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COLUMBIA RIVER REGIONAL FORUM
TECHNICAL MANAGEMENT TEAM
2006 Year End Review
December 13, 2006

FACILITATOR'S SUMMARY NOTES ON FUTURE ACTIONS
Facilitator: Donna Silverberg
Notes: Robin Harkless

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members. Most presentations were accompanied by Power Point or other electronic information. Please go to the agenda on the TMT web page to see more detailed information.

2005 Comparison to Previous Years

- *Water and Runoff Patterns*: Cathy Hlebechuk, COE, presented information comparing runoff patterns 2003-2006 and specific operations for each of the projects in 2006. This year, actual runoff exceeded the objectives for April-June at Lower Granite, McNary and Priest Rapids. Cathy briefly highlighted operations at specific projects: Libby saw high runoff early in the spring and spill in June. Dworshak spilled in April for flood control, and released cold water before July 4 due to high summer temperatures. Hungry Horse saw several peak inflows in May and June, and Grand Coulee drafted into May.
- *TDG/Temperature:* Jim Adams, COE, reported on 2006 temperatures and total dissolved gas (TDG) exceedances. He noted that the McNary forebay gauge on the Oregon side was removed so there was one less fixed monitoring gauge in the system this year. Jim shared the spill operations at each of the projects, and reported 575 TDG exceedances due to involuntary spill, load issues, and uncertainty using best professional judgment. This year, a new spill pattern and high tailwaters at Bonneville posed operating challenges.
    - **LESSON LEARNED***:* For future consideration, a suggestion was made to seek a better balance of load and spill between day and night to address gas issues during high flow seasons/years.
    - Dworshak outflows ramping up to address high temperatures at Lower Granite was successful in keeping the river at acceptable temperature levels. Drafting cool water in the summer could be the cause of this year's warmer temperatures in the winter in the Dworshak reservoir – AND, the warmer reservoir temperatures could be a result of warmer air temperatures. The region should continue to monitor this change and try to better understand it for the future.
- *Adult Fish Runs/Fisheries Update*: Cindy LeFleur, WDFW, reported that this year's adult spring chinook returns were higher than what was forecasted, and the run timing was later than usual. The fall chinook (not yet final) estimate has turned out lower than pre-forecasted and all returns are down from recent past years. It was noted that upriver bright fall chinook numbers are healthy, but that the tules have seen a much sharper decline. 2007 numbers are

expected to be down from this year (upriver fall chinook are expected to drop by 20% from 2006).

- *Fish Passage*: Jerry McCann, Fish Passage Center, reported on 2006 smolt migration. Timing for yearling chinook was earlier than the 10-year average, and steelhead numbers were higher and run timing later than the 10-year average. Re: transportation operations, an estimated 87% of steelhead were passing Lower Granite during collection, with a 79% probability of the wild run transported. 68% wild chinook were passing and 58% of those were transported; 86% hatchery chinook were passing with 61% of those transported. Jerry also reported that subyearling chinook run timing was earlier and shorter than the 10-year average.
    - **LESSONS LEARNED**: A question was asked about holdover fish, to which Jerry responded that, while these fish were not counted, they also would not have influenced the results of the survival data in relation to spill, temperature, or transit time.
    - Water transit time shows the highest relationship to smolt survival of those criteria noted above.
- *Weather*: Kyle Dittmer, CRITFC, reported that extreme precipitation and temperature patterns were the 'norm' in 2006, and he called it a 'yo-yo year' for weather. Record high temperatures were experienced in every quarter of WY 2006. The water year precipitation ended at 105% of normal for the Columbia River at The Dalles, with 89% to 95% at the low end and 125% to 133% at the high end. Winter forecasts presented at the OR-AMS Winter Weather meeting suggest near normal precipitation and near normal to above normal temperatures. The 2007 pre-season volume forecasts, for the Columbia River at The Dalles, vary from 88% to 104%
- *Montana 2006 VARQ Operation*: Brian Marotz, Montana, began his presentation with a recap of conditions and Libby operations in 2006: Less water was released April-May than that prescribed in strict VARQ, and given the 'yo-yo weather year', Libby filled faster than in past years, causing the project to spill in the summer, resulting in TDG levels exceeding the Montana standard. Gas bubble trauma was found in migrating bull trout due to these higher TDG levels. While there was not a high level of direct mortalities, Montana remains concerned for latent mortality effects and plans to do sample monitoring next spring to better understand the longer-term impacts of 2006 operations. Cindy Henriksen, COE, also reported on the COE's 'After Action Report' (a requirement for any emergency operation costing over $500,000) which includes discussion of the Libby operation. The report can be found on the Seattle District COE web page. Cindy suggested that of special interest to TMT might be Chapter 2 (overview of the spring flood event/operation decisions); Chapter 4 (observations from the event); Chapter 5 (conclusions); and Appendix Y (lessons learned).
    - **LESSON LEARNED**: The COE is looking back at past years' VARQ operations and currently in executive level discussions with the region about whether to operate to VARQ in 2007. The COE planned to make a decision about this matter by the end of December.
- **SPECIAL TMT discussion: SOR 2006-8**: TMT met to discuss an SOR brought forth by the salmon managers regarding VARQ operations for 2007. It was discussed here as it was relevant to the year end review item above. The request was to implement Libby VARQ in

2007 and was brought forth in an attempt to inform the COE of the fisheries' perspective on the issue, and get ahead of the COE's decision for 2007 operations.

The issue was also slated to be discussed at IT in January. Considering the timeline for decision, the COE suggested that folks weigh in at the executive level as this is the level at which is being discussed. A question was raised about consultation with the lower river tribes, and why this issue has not been vetted at the technical level. Some members of the Regional Forum urged the COE to consider waiting to make a decision until after the issue could be discussed through the Regional Forum. Again, the COE said that from the agency's perspective, the decision must be made by December 31.

Mainstem Lessons Learned:

- The thermocline in the forebay at Dworshak is warmer than in previous years. Potential causes and links to air temperature and/or system operations should be further explored.
- For future TMT Year End Reviews: Provide a list of changes in operations and initial lessons learned ahead of time. (It was noted that TMT will also continue its lessons learned discussion at their next process meeting in early 2007.)
- The extreme variability in weather patterns this year made it difficult for the RFC to forecast and in turn made it difficult to plan project operations.

