CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 4.5

User Manual:
Part 5 – Model Utilities

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Preface

This manual documents the two-dimensional, laterally averaged, hydrodynamic and water quality model CE-QUAL-W2. As in all complex models, there have been many contributors. This re-write of the User Manual was based on prior User Manuals: Environmental and Hydraulic Laboratories (1986), Cole and Buchak (1995) Version 2, and Cole and Wells (2000) Version 3.0 through Cole and Wells (2019) Version 4.1. Hence, one can think of the primary author as merely an editor of past documents, rather than reflecting one person's sole authorship. This updated User Manual contains numerous corrections, new figures, new sections, additional documentation, and improvements in organization and presentation of information compared to Cole and Wells (2019).

This section of the User Manual Part 5 documents the model utilities used in supporting the model, the model release notes and a detailed list of bug fixes.

The other sections of the User Manual are divided into multiple sections for ease of updating and editing:

- User Manual Part 1: Introduction to CE-QUAL-W2, Model download package, how to run the model, model versions, changes between model versions

- User Manual Part 2: Theoretical basis for CE-QUAL-W2: hydrodynamics and water quality, particle transport and numerical scheme

- User Manual Part 3: Model input and output file descriptions and input/output file examples

- User Manual Part 4: Model examples

- User Manual Part 5: Release notes, bug fixes, differences in model versions, history of bug fixes, and other user manuals such as for the GUI interface, the water balance algorithm, and other external codes.

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Or for a specific section:

Cole, Tom (2023) "Water Balance Utility," in "CE-QUAL-W2: A two-dimensional, laterally averaged, hydrodynamic and water quality model, version 4.5, user manual part 5, model utilities and release notes," ed. S. Wells, Department of Civil and Environmental Engineering, Portland State University, Portland, OR.

1. Introduction

Several useful CE-QUAl-W2 model utilities are available for editing the control file, post-processing model results, and setting up model input files. A description of these utilities is included in this part of the User Manual.

Also, this document shows model changes and bug fixes, model changes between versions, and a history of bug fixes in earlier versions.

Hence, this section of the User Manual includes the following sections:

- Model utilities
  - o Water balance utility
  - o Converter utility from w2_con.npt control file to Excel version
  - o GUI control file editor and bathymetry viewer for Versions 3.7-4.22
  - o Post-processor provided by DSI, Inc. including a bathymetry viewer
  - o Excel macro utility for writing out input files for CE-QUAL-W2
- Model release notes
  - o Current Bug fixes
  - o Model Know Limitations
  - o Model changes between versions
  - o Model bug fixes between versions

2. Water Balance Utility

Primary author: Tom Cole

How to use the water balance utility GUI application

Running the water balance program

When the executable is run, a window appears that allows the following inputs (note that the executable runs under the Windows operating system only) as shown in Figure 1.

Figure 1. Dialog box for water balance utility.

:

When the dialog box first appears, default values populate the edit boxes. The user can then edit each one if the default values are not correct. Selecting Run will run the waterbalance utility to completion as shown in the following dialog box (Figure 2).

Figure 2. Dialog box for water balance utility if successful completion.

Observed elevations filename. This file consists of a Julian day and observed elevation as in the following example:

```
2000-2001 Oologah Reservoir observed water surface elevations

    JDAY     ELO
  90.792 195.453
  90.833 195.456
  90.875 195.459
  90.917 195.441
  90.958 195.444
  91.000 195.450
  91.042 195.441
```

```
91.083 195.441
91.125 195.447
91.167 195.441
91.208 195.444
91.250 195.438
91.292 195.432
```

This example skips the first 3 lines and is of a similar format to all other CE-QUAL-W2 time-varying inputs with a fixed format with eight columns each for the JDAY and ELO values. However, the utility will read in values using variable field lengths so long as the JDAY and ELO values are separated by a space. Data need not be at regular intervals that might cause a repeat of the same values. Sometimes better results have been obtained if the same values that repeat over a time interval are not included (such as the water surface elevation at day 91.083 above).

Also note that the degree of accuracy in the observed elevations can have an impact on the computed flows. It is up to the user to decide the necessary precision used in the observed water surface elevations.

Computed elevations filename. The following shows an example output file from a time series file (the columns to the right have not been shown):

```
    JDAY,       DLT,       ELWS, ..............................
  92.000,    456.39,     195.37, ..............................
  93.000,    952.28,     195.28, ..............................
  94.000,    494.28,     195.27, ..............................
  95.000,     34.43,     195.17, ..............................
  96.000,    170.88,    195.08, .............................
  97.000,    211.93,     194.99, ..............................
  98.000,    255.11,     194.92, ..............................
  99.000,   1459.08,     194.78, ..............................
```

The water balance utility reads in the [JDAY] and [ELWS] values and uses these in the water balance computations. The user must turn on time series output in the model control file and specify the segment at which the water surface elevation values are output (typically the segment next to the dam for reservoirs). Information on how to accomplish this is given in the User's Manual under the Time Series output file discussion.

Add to previous water balance . For various reasons, the water balance utility may not perfectly close the water balance the first time through the computations. Depending upon the discrepancies between computed and observed elevations, the utility may need to be used iteratively by rerunning the model using output from the first run of the water balance utility and then rerunning the water balance utility on the water surface elevations output in the new time series file. For a system with multiple branches, each iteration of the utility and the resulting output file can be saved as a separate file that is then incorporated as a distributed tributary for branch 2, then branch 3, etc. In the case of a system with only one branch, this approach cannot be used. Rather, the new flows generated at the second iteration need to be added to the previously computed flows and incorporated as an "improved" distributed tributary inflow file. This option allows the user to continue adding flows to the same inflow file.

The computed flows are contained in the "**qwb.opt**" file. For most simulations, these flows will generate water surface elevations sufficiently close to the observed elevations such that further refinement is unnecessary. However, as mentioned above, the solution may need to be iterated. Rarely, manual adjustment of the generated flows may be required. This is usually only needed when observed water surface elevations change significantly over a short time period.

Previous water balance filename. If the "Add to previous water balance" option is used, you must specify the existing water balance output file for the computed flows to be added to.

Skip interval. Some reservoirs have a lot of noise in the observed water surface elevation data, such as in peaking hydropower operations, and this option allows the user to specify how many observed elevations are ignored when computing the flows between observed elevations. For example, if water surface elevations are available on an hourly interval, the resulting flows generated by the water balance utility can have large + and – flows that are completely unrealistic as opposed to using observed elevations on a daily basis taken during periods of no hydropower generation. In order to smooth out the computed flows, a skip factor of 24 would result in computed flows being output on a daily basis with all of the "noise" generated by hydropower operations ignored over the 24-hour period.

Averaging interval. This option computes a running average of the water surface elevation based on the input value. This is an additional aid to smooth out water surface elevation "noise". For example, consider the case in which there is no inflow/outflow to the system, but there is considerable wind seiching. The water balance utility would compute alternating inflows and outflows from the system that, depending on the amount of seiching, could be very large when in reality there should not be any flows added to or subtracted from the system. Using a running average alone or in combination with skipping over a number of observed elevations specified in (4) can help alleviate many of the problems caused by an automated water balance computation.

Waterbody number. In the case of multiple waterbodies each of which has a separate bathymetry input file, the user must specify which waterbody (and thus which bathymetry file) the water balance is being computed for. This capability is necessary for modeling systems with multiple reservoirs.

Incorporating the computed flows into the simulation

The water balance utility can be used for lakes and reservoirs in which water surface elevations are a function of inflows and controlled outflows from the system. The utility computes the flows necessary to match observed water surface elevations (typically taken at the dam) and outputs them to the "**qwb.opt**" file. This file is composed of a Julian date and an inflow (m^3 sec^{-1}). The flows can be either positive or negative. Temperatures and/or constituent concentrations must also be provided in the corresponding temperature and constituent concentration input files if the computed flows are incorporated as inflows to the system. *The water balance utility does not provide this information*, but this information needs to be provided by the user depending upon how the computed flows are incorporated into the simulation. Considerable thought should go into how best to incorporate temperature and constituent concentrations and is discussed in more detail below.

Note that negative flows use temperatures/concentrations in the waterbody when calculating the impact on the system of these flows rather than the temperatures/concentrations in the corresponding inflow temperature and constituent concentration files. This ensures that negative flows generate no change in temperature or constituent concentrations. However, positive flows can impact simulation results and care must be taken as to how the flows are incorporated into the simulation.

The flows required to complete the water balance are computed as a step function. If they are incorporated into the model as an additional inflow or outflow whose current values are being linearly interpolated, such as a branch inflow, then the resulting water balance will not be correct. Typically, the flows in the qwb.opt file are first included as a distributed tributary inflow assigned to the mainstem branch and interpolation [DTRIC] is turned "OFF". The corresponding distributed tributary inflow temperatures are

usually set to air temperatures in the qdt_br1.npt file. When running water quality, care must be taken as to what constituents should be included in the corresponding inflow constituent concentration file. Typically, only DO values are included if the distributed tributary option of incorporation is used, and they are set to saturated values corresponding to the observed air temperatures. Keep in mind that if the water balance flows are incorporated as branch inflows, then the mass loading of organic matter and nutrients will be increased as well.

The branch corresponding to the distributed tributary inflow is usually assigned to the mainstem branch of a reservoir. Using a distributed tributary minimizes the impact of the flow, temperature, and/or water quality associated with the distributed tributary by distributing the flow throughout all segments in a branch weighted by surface area. Be aware that large flows as a result of large errors in inflow/outflow measurements can and have had a significant impact on temperature and water quality calibration in the surface layers. Usually, this is not a problem, but sensitivity analyses should be conducted to see if the flow and associated temperature/constituent concentrations have an impact on the simulation results. If so, then the following discussion is of particular relevance.

As emphasized previously, a great deal of thought should go into how the flows generated from the water balance utility are incorporated into the simulation. As discussed previously, these are typically incorporated as distributed tributary inflows so as to minimize the impact of the flows on the simulation. However, this may not always be the best, most accurate, or most realistic method. For example, suppose that the water balance flows are consistently negative. This would indicate that either inflows are consistently overestimated or outflows are consistently underestimated. Obviously, incorporating the flows as a positive increase in the outflows as opposed to subtracting them from the inflows can potentially have a very significant impact on simulation results. In this case, sensitivity analyses should be conducted to determine which method improves the simulation results. If, say, hypolimnetic temperatures are consistently being underestimated, then incorporating the flows into a hypolimnetic outflow could improve the simulation results. Conversely, if hypolimnetic temperatures were being overpredicted, then the inflows should probably be reduced. The key point to keep in mind is that there are a number of different ways to incorporate the computed flows, and they generally should all be tested to determine the best way to incorporate the computed flows into the simulation.

As another example, consider the case in which the generated flows are consistently positive and a branch in which sometimes significant inflows are ungauged. In this case, a sensitivity analyses should be performed to determine if incorporating the flows or a portion of the flows into the ungauged branch inflow improves model results. Oftentimes, the model can be used as a guide as to how best to incorporate the computed flows into the simulation.

Example from Tom Cole

Walter F. George is a U.S. Army Corps of Engineer reservoir located on the Chattahoochee River in Alabama. The reservoir is operated as a peaking hydropower facility. During calibration, the model consistently underpredicted hypolimnetic temperatures by 0.5-1ºC. Wind sheltering could be adjusted to increase hypolimnetic temperatures, but this adjustment always adversely impacted thermocline depth. After considerable thought, it was concluded that including possible seepage at the dam might improve hypolimnetic temperature predictions. A portion of the distributed tributary flows were incorporated as an additional outflow at the bottom of the dam. The final value used was 5 m^3 sec^{-1}, which was less than 1% of the average outflows and brought hypolimnetic temperatures into almost exact agreement with observed temperatures. Further investigation of the outflows revealed that during times of no power generation, an additional flow of 5.1 m^3 sec^{-1} was specified in a file that was not originally sent as part of

the outflow data. Thus, the model pointed the way as to how best to incorporate the computed flows and was a surprisingly accurate indicator of what was occurring in the prototype.

How to use the water balance utility console application

A console application that reads an input file is also available to perform the waterbalance. This new console version of the water balance code provides the following updates:

1. This is not a windows dialog box driven code so it can easily be used in batch files.
2. There is now an input file for model parameters for the water balance utility and an output file for model errors.
3. There are several enhancements: one has more flexibility over file naming, the number of header lines to skip in input files, and the number of waterbodies to use in the analysis.

Input File: "WatBal.npt"

The new input file, "WatBal.npt" has the following format:
```
Water Balance input file for Console Application
"el_obs.npt"        , file for observations, time and water level time series in 2 columns
"tsr_8_seg36.opt"   , tsr file for model predictions-assuming only one line skipped in
file header
"qwb1.npt"          , Output file name
1                   , NSKIPS - number of skips of data
1                   , NAV - averaging interval, number of data points to average
1,1      , waterbody to perform water balance: JW1:STARTWB,JW2:ENDWB:1,2=WB1&2;1,1==WB1
ONLY
3         , number of lines to skip in the header for the water level data file
0                   , past water balance PWB file: Yes==1, No==0
"qwb.npt"           , Previous Water Balance file name
```

The explanations of each line are shown in the example file above. If performing over multiple waterbodies, keep in mind that all waterbodies must have the same grid (i.e., ELBOT and vertical spacing must be the same). Currently all the flow correction is given to only 1 water balance file. A later option will be for multiple WB files so that one can distribute them across several waterbodies.

Output File: "WatBal_Errors.opt"

If there are errors, any errors will be shown in this text file. If no errors, then this file will not be written to the disk.

An example of the error file output is shown below:

```
Could not open simulated elevations file tsr_8_seg39.opt
```

Output File: "el_stats.opt"

This output file displays model error statistics of the water level and average flow rate in the qwb output file. Typical output from this program are shown below:
```
     N    Mean Error  Absolute ME    RMS Error
   238         0.00         0.00         0.00

Average water balance flow correction = .00 m^3/s for period covering Julian day 1.04 to
239.94
```

Output File from water balance

The main output file from the water balance utility is a time series of flows necessary to match the water level.

A typical output file is shown below:

```
Computed flow to complete water balance
        1         1
     JDAY      QWB
    1.040     0.00
    2.000    24.34
    3.000     2.33
    4.000     2.34
    5.000     3.72
    6.000     2.33
    7.000     4.67
    8.000     2.34
    9.000     3.71
   10.000     3.29
   11.000     4.66
   12.000     2.34
   13.000     3.69
   14.000     2.34
   15.000     3.32
   16.000     3.31
   17.000     3.49
```

How to Run the Console Water Balance Utility

The water balance utility is run by executing the exe file for 32 (**WBconsole32.exe**) or 64 bit (**WBconsole64.exe**) Windows operating system. One also needs the input file **WatBal.npt** in the directory of the executable.

3. Control File Converter for CE-QUAL-W2

This section outlines the steps required to convert a legacy application control file, **w2_con.npt**, and its companion **graph.npt** file into the Excel version of the control file or to convert a w2_con.csv file from 4.1 or 4.22 to 4.5.

This is a relatively simple process that involves these steps:

1. Copy **ConverterControlFile.exe** into the directory of a legacy application or copy the three files read by the program (w2_con.npt, graph.npt, and the bathymetry file) into a directory with the executable. If you are just converting a 4.1 or 4.22 w2_con.csv file to the new format, just copy w2_con.csv and the bathymetry file into a new directory. After execution (double click the converter executable), the following files are written to the directory:

   a. **w2_con45.csv** – this is a csv file format of the control file. This will then need to be copied into a Version 4.5 example **w2_con.xlsm** template.

   b. A csv form of the bathymetry file (if the bathymetry file was not already in csv format). The output bathymetry file is named **bthX.csv,** where X is the waterbody number. This new format is much easier for editing and analysis than the older file format. The file name in the **w2_con.csv** is also changed to **bthX.csv**.

2. Copy **w2_con.csv** into an existing Version 4.5 example file *.xlsm** from another application (you can use one from the W2 Model Examples) by following these steps:

   a. Open the file **w2_con.xlsm** (or it may have a different descriptive name, such as **w2_con_DeGray.xslm)** from an existing example problem supplied in the CE-QUAL-W2 example problems.

Figure 3. An example of an existing w2_con.xlsm file. Columns A and B are not used in the control file and we will be pasting the w2_con45.csv into column C1, not A1.

   i. The easiest option is to open the file **w2_con45.csv** from the converter utility in Excel. Select the columns and rows with data. Do not select the entire sheet

since you cannot copy and paste these into Cell C1 in **w2_con.xlsm**. Select the rows and columns necessary to select all the data. Be careful you select all the columns – especially for the SOD specification per segment. You will need to select as many columns as the # of segments (IMX).

Figure 4. An example of the w2_con45.csv file from the converter utility.

     ii.   Then Copy the selected cells from **w2_con45.csv** and paste to **w2_con.xlsm** cell C1 using *Paste Values and Number Formatting* so that the colors and other formatting are preserved in the original document.

b.   The next step is to adjust rows for the number of constituents. The template file you used **w2_con.xlsm** had an assumed number of water quality constituents that may be different from the number you will use. Go to approximately row 384 as shown below and delete or add cells ***in only column A and B*** only to match the specified number in the formula. So, if you need to add cells, then select the correct number of cells in column A and B, right click your mouse and choose 'Insert', then 'shift cells down.' If you need to delete cells, then select the correct number of cells in column A and B, right click your mouse, choose 'Delete', then select 'move cells up'. Now the information in column A and B should line up with what is written in Column C.

Model Utilities

374		RESTART	RESTART						
375		RSOC- Restart control ON or OFF- for writing restart files	OFF						
376		NRSO- # of restart dates and frequencies of output		0					
377		RSIC- Restart read in control- ON or OFF- read in a restart file	OFF						
378		RSI FILE RSIFN- restart in file name	rsi.npt - not used						
379		RSO DATE- RSOD(NRSO) - output dates in Julian days							
380		RSO FREQ- RSOF(NRSO) - frequency of output in days							
381									
382		CST COMP - Water quality computations	CCC	LIMC	CUF				
383		CCC: Turn ON or OFF water quality calculations, LIMC: Limiting nutrient computation	OFF	ON	3				
384	**Verify that you have this many constituent rows below:**	30							
385		CST - Concentration State variables and initial conditions	CNAME2 Sho CNAME Lo CAC Active FMTC Fort CMULT Ou C2IWB1 Ini CPRWBC1 CINBRC1 In CTRTRC1 T CDTBRC1							

#	CNAME2	CNAME Lo	CAC Active	FMTC	CMULT Ou	C2IWB1 Ini	CPRWBC1	CINBRC1 In	CTRTRC1 T	CDTBRC1
1	TDS	"TDS, g/m^	OFF	(g10.3)	1	51 OFF	OFF	OFF	OFF	
2	Gen1	"GC1, g/m^	ON	(g10.3)	1	100 ON	ON	ON	ON	
3	Gen2	"Age, days	ON	(g10.3)	1	0 ON	ON	ON	ON	
4	Gen3	"GC3, g/m^	OFF	(g10.3)	1	10 OFF	OFF	OFF	OFF	
5	ISS1	"ISS, g/m^	ON	(g10.3)	1	2 ON	ON	ON	ON	
6	PO4	"Phosphat	ON	(g10.3)	1	0.005 ON	ON	ON	ON	
7	NH4	"Ammoniu	ON	(g10.3)	1	0.01 ON	ON	ON	ON	
8	NO3	"Nitrate-N	ON	(g10.3)	1	0.04 ON	ON	ON	ON	
9	DSI	"Dissolved	OFF	(g10.3)	1	0 OFF	OFF	OFF	OFF	
10	PSI	"Particulat	OFF	(g10.3)	1	0 OFF	OFF	OFF	OFF	
11	FE	"Total iron	OFF	(g10.3)	1	0.1 OFF	OFF	OFF	OFF	
12	LDOM	"Labile DO	ON	(g10.3)	1	1 ON	ON	ON	ON	
13	RDOM	"Refractor	ON	(g10.3)	1	2 ON	ON	ON	ON	
14	LPOM	"Labile PO	ON	(g10.3)	1	0.2 ON	ON	ON	ON	
15	RPOM	"Refractor	ON	(g10.3)	1	0.2 ON	ON	ON	ON	
16	ALG1	"Algae1, g	ON	(g10.3)	1	0.2 ON	ON	ON	ON	
17	ALG2	"Algae2, g	ON	(g10.3)	1	0.01 ON	OFF	OFF	OFF	
18	ALG3	"Algae3, g	ON	(g10.3)	1	0 ON	OFF	OFF	OFF	
19	DO	"Dissolved	ON	(g10.3)	1	10 ON	ON	ON	ON	
20	TIC	"Inorganic	OFF	(g10.3)	1	11.91 OFF	OFF	OFF	OFF	
21	ALK	"Alkalinity,	OFF	(g10.3)	1	31 OFF	OFF	OFF	OFF	
22	ZOO1	"zooplankt	ON	(g10.3)	1	0.001 ON	OFF	OFF	OFF	

Row 386-407 column A/B notes:

386	Must include text in quotes if there are spaces or other symbols like '/' for CNA
387	**SEE TAB SHOWING REQUIRED CONSTITUENT ORDER**
388	
389	Note that epiphyton and macrophytes are turned ON below, not here
390	
391	
392	**Note the order of these columns for this section:**
393	CNAME2, CNAME, CAC, FMTC, CMULT,
394	C2IWB (repeat for each waterbody)
395	CPRWBC (repeat for each waterbody)
396	CINBRC (repeat for each branch)
397	CTRTRC (repeat for each tributary - include at least 1 even if no tribs)
398	CDTBRC (repeat for each branch)
399	CPRBRC (repeat for each branch)
400	Your last column should be in COLUMN:
401	**M**
402	11
403	
404	
405	
406	
407	

Figure 5. Location in Excel template where the constituent order is shown. In this example, the required number of constituents is 30. This is a formula computed in the Excel sheet. Make sure that you have that same number in the list that follows. There is guidance on another tab in the Excel file on the required order based on your dimensioning of number of algal groups, BOD groups, macrophyte groups, periphyton groups, suspended solids groups, and generic constituent groups. Also note that in column A, guidance is given on setting the number of columns needed in this section.

c. If you have more than 5 structures, 5 epiphyton/periphyton groups, 5 algae groups, 5 macrophyte groups, or 5 zooplankton groups, you will have to add additional rows where necessary only in columns A and B. You can search in Column A for "increase # of rows" for where these areas are located.

i. For structures, look at rows 136-165 – there are notes in Col A and B describing where to add rows if more than 5 structures.

