Subject: FW: Aquatic Studies Update Meeting: August 21, 2008

Attachments: Aquatic_Study_Update_Presentation_final [Compatibility Mode].pdf; Wells_Aquatic_Studies_Summaries.pdf; Study Update Agenda.pdf

From: Bao Le [mailto:ble@longviewassociates.com]
Sent: Wednesday, August 20, 2008 3:47 PM
To: 'Art Viola'; 'Bill Towey'; Bob Clubb; 'Bob Jateff'; 'Bob Rose'; Brad Hawkins; 'Brad James'; 'Bryan Nordlund'; 'Carmen Andonaegui'; 'David Turner'; 'Dennis Beich'; 'Joe Miller'; 'Joe Peone'; 'John Devine'; 'Jonathan Merz'; 'Keith Kirkendall'; 'Mark Miller'; 'Molly Hallock'; 'Pat Irle'; 'Robert Easton'; Shane Bickford; 'Steve Lewis'; 'Steve Parker'
Subject: Updated Handouts for Aquatic RWG Relicensing Studies Update Meeting, Aug 21, 2008

Aquatic RWG members, please find attached updated handouts for the Aquatic Studies Update Meeting to be held at Douglas PUD tomorrow from 10am-3pm. Minor edits were made to the summaries and presentation documents. The agenda which has not changed, is attached for your convenience. For those attending in person, we will have copies of all handouts at the meeting. Feel free to call if you have questions. Thanks. Bao

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From: Bao Le [mailto:ble@longviewassociates.com]
Sent: Monday, August 18, 2008 11:07 AM
To: 'Patrick Verhey'; 'Tony Eldred'; Mary Mayo
Subject: FW: Aquatic Studies Update Meeting: August 21, 2008

Hi guys, you were not on the my old, outdated Aquatic RWG mailing list. It is now updated. Sorry about that. See info below for upcoming meeting. Thanks. Bao

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From: Bao Le [mailto:ble@longviewassociates.com]
Sent: Monday, August 18, 2008 10:44 AM
To: 'Art Viola'; 'Bill Towey'; 'Bob Clubb'; 'Bob Jateff'; 'Bob Rose'; 'Brad Hawkins'; 'Brad James'; 'Bryan Nordlund'; 'Carmen Andonaegui'; 'David Turner (david.turner@ferc.gov)'; 'Dennis Beich'; 'Joe Miller'; 'Joe Peone'; 'John Devine'; 'Jonathan Merz'; 'Keith Kirkendall'; 'Mark Miller'; 'Molly Hallock'; 'Pat Irle'; 'Robert Easton (Robert.Easton@ferc.gov)'; 'Shane Bickford'; 'Steve Lewis'; 'Steve Parker'
Subject: Aquatic Studies Update Meeting: August 21, 2008

Aquatic RWG members, please find attached an agenda, abstract summaries, and presentations for the upcoming Studies Update Meeting at Douglas PUD from 10am-3pm on August 21. Please let me know if you have any questions. If you have not already let me know whether you'll be attending by phone or in person,

please do so as soon as possible.

Best Regards, Bao

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SURVIVAL AND RATES OF PREDATION FOR JUVENILE PACIFIC LAMPREY MIGRATING THROUGH COLUMBIA RIVER HYDROELECTRIC PROJECTS

(Juvenile Lamprey Study)

Study Goal

- Collect up-to-date information on the survival and the rates of predation of juvenile Pacific lamprey macropthalmia migrating through Columbia River hydroelectric Projects and collect site specific information on rates of predation on juvenile lamprey in the waters immediately upstream and downstream of Wells Dam.

Study Objectives

- Conduct a literature review on juvenile lamprey survival and predation studies conducted at Columbia River hydroelectric projects;
- Conduct an analysis on the stomach contents of predatory fish and birds to assess the location and level of predation that may be occurring on juvenile Pacific lamprey in the Wells forebay and tailrace.

Literature Review

- 31 reports were evaluated during the literature review.
- The review supported the common views that:
  - Technology is limiting the ability of researchers to measure the effects of dams on macropthalmia.
  - Passage at hydroelectric facilities may be problematic including:
    - Passage through Turbines
    - Impingement on submerged bar screens
    - Increased predation at dams

Site Specific Stomach Analysis

- Very few juvenile lamprey were observed in the stomachs of pikeminnow collected from the forebay and tailrace of the Wells Project;
- Differences between forebay and tailrace were not detectable;
- Rates of predation by birds was the highest of all the predators sampled but the sample size for the bird samples was small (N=11).

Species	Number sampled	Number with food items present	Number with lamprey present	Number with other fish present	Number with other organic items present	Number with inorganic items present
California gull	2	2	0	2	0	0
Caspian tern	1	1	0	1	0	0
Double-crested cormorant	5	5	1	4	5	2
Ring-billed gull	3	3	1	3	1	0
Northern pikeminnow	1,022	444	3	154	307	23
Smallmouth bass	19	9	0	8	3	0
Walleye	1	0	0	0	0	0
Grand Total	1,053	464	5	172	316	25

Species	Percent with food items present	Percent with lamprey present	Percent with other fish present	Percent with other organic items present	Percent with inorganic items present
California gull	100.0%	0.0%	100.0%	0.0%	0.0%
Caspian tern	100.0%	0.0%	100.0%	0.0%	0.0%
Double-crested cormorant	100.0%	20.0%	80.0%	100.0%	40.0%
Ring-billed gull	100.0%	33.3%	100.0%	33.3%	0.0%
Pikeminnow	43.4%	0.3%	15.1%	30.0%	2.3%
Smallmouth bass	47.4%	0.0%	42.1%	15.8%	0.0%
Walleye	0.0%	0.0%	0.0%	0.0%	0.0%
Grand Total	44.1%	0.5%	16.3%	30.0%	2.4%

Conclusions

- Pikeminnow predation on juvenile lamprey is likely not substantial at this time;
- Predation differences between the forebay and tailrace are not detectable in pikeminnow based on these results;
- Piscivorous fish predation (bass and walleye) of juvenile lamprey in the Wells Project does not appear to be significant, though a greater sample size would be required to make any conclusions;
- Bird predation of juvenile lamprey in the Wells Project may be significant, though a greater sample size would be required to make any conclusions;
- The lack of trapping and tagging technology to produce reliable survival estimates will continue to limit the ability to quantify the impacts of hydroelectric operations on juvenile lamprey populations

ADULT PACIFIC LAMPREY PASSAGE AND BEHAVIOR STUDY

(Adult Lamprey Passage Study)

Study Objectives

- Conduct literature review;
- Identify methods for capturing adult Pacific lamprey;
- Document timing and abundance;
- Determine whether adult lamprey are bypassing the adult counting windows at Wells Dam;
- Estimate passage metrics.

Literature Review

- Provided insight to commonalities among adult Pacific lamprey behavior and interactions at hydroelectric dams throughout the Columbia and Snake rivers.
  - fishway entrance efficiency is generally low (≤ 50%).
  - project passage times are comparatively slow throughout the basin.
  - problematic areas occur at entrances, within confined portions of the fishways and at counting windows.

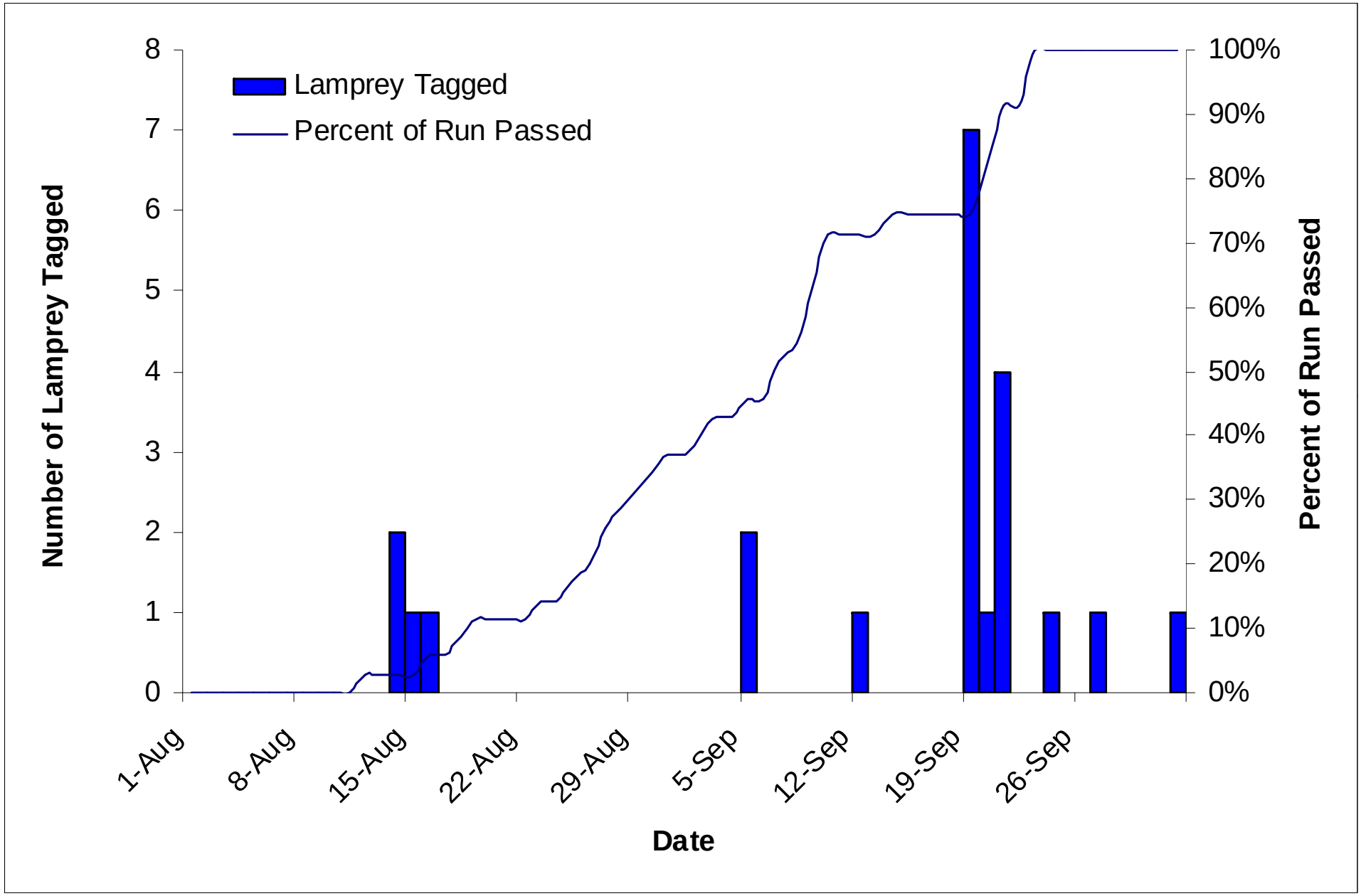
Capture Methods

Timing and Abundance

Year	Start date	25%	50%	75%	Finish date	Total lamprey	Length of run	Average fish/day
1998	30-Jun	27-Aug	5-Sep	14-Sep	30-Sep	343	92	3.7
1999	31-May	1-Sep	9-Sep	12-Sep	11-Oct	73	133	0.5
2000	22-Jul	25-Aug	2-Sep	16-Sep	20-Oct	155	90	1.7
2001	4-Jul	26-Aug	16-Sep	24-Sep	11-Nov	262	130	2.0
2002	31-May	2-Sep	9-Sep	19-Sep	8-Nov	342	161	2.1
2003	27-Jun	6-Sep	7-Oct	28-Oct	15-Nov	1,410	141	10.0
2004	4-May	19-Aug	12-Sep	11-Oct	14-Nov	647	194	3.3
2005	28-Apr	22-Aug	6-Sep	27-Sep	3-Nov	214	189	1.1
2006	4-May	19-May	15-Aug	20-Sep	29-Sep	21	148	0.1
2007	12-Aug	27-Aug	7-Sep	14-Sep	23-Sep	35	42	0.8
Min	28-Apr	19-May	15-Aug	12-Sep	23-Sep	21	42	0.1
Max	12-Aug	6-Sep	7-Oct	28-Oct	15-Nov	1,410	194	10.0
Median	13-Jun	26-Aug	8-Sep	19-Sep	27-Oct	238	137	1.9
Average	12-Jun	17-Aug	8-Sep	24-Sep	22-Oct	350	132	2.6
Stand Dev.	36	32	13	15	21	416	47	2.9

Collection and Tagging

- 4 Wells Dam traps checked 112 times each over 10-week trapping period ending third week of October (56 days of effort per trap).
- 6 lamprey captured at Wells Dam traps which resulted in decision to trap concurrently at RRH (September 20 to October 20) to reach proposed sample size (n=40)
- 15 additional lamprey captured at RRH, transported and tagged at Wells Dam (September 20 to October 3).
- 15/21 fish tagged late in the run which could have affected migratory performance


Lamprey Tagged
Percent of Run Passed
Number of Lamprey Tagged
Percent of Run Passed
Date
0
1
2
3
4
5
6
7
8
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
12-Sep
19-Sep
26-Sep

Count Windows Bypass

- 11 tagged lamprey passed counting facility
- 9 detected by video bypass antenna (3 detected for less than 20 seconds)
- 8 fish were not counted at the window
- Majority of tagged lamprey are interacting with the video bypass system if not utilizing it as an alternative passage route
- Not a passage issue but an enumeration issue

Passage metrics

- Entrance efficiency
  - 7 of 9 tagged fish approached entrances, 1 successful entrance
- Lower fishway (n =1)
  - 32:41, including 6:07 (lower), 5:53 (upper), and 20:10 (at below trap antenna)
- Upper fishway (n =11)
  - 2:48-29:05, median = 7:53

Conclusions

- The adult lamprey run at Wells Dam was relatively small in 2007 (N=35);
- The traps used at Wells in 2007 were marginally effective at capturing lamprey (N=6). Fish from Rocky Reach had to be used for the study (N=15);
- Most fish were tagged late in the run which may have influenced their overall performance;
- The sample size for the study was very small.

