Columbia River Regional Forum
2012 Post Spill Season Monitoring System Review
November 15, 2012
Notes By: Pat Vivian

1. Meeting Purpose and General Overview

The 2012 post spill season review of the U.S. Army Corps of Engineers (COE) regional water quality monitoring program was chaired by Steve Juul, COE, with representatives of the COE, U.S. Geological Survey (USGS), Bureau of Reclamation (BOR), Douglas PUD, Grant PUD, Fish Passage Center (FPC) and others attending.

The purpose of today's meeting was to exchange water quality data evaluations from fixed monitoring sites (FMSs) throughout the region, note modifications or adjustments made to equipment in the past year, and review data quality processing in the past year. Each presentation included a program overview, description of network sites and equipment, data quality review, and a summary of seasonal compliance with applicable water quality standards.

2. Portland District Spill Season Review

Dwight Tanner gave a presentation on the water quality monitoring program managed at eight sites by the COE Portland District. Four of these sites operate year round and four during spill season only. FMSs are located in dam forebays and tailwater sites at Bonneville, The Dalles and John Day dams, with three of the sites downstream of Bonneville Dam. These are Warrandale, Cascade Island and Camas-Washougal; The Camas-Washougal FMS is managed to the 115% forebay site standard under spill season waiver.

The year 2012 brought high flows, spill levels and TDG readings from April through July. Because the equipment at the Cascade Island site was damaged in spring 2011, the district installed two new metal pipes prior to the 2012 spill season, one for the reference sonde and one for the sonde at the site. On April 25, 2012, the Cascade Island site was again damaged by high flows. The new pipes installed on June 6, 2012, are very sturdy and should hold up well to future high flows. The district also rebuilt the John Day tailwater site prior to the 2012 spill season, relocating instruments higher up the bank and out of the river to prevent damage.

Equipment: The district uses Hydrolab Minisondes, two Sutron Satlink 2 DCPs that transmit data hourly, and a NovaLynx hand held digital barometer.

Data Completeness: Overall 97.0 percent of the TDG data were received for the eight monitoring stations in real time and were within 1 percent TDG of the expected value on the basis of calibration data, replicate quality-control measurements in the river, and comparison to ambient river conditions at adjacent sites. Data received from the Cascade

Island site were only 77.8 percent complete because the equipment was destroyed by high water. The other stations ranged from 98.9 to 100.0 percent complete.

The high flows of spring 2012 brought some TDG readings of more than 120% in tailwater sites and readings of more than 115% for forebay sites. Calibration this year was good, and TDG sensors checked out in the field within ±1% of accuracy during field checks . All data were within ± 1 mm Hg for barometric pressure and within ± 0.2 degrees C for water temperature. Lab checks of TDG readings were all within 0.7%.

Season Summary: The biggest problem facing the district this year was loss of the Cascade Island site, which resulted in 1,042 hours of missing or deleted data. The pipes were swept sideways, and although the electronics were not damaged, the site was out of service for several weeks because the pipes had to be replaced. The new pipes are made of HDP 5-inch steel, so they should hold up well to future flows.

The rest of the missing data were caused by site problems that lasted for a few hours. In one case, the Camas site membrane was broken and needed repair.

Generally, the lower river sites had the most TDG instances (readings exceed the state water quality standards), i.e. the three sites below Bonneville Dam. All three sites had discharges of around 500 cfs, or around 400 kcfs at all 3 lower river dams, with short excursions of more than 230 kcfs.

Flows in 2012 were lower than in 2011, when spill reached 300 kcfs. When spill at Cascade Island reached 250 kcfs this year, the instrumentation was lost. However, the instruments worked again once spill levels declined. Because Camas Washougal site has temperature and dissolved oxygen problems that tend to raise TDG levels, it had TDG readings of over 115% this summer.

Laura Hamilton, COE, asked whether anything could be done to protect the Cascade Island site in future years from being damaged by high flows. Tanner suggested being proactive during times of the year when spill is low. There has been talk of other possible fixes, but basically we’re doing what can be done within the constraints of nature. Copeland suggested pointing nodes downstream, not perpendicular to the flow would reduce the stress against the pipe.

Joe Rinella, USGS, asked whether any comparisons have been made between the Camas Washougal and Cascade Island sites. Warrandale site has been used for spill management during the past two years when Cascade Island site was down, Hamilton replied. The COE has a policy now of keeping Warrandale site in operation year-round as backup for the Cascade Island site.

