# Memorandum

August 31, 2004

To: Jim Bloom and Greg Aldrich, Oregon Department of Environmental Quality

From: Scott Wells, Robert Annear, and Chris Berger, Dept. of Civil and Environmental Engineering, Portland State University

Re: Updates to the Willamette River model calibration

In early 2004 we provided Oregon Department of Environmental Quality (ODEQ) with model files for the different sections of the Willamette River model listed in Table 1. In February, 2004 we posted the model files from PSU, ODEQ and the U.S. Geological Survey (USGS) on the website http://www.ce.pdx.edu/w2/?projects_willamette_river.html.

**Table 1: Willamette River TMDL model sections developed by Portland State University**

| Model Description | RM Range |
|---|---|
| Lower Willamette River (includes Columbia River) | RM 0.0 to 26.5 |
| Middle Willamette River | RM 26.5 to 85.0 |
| Upper Willamette River | RM 85.0 to 187.0 |
| Coast Fork Willamette River and Middle Fork Willamette River (includes Row River and Fall Creek) | CF RM 0.0 to 28.9<br>MF RM 0.0 to 16.5 |
| Lower Clackamas River | RM 0.0 to 26.5 |
| McKenzie River | RM 0.0 to 60.8 |
| Long Tom River | RM 0.0 23.7 |

Since February, 2004 we have been working on writing 3 reports: the data report (documenting the model development), the calibration report (documenting the model calibration for both years), and the model scenario report (documenting the results of 21 model scenarios run during the fall of 2003). During that time we identified some areas where model changes could be made to improve their calibration relative to data sets collected in 2001 and 2002.

Changes have been made to all of the models except the Coast and Middle Forks of the Willamette River. The draft calibration report posted on the website presents result that already incorporate some of these changes. An updated report will posted in the next few days. The purpose of this memo is document the specific changes to each of the models and why those changes were made. Additionally, some overall comments are made regarding the impact the changes have on the model scenarios already run or which are in-progress. The updated model files are to be posted on the website as a separate table of downloaded files in a few days. The changes to each model piece are discussed below and an appendix is included showing changes in model-data error statistics for model changes on the McKenzie River.

**Lower Willamette River model**

Changes to the model files for the Lower Willamette River model are described in Table 2 and were applied to both years unless specified in the table.

**Table 2: Lower Willamette River model file changes for 2001 and 2002**

| File | Difference between model provided to ODEQ and current model | Reason for change |
|---|---|---|
| BeaverWL.npt | Negligible changes before September 30, 2001, data after 9/30/2001 was refined and continues past October 30, 2001. For 2002 the water level data are the same except going to one more decimal place. | Used updated and more complete USGS data set. |
| WashougalQ.npt | Flows were recalculated, about 10% lower | Based on updated flow correlation. |
| Bth_colr.npt | Segment 118 to 347 (main stem Columbia River) decreased Manning's n from 0.025 to range of 0.022 to 0.024, Segment 350 to 461, side channels increased Manning's n from 0.025 to 0.035 | Improved water level and temperature calibration |
| Bth_will.npt | Changed Manning's n from 0.025 to range of 0.024 to 0.030 | Improved water level and temperature calibration |

## Middle Willamette River model

Changes to the model files for the Middle Willamette River model are described in Table 3 and were applied to both years unless specified in the table.

**Table 3: Middle Willamette River model file changes for 2001 and 2002**

| File | Difference between model provided to ODEQ and current model | Reason for change |
|---|---|---|
| Wsc.npt | The wind sheltering coefficient was decreased on Julian Day 200 for Branches 4 to 6 for the 2002 model from 0.30 to 0.10. | Improved calibration for temperature |
| Btha.npt | Manning's friction increased for most segments from 0.020 to 0.023 or 0.040 | Improved calibration for temperature and water level |
| Bthb_adj.npt | Manning's friction increased for all segments from 0.02 to 0.04 | Improved calibration for temperature and water level |
| W2_con.npt | Model start day is later, initial temperature is higher, sediment temperature is 1.5 $^{o}$C higher, and the light extinction is lower for 2001 model. An additional maximum time step limitation was added, sediment temperature was decreased for furthest downstream branch, and the light extinction is lower for the 2002 model. | Improved calibration for temperature and water level |
| Wilsonville WWTPT.npt | Duplicate value removed at Julian Day 301.045 for the 2001 model. | Error fixed |
| SalemT.npt | Temperature increase adjusted at Julian Day 296.375, localized to one hour, for the 2001 model. | Error fixed |

## Upper Willamette River model

Changes to the model files for the Upper Willamette River model are described in Table 4 and were applied to both years unless specified in the table.