Snake River Review:

- *Surface Passage Studies*: Tim Wik, Walla Walla District COE, provided information on surface passage studies, and noted that draft reports on each would be developed and sent out soon. The Lower Granite RSW summer study, which involved flat and bulk patterns, found that the patterns were not statistically different in how well they diverted fish from turbines. Ice Harbor survival probabilities showed little difference between treatments for any of the summer juveniles.
    - **LESSON LEARNED**: Studies show that fish passage is deeper in the summer, and that fish pass near the crest of the RSW.
- *Snake River Navigation Operations*: Rob Wall, COE, reported on navigation operations in 2006: Dredging brought Ice Harbor, Little Goose, and Lower Granite pools to MOP ; spill pattern adjustments made in coordination with towboaters' and to address safety needs; and investigating 'silt' problems below Lower Monumental. He also discussed the phenomenon of Little Goose forebay readings being higher than Lower Granite tailwater readings, resulting in raising Little Goose forebay to provide 1' of sill depth at the downstream Lower Granite lock.
    - **LESSON LEARNED**: Spill pattern adjustments made were successful in addressing safe passage for towboaters on the Lower Snake.
- *Fish Conditions*: Bill Muir, NOAA, presented information on reach survival of Snake River fish. For all reaches, survival of Lower Snake fish was higher than previous years for all but steelhead, of which survival percentages were slightly lower from John Day to Bonneville. Bill suggested that this lower steelhead survival is due to caspian tern predation on Crescent Island. Overall, survival through the hydrosystem was the highest ever, at 58%. It has not been determined whether reduced travel time results in higher survival.

- **LESSON LEARNED**: No relationship has been found between juvenile survival through the hydropower system and adult return rates. Therefore, survival, travel time and ocean conditions should all be considered.
- **LESSON LEARNED**: Survival for Snake River Fall chinook is difficult to interpret in terms of juvenile survival estimates. Instead, look at SAR's.
- **LESSON LEARNED**: Future research topics: Survival relationship to MOP, and survival relationship to exotic fish predation.

- *Water Temperature Modeling*: Ben Cope, EPA, reported on EPA's RMB-10 model used to predict temperature forecasts for the Snake River based on releases from Dworshak, and actual conditions/operations for 2006. Mike Schneider, COE, presented information from his CE-QUAL W2 model used by the COE to regulate temperatures at Dworshak, and also discussed actual conditions and operations over the 2006 summer.
    - **LESSON LEARNED**: The first half of July will continue to be the most challenging for maintaining temperatures. TMT members should begin discussing Dworshak/Lower Granite temperature issues earlier in the season, in early June, to get ahead of problems that might arise with summer temperature spikes.
    - **LESSONS LEARNED**:
        - Look at inflow loads to the system (e.g. Anatone) to manage Snake River temperatures.
        - Consider alternative metrics for travel time.
        - Models should include uncertainty/variability components.
    - **FOR FUTURE CONSIDERATION:**
        - Washington's water quality standards have been updated and may not be applied the same way on the Lower Snake.
        - Suggest looking at whether using Dworshak cool water earlier at a greater volume would have proven a better operating choice to balance temperatures, and what the trade-off would have been.

2006 Study Information that Might Impact 2007 Operations

- *Surface Passage Studies*: Brad Eppard, COE, reviewed surface passage studies for John Day, The Dalles, Bonneville, and Lower Granite. He also noted a 'tag effects study' that showed no survival difference between two different tags used.
    - **LESSON LEARNED**: System-wide, John Day yielded the best direct survival and the least injury.
- *SLED Research*: Robert Stansell, COE, reviewed the hazing program and SLED installation to deter sea lion predation at and below Bonneville. The expectation for 2007 is a more intensive hazing program, possibly trapping and branding, but likely no lethal take.
    - **LESSON LEARNED**: Acoustics did not deter sea lions, and did not impact salmonid passage. The SLEDs worked well as a deterrent (except for C-404) and did not appear to impact salmonid passage. Hazing was determined to be a short-term deterrent.
- *John Day T-1 Outage*: Dave Clugston, COE, reported on the John Day T-1 outage and potential impacts to: fish passage; The Dalles ladder usage; and Bonneville fallback, reascension and effects on escapement. He found that reductions to ladder use was minimal

and may not have been due just to the John Day outage. The Dalles ladder passage was very low compared to previous years, likely due to high flows/the new spill pattern.

- **LESSON LEARNED**: Bonneville saw more fallback and less re-ascension. Could this be due to sea lion predation?

- *Vernita Bar Preliminary Studies*: Russell Langshaw, Grant County PUD, reported initial findings from a two year alternative load study.
    - **LESSON LEARNED**: The Vernita Bar operation implemented this year was similar to Bonneville operations for chum, with two nighttime peaks to water redds already placed at higher elevations while discouraging new spawning in higher areas. At Vernita Bar, the operation was successful until the end of the operation, when peaks were longer. Shorter peaks, closer together, would likely produce more success. (It was also suggested to use caution when suggesting that the peaks were the cause of higher numbers of redds at higher elevations, and that this could be due to other factors.)

Other Lessons Learned/Thoughts

- RSW efficiency information may be misleading. The salmon managers would like to see what the response curves were for proportion of spillway passage.

All power point presentations from the TMT Year End Review can be found linked to the agenda on the TMT web page. Thank you all for your participation!

Technical Management Team Year-End Review

December 13, 2006

1. Greetings and Introductions.

Donna Silverberg facilitated the December 13 year-end review meeting of the Technical Management Team. The following is a summary (not a verbatim transcript) of the topics discussed and decisions made at this meeting. Anyone with questions or comments about these notes should contact Cathy Hlebechuk at 503-808-3942.

Please note that all of the presentations for the year-end review meeting are hot-linked to today's agenda on the TMT homepage. Please refer to these presentations for full details.

2. Mainstem Review.

A. 2006 Water Temperature and Runoff Patterns. Cathy Hlebechuk began with a description of runoff patterns and operations of the major storage projects. Runoff volumes were near-normal at most of the storage projects, but the runoff was shaped heavily toward the early part of the spring in some basins. At Lower Granite, actual

flows, April 3-June 20, were 125 Kcfs, well in excess the 100 Kcfs objective. For the June 21-August 31 period, actual flows were 38 Kcfs; the target was 54 Kcfs.