Conclusions

- Based upon small numbers of fish, adult lamprey may be having difficulty negotiating the fishway entrances;
- Pacific lamprey are passing the lower and upper fishways at high rates, in a reasonable amount of time, and with negligible drop back within the ladder;
- A high proportion of Pacific lamprey are bypassing the adult counting windows, thus biasing the adult fishway counts (low).

Future Work

- In an effort to meet the remaining objectives of the study, Douglas PUD is currently conducting a second adult lamprey passage study (2008) using new trapping methods.

- 16 fish have already been tagged and released at Wells Dam in 2008 (the run is just starting at Wells).

Assessment of DDT and PCB in Fish Tissue and Sediment in the Lower Okanogan River

(Okanogan Toxins Study)

Study Goal

- Goal: to determine the concentrations of DDT/PCB in recreational fish species and in swimming areas of the lower Okanogan River (15.5) within the Wells Project.

Okanogan Toxins Study
Objectives

- Collect and analyze sediment samples for DDT and PCBs from recreation sites in the Lower Okanogan River.
- Collect and analyze fish tissue for DDT and PCBs from recreational species of interest consumed by tribal and recreational anglers.
- Use this information to inform the development of human health risks education for recreational use.

DDT and PCBs Study Preliminary Implementation

- 60 personnel days were spent on fish collection, 5 times the planned effort.
- Mountain whitefish were not caught.
- Moderate numbers of carp were collected and only in lower and middle reaches.
- Bass sample sizes were achieved (main tribal and recreational resident fish species of interest in the Okanogan River).
- Fish tissue samples are now undergoing lab analyses for DDT and PCBs.

DDT and PCBs Study Preliminary Results

- The total organic carbon content and sediment moisture content were higher in downstream sampling locations.
- PCBs were undetected in all samples at the 3.9 to 4.0 µg/kg reporting limits.

DDT and PCBs Study Preliminary Results

- Total DDT:

  Near Chilliwist Creek mouth: below reporting limits
  Below Wakefield Bridge: below reporting limits
  Near Crazy Rapids pump house: 2.2 µg/kg
  RM 8: 4.7 µg/kg
  Near Monse Bridge boat ramp: 19.3 µg/kg

- DDT concentrations were simlar to the 8.3 to 23 µg/kg reported by Ecology (Serdar 2003) for the Upper and Middle reaches of the Okanogan River.

Future Work

- Data quality review for sediment sample results.
- Lab analyses completed for fish tissue samples.
- Data quality review for tissue sample results.
- Results from 2008 need to be compared to previous studies in the Okanogan
- Draft study report to the PUD by September 1.
- Final report will be provide in the ISR.

AN INVESTIGATION INTO THE TOTAL DISSOLVED GAS DYNAMICS OF THE WELLS PROJECT

(Total Dissolved Gas Study)

Study Goal

- Goal: to better define the relationship between spill operations at Wells Dam and resultant downstream total dissolved gas pressures and, if needed, identify possible measures to improve operational performance related to TDG.

Study Task

- Task: Development of a TDG numeric model for Wells Dam.

  The model will be used to gain a better understanding of the effect of spill type and plant operations on the production, transport and mixing of TDG in the Wells Dam tailrace.

Total Dissolved Gas Model Development

- IIHR-Hydroscience & Engineering is developing a numerical model to characterize the hydrodynamics and three-dimensional distribution of TDG in the Wells Dam tailrace.
- IIHR is using data collected by Douglas PUD during 2005, 2006 and 2007 to tune the model.

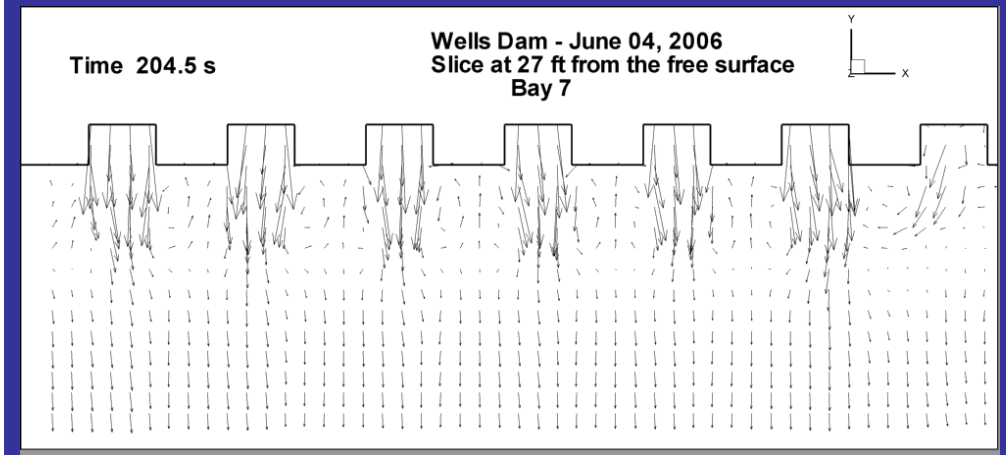
Methodology

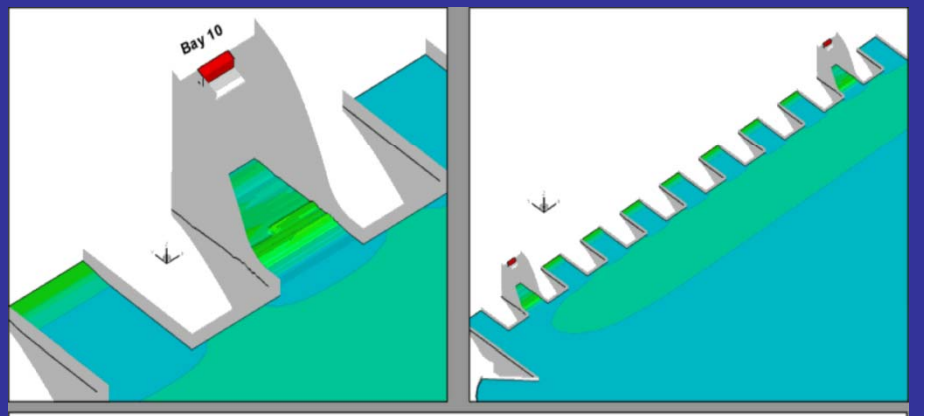
- Two models are being used in the IIHR study:
  - A volume of fluid (VOF) model to predict the flow regime and the free surface characteristics.
  - A rigid-lid model that calculates the TDG considering the bubble/liquid mass transfer, function of the gas volume fraction and bubble size. The free surface shape and upstream velocity profiles derived from the VOF model are input into this model.

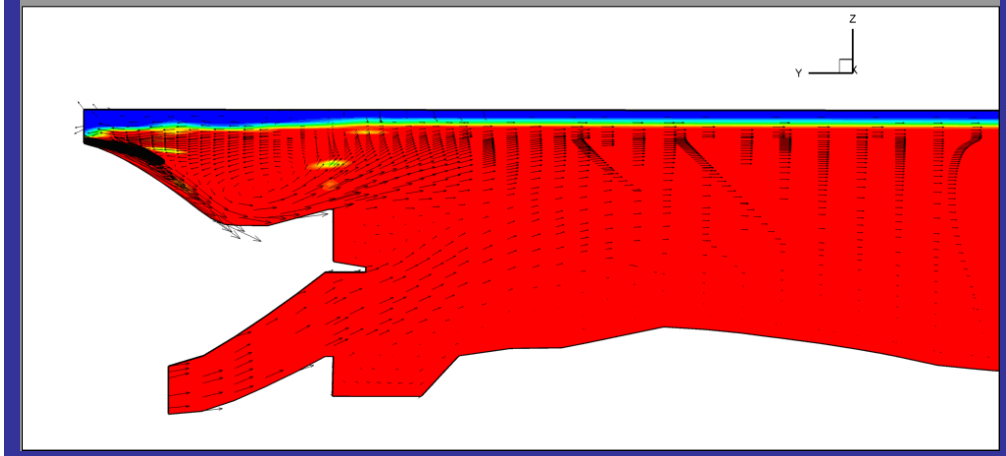
Numerical Simulations

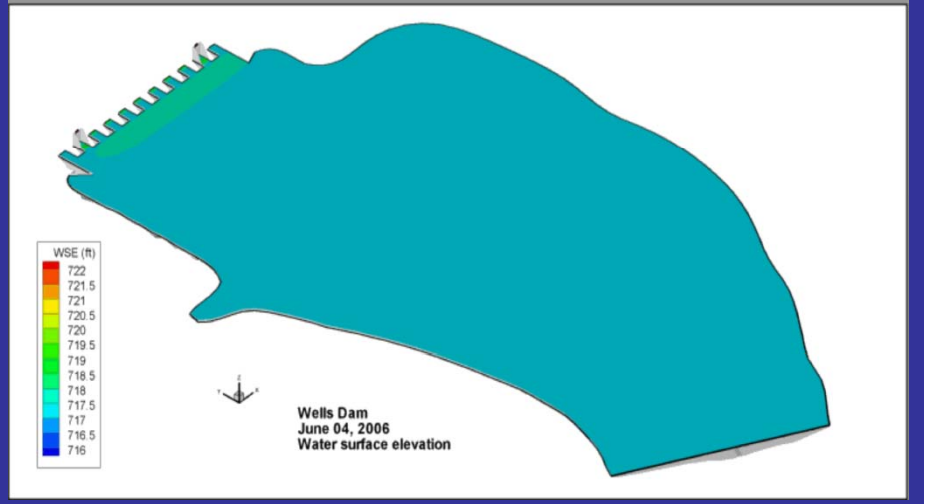
- Calibration: the model is calibrated against velocity and TDG data collected at three transects on June 4 and June 5, 2006.
- Validation: the model is validated against TDG measurements for three different spillway conditions tested in 2006.
- Testing: after calibration and validation, the model will be tested to cover a range of spillway operating conditions to scope the sensitivity of the TDG as a function of project operations.