	A	B	C	D	E	F	G	H	I	J	K	L	M
131		STRCKLR Only active if AZC=TKE1; If this is =0.0, then the Strick-ler Nickuradse relati	24										
132		BOUNDFR Only active if AZC=TKE1; if =0.0, then Boundary pro-duction is OFF. If > 0.(	10										
133		TKECAL Only active if AZC=TKE1; select either the implicit or explicit vertical transpo	IMP										
134													
135		STRUCTURES for each branch. These are known outflows at the end of a branch	BR1	BR2	BR3	BR4	BR5	BR6	BR7	BR8	BR9	BR10	
136	**DYNELEV: use dynamic centerline elevation for the structure.**	NSTR - Number of branch outlet structures	1										
137	Usually the centerline elevation is fixed and specified with ESTR. If this is ON,	DYNELEV - Dynamic elevation control ON or OFF	OFF										
138	the model will read a separate file for each branch called dynselevX.npt where	STRIC1-Turns ON/OFF interpolation of structure outflows for structure 1	OFF										
139		STRIC2-Turns ON/OFF interpolation of structure outflows for structure 2											
140		STRIC3-Turns ON/OFF interpolation of structure outflows for structure 3											
141		STRIC4-Turns ON/OFF interpolation of structure outflows for structure 4											
142	**If have more than 5 structures then add lines**	STRIC5-Turns ON/OFF interpolation of structure outflows for structure 5											
143	Leave blank if no values	KTSTR1-Top layer above which selective withdrawal will not occur for structure 1	2										
144		KTSTR2-Top layer above which selective withdrawal will not occur for structure 2											
145		KTSTR3-Top layer above which selective withdrawal will not occur for structure 3											
146		KTSTR4-Top layer above which selective withdrawal will not occur for structure 4											
147	**If have more than 5 structures then add lines**	KTSTR5-Top layer above which selective withdrawal will not occur for structure 5											
148		KBSTR1-Bottom layer below which selective withdrawal will not occur for structure	46										
149		KBSTR2-Bottom layer below which selective withdrawal will not occur for structure 2											
150		KBSTR3-Bottom layer below which selective withdrawal will not occur for structure 3											
151		KBSTR4-Bottom layer below which selective withdrawal will not occur for structure 4											
152	**If have more than 5 structures then add lines**	KBSTR5-Bottom layer below which selective withdrawal will not occur for structure 5											
153		SINKC1 - Sink type used in the selective withdrawal algorithm, LINE or POINT, struct	POINT											
154		SINKC2 - Sink type used in the selective withdrawal algorithm, LINE or POINT, structure 2											
155		SINKC3 - Sink type used in the selective withdrawal algorithm, LINE or POINT, structure 3											
156		SINKC4 - Sink type used in the selective withdrawal algorithm, LINE or POINT, structure 4											
157	**If have more than 5 structures then add lines**	SINKC5 - Sink type used in the selective withdrawal algorithm, LINE or POINT, structure 5											
158		ESTR1-Centerline elevation of structure 1, m	456.9										
159		ESTR2-Centerline elevation of structure 2, m											
160		ESTR3-Centerline elevation of structure 3, m											
161		ESTR4-Centerline elevation of structure 4, m											

Figure 6. Location in Excel file where the number of rows needs to be increased in case there are more than 5 structures.

ii. For more than 5 epiphyton/periphyton groups, look in the epiphyton section (search for epiphyton).

Figure 7. Location in Excel file where the number of rows needs to be increased in case there are more than 5 epiphyton/periphyton groups..

    iii.   For more than 5 algae and 5 zooplankton groups, look in the zooplankton section (search for zooplankton).

Figure 8. Location in Excel file where the number of rows needs to be increased in case there are more than 5 zooplankton groups.

    iv.   For more than 5 macrophyte groups, look in the macrophyte section (search for macrophyte).

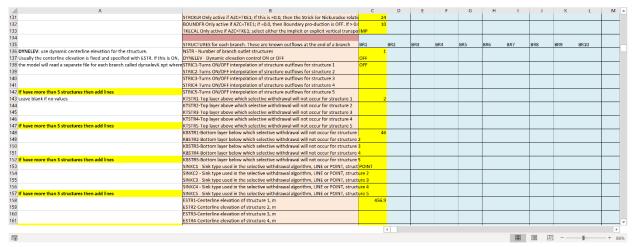|	MACROPHYTES	WB1	WB2	WB3	WB4	WB5	WB6	WB7	WB8	WB9	WB10
Initial conditions for 5 macrophyte groups - rows must be added to if more th...											
You must keep the 5 groups even if not used	MAC Waterbody macrophyte 1 computations, ON or OFF	OFF									
	MAC Waterbody macrophyte 2 computations, ON or OFF	OFF									
	MAC Waterbody macrophyte 3 computations, ON or OFF	OFF									
	MAC Waterbody macrophyte 4 computations, ON or OFF	OFF									
Increase rows if more than 5 macrophyte groups	MAC Waterbody macrophyte 5 computations, ON or OFF	OFF									
	MPRWBC Macrophyte 1 concentration print output, ON or OFF	OFF									
	MPRWBC Macrophyte 2 concentration print output, ON or OFF	OFF									
	MPRWBC Macrophyte 3 concentration print output, ON or OFF	OFF									
	MPRWBC Macrophyte 4 concentration print output, ON or OFF	OFF									
Increase rows if more than 5 macrophyte groups	MPRWBC Macrophyte 5 concentration print output, ON or OFF	OFF									
	MACWBCI-Group1 Initial macrophyte concentration for each macrophyte group, gm...	0									
	MACWBCI-Group2 Initial macrophyte concentration for each macrophyte group, gm-3										
	MACWBCI-Group3 Initial macrophyte concentration for each macrophyte group, gm-3										
	MACWBCI-Group4 Initial macrophyte concentration for each macrophyte group, gm-3										
Increase rows if more than 5 macrophyte groups	MACWBCI-Group5 Initial macrophyte concentration for each macrophyte group, gm-3										
	MAC RATE	MacGroup1	MacGroup2	MacGroup3	MacGroup4	MacGroup5					
	MG maximum macrophyte growth rate, day-1	0.3									
	MR maximum macrophyte respiration rate, day-1	0.05									
	MM maximum macrophyte mortality rate, day-1	0.05									
	MSAT light saturation intensity at maximum photosynthetic rate, W m-2	30									
	MHSP macrophyte half saturation for phosphorus limited growth, g m-3	0									
	MHSN macrophyte half-saturation for nitrogen limited growth, g m-3	0									
	MHSC macrophyte half-saturation for carbon limited growth, g m-3	0									
	MPOM Fraction of macrophyte biomass that is converted to particulate organic mat...	0.9									
	LRPMAC Fraction of POM which originates as dead macro-phytes becoming labile PO...	0.2									
	PSED Fraction of phosphorus uptake by macrophytes ob-tained from sediments	0.5									
	NSED Fraction of nitrogen uptake by macrophytes obtained from sediments	0.5									
	MBMP Threshold macrophyte concentration for which growth is moved to the abov...	40									
	MMAX Maximum macrophyte concentration, g m-3	500									

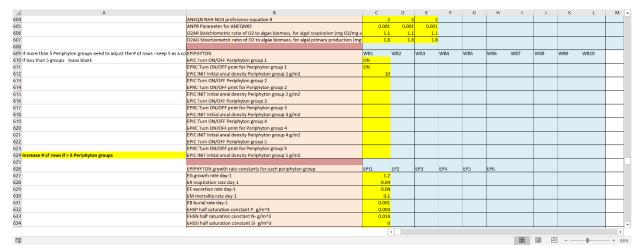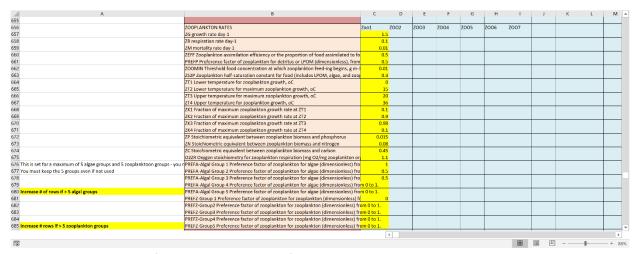**Figure 9. Location in Excel file where the number of rows needs to be increased in case there are more than 5 macrophyte groups.**

d. You will need to put quotes around the **TITLE** field, **HNAME** field, **CNAME** field, and **CDNAME** field. This can be done by setting up a formula using the existing cells as '=char(34)&[CELLREF]&char(34)' where CELLREF is the cell reference number of the orig-inal text. Then paste the *values* with the double quotes to the locations in the control file. *If anyone figures out an easier way to do this let me know! Frustratingly, Excel drops the double quotes on importing them.*

e. The **w2_con.xlsm** file should now be working. As edits are made in this file, you will push the button on the top of the file in Column B to export it to **w2_con.csv**, which is read in by the W2 model. The preprocessor will 'yell' at you in case there is an error in the set up.

4. GUI Interface for CE-QUAL-W2 for Versions 3.7-4.20

Figure 10. About W2 Control GUI preprocessor.

Introduction

This section describes the GUI interface that is released with CE-QUAL-W2. This works with the old version of the control file, **w2_con.npt (only up to Version 4.2)** but does work with the Excel version of the control file (**w2_con.csv**). The w2_post program shown in the next section has a bathymetry viewer that can be used with the **w2_con.csv** control file.

The manual describes the uses of the GUI for editing the control file (**w2_con.npt**) and the bathymetry file (user-defined filename, typically called **bth.npt** or **bth.csv**). Please note that the model files can be edited using a text editor or in Excel, and the GUI is therefore not required to run the model. The GUI though may be very helpful for the new CE-QUAL-W2 user as is the Excel version of the control file. The bathymetry editor is very useful in viewing the model grid and making changes to the grid (e.g., grid refinement). The bathymetry editor though does not assist in setting up the bathymetry. The model user must have already developed the bathymetry file using other programs. The bathymetry editor only edits an existing bathymetry file. Often the bathymetry is developed using GIS software or programs like SURFER or other 3-D contour plotting software packages.

Installing the GUI Interface

After downloading the GUI interface setup files and unzipping them, from Windows Explorer double-click on 'setup.exe' to guide you in the set-up process.

Opening the GUI Interface

By double-clicking on the W2 icon from the Desktop or from Windows Explorer, the user is presented with the following screen:

Figure 11. Dialog box menu.

This interface is meant to be simple and uncomplicated.

Menus

The user has 3 menus: File, Window, and Help. The File menu controls which control file to open and to save. The user can only open a CE-QUAL-W2 control file – such as w2_con.npt. Opening any other file type will result in an error. The File save button and file open buttons and menu items only affect the control file and the associated files (bathymetry and graph files). Note that when you save a file, you overwrite the original file with which you started. The GUI program though copies the original output file to a similar name but with a number designator. This allows the user always to go back and track changes made over time to the control file or bathymetry files.

Button Bar

The buttons become active as the user opens the files that affect the buttons. For example, once the bathymetry file is opened, the 4 grid viewing options are then displayed (see more information below). The open file button opens the w2_con.npt file or another file that is in the format of the control file. The save button becomes active once a file is opened and changes are made. The print button prints the current screen (I would not use this since it is not a very useful print out. It is much more convenient to just print the text file directly from Notepad or other text editor.) The next buttons are described below.
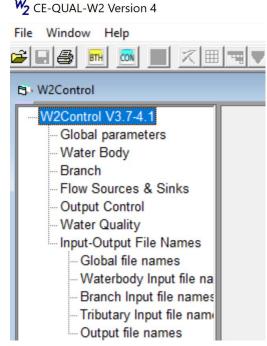

Figure 12. Menu of w2control.

Editing the Control File

Once you have chosen a control file to open (w2_con.npt), open it and adjust the window so that the window options are visible. If the file does not open there may be serious formatting errors in the file or you may have not chosen a CE-QUAL-W2 control file. Check the file for errors using the CE-QUAL-W2 preprocessor (a separate program released with W2).

You will notice that the BTH button is now active, meaning that you can also open the bathymetry file. The left pane now has 7 headings – each subheadings that can be shown by double-clicking on the main heading. For example, several of the subheadings have been expanded, as shown to your right.

By double-clicking on a subheading, the user can edit the information in a cell. Information about each model parameter is shown in Appendix C in the User Manual.

Once you have edited the cells (either by changing a number or changing a menu parameter), there are 2 buttons at the bottom of the page as shown below.

Epiphyton/Periphyton Rate and Constants:

# of Epiphyton Groups	[NEP]	1
		Epiphyton#1
Ephiphyton growth rate, 1/day	[EG]	1.5
Epiphyton dark respiration rate, 1/day	[ER]	0.05
Epiphyton excretion rate, 1/day	[EE]	0.02
Epiphyton mortality rate, 1/day	[EM]	0.1
Epiphyton burial rate, 1/day	[EB]	0.00001
Epiphyton half-saturation P	[EHSP]	0.002
Epiphyton half-saturation N	[EHSN]	0.002
Epiphyton half-saturation SI	[EHSSI]	0
Epiphyton Light Saturation, W/m^2	[ESAT]	150
Epiphyton Half Saturation Biomass Limitation, g/m^2	[EHS]	15
Epiphyton Ammonia Preference Equation 1 or 2	[ENEQN]	2
Epiphyton Ammonia Preference Factor, g/m^3	[ENPR]	0.001
Temperature Rates		
Lower temperature for epiphyton growth	[ET1]	1
Lower temperature for max. epiphyton growth	[ET2]	3
Upper temperature for max. epiphyton growth	[ET3]	20
Upper temperature for epiphyton growth	[ET4]	30
Fraction of epiphyton growth rate at AT1	[EK1]	0.1
Fraction of max. epiphyton growth rate at AT2	[EK2]	0.99
Fraction of max. epiphyton growth rate at AT3	[EK3]	0.99
Fraction of epiphyton growth rate at AT4	[EK4]	0.1
Stoichiometry		
Fraction P	[EP]	0.005
Fraction N	[EN]	0.08
Fraction C	[EC]	0.45
Fraction Si	[ESI]	0
Chlorophyll-algae ratio	[ECHLA]	65
Frac. algae lost by mortality to POM	[EPOM]	0.8
Oxygen equivalent of organic matter for epiphyton respiration	[O2ER]	1.1
Oxygen equivalent of organic matter for epiphyton growth	[O2EG]	1.4

Figure 13. Example of w2control menu.

The Apply button is used to set the parameters of the table. For example above, the # of epiphyton groups is '1". If one wanted to change this to "2". One would enter 2 in the cell for NEP and then press "Apply". The table will be re-drawn as shown below.

Figure 14. Dialog box example.

Epiphyton/Periphyton Rate and Constants:

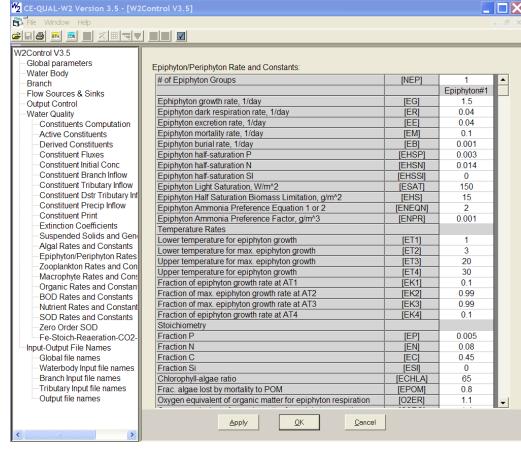|		Epiphyton#1	Epiphyton#2
# of Epiphyton Groups	[NEP]	2	
Ephiphyton growth rate, 1/day	[EG]	1.5	2
Epiphyton dark respiration rate, 1/day	[ER]	0.04	0.04
Epiphyton excretion rate, 1/day	[EE]	0.04	0.04
Epiphyton mortality rate, 1/day	[EM]	0.1	0.1
Epiphyton burial rate, 1/day	[EB]	0.001	0.001
Epiphyton half-saturation P	[EHSP]	0.003	0.002
Epiphyton half-saturation N	[EHSN]	0.014	0.002
Epiphyton half-saturation SI	[EHSSI]	0	0
Epiphyton Light Saturation, W/m^2	[ESAT]	150	150
Epiphyton Half Saturation Biomass Limitation, g/m^2	[EHS]	15	15
Epiphyton Ammonia Preference Equation 1 or 2	[ENEQN]	2	1
Epiphyton Ammonia Preference Factor, g/m^3	[ENPR]	0.001	0.001
Temperature Rates			
Lower temperature for epiphyton growth	[ET1]	1	5
Lower temperature for max. epiphyton growth	[ET2]	3	15
Upper temperature for max. epiphyton growth	[ET3]	20	25
Upper temperature for epiphyton growth	[ET4]	30	30
Fraction of epiphyton growth rate at AT1	[EK1]	0.1	0.01
Fraction of max. epiphyton growth rate at AT2	[EK2]	0.99	0.9
Fraction of max. epiphyton growth rate at AT3	[EK3]	0.99	0.99
Fraction of epiphyton growth rate at AT4	[EK4]	0.1	0.1
Stoichiometry			
Fraction P	[EP]	0.005	0.005
Fraction N	[EN]	0.08	0.08
Fraction C	[EC]	0.45	0.45
Fraction Si	[ESI]	0	0
Chlorophyll-algae ratio	[ECHLA]	65	65
Frac. algae lost by mortality to POM	[EPOM]	0.8	0.8
Oxygen equivalent of organic matter for epiphyton respiration	[O2ER]	1.1	1.1
Oxygen equivalent of organic matter for epiphyton growth	[O2EG]	1.4	1.4

W2Control V3.5
- Global parameters
- Water Body
- Branch
- Flow Sources & Sinks
- Output Control
- Water Quality
  - Constituents Computation
  - Active Constituents
  - Derived Constituents
  - Constituent Fluxes
  - Constituent Initial Conc
  - Constituent Branch Inflow
  - Constituent Tributary Inflow
  - Constituent Dstr Tributary Inf
  - Constituent Precip Inflow
  - Constituent Print
  - Extinction Coefficients
  - Suspended Solids and Gen
  - Algal Rates and Constants
  - Epiphyton/Periphyton Rates
  - Zooplankton Rates and Con
  - Macrophyte Rates and Cons
  - Organic Rates and Constan
  - BOD Rates and Constants
  - Nutrient Rates and Constant
  - SOD Rates and Constants
  - Zero Order SOD
  - Fe-Stoich-Reaeration-CO2-
- Input-Output File Names
  - Global file names
  - Waterbody Input file names
  - Branch Input file names
  - Tributary Input file names
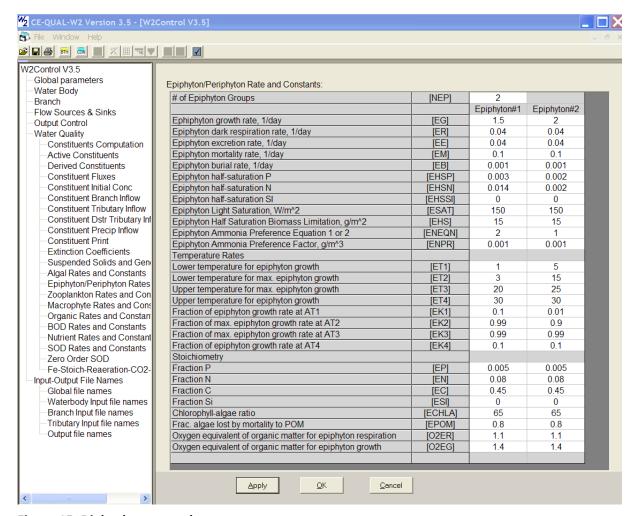 - Output file names

Apply   OK   Cancel

Figure 15. Dialog box example.

Then after making changes, the OK button MUST be pressed. But this does not SAVE the file to the hard disk. The User must also then press the SAVE button on the button bar above (or the menu FILE/SAVE file) to save these changes to the disk. The save button will be highlighted after a selection is changed.

Editing the Bathymetry File

After opening the control file, the bathymetry file can be opened by clicking the BTH button. Note that the bathymetry file name is under the 'INPUT-OUTPUT FILE NAMES' Menu and the submenu 'WATERBODY INPUT FILE NAMES'. At this point there are 4 views that become active: Side View, Top View, Data View, End View.

The buttons on the top allow one to toggle between the different bathymetric views. By expanding the Top View, one can enlarge the view by holding down the left mouse button and scrolling from right to left (see example below). To decrease the image size, hold down the left mouse button and scroll from right to left.

To change the active segment and layer, you must place the mouse cursor in the Data View at a segment and layer of interest and click the 'Refresh View' button. This affects which segment is shown in the End View and which segment is highlighted in the Side View.

To edit the bathymetry, click on the variable and change its value. Then the user must click the 'OK' button to accept these changes. Using the SAVE button saves all the user files.
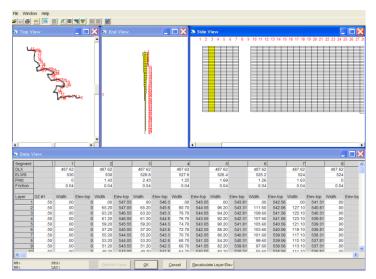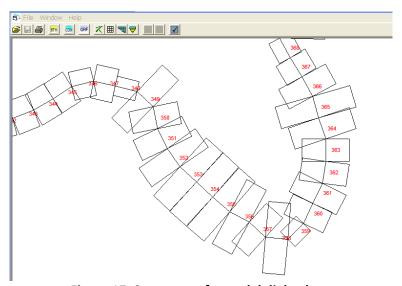

Figure 16. Bathymetry dialog box example.

Figure 17. Segments of a model dialog box.

Merging or Splitting Segments or Layers

In order to perform this operation, open the Data View and select the range of layers and/or segments to merge or split by highlighting them with the mouse. You will notice in the left hand corner a box shows what segments and layers have been selected.

In the example below I have selected layers 5-14 and segments 2 and 3. You will also now notice that the layer and segment merge/split buttons are now active. To merge or split segments, click on the Merge/Split segment button. A small dialog box will come up with options for merging or splitting the segments (see below). You then have the option to merge the 2 segments or split them into many more segments. The control file (w2_con.npt) will automatically adjust segment numbers when using this option. But keep in

mind that the following files will need to be edited to adjust them for changes in the number of model segments: the wind sheltering coefficient file (wsc.npt) and the shading file (shade.npt).

A similar process is followed for merging or splitting layers.