At McNary, for the April 10-June 30 period, the objective was 260 Kcfs; actual flows were 326 Kcfs. For the July 1-August 31 period, actual flow was 166 Kcfs, while the objective was 200 Kcfs. At Priest Rapids, for the April 10-June 30 period, actual flows were 191 Kcfs; the target was 135 Kcfs.

At Libby, it was an unusual year, said Hlebechuk. The April-August actual runoff volume was 106% of normal; the May volume was 141% of normal. The reservoir climbed steeply toward full, elevation 2459, beginning in mid-May; the project was full by mid-June. The reservoir filled 37 feet in May, and we had to start spilling by June 8. Spill reached 31 Kcfs by the third week in June. The State of Montana and Kootenai Tribe submitted a SOR which requested a flat flow to draft 10 feet by the end of September rather than draft 20 feet by the end of August, per the Biop. The agreement was to release about 15 Kcfs from late July through August 31. The 15 kcfs operation was coordinated at the policy level. Outflow was then stepped down to about 9 Kcfs through September 30. That operation was coordinated through TMT.

At Dworshak, we also saw inflow spikes, Hlebechuk said. The 2006 Dworshak operation was also somewhat unusual, because there was a request to begin the cool water releases from Dworshak prior to Fourth of July weekend, due to high temperatures. We had some CE-QUAL W2 modeling from Mike Schneider that helped guide our operations throughout the season, she said; Dworshak was operated basically for water temperatures throughout the season. There was some Dworshak spill in April to draft to it's end of April flood control rule curve; the other goal was to refill Dworshak by June 30. Refill was achieved by July 1 at Dworshak. At Dworshak, there is also a Snake River Adjudication Agreement that gives the Nez Perce Tribe 200 kaf – 15 feet of Dworshak storage – for use during September. Some of that water was released in August to control warm Lower Granite temperatures so we actually released 153.5 kaf during September this year, Hlebechuk said. This operation was coordinated at TMT with members including the Nez Perce Tribe.

At Hungry Horse, the project almost filled by the end of June, Hlebechuk said; inflows peaked sharply at that project in May and early June due to warm temperatures and snowmelt, as well as a mid-June rain event that deposited 2 inches of precipitation in that basin. The State of Montana and Kootenai Tribe submitted a SOR which requested a flat flow to draft 10 feet by the end of September rather than by the end of September per the Biop. The agreement was to release about 3 Kcfs from late July through August 31. The 3 kcfs operation was coordinated at the policy level.

At Grand Coulee, the project drafted from January into May for power and chum flows. Grand Coulee refilled by July 4, to elevation 1290. Per the BiOp, 10 feet of storage was drafted by August 31; it was then refilled to elevation 1283 for kokanee spawning.

Why were we so far below Upper Rule Curve at Grand Coulee on March 31? Bpb Heinith asked. This graph is not correct, Hlebechuk replied – the actual shifted flood control elevation on March 31 at Grand Coulee was 1263.6. I will have the corrected graph posted. The project reached it's April 10 upper rule curve elevation, John Roache', BOR TMT representative, added.

B. Temperature/TDG Level Variations. Jim Adams provided an overview of water quality in the Columbia basin in 2006. He touched on the following major topics:

- Fixed monitoring stations: the Corps operated 28 gauges in 2006, one less than previous years (McNary forebay gauge, Oregon side was eliminated). Reclamation operated four additional gauges; the Mid-Cs operated 10 gauges.
- TDG – start of spill, end of spill, total days of spill at the 8 FCRPS projects (table)
- Snake River spill operations, by project (table)
- Lower Columbia spill operations, by project (table)
- Total Dissolved Gas – 575 total exceedences in 2006, significantly higher than anything seen in previous years. About 23% of the days monitored showed exceedences in 2006. The reason was that there was a lot of involuntary spill this year, due to the shape of the runoff, lack of load and lack of hydraulic capacity.
- TDG: number of days of exceedence, by project (table)
- TDG: types of exceedence, 2006 (table)
- Bonneville spill patterns – new spill pattern developed for spill flows less than 100 Kcfs, that increased spill at the end bays. This resulted in high TDG levels at the Cascades Island gauge, which may have resulted in an overestimation of actual TDG levels across the river.
- 2006 spring spill – Bonneville Dam (April 21-April 26) – graph

Russ Kiefer suggested that the TMT needs to address the lack-of-load problem during the spring – we need to do a better job of avoiding high volumes of nighttime spill, which then result in our having to curtail spill during the day to keep TDG levels down. Good suggestion, said Silverberg.

Continuing on, Adams touched on:

- Dworshak summer operations – June 28-September 13 (table)
- Dworshak outflows and Lower Snake River tailwater temperatures, 2006 – sharp rise in temperature by mid-June, with the temperature standard exceeded in late June. For the most part, the Corps was able to keep tailrace temperatures at the Lower Snake projects below the 68-degree standard during the summer of 2006.
- Lower Granite inflows and temperatures, 2006 (graph)
- Lower Granite tailwater temperatures, 2000-2006 (graph). In 2006, temperatures were warmer earlier in the season than normal, due to hot weather.
- Dworshak summer operations and Lower Granite tailrace temperatures – 223 hours of exceedence in 2006, the highest total since 1998.
- Dworshak forebay thermocline, 2006 – the reservoir was slightly warmer in 2006 than in previous years, either because of the warm weather or because we’re causing a change in Dworshak thermocline temperatures because we’re drafting the coldest water each year. The answer is unknown at this time, but needs to be investigated, Adams said.

