition, flood team rosters have been updated to reflect personnel changes and to eliminate team member overlap. These will be evaluated and updated on a continuing basis. For additional information on levee conditions along the Kootenai River from Bonners Ferry to the international border see Appendix A.

Tab One Issue #2 Recommendation– Flood Response Contracting Support: The Corps will review and revise the Emergency Purchasing Standard Operating

[3] The Lessons Learned can be found as Appendix Y to the 2006 AAR.

Procedure (SOP) as required on a continuing basis. Contracting Division and Purchasing Branch personnel will receive annual flood procurement training.

Tab One Issue #2 Status
On-going: An initial scoping meeting for SOP revision was held in October 2007. Emergency Management Branch and Contracting Division are currently updating the Emergency Purchasing SOP and will incorporate it into Emergency Operations Center SOP by September 30, 2008.

Tab One Issue #3 Recommendation– Emergency Operations Center (EOC) Staffing: The Corps is committed to conducting annual EOC staff training. Additional team members will be sought to provide adequate and appropriate personnel for EOC operations. Each functional team will be adequately staffed and trained. EOC functional team guides and the EOC plan will be updated. EOC exercises will be conducted on a routine basis. In the future, the Corps will utilize the EOC plan during emergency response operations.

Tab One Issue #3 Status
Complete: Emergency Management Branch updated the EOC staff roster and conducted an all day training and desk top exercise in October 2007. Each EOC functional team has been staffed with experienced and trained personnel. All teams successfully conducted EOC operations during the December 1 to 15, 2007 flood event. This event demonstrated EOC staffing to be adequate and personnel adequately trained. The EOC staff roster will be reviewed and updated, and EOC staff will be trained prior to each flood season.

Tab One Issue #4 Recommendation – Flood Response Communications (external): In the future, the Corps will make contact with the affected state as soon as we are aware of a potential flood event. The Corps will continue to train and implement the Incident Command System (ICS) structure into Corps response activities and the EOC plan, as well as provide daily updates to the State, in addition to the situation reports (SITREPs).

Tab One Issue #4 Status
On-going:

a. Prior to deploying disaster response personnel, Seattle District opens daily communications with affected state EOCs. Deployment of Seattle District personnel to the WA State EOC during the December 1 to 15, 2007 floods in western Washington illustrates the District's effective execution of this concept. Seattle District identified and trained three people to deploy to state and local EOCs. These employees staffed the Washington State EOC during the December 2007 flood on a rotational basis and successfully performed state liaison duties. They provided a critical information link between the State and Corps operations. Two Portland District personnel also visited the Washington EOC and were trained on liaison duties as a backup to Seattle District. In addition to staffing the Washington EOC, Seattle District exchanged SITREPs with Washington and Oregon EOCs on a daily basis during the December 2007 flooding. Emergency Management will incorporate these procedures into the Seattle District EOC SOP update by September 30, 2008.

b. The District EOC staffing plan has been modeled after the ICS format. In counties where ICS is used, the Corps has designated personnel to represent the Corps in the local ICS organization. Boundary County, Idaho, and Lincoln County, Montana, have integrated Corps flood response personnel into the local ICS structure.

Tab One Issue #5 Recommendation – Flood Response Communications (internal): The Corps will continue daily conference calls and emails between EOC and Seattle District Reservoir Control Center (RCC) during emergency events.

Tab One Issue #5 Status

On-going: EOC procedures have been modified to include the Seattle District RCC in daily briefings as part of the established operations schedule. Emergency Management staff attends the RCC morning brief at 0800 daily during floods. In turn, RCC staff updates the Crisis Management Team (CMT) and Seattle District Emergency Management on river and weather information daily as part of a 1030 EOC brief. This concept was tested and successfully executed in the December 1 to 15, 2007 floods in western Washington, and was useful linking both Emergency Management and system-wide Water Management operations.

Tab One Issue: #6 Recommendation– Data Collection and Upward Reporting: Recommendations include…

a. The EOC will provide copies of all relevant information in an easily accessible location for others within the district to access (whether in electronic format or by hard copy). Examples are SITREPs, weather updates, RCC information, ongoing tasks, flood teams activated, and team members deployed.
b. EOC staff will be more diligent in completing conversation records for all calls and discussions for posting on the message board. This will ensure all information is available for staff and command use, and a complete legal record is kept.
c. The Seattle District Commander and the CMT will receive a briefing each day that the EOC is activated.

Tab One Issue #6 Status

Complete:

a. All relevant information is updated and posted daily in the Kaiser Room in Seattle District by EOC staff. This includes SITREPs and pertinent information from the CMT briefing package, including weather updates, RCC information, ongoing tasks, flood teams activated, and team members deployed. In addition, daily district SITREPs and CMT briefs are emailed to a SITREP e-mail distribution list, which informs pertinent local, state, Corps, and Congressional addressees of district response activities.

b. The EOC staff has refined the EOC data collection and action tracking system. A Microsoft Access system was developed to collect data, track actions, and display scaleable reports. The data collection and action tracking system was tested during the EOC table top exercise and successfully used during the December 2007 western Washington floods. The updated system resides in a shared computer drive at Seattle District and instructions will be documented in the EOC SOP.
c. This practice will be included in the EOC SOP. An example of implementation was a daily 1030 brief for the Seattle District Commander and the CMT during EOC activation in the December 2007 floods.

Tab One Issue #7 Recommendation– Bonners Ferry Flood Stage: The Corps has begun, and will continue to collect flood data and provide this and other information to the National Weather Service for their consideration in setting flood stage at Bonners Ferry.

Tab One Issue #7 Status
Complete: Seattle District provided information about the 2006 flood impacts and EM response to the National Weather Service in April 2007; and followed up with updates in October 2007. On October 29, 2007, the National Weather Service announced their decision to retain the Kootenai River flood stage of 1764 feet at Bonners Ferry, Idaho.

Tab One Issue #8 Recommendation– Environmental Coordination during Flood Response: Once there is a determination of an emergency flood fight, the EOC will directly contact a designated point-of-contact in the Seattle District Environmental Resources Section (ERS). The ERS designee will be involved in initial field work to help provide engineers with advice concerning the environmental impacts associated with different design alternatives. Further, the State Historic Preservation Officer (SHPO) and appropriate Tribal departments will also be contacted regarding the location and impacts of proposed work. The Corps will review existing processes and modify as necessary to insure adequate environmental coordination before, during and after flood fight activities.

Tab One Issue #8 Status
Complete: The current environmental coordination procedures were reviewed and tested during the recent EOC table top exercise. EOC staff members are familiar with the notification procedures. These procedures were also successfully executed in the December 1 to 15, 2007 flood event in western Washington.

Tab One Issue #9 Recommendation– Event Specific Information: The Corps is committed to improving internal Corps communication (HQ, Division, District) concerning operational considerations (flood damage reduction, Endangered Species Act responsibilities, as well as other operational objectives) for projects. The various Corps' offices (HQ, Division, and District) will discuss the policy of funding localized flood damage impacts related to project operations for the multiple purposes of the project that are within authorized range of operations.

Tab One Issue #9 Status
Completed: During the spring refill season, required releases under any continued VARQ flood control operations and flow augmentation for sturgeon will likely result in river stages near flood stage in many years. Emergency Management worked with HQ and Division to clarify the policy and authorization for addressing flood damage impacts along the Kootenai River. The Kootenai River Flood Response Protocol (See Appendix B) applies existing regulations to Corps emergency response activities related to the multiple purpose operation of Libby Dam. The Corps is committed to monitoring the real-time effects of high river flows and assisting local communities in addressing potential impacts to life and safety. The Corps will continue to operate Libby Dam with protection of life and safety as a first priority, while recognizing the Corps' responsibilities to provide flow augmentation for threatened and endangered fish species, to the extent practicable.

3.1.2 Tab Two - Public Affairs Lessons Learned

Tab Two Issue #1 Recommendation – Communication with the Public and Media: One or more public affairs specialist(s) should augment the project staff and provide public support during major events on-site.

Tab Two Issue #1 Status
Complete/On-going: Staff from Seattle District's Public Affairs Office is prepared to travel to Libby Dam to support Libby Project staff during a major event.

Tab Two Issue #2 Recommendation– Communication between Northwestern Division and Seattle District: During the spring run-off event, water management information from Northwestern Division was, at times, shared with local stakeholders (emergency responders), but not with Seattle District staff.

Tab Two Issue #2 Status
Complete/On-going: Libby Strategic Communication Plan for the 2007 operation was developed, coordinated, and used for the day-to-day operations. No emergencies occurred in the 2007 runoff. Seattle District's Public Affairs Office will continue to update the communication plan for 2008 operations and as needed.

<u>Tab Two Issue #3 Recommendation– Communication with Federal Agencies</u>: Develop and maintain a list of federal contacts in the basin and update on an annual basis. Keep contacts on the list informed of Corps activities in the basin.

<u>Tab Two Issue #3 Status</u>
Complete/On-going: Seattle District's Public Affairs Office worked with Libby Dam project biologist to update the e-mail notification list for Kootenai River Basin activities. The Public Affairs Office will continue to update and review the list on an annual basis.

<u>Tab Two Issue #4 Recommendation – Public Information, Risk Communication, and Coordination</u>: Existing forums for public and stakeholder involvement in Libby Dam operations and their effects downstream should be reviewed for their effectiveness and level of transparency. Future communications from the Corps will better inform the public and stakeholders of the risks of operating Libby Dam.

<u>Tab Two Issue #4 Status</u>
Complete/On-going: Stakeholders are notified about changes in operations at Libby Dam by news release, web site postings, email, and phone calls. An expanded effort to communicate risk has been made in public meetings, news releases, emails and communications with stakeholders. Communication with other agencies and community leaders has increased.

<u>Tab Two Issue #5 Recommendation– Flood Response Communication (external)</u>: The Corps should initiate contact with the impacted state and provide daily updates. Continue to train and implement ICS structure into Corps response activities and EOC plan. Ensure that Libby Dam has the ability to adequately support conference calls during emergency situations.

<u>Tab Two Issue #5 Status</u>
On-going: The EOC communication procedures were exercised and tested during the 2007 table top EOC exercise. The communications SOP will be included in the EOC SOP update scheduled to be completed later this year. The external communication procedures are reviewed at the flood engineer's semi-annual meeting. The District now has a teleconference line for use for updates and coordination during emergency situations that can accommodate as many callers as necessary.

3.1.3 Tab Three –Libby Operations Lessons Learned

<u>Tab Three Issue #1A Recommendation – VARQ flood control Refill Guidance</u>: The Corps is committed to reviewing and revising the processes and procedures for issuing VARQ flood control Refill Guidance.

<u>Tab Three Issue #1A Status</u>
Complete: Procedures for issuing VARQ flood control Refill Guidance have been clarified (see Appendix C) and incorporated into the updated Water

Control Plan as part of the Water Control Manual for Libby Dam and Lake Koocanusa.

Tab Three Issue #1B – Modification Process to VARQ Flood Control Guidance: A timely risk assessment to address real-time conditions will be developed to address requests for modifications from the Flood Control Guidance, including VARQ flood control Refill Guidance (aka deviation request).

Tab Three Issue #1B Status

Complete: The Corps has developed a new regulating tool that models all Libby traces from the Ensemble Streamflow Prediction (ESP) approach to probabilistic forecasting. Throughout the 2007 runoff season, this tool was used each week to analyze possible runoff scenarios and to test various operational plans. The Corps will continue to utilize this tool during the 2008 runoff season. A Division-wide group of water managers met in March 2007 to explore the potential for other new risk assessment tools, but no new methodologies have been developed to date.