3. Seattle District Spill Season Review

Kent Easthouse gave a presentation. The COE Seattle District operates five monitoring sites including forebay and tailwater sites at Chief Joseph and Albeni Falls dams and a

tailwater site at Libby Dam. These are all seasonal sites which are calibrated every two weeks from April 11-September 30 by John Lemons, Columbia Environmental.

Equipment: The equipment in use is the same as last year, Hydrolab Minisondes and Sutron Satlink DCPs.

Data Completeness: This was a record year for the Seattle district. Usually there are problems with missing data at Albeni Falls and Libby. However, everything went well this year. When Albeni Falls went on free flows, high flows from the Pend Oreille river smashed the pipe holding the monitoring equipment for the tailwater site. Nevertheless, all data were 96-99% complete. Most of the issues with missing data were caused by small glitches in DCP transmission. There were problems with the barometer and probe at Albeni Falls when the pipe was smashed.

Field calibration data for temperature readings were within 0.2 degrees C of the secondary standard thermometer. Field calibration data for TDG readings were within 10-15 mm Hg at most stations. Barometric pressure readings were within 1-2 mm of Hg. Laboratory readings were good. Field calibration data for barometric pressure were within 2 mm Hg of the secondary standard.

Season Summary: Spill was moderately high at Chief Joseph Dam this year, but 2012 was a different type of year because Grand Coulee didn't spill much out of the outlet tubes, which tends to gas up Chief Joseph forebay. The main issue this year was TDG readings in Chief Joseph tailwater because the dam rarely spilled out of all 19 spill bays. For most of the spill season, only 14-17 of the 19 bays were in service due to hatchery work and other scheduled maintenance. This resulted in some TDG levels over 120%. If Chief Joseph spills out of all 19 bays, TDG levels in the tailwater tend to remain under 120% thanks to the flow deflectors in each bay. This generally remains true when the dam is spilling 150 kcfs spread evenly across all bays, i.e. 10 kcfs per bay.

This was a high flow year on the Pend Oreille River, so Albeni Falls was on free flows for a while. Generally, free flows don't increase TDG, and the highest readings this year were around 118% in the tailwater and 117% in the forebay. An exception occurred at the end of September when only 3 of 10 spill bays were available to spill the entire river. This produced a fair amount of TDG for spill of only 9 kcfs. Temperatures remained cool due to Libby's selective withdrawal system. Libby basin experienced high rain levels in May and June, with correspondingly high flows on the Kootenai River.

4. Walla Walla District Spill Season Review

Dewey Copeland gave a presentation. The COE Walla Walla district operates 15 water quality monitoring sites, six of which operate year round and nine are seasonal. Five of these are forebay sites, six are tailwater sites and four are riverine sites. This includes forebay and tailwater sites at McNary, stations at all four Snake River dams, and the Anatone, Clearwater and Lewiston sites on the Snake River.

There were problems in January with the monitoring station below Dworshak Dam near the hatchery. Muskrats or otter got into the deployment tube and ate the equipment cables. Installing a screen over the tube and repairing the cables fixed the problem. However, the site is not yet ready for use because some of the data are questionable. There are also problems with access to the McNary forebay and tailwater sites during high flows.

Equipment: The district has 37 Hydrolab Minisondes, Sutron digital barometers at all field sites, hand held digital barometers, and 14 Satlink DCPs. A Sutron 8210 DCP modem is used at Dworshak Dam. Every year the district buys 25 new TDG membranes. Lab equipment includes a Heise calibrated digital pressure gage, an Ashcroft digital gage, two digital thermometers and a barometric pressure gage.

Data Completeness: Overall, 99.9% of barometric pressure, 98% of TDG and 99.9% of water temperature data were received in real time and passed provisional QA/QC review. Three sites accounted for 90% of the bad TDG data, and half of these were the result of TDG readings that were too low. The Peck site had 372 hours of unusable barometric pressure and TDG data; Lewiston had 318 hours; Little Goose, 182 hours; and Dworshak, 178 hours. Some of these data gaps are due to low TDG readings, which are probably caused by siltation at these four sites when spill drops off near the end of spill season. Copeland speculated that aquatic growth is partly responsible for this phenomenon. Low TDG readings are determined by a comparison of tailwater site readings and the next forebay site. Relocating the suspect sites might help, but divers would probably be required for the relocation.

Season Summary: There were 2.0% missing or anomalous data, with half of that attributed to low TDG readings. Differences in barometric pressure were $\pm$ 0.1 mm Hg; differences in water temperature readings were 0.02-0.01 degrees C. Copeland reported that he was injured this year when the propane cannon that is used at Little Goose Dam to deter avian predators went off because a guard dropped a lunch box on it.