C. Adult Fish Runs/Fisheries Review. Cindy LeFleur led this presentation, touching on the following major topics. She noted that all of these returns are to the mouth of the Columbia:

- Upriver spring chinook runs: 2006 prediction 88,000; 2006 return 132,000. The run timing was unusual, peaking about May 10, significantly later than the 10-year average of the third week in April.
- Spring chinook daily passage at Bonneville Dam – 2006 vs. 10-year average.
- Spring chinook fisheries, 2006 – 87,000 recreational angler trips, 7,000 fish kept. Commercial: 4,300 fish kept, ex-vessel value $5.50/lb. SAFE commercial harvest 6,600 fish. Tribal fishery kept 8,400 spring chinook. The ESA impact rate was 1.8% vs. the 2% guideline (non-Indian) and 6.6% (treaty Indian) vs. the 8% guideline.
- Upper Columbia summer chinook returns, 1982-2006 (graph). 2006 forecast: 49,000; actual return 76,000.
- Summer chinook fisheries, 2006: recreational fishers caught 5,200 fish; commercial fishers kept 4,800 fish; the treaty fishery harvested 16,300.
- Columbia River Fall chinook returns, 1982-2006 graph) – prediction 475,000, actual return about 396,000.
- Upriver bright fall chinook returns, 1982-2006: 2006 forecast 249,000; actual return about 225,900.
- Mid-Columbia bright fall chinook returns, 1982-2006 86,600 vs. 71,900 actual.
- Bonneville pool hatchery fall chinook returns (tules): 2006 forecast 51,800; actual return about 33,700.
- Fall chinook fisheries, 2006: recreational, 13,700 chinook harvested, 26,000 commercial, treaty harvest 82,600. An excellent ex-vessel price of about $3.50/lb.
- Forecast accuracy, upriver spring chinook – underpredicted in 2006. Upriver summer chinook were also underpredicted in 2006. Upriver bright fall chinook overpredicted in 2006. Total fall chinook were also overpredicted in 2006.
- Outlook for 2007 returns: generally down from 2006 – upriver spring chinook prediction: 78,500, down from 132,000 in 2006. Summer chinook: 45,000 predicted vs. 76,000 actual in 2006. Sockeye: 27,300 predicted in 2007, close to the 2006 return. Fall chinook: about 20% less than 2006.

In response to a question from Scott Bettin, LeFleur said she does not have an estimate of the 2006 chum return yet, but will provide that to the TMT. In response to another question from Paul Wagner, LeFleur said she will also provide summer steelhead information to the TMT. She said steelhead numbers have been pretty stable, at about 300,000, hatchery and wild above Bonneville, in recent years, and she expects the numbers to be similar for 2007.

D. Fish Passage. Jerry McCann led this presentation. He touched on the following major topics:

- Review of 2006 smolt migration – run size, timing, spread-the-risk delayed transport, Snake River subyearling survival and summer spill.
- Yearling chinook population index at Lower Granite and hatchery releases, 1998-2006 (graph)
- Combined H&W steelhead population at Lower Granite and hatchery releases, 1998-2006 (graph)
- Timing of spring migrants at Lower Granite, 2006 vs. 10-year average (graph) – 2006 steelhead timing slightly earlier than 10-year average; hatchery chinook timing average in 2006; wild chinook earlier than hatchery chinook in 2006, but typical for wild fish 10-year average.
- Wild PIT-tagged yearling chinook timing at Lower Granite and wild run at large (graph) – timing within the wild groups of fish is diverse. The earliest stock in 2006 was the Imnaha, with the Salmon River stock coming out later. The peak of the run timing coincided with the peak in flow and spill.
- Wild PIT-tagged steelhead timing at Lower Granite and combined run at large (graph) – Clearwater stock earliest; Imnaha stock latest in 2006.
- Run-at-large steelhead and chinook 10-year average timing at Lower Granite (graph) – 10-year average daily proportions of yearling chinook and steelhead. Steelhead start to predominate in late May, typically – may be a better way to look at impacts of operations on various populations, in the context of deciding when transportation should begin each year.
- Summary of 2006 transport, by species (table) – Lower Granite, Little Goose, Lower Monumental, McNary. Proportion passing during transport, estimated collection efficiency, proportion of population transported – ranged from 58% (wild spring/summer chinook) to 79% (wild steelhead).
- Other ways to measure transport proportion (table)
- Hatchery/supplementation releases of subyearling chinook above Lower Granite (graph) – 1995-2006
- Subyearling chinook timing at Lower Granite, May 3-October 18 – 1995-1999, 2000-2005, run-at-large 2006 (graph)
- Survival for production subyearling chinook, Lower Granite to McNary 1998-2006, with 95% CIs (graph) – about 70% in 2006.
- Weighted regression example (graph)
- AH subyearling chinook survival vs. average spill percent, Little Goose, Lower Monumental, Ice Harbor and McNary, May 20-July 15 (graph)
- AH subyearling chinook survival vs. summer water transit time, Little Goose, Lower Monumental, Ice Harbor, McNary, 2006
- AH subyearling chinook survival vs. average temperature, Little Goose, Lower Monumental, Ice Harbor, McNary, 2006.

To what extent are these results influenced by the holdover fall chinook? Jim Ruff asked. Very little, McCann replied – it is not a significant proportion of the overall population. In response to another question, McCann said the tightest correlation to survival among these variables was with water transit time.

E. Weather. Kyle Dittmer led this presentation, touching on the following major points:

- Water year 2006 will be noted for its extremes in weather patterns, precipitation and temperature.
- Water year 2006 Columbia Basin precipitation, by month (graph) – very wet fall, winter and spring, particularly in April, the last week in May and the first two weeks in June
- Water year 2006 Columbia Basin temperature (graph) – many new record daily highs during spring, particularly in May, June and July. Temperatures reached 110 degrees one day in late July in the Portland area
- The Dalles precipitation was 105% of normal in 2006; other subbasins hit between 89% to 133% of normal.

Dittmer then moved on to a summary of the AMS annual winter weather meeting forecasts. The bottom line is that there was agreement that we are heading into an El Niño year, Dittmer said. The CRITFC forecast is for near-normal temperatures and precipitation this year; most of the other forecasters expect above-normal temperatures and below-normal precipitation. He provided a graph showing moderate El Niño conditions predicted in 2007, but said that his interpretation of the sun spot data leads him to predict near-normal temperature and precipitation in water year 2007.

Dittmer then provided a table showing runoff predictions for The Dalles in 2007 (January-July), which ranged from 88% of normal (CRITFC) to 104% of normal (CIG-UW). He noted that, in 2005-2006, the CIG forecast was the most accurate.

