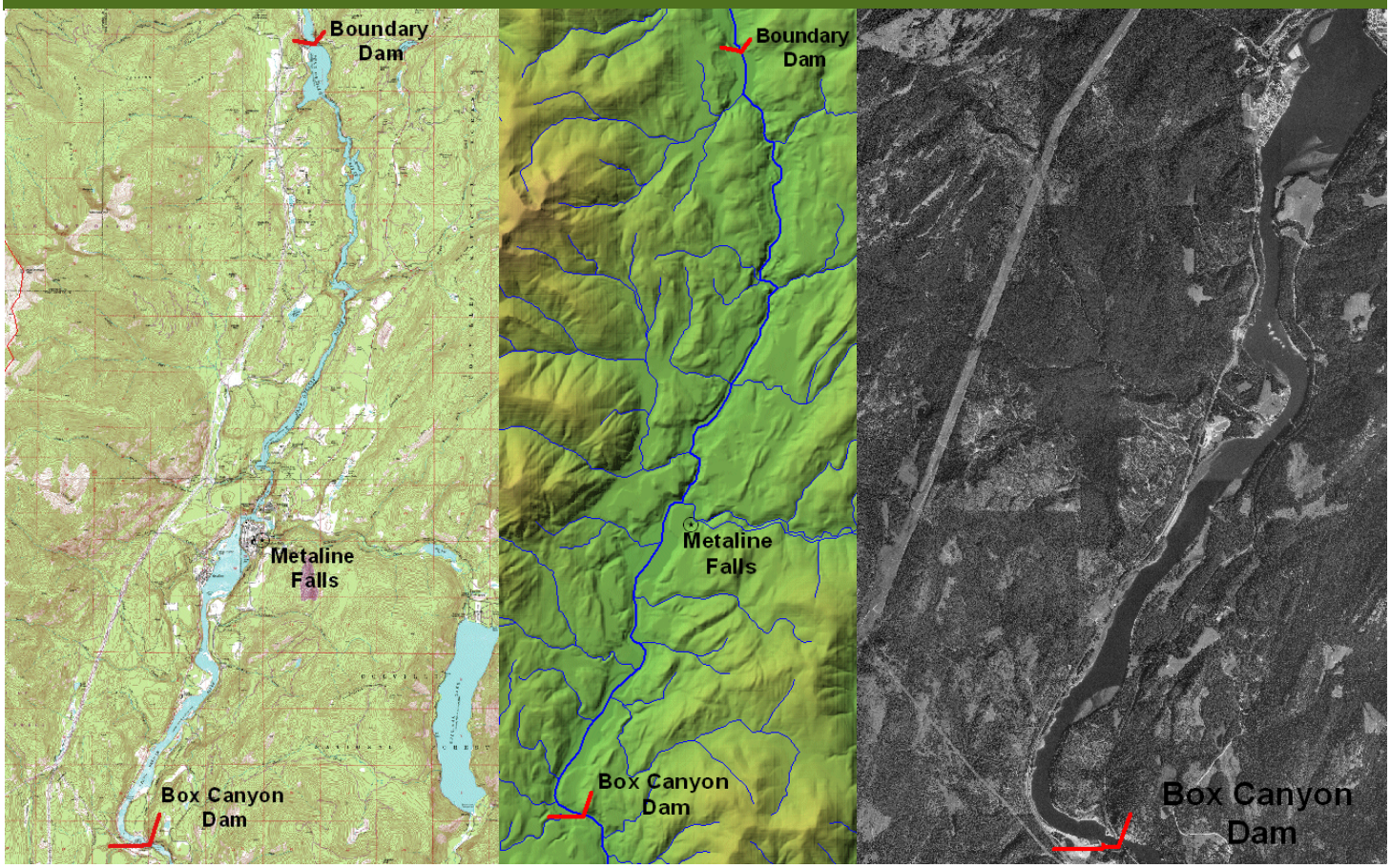
Pend Oreille River, Boundary Dam Reach

Model Peer Review



Water Quality Research Group
Department of Civil and Environmental Engineering
Maseeh College of Engineering and Computer Science

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Portland State UNIVERSITY

Pend Oreille Boundary Dam Reach CE-QUAL-W2 Model Review

Prepared for the Washington Department of Ecology

by

Scott A. Wells, Ph.D., P.E.

Robert Annear, Ph.D.

and

Chris Berger, Ph.D., P.E.

Technical Report EWR-04-07

Maseeh College of Engineering and Computer Science
Department of Civil and Environmental Engineering
Portland State University

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Table of Contents

Table of Contents 2
List of Figures 2
List of Tables 2
Introduction 3
Review Comments on Technical Report 3
Review of Forcing Function Model Input Data 8
Meteorology 8
Vegetative and topographic shade 15
Inflow-Outflow Boundary Conditions 16
Review of parameter values used in Boundary Dam CE-QUAL-W2 model 18
Summary and Conclusions 20
References 21
Appendix Preprocessor Errors and Warnings 22

List of Figures

Figure 1: Pend Oreille River, ID model meteorological site locations. 9
Figure 2: Box Canyon Data and Theoretical Clear Sky Solar Radiation. 11
Figure 3: Boundary Data and Theoretical Clear Sky Solar Radiation. 11
Figure 4: Solar radiation at Box Canyon and Boundary Dams 12
Figure 5: Model grid orientation. 14
Figure 6: Pend Oreille River model channel bottom elevations 15
Figure 7: Discharge temperatures, 2004 and 2005. 17
Figure 8: Lime Creek Flow, 2004 and 2005. 17