Preliminary Results



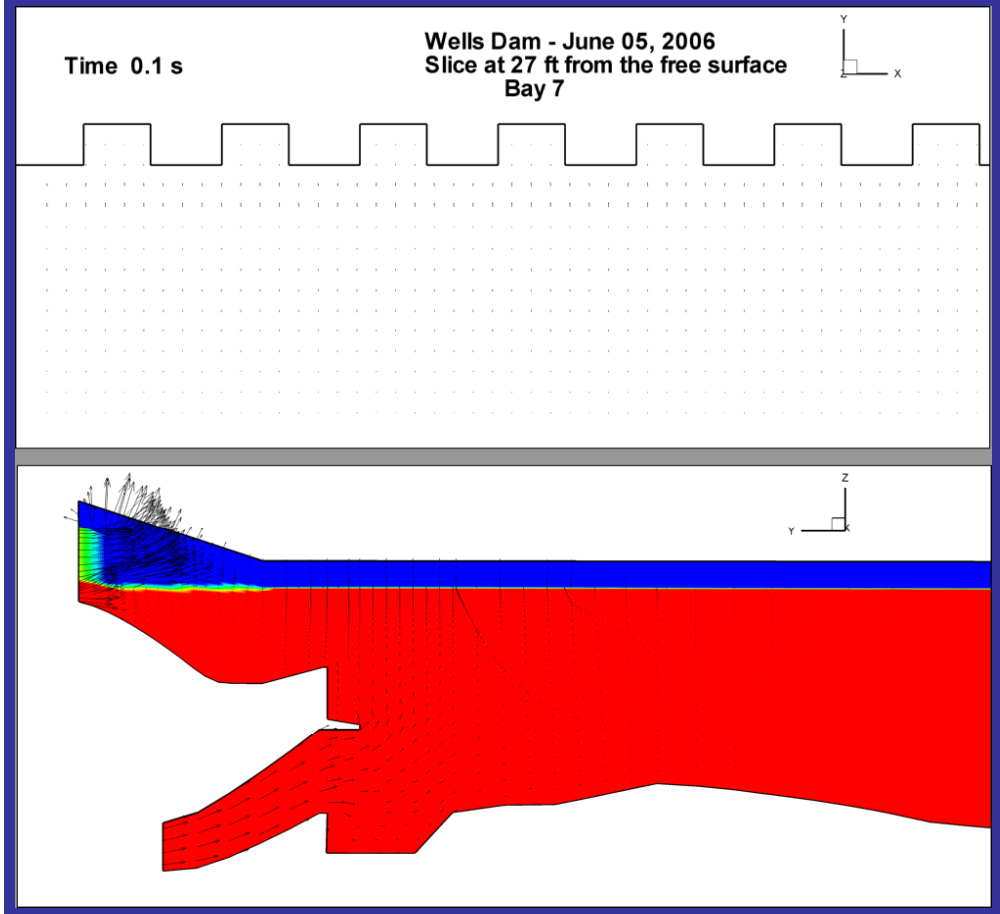


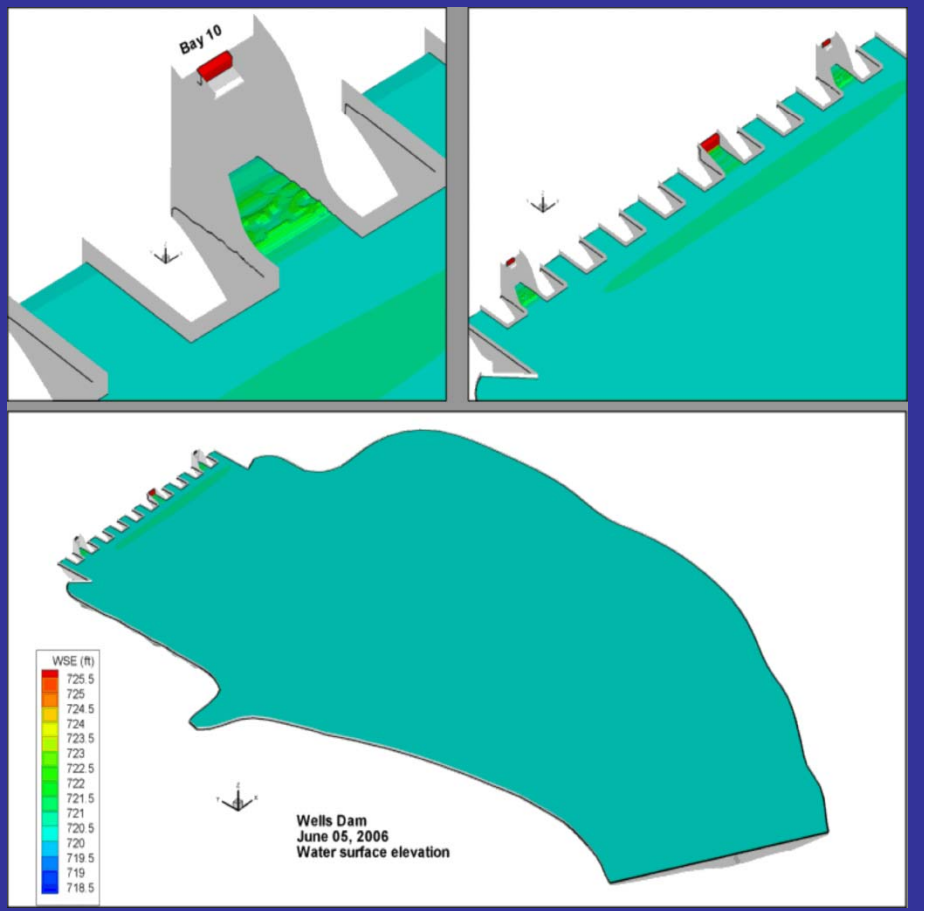




VOF model – June 4, 2006. Spread flow.

Preliminary Results



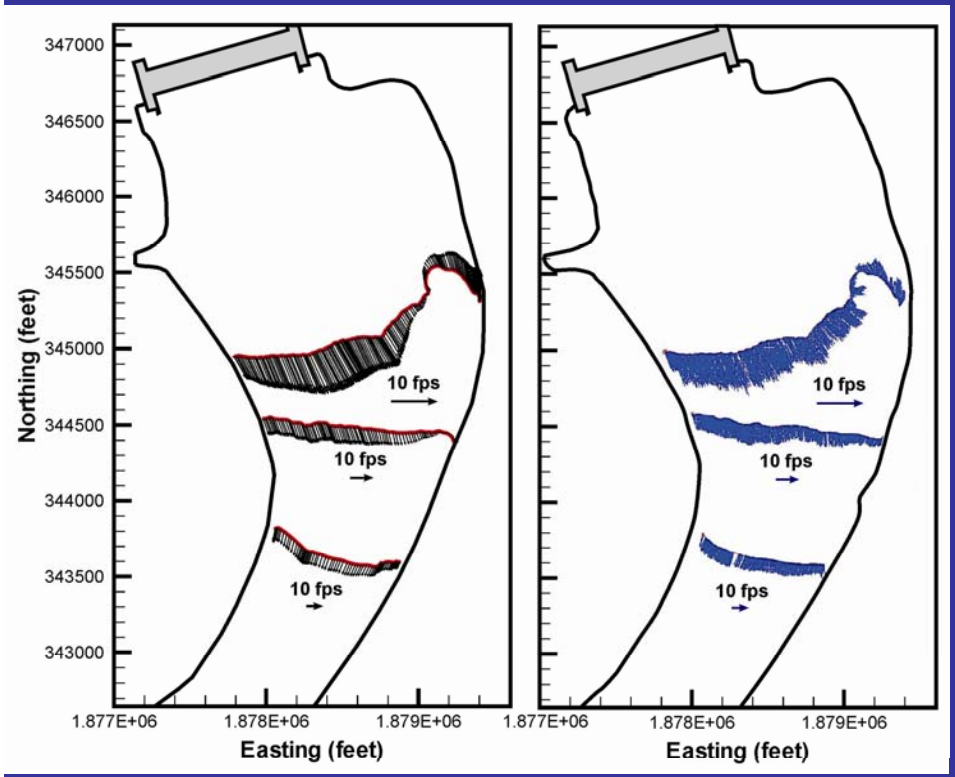


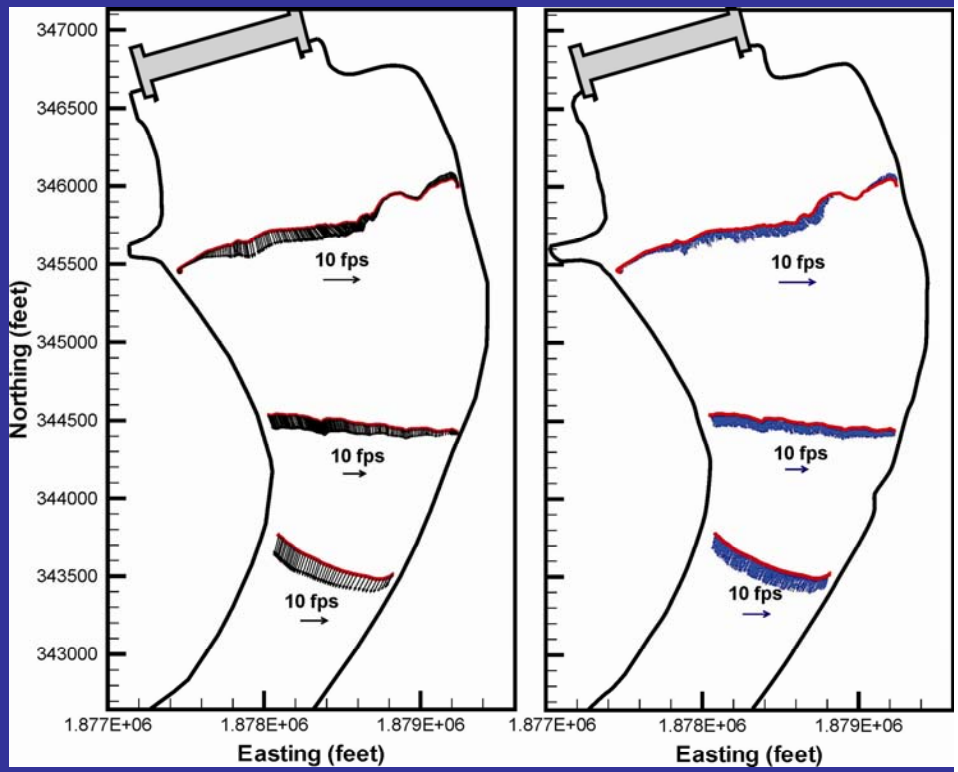
VOF model –June 5, 2006. Full open gate.

Preliminary Results

Hydrodynamic validation rigid-lid model

Black vectors: predicted velocities Blue vectors: field data



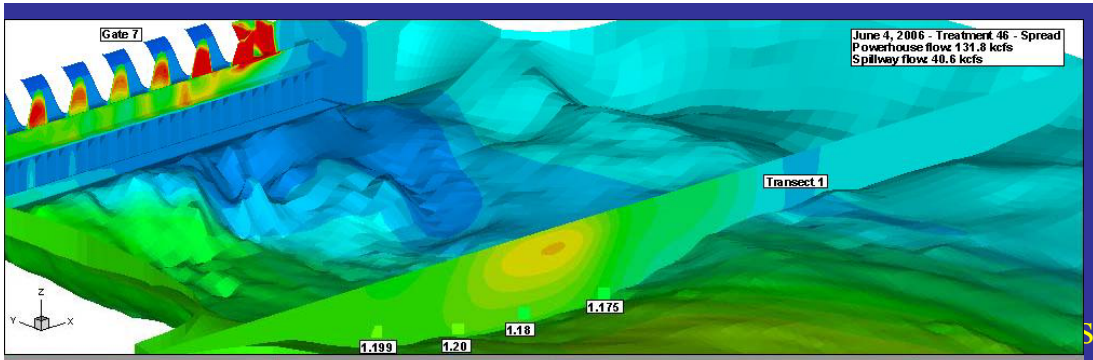


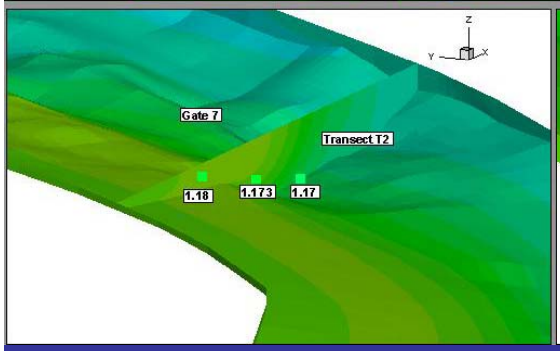
June 5, 2006. Spread flow.

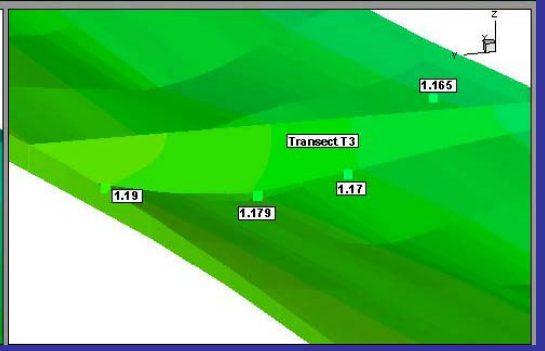
June 4, 2006. Full open gate.