F. Montana's 2006 VARQ Operations. Brian Marotz led this presentation, touching on the following major topics:

- What VARQ is and how it works – moves more water into the spring and summer period than typical historic operations
- In 2006, less water was released in April and May than would have been released if VARQ had been fully implemented, which resulted in less storage space being available to contain the high volume of runoff in May and June. This caused spill to occur at Libby, which caused significant exceedences of the Montana State standard of 110% TDG. TDG levels exceeded 130% when spill reached 31 Kcfs at Libby. By day 4 of spill, over 30% of the fish sampled showed signs of GBT; after day 11, that percentage reached 100% of the bull trout and 90%+ of the rainbow trout and mountain whitefish sampled. Direct mortality was relatively light, but Montana remains concerned about latent mortality as a result of the 2006 spill at Libby. More information will be available on latent mortality by this spring.
- In terms of population-level effects, we sampled in the fall; preliminary results indicated no apparent population impacts in the farthest downstream reach, where TDG levels were 125%. The reaches nearest the dam will be sampled this spring.

Did you notice a big difference in symptoms between the left bank and the right bank? one participant asked. Initially, yes, but as spill continued, the TDG

mixed across the river, and we saw fairly consistent incidence of signs across the river, Marotz replied. And what's the depth of the river below Libby? Ruff asked. About 30-40 feet in the stilling basin, but much shallower below David Thompson Bridge, Marotz replied. There are pockets down to 30-40 feet below the bridge, however, Marotz said.

Cindy Henriksen then led a presentation titled "Libby 2006 After-Action Report." She touched on the following major topics, noting that the report itself is quite lengthy:

- An after-action report is produced whenever the Corps launches an emergency action operation costing more than $500,000.
    - The report is available from the Corps Seattle District webpage: www.nws.usace.army.mil.
- Contents of the report. From the TMT perspective, Chapter 2 ("Overview of 2006 Spring Flood Event") and Appendix K ("Water Management") are probably the most germane. Chapter 4 ("Observations from 2006 Flood Event") and Chapter 5 ("Conclusions") may also be of interest.
- Lessons learned are covered in Appendix Y; it covers flood response, public affairs and Libby operation.

There has been a lot of regional discussion of what will happen at the Montana projects in 2007, Henriksen said; the Corps of Engineers has not yet made a decision, but is considering everything from VARQ operations to standard flood control operations.

On December 12, the salmon managers submitted SOR 2006-8, covering Libby Dam VARQ operations. Wagner explained that this SOR, developed during yesterday's FPAC meeting, requests that the Corps implement VARQ at the Montana projects in 2007. The fishery managers wanted to get out ahead of the curve and let the Corps know that their operational preference, from a fisheries perspective, is to implement VARQ in 2007, Wagner explained.

We may have erred in not also including Hungry Horse in this SOR, David Wills observed – we would also like to see VARQ implemented at Hungry Horse in 2007.

Ruff observed that the IT will be discussing this issue at its January 11 meeting. He asked what is called for in the current draft of the 2007 Water Management Plan. The 2007 WMP is still in draft form; it rolled over the 2006 operation, Henriksen replied. We have been open to the concept that standard flood control may be on the table again, she said; that decision needs to be made by the end of 2006. This has been discussed extensively at the policy level, Henriksen said, but it's important to note that we are discussing 2007 operations only – not longer-term operations at the Montana projects. Basically, you're saying that the Corps needs to make its decision before the IT meets on January 11? Ruff asked. That's correct, said Eric Braun – any input needs to be made at the policy level, as soon as possible.

What will the operation of Libby be for the end of December? Ruff asked. That will be based on the end-of-December forecast, Henriksen said – the December final forecast for Libby was 122% of average, which puts Libby's December 31 elevation at 2411. Hlebechuk reiterated that the 2007 WMP is still in draft form and the Corps is still awaiting comments from many agencies.

Is the Corps engaged in formal consultations on this issue? Bob Heinith asked. We're not in a formal consultation process yet – we're having executive-level discussions on this issue, Braun replied. How did this issue go all the way to the executives without pausing at the technical level? Mark Bagdovitz asked. My guess is that, because the Corps has not yet signed an ROD on the Upper Columbia EIS, it is a timing issue, Henriksen replied. There have been some discussions of present operations at TMT, but not of future operations, Silverberg added.

Does the Corps believe VARQ has been implemented as designed since 2003? Marotz asked. No, it has not been implemented exactly as per the guidance, Henriksen replied, but there are different interpretations of what exactly full implementation would entail. I would agree with Mark that this decision has totally bypassed the Regional Forum process, said Ruff. An emergency IT meeting to discuss this is still an option, Silverberg observed. Russ Kiefer noted that, no matter what the Corps decides, Libby will be at 2411 on December 31; he asked that the Corps delay its decision until after the IT weighs in on January 11. Henriksen replied that 11 days can make a significant difference in Libby operations, and the Corps is obligated to make its decision on this issue by December 31.

G. Q&A and Lessons Learned, 2006. Ruff said the discussion about Dworshak, in particular, the changing thermocline in 2006, as well as the above-normal temperature departures in 2006 during the winter and spring period, lead him to conclude that weather, rather than the operation of Dworshak, was the cause of warmer thermocline temperatures in 2006. Adams replied that, in his opinion, more investigation is needed before that conclusion can be verified.

Ron Boyce observed that it would be nice to have a list, in advance of the year-end review meetings, of the lessons learned in a given year. We need some information on the "so what" part of the equation, Boyce said – what are the next steps, operationally, that would result from the lessons learned. So noted, Silverberg said.

Dittmer noted that increasingly extreme variability in weather patterns make forecasting and subsequent project operations very challenging. A quicker response to changing weather patterns is warranted. Everyone needs to be able to adapt quickly to changing weather, he said.

3. Snake River Review.

A. Surface Passage Studies. Tim Wik led this presentation, touching on the following major topics:

- Objectives (Lower Granite): compare fish passage performance, spring BGS in, BGS out, summer, bulk vs. uniform spill
- Treatment study: stratified two-treatment experimental design, spring (BGS in and BGS out) – uniform spill pattern, 2-day treatment periods with 4-day blocks, and summer (bulk vs. uniform spill) – 1-day treatment periods with 2-day blocks
- BGS in place or stowed upstream (diagram)
- BGS diverted fish in upper water column toward spillway (fish distribution during in and out treatments) – table showing FPE, SPE, SPS, FGE, RPE (% of fish over RSW) and RPS (effectiveness of RSW, #of fish vs. flow volume) with BGS in and out. FGE was more than 20% higher with the BGS out.
- BGS diverted 1/3 or more of spring migrants (graphs)
- Bulk spill decreased summer RSW performance (FPE, SPE, SPS, FGE, RPE and RPS under uniform and bulk spill patterns) – table
- Bulk spill reduced RSW efficiency and effectiveness (graph)
- Conclusions: BGS: reduced-height BGS diverted just over 33% of fish away from occluded spillway units, summer bulk spill, slightly more fish passed the spillway, but fewer fish passed via the RSW.