List of Tables

Table 1: Review comments by topic based on review of technical report. 3
Table 2: Key issues in meteorological data analysis. 8
Table 3: Pend Oreille River model meteorological monitoring sites 10
Table 4: Key issues in model grid bathymetry 12
Table 5: Key issues in shade inputs 15
Table 6: Key issues in inflow-outflow boundary conditions. 16
Table 7. W2 Model control file coefficient values. 18
Table 8: Key issues in parameter values used CE-QUAL-W2 model. 18
Table 9: Preprocessor error file, Existing Conditions 22
Table 10: Preprocessor warning file, Existing Conditions 23
Table 11: Preprocessor error file, Natural Conditions 24
Table 12: Preprocessor warning file, Natural Conditions 24

Introduction

This is a peer-review of the CE-QUAL-W2 model of the Pend Oreille River for the Boundary Dam reach. This reach is from Box Canyon Dam to Boundary Dam and to the border with Canada.

1. Reviewing the technical draft report:
   - Temperature Modeling of the Pend Oreille River, Boundary Hydroelectric Project CE-QUAL-W2 Model Calibration Report, by Stephen A. Breithaupt and Tarang Khangaonkar, DRAFT, May 2007 Prepared for Seattle City Light, Battelle—Pacific Northwest Division, Richland, Washington 99352
2. Reviewing the CE-QUAL-W2 model input files provided by the Washington Ecology, who received them from Seattle City Light
3. Reviewing the model calibration and the use of the no-dam simulation for the model simulations

The basic philosophy of this review was to provide constructive comments to improve the science and engineering being applied to Pend Oreille River. The purpose of this review was to provide an independent assessment of the model development process and to make suggestions for improving the Pend Oreille model.

The CE-QUAL-W2 model of the Boundary Reach was performed by Battelle under contract with Seattle City Light. This review was contracted by Washington Department of Ecology to assess the reliability of model tools used in the Pend Oreille TMDL process.

Details of this review are shown in the following sections:

- Review of the technical report
- Review of the meteorological and boundary forcing
- Review of model kinetic coefficients
- Review of no-dam scenario

Review Comments on Technical Report

The technical report by Breithaupt and Khangaonkar (2007) is well-organized and well-documented. The review comments were sorted by topic. Minor comments and typos were also summarized. Comments on the technical report (Breithaupt and Khangaonkar, 2007) are shown in Table 1.

Table 1: Review comments by topic based on review of technical report.

#	Subject	Comment
1	Bathymetry/Grid resolution issues	1. In Section 2.4 bathymetric data from the present study taken by Battelle were compared to that from Morrison Knudsen in 1997. These differences were summarized in Figure 2.4, a and b. Comment: A comparison of the 2 different bathymetries would have been useful by showing a difference plot of the elevation vs. river mile. It

#	Subject	Comment
		appears that the 1997 data are deeper in the upper part of the Box Canyon reach by more than 10 ft. Is there any reason for this discrepancy and more importantly are the model results affected by a change in bathymetry? A sensitivity of this different source of data was suggested later in this table under Sensitivity Analysis.
2	Forcing Conditions: Meteorological and Flow Forcing	1. In Section 2.7, The use of a criterion of r^2>0.8 as the basis for using regression equations is a useful criteria. Even though this seems reasonable, was there a rationale as to why 0.8 was used, rather than 0.85 or another number? 2. In Section 2.7.3, as expected with wind data, data collected at one site does not correlate well with data measured at another site. The Box and Boundary wind data were poorly correlated. Segments near Box used the Box data and segments near Boundary used data from the Boundary site. <u>Comment</u>: In systems that follow canyon walls, wind moves along the axis of the channel rather than at the fixed direction of the measurement location at the dam. We would suggest doing a model simulation where wind was oriented along the axis of each segment as a sensitivity analysis. This may not change model results but may help determine the systematic error in the temperature model. Were there additional wind direction and magnitude data measured during sampling events? 3. In Section 3.2.4, missing inflow temperatures from Boundary reservoir were used from the prior season. <u>Comment</u>: This is reasonable for the winter period of 2005 where temperatures are predictable. How did using the 2005 inflow temperature data from the period before July 2004 affect model calibration? A comparison of temperatures when there were duplicate sets for the 2 years would be useful to assess how important this change was. Suggest adding a graph showing comparisons for summer 2004 compared to summer 2005 and what the bias may or may not have been. 4. The downstream boundary condition at the international boundary was set as a fixed water surface condition. <u>Comment</u>: Having a prescribed head condition for this last section of the Pend Oreille River going to the Canadian border is unusual since the water level data are taken from the tailrace of the Boundary dam. Compared to other sections of the model, the temperature predictions in this reach were not as good. The proper specification of the final section of the Pend Oreille River should be a spillway condition at the end of the river, setting a flow-head relationship at the international border. One of the issues is whether the downstream water levels affect the tailrace. The report states