Tab Three Issue #1C – NEPA Documentation on VARQ Flood Control: Address assumptions made in the Upper Columbia Alternative Flood Control and Fish Operations Final Environmental Impact Statement (UCEIS) concerning system operations for flood control, effects on all project uses, and compliance with applicable laws and regulations.

Tab Three Issue #1C Status

Complete: Appendix D details an analysis which evaluated and determined that the modeling of Columbia River system operations in the UCEIS adequately addresses system flood control impacts from a range of Libby Dam alternative operations. Previous UCEIS analysis addressed effects on all project uses and compliance with applicable laws and regulations.

Tab Three Issue #1D Recommendation – Corps NWD and NWS Roles: The Corps will identify a systematic approach for ensuring that all parties on the Corps' regional team have a common understanding of planning protocols and operational requirements and are communicating on a regular basis to discuss upcoming operations and any potential modifications.

Tab Three Issue #1D Status

Complete: Systematic approaches for understanding protocols/requirements and for NWS/NWD communication were developed and documented in the Water Management Communication Plan for Libby Dam. They continue to be a key consideration through current re-organization of the Corps Columbia Basin Water Management organization, as described in the Draft Water management Phase II Transition Report of System and Tributary Regulation.

Tab Three Issue #1E – Libby Water Control Plan and Water Control Manual: The Corps will review the procedures for updating the Water Control Manual in a timely manner, as appropriate.

Tab Three Issue #1E Status

Partially Complete: Seattle District updated the Water Control Plan in the Water Control Manual for Libby Dam and Lake Koocanusa in December 2007 (see Issue #1A above) to reflect interim operations under the VARQ flood control Operating Procedures. After a decision is made on long-term Libby operations (currently planned for May 2008), the Water Control Plan and Water Control Manual will be updated as necessary to reflect any operational changes.

Tab Three Issue #1F – VARQ and ESA Operations: The Corps is committed to reviewing and re-assessing the effects of implementing VARQ flood control with and without flexibility to provide for system and local flood damage reduction and the desired objectives for listed species as expressed by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Services (formerly, NOAA Fisheries).

Tab Three Issue #1F Status

Complete: See Appendix D. The assessment of VARQ flood control was done by modeling VARQ without flexibility (i.e. assuming no deviations) for the UCEIS (see Tab Three Issue #1C above) and results were fully coordinated with USFWS and NMFS before and during the official NEPA disclosure process. Libby operations in 2007 and 2008 implemented VARQ flood control in strict accordance with the procedures. Future operations under VARQ flood control would continue to maintain a reasonable level of flood protection (i.e. similar to Standard flood control when fish flows are considered). If flexibility in VARQ flood control operations were to be allowed for ESA or other purposes, it could be accomplished via evaluation and approval through a deviation request process (NWD Regulation 110-2-6) that would ensure that risks of the proposed deviation are minimized. Implementation of VARQ flood control in this manner enables the Corps to meet its ESA responsibilities by providing more water storage for fish flows while mimicking a more natural river flow compared to Standard flood control.

For additional information regarding sturgeon and bull trout response to the 2006 operation, see Appendix E.

4. Reference

U.S. Army Corps of Engineers. 2006. *2006 Spring Flood Event, Kootenai/Kootenay River Basin, After Action Report*. Seattle District and Northwestern Division.

Appendix A – Levee Conditions Along the Kootenai River

LEVEE CONDITIONS

The following section provides updated information on levee conditions along the Kootenai River from Bonners Ferry downstream to the international border.[1] The information provided in this section is drawn from two sources. The first source is the 2005 *Bonners Ferry Flood Level Study Report*[2] (Corps 2005), which provides the most accurate characterization of levee conditions prior to the 2006 flood event. The second source is the 2007 *Kootenai River Levee Inspection Report*[3] (Corps 2007), which documents the findings of levee inspections during the fall of 2006 (i.e., after the 2006 flood event).

The 2005 report considered levee conditions, river conditions under different dam operations, and flood risk to estimate the likelihood that area protected by different levee sections would experience flooding in any given year. The 2007 report, which provides a snapshot of levee conditions after the 2006 event, provides an opportunity to assess whether the 2006 flood event resulted in deterioration of levee conditions that could lead to an increase in flood likelihood.

The Corps has looked at whether revisions to this study would be needed in light of 2006 operations and subsequent levee observations. The Corps has determined that the existing levee analysis is still valid. Likewise, the Libby Dam operations as modeled remain valid because the fundamental VARQ or Standard flood control rules are followed. Overall, the study as conducted is an appropriate representation of levee condition and flood risk for the Kootenai River valley (see below).

It is important to note that the levee condition inspections conducted pre- and post-flood event had different objectives. The pre-flood event inspection was for a flood level study and required a determination of the water level that could be passed within certain bands of risk. In contrast, the post-flood event inspection was done to assess potential eligibility into a government program, and called for a qualitative, though very thorough, review of levee characteristics. Despite the differing objectives, it is prudent to verify that the levee inspection conducted in the fall of 2006 did not reveal anything to suggest that the findings from the *Bonners Ferry Flood Level Study* might be invalid. This is particularly important, in light of the sustained high water levels experienced in May and June 2006.

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[1] Note that the levees in the Kootenai valley in Idaho are not federal levees. Thus, it is the responsibility of the local owner (i.e., county or drainage districts) to maintain them, and the Corps has no unilateral authority to maintain or improve them.

[2] This report was prepared to comply with three elements of the Reasonable and Prudent Alternative provided in the US Fish and Wildlife Service's 2000 Biological Opinion on Federal Columbia River Power System operations.

[3] This report was prepared in response to letters from Boundary County, Idaho and the City of Bonners Ferry, Idaho, requesting the Corps to inspect drainage district levees and to evaluate their potential for inclusion in the Corps Rehabilitation and Inspection Program. Levees included in this program may be eligible for federally managed, cost-shared rehabilitation of flood damage, when it occurs, in accordance with Public Law 84-99.

The findings documented in the inspection report are consistent with what was seen and expected when the Bonners Ferry Flood Level Study was conducted. An exception to this would have been at the right bank levee adjacent to the Bonners Ferry waste water treatment plant, where signs of erosion prompted a request for flood fighting assistance in May 2006. After significant strengthening with riprap during the 2006 flood fight and subsequent repair of additional areas in 2007, the integrity of the levee has likely improved from what it was when the levee conditions were assessed prior to the 2006 flood event.

FUTURE MONITORING OF KOOTENAI RIVER LEVEES

The Corps inspects levees along the Kootenai River in Idaho at least bi-annually. The inspection records damage locations, damage severity, and maintenance deficiencies. Routine maintenance of the levees in Idaho is the responsibility of local entities. In the Kootenai valley, many levees are not eligible for federally-managed cost-shared repairs under the Corps' Public Law (PL) 84-99 emergency management authority, unless and until the responsible local entities perform substantial maintenance work to bring them up to the Corps' Rehabilitation and Inspection ("RIP") program standards. Once up to RIP program standards, the levees are eligible to participate in the RIP program, and participating levees that experience subsequent flood damage may be eligible for cost-shared rehabilitation of flood damage under PL 84-99. The Corps will continue to provide technical assistance to local drainage districts and governments for their maintenance efforts even for levees that are not eligible in the RIP program, but we do not have authority to repair levee damage resulting from deterioration due to lack of maintenance. For levees in the valley that are enrolled in the Corps' RIP/PL 84-99 program, the Corps is authorized to repair flood-damaged levees to pre-flood conditions.

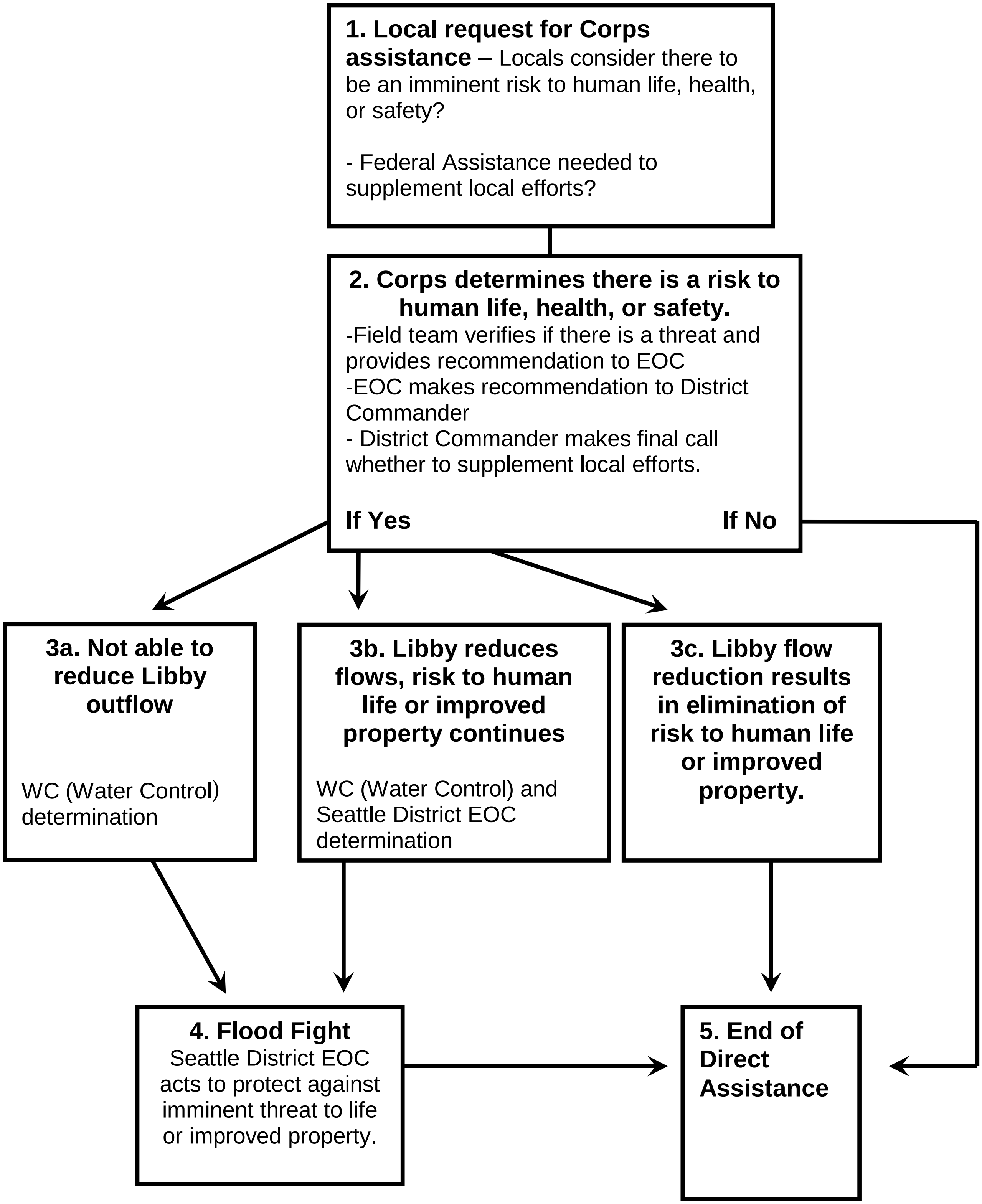
REFERENCES

U.S. Army Corps of Engineers. 2007. *Kootenai River Levee Inspection Report.* Seattle District.

U.S. Army Corps of Engineers. 2005. Bonners Ferry Flood Level Study Report. Seattle District.

