Columbia River Regional Forum
Transboundary Gas Group
Meeting at Chief Joseph Dam

October 10, 2007

1. Introductions and Spillway Viewing

Today's meeting was co-chaired by Mark Schneider of NOAA Fisheries and Dan Millar of Environment Canada, with representatives of B.C. Hydro, U.S. Army Corps of Engineers, Bureau of Reclamation, Washington Dept. of Ecology, the Colville and Spokane Tribes, Chelan Co. PUD, Grant Co. PUD, D.C. PUD, Columbia Power Castlegar, Cominco Metals Ltd., and Avista Corp attending.

The meeting began with a briefing and site visit led by USACE fisheries biologist Jeff Laufle to observe the spillway deflectors which are being installed in all 19 of the spill bays at Chief Joseph Dam. To date, 10 deflectors have been installed, with another currently being constructed against the north training wall. The time involved in constructing a single deflector has dropped from 71 days to a month due to increased efficiency, Laufle said. The contractor has been working year-round, except for some enforced shutdown for brief periods of (involuntary) spill, or when the likelihood of spill is high.

Mark Schneider (NOAA) asked what the effects of the spillway deflectors will be on operational guidelines for a previously negotiated shift in spill priorities from Grand Coulee to Chief Joseph so Grand Coulee can continue to generate power. The "swap" or shift in spill priorities, which was part of NEPA analysis of the spillway deflectors, is already being implemented because Chief Joseph generates less gas than Grand Coulee does, Laufle said. This yields a number of benefits, including protecting resources at Chief Joseph from gas generated at Grand Coulee. Once the deflectors are fully operational, the whole system will be in better shape from a dissolved gas standpoint.

Laufle described the spill testing this spring, which was intended to evaluate uplift pressure generated in joint seals in the spillway, with deflectors in place on parts of the spillway where this is a concern. Results of the uplift monitoring were satisfactory. Mike Schneider and others from the Corps carried out dissolved gas monitoring as an adjunct to this test. The test and did not raise any "red flags" concerning the deflector performance. In the meeting, Laufle talked using a printout of a Powerpoint presentation prepared by Mike Schneider, who could not be at the meeting, and copies of the presentation were handed out to the attendees.

To carry out the testing, TDG levels at two deflectors were monitored at varying distances downstream of the spillway and levels of spill per deflector. Uplift pressure measurements were made inside the spillway. Velocities,

dissolved oxygen levels, and circulation patterns were documented, Laufle said. In addition to physical parameters, effects on fish were monitored with hatchery rainbow trout confined near the surface in buckets with holes for water circulation—a monitoring design intended to create symptoms if any were going to occur. No symptoms were seen. One bucket, however, was dewatered when the tailrace dropped, which coincided with the highest spill levels, nullifying the most critical part of the test. The fish observations will likely be repeated during a full-scale test of the deflectors planned for when they are all installed.

The project should be finished by the end of 2008 or early 2009.

Initial computer model analysis performed in the late 1990's indicated that benefits of the deflectors could extend as far as Priest Rapids. In terms of total dissolved gas, the design spill capacity of each bay will be approximately 7.5 kcfs with deflectors installed, based on a flow volume of approximately 141 kcfs spread out over all the spill bays (the 7-day average high flow resulting from a 10-year event, which also accounts for some additional flow through the turbines). Testing indicated that gas levels can be kept below 120% as long as spill doesn't exceed that amount. Higher spill volumes than 141 kcfs will tend to produce higher gas concentrations. Furthermore, the gas travels downriver for some distance, so effects are not just localized.

A meeting participant asked, is entrainment mortality not a high consideration, or will fish benefit more from the reductions in TDG levels associated with the deflectors? That bears looking at, Laufle said. Chief Joseph never spills voluntarily, and is at the upstream limit of salmon migration. It was not built for fish passage. Fish are subjected to high-velocity flows, either with TDG or without it. A photo in Laufle's presentation shows 6.5 kcfs plunging out of a spill bay.