5. Bureau of Reclamation Spill Season Review

John Lemons, Columbia Basin Environmental, gave a presentation. BOR maintains four sites, three year-round sites at Grand Coulee and one at Hungry Horse. Grand Coulee Dam has a forebay and tailwater site, plus a third site near the international boundary. For quality assurance, equipment is calibrated in the field. The sites are maintained bi-weekly from March through October and once monthly in the winter months.

Equipment: This includes Sutron 8201 DCPs and a Sutron Satlink DCP at Hungry Horse as well as Sutron barometers. For quality assurance, equipment is calibrated in the field.

Data Completeness: Field comparisons of data found an average of 2 mm for temperature. A mercury thermometer serves as a primary standard in the lab for temperature calibration, and a mercury barometer serves as a primary standard in the lab

for TDG calibration. Individual sites performed well, having TDG data within 1% of accuracy.

Season Summary: All problems this season were related to equipment failures. A bad temperature sensor was replaced at Grand Coulee tailwater site, which led to blown DCP fuses. There was also some data loss at the boundary site. Next year the DCPs will be updated to the 9210 Sutron and Satlink 2 models. The Lake Roosevelt site will probably be the first to transition to the new equipment.

6. Grant County PUD Spill Season Review

Carson Keeler gave a presentation covering Grant County PUD's calibration, quality assurance and water quality compliance calculations for 2012. Grant PUD manages four sites for temperature and TDG levels with hourly readings year-round. These include forebay and tailwater sites at Priest Rapids and Wanapum dams. The tailwater site at Wanapum Dam is located at Beverly Bridge downstream, and the Priest Rapids tailwater site is approximately nine river miles downstream at Vernita Bridge. Grant PUD manages all its water quality sites to requirements of their 2008 FERC license, the 2008 FCRPS BiOp, and a quality assurance project plan (QAPP) monitored by WDOE.

Equipment: Grant County PUD uses Hydrolabs, data sondes, minisondes and Sutron DCPs at all sites. Equipment is calibrated biweekly during spill season in April-August and approximately every 3 weeks during non-spill season. Calibrations are done in the lab with newly calibrated probes for the next day. QA/QC redeployment methods follow established guidelines set forth in the QAPP.

Data Completeness: The only site that lost hourly TDG readings in 2012 was Wanapum tailrace, with 68 hours lost as a result of membrane issues on three different days. These account for a 0.5% rate of data loss and a data completeness of 99.5% which is well within QAPP guidelines.

There was discussion of how Grant PUD accounts for double counting issues that occur when TDG values are calculated using the Washington state methodology for calculating consecutive 12-hour averages under the state waiver. Grant PUD tracked these TDG instances and found that 17 of them occurred from March 18 to August 6 this year: 3 at Wanapum tailwater site, 4 at Priest Rapids forebay, 4 at Priest Rapids tailrace, and 5 at the Pasco site. Most TDG instances in 2012 occurred between April 23 and June 14 during spring spill. There were some gaps in data periods when the TDG sensor membrane failed or 7Q10 flows of 265 kcfs for both dams were exceeded and water quality standards didn't apply.

Season Summary: Grant PUD will continue to conduct hourly TDG and temperature monitoring bi-weekly and trend monitoring of turbidity year-round, and will continue to carry out the QAPP gas abatement plan. Ongoing and proposed improvements to both Priest Rapids and Wanapum dams are expected to decrease existing TDG levels. The amount of added capacity for Wanapum powerhouse remains to be seen, based on the

increased operation of turbines from 162 kcfs to 170 kcfs. The Priest Rapids spill apron will be altered soon to create a top spill bypass for spill bays 20-22. Grant PUD will continue to conduct survival studies throughout the FERC license period.

Margaret Filardo, FPC, asked how the double-counting issue affects spill caps at Wanapum and Priest Rapids dams. Are we decreasing fish protection to meet the 24-hour rolling average? The river is managed to TDG values every 15 minutes, not the 12-hour average, which is a reporting anomaly, Keeler replied.

7. Douglas County PUD Spill Season Review

Andrew Gingerich gave a presentation. Douglas County PUD tries to meet gas abatement standards every year at Wells Dam, which has a 200 kcfs powerhouse capacity. Wells is a hydrocombine, with spill bays sitting on top of 10 turbine units. The Wells juvenile bypass facility differs from those built by the COE and works through spill exclusively. It has roughly 96% efficiency when flows are at powerhouse capacity.