Appendix B – Kootenai River Flood Response Protocol

20 Feb 2008


1. Local request for Corps assistance – Locals consider there to be an imminent risk to human life, health, or safety?
- Federal Assistance needed to supplement local efforts?
2. Corps determines there is a risk to human life, health, or safety.
-Field team verifies if there is a threat and provides recommendation to EOC
-EOC makes recommendation to District Commander
- District Commander makes final call whether to supplement local efforts.
If Yes
If No
3a. Not able to reduce Libby outflow
WC (Water Control) determination
3b. Libby reduces flows, risk to human life or improved property continues
WC (Water Control) and Seattle District EOC determination
3c. Libby flow reduction results in elimination of risk to human life or improved property.
4. Flood Fight
Seattle District EOC acts to protect against imminent threat to life or improved property.
5. End of Direct Assistance

The Corps intends on operating Libby Dam with a strict application of the eight-step VARQ Operating Procedures. Under this strict application of VARQ, the Corps plans to continue operating Libby Dam, to the extent practicable, at or below a stage of 1764 feet measured at Bonners Ferry, Idaho, and will provide flows for sturgeon based on the Flow Plan Implementation Protocol and the volume tiers in the U.S. Fish and Wildlife Service 2006 Biological Opinion. The Corps believes that this planned operation will be protective of human life, health, or safety[1]. If, however, an emergency event develops in the Kootenai River Basin, the following emergency response protocol steps should be followed:

STEP 1: REQUEST FOR CORPS ASSISTANCE.

Public Law 84-99 allows the Corps to provide flood emergency assistance at the request of local government. Requests for assistance can initially be made verbally to the Seattle District to be followed up in writing. The specific requirements regarding the request for assistance can be found in ER 500-1-1 and EP 500-1-1.

STEP 2: EVALUATION OF RISKS FROM FLOODING.

Upon receipt of a request for flood emergency assistance, the Corps field team will evaluate the flood hazard and determine if:

1. There is an imminent flood threat to human life, health, or safety.
2. The situation and proposed response action is beyond the capability of the local community.
3. Identify a constructible, temporary measure that will alleviate the immediate flood threat.
4. Implementing the recommended alternative is in the public interest.
    - Economically justified.
    - Protecting public infrastructure or multiple properties (per ER 500-1-1 guidance).
    - Limit adverse environmental impacts to the extent practical.

The Seattle field team will make a recommendation to the Seattle District EOC, who, after conferring with a multi-disciplinary team, will provide a recommendation to the Seattle District Commander. The Seattle District Commander will then determine if there is an imminent threat to human life, health, or safety and that the emergency response required is beyond the capability of the locals. If the Seattle District Commander considers it warranted under the situation, s/he will declare a flood emergency and will request PL 84-99 authority and funding.

[1] The phrase "human life, health, or safety" is defined for purposes of this protocol as an imminent flood risk to a person's life, public infrastructure/public utilities that support the health and well-being of the community, and/or the structures in which people live, subject to the general guidance of ER 500-1-1.

STEP 3: LIBBY DAM OPERATIONAL DECISIONS TO REDUCE THREAT TO LIFE, HEALTH OR SAFETY.

If it is determined by the Seattle District Commander in Step 2 that an imminent threat to human life, health, or safety exists, the Chief of the Northwestern Division Water Management and WC (Water Control)will determine if Libby Dam can meaningfully reduce outflows in the short term to reduce the threat to human life, health, or safety downstream after considering Libby Dam's authorized operation and project purposes, system-wide impacts, ESA responsibilities, and the VARQ Operating Procedures. When necessary to protect human life, health, or safety, rule seven from the VARQ Operating Procedures may be implemented. This decision will be communicated to the field team, Seattle District EOC, and the Seattle District Commander.

STEP 4: EMERGENCY FLOOD RESPONSE ASSISTANCE:

If modification of Libby Dam operations per Step 3 does not eliminate an imminent threat to human life, health, or safety, the Corps will provide emergency flood response assistance to supplement local efforts, as needed, authorized, and funded. At the discretion of the Seattle District Commander, this may include flood fighting to protect against a threat to human life, health, or safety, even if outflow from Libby Dam is not reduced. Assistance would be limited to meeting the immediate flood threat, and the Corps participation will end when there is no longer an imminent threat of flooding. See ER 500-1-1 and EP 500-1-1 for additional information.

STEP 5: END CORPS FLOOD RESPONSE ASSISTANCE:

The Corps would continue to provide technical assistance for evaluating flood threats, selecting response alternatives, updating the local emergency response plans, etc.

Appendix C - VARQ flood control Operating Procedures at Libby Dam

INTRODUCTION.

Libby Dam provides storage for local flood damage reduction in the Kootenai River basin, as well as system flood damage reduction on the lower Columbia River. Libby Dam operations are seasonal, with an annual reservoir evacuation and refill cycle. The VARQ Flood Control Procedure consists of an evacuation period in the winter (approximately December - April) and a refill period (approximately May-July). The evacuation and refill operations are based on the April - August Water Supply Forecast for the expected inflow volume to Libby Dam, which the Corps currently prepares once a month during the months of November through June. During evacuation, flood control storage space is the flood control requirement. During refill, VARQ outflows are the flood control requirement. The following rules govern the VARQ Flood Control Procedure at Libby Dam:

<u>Rule 1. Flood Control during the Evacuation Period.</u> A storage reservation diagram (SRD) for Libby Dam (see Figure 1) is used to guide the evacuation of water in the reservoir for flood control purposes. The required storage space for flood control is a function of the time of year (month) and the most recent April - August Water Supply Forecast at Libby Dam. During evacuation and until the initiation of refill, outflows are to be limited to hydraulic capacity of the powerhouse to the best extent possible. This may result in some years where it is not possible to draft down to the required storage space. In most cases, Rule 4 will adjust VARQ flows to adequately compensate for this reduced storage space. However, in rare situations, such as the loss of hydraulic capacity or significantly changing forecasts, engineering judgment may determine that spill is warranted. There may also be some years where more than the required storage space is provided. In these years, Rule 4 will adjust VARQ flows to attempt to compensate for this additional storage space. Once the evacuation period is complete, the required storage space needs to be maintained until the initiation of refill, which is defined by Rule 2.

<u>Rule 2. Initiation of Refill.</u> Initiation of refill is determined by the operating procedures for system flood control on the lower Columbia River. These procedures are described in *Columbia River Treaty, Flood Control Operating Plan, May 2003* (FCOP). In most cases, Libby Dam refill is initiated approximately ten days prior to when streamflow forecasts of unregulated flow are projected to exceed the Initial Controlled Flow (ICF) at The Dalles, Oregon (herein referred to as the *computed refill start date*). Under certain conditions, the Flood Control Refill Curve (FCRC) procedure will be used to determine when refill is to begin. A detailed discussion of conditions that trigger application of the FCRC procedures are provided in the FCOP, Section 5-6. The FCRC is a curve to fill the reservoir with 95 percent confidence.

Refill operations are determined by computing and operating to VARQ outflows. During refill, follow Rules 3, 4, and 5, to determine VARQ outflows, then repeat when the latest April – August Water Supply Forecast becomes available.

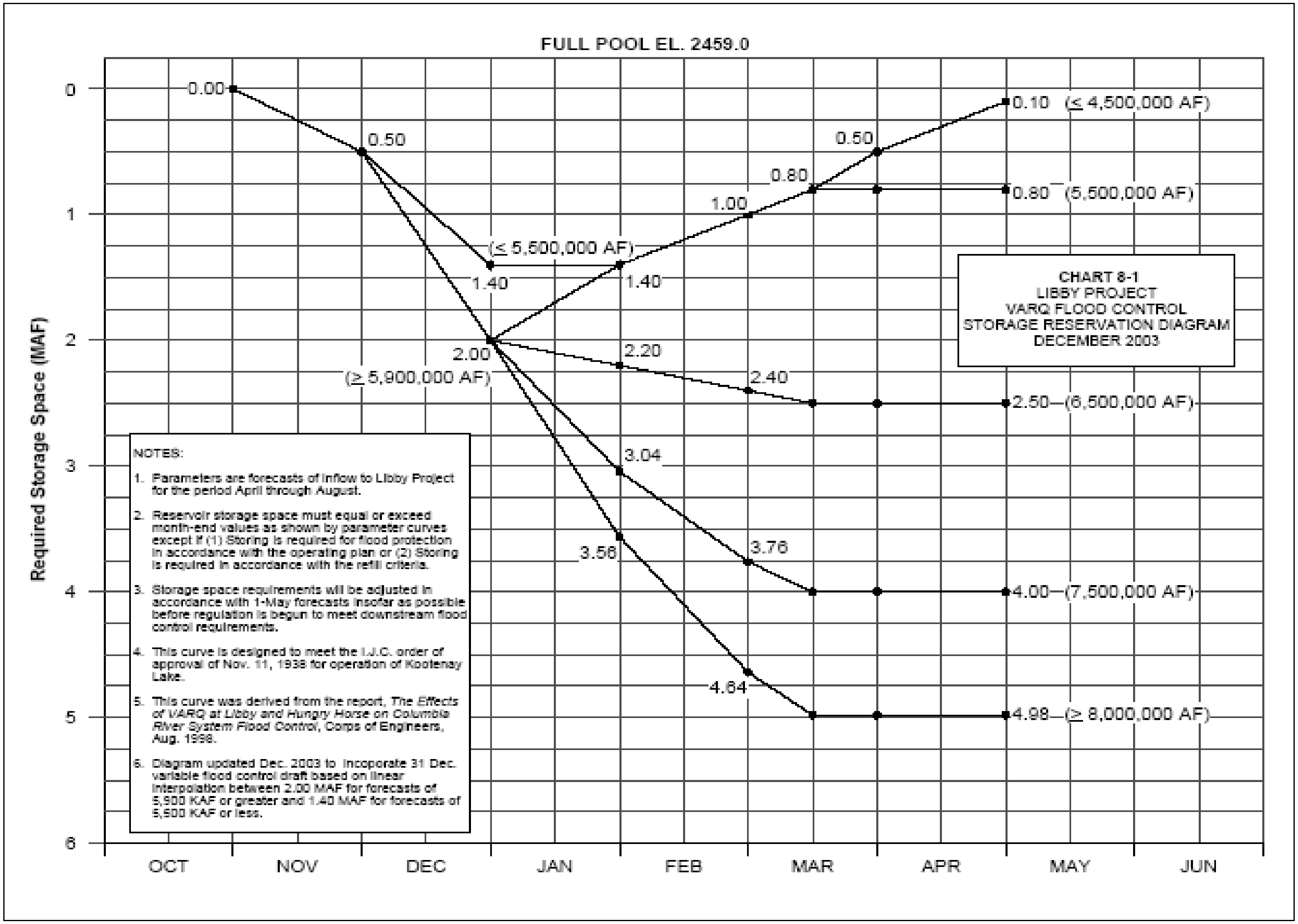


Figure 1. VARQ Storage Reservation Diagram for Libby Dam

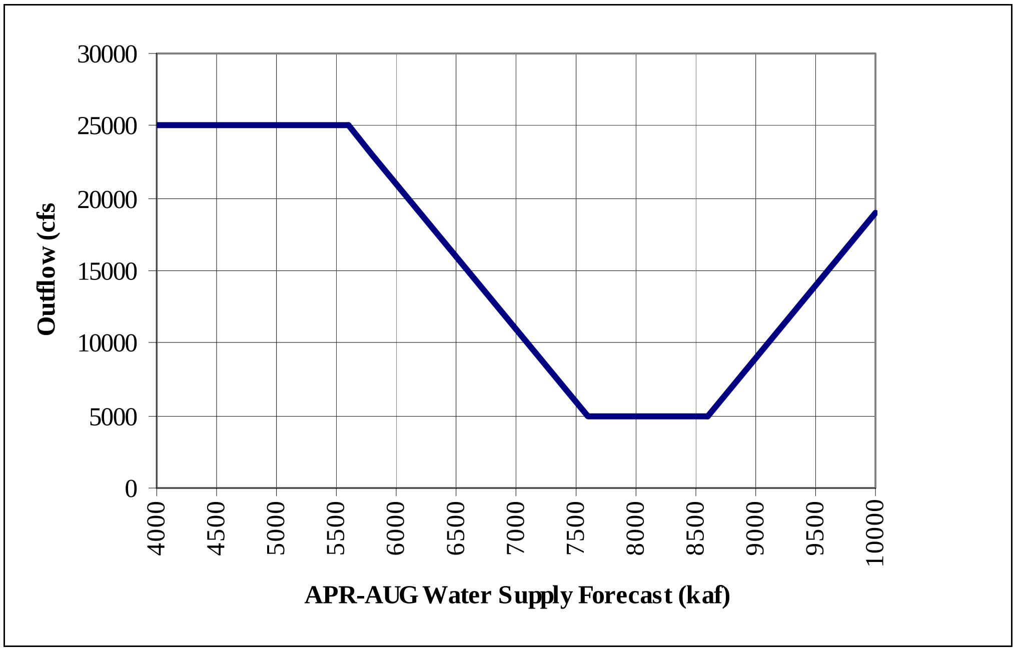


Figure 2. VARQ Outflows at Libby Dam

Rule 3. Initial VARQ Outflow during Refill. As soon as the most recent April - August Water Supply Forecast becomes available, use Figure 2 to determine an initial VARQ outflow for Libby Dam.