Gary Birch (B.C. Hydro) asked, is erosion of the deflectors a concern? Laufle, Mark Schneider, and Laura Hamilton (USACE) agreed the deflectors are constructed for the long term, and while erosion has been a problem at other projects, deflectors were not affected. Pitting from rocks hitting the spillway surface has caused problems getting the cofferdams sealed around the work area, Laufle said. Flows at times may exceed the design criteria, but once all deflectors are in place, the protocol will be to spread out spill as much as possible across all bays.

Mark Schneider asked about the effect of dissolved gas on entrained water. That was a concern during the test, which couldn't replicate what conditions will be like when all deflectors are operating, Laufle said. Hamilton (whose job it is to help determine daily spill rates for each FCRPS dam, using the SYSTDG model) pointed out that entrainment effects vary widely from dam to dam, with some dams on the Snake experiencing significant entrainment of powerhouse flows into the aerated flow from spillway releases. As an example of

individual differences between dams, even small amounts of spill at Grand Coulee Dam gas up the river for many miles, while Chief Joseph Dam has been a more favorable place to spill, even without spillway deflectors.

Following this discussion, the group drove out to observe deflector construction, which was the intent of holding the meeting at Chief Joseph Dam. The participants visited two vantage points. First stop was the right bank training wall, next to which a small cofferdam was installed, and spillway face demolition was going on. Purpose of the demolition was to create a shallow depression into which the deflectors could be keyed, with a flush transition from the spillway face above, to the transition curve on the top of the deflector. Rebar would be installed in drilled holes in the demolished part, and concrete poured within forms, after being mixed on the left bank in a batch plant, then transported in large buckets on a barge to the cofferdam. The second stop was the trunnion bridge running along the spillway just out from the top of it. The group was thus able to more directly peer down into the operating cofferdam near the right bank, as well as into a full-sized cofferdam sitting idle midway along the spillway at the last-completed deflector. Water clarity was good enough to allow the completed deflectors to be seen. Attached are two photos taken by Anna Ruddell during the trunnion bridge visit.

Following the site observations, the attendees returned to the meeting room for the remainder of the meeting.

2. WDOE Literature Review

Chris Maynard (WDOE) discussed his review of literature concerning biological effects of TDG, which was part of WDOE's response to a legal challenge by Save Our Wild Salmon of the 115% forebay limit on TDG levels. The state of Washington standard is currently 115% in the forebay and 120% in the tailrace. The state is considering a standard of 110% in the distant future.

Of 238 studies, Maynard and his colleagues have reviewed 154, zeroing in on those that involve freshwater creatures (not just salmon) that were exposed to TDG levels of 100% to 120% (the assumption being that anything over 120% will harm fish). Maynard's review concludes with a synthesis of what's been learned so far and identifies gaps in knowledge. There are no conclusions yet; these will be written after the document is published or goes through peer review.

Shallow water is the biggest concern, Maynard said; for every meter of depth, there is a 10% reduction in the effects of dissolved gas on fish. Fish can't detect high gas levels, but appear to avoid them. Susceptibility to the effects of gas vary according to species, life stage, activity, and other stressors such as disease or dam passage. Gas levels on the edges of rivers have been found to be lower than mid-river levels, especially around inlets and bays. At higher levels of exposure, death can occur with no signs of gas bubble trauma.

Eggs under pressure are not very susceptible to gas, Maynard said, but susceptibility is highest when they hatch as alevins and when they emerge. Bullfrogs were affected at 116% TDG as surface dwelling organisms. Susceptibility among salmon species varies, with spring Chinook being less susceptible. Smaller creatures can pass gas out of their circulatory systems more easily than larger ones, but are subject to air blockages in the gut that cause them to die of starvation. Repeated exposure can predispose gas bubble development on existing sites. Cage studies have shown less TDG trauma than lab studies, but cage studies can't replicate the conditions fish are exposed to when they migrate on their own.

Air entrainment is 10 times greater in a salt water environment, Maynard said. Spill is not necessary for high levels of dissolved gas to form. Studies of dissolved gas done before 1980 should be assigned a large margin of error due to technology improvements since then.