#	Subject	Comment
		that this was "unknown". In that case, the spillway condition should be used. This would probably reduce the water level in this section of the river from the current model formulation. 5. Section 2.7.4 Solar Radiation and Cloud Cover (Page 2.10 and Figure 2.27 (a) and (b): Solar Radiation (Page 2.37) Comments: a. The discussion in the report seems to imply that solar radiation data were used for calibration. Looking at the model files, solar radiation data were computed internally in the CE-QUAL-W2 model since SROC was OFF in the model input files. We always recommend using on-site data if available unless there is a bias in the data. Final report should have a statement showing why the W2 computed solar radiation was used. b. If solar radiation data were used in the W2 model, the Priest Lake data seem to be incorrect; the solar data vary too much from the data at the other sites. We recommend that these data not be used. c. If solar radiation data were used in the W2 model, the use of "adjacent days" data to fill in data gaps may not be necessary. A more appropriate approach might be to find the closest site with solar data during this time period. 6. Section 2.7.4 Solar Radiation and Cloud Cover (Page 2.10 and Figure 2.28 (a) and (b): Cloud Cover (Page 2.38) Comment: The cloud cover is daily data and interpolated to hourly values. Since there are solar radiation data available on an hourly basis the solar radiation could be compared to the theoretical clear sky solar and used to calculate hourly cloud cover values during the daylight hours. At night we usually take the cloud cover during the last hour of light and use that until morning.
3	Model calibration and validation	1. Model calibration statistics were presented in Section 3.3 for both water level and temperature. Water balance flows were reasonably small and the 24-hr averaging interval was reasonable. Comment: It was not stated why the distributed water balance flows were added or subtracted only from water body 3, rather than from water bodies 1-3. This probably would not impact the model results significantly if the flows were distributed also to WB1 and WB2. Also, Figure 3.3 showing the water levels of the model compared to field data is hard to discern differences. It would be more instructive even with a small error to show a difference graph of water levels between measured and predicted.

#	Subject	Comment
		2. The temperature calibration discussed in section 3.3.2 shows that there is a consistent bias in the temperature prediction of about 0.2^{o}C too cool. Adjusting the ELBOT of one branch was performed in order to add more radiation to the model. In general the other error statistics were reasonable. Station T8 had higher model errors than other sites. Comment: A sensitivity of the model to factors that affect temperature would be useful. Even though the wind was measured at the Box Canyon and Boundary Dams, the effect of WSC on temperature predictions would be useful. Oftentimes wind at dams is higher than measured on the lake/reservoir surface. The wind measuring height was specified as 2 m – was this the height above the water surface for the wind gages at Box Canyon and Boundary dams? The impact of varying the WSC should be explored using a sensitivity analysis. The higher model errors at station T8 may be related to the boundary conditions used in that reach (as discussed above in comment #2.
4	Model sensitivity analysis	1. The model report did not have a sensitivity analysis section. This section would have been useful to understand why certain modeling decisions were made and what could be used to reduce the small temperature calibration bias. Comment: Show the impact in a calibration section of the following: a. Compare the bathymetry from Morrison Knudsen, 1997 with that from the current study. The current model grid seems to be shallower than the 1997 field data near Box Canyon Dam outlet. Do temperature results from the 1997 bathymetry affect model predictions? b. Compare model predictions with and without topographic and vegetative shading. c. Adjust the model WSC to see the impact of wind on temperature. d. Use different solar radiation data to see if this is the source of the lower water temperatures. e. Adjust TSEDF to see if it affects model temperatures. If another reason for the temperature bias is found, then the EBOT of the branch upstream of Metaline Falls could be readjusted back to its measured datum.
5	Analysis of measured temperature data	1. In section 2.6.1, the authors compare temperature measurements at different stations and conclude that these data “suggest that the system was cooling slightly”. Even though this may be occurring, the field data may only be reflecting the heating/cooling changes associated with travel time from Box Canyon dam. This is a minor point but the apparent cooling may be due to where the sample station was located relative to the location of the daily

#	Subject	Comment
		maximum/minimum. Comment: Perhaps another sentence explaining this concept would be useful. 2. In Section 2.6.2, Vertical Profiles and Figure 2.12 to 2.18 and Figure 3.8 to 3.13, The authors note the temperature vertical profile data are spot measurements. Comment: The vertical profile figures for the measurements should be plotted as discrete points, not as a continuous lines unless the authors have refined data indicating temperature measurements are frequent enough to be close to the model's vertical resolution of 1 to 2 m.
6	Typos/Text corrections	1. p. 2.2: footnote for Table 2.3: change "averages ere computed" change to "averages were computed" 2. p. 2.5 1st sentence under 2.6.1: change "measurements were collect" to "measurements were collected" 3. Figure 2.26: It is unclear what the difference is between the (a) graph and the (b) graph. Please add information to the graph showing the difference between these two. The graph caption refers to Box Canyon Dam but it is not included in the figure. 4. p. 3.1 Under 3.2.1: Change "the model uses the finite- volume method" to "the model uses the finite-difference method" 5. p. 3.2 Under 3.2.2: 2nd paragraph, last sentence: Change "by the length of the segment gave an average" to "by the length of the segment and a Δz of 1m gave an average". This clarifies that the width is the volume over the layer height and segment length. 6. Figure 3.4 on p. 3.10 shows temperatures from -10 to 40C – this obscures the error in the temperature predictions compared to data. Change the scale to 0 to 30C. Also, a difference plot could be used to show the differences when they are small. 7. Table 0.1 on p. 1 – the row for segment lengths and segment widths gives a range and average – the order of these needs to be changed.