Rule 4. Adjusting VARQ Outflows for Delta Storage during Refill. As soon as the most recent April - August Water Supply Forecast becomes available, adjust the initial VARQ outflow, if necessary, to compensate for any storage difference between the actual space based on the computed refill start date and the recalculated required storage space using the most recent April - August Water Supply Forecast. This difference may reflect under or over-drafted conditions (Delta).

The adjusted storage (ADJSTO) is given by:

$$\text{ADJSTO} = \frac{\text{Delta (kaf)} * 0.504\ \text{(ksfd/kaf)}}{\text{Duration (days)}}$$

Where:

Delta = Required storage space (using the most recent April – August Water Supply Forecast) minus the Actual space (on computed refill start date)

Duration = The greater of either the *system flood control duration* or the *local flood control duration*, where:

System flood control duration is determined using the Figure 3. Select the appropriate curve based on the level of the most recent projected control flow at The Dalles (ICF). If the

ICF is less than 350 kcfs, for purposes of this computation, the system duration is assumed to be zero.

Local flood control duration is determined by the number of days from the computed refill start date through June 30.

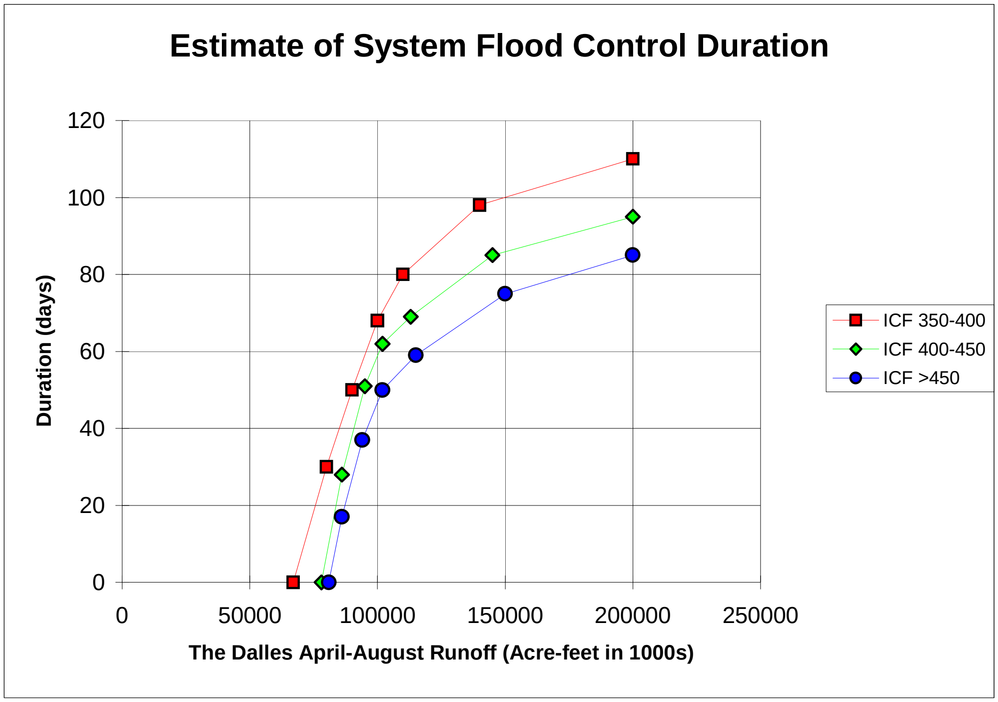


Figure 3. Estimate of System Flood Control Duration

The new VARQ flow is then given by:

VARQ(new) = VARQ(initial) + ADJSTO

Rule 5. Adjusting VARQ Outflows for Prior Releases During Refill. VARQ releases are seasonal in nature, generated using April - August Water Supply Forecasts. This rule accounts for the difference in actual outflows released since the computed refill start date and the new VARQ outflows developed using the most recent April - August Water Supply Forecast:

$$\text{ADJDUR} = \frac{[\text{VarQ(new)} - Q_{out}\text{(prior)}] * [\text{Prior Release(days)}]}{[\text{New Duration(days)} - \text{Prior Release(days)}]}$$

- Compute final VARQ outflow:
  VARQ(final) = VARQ(new) + ADJDUR

Rule 6. Inflows Less than VARQ Outflows. At the initiation of refill, if inflows are less than the VARQ outflow, pass inflow until inflows rise to the VARQ level. Thereafter, if inflows drop below the VARQ outflow, pass inflow until they rise again to the VARQ level.

Rule 7. Adjusting VARQ Outflows for Flood Damage Reduction. Use available forecasts to evaluate the performance of the VARQ outflows in meeting system and local flood control objectives. VARQ outflows may be adjusted (increased or decreased), if necessary to provide protection for human life, health and safety, insofar as possible.

Rule 8. Adjusting VARQ Outflows to Achieve Refill Objective. Increase outflows during the final stages of refill to avoid overfilling and unwanted spill. Likewise, decrease outflows during the final stages of refill if the present outflow would otherwise not fill the reservoir. Use available information and engineering judgment to select the appropriate outflows.

Appendix D - Analysis of Adequacy of Existing System Flood Control Analysis of VARQ Flood Control

Response to 2006 Libby After Action Report
Tab Three - Libby Operations Issue #1C
NEPA Documentation on VARQ

June 26, 2007

Executive Summary

BACKGROUND

Lessons Learned in the 2006 Libby After Action Report recommended review of the effects addressed in the Upper Columbia Alternative Flood Control and Fish Operations Final Environmental Impact Statement (UCEIS). Since simulated hydrology provides the foundations for the effects analysis in the UCEIS, the Corps reviewed the hydro-regulation modeling effort to determine if the modeling in the UCEIS is still valid in light of the observed conditions during the 2006 flood event. The Corps also reviewed the validity of the hydro-regulation simulations supporting its 2002 Environmental Assessment (EA) on interim implementation of VARQ flood control at Libby Dam.

PURPOSE

This document will report on an assessment to determine if system flood control is adequately addressed in the EA/UCEIS. The differences between modeling input data between the EA and the UCEIS for the Upper Columbia Flood Control and Fish Flow studies will be evaluated. In addition, this report addresses if in-season modifications at Libby should be used to aid in system flood control, and to determine if a Phase II detailed system study is needed. Phase II would require a detailed study to determine the differences in the level of protection at The Dalles in comparing standard and VARQ flood control with updates in system flood control operating criteria and other inputs since the EA was prepared. Results from Phase II would be used to evaluate potential environmental impacts at Grand Coulee and downstream.

The EA fully addressed the system impacts of VARQ flood control as compared to standard flood control. For the UCEIS, flood control curves were estimated which incorporated input data changes since the EA; these curves were produced for the purposes of the UCEIS power impact studies. At that time, an assessment was made that the system flood control studies would not need to be revised to account for the input data changes. Since the UCEIS was prepared, additional changes to input data would be used in consideration of a Phase II study.

EVALUATION

For this report, the major differences between input data used in the EA and updated input data which would be used in a Phase II study were identified. Each input data difference was evaluated to determine if the results of the changes would have a significant impact on system flood control. Differences in input data consist of changes to Mica and Arrow flood control space allocations, updated forecast volumes that determine flood control curves, refinements to the refill start dates for Libby and Hungry Horse, variations to refill procedures at other projects, and the use of Variable End of December flood control at Libby.

In-Season Modification at Libby for System Flood Control

An assessment was made regarding whether in-season modifications to Libby should be considered in potential Phase II studies. If Phase II studies were to be implemented, the group agreed that in-season modifications at Libby should not be included for the following reasons: flow reductions would be relatively small compared to flows in the lower Columbia, any excess flood control capability that Libby had has already been reduced by going from Standard to VARQ flood control, and travel time to the lower Columbia along with dampening of Libby outflows due to Kootenay Lake limits the effectiveness of Libby's operation on the lower Columbia. It is recommended that Libby operate with no modifications to the VARQ procedures. Therefore in-season modifications should not be included in Phase II studies if it were carried forward.

Summary of Results and Recommendation

After reviewing the extent of the differences in inputs for system modeling and local modeling between the EA and a potential Phase II study, and providing an evaluation on the impacts of the differences of input data, it has been assessed that the differences are either not significant, or the individual differences in input data that would provide higher flows to the system would be offset by other input differences that would provide lower flows to the system. Therefore, it is recommended that a Phase II study does not need to be carried forward and that the EA system flood control modeling, as part of the UCEIS, continue to be used in comparing the impacts of VARQ Flood Control to Standard Flood Control.

Along with the determination that Phase II is not needed, the Corps has concluded that the previous modeling which characterizes the environmental impacts from spill at Grand Coulee is still valid. The primary area of concern is the level of total dissolved gas (TDG) that is produced when Grand Coulee spills. It is highly probable that previous modeling has conservatively captured the amount of spill to be expected. If new modeling was undertaken, the results would likely show that spill from Grand Coulee would be lower in magnitude and duration when compared to previous modeling.

Response to 2006 Libby After Action Report
Tab Three - Libby Operations Issue #1C
NEPA Documentation on VARQ
June 26, 2007

BACKGROUND

Since 2003, the Corps has operated Libby Dam under VARQ flood control based on the assessment of effects documented in a 2002 Final Environmental Assessment (EA). In April 2006, the Corps issued the Upper Columbia Alternative Flood Control and Fish Operations Final Environmental Impact Statement (UCEIS). The UCEIS assesses effects of various alternative Libby Dam operations on resources in the Kootenai and Columbia river basins. The foundation for the analysis of effects in both the EA and UCEIS is the modeling of the effects of dam operations on the hydrology of the affected rivers. This modeling is based on applying specific assumptions to different alternative dam operations. Changes to either the assumptions or dam operations would result in different hydrologic effects. The effects on things like fish, recreation, water quality and other resources would not likely change unless different assumptions or dam operations resulted in changes in the simulated magnitude, timing, or duration of resultant river flows or reservoir levels.

Lessons Learned in the 2006 Libby After Action Report recommended review of the effects addressed in the Upper Columbia Alternative Flood Control and Fish Operations Final Environmental Impact Statement (UCEIS). Since simulated hydrology provides the foundations for the effects analysis in the UCEIS, the Corps reviewed the hydro-regulation modeling effort to determine if the modeling in the UCEIS is still valid in light of the observed conditions during the 2006 flood event. In this effort, the Corps also reviewed the validity of the EA hydro-regulation simulations.