Preliminary Results

symbols: field data colored by TDG concentration

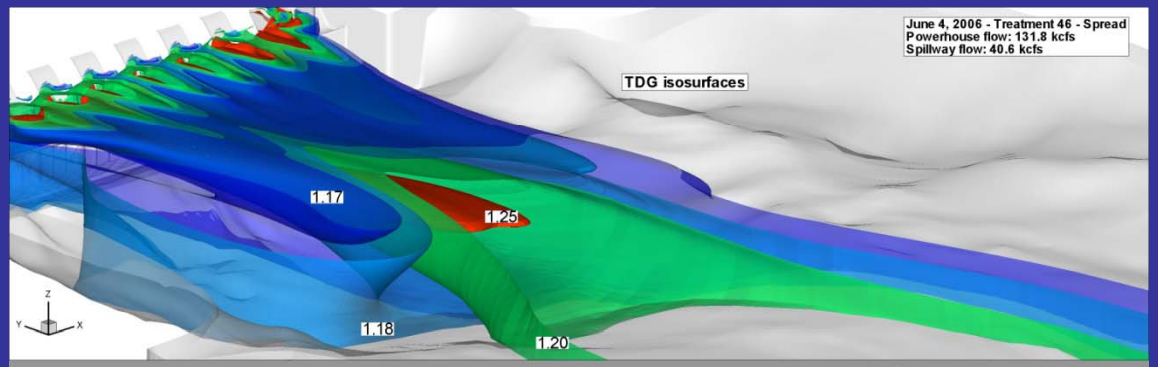


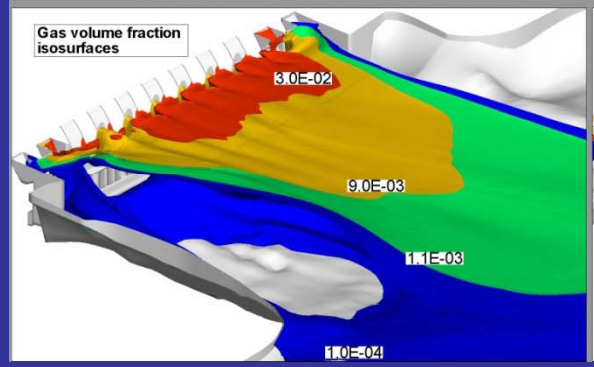


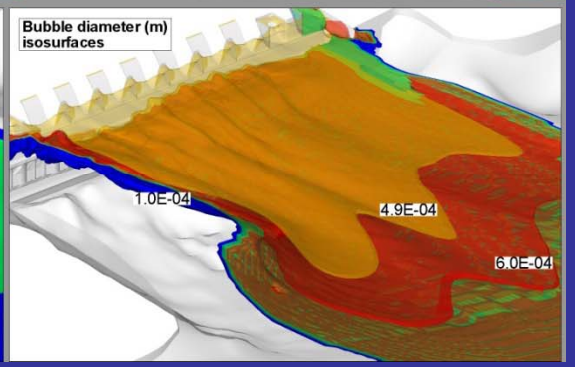


TDG validation rigid-lid model

June 4, 2006. Spread flow.

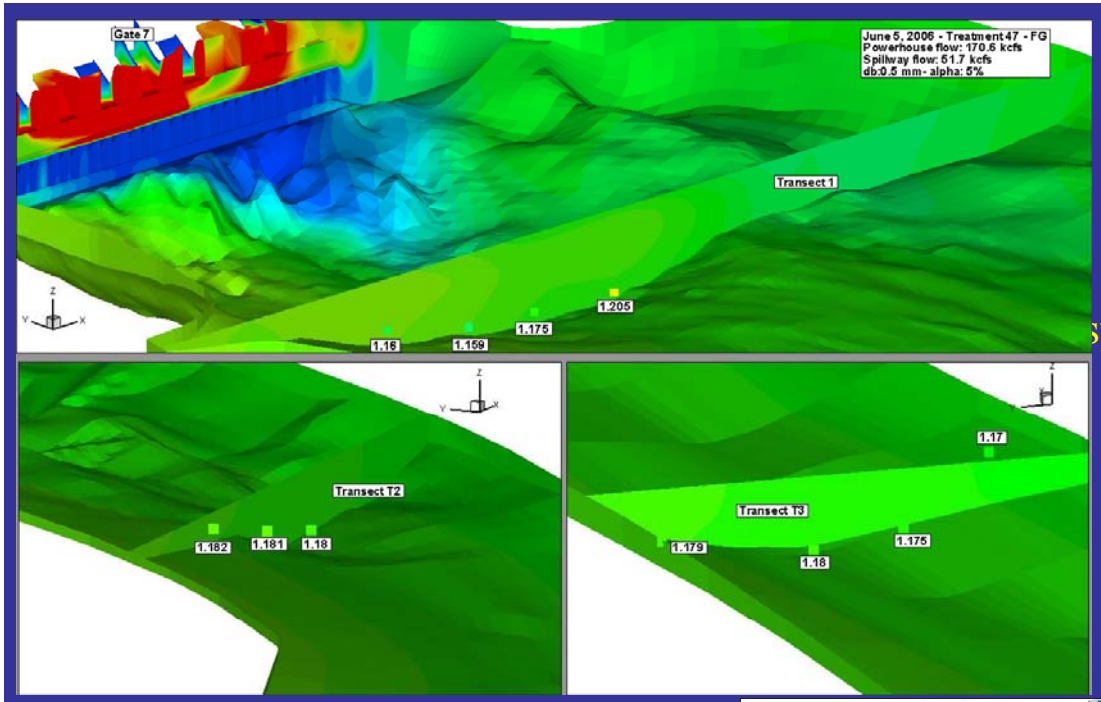






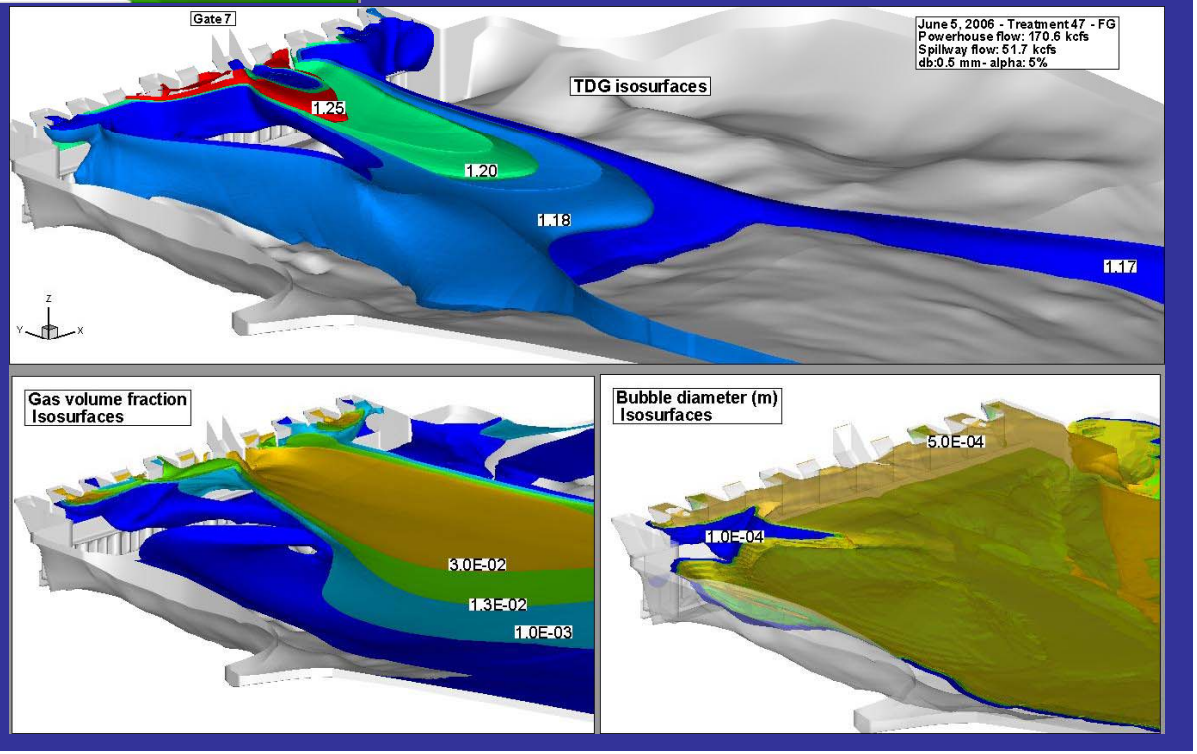
Preliminary Results

symbols: field data colored by TDG concentratio

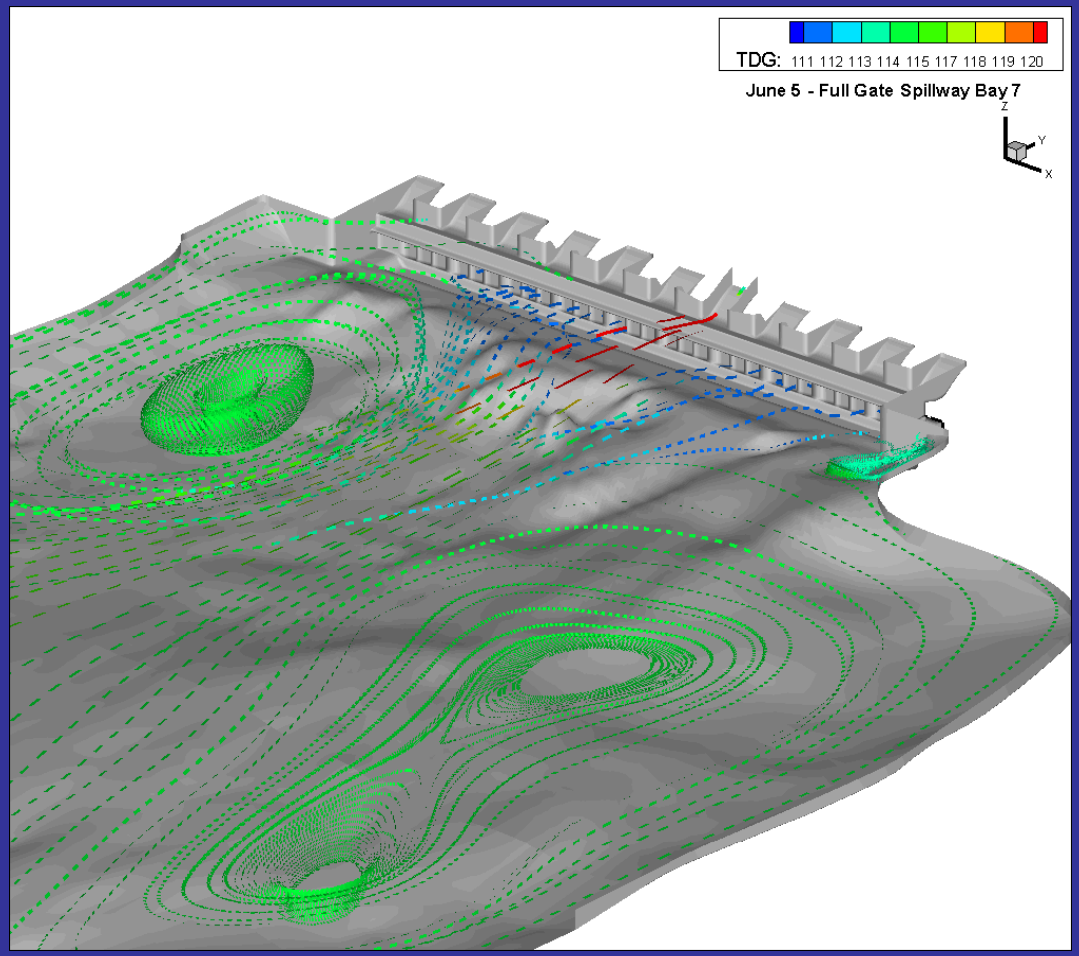


TDG validation rigid-lid model

June 5, 2006. Full open gate.



Preliminary Results



TDG validation rigid-lid model

June 5, 2006. Full open gate.

Future Work

- Flooding in Iowa and the complexity of the model have delayed completion of the model.
- Phase II model testing will evaluate the TDG performance of nine different operational scenarios at spill levels approaching 7Q10 flow.
- An interim report will be provide in the ISR due to FERC on Oct. 15, 2008
- The final report will be available in December 2008.

DEVELOPMENT OF A WATER TEMPERATURE MODEL RELATING PROJECT OPERATIONS TO COMPLIANCE WITH THE WASHINGTON STATE AND EPA WATER QUALITY STANDARDS

(Water Temperature Study)

Background

- Ecology is responsible for administering the State Water Quality Standards and for the issuance of 401 water quality certificates for FERC hydroelectric relicensing processes in the state of Washington.