How significant is the 33% number? Wagner asked. It depends how you look at it, Wik replied – it diverted some fish, but the significance is hard to determine. High flows and spill during that period probably muddied the waters somewhat.

Moving on, Wik touched on:

- Spring conditions – powerhouse and total project during the study period
- Passage location – yearling chinook salmon – percent of fish by unit, spill bay and RSW, BGS stored and BGS deployed (graphs)
- Passage location – juvenile steelhead, by spill bay and unit, BGS deployed and BGS stored – a very high percentage of juvenile steelhead passed via unit 5 with the BGS deployed
- Survival probability, yearling chinook, BGS deployed vs. BGS stored – not much difference between passage route (pool, forebay, spill, RSW, turbine, bypass, dam
- Survival probability, juvenile steelhead, BGS deployed vs. BGS stored, by route of passage – no meaningful difference between treatments
- Passage location – summer study, subyearling chinook bulk spill vs. uniform spill: RSW passed the most fish
- Survival probability, subyearling chinook, by route of passage – no meaningful difference between treatments, although survival was about 10% higher with the bay open 4 stops

Next, Wik provided the following information for radio-tagged fish at Ice Harbor:

- Project operations at Ice Harbor Dam for radio-tagged spring migrants, 2006, 30-40% spill vs. BiOp spill
- First approach and passage distribution, 30-40% spill (graph)
- First approach and passage distribution, BiOp spill treatment – slightly fewer fish passed the RSW during this treatment (graph)
- Chinook passage metrics by spill treatment (graph)
- Steelhead passage metrics by spill treatment (spill efficiency 20% higher under bulk spill) – graph
- Chinook survival by spill treatment (graph) – no significant difference between treatments
- Steelhead survival by spill treatment (graph) – no significant difference between treatments

In response to a question, Wik said that, with respect to the higher-than-100% survival estimates, all he can say is that the control fish died at a slightly higher rate than the fish that passed the dam. Moving on, Wik touched on passage behavior and survival for radio-tagged subyearling chinook at Ice Harbor, 2006:

- 2006 results: passage distribution (nearly 70% passed via the RSW)
- 2006 results: passage metrics – FGE averaged 70.4%. RSW effectiveness was 4.56.
- 2006 results: relative survival – 95.2% for the dam, 98% for the RSW, 98.8% for spillway
- 2006 results summary: 75% of the fish approached the RSW area first; 94% of the fish passed via spillway, 68% through the RSW; forebay residence time shorter than previous years; passage metrics were all high; tailrace egress time was less than 11 minutes; all relative survival estimates for actively migrating subyearling chinook were high.

Wik then moved on to “Evaluation of Fish Passage Distribution at the Ice Harbor RSW, 2006.” He touched on the following topics:

- Objective
- Methods: frame mount and new magnet-mount deployments
- Results: fish pass near the surface in the spring (graph)
- Passage is deeper during the summer (graph)
- Vertical distribution at release pipe is similar across deployments (table)
- Conclusions: fish pass near the RSW crest; late-summer conditions increase the proportion passing near the crest

B. Snake River Navigation Operations. Rob Wall from the Corps Walla Walla district led this presentation:

- 2006 dredging brought Ice Harbor, Little Goose and Lower Granite pools

back to MOP, something that hasn't happened in recent years

- Lower Granite and Lower Monumental spill patterns had to be adjusted to accommodate navigation, to eliminate a whirlpool that was forcing barges into the guide wall. Two spill patterns developed, one of which produced acceptable safe operating conditions for navigation.
- Little Goose and Ice Harbor pools also had to be adjusted during periods of low flow and high spill

The Ice Harbor pool was adjusted because a barge operator reported a grinding, scraping noise, Wall said; a sounding showed a depth of 12 feet in one location, less than the required 14 feet, so the project elevation was increased above MOP. The surveys were repeated in September, and found no problem. Pool elevation was then reduced to MOP, after about two weeks above MOP. So you're not anticipating any problems operating at MOP for 2007? Wills asked. No, Wall replied. We may still have that problem at Little Goose, because of the need for one foot of sill depth, Hlebechuk added. With respect to the Lower Granite adjustment, that occurred during April, when flows were above 75 Kcfs. Once flows dropped below 75 Kcfs, the navigators had no problem until flows reached a very low level, Hlebechuk said. Also, with respect to Lower Monumental spill, the operators kept a log showing how often spill had to be curtailed or modified. Foss Maritime's tugs Clarkston and Lewiston were the tugs requiring all but 2 of the spill changes for non-fish transport barges at Lower Monumental. I will post that information on the Year End Review agenda, she said.

C. Fish Conditions. Bill Muir led this presentation, titled "Downstream Survival of Juvenile Stream-Type Chinook and Steelhead Through the Snake/Columbia Hydropower System and Subsequent Adult Returns," touching on the following major topics:

- Outline
- All estimates are for PIT-tagged fish
- Juvenile detector locations (map) – The Dalles is the only project without detection capabilities in the Lower Columbia; Rocky Reach is the only project that has PIT-tag detection capabilities in the upper Columbia
- Flow and spill, 2006
- Transportation – 62% of the non-tagged stream-type chinook were barged in 2006, along with 76% of steelhead
- Survival, release to Lower Granite vs. distance, hatchery stream-type chinook, 1993-2006 (graph)
- Survival, stream-type chinook, all Snake River Basin hatchery stocks combined, release to Lower Granite vs. distance (61% overall)
- Estimated survival, stream-type chinook and steelhead, by reach, Lower Granite to McNary (graphs)
- Lower Monumental-McNary survival partitioned in 2006 (89% for chinook, Lower Monumental-McNary, about 77% for steelhead, probably due to the tern colony encountered en route)
- Historic McNary-to-John Day estimated survival, stream-type chinook and

steelhead (84% vs. 72%, respectively)