PURPOSE

The purpose of this effort is to assess the differences of modeling input data between the 2002 Environmental Assessment (EA) and the 2006 UCEIS studies, to determine if system flood control is adequately addressed in the EA/UCEIS. In addition, this Phase I analysis will determine if in-season modifications at Libby should be used to aid in system flood control, and to determine if Phase II, a detailed system study is needed. Phase II would require a detailed study to determine the differences in the level of protection at The Dalles in comparing standard and VARQ flood control with updates in system flood control operating criteria and other inputs since the EA was prepared. Results from Phase II would be used to evaluate potential environmental impacts at Grand Coulee and downstream.

2002 EA BACKGROUND

A system flood control study for the EA was prepared and documented in the report, “Hydrologic Analysis of Upper Columbia Alternative Flood Control and

Fish Operations On Columbia River System including the VARQ Flood Control Plan at Libby and Hungry Horse Projects", dated October 2002. The system flood control was evaluated in determining the impacts of VARQ flood control compared to Standard flood control by performing a daily-time step regulation using procedures in accordance with the Columbia River Treaty Flood Control Operating Plan. The EA fully addressed a coordinated system flood control operation.

UCEIS BACKGROUND

For the UCEIS, end-of-month flood control curves for projects other than Libby and Hungry Horse were produced for purposes of the system power studies. These curves were different than those determined from the EA because of changed flood control operating criteria (see next paragraph) since the preparation of the EA. To incorporate the changes in flood control criteria, the procedure to determine the end of month flood control curves for individual projects used refill criteria based on various previous studies, not from a single coordinated system study, therefore the flood control curves produced for the UCEIS power study were not from a detailed coordinated system flood control study. End of month flood control curves for Libby and Hungry Horse were based on daily regulations prepared for the UCEIS and were included in the system power study.

DIFFERENCES BETWEEN EA AND UCEIS

The main differences between the EA and the UCEIS with respect to flood control at individual projects are a change to the Arrow /Mica flood control allocation split of 5.1 million acre-feet (MAF)/2.08 MAF (5/2), to 3.6 MAF/4.08 MAF (3/4), a change in forecast procedures used at Libby and Hungry Horse resulting in changed flood control curves, and a change in the refill start dates at Libby and Hungry Horse. For the EA, Kuehl-Moffitt (K-M) forecasts were used for both Libby and Hungry Horse. For the UCEIS, Wortman-Morrow (W-M) forecasts were used for Libby, and Bureau of Reclamation forecasts were used for Hungry Horse. These differences have potential impacts to Grand Coulee's flood control curves and system flood control. Modifications were made to the flood control curves for individual projects for the UCEIS power study to account for these changes, however, the flood control data sets used in the UCEIS did not provide for a detailed coordinated system flood control operation for protection of the lower Columbia in the May through June timeframe.

SYSTEM IMPACT ASSUMPTIONS DUE TO DIFFERENCES BETWEEN EA AND UCEIS

System impacts refer to changes in flows downstream of Grand Coulee due to differences in assumptions. When the UCEIS was prepared, it was assumed that system differences between the EA and UCEIS due to Libby and Hungry Horse would be minor, the impact of the different splits would not have a negative impact on system flood control, and using the ICF date to trigger refill would not impact system flood control substantially, therefore changes in the system flood control operation would be minor. To verify that local Kootenai modeling for the UCEIS did not contradict system flood control modeling for the EA, Corra Linn Dam outflows for each study were compared. At that time (late 2003), it was concluded that differences were not significant, and therefore, the system flood control modeling for the EA remained valid. The system flood control modeling for the EA used Grand Coulee and Arrow to regulate flows at The Dalles.

PHASE II POTENTIAL MODELING

Since the preparation of the UCEIS, new input data has become available which may be considered in determining if additional system flood control studies should be prepared. A comparison of the flood control modeling differences between the EA and UCEIS is provided in the following Tables 1.a and 1.b along with the new input data that may be considered for Phase II modeling.

Table 1.a
Differences in System Modeling between the EA, UCEIS, and Potential Phase II Recommended Studies

	EA (EISBA1F, EISVQ1F) (AUTOREG for system modeling)	UCEIS (Riverware/AUTOREG for local modeling; HYSSR for system modeling)	Phase II Recommended (AUTOREG)
Arrow/Mica Split	5.1/2.08	3.6/4.08	3.6/4.08
Arrow Refill	Refill based on FCOP Charts 3 and 6 (Synthetic Reservoir operation)	Refill Percentages based on 3.6/4.08 split study, 1995	Refill based on FCOP Charts 3 and 6 (Synthetic Reservoir operation)
Mica Refill	Flat outflow to fill, Min outflow of 10 kcfs	Default refill percentage, same value every year	Regulated based on FCOP and minimum flow of 3 kcfs
Duncan Forecasts	Kuehl-Moffitt 1929-1981 1982-99 BCH Forecasts (1997)	Kuehl-Moffitt 1929-60 BCH Forecasts 1961-99 (1997)	Kuehl-Moffitt 1948-60 BCH Forecasts 1961-65 (1997) BCH Forecasts 1966-99(2006)
Grand Coulee Refill	Refill based on FCOP Charts 3 and 6 (Synthetic Reservoir operation)	Refill percentages from EA study w/ 5/2 split for April-Jul	Refill based on FCOP Charts 3 and 6 (Synthetic Reservoir operation)
Modified Streamflows	90-Level	90-Level for flood control	2000-level
Study period	1929-1989, then added 1990-99	1948-1999	1948-1999 possibly add 2000-2006
Dworshak Forecast	Kuehl-Moffitt 1929-82 Wortman 1983-99	Kuehl-Moffitt 1929-82 Wortman 1983-99	Kuehl-Moffitt 1929-60 PCReg 1961-99
City of Revelstoke flood stage	No	No	86 kcfs when Arrow forebay is at El. 1444 (provided by BCH)
Revelstoke Dam Max release	No restriction	No restriction	100,000 cfs

Table 1.b

Differences in Libby and Hungry Horse Modeling between the EA, UCEIS, and Phase II Recommended Studies

	EA (EISBA1F, EISVQ1F)	UCEIS (EIS2FCBA, EIS2FCVQ)	Phase II Recommended
LIB Forecasts	Kuehl-Moffit-1929-82, Wortman-Morrow 1983-89	Wortman-Morrow	Wortman-Morrow 1948-60 PCReg 1961-99
LIB May-Jul VARQ outflow with Bonners Ferry flood stage of 1764	Refill start date 1 May and VARQ flows used estimated ICF	Start refill 10 days before ICF date from EA, and VARQ flows used estimated ICF	Start refill 10 days before ICF date and use ICF from Phase II regulations
HGH Forecast procedure	Kuehl-Moffit-1929-82, NWRFC's forecast 1983-99	Reclamation Procedure	Reclamation Procedure
HGH May-Jul Refill	Based on VARQ outflow procedure	Used Reclamation elevations	Use Reclamation elevations
Libby Powerhouse rating curve	High Qphc (full wicket gate opening)	Realistic Qphc (based on actual powerhouse rating curves)	Realistic Qphc (based on actual powerhouse rating curves)
Libby Var. End of December	No	No	Yes

The following is a discussion of the differences in input data between the EA and a possible Phase II study.

The Arrow/Mica Split

The flood control draft split used in the EA was 5.1 MAF/2.08 MAF. With the addition of generating units at Arrow it was advantageous to operate with a higher head at Arrow, therefore the Arrow/Mica split currently used is 3.6 MAF/4.08 MAF. A study prepared by the Corps Northwestern Division entitled, "SUMMARY REPORT, REALLOCATION OF FLOOD CONTROL SPACE IN MICA AND ARROW RESERVOIRS", dated October 1995, showed no negative impact to system flood control due to the differences in the split. The combined Arrow plus Mica draft with the updated split would be up to 0.5 MAF greater, resulting in an increase of Grand Coulee flood control curves of approximately 1 to 2 feet in the middle water years, providing approximately the same level of system flood control protection.

Arrow Refill

Arrow would refill by using the same procedure used in the EA.

Mica Refill

In the EA, Mica refilled by releasing a minimum flow of 10 kcfs, which is generally, the minimum flow for the annual Treaty power planning studies. In a Phase II study, the minimum flow of three kcfs would be used during refill, taking into consideration protection for the Revelstoke area (see paragraph regarding City of Revelstoke). Reducing outflow from 10 kcfs to three kcfs at Mica results in a difference in the shape of refill of the system flood control space during the controlled flow period; however outflows from Mica are re-regulated by Arrow which would refill using the same procedure in the EA. There is high confidence that this change will not adversely impact system flows.

Duncan Forecasts

Duncan's flood control curves are based on its April-August volume forecasts. The average difference between the April forecast volumes used in the EA and the volumes that may be used in Phase II is 0%. The standard deviation is 106 kaf and the average April forecast used in the EA is 2116 kaf. These small differences would not have a significant impact on system flood control from that provided in the EA.

Grand Coulee Refill

Grand Coulee would refill using the same procedure as in the EA by using Charts 3 and 6 from the Columbia River Treaty Flood Control Operating Plan (2003).

Modified Streamflows 1990-level vs 2000-level

The 1990-level modified streamflows were used as the unregulated flows for the development of flood control regulations for the EA. For a possible Phase II study, 2000-level modified streamflows are available. The 2000-level flows reflect updates to depletion levels. The differences in depletions are about 1-2 kcfs at The Dalles and is considered insignificant.

STUDY PERIOD

Extending the study period used in the EA an additional seven years, from 2000 through 2006 has been considered. Unregulated inflow data along with forecast volumes would need to be developed and collected. For the years 2000-2006, only year 2006 had a May, April-August volume forecast for The Dalles greater than average. The 2006 percent of average was 102.7%. For system modeling purposes, addition of these years would not change the frequency curve at the higher flood stages.

DWORSHAK WATER SUPPLY FORECAST

The flood control curves for Dworshak are based on its April – July volume forecast. The average difference between the April forecast volumes used in the EA and a potential Phase II study is 1%, and is greater in the updated forecast procedure. The standard deviation of the differences is 174 kaf, and the average K-M April forecast is 2736 kaf. With a higher forecast volume, flood control curves would be lower, slightly reducing outflows at The Dalles in the refill period, which would be insignificant and would not have a negative impact on system flood control.

CITY OF REVELSTOKE FLOOD STAGE AND REVELSTOKE DAM MAXIMUM RELEASE

Since the EA had been prepared, new criteria have been provided by BCHydro to protect for flood stages at the City of Revelstoke, and to protect against erosion below Revelstoke Dam. Protection of the Revelstoke area is provided by regulation of Mica. Review of the latest flood control study using this operation shows that the operation occurs after the system controlled flow period, therefore this would not impact system flood control.

LIBBY WATER SUPPLY FORECASTS

A comparison of the forecast volumes used for the EA, UCEIS, and for a potential Phase II study, are provided in Table 2. The forecast procedures used in the UCEIS are similar to that which would be used in a Phase II study, therefore the UCEIS can be used as a surrogate to estimate Libby's system impacts in a Phase II study. The average April forecast of the April-August forecast volume is 212 kaf higher in the Phase II recommended procedure than used in the EA. The standard deviation of the differences is 552 kaf, and the average April forecast in the Kuehl-Moffitt procedure is 6360 kaf.