- To assess compliance, Ecology needs to know if Wells Project causes increases of more than 0.3 ^{o}C above criteria temperatures for various classes of aquatic life.

Study Goal

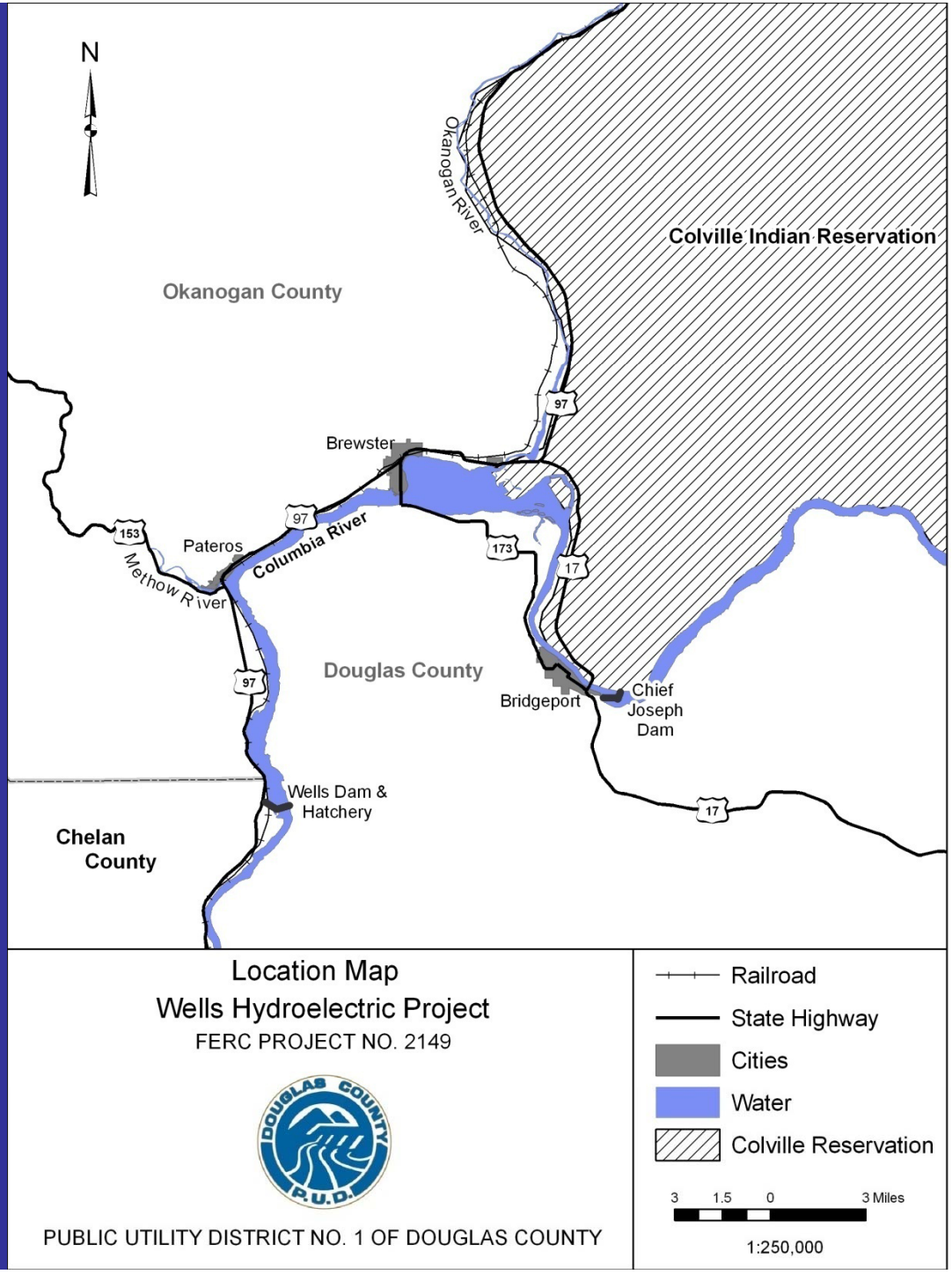
- The objective of the study is to develop a temperature model (e.g., CE-QUAL-W2) to assess the effects of Wells Project operations on water temperatures at Wells Dam and within the Wells Reservoir as they relate to compliance with the Washington State Water Quality Standards and the 401 certification process.

APPROACH

- Develop 2-D (longitudinal and vertical) models of:
  - Existing conditions ("With Project")
  - "Without Project" conditions
- Compare results with actual observations from various locations within the reservoir
- Use calibrated model to evaluate "compliance" with the temperature standard
- Use Corps of Engineers model CE-QUAL-W2

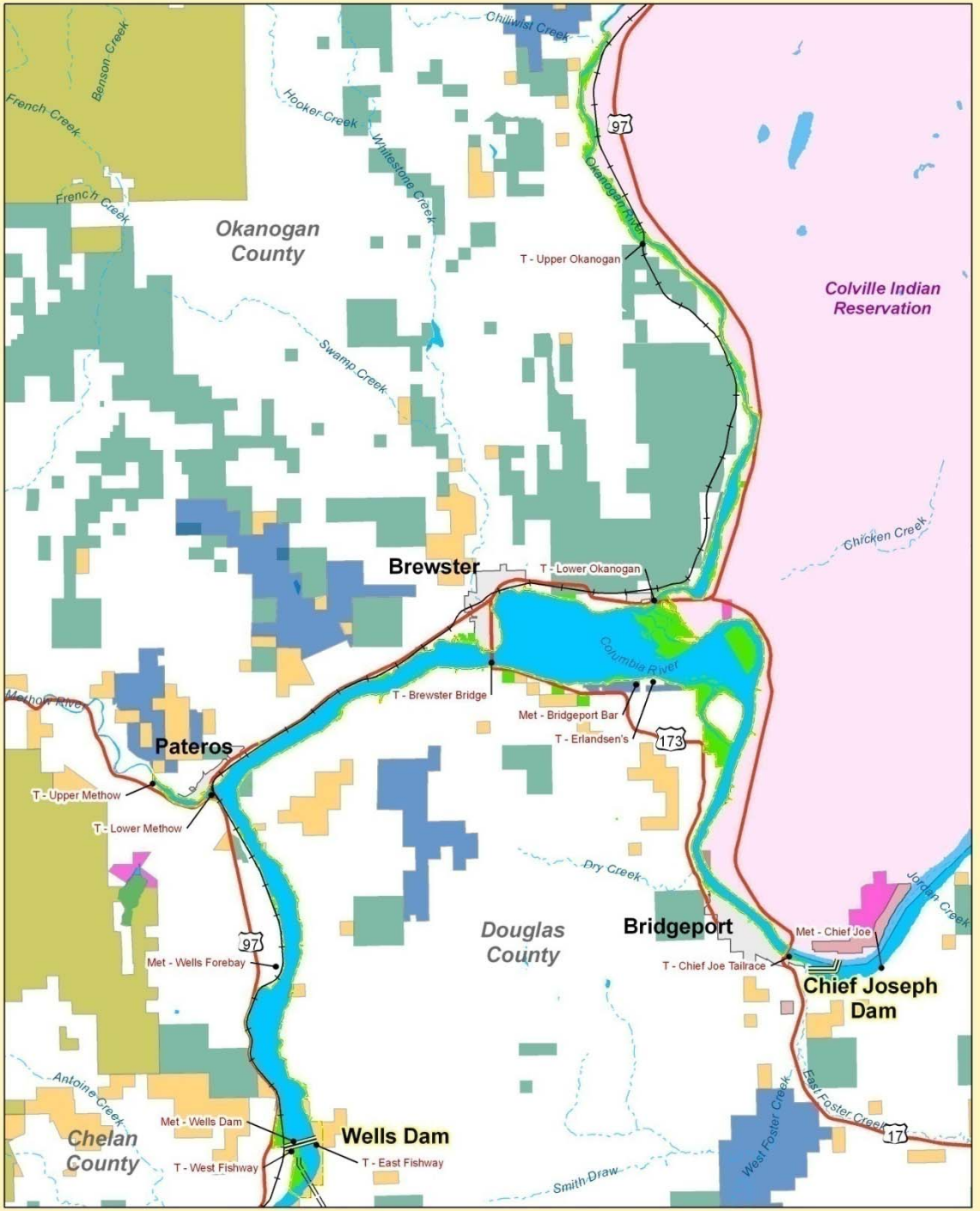
STUDY AREA

- 30 miles of Columbia River
- 15.5 miles of Okanogan River
- 1.5 miles of Methow River



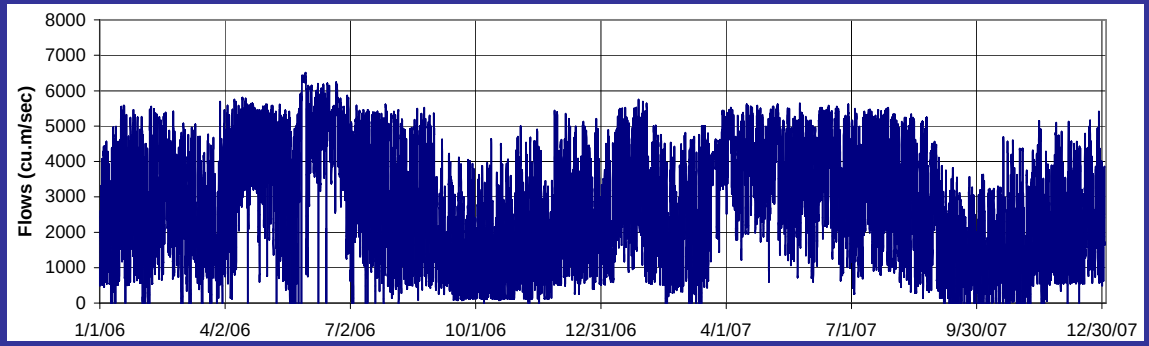
MODEL DATA

- Bathymetry
- Flows and stage
- Water temperature
- Meteorology

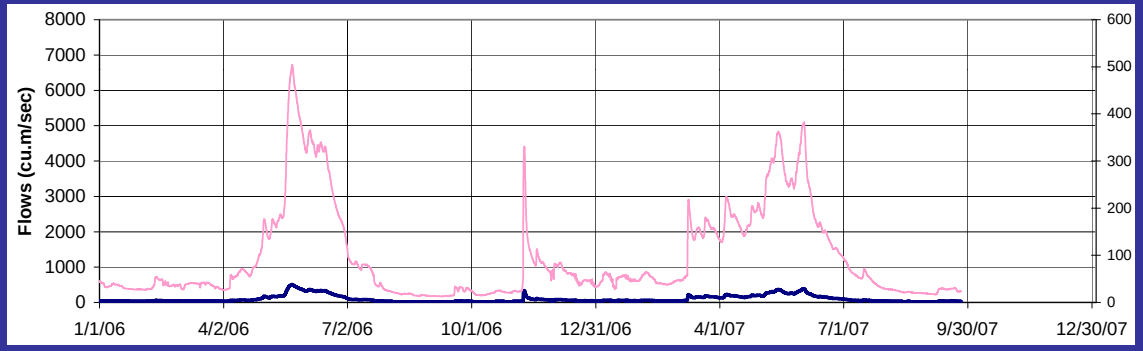


Project Flows and Temperatures

Chief Joseph Flows
(95% of Wells)