**Table 4: Upper Willamette River model file changes for 2001 and 2002**

| File | Difference between model provided to ODEQ and current model | Reason for change |
|---|---|---|
| qdt_br9_calib_fn5.npt | Branch 9, water balance flow as a distributed tributary was updated for 2001 only. | Improved model calibration |
| qdt_br10_calib_fn5.npt | Branch 10, water balance flow as a distributed tributary was updated for 2001 only. | Improved model calibration |
| qdt_br11_calib_fn5.npt | Branch 11, water balance flow as a distributed tributary was updated for 2001 only. | Improved model calibration |
| qdt_br12_calib_fn5.npt | Branch 12, water balance flow as a distributed tributary was updated for 2001 only. | Improved model calibration |
| qdt_br13_calib_fn5.npt | Branch 13, water balance flow as a distributed tributary was updated for 2001 only. | Improved model calibration |

## Clackamas River model

Changes to the model files for the Clackamas River model are described in Table 5 and were applied to both years unless specified in the table.

**Table 5: Clackamas River model file changes for 2001 and 2002**

| File | Difference between model provided to ODEQ and current model | Reason for change |
|---|---|---|
| W2_con.npt | Maximum time step decreased after Julian Day 101, Spillway coefficients were modified for spillway at end of model for 2001 model, no changes for 2002 model | Improved model calibration |
| Bth1.npt | Increased Manning's friction from Segment 91 to 148. Before Segment 80 some segment layers were narrowed, Model segments 122 to 142 had several model layers which were widened | Improved model calibration |

## Long Tom River model

Changes to the model files for the Long Tom River model are described in Table 6 and were applied to both years unless specified in the table.

**Table 6: Long Tom River model file changes for 2001 and 2002**

| File | Difference between model provided to ODEQ and current model | Reason for change |
|---|---|---|
| W2_con.npt | Spillway 4 from Branch 1 to Branch #2 was adjusted slightly (0.4 m), the longitudinal eddy diffusivity was adjusted for the dye study for the 2002 model only | Improved model calibration |

| File | Difference between model provided to ODEQ and current model | Reason for change |
|---|---|---|
| Wsc.npt | Wind sheltering was modified between Julian Day 150 and 280 for the 2001 model only | Improved model calibration |
| Qgt.npt | Weir gate height were decreased for Julian Day 162 to 178 for Old Long Tom Channel for the 2001 model only | Improved model calibration |
| C_dye_stroda.npt | Dye slug on Julian Day 231.500 was increased for the 2002 model only | Error fixed |
| C_dye_alvadore.npt | Dye slug on Julian Day 127.271 was increased for the 2002 model only | Error fixed |
| C_dye_ferguson.npt | Dye slug on Julian Day 128.333 was increased for the 2002 model only | Error fixed |

**McKenzie River**

Changes were made to the bathymetry files to improve channel width and dye study results. The changes also resulted in improved temperature model-data errors statistics (See Appendix). No changes to water balance files and as a result this resulted in slightly worse hydrodynamic model-data error statistics but remained small. The bathymetry files were the same between the 2001 and 2002 models so changes made to the bathymetry files with the current model(s) applied to both years as well.

Changes to the model files for the McKenzie River model are described in Table 7 and were applied to both years unless specified in the table.

**Table 7: McKenzie River model file changes for 2001 and 2002**

| File | Difference between model provided to ODEQ and current model | Reason for change |
|---|---|---|
| Bth1aa.npt | Segments were narrowed in upper layers, less so in lower layers | Changes were made to improve width and dye study results. The changes also improved temperature results. |
| Bth2aa.npt | Bottom two layers were narrowed at 2 segments and layers above were narrowed. Last 13 segment all layers were widened. | |
| Bth3.npt | Bottom three layers were widened and layers above were narrowed | |
| Bth4aa.npt | Upper layers were narrowed and lower layer were narrowed or widened to smooth width transitions | |
| Bth5ba.npt | Layers above layer 20 were narrowed. Manning's n friction values were reduced from 0.065 to 0.052 for Segments 236 to 334 | |

The majority of the changes to the bathymetry files concerned higher layers in the model to adjust them to better match time-of-travel studies and channel widths measured in surveys conducted by USGS and geographical system analyses conducted by ODEQ. The flows associated with these time-of-travel studies and channel widths along the McKenzie River were higher than some of flows in 2001 and 2002. The result was that the adjustments made to the model were made mostly in the higher model grid layers. The water balance flows were not adjusted indicating there was negligible influence on the travel times in 2001 and 2002.

**Discussion of impact**

None of these model changes resulted in substantive model changes. These were merely fine-tuning at a couple locations where small issues were evident. This could result in model alternatives at a few locations being somewhat different. We suggest that DEQ run a couple model runs to test and see if there are any notable differences in results that they have used for their TMDL. We do not expect to see any notable differences.