Flood control curves for Libby are based on its April-August volume forecasts. Table 3 shows the differences between flood control curves use in the EA and UCEIS. After 1983, forecasts used in the EA and the UCEIS were the same, therefore there were no differences in flood control curves in January through March. When values are positive, the EA had higher flood control elevations than in the UCEIS. Differences range from plus or minus 75 feet for the end of April. In over 79% of the time flood control curves at the end of April in the UCEIS were equal to or lower than that in the EA due to the higher volume forecasts.

The flood control curves are targets for flood control regulations. Table 4 shows Libby regulated elevation differences between the EA and UCEIS from local flood control only regulations. These are different than as shown in Table 3, as in these regulations Libby will attempt to meet the flood control elevation targets but may be unable to due so due to insufficient inflows or regulations needed to meet local flood control objectives. In 83% of the years, the April regulated elevation was lower in the UCEIS than in the EA.

LIBBY MAY-JUL VARQ OUTFLOW

The result of the lower April elevations in the UCEIS is that the May-Jul outflows will also be lower in the UCEIS, which will not have a negative impact on system flood control. Table 5 shows the difference in the regulated flows between the EA and UCEIS modeling. Peak outflows from UCEIS modeling tended to be lower than for the EA. There are two main reasons for this: (1) the UCEIS modeling used water supply forecasts that were closer to the observed volumes than the EA, and (2) the UCEIS used more refined modeling assumptions such as tracking residual volume.   May through July outflows are also influenced by the refill start date. The EA used a start date of May 1 in every year. The local modeling for the UCEIS computed Libby VARQ outflows using the start date of 10 days before the EA's Initial Controlled Flow (ICF) Date, which would be similar to the ICF Date used if a Phase II study were to be prepared. In May, about 61% of the time the flows in the UCEIS were less than in the EA. In the years that flows were greater in the UCEIS, the magnitude was less than about 5 kcfs except for 2 years where flow differences were in the 8-10 kcfs range. For flows less than 5 kcfs, Grand Coulee would primarily manage the controlled flows at The Dalles, not significantly impacting system flood control. For the 2 years where flow differences were in the 8-10 kcfs range, refill trigger dates were in May or early June, which required Libby to pass inflow or draft for most of May. In these years (1974 and 1965), Libby passed more water in May awaiting refill which began in late May. As more water was released in May in the UCEIS, small differences between the EA and UCEIS occurred in June, therefore system flood control would not be significantly impacted during the controlled flow period.

HUNGRY HORSE WATER SUPPLY FORECAST

Hungry Horse flood control curves are based on the May-Sept forecast volume. The average difference was either 1% or 0%, therefore the differences in forecasts would not have a significant impact on its April flood control curves.

HUNGRY HORSE MAY-JUL REFILL

Table 6 shows the regulated flow differences between the EA and UCEIS. Regulated outflows in May tended to be higher in the UCEIS than in the EA._Differences are under about 5 kcfs, and would have minimal effects on system flood control, however there was 1 year where the flow difference was about 7900 cfs. In this year (1974), Hungry Horse passed more water in May awaiting refill which began in late May. As more water was released in May in the UCEIS, less water was released in June, therefore system flood control would not be significantly impacted during the controlled flow period.

LIBBY POWERHOUSE RATING CURVE

The maximum power house releases used in the EA were based on turbine data with a full wicket gate opening. A Phase II study would use a more realistic powerhouse release where outflows would be about 3 kcfs lower when operations were at their powerhouse capacity. This would provide a slight benefit to system flood control during the system flood control period. In a few instances, a lower powerhouse capacity would ultimately result in higher outflows from Libby during late June or July, but the increase in magnitude of these flows would have little impact during the end of the controlled flow period.

LIBBY VARIABLE END-OF-DECEMBER DRAFT

Neither the EA or UCEIS incorporated the use of Variable December flood control since it had not been developed at that time. A monthly time step study to estimate the impacts of Variable December flood control was developed by NWD, Power Branch in February, 2005. The study looked at the differences in Libby outflows with and without Variable December, both with VARQ flood control. In the 13 years that the December flood control was relaxed, there were 6 years where there were increases in flows in the May through July period. Of the 6 years, there were 4 periods that had flow differences greater than 4000 cfs. The maximum difference in flow was 9700 cfs in May 1977, which is the lowest January-July volume year for The Dalles. Since there is a good correlation between Libby water supply and The Dalles water supply, it is likely that Libby December elevations would be relaxed if below average volumes are forecasted for The Dalles. Increases in flow in low water years at The Dalles would not be a problem for system flood control.

Table 2

	Libby Apr-Aug April Forecasts (Kaf)				Hungry Horse May-Sep April Forecasts (Kaf)		
	EA	**UCEIS**	**Observed**	**Phase II 1948-60 WM 1961-99 PCReg**	**EA**	**UCEIS and Phase II**	**Observed**
1948	6188	7538	8434	7538	2073	1492	2318
1949	6240	6030	5023	6030	1893	1653	1644
1950	8414	7146	7362	7146	2552	1521	2740
1951	8119	8477	8497	8477	2279	1758	2137
1952	5990	6973	6301	6973	2189	2186	1625
1953	6117	6167	6556	6167	1763	2141	2062
1954	7810	8673	9105	8673	2166	1743	2657
1955	5503	5809	6583	5809	1542	1771	1981
1956	7937	8468	8700	8468	2514	1512	2237
1957	6191	6436	5991	6436	1945	1702	1804
1958	5578	5967	5703	5967	1946	1843	1763
1959	7468	7247	8099	7247	2592	1666	2798
1960	7182	6946	6409	6946	2081	1508	1807
1961	7408	7275	7823	6930	1884	1594	2010
1962	5425	6349	5939	6106	2156	2129	1968
1963	5912	5854	6413	5754	1798	1153	1444
1964	6210	6703	6912	6270	2018	1484	2467
1965	7608	7585	6939	7552	2492	1909	2456
1966	7258	7004	7159	6736	1647	2338	1720
1967	7973	8915	8137	8526	2584	1895	2461
1968	5333	6173	6217	6315	1871	1960	1927
1969	6994	7573	8226	7438	2289	2544	1693
1970	4673	5009	4633	4691	2188	2224	2151
1971	6679	7738	7962	7683	2437	1979	2520
1972	7762	9327	8861	9156	2745	1816	2619
1973	5201	5662	5014	5731	1405	2285	1314
1974	8398	8921	9241	8871	2636	1635	2739
1975	7454	7021	6005	6383	2101	2303	2453
1976	6770	7648	7426	7699	2210	1803	2183
1977	3439	4034	3447	3953	1228	1788	999
1978	5971	5880	6290	6210	2023	2591	2032
1979	4821	5426	4201	4845	1916	1841	1844
1980	5593	5884	5970	6522	1676	1784	1578
1981	6038	5735	7442	6603	1430	1929	1929
1982	6676	7380	6470	6986	2208	1584	2382
1983	6277	6277	5912	5774	1553	2016	1640
1984	4998	4998	5062	5009	1824	2467	1579
1985	5571	5571	4765	5477	1796	1668	1886
1986	5839	5839	6066	5691	1459	2560	1425
1987	5548	5548	4987	4942	1503	1752	1038
1988	4609	4609	4621	4656	1405	1998	1127
1989	6195	6195	5552	6055	2094	2033	1856
1990	7236	7236	7554	6962	2015	2498	1889
1991	8430	8430	8462	8506	2463	2641	2465
1992	4977	4977	4460	4967	1426	1412	1120
1993	4366	4366	5470	4433	1401	2535	1727
1994	5176	5176	5210	4986	1296	2061	1146
1995	5733	5733	6311	6219	1519	2176	1547
1996	7665	7665	8349	8130	2308	1349	2145
1997	7610	7610	7816	8581	2731	1979	2935
1998	5189	5189	5819	5154	1340	1911	1430
1999	6956	6956	7067	7341	2080	1617	1919
Average	**6360**	**6603**	**6596**	**6572**	**1975**	**1918**	**1949**

Table 3

Libby Flood Control Differences EA – UCEIS (ft) [EA scenario is EISVQ1F, UCEIS scenario is EIS2FCVQ (also called LV)]

	Based on URC			EA Based on URC, UCEIS based on URC or Flood Control Reg. if ICF<May10	Based on Flood Control Regulated Elevations		
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
1948	53.6	52.3	58.9	75.6	34.8	0.2	0
1949	2.4	3.8	-8.2	0.8	1.7	-2.8	0
1950	14.6	3.3	-24	-74.9	-0.1	0.4	0
1951	36	30.4	0	0	10.1	2.5	0
1952	39.5	44.9	56.8	41.7	16.8	8.2	0
1953	0	6.9	7.4	2.3	-1	-1.1	0
1954	27.3	29.5	8.9	22.5	18.1	2.8	0
1955	5.4	5.4	0.5	12.4	-5.4	-1	0
1956	16.7	30.1	41.8	11	17	3.5	0
1957	22.4	29.7	16.5	14.9	8.9	0	0
1958	24.8	33	23.8	16.2	3.3	2.9	0
1959	13.4	-13.3	-14.2	-14.2	-6	-4.1	0
1960	21.1	3.6	6.1	-13.6	-3.1	-4.1	0
1961	11.3	-5.1	-16	-8.4	-2.3	-0.1	-0.1
1962	24	49.3	37.2	38.3	17.1	8.5	0
1963	21.9	8.3	9.5	-2.5	5.3	-0.4	-0.1
1964	24.1	15.1	29.9	24.6	5.3	0.1	0
1965	1	-26.1	-13.8	-2.2	11.8	9.4	0
1966	11.9	11.7	13.2	0.3	-0.7	0.1	-0.3
1967	27.1	23.9	54.4	9	37.8	8.4	-0.1
1968	31.6	39.5	32.8	31.3	7.5	3.2	-0.1
1969	20.1	25.5	34.3	37.6	13.9	1	0
1970	1	2.1	1.5	5.2	-3.2	-1.8	-0.3
1971	15.3	39.1	49.3	70.5	20	3.9	0
1972	29	55.7	25.3	27.6	30.1	10.5	0
1973	14.7	15.5	15.3	11.3	1.9	2.3	0
1974	24.5	0	0	0	20.8	7.2	0
1975	3.6	-11.7	-30.1	-26.6	-7.3	-2.5	0
1976	40.6	30.9	51.2	56.7	18	8.8	0
1977	0	0	0	0	1.2	1.1	1.1
1978	10.3	9.1	7.2	-3.9	-0.5	-2.5	0
1979	15.4	0	17.4	0.5	5.5	4.4	2.5
1980	15.7	16.4	15.4	6.4	4.5	-0.1	-0.1
1981	22.9	1	-4.1	-12.9	-0.4	-1.6	-0.2
1982	20.9	27.5	28.7	40.3	16	6	0
1983	0	0	0	0	-0.1	1.1	0
1984	0	0	0	0	-1.3	3.3	0
1985	0	0	0	0	-3.4	-1.8	0
1986	0	0	0	0	-3.9	-0.3	0
1987	0	0	0	4.3	5.3	5.6	0
1988	0	0	0	0	-2	0.8	0
1989	0	0	0	0	0.9	3.1	0
1990	0	0	0	0	11	4.5	-0.2
1991	0	0	0	0	-2.4	0.5	0
1992	0	0	0	3.3	5.6	5.2	0.5
1993	0	0	0	0	-1.3	-1.7	0
1994	0	0	0	0	0.7	-3.3	-0.6
1995	0	0	0	0	-0.9	1.2	0
1996	0	0	0	0	-4.3	-0.4	0
1997	0	0	0	0	-1.4	0.8	0
1998	0	0	0	3.7	4.4	0.8	0
1999	0	0	0	0	1.7	1.8	0
Ave	**12.8**	**11.3**	**10.2**	**7.9**	**5.9**	**1.8**	**0.0**
Min	**0**	**-26.1**	**-30.1**	**-74.9**	**-7.3**	**-4.1**	**-0.6**
Max	**53.6**	**55.7**	**58.9**	**75.6**	**37.8**	**10.5**	**2.5**