Segment				1		2		3		4		5		6		7		8	
DLX				250.2		250.2		250.2		250.2		250.2		250.2		250.2		250.2	
ELWS				41.63		41.63		41.5		41.37		41.23		41.1		40.97		40.84	
PHI0				0		4.21		4.37		4.32		3.8		3.48		3.45		3.41	
Friction				0.04		0.04		0.04		0.04		0.04		0.04		0.04		0.04	

Layer	DZ #1	DZ #2	DZ #3	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-to
1	1.00	1.00	1.00	.00	0	.00	51.16	.00	51.03	.00	50.9	.00	50.77	.00	50.64	.00	50.51	.00	50.
2	1.00	1.00	1.00	.00	0	284.76	50.16	307.73	50.03	373.35	49.9	236.76	49.77	249.74	49.64	325.37	49.51	420.67	49.
3	1.00	1.00	1.00	.00	0	284.76	49.16	307.73	49.03	373.35	48.9	236.76	48.77	249.74	48.64	325.37	48.51	420.67	48.
4	1.00	1.00	1.00	.00	0	284.76	48.16	307.73	48.03	373.35	47.9	236.76	47.77	249.74	47.64	325.37	47.51	420.67	47.
5	1.00	1.00	1.00	.00	0	284.76	47.16	307.73	47.03	373.35	46.9	236.76	46.77	249.74	46.64	325.37	46.51	420.67	46.
6	1.00	1.00	1.00	.00	0	284.76	46.16	307.73	46.03	373.35	45.9	236.76	45.77	249.74	45.64	325.37	45.51	420.67	45.
7	1.00	1.00	1.00	.00	0	284.76	45.16	307.73	45.03	373.35	44.9	236.76	44.77	249.74	44.64	325.37	44.51	420.67	44.
8	1.00	1.00	1.00	.00	0	284.76	44.16	307.73	44.03	373.35	43.9	236.76	43.77	249.74	43.64	325.37	43.51	420.67	43.
9	1.00	1.00	1.00	.00	0	284.76	43.16	307.73	43.03	373.35	42.9	236.76	42.77	249.74	42.64	325.37	42.51	420.67	42.
10	1.00	1.00	1.00	.00	0	284.76	42.16	307.73	42.03	373.35	41.9	236.76	41.77	249.74	41.64	325.37	41.51	420.67	41.
11	1.00	1.00	1.00	.00	0	284.76	41.16	307.73	41.03	373.35	40.9	236.76	40.77	249.74	40.64	325.37	40.51	420.67	40.
12	1.00	1.00	1.00	.00	0	284.76	40.16	307.73	40.03	373.35	39.9	236.76	39.77	249.74	39.64	325.37	39.51	420.67	39.
13	1.00	1.00	1.00	.00	0	284.76	39.16	307.73	39.03	373.35	38.9	236.76	38.77	249.74	38.64	325.37	38.51	401.30	38.
14	1.00	1.00	1.00	.00	0	282.94	38.16	302.99	38.03	365.51	37.9	227.49	37.77	235.22	37.64	296.11	37.51	378.97	37.
15	1.00	1.00	1.00	.00	0	280.54	37.16	296.96	37.03	358.02	36.9	220.05	36.77	226.26	36.64	270.19	36.51	258.89	36.
16	1.00	1.00	1.00	.00	0	167.55	36.16	207.53	36.03	343.54	35.9	209.81	35.77	213.84	35.64	240.60	35.51	173.75	35.
17	1.00	1.00	1.00	.00	0	122.64	35.16	117.59	35.03	242.47	34.9	188.69	34.77	196.98	34.64	180.43	34.51	138.98	34.
18	1.00	1.00	1.00	.00	0	18.33	34.16	17.71	34.03	102.91	33.9	151.01	33.77	113.00	33.64	144.18	33.51	22.25	33.
19	1.00	1.00	1.00	.00	0	.00	33.16	.00	33.03	12.78	32.9	24.13	32.77	17.59	32.64	22.53	32.51	.00	32.
20	1.00	1.00	1.00	.00	0	.00	32.16	.00	32.03	.00	31.9	.00	31.77	.00	31.64	.00	31.51	.00	31.
21	1.00	1.00	1.00	.00	0	.00	31.16	.00	31.03	.00	30.9	.00	30.77	.00	30.64	.00	30.51	.00	30.
22	1.00	1.00	1.00	.00	0	.00	30.16	.00	30.03	.00	29.9	.00	29.77	.00	29.64	.00	29.51	.00	29.
23	1.00	1.00	1.00	.00	0	.00	29.16	.00	29.03	.00	28.9	.00	28.77	.00	28.64	.00	28.51	.00	28.
24	1.00	1.00	1.00	.00	0	.00	28.16	.00	28.03	.00	27.9	.00	27.77	.00	27.64	.00	27.51	.00	27.
25	1.00	1.00	1.00	.00	0	.00	27.16	.00	27.03	.00	26.9	.00	26.77	.00	26.64	.00	26.51	.00	26.
26	1.00	1.00	1.00	.00	0	.00	26.16	.00	26.03	.00	25.9	.00	25.77	.00	25.64	.00	25.51	.00	25.
27	1.00	1.00	1.00	.00	0	.00	25.16	.00	25.03	.00	24.9	.00	24.77	.00	24.64	.00	24.51	.00	24.
28	1.00	1.00	1.00	.00	0	.00	24.16	.00	24.03	.00	23.9	.00	23.77	.00	23.64	.00	23.51	.00	23.
29	1.00	1.00	1.00	.00	0	.00	23.16	.00	23.03	.00	22.9	.00	22.77	.00	22.64	.00	22.51	.00	22.
30	1.00	1.00	1.00	.00	0	.00	22.16	.00	22.03	.00	21.9	.00	21.77	.00	21.64	.00	21.51	.00	21.
31	1.00	1.00	1.00	.00	0	.00	21.16	.00	21.03	.00	20.9	.00	20.77	.00	20.64	.00	20.51	.00	20.
32	1.00	1.00	1.00	.00	0	.00	20.16	.00	20.03	.00	19.9	.00	19.77	.00	19.64	.00	19.51	.00	19.
33	1.00	1.00	1.00	.00	0	.00	19.16	.00	19.03	.00	18.9	.00	18.77	.00	18.64	.00	18.51	.00	18.
34	1.00	1.00	1.00	.00	0	.00	18.16	.00	18.03	.00	17.9	.00	17.77	.00	17.64	.00	17.51	.00	17.
35	1.00	1.00	1.00	.00	0	.00	17.16	.00	17.03	.00	16.9	.00	16.77	.00	16.64	.00	16.51	.00	16.
36	1.00	1.00	1.00	.00	0	.00	16.16	.00	16.03	.00	15.9	.00	15.77	.00	15.64	.00	15.51	.00	15.
37	1.00	1.00	1.00	.00	0	.00	15.16	.00	15.03	.00	14.9	.00	14.77	.00	14.64	.00	14.51	.00	14.
38	1.00	1.00	1.00	.00	0	.00	14.16	.00	14.03	.00	13.9	.00	13.77	.00	13.64	.00	13.51	.00	13.
39	1.00	1.00	1.00	.00	0	.00	13.16	.00	13.03	.00	12.9	.00	12.77	.00	12.64	.00	12.51	.00	12.

WB:1 - 1   SEG:2 - 3
BR:1 - 1   LAY:5 - 14

[Refresh Views] [OK] [Cancel] [Recalculate Layer Elev]

Figure 18. Splitting or merging layers example.

Note that in the bottom left corner of the above screen shot, the layers and segments that were selected is shown.
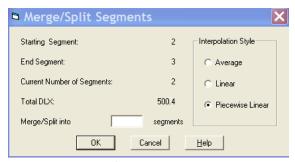
Merge/Split Segments

Starting Segment:	2
End Segment:	3
Current Number of Segments:	2
Total DLX:	500.4
Merge/Split into	[ ] segments

Interpolation Style
- ☐ Average
- ☐ Linear
- ☑ Piecewise Linear

[OK] [Cancel] [Help]

Figure 19. Merge/split dialog box.

Model Utilities

Running the Preprocessor within the GUI

The preprocessor which checks all input files can be executed from within the GUI by clicking on the CHECK button. At which point a dialogue box will pop up with information about running the preprocessor. The preprocessor executable must be in the root directory with the input files.
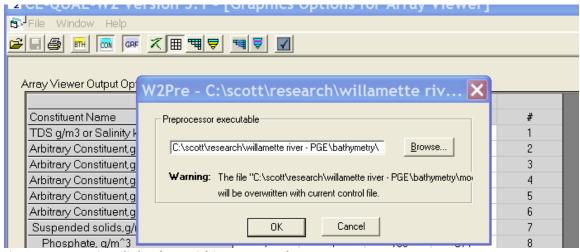

Figure 20. Running dialog box within w2control.

A Note on Saving Files

The GUI interface makes a backup copy of each file opened during a session. It will add an integer number to the files opened. This integer is based on whether previous backup files have been created or not. For example, the 1st time the GUI opens the files, w2_con.npt, graph.npt, and bth.npt; the program will write as backup copies of the unaltered original files: w2_con.npt2, graph.npt2, and bth.npt2. The next time the program opens these files, the files w2_con.npt3, graph.npt3, and bth.npt3 will be created (if you have already deleted the *.*2 files from your hard disk, the GUI will again use the integer '2' rather than '3').

Typical Errors with the GUI

Sometimes the GUI cannot read a control file because of the format of the text. UNIX/Linux systems often use a line-feed at the end of a line, while Windows text files include a carriage-return and a line-feed. You must convert the file to a Windows text file for the GUI to work properly. In a text editor you can view all the characters and verify you have the proper Windows format if the GUI is having problems reading the file. Many text editors automatically convert files from one type to the other (such as the text editor 'Notepad ++').

It is recommended that you use the W2 preprocessor to catch errors in the set-up files first before using the GUI. The W2 preprocessor though will not catch the line-feed error noted above and will read the files correctly whether in UNIX/Linux or Windows format.

Command Line Processing

The GUI also can be controlled by command line passing of the working directory and file. In a batch program or from the command line in a DOS box you can execute the GUI as follows:

"C:\scott\research\corps of engineers\tomcole\w2code\GUI36\w2control\w2control4.exe" C:\scott\w2workshop\2009 workshop\waterqual\problem1\w2_con.npt

The first string in quotes executes the GUI (this shows the path to the GUI – your path to the GUI will be different). The command line argument is NOT in quotes. This program was developed in VB6 and does not take quotes around the command line. Note that this is different than the FORTRAN command line argument. So the above command will open the GUI and load the control file automatically from the directory "C:\scott\w2workshop\2009 workshop\waterqual\problem1".

Using the GUI W2Control on Touchscreen Laptops and Monitors

The software, W2Control, is a GUI preprocessor for the W2 model. It works fine on non-touch enabled monitors. But for touch screen monitors, like many of the latest laptops, the opening "treeview" menu does not work because of a software incompatibility with VB6, the source code. W2Control can though be used on a touch screen laptop by doing the following:

Go to Services by typing 'Services' in the command line or Cortana line. In the list choose 'Touch keyboard and Handwriting Panel Service'. Right click your mouse and choose Properties and change 'Automatic' to 'Disabled'. Then click STOP in the Service Status to stop the service. Click APPLY. The W2Control then works as expected.

5. Post-Processor for CE-QUAL-W2 by DSI, Inc.

Paul Craig at DSI, Inc. has generously provided a software system for evaluating model results. There is a short user's manual produced by DSI that documents the software utility and this is a separate pdf file download. This post-processor currently works for Version 3.7 to the current version. This post-processor, as shown in Figure 21 and Figure 22, allows the user to look at model bathymetry, show time series, profile plots, contour plots, velocity vectors, and animations with up to 4 simultaneous state variables.

**Quick Guide for the
CE-QUAL-W2 Post Processor
W2_Post**

July 2012 Updates June 2016

W2_Post

A post-processor for CE-QUAL-W2 Version3/4 that provides the user with a broad range of visualization and analyses of the model results. W2_Post provides for rapid visualization and assessment of W2 model results. W2_Post uses a binary file generated by the CE-QUAL-W2 (i.e. the "W2L" file extension) for all of its model data analysis. No need to output multiple types of output from W2. The post-processor provides extensive model calibration / measured data comparison tools and statistics. The following are summaries of each major type of post-processing available.

Figure 21. Splash screen for W2_Post.

Figure 22. Menu for w2_post.exe post-processing tool from DSI.

6. Excel Macro Utility for CE-QUAL-W2

This Excel macro was written by Jeffrey Gregory, P.E., Civil Engineer, USACE, Nashville District and up-dated by Scott Wells, PSU.

The Excel macro, "w2tools_examples.xlsm", can be used to develop and write out input files for the CE-QUAL-W2 model. This can be especially useful if the model user develops an Excel workbook with separate tabs for the different input files for the model.

For example, consider the input file for wind sheltering using the new free format (or csv) formatting option. You develop a workbook for this as shown below. The coloring in the workbook is optional and is just an aid to developing your work.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	$wsc input file												
2		Segment #s											
3	JDAY	1	2	3	4	5	6	7	8	9	10	11	12
4	1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
5	1400	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

Now one opens "w2tools_examples2.xlsm" and 'Enables Macros". Once this file is opened, the user will notice that the sheet now has a header termed "Add-Ins". Clicking this header one obtains the following options as shown below: "Modify Selection", "Export Selection", or "Run EXE".

The user then selects by highlighting the portion of the file to export or modify. By selecting "Export Selection" then "Any selection to csv format". The file is written as a free-format csv file with the file name based on the worksheet name, i.e. in this case "wsc.npt". There are many other export file formats that can be used that are compatible with CE-QUAL-W2. Also, the worksheets in the "w2tools_examples.xlsm" generally show how to use the different macro features. These sheets are only used to show examples of the use of the Add-In macros.

This set of tools also allow you to modify a selection by multiplying, adding, interpolating data gaps, rounding, and transposing. Select the area of the spreadsheet that you want to modify, then select Add-Ins, Modify Selection, and one of the tools, such as Interpolate (either the X column or the Y column of a 2 column selection).

7. W2 V4.5 Bug Fixes, Enhancements, and User Manual Changes

Table 1 shows a list of model bug fixes since the release of CE-QUAL-W2 Version 4.5.

Table 1. List of bug fixes and enhancement code changes since CE-QUAL-W2 Version 4.5 was released. Note that shaded areas toggle between release versions.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
1	W2/PREW2	Release	Initial code release	7/26/2021
2	W2/PREW2	Update	Re-release fixing minor read error in sediment diagenesis	7/30/2021
3	W2	Sediment diagenesis bug fix – critical fix	The sediment temperature for the aerobic layer and anaerobic layers were re-written. There were a couple mistakes in the earlier version since Version 4.0. These have been tested and are working fine now. Also 2 diagenesis files are now produced showing the model temperature in the aerobic layer and the anaerobic layers over time and segment.	8/30/2021
4	Converter	Bug fix	The converter utility output formats were adjusted to avoid character overflow in the output file and a bug in reading the w2_con.npt file was corrected in case epiphyton were set to zero.	8/30/2021
5	W2	Withdrawal.f90	A parentheses error was found by Stewart Rounds that has been corrected. Old code: IF ((WSEL-EL(KBOT,ID)-ELR) /= 0.0) THEN Updated code: IF (WSEL-(EL(KBOT,ID)-ELR) /= 0.0) THEN This code error would not have affected any simulation with zero slope which includes all lakes and reservoirs.	11/19/2021
6	W2	Sediment diagenesis	More output files were added to evaluate the computations within the sediment diagenesis model, these include porewater concentrations of NO3, NH3, PO4, and SO4 in both aerobic and anaerobic layers. The user manual was also updated.	11/19/2021
7	Converter	Bug fix	There was a bug fix for older bathymetry file formats. This has been fixed.	12/17/2021

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
8	W2	C vs Organic matter	The input variables when all organics are in terms of C basis was adjusted in the code to mimic the existing organic matter decay paths. Some of the additional functionality of this will be added in a subsequent release when the organic matter and C species are done similarly.	12/17/2021
9	Waterbalance	Csv file type output	A few minor changes were made to prevent spurious error messages and changing the GUI version to write out csv files rather than fixed format. Also, the console version had a couple errors that were fixed in variable type.	12/20/2021
10	PreW2	Preprocessor water balance	An error was fixed in the output for pre.opt file showing the waterbalance flows if there were multiple withdrawals and tributaries	12/28/2021
11	W2	Gates	There was no bug fix, just a refinement in the gate algorithm when the gamma variable was set equal to zero in the rating curve. In this case the rating curve is similar to a spillway rather than a gate where the term B raised to the gamma power is assumed to be '1'. In the code this was forced to '1' rather than being calculated from the exponentiation. This avoids a problem if the gate opening is zero raised to the zero power. Fortran will equate this to zero, not 1.	12/28/2021

12	W2	ICE=ONWB	When Ice=ONWB, the volume balance calculation was not correct in the SNP output and in the last column of the flowbalance.csv output file. Changed line of code for ice balance from temperature subroutine to main program code since it apples to the next rather than current time step:
			
			`!VolIce(jb)=VolIce(jb)+iceqss(i)*dlt`
			`! since this flow is not exercised un-`
			`til the next time step - moved code to`
			`main program calculation of qss`
				1/13/2022

13	W2	DO for gates and spillways	Added another option for DO at gates and spillways. Reaeration is increased by a fraction of the input dissolved oxygen. In many cases dams have turbine venting or other processes that introduce air into the turbine discharge. The model user can specify when this occurs by submitting a time series file of fractions that are multiplied by the incoming dissolved oxygen concentrations. The W2 code, preprocessor and User Manual has been updated.	1/18/2022

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
14	Prew2	pre.opt	More variables were output to pre.opt such as the gate and spillway gas equations to allow for a more thorough review of input variables.	1/18/2022
15	W2	Restart	Restart input files may have had an incorrect Jul-ian day if the number was greater than 8 digits. That has been fixed for all restart time series.	2/15/2022
16	W2	Restart with ONH	A variable was not initialized properly for cases where the WITHDRAWAL OUTPUT file was set to ONH implying hourly or ONS implying seconds for the output frequency.	3/12/2022
17	W2	Sediment Dia-genesis	Fixed output for PO4 and SO4 from sediment di-agenesis output files. Also, added new output files for reduced Fe, Mn, and CH4 in the aerobic and anaerobic layers.	5/24/2022
18	W2	CH4	The sediment model had CH4 in O2 equivalents while the water column model had CH4 in as C units. The water column concentrations were ad-justed to a more common reporting unit of mg/l as CH4 and the link between the sediment and water column was fixed.	5/24/2022
19	W2	Lowering layer output of SED in TSR file	The model has an algorithm to create a deep slot in a segment in case the water layer is too low. This keeps the segment hydrated during low flow events. When using the first order sediment model in a shallow stream, the values of SED, SEDC, SEDP, and SEDN were set to zero for this new lower layer. The output for SED in the tsr file was updated using the value for the current bot-tom layer rather than the fictious lower layer.	5/26/2022
20	W2	Constriction	The input file User Manual description was in-consistent. Fixed code and User Manual to agree with spreadsheet template for constriction.	7/12/2022
21	W2	Water Quality	The Generic constituent's new feature of release based on SOD was not implemented correctly. This was fixed. The MNII reduction computation used the FeII reduction rate rather than the MnII reduction rate. This was fixed. Many thanks to Cory McDonald at Hydros in Boulder for finding those!	7/21/2022
22	W2	W2_POST	Post-processing using W2_post has been en-hanced. Now all derived variables are able to be viewed as time-series, profiles, contours, and an-imations. Prior to this, only state variables were able to be viewed.	10/13/2022

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
28	PreW2	Water balance	The water balance summary in pre.opt had a bug in computing and displaying the tributary and withdrawal flows. This has been fixed.	10/13/2022
29	W2	ENVR perfor-mance	The Environmental performance Julian day range was implemented as a yearly criterion implying that if one chose JD 20-60 over a multiple year scenario, it would use JD 20-60 each year to compile statistics. Now the user can specify yearly or a discrete set of Julian days. The User Manual has been updated. Now the Julian day range is only applied to the given range. If the first Julian day is negative, it is applied yearly.	10/13/2022
30	W2	PARTP	A bug has been fixed in the PARTP algorithm where P sorbs onto inorganic SS. This fix will somewhat reduce the P loss since it was overes-timated before. This may result in using a higher value of PARTP to get similar loss of Pas in the earlier model.	10/13/2022
31	W2	Example prob-lems	The Excel macro for writing out the example problems was updated to account for systems where the estimated number of columns was un-der-estimated. For each example, the Excel macro input file macro code was updated.	10/13/2022
32	W2	Sediment Dia-genesis	The updated sediment diagenesis code was called – not every time step – but every CUF time steps. The Time for the sediment diagenesis model was computed as $SD\_tc = dlt*CUF/DAY$ Which is the time step in days for the sediment diagenesis algorithm. This is approximately cor-rect, but not exact since the time step can vary over time and is not constant. The exact time be-tween calls for Update Kinetics was computed from $SD\_tc=JDAY-JDAY\_INIT$ Where JDAY_INIT was the JDAY at the beginning of the last call to Update Kinetics.	10/15/0222
33	W2	Flux output	The columns for flux output for DOEP (epiphyton production) and DOAR (algae respiration) were accidentally switched from the order in the con-trol file. This has been fixed.	10/20/2022

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
34	W2	Tsr output	If the tsr output with derived concentration vari-ables followed an 'Add Layer' event, the derived variables in the output were often zero or incor-rectly initialized in the layer add subroutine. All state variables were correctly initialized. On the next time step the model recomputed derived variables correctly. This only affected output.	11/10/2022
35	W2	TSR output	Further improvements for #34. APLIM, ANLIM output fixed also for special output conditions.	11/17/2022
36	W2	FLX output file	The flux output file similar to the SNP file had a limitation of 200 segments output. That has been corrected to 2000 in case one has more than 200 active segments defined in one waterbody.	1/12/2023
37	W2	Sediment Dia-genesis: Fe and Mn	The Fe and Mn routines were re-written. The prior routines did not interact with the water col-umn (oops!). These have been corrected as well as adding temperature effects for oxidation and reduction in the sediments and water column us-ing an Arrhenius approach with a theta value of 1.05.	1/12/2023
38	W2	Sediment Dia-genesis out-put	More sediment diagenesis output files are now written out including the transfer velocity (m/d) for each sediment layer.	1/12/2023
39	W2	Sediment Dia-genesis tem-perature	Another term has been added to the sediment diagenesis input file – at the end – that tells the diagenesis model to either compute temperature of the aerobic and anaerobic layers dynamically or use adjacent water temperature for aerobic and anaerobic layers.	1/12/2023
40	W2	Habitat out-put	The model user can now use a new control, DOVOL, to specify the output of volume below 1 mg/l over time. See the User Manual Part 3 on Habitat volume.	2/1/2023

8. Frequently Asked Questions

This is a list of common questions and answers for debugging your model applications.

Question topic	Question	Response
Numerical Stability	I'm modeling a canal system with high flows (~80 cms) that has a se-ries of gates and pumps to control the flows. I don't have flow rating	I would force DLTMAX lower during the high velocity period – there is no way a priori to exactly predict the numerical stability

	data on the gates, so I'm using structures to control the flows. I have data on flow rates at the pumps and infer flows at the gates. At higher flows, the model gets unstable and crashes. Is there something withing the structure algorithms that would cause a crash or would you infer that it's just a model construct?	for a non-linear PDE – it is just an estimate. Also make sure you don't set all inflows to be placed by density (PQC) and use the implicit turbulence closure scheme rather than explicit (AZSLC).

9. W2 Known Code Limitations

Table 2 shows known bugs and issues with the current release of the code:

Table 2. Known bugs in code.

#	Item	Description
1	Water levels in a "bowl"	If water levels decrease in a waterbody shaped like a "bowl", the removal of model layers as the water level decreases will cause the model to bomb if an upstream segment dries up.
2	Pipes under high head	The pipes algorithm does not handle well high-head, high-speed, dynamic flow conditions in a pipe as a result of numerical stability.
3	Time step limitation in a complex system model	The time step for stability in a system model is governed by the lowest time step for numerical stability. If you have a very dynamic river with several reservoirs, the time step for the river will control. This can result in very long run times. One can still break apart the model and run the pieces separately using the WDOUT files to provide boundary conditions for downstream waterbodies.
4	Partitioning	The partitioning coefficient for sorption is currently constant for all organic and inorganic compartments

#	Item	Description
5	Internal weir at a Dam segment	Putting an internal weir at a Dam segment does not affect the outflow from the selective withdrawal structure. One must limit selective with-drawal rather than use an internal weir at the dam segment. Remember the internal weir works for the right-hand-face of a model layer.
6	W2 multiple file error check	If the model user accidentally enters duplicate file names for an input file, the w2 executable will "bomb" because it will try to read the file in more than once. The first use of the file will lock its availability for the second instance. The W2 error message that comes on the screen (traceback error) should mention the file name that has problems. The W2 preprocessor should catch this potential error.
7	Raising level of spill-way/weir above grid	The preprocessor will say there is an error if the user raises the weir, spillway, gate, water level control or any other hydraulic element above the current top-of-the-grid. The w2 code will still run properly though. But more correctly, the model user should increase the DZ of the upper-most layer to a value that would eliminate this problem. Keep in mind that the segment widths from the top layer then extend upward at that same width.
8	Internal weirs	The internal weir algorithm does not work when all vertical layers of a segment are blocked by the weir.
9	Multiple dams into one downstream reach	Currently, the code will allow one dam inflow to a downstream branch by a user-specified outflow file. The code though does allow multiple dams inflowing to a common downstream branch if the outflow is specified as a hydraulic structure.
10	Problems reading file in GUI or in W2 pre-processor of in W2 model	Sometimes the control file or bathymetry file or an input file cannot be read properly. This can be a result of the text editor used to produce the file or file conversions that occur when transferring files from workstations running Linux or from email. There may be a problem with the end of line character in the file. For Windows files, the stand-ard end of line is a carriage return followed by a line feed: <CR><LF>. For UNIX systems it is usually only a Line Feed <LF>. To convert this from a UNIX system to a Windows system text file, use Notepad++ (a free windows text editor), go to EDIT/EOL Conversion and select Windows. Another issue common in reading text files is that the editor adds 'tabs'. All 'tabs' must be converted to 'spaces' for the file to be read properly.

10. Appendix A: Differences between CE-QUAL-W2 Versions

Differences between Version 4.22 and 4.5

In a large departure from keeping the version form almost static, Version 4.5 has many differences in the fixed format text file and the Excel xlsm file that has the w2_con.csv version of the control file.