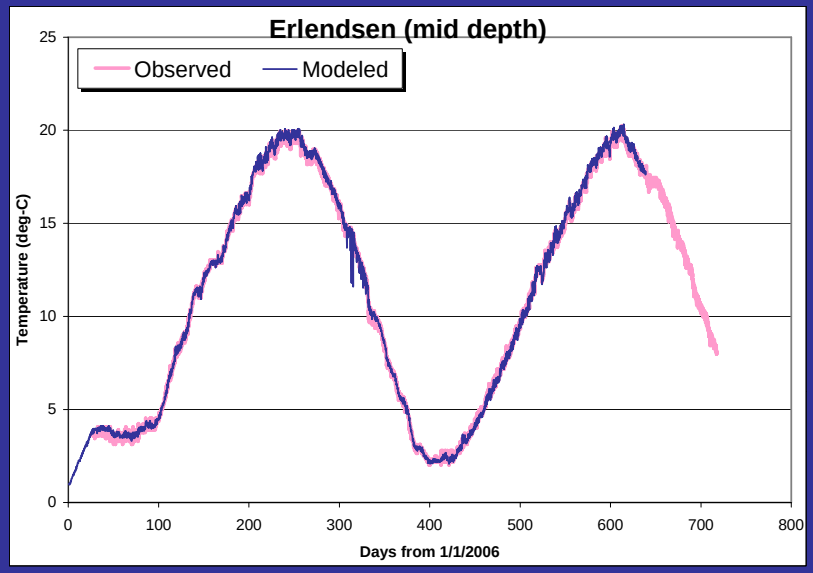


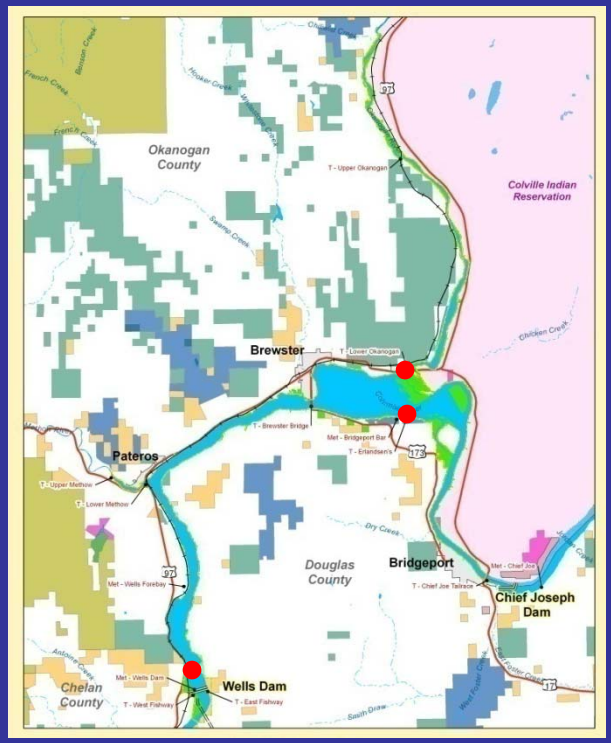
Okanogan River Flow
(3% of Wells)

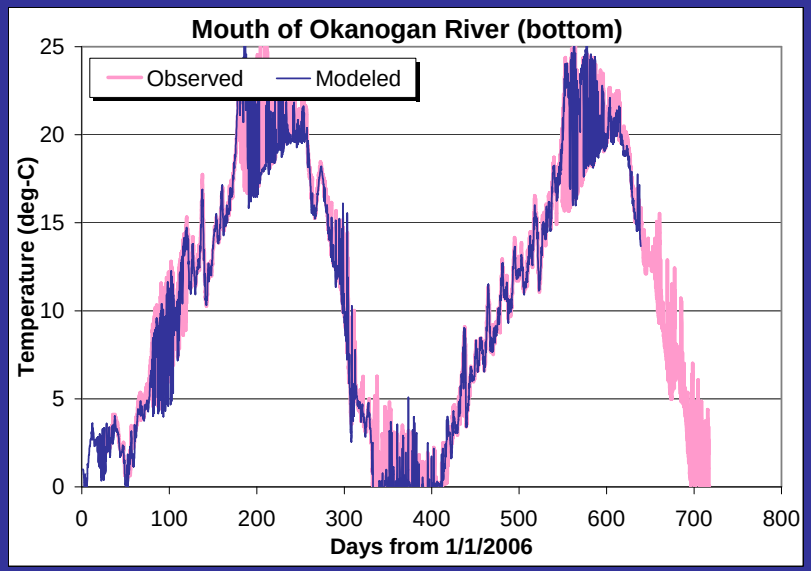


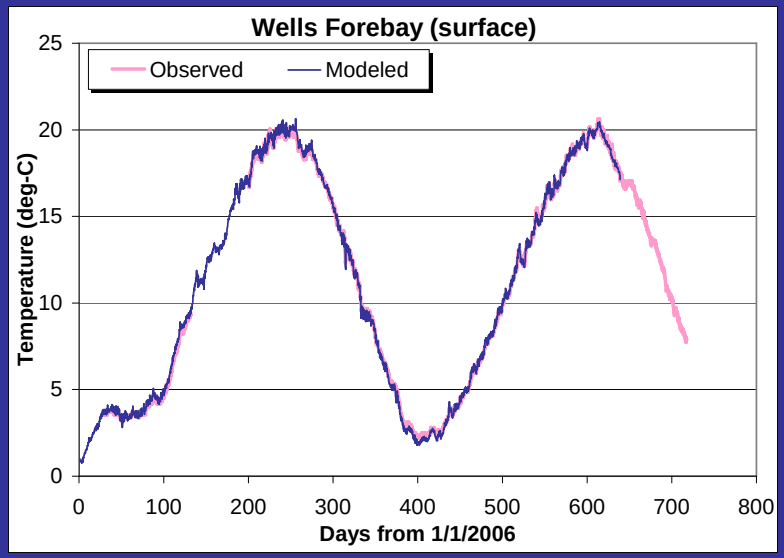
Temperatures

Model Calibration

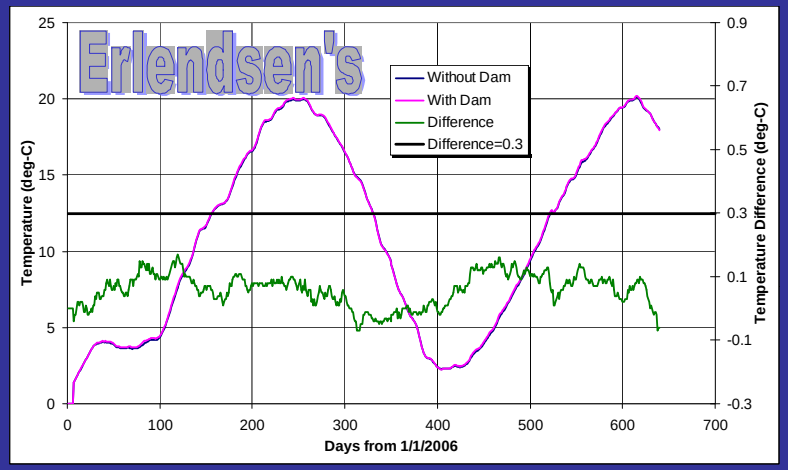


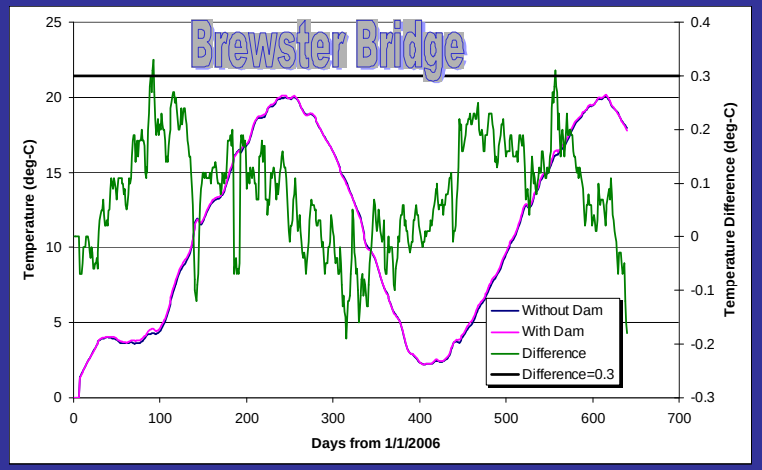


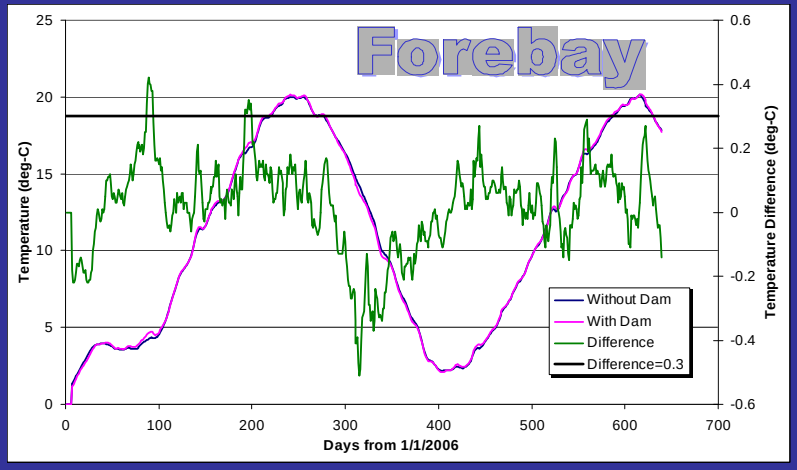


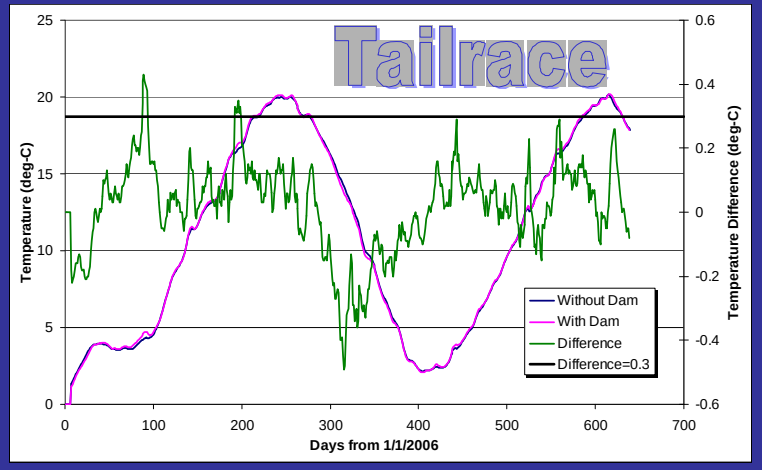


7_DADMax Temperatures









SUMMARY

- The 2D model is developed and calibrated.
- The 2D model is developed for both the “with” and “without Project” conditions.
- Preliminary Results indicate very small changes in temperatures in the Columbia, Okanogan and Methow rivers, and general compliance with temperature criteria.
- The results in the lower Methow and Okanogan rivers show mixing in the lower reaches with the Columbia River.
- Evaluation of compliance with the standards is still pending.

Future Work

- The 7DADMax and Exceedance Curves still need to be developed for the Okanogan rivers and then compared to the temperature compliance standards.
- Draft Report will be delivered to the Douglas PUD by August 21, 2008.
- The Final Report will be included into the ISR filed with FERC on October 15, 2008.

Continued Monitoring of DO, pH, and Turbidity in the Wells Forebay and Lower Okanogan River

(DO, pH, and Turbidity Study)

- Study not Required by FERC -

DO, pH, and Turbidity Study Goal and Methods

- Goal: to continue monitoring DO, pH, and turbidity in select sites of Wells Project and support the CWA §401 water quality certification.
- Hydrolab Minisonde5 instruments equipped with pH, DO and turbidity probes were installed in protective housings attached to bridge pilings in the Okanogan River at Highway 97 (RM 0.5), Monse (RM 5.0) and Malott (RM 17.0) and in the Columbia River in the forebay of Wells Dam (RM 515.6).
- Recording at 30-min intervals since 5/6/08.

DO, pH, and Turbidity Study Implementation

- Six instrument servicing events thus far: data downloading, maintenance, calibration, QC measurements, battery replacements.

- Access difficulties, log jam, and faulty batteries have resulted in some gaps in the monitoring records.

DO, pH, and Turbidity Study Preliminary DO Results

- DO concentrations have ranged from 9 to 11 mg/L in the late spring with excursions below the 8.0 mg/L standard starting in early July as snowmelt runoff receded and the river warmed. DO levels in the Okanogan River are entering the Wells Project below the 8.0 mg/L standard.

- Minimum daily DO concentrations have been below 8.0 mg/L since early July at Malott (RM 17 above the Wells Project) and at Monse (RM 5 in the Wells Project).

DO, pH, and Turbidity Study Preliminary pH Results

- Okanogan River pH is slightly alkaline: 7.4 to 8.6 at Highway 97, 7.1 to 8.7 at Monse, and 7.2 to 8.7 at Malott.
- Upstream from the Wells Project at Malott (RM 17) the pH has exceeded 8.5 daily since July 24 particularly during late afternoon to nighttime hours.
- Within the Wells Project, only occasional readings greater than the 8.5 standard have been measured at Highway 97 (RM 0.5) and at Monse (RM 5.0).