- John Day-to-Bonneville survival, 1998-2006 89 and 85%, historic average, 95% and 83%, 2006, respectively)
- Snake River trap to Bonneville, estimated survival, stream-type chinook and steelhead, 1998-2006. 2006 survival the highest on record since 2006 – 58% and 37%, respectively.
- Median travel time, stream-type chinook, Lower Granite to Bonneville, 1997-2006. Travel times normal in 2006 except during the latter part of the season, when the travel times were the highest on record.
- Lower Granite-to-Bonneville travel time, by number of detections, 2005 vs. 2006 (graphs)
- Snake River Trap to Bonneville Dam tailrace, hydrosystem survival by outmigration year, 1965-2005, steelhead and chinook (graphs)
- How big a part does hydrosystem survival play in adult return rates?
- Hydropower system survival, stream-type chinook, and SARs (graph)
- SAR vs. hydropower system survival, chinook and steelhead (graphs) – little relationship is apparent between survival through the hydropower system and adult returns, which means the marine phase of the life-cycle is the dominant influence on adult returns
- Snake River fall chinook – because not all fall chinook migrate while bypass systems are on, estimates of their survival are difficult to interpret. Therefore, we rely on SARs.
- Conclusions: stream-type chinook survival averaged 64% from hatchery release to first dam in 2006.

Do you have estimates of tern predation in 2006? Dan Spear asked. It averages about 22% of the PIT tags we release each year, Muir replied. Has there been any research on survival rates and travel time under MOP and non-MOP operations? Hlebechuk asked. We haven't looked at that specifically, but I wouldn't expect to see a lot of difference, Muir replied.

D. Fall Chinook Survival Study Review. This topic was not coevered during today's meeting.

E. Water Temperature: CE-QUAL-W2 Modeling. Ben Cope led this presentation, noting that he would be presenting his predictions of the outcome of different release patterns from Dworshak on water temperatures. He touched on the following major topics:

- Temperatures in the Clearwater River at Peck, June 12-September 30, based on 1975, 1985, 1990, 1991 weather) – graph showing predicted vs. observed temperatures in 2006. The correlation was "not too bad" in 2006, according to Cope, particularly once actual release temperatures from Dworshak began to mirror assumed release temperatures in late August.
- Temperatures in the Snake River at Lower Granite Dam, June 12-September 30, predicted vs. observed. Actual temperatures were higher than predicted early and late in the summer.
- Dworshak releases (planned vs. actual flows) – graph

Overall, the matrix managing team we have in place has done a good job of keeping water temperatures below 20 degrees C during the summer, Cope observed. One additional observation, said Dittmer – the present modeling method we're using hasn't been doing a very good job of capturing that rapid rise in temperature in late June or early July, and we will work on that for 2007. We would like Jim Adams to start looking at these water temperatures in June in 2007, Kiefer said – by the time we started looking at temperatures last year, we were too late. So noted, said Silverberg.

Next, Mike Schneider provided a presentation on Lower Snake temperature management issues. He touched on the following major topics:

- Lower Snake River temperature management, 2006 – water temperature released from Lower Granite Dam was generally less than 20 degrees C during July and August. There were several short excursions above 20 degrees C, due primarily to some very hot weather. The Snake at Ice Harbor was above 20 degrees C for more than 2 months. The Snake River at Anatone, above Lower Granite, was above 20 degrees C for more than 3 months, and reached 25 degrees C during some periods.
- Flow contribution to the Lower Snake, 2006 – Clearwater River at Spaulding, North Fork Clearwater, Salmon, Grande Ronde, Imnaha, Snake River from Hells Canyon Dam (graph)
- Snake River temperatures at Anatone, 1992-2006 – 2006 temperatures were the highest on record during early July (graph)
- Snake River flow at Anatone, January 2006-December 2006 (graph)
- Dworshak forebay cross-section, June-December (graph)
- 2006 Dworshak operations, March 1-September 30 – flow, spill, release temperature (graph)
- Temperature and flow at Lower Granite Dam, March 1-September 30, 2006 – a very rapid rise occurred between June 21 and July 5 (graph)
- Temperature and flow at Ice Harbor Dam, 2006 (graph)
- Lower Snake River reservoir temperature profiles, 2006 (graph)
- 2006 CE-QUAL simulation vs. observed conditions (sample graphs)
- Water temperature contours in Lower Granite pool, August 12-17, (sample simulations)
- Velocity fields in Lower Granite pool, August 12-17 (sample simulations)
- Temperature field in Dworshak pool, July 23 (sample simulation) – there is evidence that operating in undershot mode changed the temperature structure within the reservoir
- Lower Snake River temperature management – real-time forecasting methods
- Sample model outputs
- 2006 simulation without Dworshak – water temperatures in the Lower Granite tailrace would have exceeded 20 degrees C from July 1 through mid-September
- Lessons learned: need to look more closely at inflow temperature loads to the system, and develop operational guidance for Dworshak releases

involving thermal loading to Lower Granite pool, time of travel and atmospheric heating. The first half of July will continue to be the most challenging temperature management period.

- Snake River temperature management (graph)
- The uncertainty inherent in the forecasting effort in the Snake. Flexibility in scheduling Dworshak releases will lead to greater control of temperatures in the Lower Snake River, and optimal allocation of cold water.
- There is a potential conflict between CWA and ESA for the development of temperature management policy for the Lower Snake River – Washington's new temperature standard for the Lower Snake have been updated.

Given the conditions we saw in the first two weeks of July 2006, have you done any simulations showing what might have happened if we had used Dworshak to a greater extent earlier in the season? Filardo asked. There certainly would have been a cooling effect, but we haven't run a retrospective analysis, Schneider replied. If you use more early, it won't be there later on. We can certainly run that analysis, however, Schneider added.

4. 2006 Study Information.

A. Surface Passage Studies. Brad Eppard led this presentation, covering results from 2006 Portland District AFEP research. Eppard touched on the following topics:

- John Day research included turbine and tailrace survival
- The Dalles research focused on spillway studies
- Bonneville studies focused on corner collector PIT detection, pool and spillway survival
- System studies included the Turbine Passage Survival program, others
- John Day: 2006 operations – flow and spill, April-September (graph)
- John Day turbine and tailrace survival study – release locations, results and conclusions. Survival estimates by release point ranged from 88% (turbine) to 100% (tailrace) to 89% (combined)
- John Day plan for 2007: TSW development, to be installed by 2008
- The Dalles 2006 operations – flow and spill, April-September (graph)
- The Dalles spillway vortex study – distribution, survival, tailrace egress, 2005 vs. 2006 (graphs).
- The Dalles plan for 2007: study planned to look at higher gate openings (16 feet)
- Bonneville Dam 2006 operations
- Bonneville Dam corner collector PIT detection and yearling and subyearling chinook survival results (graphs)
- System study results: turbine survival program – biological index testing, results and conclusions – the best geometry provided the most benign passage
- System study results: post-FCRPS survival, Lower Granite to estuary (yearling chinook only) and Bonneville to estuary (about 40% and just over

60%, respectively). Conclusions: the Corps undertook a tag effects study, JSATS vs. PIT-tags in the field and the laboratory. There is some evidence of bias for age-zero chinook less than 95 mm fork length. Sample sizes precluded the ability to measure small differences, however.