Below are the changes in the w2_con.npt file, but comparable ones are found in the Excel input file version. Only areas with new variables are highlighted:

```
MISCELL      NDAY SELECTC HABTATC ENVIRPC AERATEC INITUWL   ORGCC   SEDIAG
              100     OFF      ON      ON     OFF     OFF     OFF     OFF


Eliminated the unused variables UQB and DQB:
BRANCH G      US      DS     UHS     DHS   NLMIN   SLOPE  SLOPEC
BR1            2      31       0       0       2 0.00000   0.000


TSR SEG     ITSR    ITSR    ITSR    ITSR    ITSR    ITSR    ITSR    ITSR    ITSR
              31

TSR LAYE    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR
           0.00000

WLOUT        WLC  WLFREQ
              ON     0.5

FLOWBAL   FLOWBC  FBFREQ
              ON     7.0

NPBAL     NPBALC NPBFREQ
              ON     7.0

WITH OUT    WDOC    NWDO   NIWDO
              ON       1       1




RSO FREQ    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF


CST COMP     CCC    LIMC     CUF  CO2PPM CO2YRLY
              ON      ON       3    400.      ON

ATMDEP    ATMDPC ATMDPIN
WB1           OFF      ON

CST ACTIVE   CAC
TDS           ON
Gen1          ON
Gen2          ON
```

```
CST ACTIVE   CAC
TDS          ON
Gen1         ON
Gen2         ON
Gen3         ON
ISS1         ON
WATERAGE     OFF
BACTERIA     OFF
DGP          OFF
N2           OFF
H2S          OFF
CH4          OFF
SO4          OFF
FEII         OFF
FEOOH        OFF
MNII         OFF
MNO2         OFF
PO4          ON
NH4          ON
NO3          ON
DSI          OFF
PSI          OFF
FE           ON
LDOM         ON
RDOM         ON
LPOM         ON
RPOM         OFF
ALG1         ON
DO           ON
TIC          ON
ALK          ON
ZOO1         OFF
LDOM_P       OFF
RDOM_P       OFF
LPOM_P       OFF
RPOM_P       OFF
LDOM_N       OFF
RDOM_N       OFF
LPOM_N       OFF
RPOM_N       OFF
MICROCY      OFF
CYLINDR      OFF
ANATOXIN     OFF
SAXITOXN     OFF

CST DERI   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC
DOC          OFF
POC          OFF
TOC          ON
DON          OFF
PON          OFF
TON          OFF
TKN          OFF
TN           ON
NH3          ON
DOP          OFF
POP          OFF
TOP          OFF
TP           OFF
APR          OFF
CHLA         OFF
ATOT         OFF
%DO          OFF
TDG          ON
TURBIDITY    OFF
TSS          OFF
```

```
TISS        OFF
CBOD        OFF
pH          OFF
CO2         OFF
HCO3        OFF
CO3         OFF
SECCHI      OFF

CST FLUX    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC
TISSIN      OFF
TISSOUT     OFF
PO4AR       OFF
PO4AG       OFF
PO4AP       OFF
PO4ER       OFF
PO4EG       OFF
PO4EP       OFF
PO4POM      OFF
PO4DOM      OFF
PO4OM       OFF
PO4SED      OFF
PO4SOD      OFF
PO4SET      OFF
NH4NITR     OFF
NH4AR       OFF
NH4AG       OFF
NH4AP       OFF
NH4ER       OFF
NH4EG       OFF
NH4EP       OFF
NH4POM      OFF
NH4DOM      OFF
NH4OM       OFF
NH4SED      OFF
NH4SOD      OFF
NH3GAS      ON
NO3DEN      OFF
NO3AG       OFF
NO3EG       OFF
NO3SED      OFF
DSIAG       OFF
DSIEG       OFF
DSIPIS      OFF
DSISED      OFF
DSISOD      OFF
DSISET      OFF
PSIAM       OFF
PSINET      OFF
PSIDK       OFF
LDOMDK      OFF
LRDOM       OFF
RDOMDK      OFF
LDOMAP      OFF
LDOMEP      OFF
LPOMDK      OFF
LRPOM       OFF
RPOMDK      OFF
LPOMAP      OFF
LPOMEP      OFF
LPOMSET     OFF
RPOMSET     OFF
CBODDK      OFF
DOAP        OFF
DOEP        OFF
DOAR        OFF
DOER        OFF
DOPOM       OFF
DODOM       OFF
```

```
DOOM       OFF
DONITR     OFF
DOCBOD     OFF
DOREAR      ON
DOSED       ON
DOSOD      OFF
TICAG      OFF
TICEG      OFF
SEDDK      OFF
SEDAS      OFF
SEDLPOM    OFF
SEDSET     OFF
SODDK      OFF


CST ICON  C2IWB      C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB
TDS        51.0000
Gen1       100.000
Gen2       0.00000
Gen3       10.0000
ISS1       2.00000
WATERAGE      0.0
BACTERIA      0.0
DGP           0.0
N2            0.0
H2S           0.0
CH4           0.0
SO4           0.0
FEII          0.0
FEOOH         0.0
MNII          0.0
MNO2          0.0
PO4        0.00100
NH4        0.00200
NO3        0.14000
DSI        0.00000
PSI        0.00000
LDOM       0.70000
RDOM       2.02200
LPOM       0.10000
RPOM       0.00000
ALG1      -1.0000
DO        -1.0000
TIC        11.9100
ALK        31.0000
ZOO1        0.1000
LDOM_P     0.0005
RDOM_P     0.0005
LPOM_P     0.0005
RPOM_P     0.0005
LDOM_N     0.0080
RDOM_N     0.0080
LPOM_N     0.0080
RPOM_N     0.0080
MICROCYS      0.0
CYLINDRO      0.0
ANATOXIN      0.0
SAXITOXN      0.0

CST PRIN  CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC
TDS            ON
Gen1           ON
Gen2          OFF
Gen3          OFF
ISS1           ON
WATERAGE      OFF
BACTERIA      OFF
DGP           OFF
```

```
N2           OFF
H2S          OFF
CH4          OFF
SO4          OFF
FEII         OFF
FEOOH        OFF
MNII         OFF
MNO2         OFF
PO4          ON
NH4          ON
NO3          ON
DSI          OFF
PSI          OFF
LDOM         ON
RDOM         ON
LPOM         ON
RPOM         OFF
ALG1         ON
DO           ON
TIC          OFF
ALK          OFF
ZOO1         OFF
LDOM_P       OFF
RDOM_P       OFF
LPOM_P       OFF
RPOM_P       OFF
LDOM_N       OFF
RDOM_N       OFF
LPOM_N       OFF
RPOM_N       OFF
MICROCYSTIN  OFF
CYLINDROSP   OFF
ANATOXIN     OFF
SAXITOXIN    OFF

CIN CON    CINBRC   CINBRC   CINBRC   CINBRC   CINBRC   CINBRC   CINBRC   CINBRC   CINBRC
TDS          ON
Gen1         ON
Gen2         OFF
Gen3         ON
ISS1         ON
WATERAGE     OFF
BACTERIA     OFF
DGP          OFF
N2           OFF
H2S          OFF
CH4          OFF
SO4          OFF
FEII         OFF
FEOOH        OFF
MNII         OFF
MNO2         OFF
PO4          ON
NH4          ON
NO3          ON
DSI          OFF
PSI          OFF
LDOM         ON
RDOM         ON
LPOM         ON
RPOM         OFF
ALG1         ON
DO           ON
TIC          ON
ALK          ON
ZOO1         OFF
LDOM_P       OFF
RDOM_P       OFF
```

```
LPOM_P        OFF
RPOM_P        OFF
LDOM_N        OFF
RDOM_N        OFF
LPOM_N        OFF
RPOM_N        OFF
MICROCYSTIN   OFF
CYLINDROSP    OFF
ANATOXIN      OFF
SAXITOXIN     OFF

CTR CON   CTRTRC   CTRTRC   CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC
TDS          ON       OFF
Gen1         ON       OFF
Gen2        OFF       OFF
Gen3         ON       OFF
ISS1         ON       OFF
WATERAGE     OFF      OFF
BACTERIA     OFF      OFF
DGP          OFF      OFF
N2           OFF      OFF
H2S          OFF      OFF
CH4          OFF      OFF
SO4          OFF      OFF
FEII         OFF      OFF
FEOOH        OFF      OFF
MNII         OFF      OFF
MNO2         OFF      OFF
PO4          ON       OFF
NH4          ON       OFF
NO3          ON       OFF
DSI         OFF       OFF
PSI         OFF       OFF
LDOM         ON       OFF
RDOM         ON       OFF
LPOM         ON       OFF
RPOM        OFF       OFF
ALG1         ON       OFF
DO           ON       OFF
TIC          ON       OFF
ALK          ON       OFF
ZOO1        OFF       OFF
LDOM_P      OFF       OFF
RDOM_P      OFF       OFF
LPOM_P      OFF       OFF
RPOM_P      OFF       OFF
LDOM_N      OFF       OFF
RDOM_N      OFF       OFF
LPOM_N      OFF       OFF
RPOM_N      OFF       OFF
MICROCYSTIN  OFF      OFF
CYLINDROSP   OFF      OFF
ANATOXIN     OFF      OFF
SAXITOXIN    OFF      OFF

CDT CON   CDTBRC   CDTBRC   CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC
TDS          ON       OFF
Gen1         ON       OFF
Gen2        OFF       OFF
Gen3         ON       OFF
ISS1         ON       OFF
WATERAGE     OFF      OFF
BACTERIA     OFF      OFF
DGP          OFF      OFF
N2           OFF      OFF
H2S          OFF      OFF
CH4          OFF      OFF
```

Model Utilities

```
SO4           OFF       OFF
FEII          OFF       OFF
FEOOH         OFF       OFF
MNII          OFF       OFF
MNO2          OFF       OFF
PO4           ON        OFF
NH4           ON        OFF
NO3           ON        OFF
DSI           OFF       OFF
PSI           OFF       OFF
LDOM          ON        OFF
RDOM          ON        OFF
LPOM          ON        OFF
RPOM          OFF       OFF
ALG1          ON        OFF
DO            ON        OFF
TIC           ON        OFF
ALK           ON        OFF
ZOO1          OFF       OFF
LDOM_P        OFF       OFF
RDOM_P        OFF       OFF
LPOM_P        OFF       OFF
RPOM_P        OFF       OFF
LDOM_N        OFF       OFF
RDOM_N        OFF       OFF
LPOM_N        OFF       OFF
RPOM_N        OFF       OFF
MICROCYSTIN   OFF       OFF
CYLINDROSP    OFF       OFF
ANATOXIN      OFF       OFF
SAXITOXIN     OFF       OFF

CPR CON    CPRBRC    CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC
TDS           ON        ON
Gen1          ON        OFF
Gen2          OFF       OFF
Gen3          ON        OFF
ISS1          ON        OFF
WATERAGE      OFF       OFF
BACTERIA      OFF       OFF
DGP           OFF       OFF
N2            OFF       OFF
H2S           OFF       OFF
CH4           OFF       OFF
SO4           OFF       OFF
FEII          OFF       OFF
FEOOH         OFF       OFF
MNII          OFF       OFF
MNO2          OFF       OFF
PO4           ON        OFF
NH4           ON        OFF
NO3           ON        OFF
DSI           OFF       OFF
PSI           OFF       OFF
LDOM          ON        OFF
RDOM          ON        OFF
LPOM          ON        OFF
RPOM          OFF       OFF
ALG1          ON        OFF
DO            ON        OFF
TIC           ON        OFF
ALK           ON        OFF
ZOO1          OFF       OFF
LDOM_P        OFF       OFF
RDOM_P        OFF       OFF
LPOM_P        OFF       OFF
RPOM_P        OFF       OFF
LDOM_N        OFF       OFF
```

```
RDOM_N        OFF      OFF
LPOM_N        OFF      OFF
RPOM_N        OFF      OFF
MICROCYSTIN   OFF      OFF
CYLINDROSP    OFF      OFF
ANATOXIN      OFF      OFF
SAXITOXIN     OFF      OFF


GENERIC    CGQ10   CG0DK   CG1DK     CGS   CGLDK   CGKLF    CGCS    CGR
CG 1     0.00000 0.00000 0.00000 0.00000     0.0     0.0     0.0    0.0
CG 2     0.00000 -1.0000 0.00000 0.00000     0.0     0.0     0.0    0.0
CG 3     1.04000 0.00000 1.40000 0.00000     0.0     0.0     0.0    0.0

S SOLIDS     SSS   SEDRC   TAUCR    SSCS
SS# 1    1.00000     OFF 0.00000     0.0

BACTERIA BACTQ10 BACT1DK   BACTS BACTLDK
WB1        1.025   0.100    0.00   0.050

H2S         H2SR  H2SQ10  H2S1DK    SO4R
WB1        0.005    1.04    0.10   0.050

CH4         CH4R  CH4Q10  CH41DK
WB1        0.004  1.0400    0.05

FE         FEIIR KFEOXID  KFERED HalfSat  SetVel
WB1        0.004  1.0400    0.05    0.10    0.10

MN         MNIIR KMNOXID  KMNRED HalfSat  SetVel
WB1        0.004  1.0400    0.05    0.10    0.10

ALGAL RATE    AG      AR      AE      AM      AS    AHSP    AHSN   AHSSI    ASAT
ALG1     2.00000 0.04000 0.04000 0.10000 0.10000 0.00300 0.01400 0.00000 100.000

ALG STOI   ALGP    ALGN    ALGC   ALGSI   ACHLA   ALPOM   ANEQN    ANPR AVERT_M
ALG1     0.00500 0.08000 0.45000 0.00000 0.06500 0.80000       1 0.00100     OFF

OM STOIC   ORGP    ORGN    ORGC   ORGSI
WB 1     0.00500 0.08000 0.45000 0.18000

OM RATE    OMT1    OMT2    OMK1    OMK2
WB 1     4.00000 30.0000 0.10000 0.99000

TURBSEC  COEFFA  COEFFB  SECCHI
WB1        1.10    0.05     1.5

CBOD       KBOD    TBOD    RBOD   CBODS
BOD 1    0.25000 1.01500 1.85000     0.0

REAERATION TYPE    EQN#   COEF1   COEF2   COEF3   COEF4   DGPO2   MINKL
WB 1       LAKE       2 0.00000 0.00000 0.00000 0.00000   1.027     0.6


MET FILE................................METFN.................................
WB 1    met.npt

EXT FILE................................EXTFN.................................
WB 1    ext_1.npt

ATD FILE................................ATDFN.................................
WB 1    atm_dep_wb1.csv

VPR FILE................................VPRFN.................................
WB 1    vpr.npt
```

Also, there are many changes in the other input files for activating different processes in Version 4.5. See the User Manual Part 3 for the new format for these ancillary input files.

Differences between Version 4.2.2 and Version 4.2.1

Version 4.2.2 has 2 new variables, [**CO2PPM**] and [**CO2YRLY**], that were added to the main control file, **w2_con.npt** and **w2_con.csv**. The old fixed format card in **w2_con.npt** is shown below:

```
RSO DATE    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD


RSO FREQ    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF


CST COMP    CCC     LIMC    CUF
            ON      OFF     10

CST ACTIVE  CAC
TDS           ON
Gen1          ON
ISS1          ON
ISS2          ON
```

The Version 4.2.2 file, **w2_con.npt** is shown below with the changes highlighted:

```
RSO DATE    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD


RSO FREQ    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF


CST COMP    CCC     LIMC    CUF     CO2PPM CO2YRLY
            ON      ON      10      400.        ON
CST ACTIVE  CAC
TDS           ON
Gen1          ON
ISS1          ON
ISS2          ON
```

In the Excel macro version, the new variables are shown below:

Differences between Version 4.2.1 and Version 4.2

Version 4.2.1 is file compatible except that the **multiple_wb.npt** format has changed. Also, a new input file, **w2_con.csv**, can be read by the model. This file is developed using the Excel file **w2_con.xslm**.

Differences between Version 4.2 and Version 4.1

Version 4.2 is file compatible with Version 4.1. There are no changes in the main control file. There are new control files though that control new processes: (1) Multiple processor simulation for cascade of waterbodies (**multiple_wb.npt**), (2) SYSTDG Total Dissolved Gas algorithm for spillways (**systdg.npt**).

Differences between Version 4.1 and Version 4.0

Version 4.1 is file compatible with Version 4.0. There are no changes in the main control file. There is only 1 new input file, '**particle.csv**', that serves as an input file to the particle tracking algorithm.

Differences between Version 4.0 and Version 3.72

Version 4 is file compatible with Version 3.72, even though there are new options in the main control file, w2_con.npt, and new input files whose presence or absence is detected by the model. For example, for ICEC control the options now include ON, ONWB, and OFF, where ONWB is a new option. New input files include a file for sediment diagenesis, 'W2_CEMA_Input.npt', and a file for the dynamic alkalinity calculation, 'pH_buffering.npt'

Control file differences are in the Generic Constituent Section of the Code where new variables were added to the control file to allow for phot-degradation and the new N2 state variable for TDG:

```
GENERIC   CGQ10   CG0DK   CG1DK    CGS    CGLDK    CGKLF     CGS
CG 1     0.00000 0.00000 0.00000 0.00000 0.00000 1.03400 -1.0000      ! TDG
CG 2     0.00000 -1.0000 0.00000 0.00000 0.00000 0.00000 0.00000
CG 3     1.04000 0.00000 1.40000 0.00000 0.00000 0.00000 0.00000
```

Differences between Version 3.72 and Version 3.71

These 2 codes are file compatible. Besides a few bug fixes since the last release of Version 3.71, Version 3.72 includes the USGS automatic port selection code. This can be activated by setting SELECTC='USGS' in the control file w2_con.npt. In Version 3.71, only 'ON' or 'OFF' were input variables for SELECTC. If one sets SELECTC='USGS', the format of the file w2_selective.npt is also changed from Version 3.71. Details of this and examples are provided in the User's Manual and on-line.

Differences between Version 3.71 and Version 3.7

There is only one change in the control file between Version 3.7 and 3.71. There is a new option for outlet structures – dynamic centerline elevation. In the control file, there is an ON/OFF option after declaring the # of structures for each branch:

```
EDDY VISC      AZC    AZSLC   AZMAX      FBC        E    ARODI STRCKLR BOUNDFR   TKECAL
WB 1           TKE      IMP 1.00000       3  9.53500 0.43100 0.00000 0.00000      IMP

N STRUC       NSTR DYNELEV
BR1             17      ON
BR2              0     OFF
BR3              0     OFF

STR INT     STRIC    STRIC    STRIC    STRIC    STRIC    STRIC    STRIC    STRIC    STRIC
```

If these fields are missing the model will assume that DYNELEV=OFF.

Differences between Version 3.7 and Version 3.6

Even though there are some cases where a Version 3.7 executable will run Version 3.6 and Version 3.5 files fine, there are updates required to the w2_con.npt file that need to be made. The preprocessor will catch these errors.

Control file changes: w2_con.npt

The main changes to the W2 control file are additional flags to turn ON/OFF new control file options and the addition of new state variables for water quality, BOD-N and BOD-P for each BOD group.

Below is a list of changes in the control file with the card image header for each line changed (highlighted options are new in V3.7). Descriptions of these new features are in the W2 User's Manual.

1. MISCELL

```
MISCELL      NDAY SELECTC HABTATC ENVIRPC AERATEC INITUWL
             100     OFF      ON      ON      ON     OFF
```

Five new variables, SELECTC, HABITATC, ENVIRPC, AERATEC, and INITUWL, are 5 new control variables that turn ON/OFF the use of automatic selective withdrawal, fish habitat volumes, environmental performance criteria, artificial aeration, and the initial water surface and velocity computations, respectively. If

using an old Version 3.6 control file, all of these would default to 'OFF' if they were left blank. Also the model preprocessor would flag these are missing variables.

2. DLT CON

```
DLT CON      NDT  DLTMIN  DLTINTR
              1 1.00000      OFF
```

where DLTINTR is a control for interpolating the the time step DLTMAX and DLTF rather than use as a step function

3. BRANCH G

```
BRANCH G      US      DS     UHS     DHS     UQB     DQB   NLMIN   SLOPE   SLOPEC
Br 1           2      59       0       0       0       0       1     0.0      0.0
```

where SLOPEC is the hydraulic equivalent slope for a river channel that affects the momentum equation.

4. GATE WEIR

```
GATE WEIR   GTA1    GTB1    GTA2    GTB2  DYNVAR     GTIC
Gate1    1.00000 1.50000 1.00000 1.50000    FLOW       ON
```

where GTIC is an interpolation control for the specified DYNVAR for the GATE-WEIR.

5. Dynamic pipe

```
PIPES       IUPI    IDPI    EUPI    EDPI     WPI   DLXPI     FPI  FMINPI  LATPIC  DYNPIPE
Pi 1          24      28    28.0    27.0     0.5   230.0   0.065     0.1    DOWN       ON
```

where DYNPIPE controls whether the pipe is controlled by time series of an ON/OFF or partially open gate

6. Dynamic pump

```
PUMPS 1     IUPU    IDPU     EPU  STRTPU   ENDPU   EONPU  EOFFPU     QPU   WTHLC  DYNPUMP
             111       0    440.    1.00    366.   441.0   435.0     1.0    DOWN       ON
```

where DYNPUMP controls the EPU, EONPU, EOFFPU, and QPU over time by reading in a time series file

7. INIT CND

```
INIT CND   TEMPI    ICEI  WTYPEC    GRIDC
WB 1      -1.0000 0.00000   FRESH     RECT
```

where GRIDC controls whether the grid is interpreted as rectangular in depth or trapezoidal.