DO, pH, and Turbidity Study Preliminary Turbidity Results

- Results have been complicated by loss of equipment, limited access due to flooding and loss of data due to operator error and faulty batteries.
- 0.1 to 400 NTU at Highway 97

Future Work

- Continue monitoring through October, 2008.
- Data quality review will take place in November 2008.
- Further examination of data pertaining to the water quality standards and final report due by the end of 2008.
- An interim report for the ISR will include data up to August 5, 2008.
- Final report will be available in December 2008

AN ASSESSMENT OF ADULT PACIFIC LAMPREY SPAWNING WITHIN THE WELLS PROJECT

(Lamprey Spawning Assessment)

- Study not Required by FERC -

Study Goal and Objectives

- Goal: Assess the level of spawning activity by adult Pacific lamprey in the Wells Project and whether Wells Dam operations are affecting this activity.

- Objectives:
  - Identify areas within the Wells Project where suitable spawning habitat may exist for adult Pacific lamprey.
  - Survey these areas for use.
  - If spawning is observed, assess whether impacts from operations exist.

Identify Suitable Spawning Habitat

- GIS analysis using existing bathymetry and orthophotography to identify all habitat less than 10 ft depth at full reservoir elevation (781 above msl).
- Preliminary site validation:

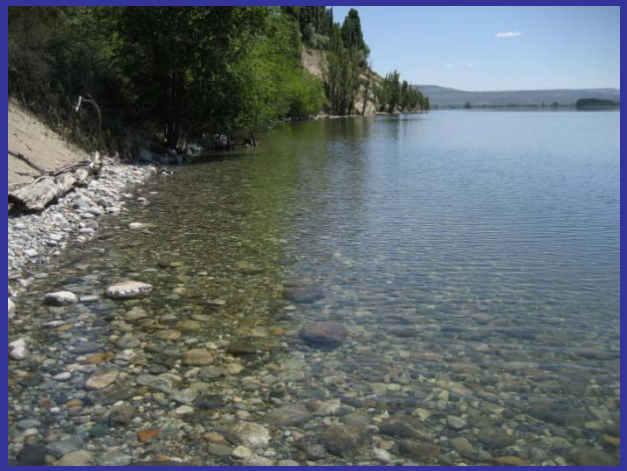
  Initial Habitat Suitability Criteria: gravel dominant substrate, flow present, adequate velocity, reach greater than 10 feet in length.

4 Sites Identified as Suitable

- C1: west shore of Columbia River (RM 534) downstream of Okanogan River confluence, 1 mile long.
- C2: west shore of Columbia River (RM 536) upstream of Okanogan River confluence, 0.5 miles long.
- MR: pool-riffle habitat near Project boundary on the Methow River (RM 1.4).
- OR: riffle-run habitat on the upper Okanogan River (RM 14.5).

Spawning Habitat Sites

C1



C2

MR

OR

Spawning Ground Surveys

- April 25-August 5, 2008.
- Sites C1, C2, MR, OR were surveyed 13, 14, 6, and 4 times respectively.
- Range of water temperatures (8.5°C-21.5°C) and flows (.001-19.5 kcfs) during the study period.
- No activity observed (lamprey, nests, test digs).

Impact Assessment

- No spawning or signs of spawning observed, therefore no impact assessment conducted.

- Note that both the MR and OR sites were located in upper Project boundary which is riverine and unaffected by Project operations.

Conclusions

- Available Pacific lamprey spawning habitat in the Wells Project is limited and of marginal quality.
- Surveys were conducted over appropriate time period and environmental conditions as suggested by the literature.
- Pacific lamprey passing Wells Dam appear to be spawning above Project boundary where conditions are more suitable.

SURVIVAL AND RATES OF PREDATION FOR JUVENILE PACIFIC LAMPREY MIGRATING THROUGH COLUMBIA RIVER HYDROELECTRIC PROJECTS
(Juvenile Lamprey Study)

In 2008, a juvenile Pacific lamprey (*Lampetra tridentata*) predation study was conducted at the Wells Hydroelectric Project (Wells Project) in accordance with the ILP. The goal of the study was to collect up-to-date information on the survival and the rates of predation of juvenile Pacific lamprey macropthalmia migrating through Columbia River hydroelectric Projects and collect site specific information on rates of predation on juvenile lamprey in the waters immediately upstream and downstream of Wells Dam. Specific objectives of the study include: 1) Conduct a literature review on juvenile lamprey survival and predation studies conducted at Columbia River hydroelectric projects; and 2) conduct an analysis on the stomach contents of predatory fish and birds to assess the location and level of predation that may be occurring on juvenile Pacific lamprey in the Wells forebay and tailrace.

Although there is a growing body of information on adult Pacific lamprey and their interactions at hydroelectric projects, relatively little information exists related to the survival of outmigrating juvenile lamprey (macropthalmia) at hydroelectric projects. A review of the recent body of literature related to juvenile lamprey survival passing through hydroelectric projects concludes that there is currently a lack of methodologies and technologies to effectively quantify the level of survival of juvenile lamprey migrating through a hydroelectric facility. In other words, no studies currently exist that document the level of survival attributed to a project's operations, nor does an accepted technology currently exist that would achieve this level of assessment for juvenile lamprey.

In lieu of directly measuring survival for juvenile lamprey passing through the Wells Project, the Aquatic RWG proposed to conduct an updated literature review regarding juvenile lamprey survival at hydroelectric projects in the Columbia River Basin. Additionally, a field study was implemented during the Integrated Licensing Process (ILP) study period to assess the significance of juvenile lamprey in the diets of predatory fishes and birds present in the Wells forebay and tailrace. Stomach samples of both predatory fishes and birds were obtained through pre-existing activities that were already collecting such specimens (An evaluation of the effects and alternatives to the existing piscivorous bird and mammal control program (Terrestrial Issue, PAD Section 6.2.3.1)).

An extensive literature review was conducted (numerous search engines yielding a total of 2,380 entries on a keyword search for "lamprey"). A majority of entries addressed adult lamprey and sea lamprey. Thirty one reports were further evaluated in support of the literature review objective. These reports support the notion that information on the juvenile Pacific lamprey outmigration in the Columbia River is limited, largely due to the lack of technology to meet research needs. Eleven birds and over one thousand piscivorous fishes were collected for stomach analysis during the study. Seven lamprey

were collected out of all of the predatory fish and birds sampled, including one double-crested cormorant which had three lamprey (of five sampled), one ring-necked gull which had one lamprey (of three sampled), and three pikeminnow which each had one lamprey (of 1,022 sampled). These results suggest that:

- Pikeminnow predation on juvenile lamprey is likely not substantial at this time;
- Differences between juvenile lamprey predation in the Wells forebay and the Wells tailrace are not detectable in pikeminnow based on these results;
- Piscivorous fish predation (bass and walleye) of juvenile lamprey in the Wells Project does not appear to be significant, though a greater sample size would be required to make any conclusions;
- Bird predation of juvenile lamprey in the Wells Project may be significant, though a greater sample size would be required to make any conclusions;
- The lack of trapping and tagging technology to produce reliable survival estimates will continue to limit the ability to quantify the impacts of hydroelectric operations on juvenile lamprey populations in the Columbia River.

ADULT PACIFIC LAMPREY PASSAGE AND BEHAVIOR STUDY (Adult Lamprey Passage Study)

In 2007, an adult Pacific lamprey (*Lampetra tridentata*) passage and behavior study was conducted at Wells Dam in accordance with the ILP. The goal of this study is to evaluate the effect of the Wells Project and its operations on adult Pacific lamprey upstream migration and behavior as it relates to fishway passage, timing, and downstream passage events (drop back) through the dam. This information will be used to help identify potential areas of passage impediment within the Wells fishways. Specific objectives of the study include: 1) Conduct a literature review of existing adult Pacific lamprey passage studies at Columbia and Snake river dams; 2) identify methods for capturing adult Pacific lamprey at Wells Dam; 3) document the timing and abundance of radio-tagged lamprey passage through Wells Dam; 4) determine whether adult lamprey are bypassing the adult counting windows at Wells Dam; 5) where sample size is adequate, estimate passage metrics including fishway passage times and efficiencies, residence time between detection zones, and downstream passage events (drop back); and 6) if necessary, identify potential areas of improvement to existing upstream fish passage facilities for the protection and enhancement of adult lamprey at the Wells Project.

A review of past adult lamprey passage studies indicated commonalities among lamprey behavior at hydroelectric projects and trapping methodologies were developed to capture adult lamprey at Wells Dam. During the 2007 study, 21 lamprey were captured, surgically radio-tagged, and released. Of these fish, 10 were released into the tailrace and 11 fish were released into the fishway between mid-August and early October. One tailrace-released fish was recaptured and re-released into the fishway, bringing total ladder releases to twelve. Ten of the twelve (83%) lamprey released into the middle fishway successfully ascended, with a median upper fishway passage time of 7.9 hours. Seven of the ten (70%) lamprey released into the tailrace were detected at the outside of a

fishway entrance. Only one of these seven (14%) lamprey entered into the collection gallery and ascended the fishway with a lower fishway passage time of 6.1 hours and upper fishway passage time of 5.9 hours. This fish, along with at least one mid-ladder release, traveled through some portion of the auxiliary water supply (AWS) chamber. Including one tailrace-released fish, 6 of 11 (55%) tagged-lamprey that ascended the upper fishway were detected inside the video bypass area. Three of the eleven (27%) fish that exited the ladder passed through the upper fish ladder without being observed at the counting window. No drop backs were detected by fish that exited the fishway. These results suggest that: 1) lamprey are passing the upper fishway at high rates, in a reasonable amount of time, and with negligible drop back within the ladder; and 2) some lamprey are bypassing the adult counting windows.

ASSESSMENT OF DDT AND PCB IN FISH TISSUE AND SEDIMENT IN THE LOWER OKANOGAN RIVER (Okanogan Toxins Study)

In 2008, an Okanogan River Toxins Study was conducted at the Wells Hydroelectric Project (Wells Project) in accordance with the ILP. The goal of the study was to determine the concentration of the insecticide 1,1,1-trichloro-2,2-*bis*[*p*-chlorophenyl]ethane (DDT) and polychlorinated biphenyl (PCB) in recreational fish species and in swimming areas of the lower Okanogan River (up to RM 15.5) within the Wells Project boundary. Fish tissue of recreational fish species and sediment samples at specific recreational sites were collected and are being analyzed. The information may inform the development of an appropriate information and education program to address the human health risks towards recreational use by the public in the lower Okanogan River.

Fish species targeted for analyses were common carp (*Cyprinus carpio*), mountain whitefish (*Prosopium williamsoni*), and smallmouth bass (*Micropterus dolomieui*). These species were selected for sampling because they have historically been sampled by the Washington Department of Ecology and because these fish represent different feeding behaviors and habitat uses. Approximately 60 personnel days (483 hours), approximately five times the effort anticipated by the Quality Assurance Project Plan, was expended in fish collection efforts. Four angling events to collect mountain whitefish in early and mid June were not successful in capturing any of this species, and additional sampling efforts in July were also not successful during the use of trot lines or beach seining. Several collection efforts through July, employing beach seines, trot lines and angling gear were successful in collecting small numbers of carp from the middle and lower reaches and bass from all three reaches in the lower Okanogan River. Fish were weighed and measured to allow for comparisons to fish collected in the Total Maximum Daily Load Technical (TMDL) Assessment conducted by Ecology (2003). Filet samples from the fish were delivered to Analytical Resources, Incorporated in Seattle, Washington, for analyses of DDT and PCBs.

Sediment sampling locations were selected during a site reconnaissance to target accessible recreation sites along the lower Okanogan River within the Wells Project

boundary (RM 15.5 to RM 0.0). To characterize the surface sediments most likely to be encountered by recreational river users, three grab samples were collected from the upper 10 cm of the sediments at each site with a vanVeen grab sampler. At each site, an aliquot of sediment from each grab sample was placed in a stainless steel bowl, thoroughly homogenized by stirring, placed in sample containers, transported on ice to the analytical laboratory, and analyzed for total organic carbon (TOC), grain size, total solids, PCB (Aroclors), and DDT analogs.