Table 4

Libby Regulated Elevation Differences
EA - UCEIS (ft)
[EA scenario is EISVQ1F, UCEIS scenario is EIS2FCVQ (also called LV)]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul
1948	37.6	48.7	59	72.9	34.8	0.2	0
1949	-0.1	-0.1	-4	0.8	1.7	-2.8	0
1950	14.6	14.2	4.7	-3.9	-0.1	0.4	0
1951	13.8	14.2	15.9	15.9	10.1	2.5	0
1952	30.5	44.7	45.4	41.7	16.8	8.2	0
1953	-1.3	5.9	6.4	6.4	-1	-1.1	0
1954	18.2	25.8	29.4	30.7	18.1	2.8	0
1955	0.1	0.1	0.1	0.1	-5.4	-1	0
1956	2.6	11.5	33	29.6	17	3.5	0
1957	7.5	8	14.2	14.9	8.9	0	0
1958	5.2	5.5	5.7	5.3	3.3	2.9	0
1959	12.9	-2.5	-9.8	-14.7	-6	-4.1	0
1960	4.2	9.3	9.1	-2.7	-3.1	-4.1	0
1961	11.3	-4.9	-2.6	-2.6	-2.3	-0.1	-0.1
1962	23.1	33.7	34.5	31.1	17.1	8.5	0
1963	21.9	22.2	22.4	21.7	5.3	-0.4	-0.1
1964	11.9	14.1	14.5	14.2	5.3	0.1	0
1965	1.1	-24.5	-20.9	-14.2	11.8	9.4	0
1966	11.9	8.5	9.8	0.3	-0.7	0.1	-0.3
1967	27.2	27.6	44.4	44.5	37.8	8.4	-0.1
1968	13.2	13.7	13.7	13.8	7.5	3.2	-0.1
1969	20.1	18.7	25.5	32.5	13.9	1	0
1970	-0.6	-0.7	-0.7	-0.7	-3.2	-1.8	-0.3
1971	7.5	20.7	28.7	32.4	20	3.9	0
1972	29	34.4	35.6	35.6	30.1	10.5	0
1973	4.5	4.6	4.8	4.6	1.9	2.3	0
1974	5.1	3	2.8	1.3	20.8	7.2	0
1975	3.6	-12.2	-16	-12.6	-7.3	-2.5	0
1976	24.2	31.7	40.6	41.6	18	8.8	0
1977	-0.3	-0.3	-0.4	-0.4	1.2	1.1	1.1
1978	11.6	10.4	10.4	10.2	-0.5	-2.5	0
1979	-0.3	-0.3	-0.3	0.5	5.5	4.4	2.5
1980	-0.5	-0.6	-0.6	6.4	4.5	-0.1	-0.1
1981	3.3	12.7	12.5	12	-0.4	-1.6	-0.2
1982	4.2	15.4	19	23.8	16	6	0
1983	0	0	0	0	-0.1	1.1	0
1984	0	0	0	0	-1.3	3.3	0
1985	0	0	0	0	-3.4	-1.8	0
1986	0	0	0	0	-3.9	-0.3	0
1987	-0.6	-0.6	-0.6	4.3	5.3	5.6	0
1988	-1.4	-1.3	-1.4	-1.4	-2	0.8	0
1989	0.5	0.5	0.6	0	0.9	3.1	0
1990	0.7	-0.1	0.1	0.1	11	4.5	-0.2
1991	-5.9	-7.7	-7	-7.3	-2.4	0.5	0
1992	-0.4	-0.3	-0.4	3.3	5.6	5.2	0.5
1993	-0.7	-0.7	-0.8	-0.8	-1.3	-1.7	0
1994	-0.4	-0.4	-0.3	-0.1	0.7	-3.3	-0.6
1995	-0.3	-0.3	-0.3	-3.2	-0.9	1.2	0
1996	-2.6	-3.6	-3.6	-3.7	-4.3	-0.4	0
1997	-0.4	-0.5	-0.4	-2.1	-1.4	0.8	0
1998	-0.6	-0.7	-0.7	3.7	4.4	0.8	0
1999	0	-0.1	3.6	-0.5	1.7	1.8	0
Ave.	**7.1**	**7.6**	**9.1**	**9.3**	**5.9**	**1.8**	**0**
Min	**-5.9**	**-24.5**	**-20.9**	**-14.7**	**-7.3**	**-4.1**	**-0.6**
Max	**37.6**	**48.7**	**59**	**72.9**	**37.8**	**10.5**	**2.5**

Table 5

Libby Month Average Regulated Flow Differences EA - UCEIS (cfs)

[EA scenario is EISVQ1F, UCEIS scenario is EIS2FCVQ (also called LV)]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul
1948	-19711	-4439	-2901	-7212	10660	22259	167
1949	-539	0	2129	-2752	-528	3283	-1995
1950	-7999	1982	3833	3313	-1517	-191	217
1951	-7723	1085	4	0	33	4420	1787
1952	-15475	-3593	0	-883	8920	4691	5947
1953	-133	-3812	-208	0	3563	220	-806
1954	-10641	-1111	11	-146	1627	7450	1912
1955	-1011	0	0	0	3339	-2694	-702
1956	-2091	-2966	-5978	856	287	6538	2541
1957	-5382	0	-2774	-685	1708	6350	0
1958	-4148	0	0	0	707	136	2160
1959	-7307	8261	2667	2065	-2602	-25	-2963
1960	-2583	-1969	0	5341	332	1191	-2677
1961	-7149	9399	-1426	0	239	-1184	0
1962	-12974	-5449	0	0	6029	4927	6118
1963	-12266	0	0	0	7932	3634	-235
1964	-7614	-352	0	0	3757	3024	162
1965	-1263	10209	-2463	-1671	-9631	-1432	6351
1966	-7010	2954	-542	3623	485	-492	319
1967	-13482	3311	-3844	0	-1739	9827	6089
1968	-7945	0	0	0	2427	2503	2470
1969	-10430	3315	-2088	-4058	4622	8068	555
1970	-542	0	0	4	1673	-573	-1059
1971	-5504	-5719	-2948	-1992	1744	9647	2860
1972	-15176	1412	36	0	-1144	6526	7639
1973	-3719	0	0	0	1317	-333	1743
1974	-3233	1534	183	567	-8278	3796	5005
1975	-2931	8997	779	-1635	-1782	-1877	-1692
1976	-13053	-2296	-2231	-582	6383	4606	6521
1977	-696	0	0	0	-972	0	0
1978	-6700	1140	0	0	5378	1604	-1846
1979	-891	0	0	-501	-3112	328	1245
1980	-741	0	0	-4388	791	3605	0
1981	-2237	-4654	0	0	6165	890	-981
1982	-3625	-6617	-1274	-2342	2504	5357	4346
1983	-926	0	0	0	71	-945	742
1984	-842	0	0	0	812	-3284	2403
1985	-854	0	0	0	2186	-893	-1374
1986	-693	0	0	0	2639	-2527	-210
1987	-714	0	0	-3310	-821	-504	4035
1988	-208	0	0	0	522	-2007	521
1989	-916	0	0	282	-558	-1705	2065
1990	-1256	548	-104	0	-5216	2462	3235
1991	1799	207	-421	117	-1392	-1549	337
1992	-687	0	0	-2270	-1488	-111	3351
1993	-93	0	0	0	426	364	-1277
1994	-652	0	0	-167	-461	3266	-2106
1995	-514	0	12	1731	-1365	-1474	854
1996	879	279	30	38	525	-1914	-340
1997	-672	0	0	906	-184	-1510	600
1998	-521	0	0	-2788	-805	2659	600
1999	-505	67	-1659	1751	-1052	-473	1403
Ave.	**-4448**	**225**	**-407**	**-323**	**868**	**2037**	**1270**
Min	**-19711**	**-6617**	**-5978**	**-7212**	**-9631**	**-3284**	**-2963**
Max	**1799**	**10209**	**3833**	**5341**	**10660**	**22259**	**7639**

Table 6

HGH Regulated Flow Differences EA - EIS (cfs)							
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
1948	-943	-480	3218	4958	-2345	-2255	-2913
1949	-966	-1945	1283	8841	490	2417	-2845
1950	-3529	-762	5029	5100	-3158	1114	-1447
1951	-6057	3059	3883	774	-1089	-224	-3414
1952	-4998	-585	4217	9392	-4126	-2055	-3354
1953	-1309	3480	136	3770	1167	2742	-2280
1954	-235	2042	3222	1167	-303	2822	-2371
1955	-888	-1609	-1965	2357	-47	3898	-2431
1956	454	4660	3183	726	-1218	-3720	-4335
1957	816	-361	3039	4851	-352	-2309	-2851
1958	-558	-436	4472	3955	2046	474	-3050
1959	-2717	2995	1162	-174	-4095	1953	-1419
1960	-2506	2350	2709	4376	-1989	-2078	-4774
1961	152	893	4408	5061	-159	-2201	-2878
1962	2480	964	1778	6189	-2244	-1970	-3372
1963	1912	2904	745	3137	-1357	-1655	-4838
1964	-647	658	-379	7982	690	917	-2817
1965	-1363	2566	1033	514	-1598	-42	-2460
1966	-218	52	22	2854	-24	386	-2858
1967	3373	2002	1494	728	-1715	773	-2793
1968	1258	2088	4247	1298	-1442	-2375	-2208
1969	-4653	3080	3278	6533	-2708	-1694	-4395
1970	-1831	2553	2271	8650	-4859	-364	-1349
1971	2782	189	253	4230	-5	-1270	-1056
1972	1015	488	2773	5964	-1823	339	-3402
1973	417	-1589	-1879	-604	3395	5414	-1972
1974	1954	3164	-222	2772	-7894	871	1026
1975	-263	2850	1855	3840	-1705	1860	-3693
1976	-2832	2844	267	1017	-996	-513	-2874
1977	-2096	-1888	-2066	652	6969	3631	436
1978	-750	2345	3846	-450	-5605	894	206
1979	-560	-1304	5420	3108	-615	-485	-2378
1980	-1937	-2105	-1159	7566	4927	2478	-2426
1981	1608	-1027	-663	392	113	1063	-2955
1982	-479	3646	4597	2252	-1160	1909	-4599
1983	1201	943	-749	1042	-195	3212	-1752
1984	3327	2026	-421	5523	-2353	-2743	-2507
1985	1110	-1728	343	3581	1461	-83	-2882
1986	-1202	-499	2509	-1093	-427	319	-2799
1987	242	-232	-679	3525	1405	583	-2844
1988	-2284	-2168	-1900	3775	7327	4051	-1257
1989	1300	1097	-740	7013	-280	-2955	-2790
1990	-4922	-77	2665	63	-132	1305	-2149
1991	-2619	-1064	3939	3351	-1279	-615	-4639
1992	1061	693	-419	0	2605	1864	-1111
1993	433	-1107	-1255	35	4857	3409	-2413
1994	-449	-775	-132	2962	3120	1123	-2866
1995	1862	2643	797	0	829	2044	-2183
1996	-4102	1231	5669	-452	-1346	654	-4885
1997	1156	-1295	5981	1164	-1001	-917	-2359
1998	-889	-462	-1096	36	4186	2340	-2703
1999	2495	3039	3786	-766	-1042	511	-2592
Ave.	**-508**	**770**	**1612**	**2953**	**-329**	**478**	**-2613**
Min	**-6057**	**-2168**	**-2066**	**-1093**	**-7894**	**-3720**	**-4885**
Max	**3373**	**4660**	**5981**	**9392**	**7327**	**5414**	**1026**

In-Season Modifications at Libby for System Flood Control

A workgroup consisting of Seattle District and Northwestern Division water managers was formed to determine whether Phase II detailed studies was needed. The workgroup discussed whether in-season modifications to Libby should be considered in the system flood control regulation. If Phase II studies were to be implemented, the group agreed that in-season modifications at Libby should not be included in the flood control regulation studies for the following reasons:

1) reductions of flow from VARQ outflows would be small (maybe 5 to 10 kcfs) compared to a controlled flow at The Dalles, therefore Libby's impact on the lower Columbia may be inconclusive and barely measurable.