8. CST ACTIVE [Note that this change only appears if NBOD>0]

```
CST ACTIVE   CAC
```

Model Utilities

```
TDS           ON
Gen1          ON
Gen2          OFF
Gen3          OFF
Gen4          OFF
Gen5          OFF
ISS1          ON
PO4           ON
NH4           ON
NO3           ON
DSI           OFF
PSI           OFF
FE            OFF
LDOM          ON
RDOM          ON
LPOM          ON
RPOM          ON
1CBOD         ON
2CBOD         ON
3CBOD         ON
4CBOD         ON
5CBOD         ON
6CBOD         ON
7CBOD         ON
8CBOD         ON
9CBOD         ON
10CBOD        ON
1CBODP        ON
2CBODP        ON
3CBODP        ON
4CBODP        ON
5CBODP        ON
6CBODP        ON
7CBODP        ON
8CBODP        ON
9CBODP        ON
10CBODP       ON
1CBODN        ON
2CBODN        ON
3CBODN        ON
4CBODN        ON
5CBODN        ON
6CBODN        ON
7CBODN        ON
8CBODN        ON
9CBODN        ON
10CBODN       ON
ALG1          ON
ALG2          ON
ALG3          ON
DO            ON
TIC           ON
ALK           ON
ZOO1          OFF
LDOM_P        ON
RDOM_P        ON
LPOM_P        ON
RPOM_P        ON
LDOM_N        ON
RDOM_N        ON
LPOM_N        ON
RPOM_N        ON
```

9. CST ICON, CST PRIN, CIN CON,CTR CON, CDT CON and CPR CON

```
CST ICON   C2IWB   C2IWB   C2IWB   C2IWB   C2IWB   C2IWB   C2IWB   C2IWB   C2IWB
```

```
TDS          0.0
AGE          0.0
TRACER       0.0
COL1         0.0
Conduct      0.0
Chlorine     0.0
ISS1         0.0
PO4          0.03
NH4          0.01
NOx          0.3
DSi          0.0
PSi          0.0
TFe          0.0
LDOM         0.1
RDOM         0.1
LPOM         0.1
RPOM         0.1
1CBOD        0.0
2CBOD        0.0
3CBOD        0.0
4CBOD        0.0
5CBOD        0.0
6CBOD        0.0
7CBOD        0.0
8CBOD        0.0
9CBOD        0.0
10CBOD       0.0
1CBODP       0.0
2CBODP       0.0
3CBODP       0.0
4CBODP       0.0
5CBODP       0.0
6CBODP       0.0
7CBODP       0.0
8CBODP       0.0
9CBODP       0.0
10CBODP      0.0
1CBODN       0.0
2CBODN       0.0
3CBODN       0.0
4CBODN       0.0
5CBODN       0.0
6CBODN       0.0
7CBODN       0.0
8CBODN       0.0
9CBODN       0.0
10CBODN      0.0
ALG1         0.1
ALG2         0.1
ALG3         0.1
DO           12.0
TIC          5.0
ALK          19.8
ZOO1         0.0
LDOM_P       0.0005
RDOM_P       0.0005
LPOM_P       0.0005
RPOM_P       0.0005
LDOM_N       0.0080
RDOM_N       0.0080
LPOM_N       0.0080
RPOM_N       0.0080

CST PRIN  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC
TDS         ON
AGE         ON
TRACER      ON
```

Model Utilities

```
COL1           ON
Conduct        ON
Chlorine       ON
ISS1           ON
PO4            ON
NH4            ON
NOx            ON
DSi            OFF
PSi            OFF
TFe            OFF
LDOM           ON
RDOM           ON
LPOM           ON
RPOM           ON
1CBOD          ON
2CBOD          ON
3CBOD          ON
4CBOD          ON
5CBOD          ON
6CBOD          ON
7CBOD          ON
8CBOD          ON
9CBOD          ON
10CBOD         ON
1CBODP         ON
2CBODP         ON
3CBODP         ON
4CBODP         ON
5CBODP         ON
6CBODP         ON
7CBODP         ON
8CBODP         ON
9CBODP         ON
10CBODP        ON
1CBODN         ON
2CBODN         ON
3CBODN         ON
4CBODN         ON
5CBODN         ON
6CBODN         ON
7CBODN         ON
8CBODN         ON
9CBODN         ON
10CBODN        ON
ALG1           ON
ALG2           ON
ALG3           ON
DO             ON
TIC            ON
ALK            ON
ZOO1           OFF
LDOM_P         ON
RDOM_P         ON
LPOM_P         ON
RPOM_P         ON
LDOM_N         ON
RDOM_N         ON
LPOM_N         ON
RPOM_N         ON
```

CIN CON	CINBRC	CINBRC	CINBRC	CINBRC	CINBRC	CINBRC	CINBRC	CINBRC	CINBRC
TDS	ON	ON							
AGE	OFF	OFF							
TRACER	OFF	OFF							
COL1	OFF	OFF							
Conduct	ON	ON							
Chlorine	OFF	OFF							
ISS1	ON	ON							

```
PO4          ON      ON
NH4          ON      ON
NOx          ON      ON
DSi          OFF     OFF
PSi          OFF     OFF
TFe          OFF     OFF
LDOM         ON      ON
RDOM         ON      ON
LPOM         ON      ON
RPOM         ON      ON
1CBOD        ON      ON
2CBOD        ON      ON
3CBOD        ON      ON
4CBOD        ON      ON
5CBOD        ON      ON
6CBOD        ON      ON
7CBOD        ON      ON
8CBOD        ON      ON
9CBOD        ON      ON
10CBOD       ON      ON
1CBODP       ON      ON
2CBODP       ON      ON
3CBODP       ON      ON
4CBODP       ON      ON
5CBODP       ON      ON
6CBODP       ON      ON
7CBODP       ON      ON
8CBODP       ON      ON
9CBODP       ON      ON
10CBODP      ON      ON
1CBODN       ON      ON
2CBODN       ON      ON
3CBODN       ON      ON
4CBODN       ON      ON
5CBODN       ON      ON
6CBODN       ON      ON
7CBODN       ON      ON
8CBODN       ON      ON
9CBODN       ON      ON
10CBODN      ON      ON
ALG1         ON      ON
ALG2         ON      ON
ALG3         ON      ON
DO           ON      ON
TIC          ON      ON
ALK          ON      ON
ZOO1         OFF     OFF
LDOM_P       ON      ON
RDOM_P       ON      ON
LPOM_P       ON      ON
RPOM_P       ON      ON
LDOM_N       ON      ON
RDOM_N       ON      ON
LPOM_N       ON      ON
RPOM_N       ON      ON

CTR CON   CTRTRC   CTRTRC   CTRTRC   CTRTRC   CTRTRC   CTRTRC   CTRTRC   CTRTRC   CTRTRC
TDS          ON      ON
AGE          OFF     OFF
TRACER       ON      ON
COL1         ON      ON
Conduct      ON      ON
Chlorine     ON      ON
ISS1         ON      ON
PO4          ON      ON
NH4          ON      ON
NOx          ON      ON
```

```
DSi         OFF     OFF
PSi         OFF     OFF
TFe         OFF     OFF
LDOM         ON      ON
RDOM         ON      ON
LPOM         ON      ON
RPOM         ON      ON
1CBOD        ON      ON
2CBOD        ON      ON
3CBOD        ON      ON
4CBOD        ON      ON
5CBOD        ON      ON
6CBOD        ON      ON
7CBOD        ON      ON
8CBOD        ON      ON
9CBOD        ON      ON
10CBOD       ON      ON
1CBODP       ON      ON
2CBODP       ON      ON
3CBODP       ON      ON
4CBODP       ON      ON
5CBODP       ON      ON
6CBODP       ON      ON
7CBODP       ON      ON
8CBODP       ON      ON
9CBODP       ON      ON
10CBODP      ON      ON
1CBODN       ON      ON
2CBODN       ON      ON
3CBODN       ON      ON
4CBODN       ON      ON
5CBODN       ON      ON
6CBODN       ON      ON
7CBODN       ON      ON
8CBODN       ON      ON
9CBODN       ON      ON
10CBODN      ON      ON
ALG1         ON      ON
ALG2         ON      ON
ALG3         ON      ON
DO           ON      ON
TIC          ON      ON
ALK          ON      ON
ZOO1        OFF     OFF
LDOM_P       ON      ON
RDOM_P       ON      ON
LPOM_P       ON      ON
RPOM_P       ON      ON
LDOM_N       ON      ON
RDOM_N       ON      ON
LPOM_N       ON      ON
RPOM_N       ON      ON

CDT CON  CDTBRC  CDTBRC   CDTBRC   CDTBRC   CDTBRC   CDTBRC   CDTBRC   CDTBRC   CDTBRC
TDS          ON      ON
AGE         OFF     OFF
TRACER       ON      ON
COL1         ON      ON
Conduct      ON      ON
Chlorine     ON      ON
ISS1         ON      ON
PO4          ON      ON
NH4          ON      ON
NOx          ON      ON
DSi         OFF     OFF
PSi         OFF     OFF
TFe         OFF     OFF
LDOM         ON      ON
```

```
RDOM         ON      ON
LPOM         ON      ON
RPOM         ON      ON
1CBOD        ON      ON
2CBOD        ON      ON
3CBOD        ON      ON
4CBOD        ON      ON
5CBOD        ON      ON
6CBOD        ON      ON
7CBOD        ON      ON
8CBOD        ON      ON
9CBOD        ON      ON
10CBOD       ON      ON
1CBODP       ON      ON
2CBODP       ON      ON
3CBODP       ON      ON
4CBODP       ON      ON
5CBODP       ON      ON
6CBODP       ON      ON
7CBODP       ON      ON
8CBODP       ON      ON
9CBODP       ON      ON
10CBODP      ON      ON
1CBODN       ON      ON
2CBODN       ON      ON
3CBODN       ON      ON
4CBODN       ON      ON
5CBODN       ON      ON
6CBODN       ON      ON
7CBODN       ON      ON
8CBODN       ON      ON
9CBODN       ON      ON
10CBODN      ON      ON
ALG1         ON      ON
ALG2         ON      ON
ALG3         ON      ON
DO           ON      ON
TIC          ON      ON
ALK          ON      ON
ZOO1         OFF     OFF
LDOM_P       ON      ON
RDOM_P       ON      ON
LPOM_P       ON      ON
RPOM_P       ON      ON
LDOM_N       ON      ON
RDOM_N       ON      ON
LPOM_N       ON      ON
RPOM_N       ON      ON

CPR CON   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC
TDS          ON      ON
AGE          OFF     OFF
TRACER       ON      ON
COL1         ON      ON
Conduct      ON      ON
Chlorine     ON      ON
ISS1         ON      ON
PO4          ON      ON
NH4          ON      ON
NOx          ON      ON
DSi          OFF     OFF
PSi          OFF     OFF
TFe          OFF     OFF
LDOM         ON      ON
RDOM         ON      ON
LPOM         ON      ON
RPOM         ON      ON
```

Model Utilities

```
1CBOD       ON        ON
2CBOD       ON        ON
3CBOD       ON        ON
4CBOD       ON        ON
5CBOD       ON        ON
6CBOD       ON        ON
7CBOD       ON        ON
8CBOD       ON        ON
9CBOD       ON        ON
10CBOD      ON        ON
1CBODP      ON        ON
2CBODP      ON        ON
3CBODP      ON        ON
4CBODP      ON        ON
5CBODP      ON        ON
6CBODP      ON        ON
7CBODP      ON        ON
8CBODP      ON        ON
9CBODP      ON        ON
10CBODP     ON        ON
1CBODN      ON        ON
2CBODN      ON        ON
3CBODN      ON        ON
4CBODN      ON        ON
5CBODN      ON        ON
6CBODN      ON        ON
7CBODN      ON        ON
8CBODN      ON        ON
9CBODN      ON        ON
10CBODN     ON        ON
ALG1        ON        ON
ALG2        ON        ON
ALG3        ON        ON
DO          ON        ON
TIC         ON        ON
ALK         ON        ON
ZOO1        OFF       OFF
LDOM_P      ON        ON
RDOM_P      ON        ON
LPOM_P      ON        ON
RPOM_P      ON        ON
LDOM_N      ON        ON
RDOM_N      ON        ON
LPOM_N      ON        ON
RPOM_N      ON        ON
```

New control files

Based on the options the user turns ON or OFF, new control files are required. These new control files are named:

1. w2_selective.npt – new variables controlling the selective withdrawal algorithm to select temperature targets
2. w2_habitat.npt – new variables controlling fish habitat limits for temperature and dissolved oxygen and surface and segment volume weighted eutrophication state variables
3. w2_envirpf.npt – new variables controlling setting environmental performance criteria
4. w2_aerate.npt – variables describing use of dissolved oxygen addition to enhance dissolved oxygen levels through diffusers

Details of these new control files are in the CE-QUAL-W2 User Manual.

Differences between Version 3.6 and Version 3.5

Version 3.6 can be run without changing any of the input files, even though the preprocessor will identify errors in the control file because of missing variables. Below is a highlighted list of locations in the file w2_con.npt where additional variables have been added. There are no other changes in the input files for Version 3.6.

The TKE algorithm has been updated with new algorithms that match experimental tank data for kinetic energy and dissipation. This is based on a Master's degree project by Sam Gould at Portland State University. A new user option is the TKE1 algorithm, in add addition to the legacy algorithm TKE. This results in several new input variables on the following line of the w2_con.npt file that are only active if TKE1 is chosen for AZC:

```
EDDY VISC    AZC   AZSLC   AZMAX    FBC       E    ARODI STRCKLR BOUNDFR  TKECAL
WB 1               W2    IMP 1.00000    3    9.535   0.430    24.0   10.00     IMP
```

The roughness height of the water for correction of the vertical velocity wind profile is now a user-defined input, z_0. Prior to this the model had hardwired the value of z_0=0.003 m for wind speed correction at 2m (for evaporation where wind height at 2 m is typical) and z_0=0.01 m for wind at 10 m (for shear stress calculations where wind height of 10 m is typical). For consistency, both conversions now use the same value of roughness height. If the user does not specify the value of z_0 (for example if he/she leaves the spaces blank for z_0 using a V3.5 control file), the code uses 0.001 m.

```
HYD COEF       AX     DX    CBHE    TSED     FI   TSEDF   FRICC        Z0
WB 1       1.00000 1.00000 0.30000 11.5000 0.01000 1.00000   MANN    0.001
```

A new option for output is in the format required for TECPLOT. For TECPLOT animation there is only a flag in the CPL output line. This allows for easy model animation of the variables U, W, T, RHO, and all active constituents at the frequency specified by the CPL file as a function of distance and elevation.

```
CPL PLOT    CPLC    NCPL TECPLOT
WB 1         ON       1       ON
```

A new variable for determining the fraction of NO3-N that is diffused into the sediments that becomes organic matter, or SED-N was introduced. According to one study, only about 37% of NO_3-N that diffuses into the sediments becomes incorporated into organic matter in the sediments. The rest is denitrified.

```
 NITRATE    NO3DK    NO3S  FNO3SED
 Wb 1        0.05     0.0    0.37
 Wb 2        0.05     0.0    0.37
```

In V3.5 the model computed an average decay coefficient of the sediments based on what was deposited. The user now has the option to dynamically compute that decay rate or to have it fixed and controlled by the model user. A new variable was introduced called DYNSEDK which is either ON/OFF to allow or not allow dynamic computation of the sediment decay rate.

```
 SEDIMENT    SEDC   PRNSC   SEDCI   SEDK    SEDS    FSOD    FSED   SEDBR DYNSEDK
```

```
Wb 1          ON     ON    0.0    0.1    0.0    1.0    1.0    0.001    OFF
Wb 2          ON     ON    0.0    0.1    0.0    1.0    1.0    0.001    OFF
```

The User can now specify the # of processors to use on the host computer. Most users find that setting NPROC=2 gets the best results. Sometimes setting this greater than 2 results in slower model performance. Also, the CLOSEC control closes the windows dialog box after the model completes its simulation. This is useful in using the windows version of the release code in batch simulations. These are specified in the control file as follows:

```
GRID        NWB    NBR    IMX    KMX    NPROC  CLOSEC
             1      4      66     117      2      ON
```

Differences between Version 3.2 and Version 3.5

The differences in V3.5 and V3.2 input files are found in the control file: **w2_con.npt** and in the **graph.npt** file. All other files are the same between the 2 versions.

w2_con.npt
Below is an example of parts of the control file from V3.5 where all new variables are highlighted. Most of these changes have to do with the new zooplankton, macrophyte, and new state variables added to the model. See the User Manual for a list of changes between V3.2 and V 3.5 in the version history. Also there were some deletions from the V3.2 w2_con.npt file. These are shown below.

New variables added to the control file are highlighted
```
.
.
IN/OUTFL    NTR     NST     NIW     NWD     NGT     NSP     NPI     NPU
              1       1       0       0       0       0       0       0

CONSTITU    NGC     NSS     NAL     NEP     NBOD    NMC     NZP
              5       1       1       1       5       0       1

MISCELL     NDAY
            100
.
.
CST COMP    CCC     LIMC    CUF
             ON      ON      10

CST ACTIVE  CAC
TDS         OFF
Gen1         ON
Gen2        OFF
Gen3        OFF
Gen4        OFF
Gen5        OFF
ISS1        OFF
PO4         OFF
NH4         OFF
NO3         OFF
DSI         OFF
PSI         OFF
FE          OFF
LDOM        OFF
RDOM        OFF
LPOM        OFF
RPOM        OFF
BOD1        OFF
BOD2        OFF
BOD3        OFF
BOD4        OFF
BOD5        OFF
ALG1        OFF
DO          OFF
TIC         OFF
ALK         OFF
ZOO1        OFF
LDOM_P      OFF
```

CST DERI	CDWBC	CDWBC	CDWBC	CDWBC	CDWBC	CDWBC	CDWBC	CDWBC	CDWBC
DOC	OFF								
POC	OFF								
TOC	OFF								
DON	OFF								
PON	OFF								
TON	OFF								
TKN	OFF								
TN	OFF								
DOP	OFF								
POP	OFF								
TOP	OFF								
TP	OFF								
APR	OFF								
CHLA	OFF								
ATOT	OFF								
%DO	OFF								
TSS	OFF								
TISS	OFF								
CBOD	OFF								
pH	OFF								
CO2	OFF								
HCO3	OFF								
CO3	OFF								

CST FLUX	CFWBC	CFWBC	CFWBC	CFWBC	CFWBC	CFWBC	CFWBC	CFWBC	CFWBC
TISSIN	OFF								
TISSOUT	OFF								
PO4AR	OFF								
PO4AG	OFF								
PO4AP	OFF								
PO4ER	OFF								
PO4EG	OFF								
PO4EP	OFF								
PO4POM	OFF								
PO4DOM	OFF								
PO4OM	OFF								
PO4SED	OFF								
PO4SOD	OFF								
PO4SET	OFF								
NH4NITR	OFF								
NH4AR	OFF								
NH4AG	OFF								
NH4AP	OFF								
NH4ER	OFF								
NH4EG	OFF								
NH4EP	OFF								
NH4POM	OFF								
NH4DOM	OFF								
NH4OM	OFF								
NH4SED	OFF								
NH4SOD	OFF								
NO3DEN	OFF								
NO3AG	OFF								
NO3EG	OFF								
NO3SED	OFF								
DSIAG	OFF								
DSIEG	OFF								
DSIPIS	OFF								
DSISED	OFF								

```
DSISOD      OFF
DSISET      OFF
PSIAM       OFF
PSINET      OFF
PSIDK       OFF
FESET       OFF
FESED       OFF
LDOMDK      OFF
LRDOM       OFF
RDOMDK      OFF
LDOMAP      OFF
LDOMEP      OFF
LPOMDK      OFF
LRPOM       OFF
RPOMDK      OFF
LPOMAP      OFF
LPOMEP      OFF
LPOMSET     OFF
RPOMSET     OFF
CBODDK      OFF
DOAP        OFF
DOAR        OFF
DOEP        OFF
DOER        OFF
DOPOM       OFF
DODOM       OFF
DOOM        OFF
DONITR      OFF
DOCBOD      OFF
DOREAR      OFF
DOSED       OFF
DOSOD       OFF
TICAG       OFF
TICEG       OFF
SEDDK       OFF
SEDAS       OFF
SEDLPOM     OFF
SEDSET      OFF
SODDK       OFF
```

CST ICON	C2IWB	C2IWB	C2IWB	C2IWB	C2IWB	C2IWB	C2IWB	C2IWB	C2IWB
TDS	0.00000								
Gen1	0.00000								
Gen2	0.00000								
Gen3	0.00000								
Gen4	0.00000								
Gen5	0.00000								
ISS1	0.00000								
PO4	0.03000								
NH4	0.01000								
NO3	0.30000								
DSI	0.00000								
PSI	0.00000								
FE	0.00000								
LDOM	0.10000								
RDOM	0.10000								
LPOM	0.10000								
RPOM	0.10000								
BOD1	0.00000								
BOD2	0.00000								
BOD3	0.00000								
BOD4	0.00000								
BOD5	0.00000								
ALG1	0.10000								
DO	12.0000								
TIC	5.00000								
ALK	19.8000								

```
ZOO1       0.1000
LDOM_P     0.0005
RDOM_P     0.0005
LPOM_P     0.0005
RPOM_P     0.0005
LDOM_N     0.0080
RDOM_N     0.0080
LPOM_N     0.0080
RPOM_N     0.0080
```

```
CST PRIN  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC
TDS        OFF
Gen1        ON
Gen2       OFF
Gen3       OFF
Gen4       OFF
Gen5       OFF
ISS1       OFF
PO4        OFF
NH4        OFF
NO3        OFF
DSI        OFF
PSI        OFF
FE         OFF
LDOM       OFF
RDOM       OFF
LPOM       OFF
RPOM       OFF
BOD1       OFF
BOD2       OFF
BOD3       OFF
BOD4       OFF
BOD5       OFF
ALG1       OFF
DO         OFF
TIC        OFF
ALK        OFF
ZOO1       OFF
LDOM_P     OFF
RDOM_P     OFF
LPOM_P     OFF
RPOM_P     OFF
LDOM_N     OFF
RDOM_N     OFF
LPOM_N     OFF
RPOM_N     OFF
```

```
CIN CON   CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC
TDS         ON
Gen1       OFF
Gen2        ON
Gen3        ON
Gen4        ON
Gen5        ON
ISS1        ON
PO4         ON
NH4         ON
NO3         ON
DSI        OFF
PSI        OFF
FE         OFF
LDOM        ON
RDOM        ON
LPOM        ON
RPOM        ON
BOD1        ON
BOD2        ON
BOD3        ON
```

```
BOD4          ON
BOD5          ON
ALG1          ON
DO            ON
TIC           ON
ALK           ON
ZOO1          OFF
LDOM_P        OFF
RDOM_P        OFF
LPOM_P        OFF
RPOM_P        OFF
LDOM_N        OFF
RDOM_N        OFF
LPOM_N        OFF
RPOM_N        OFF
```

CTR CON	CTRTRC	CTRTRC	CTRTRC	CTRTRC	CTRTRC	CTRTRC	CTRTRC	CTRTRC	CTRTRC
TDS	ON	ON							
Gen1	OFF	OFF							
Gen2	ON	ON							
Gen3	ON	ON							
Gen4	ON	ON							
Gen5	ON	ON							
ISS1	ON	ON							
PO4	ON	ON							
NH4	ON	ON							
NO3	ON	ON							
DSI	OFF	OFF							
PSI	OFF	OFF							
FE	OFF	OFF							
LDOM	ON	ON							
RDOM	ON	ON							
LPOM	ON	ON							
RPOM	ON	ON							
BOD1	ON	ON							
BOD2	ON	ON							
BOD3	ON	ON							
BOD4	ON	ON							
BOD5	ON	ON							
ALG1	ON	ON							
DO	ON	ON							
TIC	ON	ON							
ALK	ON	ON							
ZOO1	OFF	OFF							
LDOM_P	OFF	OFF							
RDOM_P	OFF	OFF							
LPOM_P	OFF	OFF							
RPOM_P	OFF	OFF							
LDOM_N	OFF	OFF							
RDOM_N	OFF	OFF							
LPOM_N	OFF	OFF							
RPOM_N	OFF	OFF							