Review of Forcing Function Model Input Data

Washington Department of Ecology provided input files for the model simulation. These files were compared against plotted figures in the reports and evaluated for accuracy. The following types of files were evaluated:

- Meteorological data
- Model grid bathymetry
- Vegetative and topographic shade
- Inflow data (flows and temperatures)

Results from running the preprocessor and examining the error and warning files are presented in Appendix A.

Meteorology

Issues associated with the meteorological data are summarized in Table 2.

Table 2: Key issues in meteorological data analysis.

#	Issue/Comment
7	Figure 1 and Table 3 list several other monitoring sites in the vicinity of the Boundary Reach of the Pend Oreille River which could be used to support meteorological file development. Sites such as Deer Park, Kettle Falls, and Sand Point could support developing wind direction, cloud cover and solar radiation time series records.
8	The solar radiation data from the monitoring sites on each dam should be compared to the daily maximum theoretical clear sky solar radiation as shown in Figure 2 and Figure 3 to ensure that the solar data is not erroneous. The figures indicate there are several data points which exceed daily maximum theoretical clear sky solar radiation and may therefore be erroneous.
9	If the decision is to use solar radiation data, note that there is a large increase in solar radiation in January 2004, February 2005 and a large decrease in October 2005 for both the Box Canyon and Boundary Dam data sets. This should be investigated to identify if there are any errors in the data sets if SROC=ON. See Figure 4.
10	The cloud cover values for the Box and Boundary dam data sets were the same (except on Julian Day 230, 08/17/2004 – this difference should be explained). As noted in the comments above, the solar radiation data are different between the two sites and can be used with the theoretical clear sky solar radiation to calculate cloud cover for each data set.
11	The wind direction data in the Box Canyon and Boundary met files were the same throughout the two years of data in the meteorological files. This does not match the data presented in Figure 2.25 (Page 2.35) in the report.
12	The wind sheltering coefficients were set to 1 for the two year model period. Since some of the wind speed record was developed from data at four sites some of the

#	Issue/Comment
	wind data may not be representative of the wind on the reservoir surface. A sensitivity analysis of the wind sheltering coefficient should be conducted.

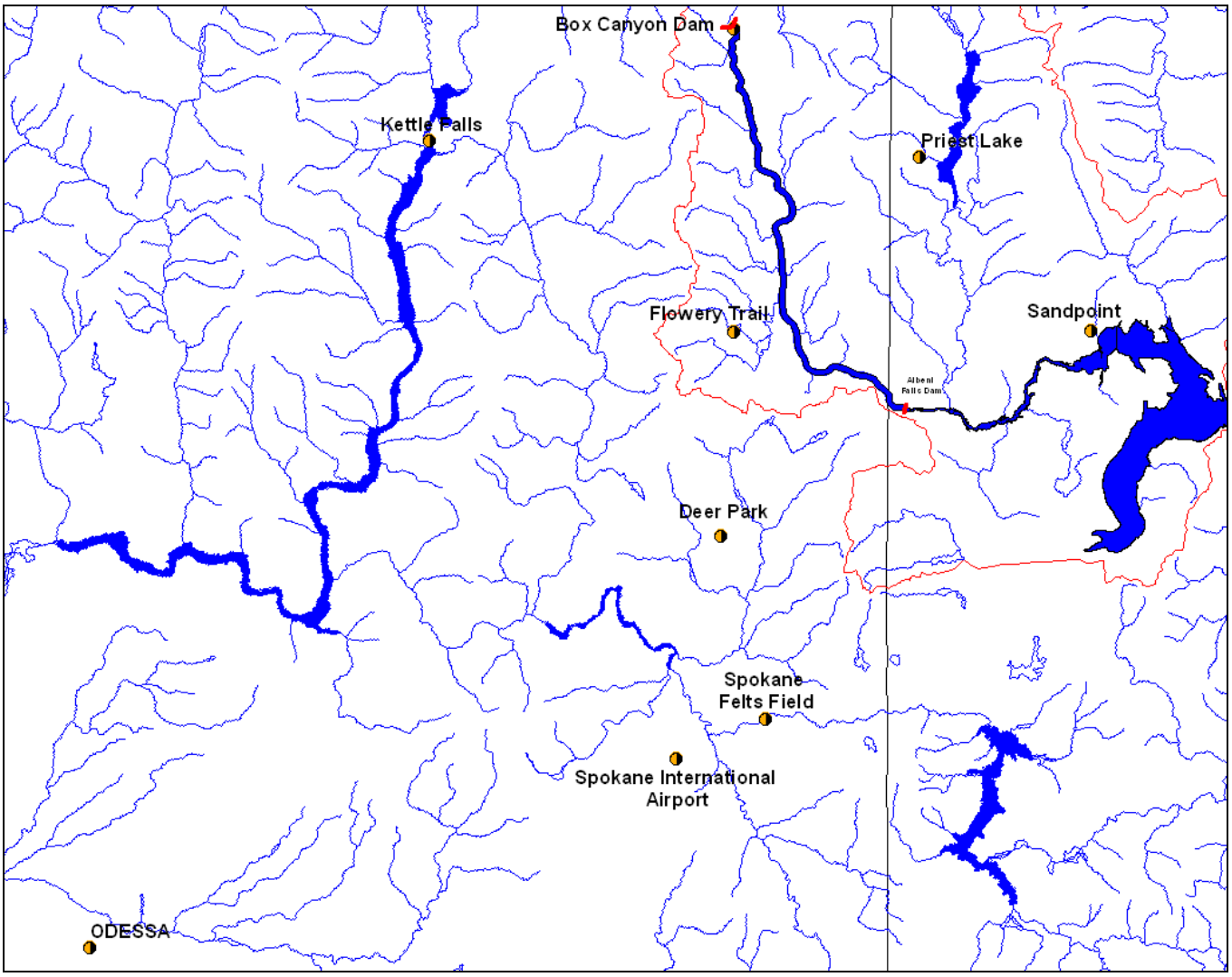

Figure 1: Pend Oreille River, ID model meteorological site locations.