Laboratory analyses have been completed for sediments collected near the Monse Bridge boat launch (SED1, RM 5), an informal swimming area and boat launch below Crazy Rapids pump house (SED2, RM 6), an informal recreation site on the west shore near RM 8 (SED3), an informal swimming area and sand beach on the east shore below the railroad bridge (SED4, RM 10), and an informal swimming area at the mouth of Chilliwist Creek (SED5, RM 14). The organic content of sediments increased from 0.1 percent at SED5 downstream to 1.2 percent at SED1, and total solids content decreased from 74 percent at SED5 downstream to 48 percent at SED1. Silt and clay fractions comprised 40 percent of the sediment at SED1 but were not measureable at SED4 and SED5. The remaining sediment was predominantly sand with finer sands found downstream and medium sand sampled upstream. All PCBs were undetected in all samples at the 3.9 to 4.0 µg/kg reporting limits. DDT analogs were not detected in samples from the SED4 and SED5 upper reach locations. At SED3, 4-4'-DDE was detected at 3.2 µg/kg and 4-4'-DDD was detected at 1.5 µg/kg. Only 4-4'-DDE was detected at SED2, at 2.2 µg/kg. At SED1, 4-4'-DDE was detected at 14 µg/kg, 4-4'-DDD was detected at 3.6 µg/kg, and 4-4'-DDT was detected at 1.7 µg/kg. Total DDT analog concentrations were 19.3 µg/kg at SED1, 2.2 µg/kg at SED2, 4.7 µg/kg at SED3, and undetected at the upper two sampling locations. These results are similar to the range of 8.3 to 23 µg/kg detected in the upper 32 cm of a 2001 sediment core collected for the TMDL study, where total concentrations were 8.8 µg/kg in the upper 2 cm and increased to 23 µg/kg in sediments from 30 to 32 cm deep.

The final results from this study will be available in October 2008.

AN INVESTIGATION INTO THE TOTAL DISSOLVED GAS DYNAMICS OF THE WELLS PROJECT (Total Dissolved Gas Investigation)

In 2008, a Total Dissolved Gas (TDG) Investigation is being conducted at the Wells Hydroelectric Project (Wells Project) in accordance with the ILP. The goal of the study is to better define the relationship between spill operations at Wells Dam and the resultant downstream total dissolved gas pressures and, if needed, identify possible measures to improve operations performance related to TDG.

Elevated supersaturation of the TDG has deleterious effects on fish and other aquatic life. Douglas PUD has initiated a series of assessments aimed at gaining a better understanding of the effect of spill operations on the production, transport and mixing of TDG at Wells Dam. IIHR-Hydroscience & Engineering is developing a numerical study

to understand the underlying phenomena leading to TDG supersaturation and evaluate the effectiveness of spill type and plant operations in reducing TDG.

Two models are being used in the IIHR study; a volume of fluid (VOF) model and a rigid-lid model. The VOF method predicts the flow regime and the hydraulic free surface characteristics, recognizing that a spillway jet may plunge to depth in the tailrace or remain closer to the surface depending upon the spillway geometry and the tailwater elevation.

The rigid-lid two-phase flow model characterizes the hydrodynamics and predicts the three-dimensional distribution of TDG in the tailrace. The free surface shape and upstream velocity profiles derived from the VOF model are input into this model. The model calculates the TDG concentration considering the air entrainment, the mass transfer between bubbles and water, degasification at the free surface, and bubble size. The bubble size and the air volume fraction at the inlet and a bubble turbulence constant are external inputs to the model.

The model predictions are compared against velocity and TDG data collected at three transects from spill tests conducted on June 4 and June 5, 2006. Once calibrated, the predictive ability of the model is validated by running the model for three different operational conditions tested in 2006. After calibration and validation, nine additional runs are performed to scope the sensitivity of TDG production in the tailrace as a function of project operations.

Hydrodynamics

VOF computations for all the runs (validation, calibration and testing) were completed. The computed free surface shape was used to create rigid-lid grids to run the TDG model. Good agreement between measured and predicted velocities was observed for June 4 and June 5, 2006.

TDG Model

The TDG model is being calibrated. A sensitivity analysis of the TDG distribution as a function of gas volume fraction and bubble size is being performed.

The TDG model for the Wells Project is currently still under development with additional model calibration and verification taking place through October 2008. Preliminary results from this study will be available in October 2008.

DEVELOPMENT OF A WATER TEMPERATURE MODEL RELATING PROJECT OPERATIONS TO COMPLIANCE WITH THE WASHINGTON STATE AND EPA WATER QUALITY STANDARDS (Water Temperature Study)

In 2008, a Water Temperature Study was conducted at the Wells Hydroelectric Project (Wells Project) in accordance with the ILP. The goal of the study was to develop a temperature model (CE-QUAL-W2) to assess the effects of Wells Project operations on water temperatures at Wells Dam and within the Wells Reservoir as they relate to compliance with the Washington State Water Quality Standards and the 401 certification process.

In support of the Clean Water Act Section 401 Certification process, the Washington State Department of Ecology (Ecology) must assess compliance with State water temperature criteria, and needs to know whether the Wells Hydroelectric Project (Wells Project) causes the 7-day average of maximum daily water temperatures (7-DADmax) to increase significantly compared to "without-Project" conditions. When the water body's temperature is naturally greater than maximum values recommended for various classes of aquatic life (Ecology, 2006), or within 0.3°C of those values, then the Project should not cause the temperatures to increase by more than 0.3°C.

In this study, we present the development and calibration of a 2D hydraulic and water temperature model of the Wells Project, and apply this and a second model of "without Project" conditions to examine the change in temperature conditions within the Project's boundaries. The model includes about 30 miles along the Columbia River, the lower 15.5 miles of the Okanogan River, and the lower 1.5 miles of the Methow River. Data were collected for 2006 and 2007, and used to develop and calibrate the model. The data include a detailed bathymetric survey, observed flows and temperatures, and meteorological data (air temperature, wind, and solar radiation). The calibrated model was presented to Ecology for review.

The results indicate that temperature increases in the Columbia River are less than 0.3^{o}C, and meet the State's temperature criteria for all aquatic life. The temperatures in the lower Okanogan and Methow rivers are still being reviewed. The Okanogan River in particular is a very complex area with extremely warm mid-summer flows entering upstream of the Wells Project boundary (at Malott) and a complex interaction of Columbia and Okanogan river water taking place within the lower few miles of the Okanogan River. This interaction results in up to 5°C of cooling in the lower extent of the Okanogan River during the summer months.

CONTINUED MONITORING OF DO, pH, AND TURBIDITY IN THE WELLS FOREBAY AND LOWER OKANOGAN RIVER (DO, pH and Turbidity Study)

In 2008, a dissolved oxygen (DO), pH, and Turbidity Study was conducted at the Wells Hydroelectric Project (Wells Project) in accordance with the ILP. The goal of the study was to continue monitoring dissolved oxygen DO, pH, and turbidity in the Wells Dam forebay and Lower Okanogan River within the Wells Project boundary.

Hydrolab Minisonde5 instruments equipped with DO, pH, and turbidity sensors were installed in protective housings and activated to begin recording water quality measurements on May 5, 2008. The instrument housings were attached to bridge pilings at the Malott Bridge (RM 17.0), Monse (RM 5.0) and Highway 97 (RM 0.5) in the lower Okanogan River. Similar instrumentation operating in the Wells Dam forebay on the Columbia River (RM 516) completed the network of four continuous monitoring instruments recording at 30-minute intervals. The Malott monitoring site is upstream of the Wells Project boundary and data collected at this site is representative of water quality conditions entering the Wells Project.

There have been six instrument servicing events since installation in early May, each event included downloading data, calibrating and performing maintenance on the instruments, performing quality control checks including Winkler's titrations for dissolved oxygen determination, and replacing batteries. High river flows and log jams limiting access to the instruments and battery failures resulted in some data gaps when the instruments were not operational.

The pH measurements thus far have ranged from 7.39 to 8.61 units at the Highway 97 bridge, 7.07 to 8.68 at Monse Bridge, and 7.23 to 8.70 at Malott Bridge. There were only a few excursions of pH outside the 6.5 to 8.5 range of water quality standards. The only extensive period of pH excursions occurred at the Malott Bridge between July 24 and August 5 when diurnal occurrences of higher late afternoon to nighttime pH reached as high as 8.70. Because the higher pH occurred mostly upstream from the Wells Project area at Malott, reservoir operations were not considered to be a contributing factor in the pH excursions during this monitoring period.

DO measurements of at least 9 to 10 mg/L early in the monitoring season dropped to below the 8.0 mg/L water quality standard in the summer as snowmelt runoff receded and water temperatures warmed. This observation included the site above the Wells Project at Mallott and at the Monse site within the project at RM 5.0. In addition, there appeared to be daily minimum DO readings that occassionally dropped below 8.0 mg/L at the Highway 97 Bridge site at RM 0.5.

Turbidity ranged from 0.1 NTU to 647 NTU at Highway 197, 489 NTU at Monse, and 400 NTU at Malott.

Water quality data for the Wells forebay site is currently being analyzed with additional sampling taking place through October 2008. Preliminary results from this study will be available in October 2008.

AN ASSESSMENT OF ADULT PACIFIC LAMPREY SPAWNING WITHIN THE WELLS PROJECT (Lamprey Spawning Assessment)

In 2008, an adult Pacific lamprey (*Lampetra tridentata*) spawning assessment was conducted at the Wells Hydroelectric Project (Wells Project) in accordance with the ILP. The goal of the study was to assess the level of spawning activity by adult Pacific lamprey in the Wells Project and whether Wells Dam operations are affecting this activity. Specific objectives of the study include: 1) Identify areas within the Wells Project where suitable spawning habitat may exist for adult Pacific lamprey; 2) survey these areas of spawning habitat for use by lamprey to confirm suitability; and 3) if spawning is observed, assess whether the operations of Wells Dam are having adverse effects on these spawning areas (i.e., dewatering, flow alterations, scour, etc.).

Wells Project bathymetry and high resolution orthophotography were spatially analyzed using a Geographic Information System (GIS) to identify preliminary spawning habitat. Four field surveys were conducted to verify the suitability of preliminary spawning habitat. Criteria for acceptance as suitable spawning habitat during field verification consisted of appropriate substrate (gravel dominant), the presence of water velocity, and a minimum reach length of 10 feet. Four reaches were concluded to have suitable spawning habitat for Pacific lamprey; two in the Columbia River (C1 and C2), one in the Methow River (MR), and one in the Okanogan River.

A total of 14 field visits were conducted between the April 25th and August 5th, 2008. Sites C1, C2, MR, OR were surveyed 13, 14, 6, and 4 times respectively. Surveys were conducted over a wide range of water temperatures (8.5°C-21.5°C) and flows (.001-19.5 kcfs). Tributary sites (MR, OR) were frequently inaccessible during the survey period due to high flows from spring run-off. During the study, no Pacific lamprey or signs of Pacific lamprey spawning (fish, nest construction activity, test digs, or nests) were observed. Since no Pacific lamprey or signs of Pacific lamprey spawning were observed, an assessment of the Wells Project operations and its potential effects on these areas was not conducted.

In consideration of the scientific literature (Close et al., Jackson et al., 1997, Kan, 1975, and Pletcher, 1963) that describes suitable spawning habitat for Pacific lamprey, the suitable habitat identified within the Wells Project can best be described as marginal. This conclusion is supported by extensive spawning ground surveys over the time period and during water quality conditions that typically define the Pacific lamprey spawning period.

Wells Dam is located at RM 515.6 on the Columbia River and is the 9th hydroelectric dam that would need to be negotiated by Pacific lamprey utilizing the Methow and

Okanogan watersheds for reproduction. As a result of this, Pacific lamprey passage numbers at Wells Dam are extremely low averaging 350 fish per year since 1998 when counting began with only 21 and 35 fish counted in 2006 and 2007, respectively. It is likely that the small numbers of Pacific lamprey that spawn in the Okanogan and Methow rivers migrate upstream of the Wells Project boundary in these tributary systems where the environment is more riverine and the availability of appropriate habitat types, substrate, and appropriate flows for spawning are more readily available.

Agenda

Aquatic Resources Work Group

Wells Hydroelectric Project Relicensing
Douglas County PUD
August 21, 2008
10:00 am – 3:00 pm

Meeting Location: **Douglas PUD**
1151 Valley Mall Pkwy.
East Wenatchee, WA 98802
Conference Call-In: (509) 881-2990, X327831

Meeting Coordinators: **Bao Le (503) 309-9423**

Meeting Goals: **1.** Provide a progress update on the Aquatic Resources studies being implemented in support of the Wells Project Relicensing.

Time	**Topic**	**Lead**
10:00 am	Welcome and Introductions	Bao Le
10:05 am	Meeting Goal and Objectives	Bao Le
10:10 am	Progress Update Presentations/Discussion 1. Juvenile Lamprey Predation 2. Adult Lamprey Passage 3. Okanogan Toxins Study 4. TDG Study 5. Water Temperature Study 6. DO, pH, Turbidity Study (not FERC required) 7. Lamprey Spawning Assessment (not FERC required)	Group
12:00 pm	**Lunch – Provided by Douglas PUD**	
1:00 pm	Continue discussions	Group
2:50 pm	Action Items and Next Steps	Bao Le
3:00 pm	Adjourn	