CDT CON	CDTBRC	CDTBRC	CDTBRC	CDTBRC	CDTBRC	CDTBRC	CDTBRC	CDTBRC	CDTBRC
TDS	ON								
Gen1	OFF								
Gen2	ON								
Gen3	ON								
Gen4	ON								
Gen5	ON								
ISS1	ON								
PO4	ON								
NH4	ON								
NO3	ON								
DSI	OFF								
PSI	OFF								
FE	OFF								

```
LDOM          ON
RDOM          ON
LPOM          ON
RPOM          ON
BOD1          ON
BOD2          ON
BOD3          ON
BOD4          ON
BOD5          ON
ALG1          ON
DO            ON
TIC           ON
ALK           ON
ZOO1          OFF
LDOM_P        OFF
RDOM_P        OFF
LPOM_P        OFF
RPOM_P        OFF
LDOM_N        OFF
RDOM_N        OFF
LPOM_N        OFF
RPOM_N        OFF

CPR CON   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC
TDS           ON
Gen1          OFF
Gen2          ON
Gen3          ON
Gen4          ON
Gen5          ON
ISS1          ON
PO4           ON
NH4           ON
NO3           ON
DSI           OFF
PSI           OFF
FE            OFF
LDOM          ON
RDOM          ON
LPOM          ON
RPOM          ON
BOD1          ON
BOD2          ON
BOD3          ON
BOD4          ON
BOD5          ON
ALG1          ON
DO            ON
TIC           ON
ALK           ON
ZOO1          OFF
LDOM_P        OFF
RDOM_P        OFF
LPOM_P        OFF
RPOM_P        OFF
LDOM_N        OFF
RDOM_N        OFF
LPOM_N        OFF
RPOM_N        OFF

EX COEF   EXH2O    EXSS     EXOM     BETA     EXC      EXIC
WB 1      0.45000 0.01000 0.40000 0.45000     OFF      OFF

ALG EX       EXA      EXA      EXA      EXA      EXA      EXA
          0.10000

ZOO EX       EXZ      EXZ      EXZ      EXZ      EXZ      EXZ
             0.2      0.2      0.2
```

```
MACRO EX    EXM     EXM     EXM     EXM     EXM     EXM
            0.0100

GENERIC   CGQ10   CG0DK   CG1DK    CGS
CG 1      0.00000 -1.0000 0.00000 0.00000
CG 2      0.00000 0.00000 0.00000 0.00000
CG 3      1.04000 0.00000 0.50000 0.00000
CG 4      0.00000 0.00000 0.00000 0.00000
CG 5      0.00000 0.00000 0.00000 0.00000

S SOLIDS    SSS   SEDRC   TAUCR
SS1       1.50000    OFF    0.00

ALGAL RATE   AG      AR      AE      AM      AS    AHSP    AHSN   AHSSI    ASAT
ALG1      2.00000 0.12000 0.02000 0.05000 0.04000 0.00500 0.00500 0.00000 50.0000

ALGAL TEMP  AT1     AT2     AT3     AT4     AK1     AK2     AK3     AK4
ALG1      5.00000 12.0000 20.0000 30.0000 0.10000 0.99000 0.99000 0.10000

ALG STOI   ALGP    ALGN    ALGC   ALGSI   ACHLA   ALPOM   ANEQN    ANPR
ALG1      0.00500 0.08000 0.45000 0.00000 65.0000 0.80000       1 0.00100

EPIPHYTE   EPIC    EPIC    EPIC    EPIC    EPIC    EPIC    EPIC    EPIC    EPIC
EPI1         OFF

EPI PRIN   EPRC    EPRC    EPRC    EPRC    EPRC    EPRC    EPRC    EPRC    EPRC
EPI1         OFF

EPI INIT  EPICI   EPICI   EPICI   EPICI   EPICI   EPICI   EPICI   EPICI   EPICI
EPI1      10.0000

EPI RATE     EG      ER      EE      EM      EB    EHSP    EHSN   EHSSI
EPI1      2.00000 0.05000 0.02000 0.05000 0.01000 0.00200 0.00200 0.00000

EPI HALF   ESAT     EHS   ENEQN    ENPR
EPI1      50.0000 40.0000       2 0.00200

EPI TEMP    ET1     ET2     ET3     ET4     EK1     EK2     EK3     EK4
EPI1      2.00000 5.00000 20.0000 30.0000 0.10000 0.99000 0.99000 0.10000

EPI STOI     EP      EN      EC     ESI   ECHLA    EPOM
EPI1      0.00500 0.08000 0.45000 0.00000 65.0000 0.80000

ZOOP RATE    ZG      ZR      ZM    ZEFF   PREFP  ZOOMIN    ZS2P
Zoo1         1.50    0.10   0.010    0.50    0.50  0.0100    0.30

ZOOP ALGP  PREFA   PREFA   PREFA   PREFA   PREFA   PREFA   PREFA   PREFA   PREFA
Zoo1         1.00    0.50    0.50

ZOOP ZOOP  PREFZ   PREFZ   PREFZ   PREFZ   PREFZ   PREFZ   PREFZ   PREFZ   PREFZ
Zoo1         0.00    0.00    0.00

ZOOP TEMP    ZT1     ZT2     ZT3     ZT4     ZK1     ZK2     ZK3     ZK4
             0.0    15.0    20.0    36.0     0.1     0.9    0.98   0.100

ZOOP STOI     ZP      ZN      ZC
           0.01500 0.08000 0.45000

MACROPHYT MACWBC  MACWBC  MACWBC  MACWBC  MACWBC  MACWBC  MACWBC  MACWBC  MACWBC
Mac1          ON     OFF     OFF

MAC PRINT MPRWBC  MPRWBC  MPRWBC  MPRWBC  MPRWBC  MPRWBC  MPRWBC  MPRWBC  MPRWBC
Mac1          ON     OFF     OFF

MAC INI  MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI
Mac1      0.00000     0.1     0.5
```

```
MAC RATE      MG       MR       MM     MSAT    MHSP    MHSN    MHSC    MPOM  LRPMAC
Mac 1        0.30     0.05     0.05    30.0     0.0     0.0     0.0     0.9     0.2


MAC SED      PSED     NSED
MAC 1        0.5      0.5


MAC DIST     MBMP     MMAX
Mac 1        40.0     500.0


MAC DRAG    CDSTEM     DWV     DMSA    ANORM
Mac 1        2.0      7e4      8.00     0.80


MAC TEMP     MT1      MT2      MT3      MT4      MK1     MK2     MK3     MK4
Mac 1        7.0     15.0     24.0     34.0     0.1     0.99    0.99    0.01


MAC STOICH    MP       MN       MC
Mac 1        0.005    0.08     0.45


DOM        LDOMDK   RDOMDK    LRDDK
WB 1       0.10000  0.00100  0.00100


POM        LPOMDK   RPOMDK    LRPDK     POMS
WB 1       0.08000  0.00100  0.00100  0.10000


OM STOIC    ORGP     ORGN     ORGC     ORGSI
WB 1       0.00500  0.08000  0.45000  0.18000


OM RATE     OMT1     OMT2     OMK1     OMK2
WB 1       4.00000  30.0000  0.10000  0.99000


CBOD        KBOD     TBOD     RBOD     CBODS
BOD 1      0.04180  1.01470  1.00000     0.0
BOD 2      0.13020  1.01470  1.00000     0.0
BOD 3      0.04690  1.01470  1.00000     0.0
BOD 4      0.08800  1.01470  1.00000     0.0
BOD 5      0.05000  1.01470  1.00000     0.0


CBOD STOIC  BODP     BODN     BODC
BOD 1      0.00500  0.08000  0.45000
BOD 2      0.00500  0.08000  0.45000
BOD 3      0.00500  0.08000  0.45000
BOD 4      0.00500  0.08000  0.45000
BOD 5      0.00500  0.08000  0.45000


PHOSPHOR    PO4R     PARTP
WB 1       0.00100  0.00000


AMMONIUM    NH4R     NH4DK
WB 1       0.00100  0.50000


NH4 RATE   NH4T1    NH4T2    NH4K1    NH4K2
WB 1       5.00000  25.0000  0.10000  0.99000


NITRATE    NO3DK     NO3S
WB 1       0.05000  0.00000


NO3 RATE   NO3T1    NO3T2    NO3K1    NO3K2
WB 1       5.00000  25.0000  0.10000  0.99000


SILICA      DSIR     PSIS     PSIDK    PARTSI
WB 1       0.10000  0.00000  0.30000  0.20000


IRON         FER      FES
WB 1       0.10000  0.00000


SED CO2     CO2R
WB 1       0.10000
```

```
STOICH 1   O2NH4    O2OM
WB 1     4.57000 1.40000

STOICH 2   O2AR     O2AG
ALG1     1.10000 1.40000

STOICH 3   O2ER     O2EG
EPI1     1.10000 1.40000

STOICH 4   O2ZR
ZOO1     1.10000

STOICH 5   O2MR     O2MG
MAC1       1.1      1.4

O2 LIMIT     KDO
          0.10000

SEDIMENT   SEDC   SEDPRC   SEDCI    SEDK    SEDS    FSOD    FSED    SEDBR
WB 1         ON       ON 0.00000 0.10000     0.1 1.00000 1.00000     0.2

SOD RATE   SODT1    SODT2    SODK1    SODK2
WB 1     4.00000 30.0000 0.10000 0.99000

S DEMAND    SOD      SOD      SOD      SOD      SOD      SOD      SOD      SOD      SOD
            0.6      0.6      0.6      0.6      0.6      0.6      0.6      0.6      0.6
            0.6      0.6      0.6      0.6      0.6      0.6      0.6      0.6      0.6
            0.6      0.6      0.6      0.6      0.6      0.6      0.6      0.6      0.6
            0.6      0.6      0.6      0.6      0.6      0.6      0.6      0.6      0.6
            0.6

REAERATION TYPE   EQN#    COEF1    COEF2    COEF3    COEF4
WB1        LAKE      6
```

Lines removed from the V3.2 control file: These are a result of eliminating the pumpback and line printer settings.

Here is the part of the V3.2 control file that was deleted:

```
DST TRIB   DTRC
Br 1         ON
Br 2         ON
Br 3        OFF
Br 4        OFF
Br 5        OFF

PUMPBACK     JBG      KTG      KBG      JBP      KTP      KBP
             0

PRINTER      LJC
             IV

HYD PRINT HPRWBC   HPRWBC   HPRWBC   HPRWBC   HPRWBC   HPRWBC   HPRWBC   HPRWBC   HPRWBC
NVIOL        OFF      OFF
U             ON       ON
```

Graph.npt file changes. These changes are a result of the new state variables in W2 and are highlighted below.

```
Hydrodynamic, constituent, and derived constituent names, formats, multipliers, and array
viewer controls

.....................HNAME....................   FMTH    HMULT    HMIN    HMAX    HPLTC
#
```

```
Timestep violations [NVIOL]                    (I10)     1.0    -1.0      1.0     OFF
1
Horizontal velocity [U], m/s                (1PE10.1)    1.0   -.1000     0.15    OFF
2
Vertical velocity [W], m/s                  (1PE10.1)    1.0   -.1E-6    -0.01    OFF
3
Temperature [T1], <o/>C                       (F10.2)    1.0   -10.0    -26.0      ON
4
Density [RHO], g/m^3                          (F10.3)    1.0   997.0   1005.0     OFF
5
Vertical eddy viscosity [AZ], m^2/s          (F10.3)    1.0   -1E-08     0.01     OFF
6
Velocity shear stress [SHEAR], 1/s^2         (F10.3)    1.0   -1E-08     0.01     OFF
7
Internal shear [ST], m^3/s                   (F10.3)    1.0   -1E-08     0.01     OFF
8
Bottom shear [SB], m^3/s                     (F10.3)    1.0   -1E-08     0.01     OFF
9
Longitudinal momentum [ADMX], m^3/s          (F10.3)    1.0   -1E-08     0.01     OFF
10
Longitudinal momentum [DM], m^3/s            (F10.3)    1.0   -1E-08     0.01     OFF
11
Horizontal density gradient [HDG], m^3/s     (F10.3)    1.0   -1E-08     0.01     OFF
12
Vertical momentum [ADMZ], m^3/s              (F10.3)    1.0   -1E-08     0.01     OFF
13
Horizontal pressure gradient [HPG], m^3/s    (F10.3)    1.0   -1E-08    10.0      OFF
14
Gravity term channel slope [GRAV], m^3/s     (F10.3)    1.0    0.0       0.0      OFF
15

....................CNAME....................    FMTC   CMULT    CMIN     CMAX    CPLTC
#
TDS, g/m^3                                    (F10.3)    1.0    -1.0    200.0      OFF
1
Age, days                                    (F10.3)    1.0    -1.0   -200.0       ON
2
Tracer, g/m^3                                (F10.3)    1.0  -20.000   100.0      OFF
3
Bacteria, col/100ml                          (F10.3)    1.0  -20.000   100.0      OFF
4
Conductivity, mhos                           (F10.3)    1.0  -20.000   100.0      OFF
5
Chloride, mg/l                               (F10.3)    1.0  -20.000   100.0      OFF
6
ISS, g/m^3                                   (F10.3)    1.0  -20.000   100.0      OFF
7
Phosphate, g/m^3                             (F10.3) 1000.0    -1.0    500.0      OFF
8
Ammonium, g/m^3                              (F10.3) 1000.0  -0.1000   300.0      OFF
9
Nitrate-Nitrite, g/m^3                       (F10.3)    1.0  -0.1000     5.0      OFF
10
Dissolved silica, g/m^3                      (F10.3)    1.0    -1.0     10.0      OFF
11
Particulate silica, g/m^3                    (F10.3)    1.0  -0.2000    15.0      OFF
12
Total iron, g/m^3                            (F10.3)    1.0  -0.1000     2.0      OFF
13
Labile DOM, g/m^3                            (F10.3)    1.0  -0.1000    -3.0      OFF
14
Refractory DOM, g/m^3                        (F10.3)    1.0  -0.1000    -4.0      OFF
15
Labile POM, g/m^3                            (F10.3)    1.0  -0.1000    -3.0      OFF
16
Refractory POM, g/m^3                        (F10.3)    1.0  -0.1000    -4.0      OFF
17
```

CBOD1, g/m^3		(F10.3)	1.0	-0.0100	3.0	OFF
18						
CBOD2, g/m^3		(F10.3)	1.0	-0.0100	3.0	OFF
19						
CBOD3, g/m^3		(F10.3)	1.0	-0.0100	3.0	OFF
20						
CBOD4, g/m^3		(F10.3)	1.0	-0.0100	3.0	OFF
21						
CBOD5, g/m^3		(F10.3)	1.0	-0.0100	3.0	OFF
22						
Algae, g/m^3		(F10.3)	1.0	-0.0100	3.0	OFF
23						
Dissolved oxygen, g/m^3		(F10.3)	1.0	-0.0100	-1.0	OFF
24						
Inorganic carbon, g/m^3		(F10.3)	1.0	-0.0100	3.0	OFF
25						
Alkalinity, g/m^3		(F10.3)	1.0	-0.0100	3.0	OFF
26						
zooplankton1, mg/m^3		(g10.3)	1000.0	-0.0100	1.0	OFF
27						
LDOM P, mg/m^3		(g10.3)	1000.0	0.0	1.0	OFF
28						
RDOM P, mg/m^3		(g10.3)	1000.0	0.0	1.0	OFF
29						
LPOM P, mg/m^3		(g10.3)	1000.0	0.0	1.0	OFF
30						
RPOM P, mg/m^3		(g10.3)	1000.0	0.0	1.0	OFF
31						
LDOM N, mg/m^3		(g10.3)	1000.0	0.0	1.0	OFF
32						
RDOM N, mg/m^3		(g10.3)	1000.0	0.0	1.0	OFF
33						
LPOM N, mg/m^3		(g10.3)	1000.0	0.0	1.0	OFF
34						
RPOM N, mg/m^3		(g10.3)	1000.0	0.0	1.0	OFF
35						

...................CDNAME...................	FMTCD	CDMULT	CDMIN	CDMAX	CDPLTC
#					
Dissolved organic carbon, g/m^3	(F10.3)	1.0	-1.0	25.0	OFF
1					
Particulate organic carbon, g/m^3	(F10.3)	1.0	-1.0	50.0	OFF
2					
Total organic carbon, g/m^3	(F10.3)	1.0	-1.0	25.0	OFF
3					
Dissolved organic nitrogen, g/m^3	(F10.3)	1.0	-1.0	25.0	OFF
4					
Particulate organic nitrogen, g/m^3	(F10.3)	1.0	-1.0	25.0	OFF
5					
Total organic nitrogen, g/m^3	(F10.3)	1.0	-1.0	50.0	OFF
6					
Total Kheldahl Nitrogen, g/m^3	(F10.3)	1.0	-1.0	15.0	OFF
7					
Total nitrogen, g/m^3	(F10.3)	1.0	-1.0	15.0	OFF
8					
Dissolved organic phosphorus, mg/m^3	(F10.3)	1000.0	-1.0	25.0	OFF
9					
Particulate organic phosphorus, mg/m^3	(F10.3)	1000.0	-1.0	-1.0	OFF
10					
Total organic phosphorus, mg/m^3	(F10.3)	1000.0	-1.0	5.0	OFF
11					
Total phosphorus, mg/m^3	(F10.3)	1000.0	-1.0	20.0	OFF
12					
Algal production, g/m^2/day	(F10.3)	1.0	-1.0	5.0	OFF
13					
Chlorophyll a, mg/m^3	(F10.3)	1.0	-5.0	145.0	OFF
14					

```
Total algae, g/m^3                         (F10.3)   1.0   -1.0   60.0   OFF
15
Oxygen % Gas Saturation                    (F10.3)   1.0   -1.0   50.0   OFF
16
Total suspended Solids, g/m^3              (F10.3)   1.0   -1.0    5.0   OFF
17
Total Inorganic Suspended Solids,g/m^3     (F10.3)   1.0   -1.0   20.0   OFF
18
Carbonaceous Ultimate BOD, g/m^3           (F10.3)   1.0    5.0    9.0   OFF
19
pH                                         (F10.3)   1.0   -1.0   10.0   OFF
20
CO2                                        (F10.3)   1.0   -1.0   10.0   OFF
21
HCO3                                       (F10.3)   1.0   -1.0   10.0   OFF
22
CO3                                        (F10.3)   0.0    0.0    0.0   OFF
23
```

Differences between Version 3.1 and Version 3.2

There are minor differences in 2 input files between the 2 versions: **w2_con.npt** and the **graph.npt** file. All other files are the same between the 2 versions.

w2_con.npt

The only section where there is a slight difference in the control file is in the section where the inorganic suspended solids group settling velocities are entered. In Version 3.1, this section looks like this:

```
ALG EX         EXA      EXA      EXA      EXA      EXA      EXA
          0.10000

GENERIC    CGQ10    CG0DK    CG1DK     CGS
CG 1      0.00000 -1.0000 0.00000 0.00000
CG 2      0.00000 0.00000 0.00000 0.00000
CG 3      1.04000 0.00000 0.50000 0.00000
CG 4      0.00000 0.00000 0.00000 0.00000
CG 5      0.00000 0.00000 0.00000 0.00000

S SOLIDS     SSS      SSS      SSS      SSS      SSS      SSS      SSS      SSS      SSS
          1.50000

ALGAL RATE   AG       AR       AE       AM       AS      AHSP     AHSN     AHSSI    ASAT
ALG1      2.00000 0.12000 0.02000 0.05000 0.04000 0.00500 0.00500 0.00000 50.0000
```

In Version 3.2, there is now a sediment resuspension capability for wind driven resuspension along the shores of lakes and reservoirs. The Version 3.2 control file has the following lines in this same section of the control file:

```
ALG EX         EXA      EXA      EXA      EXA      EXA      EXA
          0.10000

GENERIC    CGQ10    CG0DK    CG1DK     CGS
CG 1      0.00000 -1.0000 0.00000 0.00000
CG 2      0.00000 0.00000 0.00000 0.00000
CG 3      1.04000 0.00000 0.50000 0.00000
CG 4      0.00000 0.00000 0.00000 0.00000
CG 5      0.00000 0.00000 0.00000 0.00000

S SOLIDS     SSS     SEDRC    TAUCR
SS1       1.50000     OFF     0.00

ALGAL RATE   AG       AR       AE       AM       AS      AHSP     AHSN     AHSSI    ASAT
ALG1      2.00000 0.12000 0.02000 0.05000 0.04000 0.00500 0.00500 0.00000 50.0000
```

For Version 3.2, SSS is the settling velocity for particle group 1, SEDRC is the control which turns ON or OFF sediment resuspension, and TAUCR is the critical shear stress at which resuspension occurs. For Version 3.2, each line represents 1 SS group, while in Version 3.1, each group settling velocity is in the next 8 columns moving across the page.

graph.npt

The graph file controls output formatting and the graphing parameters used in Array Viewer (only for the PC platform). The files have been rearranged significantly. A Version 3.1 graph file is shown below:

```
Constituent, hydrodynamic, and derived constituent names, formats, multipliers, and array
viewer controls


.....................CNAME...................    CMULT    CMIN    CMAX   CPLTC     #
TDS g/m^3 or Salinity kg/m^3                    1.00000 -1.0000 200.000    OFF      1
Generic Constituent,g/m^3, #1                   1.00000 -1.0000 -200.00     ON      2
Generic Constituent,g/m^3, #2                   1.00000 -1.0000 1000.00    OFF      3
Generic Constituent,g/m^3, #3                   1.00000 -1.0000 5.00000    OFF      4
Generic Constituent,g/m^3, #4                   1.00000 -1.0000 -300.00    OFF      5
Generic Constituent,g/m^3, #5                   1.00000 -1.0000 -3.0000    OFF      6
Suspended solids,g/m^3, #1                      1.00000 -1.0000 15.0000    OFF      7
Phosphate, g/m^3                                1000.00 -1.0000 -50.000    OFF      8
Ammonium,   g/m^3                               1000.00 -0.1000 -300.00    OFF      9
Nitrate-Nitrite, g/m^3                          1.00000 -0.1000 -5.0000    OFF     10
Dissolved silica, g/m^3                         1.00000 -1.0000 10.0000    OFF     11
Particulate silica, g/m^3                       1.00000 -0.2000 15.0000    OFF     12
Total iron, g/m^3                               1.00000 -0.1000 2.00000    OFF     13
Labile DOM, g/m^3                               1.00000 -0.1000 -3.0000    OFF     14
Refractory DOM, g/m^3                           1.00000 -0.1000 4.00000    OFF     15
Labile POM, g/m^3                               1.00000 -0.1000 3.00000    OFF     16
Refractory POM, g/m^3                           1.00000 -0.1000 4.00000    OFF     17
CBOD, g/m^3,     #1                             1.00000 -0.1000 10.0000    OFF     18
CBOD, g/m^3,     #2                             1.00000 -0.1000 10.0000    OFF     19
CBOD, g/m^3,     #3                             1.00000 -0.1000 10.0000    OFF     20
CBOD, g/m^3,     #4                             1.00000 -0.1000 10.0000    OFF     21
CBOD, g/m^3,     #5                             1.00000 -0.1000 10.0000    OFF     22
Algae,  g/m^3,      #1                          1.00000 -0.0100 -3.0000    OFF     23
Dissolved oxygen, g/m^3                         1.00000 -2.0000 15.0000    OFF     24
Inorganic carbon, g/m^3                         1.00000 -1.0000 10.0000    OFF     25
Alkalinity, g/m^3                               1.00000 -1.0000 200.000    OFF     26


.....................HNAME...................     HFMT    HMIN    HMAX   HPLTC     #
Timestep violations [NVIOL]                     (F10.0) -1.0000  100000    OFF      1
Horizontal velocity [U], m/s                  (1PE10.1) -0.0100 0.10000     ON      2
Vertical velocity [W], m/s                    (1PE10.1)-.10E-06 0.01000    OFF      3
Temperature [T1], <o/>C                         (F10.2) -2.0000 -30.000     ON      4
Density [RHO], g/m^3                            (F10.2) 997.000 1005.00    OFF      5
Vertical eddy viscosity [AZ], m^2/s           (1PE10.1)  -1E-08 0.00100    OFF      6
Velocity shear stress [SHEAR], 1/s^2          (1PE10.1)  -1E-08 0.01000    OFF      7
Internal shear [ST], m^3/s                    (1PE10.1)  -1E-08 0.01000    OFF      8
Bottom shear [SB], m^3/s                      (1PE10.1)  -1E-08 0.01000    OFF      9
Longitudinal momentum [ADMX], m^3/s           (1PE10.1)  -1E-08 0.01000    OFF     10
Longitudinal momentum [DM], m^3/s             (1PE10.1)  -1E-08 0.01000    OFF     11
Horizontal density gradient [HDG], m^3/s      (1PE10.1)  -1E-08 0.01000    OFF     12
Vertical momentum [ADMZ], m^3/s               (1PE10.1)  -1E-08 0.01000    OFF     13
Horizontal pressure gradient [HPG], m^3/s     (1PE10.1)  -1E-08 0.01000    OFF     14
Gravity term channel slope [GRAV], m^3/s      (1PE10.1)  -1E-08 10.0000    OFF     15


.....................CDNAME...................   CDMULT   CDMIN   CDMAX  CDPLTC     #
Dissolved organic carbon, g/m^3                 1.00000 -1.0000 3.00000    OFF      1
Particulate organic carbon, g/m^3              1.00000 -1.0000 25.0000    OFF      2
Total organic carbon, g/m^3                     1.00000 -1.0000 50.0000    OFF      3
Dissolved organic nitrogen, g/m^3              1.00000 -1.0000 25.0000    OFF      4
Particulate organic nitrogen, g/m^3            1.00000 -1.0000 25.0000    OFF      5
Total organic nitrogen, g/m^3                   1.00000 -1.0000 25.0000    OFF      6
Total Kheldahl Nitrogen, g/m^3                  1.00000 -1.0000 5.00000    OFF      7
Total nitrogen, g/m^3                           1.00000 -1.0000 50.0000    OFF      8
Dissolved organic phosphorus, mg/m^3           1000.00 -1.0000 15.0000    OFF      9
Particulate organic phosphorus, mg/m^3         1000.00 -1.0000 15.0000    OFF     10
Total organic phosphorus, mg/m^3               1000.00 -1.0000 25.0000    OFF     11
Total phosphorus, mg/m^3                        1000.00 -1.0000 -1.0000    OFF     12
Algal production, g/m^2/day                     1.00000 -1.0000 5.00000    OFF     13
```

```
Chlorophyll a, mg/m^3                            1000.00 -1.0000 -70.000    OFF      14
Total algae, g/m^3                               1.00000 -1.0000 5.00000    OFF      15
Oxygen % Gas Saturation                          1.00000 -5.0000 145.000    OFF      16
Total suspended Solids, g/m^3                     1.00000 -1.0000 60.0000    OFF      17
Total Inorganic Suspended Solids,g/m^3           1.00000 -1.0000 50.0000    OFF      18
Carbonaceous Ultimate BOD, g/m^3                 1.00000 -1.0000 20.0000    OFF      19
pH                                               1.00000 6.00000 9.00000    OFF      20
CO2                                              1.00000 -1.0000 10.0000    OFF      21
HCO3                                             1.00000 -1.0000 10.0000    OFF      22
CO3                                              1.00000 -1.0000 10.0000    OFF      23
```