Model development and refinement is common and will continue. There are still areas of the model that can be improved with better quality boundary condition and channel morphology data.

Please let us know if it is acceptable to post this memo and the associated revised files on the web site for outside review.

## Appendix: McKenzie River, changes in model-data error statistics due to model improvements

| Flow, 2001 | | | | Model provided to ODEQ, Feb-2004 | | | Current Model, Aug-2004 | | |
|---|---|---|---|---|---|---|---|---|---|
| Gage ID | RM | Model Segment | Sample size, N | Mean Error, $m^3/s$ | Absolute ME, $m^3/s$ | RMS Error, $m^3/s$ | Mean Error, $m^3/s$ | Absolute ME, $m^3/s$ | RMS Error, $m^3/s$ |
| USGS 14159500 | 60.39 | 4 | 7008 | 0.00 | 0.03 | 0.07 | 0.00 | 0.03 | 0.07 |
| USGS 14162500 | 44.56 | 108 | 7008 | 0.00 | 0.27 | 0.46 | -0.02 | 0.26 | 0.42 |
| USGS 14163150 | 34.11 | 177 | 7008 | -0.02 | 0.22 | 0.51 | -0.03 | 0.21 | 0.50 |
| USGS 14163900 | 24.97 | 240 | 6996 | -0.01 | 0.25 | 0.49 | -0.04 | 0.30 | 0.62 |
| **Water Level, 2001** | | | | **Model provided to ODEQ, Feb-2004** | | | **Current Model, Aug-2004** | | |
| Gage ID | RM | Model Segment | Sample size, N | Mean Error, m | Absolute ME, m | RMS Error, m | Mean Error, m | Absolute ME, m | RMS Error, m |
| USGS 14159500 | 60.39 | 4 | 7008 | 0.00 | 0.02 | 0.04 | -0.01 | 0.03 | 0.04 |
| USGS 14162500 | 44.56 | 108 | 7008 | 0.01 | 0.01 | 0.02 | -0.08 | 0.08 | 0.08 |
| USGS 14163150 | 34.11 | 177 | 7008 | 0.04 | 0.04 | 0.04 | -0.02 | 0.02 | 0.03 |
| USGS 14163900 | 24.97 | 240 | 6996 | 0.25 | 0.25 | 0.25 | 0.16 | 0.16 | 0.16 |

| Flow, 2002 | | | | Model provided to ODEQ, Feb-2004 | | | Current Model, Aug-2004 | | |
|---|---|---|---|---|---|---|---|---|---|
| Gage ID | RM | Model Segment | Sample size, N | Mean Error, $m^3/s$ | Absolute ME, $m^3/s$ | RMS Error, $m^3/s$ | Mean Error, $m^3/s$ | Absolute ME, $m^3/s$ | RMS Error, $m^3/s$ |
| USGS 14159500 | 60.39 | 4 | 10175 | 0.00 | 0.05 | 0.29 | 0.00 | 0.05 | 0.29 |
| USGS 14162500 | 44.56 | 108 | 10174 | -0.02 | 0.51 | 1.14 | -0.03 | 0.52 | 1.21 |
| USGS 14163150 | 34.11 | 177 | 10174 | -0.04 | 0.95 | 2.13 | -0.05 | 0.94 | 2.18 |
| USGS 14163900 | 24.97 | 240 | 10174 | -0.03 | 0.69 | 2.04 | -0.06 | 1.17 | 4.02 |
| **Water Level, 2002** | | | | **Model provided to ODEQ, Feb-2004** | | | **Current Model, Aug-2004** | | |
| Gage ID | RM | Model Segment | Sample size, N | Mean Error, m | Absolute ME, m | RMS Error, m | Mean Error, m | Absolute ME, m | RMS Error, m |
| USGS 14159500 | 60.39 | 4 | 10175 | 0.06 | 0.10 | 0.17 | 0.06 | 0.10 | 0.16 |
| USGS 14162500 | 44.56 | 108 | 10174 | 0.05 | 0.06 | 0.12 | 0.00 | 0.12 | 0.16 |
| USGS 14163150 | 34.11 | 177 | 10174 | 0.00 | 0.04 | 0.04 | -0.09 | 0.09 | 0.13 |
| USGS 14163900 | 24.97 | 240 | 10174 | 0.23 | 0.23 | 0.25 | 0.13 | 0.13 | 0.17 |

