Idaho/Washington Pend Oreille River CE QUAL W2 Model: Seattle District Corps of Engineers Comments October 25, 2007

Main Issues with Current CE QUAL W2 Model

- Model Uncertainty
- Existing Errors in Model
- Representativeness of Data and Compliance Metrics
- Travel Time
- Boundary Conditions
- Sensitivity Analysis
- Model Uncertainty and Compliance Determination
- TMDL Analysis

Model Uncertainty

- Level of Uncertainty
  - Model error
  - Upstream boundary model error and sensitivity
  - Lake stage for Natural Condition Scenario
  - Other sources of uncertainty include flow and temperature at boundary conditions, forcing functions, model parameters and channel bathymetry
- Assumption of Model Certainty
  - Little discussion of model uncertainty in analysis or TMDL
  - Detection of model differences down to 0.3C is not supported by quantitative evaluation of predictive error or sensitivity analysis
  - Model in error at ID/WA border in May due to upstream boundary condition
- Overview of confidence limits for model
  - The 90 percent confidence limit of model estimates of the hourly observed water temperatures at Albeni Falls Dam during 2004 (April-September) was greater than 1.0 C
- Errors Introduced at Boundary Propagate Through Model
  - Travel Time
    - Errors introduced at boundary will propagate through system at different rates due to differences in travel times
    - When models have different travel times the variance of the Model Error will not cancel out and must be accounted for when comparing two models runs

Existing Errors in Model

- Hydrology
  - Too much flow for Existing conditions during summer
  - Error has been corrected by PSU
- Lake Stage
  - Natural Condition Scenario Lake Stage too low (2 to 3 feet) during July and August when compared to historic data
  - A difference of 2 to 3 feet results in a doubling of river depth at boundary
- Others
  - Model inputs for natural conditions

Representativeness of Data and Compliance Metrics

- Use of Surface and Bottom Cells for Compliance
  - Surface and bottom cells are not representative of river conditions
    - Volume weighted data are more representative
    - Isolated bottom cells should not be used for compliance
- Use of instantaneous metric for compliance is flawed
  - Does not account for travel time differences
  - Does not differentiate between differential transport of externally generated thermal loads and internal changes to thermal load
  - Any model that compares scenarios with different travel times will find differences between model runs for a specific date and time
- Use of Alternative Data for Compliance
  - Use of Volume weighted daily average and daily maximum
  - Use of statistics to interpret data (i.e. use of 95^{th} percentile of data)
  - Incorporating model error into compliance (i.e. 0.3C + ?)
  - Willamette TMDL
- Idaho 10% Frequency Exceedance Policy and 2002 Memo

Travel Time Issues

- Travel Time Needs to be Accounted for in Analysis
  - Natural vs. Existing scenarios will transport externally generated thermal loads at different rates through system
    - The difference in externally generated load transport does not constitute a change in thermal loading to the Pend Oreille River
    - Difficult to compare changes in temperatures resulting from upstream boundary seiching or rapid cooling due to weather
  - Errors introduced at upstream boundary will propagate through system at different rates for Natural vs. Existing scenarios

Boundary Condition Issues

- Upstream Boundary Condition in Lake Pend Oreille
  - Model is very sensitive to upstream boundary conditions
  - Model error greatest at upstream boundary due to sparseness of data
  - Lake was not modeled which results in a decoupling of the lake from the river in existing model and produces greater model error at boundary segments
  - Lake level not accurately modeled for natural scenario
- Boundary Condition at Albeni Falls (Box Canyon Model)
  - Modeled data vs. measured data at Albeni Falls Dam for Existing Scenario (measured) and Natural Scenario (modeled)
  - Travel time and error propagation

Sensitivity Analysis

- Sensitivity Analysis of Model is Needed
  - Model inputs such as lake stage, flow, boundary temperatures, forcing functions, roughness and others need to have sensitivity analysis to determine impact of each on model results
- Corps of Engineers Sensitivity Analysis
  - Increased lake stage in summer by 2 to 3 feet for Natural Scenario to better reflect historical conditions
    - Resulted in an up to 0.5C temperature difference between two Natural Scenario model runs in July and August, larger difference than compliance metric of 0.3C
  - Corps believes there are ways to identify internal and external sources of thermal load

Model Uncertainty and Compliance Determination

- Assumption of Model Certainty for Compliance
  - Analysis and TMDL assume certainty of model estimates of natural and existing temperatures
  - Detection tolerance down to 0.3C is not supported by evaluation of predictive error of model or sensitivity analysis
- Model is not Perfect
  - Model is an estimate of natural and existing conditions
  - Errors have been found in model
  - Critical model inputs for Natural Condition Scenario are uncertain: lake stage, natural hydrograph, natural channel bathymetry etc...
- Sensitivity Analysis
  - Perform sensitivity analysis to verify range of simulated thermal properties.
  - Perform quantitative analysis of model uncertainty to determine realistic/verifiable detection limits for compliance to account for model uncertainty

TMDL Analysis

- Overview
  - TMDL and analysis focus on non-compliance
  - Very little analysis on thermal enhancement from Albeni Falls
  - Albeni Falls has resulted in a net cooling when compared to hypothetical natural conditions
  - Non-compliance events are associated with seiching and cold fronts that result in rapid cooling of the shallow natural condition compared to the deeper existing condition and the different transport rate of this introduced cooler water
- Loadings
  - TMDL should be a loading analysis and quantify benefits and detriments to the thermal loading in the Pend Oreille River
  - Are there ways to look at benefits of Albeni Falls on thermal load in Pend Oreille River