An example of the same graph file but for Version 3.2 is shown below:

```
Hydrodynamic, constituent, and derived constituent names, formats, multipliers, and array
viewer controls

....................HNAME....................    FMTH    HMULT    HMIN    HMAX    HPLTC
#
Timestep violations [NVIOL]                      (I10)    1.0     -1.0     1.0     OFF
1
Horizontal velocity [U], m/s                     (Z10.8)  1.0    -.1000    0.15     ON
2
Vertical velocity [W], m/s                       (Z10.8)  1.0    -.1E-6   -0.01    OFF
3
Temperature [T1], <o/>C                          (Z10.8)  1.0    -10.0    -26.0     ON
4
Density [RHO], g/m^3                             (Z10.8)  1.0    997.0   1005.0    OFF
5
Vertical eddy viscosity [AZ], m^2/s             (Z10.8)  1.0    -1E-08    0.01    OFF
6
Velocity shear stress [SHEAR], 1/s^2            (Z10.8)  1.0    -1E-08    0.01    OFF
7
Internal shear [ST], m^3/s                      (Z10.8)  1.0    -1E-08    0.01    OFF
8
Bottom shear [SB], m^3/s                        (Z10.8)  1.0    -1E-08    0.01    OFF
9
Longitudinal momentum [ADMX], m^3/s             (Z10.8)  1.0    -1E-08    0.01    OFF
10
Longitudinal momentum [DM], m^3/s               (Z10.8)  1.0    -1E-08    0.01    OFF
11
Horizontal density gradient [HDG], m^3/s        (Z10.8)  1.0    -1E-08    0.01    OFF
12
Vertical momentum [ADMZ], m^3/s                 (Z10.8)  1.0    -1E-08    0.01    OFF
13
Horizontal pressure gradient [HPG], m^3/s       (Z10.8)  1.0    -1E-08    10.0    OFF
14
Gravity term channel slope [GRAV], m^3/s        (Z10.8)  1.0     0.0      0.0     OFF
15

....................CNAME....................    FMTC    CMULT    CMIN    CMAX    CPLTC
#
TDS, g/m^3                                       (Z10.8)  1.0     -1.0    200.0    OFF
1
Age, days                                       (Z10.8)  1.0     -1.0   -200.0     ON
2
Tracer, g/m^3                                    (Z10.8)  1.0   -20.000   100.0    OFF
3
Bacteria, col/100ml                             (Z10.8)  1.0   -20.000   100.0    OFF
4
Conductivity, mhos                              (Z10.8)  1.0   -20.000   100.0    OFF
5
Chloride, mg/l                                  (Z10.8)  1.0   -20.000   100.0    OFF
6
ISS, g/m^3                                       (Z10.8)  1.0   -20.000   100.0    OFF
7
```

```
Phosphate, g/m^3                              (Z10.8)  1000.0    -1.0   500.0    OFF
8
Ammonium, g/m^3                               (Z10.8)  1000.0 -0.1000   300.0    OFF
9
Nitrate-Nitrite, g/m^3                        (Z10.8)     1.0 -0.1000     5.0    OFF
10
Dissolved silica, g/m^3                       (Z10.8)     1.0    -1.0    10.0    OFF
11
Particulate silica, g/m^3                     (Z10.8)     1.0 -0.2000    15.0    OFF
12
Total iron, g/m^3                             (Z10.8)     1.0 -0.1000     2.0    OFF
13
Labile DOM, g/m^3                             (Z10.8)     1.0 -0.1000    -3.0    OFF
14
Refractory DOM, g/m^3                         (Z10.8)     1.0 -0.1000    -4.0    OFF
15
Labile POM, g/m^3                             (Z10.8)     1.0 -0.1000    -3.0    OFF
16
Refractory POM, g/m^3                         (Z10.8)     1.0 -0.1000    -4.0    OFF
17
CBOD1, g/m^3                                  (Z10.8)     1.0 -0.0100     3.0    OFF
18
CBOD2, g/m^3                                  (Z10.8)     1.0 -0.0100     3.0    OFF
19
CBOD3, g/m^3                                  (Z10.8)     1.0 -0.0100     3.0    OFF
20
CBOD4, g/m^3                                  (Z10.8)     1.0 -0.0100     3.0    OFF
21
CBOD5, g/m^3                                  (Z10.8)     1.0 -0.0100     3.0    OFF
22
Algae, g/m^3                                  (Z10.8)     1.0 -0.0100     3.0    OFF
23
Dissolved oxygen, g/m^3                       (Z10.8)     1.0 -0.0100    -1.0    OFF
24
Inorganic carbon, g/m^3                       (Z10.8)     1.0 -0.0100     3.0    OFF
25
Alkalinity, g/m^3                             (Z10.8)     1.0 -0.0100     3.0    OFF
26

....................CDNAME...................  FMTCD  CDMULT   CDMIN   CDMAX  CDPLTC
#
Dissolved organic carbon, g/m^3               (F10.3)     1.0    -1.0    25.0    OFF
1
Particulate organic carbon, g/m^3            (F10.3)     1.0    -1.0    50.0    OFF
2
Total organic carbon, g/m^3                  (F10.3)     1.0    -1.0    25.0    OFF
3
Dissolved organic nitrogen, g/m^3            (F10.3)     1.0    -1.0    25.0    OFF
4
Particulate organic nitrogen, g/m^3          (F10.3)     1.0    -1.0    25.0    OFF
5
Total organic nitrogen, g/m^3                (F10.3)     1.0    -1.0    50.0    OFF
6
Total Kheldahl Nitrogen, g/m^3               (F10.3)     1.0    -1.0    15.0    OFF
7
Total nitrogen, g/m^3                         (F10.3)     1.0    -1.0    15.0    OFF
8
Dissolved organic phosphorus, mg/m^3         (F10.3)  1000.0    -1.0    25.0    OFF
9
Particulate organic phosphorus, mg/m^3       (F10.3)  1000.0    -1.0    -1.0    OFF
10
Total organic phosphorus, mg/m^3             (F10.3)  1000.0    -1.0     5.0    OFF
11
Total phosphorus, mg/m^3                      (F10.3)  1000.0    -1.0    20.0    OFF
12
Algal production, g/m^2/day                   (F10.3)     1.0    -1.0     5.0    OFF
13
```

```
Chlorophyll a, mg/m^3                          (F10.3)    1.0    -5.0   145.0    OFF
14
Total algae, g/m^3                             (F10.3)    1.0    -1.0    60.0    OFF
15
Oxygen % Gas Saturation                        (F10.3)    1.0    -1.0    50.0    OFF
16
Total suspended Solids, g/m^3                  (F10.3)    1.0    -1.0     5.0    OFF
17
Total Inorganic Suspended Solids,g/m^3         (F10.3)    1.0    -1.0    20.0    OFF
18
Carbonaceous Ultimate BOD, g/m^3               (F10.3)    1.0     5.0     9.0    OFF
19
pH                                             (F10.3)    1.0    -1.0    10.0    OFF
20
CO2                                            (F10.3)    1.0    -1.0    10.0    OFF
21
HCO3                                           (F10.3)    1.0    -1.0    10.0    OFF
22
CO3                                            (F10.3)    0.0     0.0     0.0    OFF
23
```

In Version 3.2, the user has format control of all output variables, as well as MULT control (see User Manual). In Version 3.1, some groups had one but not the other. Also, in Version 3.2, the groups (HNAME, CNAME, CDNAME) were reordered.

11. Appendix B: BUG FIXES AND ENHANCEMENTS BETWEEN VERSIONS

There have been many updates and bug fixes between model versions. Even though some model updates have not been documented, we have tried to be diligent in outlining code updates since Version 3.7 between model versions. We have included below a series of tables with code fixes for multiple versions of CE-QUAL-W2 as a reference to earlier versions.

W2 V4.2 Bug Fixes, Enhancements, and User Manual Changes

Table 3 shows a list of model bug fixes since the prior release of CE-QUAL-W2 Version 4.1. Note that some of these fixes were documented before the first release of Version 4.2.

Table 3. List of bug fixes and enhancement code changes since CE-QUAL-W2 Version 4.2 was released. Note that shaded areas toggle between release versions.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
1	W2	Particle tracking	Fixed a bug when a particle was in the "air" above the water surface when in a river a 'deep slot' was added to the river bathymetry to keep it hydrated. Also, fixed a reflection error off the surface for vertical movement of the particle.	12/26/2018
2	W2	Particle tracking	For file output for finalparticle.csv, adjusted header so that it would be general for any number of monitoring stations. Previously the header was hard-wired to write only 3 monitoring locations in the title. This does not affect prior model output information only the title header.	1/3/2019
3	PREW2	Pipe invert	The preprocessor gave a 'false' error for an invert elevation being below the grid in some rare cases. This has been fixed. The model was not affected.	1/21/2019
4	W2	TN	There was a bug in the calculation of TN when large concentrations of zooplankton were present. If zooplankton were not simulated or they were a small population, there would be no impact of this TN bug. Bug fixed.	1/29/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
5	W2	Epiphyton periphyton burial and conversion to LPOM and sediments	The User Manual showed that the epiphyton parameter EB, burial rate, was in units of m/day. The model implemented this and also computed the cell layer burial rate as EB*EC (concentration of biomass per cell volume) * Surface area/Volume of a cell or EB*EC/H where H is the layer thickness. In reality though it should be the thickness of the periphyton layer. But that layer thickness is not predicted by the model. Hence, the decision was to change the burial rate to units of 1/day such that the loss of epiphyton by burial would follow a first order decay process (similar to the first order sediment model) as EB*EC. Hence, this burial rate is no longer a function of the grid. Also, there was the conversion of organic matter and nutrients at death to the sediment P, N and C compartments whereas they should go directly to LPOM first. Hence only burial goes directly into the sediment compartments.	3/5/2019
6	W2	Output files	Code was written to print the initial condition in output files at time t=0 at the start of the simulation.	3/5/2019
7	W2	Restart with Sediment Diagenesis	Prior to this date, the restart option did not work with sediment diagenesis turned ON. This enhancement has been coded and debugged and is now working.	7/1/2019
8	W2	Dynamic loading	This is a new feature in CE-QUAL-W2 and applies to linear waterbodies in series. For example, if one has a river system with 9 waterbodies, the model user can break the model into 9 separate models and run them all in parallel where the downstream model dynamically updates its boundary conditions as the upstream model moves forward in time. This has resulted in significant time savings for model runs (90%).	7/1/2019
9	W2	Sediment Diagenesis	Output files were updated to write csv files that can be plotted easily in Excel. The older output files for sediment diagenesis were hard to graph formatted text output files. All internal writes for warnings are now written to the W2 warning file, w2.wrn, and all errors are written to the w2.err output file.	7/1/2019
10	W2	Sediment Diagenesis	Bug fixes were made to the scour section of the model. The code had several errors based on the documentation from CEMA. These have been fixed and synchronized with the description in the CEMA sediment diagenesis report. Thanks to Lindsay Bearup at the USBR! Also, the scour model was not set-up for both Chezy and Manning's friction factors. This code was generalized.	7/1/2019
11	W2	Output files	Output files were not initialized properly for w2.wrn during a restart. This was fixed allowing the w2.wrn file to be appended to rather than over-written.	7/1/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
12	W2	Code updates	Pointers were allocated memory in the ALLOCATE command. This was non-standard Fortran usage and was fixed. There were extra calls to Kinetic_Rates and Temperature_Rates subroutines that were unnecessary during layer addition and in the INIT subroutine.	7/1/2019
13	W2	TDG	A new algorithm for TDG production at spillways, SYSTDG, was implemented in Version 4.2. This is a more detailed TDG correlation equation compared with the existing algorithms in Version 4.1 and before. The primary application was for the Columbia and Snake River dams. A separate technical memo is included with the User Manual on this new process.	7/1/2019
14	W2	opt to csv	Flux output files were changed from a file type opt to csv to facilitate graphing in Excel. Structure output files for the auto port selection were changed from opt to csv.	7/1/2019
15	W2	Contour output	The Tecplot and regular Contour output was not working for cases when branches went inactive. This has been fixed.	7/1/2019
16	W2	Sediment diagenesis	The input file for sediment diagenesis has been changed from w2_CEMA_input.npt to w2_diagenesis.npt for clarity of naming files. All output files have also been changed to include 'Diagenesis' as the first word and eliminating 'CEMA'. For example the file CEMALogFile.opt was changed to DiagenesisLogFile.opt.	7/1/2019

17	W2	Withdrawal	In the withdrawal subroutine, the kt index needed to be defined twice. Below is an example of the fix in 2 places:
			(1)
			
			`ELR  = SINA(JB)*DLX(ID)*0.5          ! CB 10/14/11`
			`         WSEL = ELWS(ID)-ELR                ! CB 10/14/11`
			`         kt=ktwb(jw)      ! cb 07/24/19`
			`         CALL DOWNSTREAM_WITHDRAWAL_ESTIMATE(JSTSPLT(J,1),TEMPTOP,ESTR(JSTSPLT(J,1),TSPLTJB(J)))`
			
			(2)
			`WSEL = ELWS(IWD(JWD))-ELR                ! CB 10/14/11`
			`         I=IWD(JWD)`
			`         kt=ktwb(jjw)      ! cb 07/24/19`
			`         CALL LATERAL_WITHDRAWAL_ESTIMATE(JSTSPLT(J,1),TEMPTOP,EWD(JSTSPLT(J,1)))`
				8/1/2019

18	W2	Branch inactive	The BR_INACTIVE flag that skips output in a branch that was inactive was dimensioned with the wrong variable for the CPL output (Tecplot output). This has been corrected.	8/27/2019
19	W2	Tecplot Branch	There is a new input file to specify what branches the user wants for Tecplot output, called TecplotBr.csv. This allows the user to only pick some of the branches rather than all of them for Tecplot output.	8/27/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

20	Prew2	False warning	A false warning was sometimes activated for pipes for DYNPIPE when in fact was ON or OFF as required. This was fixed. Below is final code fix:
			
			``IF ((DYNPIPE(JP) /= ' ON') .AND.
			(DYNPIPE(JP) /= ' OFF')) THEN
			    CALL ERRORS
			    WRITE (ERR,FMTI) 'Pipe DYNAMIC PIPE
			control [DYNPIPE='//DYNPIPE(JP)(4:8)//'] must
			be either "ON" or "OFF" for pipe```
				8/27/2019

21	W2	str_brX.opt	Structure output file, str_brX.opt, for automatic port selection was changed from a text delimited *.opt file to a comma delimited *.csv file	8/28/2019
22	W2	Auto Port Selection	The split algorithm for the auto port selection based on temperature now can read an input file of dynamic temperatures rather than relying on multiple rules with different fixed temperatures.	8/30/2019
23	W2	Tecplot	Tecplot output under the CPL output was not set up for restart properly. Tecplot output files now should work for cases where there are model restarts.	9/4/2019

24	W2	Water age	The code below for water age correction as a result of evaporation (a very minor adjustment) was incorrect:
			The old code was
			
			``IF(AERATEC == " ON")CALL
			AERATEMASS
			        IF(EVAPORATION(JW) .AND.
			WATER_AGE_ACTIVE)THEN ! CORRECT WATER AGE
			FOR EVAPORATION SR 7/27/2017
			            DO I=IU,ID
			                JC=NGCS+JG_AGE-1
			
			CSSB(KT,I,JC)=CSSB(KT,I,JC)-EV(I)*CG(KT,I,JC)
			            ENDDO
			        ENDIF```
			
			The updated code is
			
			``IF(AERATEC == " ON")CALL
			AERATEMASS
			        IF(EVAPORATION(JW) .AND.
			WATER_AGE_ACTIVE)THEN ! CORRECT WATER AGE
			FOR EVAPORATION SR 7/27/2017
			            DO I=IU,ID
			                JC=NGCS+JG_AGE-1
			
			CSSB(KT,I,JC)=CSSB(KT,I,JC)-
			EV(I)*CG(KT,I,JG_AGE)
			            ENDDO
			        ENDIF```
				10/17/2019

25	W2	Pipe algorithm	The pipe algorithm was revised to reduce issues with pipe algorithm instabilities. There is error trapping to reduce the prevalence of growing instabilities from a water surface slope that becomes unstable.	11/1/2019

Model Utilities

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
26	W2	W2 fixes	Small fixes that do not affect the model user: Eliminated the unused variable PHISET and changed INTEGER*8 variables in the SYSTDG algorithm to INTEGER*4. Thanks to Stewart Rounds USGS for noting these items.	11/13/2019

27	W2	Turbidity	Turbidity can be used through the sediment diagenesis model as a derived variable. This will shortly be moved to a derived constituent in W2 and taken out of the sediment diagenesis subroutine. There was a coding error in the turbidity routine that was fixed:
			``
			!CellTSSValue = C1(K,SegNumI,6)
			                 !CellTSSValue = TOTSS(K,SegNumI)
			!SW 11/15/2019 C1(K,SegNumI,nturb) ! cb
			2/18/13
			                 !C1(K,SegNumI,6) = exp(Co-
			effA_Turb*log(CellTSSValue) + CoeffB_Turb)
			                 !C2(K,SegNumI,6) = exp(Co-
			effA_Turb*log(CellTSSValue) + CoeffB_Turb)
			                   !C1(K,SegNumI,nturb) = exp(Co-
			effA_Turb*log(CellTSSValue) + CoeffB_Turb) !
			cb 2/18/13
			                   !C2(K,SegNumI,nturb) = exp(Co-
			effA_Turb*log(CellTSSValue) + CoeffB_Turb)
			                 C1(K,SegNumI,nturb) = exp(Co-
			effA_Turb*log(TOTSS(K,SegNumI)) + CoeffB_Turb)
			! cb 2/18/13
			                 C2(K,SegNumI,nturb) = C1(K,Se-
			gNumI,nturb) !exp(CoeffA_Turb*log(CellTSSValue) +
			CoeffB_Turb)
			``
				11/15/2019

28	W2	Examples and User Manual	The kinetic flux output order for DOEP and DOAR was reversed in a couple of the input files in the model example files (in w2_con.npt) and in one place in the User Manual. These were corrected.	11/15/2019

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

29	W2	Branch Active	In the process of setting inflows to upstream inactive branches to branches that were still active, the follow-ing code was updated for complex, multi-waterbody systems: [Chris Berger]
			
			``
			  IF(BR_INACTIVE(JB))THEN ! CONVERT INFLOWS TO
			TRIBS SET TO THE CUS(1) LOCATION
			  JTT=JTT+1
			  !ITR(JTT)=CUS(1) ! HARDWIRED TO FIRST BRANCH
			  ITR(JTT)=CUS(jbdn(jw)) ! changed HARDWIRE TO
			JBDN BRANCH ! cb 11/20/19
			  QTR(JTT) = QIN(JB)
			
			…
			! including tributary flows for inactive
			branches
			    DO JW=1,NWB ! cb 11/20/19
			      KT = KTWB(JW)
			      DO JB=BS(JW),BE(JW)
			        IF(BR_INACTIVE(JB))then
			          IU = CUS(JB)
			          ID = DS(JB)
			          IF (TRIBUTARIES) THEN
			           DO JT=1,JTT
			
			!********** Inflow fractions
			
			            IF (JB == JBTR(JT)) THEN
			             I = cus(jbdn(jw)) ! plac-
			ing tributary flows in upstream end of main
			branch
			             QTRF(KT:KB(I),JT) = 0.0
			             KTTR(JT) = KT
			             KBTR(JT) = KB(I)
			             KTTR(JT) = MAX(KT,KTTR(JT))
			             KBTR(JT) = MIN(KB(I),KBTR(JT))
			             IF (KBTR(JT) < KTTR(JT)) KBTR(JT)
			= KTTR(JT)
			             BHSUM = 0.0
			             DO K=KTTR(JT),KBTR(JT)
			               BHSUM = BHSUM+BH2(K,I)
			             END DO
			             DO K=KTTR(JT),KBTR(JT)
			                QTRF(K,JT) = BH2(K,I)/BHSUM
			             END DO
			             DO K=KTTR(JT),KBTR(JT)
			                QSS(K,I) =
			QSS(K,I)+QTR(JT)*QTRF(K,JT)
			             END DO
			            END IF
			           END DO
			          END IF
			        end if
			      end do
			    end do
			``
				11/22/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
30	W2	WRN output	The warning output format was improved when there were volume balance errors – thanks to Stewart Rounds, who defies retirement to provide model improvements!!	12/2/2019

In the subroutine, balances.f90, the new code is shown below:

```
      IF (VOLUME_WARNING) THEN
WRITE(WRN,'(A,F0.4,/A,I0,A,I0,A,I0,3(:/A,E15.8,
A))')                                       &
'COMPUTATIONAL WARNING AT JULIAN DAY = ',JDAY,
&
'WATERBODY=', JW, ', BRANCH=', JB, ', KT=', KT,
&
'SPATIAL CHANGE  =', VOLSBR(JB), ' M^3',
&
'TEMPORAL CHANGE =', VOLTBR(JB), '
M^3',
&
'VOLUME ERROR    =', VOLSBR(JB)-VOLTBR(JB), '
M^3'
!SR 11/16/19
 WRITE (WRN,*) 'LAYER CHANGE:', LAYERCHANGE(JW)
 WRITE (WRN,*) 'SZ', SZ(CUS(JB):DS(JB)), 'Z',
Z(CUS(JB):DS(JB)), 'H2KT',
H2(KT,CUS(JB):DS(JB)),                       &
'H1KT', H1(KT,CUS(JB):DS(JB)), 'WSE',
ELWS(CUS(JB):DS(JB)), 'Q', Q(CUS(JB):DS(JB)),
&
'QC', QC(CUS(JB):DS(JB)), 'T1',
T1(KT,CUS(JB):DS(JB)), 'T2',
T2(KT,CUS(JB):DS(JB)),                        &
'SUKT', SU(KT,CUS(JB):DS(JB)), 'UKT',
U(KT,CUS(JB):DS(JB)), 'QIN', QINSUM(JB),
&
'QTR', QTR, 'QWD', QWD    !SR 11/16/19
      WARNING_OPEN   = .TRUE.
```

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

31	W2	W2 Error Dump	The W2ErrorDump.opt file output format was changed to be easier to analyze. The file was changed to W2ErrorDump .csv to facilitate opening in Excel and for general plotting. The new code is from Stewart Rounds and is found in endsimulation.f90.
			
