Preserving the CE-QUAL-W2 Legacy Roundtable

Park City, Utah

July 10-12, 2007

Subject: Conference Summary

Tuesday, 10 July 2007

Those in attendance stood to introduce themselves. Jerry Miller and Pat Deliman introduced the purpose of the conference. Jerry raised the main questions that he hoped this conference would address. Will CE-QUAL-W2 be the model of the future or will it represent greater than 30 years of research scrapped? Why do water managers need W2? What can the model do now? What do we need to do in the future? How do we sell it to managers who control funds? Specifically, Jerry stated the purpose of the meeting to be to pass on institutional memory, to prioritize future development, to collaborate, and to share important testing models already built. He indicated that the purpose and need of CE-QUAL-W2 includes hydrodynamic studies of dam operations, DO issues, eutrophication issues, TMDL Watershed Processes vs. Reservoir Water Quality Assessment, and the possible link between blue green algae and Parkinson's disease.

Two lists were made in response to this introduction. One list stated the overriding issues of the conference and the other stated the technical wish list for the future development of CE-QUAL-W2. These lists are shown below.

Overriding Issues

1. Model Keeper
2. Regular Meetings (Interagency – TVA, EPA, etc)
3. Sharing models for research
4. Monitoring Document

Technical Wish List

1. Vertical migration of algae
2. Particle tracking – IBM, algae, oil spills
3. Sediment/Contaminant transport
4. Resuspension of contaminants
5. Sediment diagenesis
6. Simultaneous solution of branch water surfaces
7. Investigate time step restrictions in riverine applications
8. Adjustable evaporative wind speed coefficients
9. Implement different wind stress drag coefficient formulations

10. W2- needs to address water quality, water supply, and ecosystem restoration
11. Parallel version / domain decomposition version
    a. 3.2 Release, 3.5 Update
    b. Branch x Branch – Wal-Mart version
12. Select – Update W2 with latest version
13. Nutrient storage compartments within algae
14. Better time management relevant to standard date stamps (i.e. clock symbol, status bar)
15. P-Decide / Port Decide to determine how downstream objectives are going to be met in terms of volume, temperature, and water quality.
    a. Optic port decision, day by day
    b. Long range planning
    c. Does a port above the water surface continue to discharge?
16. Can EFDC handle large reservoirs with stratifications?
17. Withdrawal when port above water surface elevation or below sediment
18. W2 needs to be able to dry a branch and keep running
19. Document on monitoring and data collection
20. Fe, Mn, etc. - added capability, etc.
21. Example test cases 10-20
22. Monitoring at each outlet – W2 release water quality output at separate outlets
23. Decouple hydro and water quality where direct couplings not required
24. Build one water body as 3-D
25. Time integration fluxed between water bodies to conserve mass
26. Master code – code management tool
27. Testing new code on previous data sets
28. Expanded capabilities for W2 (watershed loadings, multiple reservoirs, res. regulation)
29. Tap into automatic data retrieval systems, especially for preliminary models

The morning session discussed evaporation, wind, and hydrodynamics. Nick Williams presented a case study for Lake Powell where he used adjustable evaporative wind speed coefficients. Adjustable coefficients yielded a more accurate representation of the epilimniom and a closer estimate of annual average evaporation. Nick also presented a Lake Mead Case Study illustrating increased mixing caused by wind and concluded that the model is too sensitive to high winds. He recommended including the option of using different wind drag coefficients in the model.

Ed Buchak shared his case study on Cayuga Lake and indicated that he obtained a much better representation of evaporation, wind, and hydrodynamics by changing the wind stress drag equation in the source code. The Jin Wu equation assumed more drag with higher wind speeds and the Neumann equation showed more drag with lower wind speeds.

The afternoon session discussed algal succession. Ed Buchak discussed particle tracking and algal succession. He discussed a proposed chemical and oil spill module that has the

advantage of simulating long river lengths with multiple bottom slopes and of reproducing side slopes more accurately than 3-D models. A particle tracking case study simulated an oil spill and predicted the location of oil shore deposits quite accurately. He also discussed algal succession and the progress that has been made so far in implementing the vertical movement of algal groups into W2. Phosphorous storage compartments have been created, but the conditions for entering and leaving storage have yet to be addressed.

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The morning session addressed Pre/Post Processing. Jim Nelson discussed pre-processing using Watershed Modeling System (WMS). Digital Terrain Models can be used to construct bathymetry files and generate storage capacity curves. Using WMS, Nick Williams reconstructed the entire Lake Powell bathymetry in a couple of weeks. WMS currently supports CE-QUAL-W2 version 3.2.

Dottie Tillman discussed some of the pre-processing tools provided with the release version of CE-QUAL-W2. The Pre.exe pre-processing tool can be used to make sure the input files are constructed properly. Another tool can be used to view bathymetry geometry to verify that the bathymetry file makes sense. The water balance tool can also be used to make sure the inflow files are correct.