The three main goals of the gas abatement plan are: no hourly values above 125% in Wells tailrace, no values above 115% in Wells forebay, and no values higher than 120% for a rolling 12-hour average in the tailrace. At Wells, 7Q10 flows are 246 kcfs, the point at which water quality standards no longer apply.

Gingerich explained that WDOE regards TDG levels that are above the standards as being compliant as long as passage through Wells Dam doesn't increase these levels even a tenth of a percent. The design of Wells presents a unique management challenge in terms of TDG reduction and juvenile fish survival.

Equipment: The dam has forebay and tailwater stations that transmit data to the COE from March through August. In 2013, Douglas County will begin year-round data collection.

Data Completeness: As part of a 10-year compliance schedule for TDG reduction at Wells Dam, Douglas PUD is looking at how TDG production occurs and what solutions might bring it into compliance. The standard of 125% for hourly values was exceeded on 41 out of 130 days. However, 38 of those were irrelevant due to 7Q10 flows that day. The remaining 9 days of noncompliance are equivalent to a rate of 98% compliance for that standard.

TDG values in Wells tailrace exceeded the 120% standard on 65 of 130 days, 51 of which had 7Q10 flows. The remaining 14 days of noncompliance are equivalent to an 89% compliance rate.

The Rocky Reach forebay standard of 115% was exceeded on 98 of 125 days, 57 of which had 7Q10 flows. The remaining 41 days of noncompliance are equivalent to 67% compliance. This standard is the most difficult of all to meet. Rocky Reach Dam is downstream of Wells Dam and is operated by Chelan PUD.

An average of the values for all three standards yields an overall rate of 84.73% compliance.

Season Summary: There are unique water management challenges at Wells, which is the first dam on the Columbia downstream of Grand Coulee and Chief Joseph dams. Grand Coulee Dam has 58 times the storage capacity of Wells Dam. Also, the hydrocombine design of Wells Dam creates a challenge in meeting both survival standards and water quality standards. Flows were high in 2012; nearly twice as much water passed the project in July as is typically seen at that time of year.

Douglas PUD does biological monitoring of the Rocky Reach juvenile bypass facility on any day when TDG values of 125% or higher were found the previous day in the Wells tailrace. Fish sampling on 24 days between May 3 and July 25, 2012, yielded an average of 23 fish per day, ± 18 fish. The TDG readings were 118-130% on those days, which provided a wide range of levels to correlate to GBT symptoms. Of 562 juveniles, 7 had GBT expression, a rate of 1.2%. However, of 800 adults arriving at Wells, none had GBT expression even when tailrace TDG values were 125%.

On November 9, 2012, Douglas County PUD began a 10-year compliance schedule, including a feasibility plan and strategy for improving TDG production below Wells. There was discussion of why Coho apparently have a higher incidence of GBT than other species. In general, only 1% of the 562 juvenile fish sampled in 2012 showed symptoms of GBT.

8. TDG Measurements: What Goes Wrong and How to Improve QA/QC

COE/ERDC Data Quality: Mike Schneider, COE/ERDC, gave a presentations on data quality control.

Mike Schneider gave a presentation based on selected project data and observations from the last 2-3 years that illustrate instances where reported TDG levels do not appear consistent with values normally anticipated for the given flows and project operations. The purpose of the presentation was to stimulate some discussion on ways to improve our evaluation of data quality without criticizing any one entity.

From Mike's experience of working on TDG monitoring for the last 10 yrs and performing TDG field research studies, he has looked at a lot of data and has seen a fair amount of consistency between what causing gas levels and what is being measuring. When he sees typical project operations resulting in uncharacteristic TDG responses, red flags are raised in his mind. If he sees repeated occurrences, then these red flags need further evaluation. This personal experience can also be quantified mathematically to help identify observed data that strays from established patterns based on the historic records.

Tailwater stations are responsive to dam operations: What is important is where the sampling site is located. Is it in the mixing zone? Is the sampling site in the spillway or in powerhouse flow or some combination of powerhouse flow and spillway flows? Mike has seen the spill magnitude and spill pattern influences on TDG levels with the ratios of flow distributed between the powerhouse and the spillway. These events tell a story and explain why we seeing the TDG levels that we do. The TDG exchange process is generally a process where identical operations will result in a consistent TDG response. TDG data that trends away from the historic patterns for similar operations is worth noting for further scrutiny.