More information is needed on where larval fish live, Maynard said, as well as on the long-term effects of exposure, especially for fish that migrate to the ocean and back again. While some indirect effects of TDG, such as predation, have been studied, others such as secondary infection are unknown. While much is known about the chum spawning area below Bonneville Dam, more information is needed regarding gas levels and spawning populations in similar shallow areas throughout the rest of the system.

In general, depth distribution and duration of exposure are the two key factors for different species. Less is known about sockeye, coho, and chum in the fry and smolt stages than for other fish. There is depth information on adult sturgeon, but only one study covers sturgeon during the fry and larval stages. There is no published gas bubble trauma information on the three species of lamprey that live in the Columbia, Maynard said. Lamprey probably wouldn't have gas issues in the mainstem Columbia because they live in backwaters for 2 to 8 years, then migrate near the river bottom, Gary Passmore (Colville Tribe) said.

There was extended discussion of the disparity in approaches to TDG standards in Oregon and Washington. Save Our Wild Salmon has withdrawn its petition challenging the 115% forebay criteria in Washington with the understanding that WDOE would pursue the gas issue further, Maynard said. A standard of 110% is an instantaneous criterion, which doesn't address the fact that the duration of exposure is key.

Laura Hamilton (USACE) asked, how will operation of the dams on state lines be coordinated in light of Oregon's long-term goal of adopting a 110% dissolved gas standard by 2010, as identified in the TMDL regulations? Schneider wondered about the status of the adaptive management team that

was chartered last June, at ODEQ's request, in response to a joint application by the USACE, USFWS and NOAA for a five-year waiver of the 110% Oregon standard. The USACE tends to default to the strictest standard, Hamilton said. If the state of Washington adopts a standard of 115% in the forebays and 120% in the tailrace, but Oregon's standard is set at 110%, the USACE will operate the dams that touch both states to the 110% standard by default.

Maynard asked TGG members to send him their comments after they've reviewed his work. Schneider urged TGG members to inform Maynard if they're aware of any studies or other relevant information sources – such as dissertations – that aren't in the TDG literature review and should be. Maynard will add to the document as new information becomes available.

The complete TDG literature review is available online at: http://www.ecy.wa.gov/programs/wq/tmdl/columbia_rvr/columbia_tdg.html.

3. B.C. Hydro Presentation

Gary Birch (B.C. Hydro) discussed two recent TDG-related studies B.C. Hydro has completed. The first was on the Pend Arielle in association with Seattle City Light. As part of their FERC license application at Boundary Dam, Seattle City Light looked at ways to reduce supersaturation. However, this study did not coalesce because high flows predicted for this year did not materialize. Peak spill occurred on June 8, and turbine discharge was 1,465 cubic meters per second.

The second TDG study was done at Ruskin Dam, about 40 km east of Vancouver on the Frazier River. There is interest in the area below Ruskin Dam due to the presence of chum and steelhead. Two spawning channels have been built there. In the past, the area has had problems with dissolved gas. On Feb. 12 and13 this year, B.C. Hydro drew the reservoir at Ruskin down 13 meters for dam safety work. On Feb. 15, there were reports of dead fish downstream, most of which showed signs of GBT. Measurements showed that gas levels in the river had peaked at around 135% with the highest readings at the upper end of the two spawning channels. The duration of exposure was approximately 9 hours. Further investigation revealed that water passing through accumulated debris had formed large vortices, which generated the high TDG levels. Hydraulic sampling found 10-12% mortality among the alevins in the spawning channels. The sampling procedure, which involves pumping air into the redd to dislodge eggs and alevins for inspection, and is especially hard on alevins. Spade studies found 5-9% mortality rates, but no evidence of bubble trauma on alevins. B.C. Hydro is seeking funding to study this phenomenon further. Birch noted that supersaturated gas is not considered a noxious substance under Canadian law. Therefore Canada has guidelines but no set standards for levels of gas.

4. Next Meeting

Mark Schneider announced that he would be retiring soon and could no longer serve as the U.S. co-chair for this group (Kelly Hampton of Chelan PUD later offered to take on the role). The TGG agreed to meet next on Oct. 22, 2008, at either Mica or Revelstoke Dams in British Columbia. This meeting summary prepared by consultant and writer Pat Vivian.

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Gary Birch	B.C. Hydro
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