Table 3: Pend Oreille River model meteorological monitoring sites

Site	Agency (Program)	Meteorological Parameters
Sandpoint Municipal Airport	National Weather Service (AWOS)	Air Temperature, Dew Point Temperature, Wind Speed, Wind Direction, Cloud Cover
Deer Park Airport	National Weather Service (AWOS)	Air Temperature, Dew Point Temperature, Wind Speed, Wind Direction, Cloud Cover
Priest Lake	U.S. Forest Service (RAWS)	Air Temperature, Relative Humidity, Wind Speed, Wind Direction, Solar Radiation
Flowery Trail	U.S. Forest Service (RAWS)	Air Temperature, Relative Humidity, Wind Speed, Wind Direction
Kettle Falls	Bureau of Reclamation (AgriMet)	Air Temperature, Dew Point Temperature, Relative Humidity, Wind Speed, Wind Direction, Solar Radiation
Spokane International Airport	National Weather Service (METAR)	Air Temperature, Dew Point Temperature, Relative Humidity, Wind Speed, Wind Direction, Cloud Cover
Spokane Felts Field	National Weather Service (METAR)	Air Temperature, Dew Point Temperature, Relative Humidity, Wind Speed, Wind Direction, Cloud Cover
Odessa, WA	Bureau of Reclamation (AgriMet)	Air Temperature, Dew Point Temperature, Relative Humidity, Wind Speed, Wind Direction, Solar Radiation

Figure 2: Box Canyon Data and Theoretical Clear Sky Solar Radiation.

Figure 3: Boundary Data and Theoretical Clear Sky Solar Radiation.

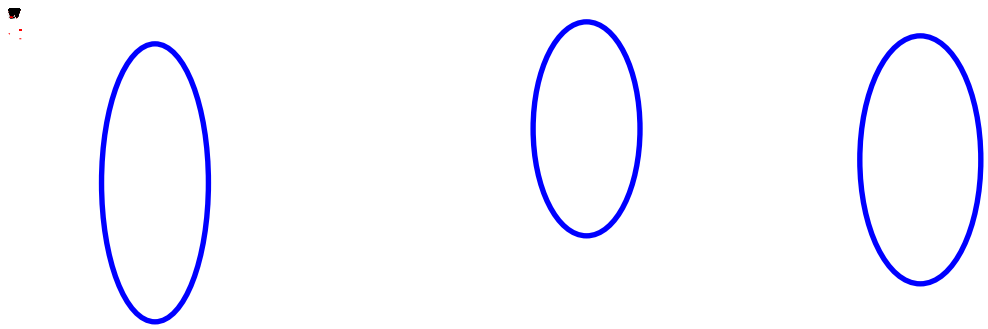

Figure 4: Solar radiation at Box Canyon and Boundary Dams

Model grid bathymetry

Table 4: Key issues in model grid bathymetry

#	Issue/Comment
13	The model segment orientation (Existing and Natural Conditions models) is off by 180 degrees, the river is flowing south instead of north. Refer to Figure 5. This will also have implications for the vegetative and topographic shade and wind direction.
14	The Natural Conditions model grid has several segments where the bottom of the grid has several layers isolated from the rest of the model grid and would result in limited water movement with adjacent segments. Example: Segment 79 is 4 layers deeper than the adjacent segments and therefore gets no circulation. See also segments 2, 7, 31, 35, 60, 76, 84, 94, and 120. Any model output statistics at these segments will be influenced by these isolated layers. This would have little impact though on the overall river temperatures.
15	The Existing Conditions model grid has several segments where the bottom of the grid has several layers isolated from the rest of the model grid and would result in limited water movement with adjacent segments. Example: Segment 88 is 4 layers deeper than the adjacent segments and therefore gets no circulation. See also segments 7, 31, 35, 73, 76, 82, 84, 92, 94, 101, 103, and 110. Any model output statistics at these segments will be influenced by these isolated layers. This would have little impact though on the overall river temperatures.

#	Issue/Comment
16	For both the Natural Conditions and Existing Conditions models, water bodies 1 and 4 had layer thickness of 1 m but water body 2 and 3 had layer thicknesses of 2 m. While 2 m vertical layers are reasonable for a reservoir, the sensitivity should be examined for a river model. 1 m layers in a river more accurately capture the channel widths over depth.
17	For the Natural Conditions model, the Manning's friction values were either set at 0.04 or 0.10. These represent the low and high ends of the range for a river model. How sensitive are the model results to the Manning's friction?
18	Figure 6 shows the channel bottom elevations for the model segments for the Existing and Natural Conditions models. The figure indicates there are some minor elevation differences as expected when switching from a zero slope reservoir to a sloping river channel. There are some large differences in the bottom elevations. These differences should be discussed and justified.