| Continuous Temperature, 2001 | | | | Model provided to ODEQ, Feb-2004 | | | Current Model, Aug-2004 | | |
|---|---|---|---|---|---|---|---|---|---|
| Site ID | RM | Model Segment | Sample size, N | ME, °C | AME, °C | RMS, °C | ME, °C | AME, °C | RMS, °C |
| USGS 14159500 | 60.39 | 4 | 6982 | 0.06 | 0.10 | 0.16 | 0.06 | 0.10 | 0.16 |
| LASAR 26770 | 50.99 | 65 | 6638 | -0.43 | 0.62 | 0.69 | -0.37 | 0.57 | 0.65 |
| USGS 14162500 | 44.56 | 108 | 7104 | -0.45 | 0.56 | 0.65 | -0.42 | 0.53 | 0.62 |
| LASAR 28504 | 40.74 | 132 | No data | | | | | | |
| LASAR 25610 | 35.72 | 167 | 5711 | -0.51 | 0.88 | 1.05 | -0.43 | 0.71 | 0.85 |
| LASAR 25612 | 30.38 | 203 | 5715 | -0.46 | 0.90 | 1.07 | -0.25 | 0.72 | 0.86 |
| LASAR 26758 | 28.45 | 215 | 4678 | -0.46 | 0.84 | 1.03 | -0.34 | 0.65 | 0.80 |
| USGS 14163900 | 24.97 | 240 | 3284 | -0.47 | 0.74 | 0.94 | -0.38 | 0.61 | 0.76 |
| LASAR 25614 | 17.90 | 285 | 5709 | -0.41 | 0.59 | 0.74 | -0.31 | 0.61 | 0.74 |
| LASAR 26757 | 15.61 | 299 | 4825 | -0.56 | 0.69 | 0.86 | -0.44 | 0.66 | 0.81 |
| LASAR 29645 | 10.40 | 333 | No data | | | | | | |
| LASAR 10376 | 3.38 | 378 | No data | | | | | | |
| LASAR 25611 | 35.78 | 402 | 5712 | -0.45 | 0.83 | 0.98 | -0.37 | 0.65 | 0.77 |
| LASAR 25613 | 30.27 | 431 | 5714 | -0.68 | 0.96 | 1.16 | -0.59 | 0.81 | 0.99 |

| Continuous Temperature, 2002 | | | | Model provided to ODEQ, Feb-2004 | | | Current Model, Aug-2004 | | |
|---|---|---|---|---|---|---|---|---|---|
| Site ID | RM | Model Segment | Sample size, N | ME, °C | AME, °C | RMS, °C | ME, °C | AME, °C | RMS, °C |
| USGS 14159500 | 60.39 | 4 | 10271 | 0.04 | 0.10 | 0.16 | 0.04 | 0.10 | 0.16 |
| LASAR 26770 | 50.99 | 65 | 5856 | -0.19 | 0.31 | 0.38 | -0.13 | 0.32 | 0.39 |
| USGS 14162500 | 44.56 | 108 | 10270 | 0.32 | 0.40 | 0.50 | 0.33 | 0.40 | 0.50 |
| LASAR 28504 | 40.74 | 132 | 3385 | 0.33 | 0.40 | 0.49 | 0.34 | 0.40 | 0.50 |
| LASAR 25610 | 35.72 | 167 | 5668 | 0.20 | 0.67 | 0.84 | 0.28 | 0.58 | 0.73 |
| LASAR 25612 | 30.38 | 203 | No data | | | | | | |
| LASAR 26758 | 28.45 | 215 | 5666 | 0.04 | 0.73 | 0.87 | 0.16 | 0.57 | 0.71 |
| USGS 14163900 | 24.97 | 240 | 10270 | 0.12 | 0.57 | 0.72 | 0.15 | 0.47 | 0.60 |
| LASAR 25614 | 17.90 | 285 | No data | | | | | | |
| LASAR 26757 | 15.61 | 299 | 4870 | -0.02 | 0.50 | 0.63 | -0.03 | 0.42 | 0.53 |
| LASAR 29645 | 10.40 | 333 | 5857 | -0.04 | 0.55 | 0.68 | -0.09 | 0.52 | 0.64 |
| LASAR 10376 | 3.38 | 378 | 5715 | 0.12 | 0.55 | 0.70 | 0.07 | 0.51 | 0.63 |
| LASAR 25611 | 35.78 | 402 | 5669 | 0.32 | 0.68 | 0.87 | 0.40 | 0.59 | 0.76 |

| Continuous Temperature, 2002 | | | | Model provided to ODEQ, Feb-2004 | | | Current Model, Aug-2004 | | |
|---|---|---|---|---|---|---|---|---|---|
| Site ID | RM | Model Segment | Sample size, N | ME, $^{o}$C | AME, $^{o}$C | RMS, $^{o}$C | ME, $^{o}$C | AME, $^{o}$C | RMS, $^{o}$C |
| LASAR 25613 | 30.27 | 431 | 5667 | 0.06 | 0.73 | 0.89 | 0.14 | 0.62 | 0.76 |