2) Any excess flood control capability that Libby had for local flood control has been reduced by going from Standard to VARQ flood control. Additional flow reductions and resulting higher pool elevations provides added risks that may not be advisable.

3) A travel time of approximately 10 days from Libby to The Dalles provides limited responsiveness from Libby to the lower Columbia

4) Kootenay Lake dampens the effectiveness of Libby's operation to affect the lower Columbia

5) Normal modeling procedures do not include Libby in regulating flow at The Dalles, only Grand Coulee, Arrow, and John Day, as provided in the Columbia River Treaty Flood Control Operating Plan (2003). In real operations, Dworshak may assist in providing regulation at The Dalles because of the short travel time between those projects.

Recommendation

After reviewing the extent of the differences in inputs for system modeling (Table 1.a) and local modeling (Table 1.b), between the EA and a potential Phase II study, and providing an evaluation on the impacts of the differences of input data, the Corps has determined that that the differences are either not significant, or the individual differences in input data that would provide higher flows to the system would be offset by other input differences that would provide lower flows to the system. Therefore, the Corps determined that a Phase II study does not need to be carried forward and that the EA system flood control modeling, as part of the UCEIS, be continued to be used in comparing the impacts of VARQ Flood Control to Standard Flood Control. Along with the determination that Phase II is not needed, the Corps has concluded that the previous modeling which characterizes the environmental impacts from spill at Grand Coulee is still valid. The primary area of concern is the level of total dissolved gas (TDG) that is produced when Grand Coulee spills. It is highly probable that previous modeling has conservatively captured the amount of spill to be expected. If new modeling was undertaken, the results would likely show that spill from Grand Coulee would be lower in magnitude and duration when compared to previous modeling.

Appendix E- Libby Dam Operations for Kootenai River White Sturgeon and Bull Trout in 2006

Kootenai River Ecosystem Function Restoration Flow Plan Implementation Protocol

In spring of 2006, regional entities worked collaboratively to develop the Kootenai River Ecosystem Function Restoration Flow Plan Implementation Protocol (Protocol). The participating regional entities were the Corps, BPA, USFWS, the Kootenai Tribe of Idaho, the Confederated Salish and Kootenai Tribes, the states of Montana and Idaho, the U.S. Geological Survey, and BC Hydro.

The objective of the Protocol is to provide a scientifically and operationally sound approach for testing different flow strategies (releases from Libby Dam) and assess their effectiveness in meeting the conservation needs and habitat attributes established by the USFWS for sturgeon. The Protocol identifies three different treatments for providing flows from Libby Dam that are intended to test the biological response of sturgeon to the effects of such release patterns on water temperatures, depth, and velocity in the Kootenai River near Bonners Ferry, Idaho.

The Protocol is designed to test each experimental flow treatment two to three times between 2006 and 2015, as water supply forecasts and other factors permit. Experimental treatments include:

- Low tier water year (i.e. no sturgeon flow augmentation),
- Shaped flow within powerhouse capacity, and
- Shaped flow to up to 10 kcfs above powerhouse capacity.

The Protocol will allow examination of depth as a limiting factor for sturgeon migration and spawning location, and to examine and evaluate resultant velocities created by flow regimes during egg incubation periods. Results of the treatments described in this document will guide adaptive management in the immediate future, including guidance for possible habitat alterations in the Braided Reach.

Using the Protocol as a guide, a technical team with representatives from federal and state agencies and the tribes has been convened each year since 2006 to provide input to the USFWS for development of a system operation request(s) (SOR) for annual Libby Dam flow augmentation strategies for sturgeon. The USFWS submits the SOR(s) to the Corps for regional discussion at the Technical Management Team (TMT) of the NMFS Regional Forum.

Below summarizes the response of sturgeon to implementation of shaped Libby Dam releases, up to powerhouse capacity, in 2006.

2006 Operations

Libby Dam operations during the spring in 2006 were managed to benefit sturgeon pursuant to requests from the USFWS. In 2006, the Corps managed flows from Libby Dam to “stack” peak Libby flows on top of peak local tributary flows such that releases were timed to provide the habitat attributes identified in the 2006 USFWS Biological Opinion for Libby Dam (velocities, depth, and temperature conditions). Temperature releases from Libby Dam were closely monitored and managed through positioning of selective withdrawal gates. The general strategy was to optimize the water temperatures of Libby releases, meaning providing for a gradual warming trend of Libby releases, to the extent possible, while minimizing the risk of a rapid decrease in river temperature after river temperatures had already warmed (i.e. a "cold shower").

The stacked flow operation was initiated on May 14, 2006 in accordance with the 2006 USFWS Biological Opinion ramping rates, and by May 17, outflows from Libby Dam reached powerhouse capacity (25,000 cfs). Libby Dam releases were controlled as much as possible to provide the appropriate temperature for sturgeon migration and spawning. The Corps maintained Libby Dam outflows at approximately 25,000 cfs (powerhouse capacity) until June 8, when releases increased, due in part to increasing inflows resulting from unusual weather conditions. The details of this event are described in the AAR. Libby discharges reached a maximum of 55,000 cfs (including 31,000 cfs spill) on June 18, where the discharge remained until June 20, and then slowly receded to powerhouse capacity on June 27.

In 2006, water temperatures at Bonners Ferry were consistent throughout the month of May, maintaining between 9°C and 10°C. Water temperature for the month of June warmed from 11°C to 14°C by 14 June, but then gradually cooled back to 10°C until 19 June. Another warming trend took place from 19 to 28 June when water temperature peaked at 15.5°C.

KOOTENAI RIVER WHITE STURGEON RESPONSE- 2006:

Since the late 1980s, Idaho Department of Fish and Game (IDFG), with funding from Bonneville Power Administration (BPA), has monitored white sturgeon behavior in the Kootenai River in Idaho.[1] In 2006, 29 tagged adult sturgeon exhibited a spawning migration (Rust and Wakkinen 2007). Of those, 12 went upstream as far as Ambush Rock (river kilometer, rkm, 243.5); nine of these fish continued upstream to near the Highway 95 bridge at Bonners Ferry (rkm 245.9), and five of these fish continued to areas upstream of Bonners Ferry (i.e. into the

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[1] Detailed discussion of the results of the IDFG monitoring can be found in annual progress reports for BPA project number 1988-065-00 (available online at www.efw.bpa.gov/searchpublications).

In recent years, the IDFG program has included a mix of tasks, including sampling of adult, juvenile, and larval sturgeon, sampling for sturgeon eggs, tracking of adult sturgeon through telemetry, and release of sturgeon larvae and embryos and experimental re-location of adult sturgeon to areas with potentially suitable habitat for egg incubation and early life stages. The results of the monitoring play into planning by the USFWS, with assistance from the Kootenai White Sturgeon Recovery Team, on efforts in the future to assist recovery of the species. The monitoring and evaluation program will continue in future years and will form the basis for adaptive management of dam operations and ecosystem restoration targeting sturgeon recovery.

braided portion of the river where more suitable spawning substrate exists). Of the fish that ventured into the braided reach, four were female and one was male. Three of these fish went as far as rkm 246.8, the remaining two (both females) were recorded as far upstream as rkm 248.6. The peak of upstream migration occurred between 17 and 24 May, which corresponded to river stages at Bonners Ferry at or above 1762 feet and river flows gradually increasing from about 37 kcfs (17 May) to near 42 kcfs (20 May), then decreasing to about 36 kcfs (25 May). Note that IDFG did not detect eggs or other evidence that the fish that moved into the braided reach actually spawned there.

RESIDENT TROUT POPULATION TRENDS – 2004 THROUGH 2007

The following discussion summarizes the results of recent trout population monitoring by MFWP[2] for the Kootenai River downstream of Libby Dam. Data going back to 2004 is presented to provide context to observations since the 2006 flood event.

In April 2004, MFWP (Dunnigan et al. 2004) estimated a total of 920 bull trout inhabited the Kootenai River reach between Libby Dam and the Fisher River (the 95% confidence interval was between 698 and 1142 fish). In April 2005, MFWP (Dunnigan et. al. 2005) estimated the population of bull trout in the reach downstream of Libby Dam at 976 fish (the 95% confidence interval was between 906 and 1068 fish). In April 2006, MFWP (Dunnigan et al. 2007) estimated that 176 adult bull trout (the 95% confidence interval was between 73 and 279 fish) were present within this three-mile section of the Kootenai River. The 2006 estimate was approximately 20% of similar estimates the previous two years. In April 2007, MFWP (R. Sylvester, MFWP, pers. comm.) estimated the bull trout population size in the same reach at 417 fish (the 95% confidence interval was between 120 and 714 fish).

MFWP data indicates that the number of bull trout in the river below the dam decreased between spring 2005 and spring 2006 and increased slightly by spring 2007. MFWP (Dunnigan et al. 2007) surmised that the observed population decrease in 2006 may be related to natural senescence of older fish. This hypothesis is supported by annual increases in mean total length of bull trout captured in this reach from 2004 through 2006. Note that the apparent decrease in bull trout population size between 2005 and 2006 is based on 2006 data obtained prior to the release of spillway flows from Libby Dam in May and June of 2006. The apparent increase in numbers of bull trout in 2007 indicates that the 2006 spill did not have an adverse impact on bull trout numbers downstream of Libby Dam.

[2] With funding from BPA, the Montana Department of Fish, Wildlife, and Parks (MFWP) monitors resident fish populations in the Kootenai River in Montana. MFWP also monitors conditions in Lake Koocanusa. The MFWP monitoring efforts will continue into the future and will provide data that the Corps will review in efforts to improve the multipurpose operation of Libby Dam.

Genetics work by MFWP indicates that roughly half of the bull trout found downstream of Libby Dam likely originated in Lake Koocanusa and were entrained through Libby Dam. Annual sampling efforts by MFWP typically capture a very low fraction of the fish that were captured and tagged during previous sampling events, which indicates that fish, after being entrained, may continue to move gradually downstream toward Idaho and are thus lost from the reaches sampled by MFWP. The transient nature of individual trout in the areas downstream of Libby Dam likely contributes to the variability in bull trout population estimates observed between 2004 and 2007.

Each April, MFWP also estimates the population size of rainbow and westslope cutthroat trout in two reaches of the Kootenai River downstream of Libby Dam. In a reach of the river near the town of Libby (Flower-Pipe at approximately river mile or RM 202), MFWP estimated the numbers of rainbow and cutthroat trout per 1000 feet of river at 813 and 547 fish in 2006 and 2007, respectively. Further upstream in the Re-Reg reach (at approximately RM 212), MFWP estimated trout densities per 1000 feet at 253 and 432 fish in 2006 and 2007, respectively. Analysis of fish size distribution indicates that the density of fish between 125 and 224 millimeters size decreased in the Flower-Pipe reach between 2006 and 2007. In the Re-Reg reach, the density of fish in this size range increased between 2006 and 2007. The changes in fish density and size distribution observed between 2006 and 2007 are consistent with annual fluctuations in fish density and size distribution in previous years. In general, changes in trout population don't appear to be highly influenced by dam operations in previous years.

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