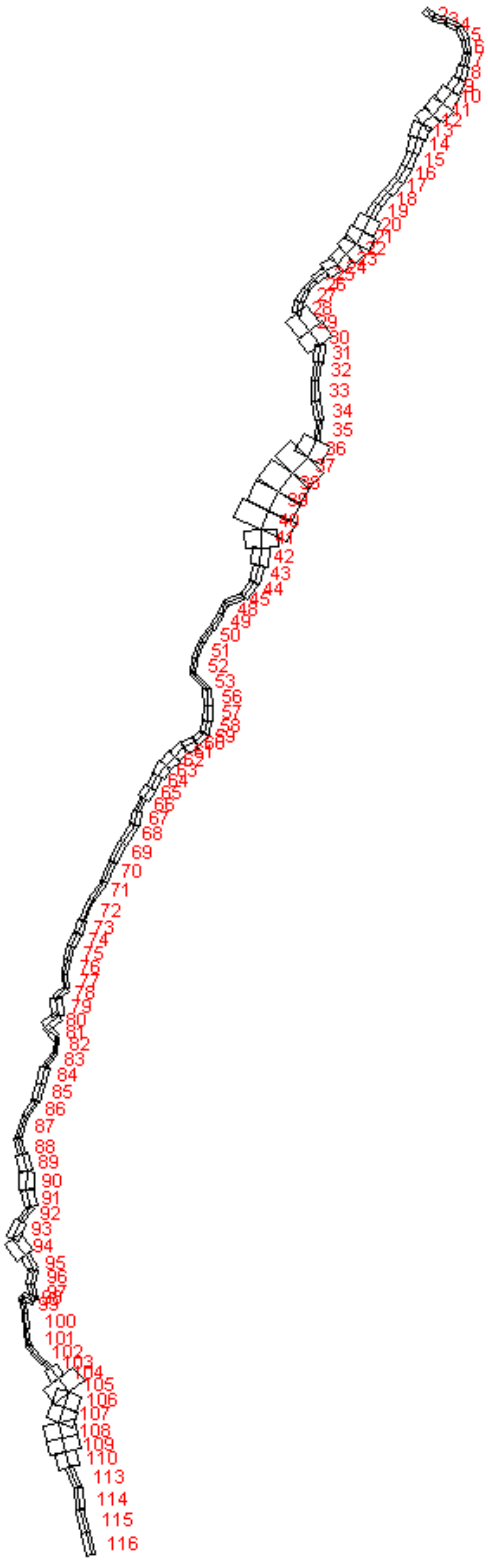

Figure 5: Model grid orientation.

Figure 6: Pend Oreille River model channel bottom elevations

Vegetative and topographic shade

Table 5: Key issues in shade inputs

#	Issue/Comment
19	Since the model segmentation is off by 180 degrees, the vegetative and topographic shade is not correct and should be fixed.
20	Segment 117 (Existing Conditions) and Segment 121 (Natural Conditions) are null segments and should have no shade characteristics but there are shade characteristics provided. Is it possible the shade characteristics are not matched correctly to the model segmentation? Null segments should have a value of 1 so the preprocessor does not identify them as errors. This does not affect the model simulation.
21	The topographic shade for the Existing Conditions and the Natural Conditions models are not the same. In some cases the Natural Conditions

#	Issue/Comment
	model has lower topographic shade angles than the Existing Conditions model. The differences in the topographic shade between the models should be discussed including if the analysis was revisited for each model.

Inflow-Outflow Boundary Conditions

A review of key issues for the inflow and outflow boundary conditions is shown in Table 6.

Table 6: Key issues in inflow-outflow boundary conditions.

#	Issue/Comment
22	The discharge temperatures for the four discharges are plotted in Figure 7. The figure indicates the temperatures for the Metaline STP, Metaline Falls STP and Selkirk HS are similar but not the same time series of monthly temperatures. The similarities and differences should be discussed.
23	Slate Creek and Flume Creek use the same temperature for the Existing Conditions and Natural Conditions models but Sullivan and Lime Creeks have lower temperatures for the Natural Conditions model. These differences should be discussed and how these Natural Conditions temperatures were developed. We assume they came from WA Ecology.
24	The Existing Conditions flow files for Lime, Slate, and Flume Creeks use a constant value for each month with daily flows changing at the start of each month. This creates a block pattern as shown in Figure 7
25	Daily distributed tributary flows for the Existing Condition averages -10 m^3/s or -1.7% of PDO River flow, which seems reasonable.
26	The distributed flow temperature file was the same as the Box Canyon Tailrace data except between Julian Day 593 and 601. The difference should be explained or the file updated.
27	The downstream boundary condition consisted of hourly water level data but the temperature data was fixed at 8 ^{o}C on the downstream boundary. How much influence does the downstream boundary condition temperature have on the temperature predictions in the last model branch below Boundary Dam? The temperature predictions may be dominated by the Dam outflows but it would be valuable to discuss the implications of the downstream boundary condition temperature.

Figure 7: Discharge temperatures, 2004 and 2005.

Figure 8: Lime Creek Flow, 2004 and 2005.