Forebay stations are responsive to upstream TDG sources. To look at a forebay gauge without consideration of what is occurring in the upstream project's operations is missing the main source of TDG and causes us to miss any inconsistencies that may be occurring. Near-dam thermal effects can also have a significant influence of forebay TDG measurements if the sonde is deployed off the face of the dam and is sampling surface oriented water impacted by thermal exchange processes..

If you look at graphs of the project data, you can see standard peaking operations, and if you overlay the next downstream dam's operations on top of this the response, you can see daily cycles. If you look at the daily cycle at a tailwater station, and see less TDG than at the next downstream forebay station, that is an indicator of instrument malfunction or sampling bias.

In the briefing, an example was presented that showed transects of TDG sensors recording TDG levels below a project. The TDG sensor at the tailwater fixed monitoring gauge showed a delayed and attenuated response to spillway releases compared to the other nearby sensors. This disparity between the two measurements was consistent with the scenario of having limited water exchange between the FMS conduit and the adjacent river. As a result, the readings from the FMS were under representing the TDG levels generated during spillway discharges.

There are cases when the forebay TDG levels are very high and spilling can actually decrease the TDG levels. This is not the typical outcome you would expect so there was a lot of pushback on it when it occurred. But the TDG gauge readings were confirmed to be correct by using a flow weighting average calculation, assuming that the forebay levels represent what was passing through the powerhouse, then factor in what occurred with the spillway. With the results of the flow weighting average, you can see that the observed TDG levels downstream of the project were correct. It also showed that spilling doesn't always add TDG to the river but can reduce it under certain circumstances.

Summary Bullets:

- You should see similar forebay and tailwater TDG levels when there is no spill. If this doesn't occur, consider it a red flag.
- If the tailwater gauge TDG levels are lower than the forebay TDG levels and spill is occurring, consider it a red flag.
- Checking data can be performed by reviewing the consistency of responses from year to year

- Checking data can be performed by reviewing the spatial information and see if there are any inconsistencies. Maybe the sampling location is not representative of the river conditions.
- If a sensor showed a delayed response to spill compared to the other nearby sensors, consider it a red flag.
- If a delayed response exists between operational changes and TDG levels that is much greater than the water travel time plus instrument response time, this is grounds for additional oversite. When there is a strong diurnal pattern in TDG reading, it may be due to either biological or thermal processes

USGS Data Quality: Kevin Wright, USGS, gave a presentation on how USGS improves the quality of its data. Temperature, TDG and barometric pressure data in real time are taken from the USGS web page. The program has automatic thresholds that delete wildly inaccurate or anomalous data from the web page. Field data are entered into the database for the sake of comparison, identification of bad sondes and indication of general trends. Also, USGS recovers missing data at this stage and loads it into the database. The two data sets are downloaded and merged at the site. This is the data quality procedure for all temperature, TDG and barometric pressure readings. Another QA/QC process involves plotting three months of data per site for temperature, TDG and barometric pressure.

The next step is creating a daily value table, which provides maximums and means for applicable days. USGS then writes a station analysis for every parameter. The document is reviewed by a data checker, who ensures that all data were entered correctly on the spreadsheet and makes notes for the reviewer, who oversees everything in a final step. When the reviewer gives approval, the document is ready for publication. Within 3-4 days of approval, it will be posted to the USGS web page for a year. The publication process takes 1-2 weeks from initial submission of a manuscript.

The review process alone takes half a day to a day per record cited, depending on whether bad data need to be removed from the database or missing data need to be loaded. USGS uses three levels of data: measured unit values (raw data), edited unit values, and computed unit values. Water temperature, and TDG data are published on the USGS web page and made available to the public. USGS also notifies the COE if there are bad data on the COE database that need to be deleted.

This meeting summary prepared by technical writer Pat Vivian.

Name	***Affiliation***
Steve Juul	COE
Dwight Tanner	USGS Portland
Dewey Copeland	USGS Kennewick
Andrew Gingerich	Douglas PUD
Carson Keeler	Grant PUD
Kevin Wright	USGS mid Columbia
Joe Rinella	USGS Portland

Norbert Cannon	BOR
Kent Easthouse	USACE
Mike Schneider	USACE – ERDC
Brandon Chockley	FPC
Margaret Filardo	FPC
Tina Lundell	COE
Heather Bragg	USGS Portland
Laura Hamilton	COE
Scott English	COE

Phone:

John Lemons	Columbia Basin Environmental
Chad Brow	WDOE
Marie Mangolv	WDOE