Gary Hauser discussed a proprietary pre-processing tool called W2i which can also be used to verify bathymetry and other input files. Using the new build option you can create a bathymetry and control file from a spreadsheet containing segment widths, lengths, and azimuths. Other input files are created using DeGray template inputs. This option lets you create a running base model that you can modify and improve one file at a time. W2i will also find the nearest meteorological stations to your reservoir and use that to create the meteorological data input file.

Scott Wells discussed the history of CE-QUAL-W2 and went over his wish-list for improving the CE-QUAL-W2 model. He talked too about methods to improve the river model in CE-QUAL-W2. He also discussed wind uncertainty – a topic of the first day – and how its impact on model calibration was significant in the Long Lake section of the Spokane River in Washington state.

The next discussion item was post-processing. Ahmad Salah discussed the linkage between a distributed overland flow model, GSSHA, and CE-QUAL-W2. Using WMS, the overland flow from the GSSHA model output can be used as input to CE-QUAL-W2. The models can be run stochastically to obtain a range of output values rather than a single deterministic value.

Gary Hauser discussed a proprietary post-processing tool called Animation and Graphics Portfolio Manager (AGPM). AGPM can be used to create animations and to make the model calibration process easier. Certain hooks must be incorporated into CE-QUAL-

W2 for AGPM to work. The program can plot active constituents, derived constituents, flux rates, horizontal velocity, vertical velocity, and water elevation as animations, profiles, time-series, dam releases, time-depths, zone volumes, or average constituents.

The afternoon session addressed sediment scouring and phosphorous genesis with algal succession. Jerry Miller discussed the behavior of phosphorous and blue-green algae in the Jordanelle and Deer Creek Reservoir system.

Nick Williams talked about modeling dissolved oxygen in Lake Powell. He showed how the W2 model has produced useful results of physical processes even though the processes were not explicitly modeled. Empirical equations for CBOD were created and tested in the Lake Powell model and modified as needed until observed dissolved oxygen deficit patterns were reproduced in the model.

Joan Klipsch gave an overview of Res-Sim (formerly HEC-5) which is designed to simulate reservoir systems. She talked about the possibility of linking Res-Sim with CE-QUAL-W2 to simulate the behavior of a multiple reservoir system.

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Nick Williams talked about selective withdrawal and suggested two selective withdrawal modifications to W2. First, structures are fixed in the current W2 framework. On structures such as those at Flaming Gorge and soon at Lake Powell outlet elevations can be adjusted. Allowing outlet elevations to vary with time would give the model the ability to better model reservoirs with adjustable outlets. The second modification involves adding equations for determining flow distribution through a multiple intake, single wet well. Hoover Dam, with four single wet well towers and two intakes on each tower is one example. Including Howington's equations in W2 would allow multiple intake, single wet well applications to determine flow distribution among multiple intakes.

Gary Hauser discussed reaeration. He mentioned several different aeration methods and the W2 modeling approach for each method. A forebay curtain can be modeled with a W2 internal weir. Intake plates can be addressed by changing the W2 intake elevation. Surface withdrawal can be addressed with the W2 surface outlet. Line diffusers can be modeled using W2 with the Bubble Plume Submodel (BUBBLEP) and BPi. BUBBLEP is a standalone model and subroutine in W2. Surface water pumps can be simulated by using W2 with near surface withdrawal, or by using 3D Fluent and SWPi. Turbine venting can be simulated with the Discrete Bubble Model (DBM) with W2 release DO. DBM is a standalone model that simulates bubble transport and tracks individual bubbles rising in water. Finally, tailwater weirs can be addressed using ADYN-RQUAL with weir aeration IBC.

Scott Wells discussed the macrophyte model in CE-QUAL-W2 and the new zooplankton algorithm. He discussed a case study on Lake Roosevelt (co-author Michael McKillip)

where the final result was to provide a fish bioenergetics model built on the hydrodynamic, temperature, algae and zooplankton models. The zooplankton model matched zooplankton data well even though the data varied over 4 orders of magnitude.

The last session addressed monitoring. Steve Ashby indicated that the best monitoring approach is to understand your physical system first, identify your purposes and needs, and then set up a preliminary W2 model. Jerry Miller discussed other monitoring steps. In order to set up a preliminary model, you have to identify the data you already have available and determine what data is meaningful. Hourly records of outflow and water surface elevations at structures are typically available, and with that you can back calculate inflows. It's important to establish your data quality objectives and then use those objectives to determine what needs to be monitored. Nutrients from tributaries can be distributed according to the hydrograph. He emphasized the need for a W2 monitoring manual that describes this process.

Clark Barlow spent a few minutes discussing the CE-QUAL-W2 wiki site. This site was designed to gather and record the information shared in the conference and to facilitate the ongoing exchange of knowledge that might benefit CE-QUAL-W2 users everywhere. Currently, anyone can edit the wiki site, though you do have to log in to upload pictures or files, but if the site is abused the system is backed up and the security settings and user privileges can easily be changed.

A CE-QUAL-W2 steering committee was organized with representatives and alternates chosen from each participating organization. The proposed committee is as follows:

Merlynn Bender, Nick Williams (USBR)
Barry Bunch, Dotty Tillman (ERDC)
Scott Wells, Jim Nelson (University)
Ed Buchak, Mark Dortch (Private)