Review of parameter values used in Boundary Dam CE-QUAL-W2 model

A review was made of the coefficient values used in the Pend Oreille CE-QUAL-W2 model (Breithaupt and Khangaonkar, 2007). Table 7 summarizes issues with the comparison of model coefficients to literature values.

Table 7. W2 Model control file coefficient values.

Variable	Description	Units	Typical values*	Calibration Values
Hydrodynamics and Longitudinal Transport				
AX	Longitudinal eddy viscosity (for momentum dispersion)	m^2/sec	1	1
DX	Longitudinal eddy diffusivity (for dispersion of heat and constituents)	m^2/sec	1	1
Temperature				
CBHE	Coefficient of bottom heat exchange	Wm^2/sec	0.30	7E-8
TSED	Sediment (ground) temperature	^oC	-	12.0
BETA	Fraction of incident solar radiation absorbed at the water surface		0.45	0.45
EXH20	Extinction for water	/m	0.25-0.45	0.25
* Cole and Wells (2006)				

Table 8: Key issues in parameter values used CE-QUAL-W2 model.

#	Issue/Comment
28	The default value for CBHE is 0.30 not 7E-8. For a river though this effect is probably not important.
29	TSEDF=1 in the control file. Hence all the energy reaching the channel bottom is kept in the river. For most river models of this depth, TSEDF is not that sensitive to model results. If TSEDF is changed to less than 1 you would lose a small amount of heat, making the system cooler still – even though it may be extremely small. A sensitivity of using TSEDF=0 should be made.
30	The latitude and longitude for the model is set to 45.2647° and 122.310°, respectively. The correct value for latitude is approximately 48.9° and is 117.4° for longitude. In this application the model internally calculates the amount of short wave radiation incident on the water surface and the short wave radiation data available in the meteorological input files are not

#	Issue/Comment
	used. Because the latitude and longitude specified are incorrect, the theoretical short wave radiation and the angle of the sun calculated by the model do not correspond to the location of the water body, which can affect temperature predictions.

Summary and Conclusions

Specific comments were made throughout this review on the draft technical report and model input files for meteorological and inflow/outflow conditions. The authors of this review realize the complexity of modeling surface water bodies and the challenges that exist in compiling boundary condition data. The suggestions and comments were meant to improve the rigor of the calibration in order to assess whether the management strategies suggested for the Pend Oreille River will be successful. A total of 30 comments were made.

The following items were suggested to improve the quality of the final report and the calibration:

(1) Use the correct latitude and longitude if SROC=OFF since this affects the solar radiation and the shading angles predicted by the model.
(2) Explore how to reduce/eliminate the systematic error of -0.2^{o}C in the temperature calibration. Items that could affect this systematic bias might include adjusting wind sheltering including evaporation models, using the correct longitude/latitude, and/or exploring using measured solar radiation with theoretical computed cloud cover.
(3) The boundary condition at the International border should be looked into further. We recommend using a flow-discharge relationship (a spillway) at the downstream boundary. Even though there apparently are times when the downstream effects cross the international boundary, the spillway condition would be more appropriate during other times of the year when there is no downstream control. The Boundary Dam tailrace temperature had a larger error than in the rest of the Boundary Dam system and this might improve model-data comparisons.
(4) Explore the impact of changing the model grid by using a 1 m vertical grid resolution in Waterbodies 2 and 3 and looking at the earlier bathymetry done by Morrison Knudsen in 1997 in the upper part of the model domain. Changing to a 1 m grid is not expected to make a large change in the model calibration since these reaches exhibit weak stratification. Nonetheless, a sensitivity section showing if model results are changed would be useful. It was assumed that this was chosen because (1) there is limited stratification and (2) the model ran faster with 2 m versus 1 m vertical grid.
(5) Re-orient the model grid to be consistent with the wind and topography orientation.

Overall the model development process was sound and the calibration reasonable. The small systematic error in the temperature calibration of about -0.2^{o}C should be reviewed further to eliminate that bias.

References

Breithaupt, S. A. and Khangaonkar, T. (2007) Temperature Modeling of the Pend Oreille River, Boundary Hydroelectric Project CE-QUAL-W2 Model Calibration Report, DRAFT, prepared for Seattle City Light, Battelle—Pacific Northwest Division, Richland, Washington, May.

Appendix Preprocessor Errors and Warnings

The preprocessor error file and warnings files were reviewed for the Existing Conditions and the Natural Conditions scenarios.

Table 9: Preprocessor error file, Existing Conditions

Comment Number	Subject	Comment
1	Julian date 0.000 <= previous date of 731.957 in met1-Box.02.npt (and met2-Box.02.npt)	Blank lines at the end of the file(s). It does not influence model results.
2	Ending time 0.000 < ending simulation time [TMEND=731.000] in met1-Box.02.npt	See Comment 1
3	Julian date 0.000 <= previous date of 731.500 in met3-Boundary.02.npt (and met4-Boundary.02.npt)	See Comment 1
4	Julian date 0.000 <= previous date of 0.000 in met3-Boundary.02.npt (10 occurrences) (and met4-Boundary.02.npt)	See Comment 1
5	Ending time 0.000 < ending simulation time [TMEND=731.000] in met3-Boundary.02.npt (and met4-Boundary.02.npt)	See Comment 1
6	Starting date 1.008] > simulation start date [TMSTRT=1.000] in BoxCanyonTailraceT.2.npt	Limited impact but it should be corrected to Julian Day = 1.000
7	Julian date 305.049 <= previous date 305.077 in BoxCanyonTailraceT.2.npt	There are two temperatures for Julian Days 305.049, 305.063, and 305.077. Minimal impact but it should be fixed.
8	Julian date 669.042 <= previous date 669.042 in BoxCanyonTailraceT.2.npt	There are two temperatures for Julian Days 669.042. Minimal impact but it should be fixed.
9	Julian date 0.000 <= previous date 731.000 in qwb_Itr38.opt	See Comment 1
10	Ending time 0.000 < ending simulation time [TMEND=731.000] in qwb_Itr38.opt	See Comment 1
11	Julian date 0.000 <= previous date 731.000 in Q-MetalineSTP.npt (and Q-MFSTP.npt)	See Comment 1
12	Julian date 0.000 <= previous date 0.000	See Comment 1