B. SLED Research Results. Robert Stansell led this presentation, touching on the following topic areas:

- Objectives
- Observations/methodology
- SLED configuration and installation locations
- USDA hazing efforts
- Boat-based hazing efforts
- Results: observed catches by pinnipeds at Bonneville Dam tailrace, 2006. Take included 7% sturgeon, much higher than previously observed. About 260 sturgeon were observed being taken. Estimated salmonid catch in 2006: more than 3,000 salmonids.
- Seasonal distribution of sea lions at Bonneville Dam, 2002-2006 (peaked on May 13 this year)
- Estimated pinniped abundance at Bonneville Dam, 2002-2006, by species
- SLEDS – how did they work? Very well, for the most part. Only one sea lion entered the fishways; although the late arrival of the spring chinook stirred concerns that the SLEDS were hampering salmonid passage, those concerns proved to be unfounded.
- Acoustics: the short story – no obvious effect on behavior of sea lions within 100 feet of fishway entrances
- Hazing: the short story – individual animals were hazed up to 21 times, so for some animals, hazing is definitely ineffective. Hazed sea lions would generally temporarily leave, but return as soon as field personnel departed.
- USDA hazing and acoustics – 2006 test results. The bottom line: more salmonids were taken by pinnipeds while hazing and acoustics were active.
- Boat hazing: slightly fewer salmonids were taken by pinnipeds while boat hazing was active.
- Summary: about 3,000 salmon were taken by pinnipeds in 2006; California and Steller's sea lions are arriving at the project earlier each year; the SLEDS were effective in keeping sea ions out of the fishways and had no effect on salmonid passage.
- For 2007, the plan is to continue full-time daylight observations, with partial observations starting in January; SLEDS will be installed by February; ADDs will be activated in February. The first sea lion has already been observed at Bonneville.

C. John Day T-1 Outage. Dave Clugston led this presentation, touching on the following major topics.

- Effects of T-1 outage on adult passage: 2006 John Day north shore

ladder. The bottom line: significant numbers of fish still used the south ladder in 2006, but a definite shift occurred to the north ladder, compared to passage numbers from previous years.

- Median passage time was half as long for the north ladder, compared to the south ladder. The overall median passage time was in the low-mid range of historic passage times.
- 2006 spring chinook passage by ladder at The Dalles. There was minimal passage via the north ladder in 2006 – about 7% – compared to previous years, in which 25-30% of spring chinook used the north ladder. This was probably due to high volumes of flow and spill early in the spring passage season, and to the change in juvenile spill pattern, which concentrated spill at the north end.
- There was no apparent effect on passage times from the Bonneville exit to The Dalles exit or the John Day exit. The Dalles will be wired up for a 2007 SP CH RT fish passage evaluation.
- 2006 Bonneville high flow and spill: effects on fallback, reascension and escapement (radio-tag study). Researchers saw nearly 14% fallback, the highest seen since 1996. The reascension rate was less than 50%, the lowest ever. If this is representative, hydrosystem escapement was reduced by 7% at Bonneville.

At John Day, are you saying that 70% of the spring chinook that approached the north ladder actually wound up passing via that ladder? Wagner asked. No, it says that 70% of the fish passed via the north ladder, Clugston replied. One concern last year was that, because of the powerhouse operation, spill was recommended to attract fish to the north ladder, Wagner said – that appears to be what happened. True, although there was uncontrolled spill during a significant portion of the season, Clugston replied. The question is whether daytime spill was effective in attracting fish to the north ladder, Wagner said. True, and we don't know the answer to that question, Clugston said.

D. Preliminary Vernita Bar Study Results. Russell Langshaw provided a brief overview of the 2006-2007 Vernita Bar study of reverse load factoring and its influence on spawning at Vernita Bar. This year, we developed a peaking program based on mean daily discharge, he explained; if flows were low, we would have one morning peak, then steady flow the rest of the day; as flows increased, we implemented two peaks.

We tagged 75 fish, 65 of which were detected on Vernita Bar, Langshaw said; some of those fish were detected on the spawning grounds for up to 10 days. We're in the process of analyzing that data now. The final official count found 37 viable redds above 65 Kcfs. And you will be producing a written report? Wills asked. Yes, Langshaw replied. Wills asked whether the Vernita Bar operation had helped to discourage higher-elevation spawning in 2006. Langshaw replied that it did appear to be successful, except during the periods when the flow peaks had to be extended longer than planned due to high flows. In the future, he said, we would like to consider shortening the duration of the peaks and moving them closer together to lengthen the low-flow period each day.

He said he will provide a more extensive presentation to TMT some time this February or March.

In response to a question from Wagner, Langshaw said the plan is to look at this year's study results, then decide whether to conduct an additional study in 2007, and go to the other signatories of the Hanford Reach agreement to work out the details of the study.

5. Other Lessons Learned.

Any first impressions as to lessons learned from 2006? Silverberg asked. One thing I noticed is that the presentations were much better this year than they were the first year we did this, she said. One concern I have is that a lot of the presentations about the RSWs focused on RSW efficiency, Kiefer said – I would prefer to see response curves for proportion spilled and proportion of fish passing via spillways. RSW efficiency is important, but so is passage via training spill, and if there is less training spill, RSW efficiency will increase. I would suggest that those involved with RSW research begin to de-emphasize RSW efficiency as a measurement of effectiveness. Kiefer added that adult return rates are the bottom-line measurement of success; he said he would trade 98% bypass survival for 92% spillway passage, because spillway passage returns more adults to the spawning ground. Sometimes what we can count, doesn't, Kiefer said, and what matters is what we can't count.