Comment Number	Subject	Comment
	in Q-MetalineSTP.npt (21 occurrences) (and Q-MFSTP.npt)	
13	Ending time 0.000 < ending simulation time [TMEND=731.000] in Q-MetalineSTP.npt (and Q-MFSTP.npt)	See Comment 1
14	Julian date 0.000 <= previous date 731.000 in Q-SullivanCr.npt	See Comment 1
15	Ending time 0.000 < ending simulation time [TMEND=731.000] in Q-SullivanCr.npt	See Comment 1
16	Julian date 0.000 <= previous date 731.875 in T-FlumeCr.npt	See Comment 1
17	Ending time 0.000 < ending simulation time [TMEND=731.000] in T-FlumeCr.npt	See Comment 1
18	Julian date 305.042 <= previous date 305.042 in Q-POMine.npt	There are two temperatures for Jdays 305.042. Minimal impact but it should be fixed.
19	Julian date 669.042 <= previous date 669.042 in Q-POMine.npt	There are two temperatures for Julian Days 669.042. Minimal impact but it should be fixed.
20	Julian date 0.000 <= previous date 731.875 in T-LimeCr.npt	See Comment 1
21	Ending time 0.000 < ending simulation time [TMEND=731.000] in T-LimeCr.npt	See Comment 1

Table 10: Preprocessor warning file, Existing Conditions

Comment Number	Subject	Comment
1	Cell width [B(X,X)=4.900] < 5m which can cause stability problems (29 occurrences)	Widths are close to 5.0 m and should not pose an issue for a reservoir model except low time step, unless there are stability issues evident.
2	Initial constituent concentration = 0 for constituent 2 in water body (1-4)	Should not pose a problem as constituent 2 is a generic constituent.
3	Initial constituent concentration = 0 for constituent 3 in water body (1-4)	Should not pose a problem as constituent 3 is a generic constituent.
4	Constituent 3 (or 2) is " ON", but inflow constituent concentration is "OFF" for branch 1 (or other branches and tributaries, 22 occurrences)	Should not pose a problem as constituents 3 (and 2) are generic constituents.

Comment Number	Subject	Comment
5	100% shade for segment X (11 occurrences)	Shade values are missing from the shade file for all null segments. This should not influence model results.

Table 11: Preprocessor error file, Natural Conditions

Comment Number	Subject	Comment
1	Upstream selective withdrawal bottom layer [KBUSP=49] >= segment bottom active layer [KB=31] for spillway 1	Selective withdrawal layers are outside the active grid. This should not influence results but should be corrected.
2	Downstream selective withdrawal bottom layer [KBDSP=49] >= segment bottom active layer [KB=33] for spillway 1	Selective withdrawal layers are outside the active grid. This should not influence results but should be corrected.
3	Upstream selective withdrawal bottom layer [KBUSP=49] >= segment bottom active layer [KB=32] for spillway 2	Selective withdrawal layers are outside the active grid. This should not influence results but should be corrected.
4	Downstream selective withdrawal bottom layer [KBDSP=49] >= segment bottom active layer [KB=36] for spillway 2	Selective withdrawal layers are outside the active grid. This should not influence results but should be corrected.
5	Upstream selective withdrawal bottom layer [KBUSP=49] >= segment bottom active layer [KB=34] for spillway 3	Selective withdrawal layers are outside the active grid. This should not influence results but should be corrected.

Table 12: Preprocessor warning file, Natural Conditions

Comment Number	Subject	Comment
1	Cell width [B(X,X)=4.900] < 5m which can cause stability problems (40 occurrences)	Widths are close to 5.0 m and should have limited if any impact on the river model.
2	Cell width [B(39,4)=46.600] < or > 7x width [B(39,5)=5.800] (47 occurrences)	Large width difference between segments and layers may result in model instabilities. 26 occurrences are between

Comment Number	Subject	Comment
		segments 116 and 117 (Br 6, WB4).
3	100% shade for segment X (11 occurrences)	Shade values are missing from the shade file for all null segments. This should not influence model results, but its not good modeling practice.
4	Initial constituent concentration = 0 for constituent 2 in water body (1-4)	Should not pose a problem as constituent 2 is a generic constituent.
5	Initial constituent concentration = 0 for constituent 3 in water body (1-4)	Should not pose a problem as constituent 3 is a generic constituent.
6	Constituent 3 (or 2) is " ON", but inflow constituent concentration is "OFF" for branch 1 (or other branches and tributaries, 22 occurrences)	Should not pose a problem as constituents 3 (and 2) are generic constituents.

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