			Old code:
			`!OPEN(W2ERR,FILE='W2Errordump.opt',status='unknown')`
			
			`!WRITE(w2err,*)'JDAY',jday,'SZ',sz,'Z',z,'H2KT',h2(kt,1:imx),'H1KT',h1(kt,1:imx),'BHR1',bhr1(kt,1:imx),'BHR2',bhr2(kt,1:imx),'WSE',elws,'Q',q,'QC',qc,'QERR',qerr,'T1',t1(kt,1:imx),'T2',t2(kt,1:imx),'SUKT',su(kt,1:imx),&`
			`!`
			`'UKT',u(kt,1:imx),'QIN',qin,'QTR',qtr,'QWD',qwd`
			
			New Code:
			`OPEN (W2ERR,FILE='W2Errordump.csv',status='unknown')`
			`    WRITE (W2ERR,*) 'JDAY = ', JDAY`
			`    WRITE (W2ERR,'(A,1000(",",F0.6))') 'QIN:',`
			`(QIN(J),J=1,NBR)`
			`    WRITE (W2ERR,'(A,1000(",",F0.6))') 'QTR:',`
			`(QTR(J),J=1,NTRT)`
			`    WRITE (W2ERR,'(A,1000(",",F0.6))') 'QDT:',`
			`(QDTR(J),J=1,NBR)`
			`    WRITE (W2ERR,'(A,1000(",",F0.6))') 'QWD:',`
			`(QWD(J),J=1,NWDT)`
			`    WRITE (W2ERR,'(/A)')`
			`'SEG,BRANCH,KT,WSE,SZ,Z,Q,QC,QERR,H2KT,H1KT,BHR1,BHR2,T1,T2,SUKT,UKT'`
			`    DO JW=1,NWB`
			`      KT = KTWB(JW)`
			`      DO JB=BS(JW),BE(JW)`
			`        DO I=US(JB)-1,DS(JB)+1`
			`          WRITE`
			`(W2ERR,'(I0,",",I0,",",I0,14(",",F0.6))') I, JB, KT,`
			`ELWS(I), SZ(I), Z(I), Q(I), QC(I), QERR(I),`
			`                H2(KT,I), H1(KT,I), BHR1(KT,I),`
			`BHR2(KT,I), T1(KT,I), T2(KT,I), SU(KT,I), U(KT,I)`
			`        END DO`
			`      END DO`
			`    END DO`
				12/30/2019

32	W2	Multiple Waterbody	Stewart Rounds improved on the code presented in Version 4.2. Instead of writing and reading restart files, the code waited for the updates before proceeding. This led to code changes in many subroutines. Also, the downstream model can now wait for input from multiple upstream files rather than just one. This update is described in the User Manual and is part of the Version 4.2.1 model update because of a new input file format for the multiple waterbody input file.	1/2/2020

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
33	PREW2	Preprocessor	A new feature was added to the preprocessor – a new windows pops up with errors if they are present. This avoids having to open the pre.err file in a word processor in case there were errors. 	3/15/2020
34	W2	Pump	Added features were added to the pump algorithm. This allows for the flow through a pump to be controlled by the downstream water level, rather than just the upstream level. If this is the case, then a negative downstream segment number is used. This also changes the logic of ELON and ELOFF. This has been updated in the User Manual also.	3/15/2020
35	W2/PREW2	Control file	A new control file option was created in Excel using a comma delimited control file, w2_con.csv. This control file is a lot simpler to use than the text file w2_con.npt because (1) strict formatting by spaces is not required, (2) easier to cut and paste large sections withing Excel, (3) variable explanations are available in Column A, (4) the graph.npt file is no longer required and is incorporated into the Excel based input file, and (5) there is a one-button function to write the input file into csv format for reading into the W2 code. This file also has many other advantages in setting up output and more intuitive variable placement (i.e., the order of the old w2_con.npt is not strictly followed.) The only negative is that it breaks the GUI W2_Control which is not necessary other than the nice visualization bathymetry tools. But many of those are in the w2Tools post-processor. There is currently not a converter from the old format to the new one. But the model executable and preprocessor work with either control file.	4/16/2020
36	W2	TSR	TSR model output headers were improved. The P, N, and Light limitation for algae headers (APLIM, ANLIM, ALLIM) now show the algae group number rather than a generic header, such as PLIM_ALG1.	5/3/2020
37	Converter	Control file	A control file converter utility and description was added to the download package. This utility converts the control file (w2_con.npt) to a format using Excel.	5/22/2020
39	PreW2	More checks	Several additional model checks were added to the preprocessor to improve its skill set.	5/22/2020 6/15/2020

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
40	W2	Tecplot out-put	A new input file Tecplotbr.csv is now used to specify which branches are output to the Tecplot contour map. Before, all model branch information was output to the Tecplot file. Now the user can control this more precisely to eliminate a lot of post-processing of the data file. This is described in the User Manual.	5/22/2020
41	W2	CO2 in atmos-phere	As the basis for Version 4.2.2, the CO2 gas saturation was redone. See User Manual Part 2 under TIC.	8/10/2020
42	Converter		Fixed a bug in writing out the csv format for the con-trol file in case there were more than 1 withdrawals.	8/27/2020
43	W2	SPR ONV	Whenever the SPR was set equal to ONV for a w2_con.csv file, this output was not implemented cor-rectly. For the input file w2_con.npt this worked as ex-pected.	10/8/2020
44	Converter		Fixed a bug when NTR was exactly 9 (this bug also affected cases where NWB=9 or NBR=9). Also fixed some of the output formatting.	11/27/2020
45	W2	Pipe	A dimensioning bug was found when there were no pipes. This did not affect model results with the exe-cutable but did show up using the debugger in the In-tel environment. This has been fixed. Many thanks to Jun Ma for noticing that!!	12/20/2020
46	W2/Pre/Converter	Csv input	When converting to the Excel macro utility for the control file and when modeling a system with no tribu-taries, the columns read for distributed inflows and precipitation may have been read incorrectly. This was adjusted by fixing the converter utility, the preproces-sor and W2 code.	2/17/2021
47	W2	Kinetic Flux	When there are layer subtractions, the Kinetic flux in the surface layer terms can not account for the mass. This did not affect the mass balance of the constitu-ents, just the flux variables used for output. Many thanks for Taylor Adams of Hydros for finding that er-ror. In layeraddsubtract.f90: KF(KT,I,KFCN(1:NAF(JW),JW)) = (KF(KT-1,I,KFCN(1:NAF(JW),JW))*VOL(KT-1,I)+ KF(KT,I,KFCN(1:NAF(JW),JW))*VOL(KT,I))/(VOL(KT-1,I)+VOL(KT,I)) ! SW Fix suggested by Taylor Adams Hydros 25Feb2021 ! KF is in units of g/m3/s KFS(KT,I,KFCN(1:NAF(JW),JW)) = KFS(KT-1,I,KFCN(1:NAF(JW),JW))+KFS(KT,I,KFCN(1:NAF(JW),JW)) ! SW Fix suggested by Taylor Adams Hydros 25Feb2021 ! KFS is in units of g KFS=KF*VOL*DT C1(KT-1,I,CN(1:NAC)) = 0.0	2/25/2021

W2 V4.1 Bug Fixes, Enhancements, and User Manual Changes

Table 4. Bug fixes and enhancements for Version 4.1.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
1	PREW2	Additional checks	Additional checks were added to the preprocessor for sediment decay temperature coefficients and stoichiometric coefficients. Concentration summaries in downstream and upstream head boundary conditions were added to the pre.opt file.	5/19/2017
2	W2	DO Saturation	The equation for computing dissolved oxygen saturation was a function of elevation and temperature. If the user set the water body type to SALT, the TDS or salinity was used to correct the dissolved oxygen saturation. The TDS correction for dissolved oxygen saturation was added to the fresh water computation also. The new code is highlighted below: `SATO = EXP(7.7117-1.31403*(LOG(T+45.93)))*P` `IF (SALT_WATER) THEN` `SATO = EXP(LOG(SATO)-SAL*(1.7674E-2-1.0754E1/(T+273.15)+2.1407E3/(T+273.15)**2))    ! SAL is in ppt` `ELSEIF(SAL > 100.)THEN` `SATO = EXP(LOG(SATO)-(SAL/1000.)*(1.7674E-2-1.0754E1/(T+273.15)+2.1407E3/(T+273.15)**2))   ! SAL is in mg/l` `ENDIF`	5/21/2017
3	W2	Sediment diagenesis output	Another line was added to the sediment diagenesis input file for the frequency of output. Prior to this it used the TSR output frequency and wrote out duplicate results if there was more than 1 waterbody.	5/25/2017
4	W2	Initialize variables	DLVOL, VOLTBR, EVBR, and QSUM were added to the initialized variables in INIT.F90. This only affects the Fortran compiler when it is in debug model. In the release executable all variables are initialized to zero even if not explicitly set to zero.	7/24/2017

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

5	W2	Sediment diagenesis code updates	We have deleted unused variables and array initializations. This has improved the speed of running the model with sediment diagenesis. These code areas are:
			
			``
			!SP CEMA
			  if(sediment_diagenesis)then
			    If(CEMARelatedCode .and. IncludeBedCon-
			solidation)Call ComputeCEMARelatedSourceSinks
			  ! If(CEMARelatedCode .and. Include-
			CEMASedDiagenesis)Call ComputeCEMADiagene-
			sisSourceSinks SW 6/27/2017
			  end if
			!End SP CEMA
			
			    !SP CEMA
			    !if(sediment_diagenesis)then
			    ! If(CEMARelatedCode .and. In-
			cludeBedConsolidation)TSS = 0.0 ! SW
			7/27/2017
			    !end if
			    !End SP CEMA
			
			!SP CEMA
			!if(sediment_diagenesis)then
			! CEMATSSCopy = TSS
			!end if
			!End SP CEMA
			``
				7/24/2017

6	PREW2	Sediment diagenesis	Additional error checking for the sediment diagenesis model was added to the preprocessor. In this case, whenever SOD was not set to zero, an error is displayed.	7/24/2017
7	W2	Assorted code improvements	Stewart Rounds of the USGS suggested a few minor updates: eliminated extra right-parentheses in a format description for time series output (the Intel compiler allowed them!), added WARNING_OPEN and ERROR_OPEN = .TRUE. in several cases where output is written to these files, and eliminated a situation where the derived output file at a withdrawal point was not written out if the file is empty. Also, for water age, evaporation should not concentrate the 'age'. Hence code was added to recognize water age and to eliminate the effect of evaporation on water age.	7/27/2017
8	W2	Branch active or inactive	In the W2 model, if a model branch became dehydrated, the model would not continue running. In order to allow for wide varieties of water levels, users would often have to add numerous deep fictitious layers to keep a branch hydrated. Now the model can handle branches becoming active or inactive automatically. Code was added to allow branches to become active as they fill up or to become inactive if they lose their water. Also, any branch inflows or tributaries entering inactive branches are automatically moved to the current active segment of the nearest hydrated branch.	7/27/2017

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

9	W2	RPOMN	Stewart Rounds, USGS, found this one. The if test below used NRPOMP rather than NRPOMN. Usually both NRPOMN and NRPOMP are both 'ON', so for most applications this should not affect the model user.
			OLD Code:
			   IF(CAC(NRPOMP) == ' ON')THEN
			    IF(RPOM(K,I).GT.0.0)THEN
			     ORGNRP(K,I)=RPOMN(K,I)/RPOM(K,I)
			NEW Code:
			   IF(CAC(NRPOMN) == ' ON')THEN
			    IF(RPOM(K,I).GT.0.0)THEN
			     ORGNRP(K,I)=RPOMN(K,I)/RPOM(K,I)
				8/2/2017

10	W2	Screen Dialog Box	Under some unique conditions, exiting the W2 dialog box reinitializes some of the output files. Added code was inserted to STOP program execution after closing the dialog box.	8/23/2017
11	W2	Sediment Diagenesis	Flux rates for P, NH3, and NO3 were added to the MASSBAL output file from sediment diagenesis so that a complete N and P balance can be evaluated for a waterbody.	8/31/2017
12	W2	Particle Tracking	Particle tracking algorithm has been added and documentation in a separate report added to the model release	8/31/2017
13	W2	Opt to csv file	Changed flowbal.opt and massbal.opt to flowbal.csv and massbal.csv in order to facilitate opening inn Excel.	8/31/2017
14	W2	Gate file	The gate file was inadvertently not converted over to a csv format in the earlier Version 4.0 code. The 4.1 code was updated to include csv gate files.	9/26/2017

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Fixed or Enhance-ment added

15	W2	Shading	Added code to allow for a canopy shading in addition to dynamic shading. The DYNSH in the shade input file can now be a negative number between -1 and 0. This will activate dynamic shading and taking the absolute value of this number will reduce the short wave solar radiation by a fixed fraction as if some of the channel has a canopy. Of course canopy cover is more complex than this small correction since it also affects long-wave radiation transfer. New code is highlighted be-low:
			
			`    SN    = MIN (HT*ABS (SIN (ABS (PHI0(I)-AZ00)))/TAN (A0)-EDGE,BI(KT,I))`
			`    SFACT = SRED*SN/BI(KT,I)`
			`100 CONTINUE`
			`    SHADE(I) = MAX (0.0,1-SFACT)`
			`    SHADE(I) = MIN(ABS(SHADEI(I)),SHADE(I))`
			`! SW 10/2/2017 Allows for fixed canopy cover over top of channel - only used if shade is less than shadei only valid for -0.99 and 0.0`
			
			Hence if DYNSH (or SHADEI) in the code were -0.9 and the dynamic shading algorithm computed the shade factor as 0.95 (which is a 5% reduction in short wave solar), the code would use 0.9 or a 10% reduction in short-wave solar. If the dynamic shade algorithm com-putes a shade greater than the fixed rate, the mini-mum of these is used.
				10/3/2017

16	W2	Sediment Di-agenesis	Changed back to the original segment width at the bottom for sediment diagenesis so that this algorithm replicates the original CEMA sediment diagenesis algo-rithm. Pulled out the CellArea as a dimensioned varia-ble computed only once rather than for each cell at each time step. Also, added a control variable to turn ON/OFF Bubbles calculation. This saves much compu-tational time and until the Bubbles subroutine is vet-ted we do not recommend its use. Also several code fixes were made in the sediment diagenesis module for mistakes in the original algorithm.	10/3/2017, 10/22/2017
17	W2	User Manual	The User Manual was updated fixing minor errors and typos and adding discussion of new features of Ver-sion 4.1. This is Revision 1 of the 4.1 Manual but in-cludes updates and fixed typos from the Version 4.0 Manual and explanations of new features.	10/3/2017

18	W2	Kinetic fluxes for ADD Layer	A bug was corrected in the Kinetic Flux layer addition code as shown below:
			`KFS(KT,I,KFCN(1:NAF(JW),JW))    = KFS(KT+1,I,KFCN(1:NAF(JW),JW))`
			`!KF(KT+1,I,KFCN(1:NAF(JW),JW))    CODE ERROR FIX SW 10/24/2017`
			This does not affect fluxes in the TSR file, only the cu-mulative fluxes (KFS) during an add layer event for the surface layer only.
				10/24/2017

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
19	W2	Header	Changed header for flux for DO reaeration from just source to source/sink which can occur during super-saturation. `KFNAME(64) = 'DO reaeration - source/sink, kg/day        '`	10/24/2017

20	W2	Fluxes	In the file, kfl_wbX.opt where X is the waterbody number, the fluxes are presented in the same format as a snapshot file. The headers showed fluxes in kg/d but they were in kg. This has been corrected. The fluxes in kg/d in the file kflux_wbX.opt were already in the correct units of kg/d. Also, added the following code since KT would have been from the prior waterbody rather than the current waterbody:
			
			`DO JW=1,NWB`
			`    KT = KTWB(JW)    ! SW 10/25/2017`
			`    IF (FLUX(JW)) CALL KINETIC_FLUXES`
			`END DO`
				10/24/2017

21	W2	Pumps	Changed some of the logic for pumps to avoid settings for older values influencing the current settings. The following code was added to hydroinout.f90:
			
			`ILAT = 0`
			`JWW  = NWD`
			`withdrawals = jww > 0`
			`if(nwdt>nwd)qwd(nwd+1:nwdt)=0.0    ! SW 10/30/2017`
			`JTT  = NTR`
			`tributaries = jtt > 0`
			`if(ntrt>ntr)qtr(ntr+1:ntrt)=0.0    ! SW 10/30/2017`
			`JSS  = NSTR`
				10/30/2017

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

22	W2	TDG at spillway	Since the new implementation of the TDG algorithm, the withdrawal.f90 algorithm at spillways had not been updated properly. This fix applies to the computation of TDG at spillways and gates. The old and new code are shown below:
			
			``
			    !if(tdgon)then ! cb
			11/6/17
			      !cdavg(js,jb,16) =
			(cavg(js,jb,ndo)/exp(7.7117-
			1.31403*(log(tavg(js,jb)+45.93)))*palt(id))*1
			00.0
			      dosat=exp(7.7117-
			1.31403*(log(tavg(js,jb)+45.93)))*palt(id)
			
			cdavg(js,jb,16)=(cavg(js,jb,ndo)/dosat)*100.0
			      IF(ngctdg /= 0)THEN
			        EA =
			DEXP(2.3026D0*(7.5D0*TDEW(JW)/(TDEW(JW)+237.3
			D0)+0.6609D0))*0.001316 ! in mm Hg
			0.0098692atm=7.5006151mmHg
			        !cdavg(js,jb,NDC) =
			(cavg(js,jb,NGN2)/(1.5568D06*0.79*(PALT(ID)-
			EA)*(1.8816D-5 - 4.116D-7 * Tavg(js,jb) +
			4.6D-9 * Tavg(js,jb)**2)))*100.0 ! SW
			10/27/15
			        n2sat=1.5568D06*0.79*(PALT(ID)-
			EA)*(1.8816D-5 - 4.116D-7 * Tavg(js,jb) +
			4.6D-9 * Tavg(js,jb)**2)
			        cdavg(js,jb,NDC) =
			100.*(0.79*(cavg(js,jb,NGN2)/n2sat) +
			0.21*(cavg(js,jb,ndo)/dosat))
			      ENDIF
			    !end if
			``
				11/8/2017

23	W2 Control	Updated GUI	A new version of W2Control has been made to account for a large number of small refinements in the control file to bring it up to Version 4.1. Otherwise, some of these changes had to be implemented by editing the text file, w2_con.npt. Also, guidance was added to the release notes how to use the GUI with a touch-screen laptop or desktop in cases where the touch screen does not work with the GUI.	3/10/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
24	W2	Csv file input for shade file	Updated reading in csv file for shade file to be compatible with preprocessor. Sometimes one needs to add an extra column of commas in a csv input file. New code: ```IF(INFORMAT=='$')THEN` ` READ(SHD,'(/)')` ` DO I=1,IMX` ` READ (SHD,*)J,SHADEI(I) ! SW 3/14/2018 ADDED TO BE COMPATIBLE WITH PREPROCESSOR` ` IF(SHADEI(I)<0.0)THEN` ` BACKSPACE(SHD)` ` READ (SHD,*) J,SHADEI(I),TTLB(I),TTRB(I),CLLB(I),CLRB(I),SRLB1(I),SRLB2(I),SRRB1(I),SRRB2(I),(TOPO(I,J),J=1,IANG),SRFJD1(I),SRFJD2(I)` ` ENDIF` ` ENDDO```	3/14/2018
25	W2	TSR file output	When the model user sets the elevation as a negative value, the model outputs variables at that layer only. When the water level went below that layer, the output was fixed at the old value of the variable until the water level rose into the layer. To eliminate issues with misinterpreting or having to edit out constant values, whenever the water level is below the layer, now a -99 is written out showing that there is no water in the layer specified.	4/5/2018
26	PREW2	More checks	Added checks for NaN in input files for meteorological files and flow, temperature and concentration files for inflows, distributed tributaries, precipitation, and tributaries. Previously, the preprocessor read input files even with NaN without reporting an error since this is a proper numerical value.	4/10/2018
27	W2	WDO output	The Withdrawal files are often used for downstream models. The withdrawal output frequency is in days. In order to make this more precise numerically, the output frequency can also be entered in hours and seconds. The problem was that 1 hour is 0.04167 days and due to round off error for long term runs of many years, the hourly frequency output would not be at the same hour. The variable WDOC now can be ON/OFF/ONS/ONH where ONS means the output frequency is in sec and ONH means the output frequency is in hours. The User Manual, GUI, and Preprocessor have been updated.	4/10/2018
28	Water-balance	Water-balance	A new waterbalance utility was released that is a console application and can be used in batch file processing. It also has more features than the old water balance utility allowing the use of multiple waterbodies in the calculation of flows. There is a new file directory for this application in the download section as well as executables and a User Manual for this utility.	4/10/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
29	PREW2	More checks	Several more preprocessor enhancements were added to the preprocessor to check for Unix file type where an EOL is a <CR> and not the windows <CR><LF>. Also a few more descriptions were added to the error output to clarify where a problem may be.	4/18/2018
30	Water-balance	Water-balance	Some refinements to the water balance utility console application were made.	6/5/2018
31	W2	Sediment Resuspension	The sediment resuspension algorithm computed sediment resuspension in all model layers except the surface layer. The fix below adds resuspension for the surface layer (highlighted code is new). ```\nIF (SEDIMENT_RESUSPENSION(J)) THEN\n FETCH = FETCHD(I,JB)\n IF (COS(PHI(JW)-PHI0(I)) < 0.0) FETCH =\nFETCHU(I,JB)\n FETCH = MAX(FETCH,BI(KT,I),DLX(I))\n U2 =\nWIND(JW)*WSC(I)*WIND(JW)*WSC(I)+NONZERO\n COEF1 = 0.53 *(G*DEPTHB(KT,I)/U2)**0.75\n COEF2 = 0.0125*(G*FETCH/U2)**0.42\n COEF3 = 0.833* (G*DEPTHB(KT,I)/U2)**0.375\n COEF4 = 0.077* (G*FETCH/U2)**0.25\n HS = 0.283\n*U2/G*0.283*TANH(COEF1)*TANH(COEF2/TANH(COEF1))\n !TS = 2.0*PI*U2/G*1.2*\nTANH(COEF3)*TANH(COEF4/TANH(COEF3))\n TS = 2.0*PI*sqrt(U2)/G*1.2*\nTANH(COEF3)*TANH(COEF4/TANH(COEF3)) ! cb 7/15/14\n L0 = G*TS*TS/(2.0*PI)\n L1 = L0 ! SW 6/28/2018 Allow for\nresuspension of surface layer\n L = L0*TANH(2.0*PI*DEPTHB(KT,I)/L1)\n DO WHILE (ABS(L-L1) > 0.001)\n L1 = L\n L = L0*TANH(2.0*PI*DEPTHB(KT,I)/L1)\n END DO\n COEF = MIN(710.0,2.0*PI*DEPTHB(KT,I)/L)\n UORB = PI*HS/TS*100.0/SINH(COEF)\n TAU = 0.003*UORB*UORB\n IF (TAU-TAUCR(J) > 0.0) EPSILON =\nMAX(0.0,0.008/49.0*(TAU-TAUCR(J))**3*10000.0/DLT)\n SSR = EPSILON*DLX(I)*(BI(KT,I)-\nBI(KT+1,I))/VOL(KT,I)\n END IF\n SSSS(KT,I,J) = -\nSSS(J)*SS(KT,I,J)*BI(KT,I)/BH2(KT,I)+SSR\n```	6/28/2018
32	W2	Sediment Flux	Added 'RECURSIVE' to the subroutine definition as it calls itself and recent updates to the Intel compiler flagged this as an error. ```\n RECURSIVE Subroutine CEMASedimentDiagenesis\n Use MAIN\n Use GLOBAL\n Use GEOMC\n Use SCREENC\n```	6/28/2018
33	PREW2	Added checks	Assorted minor updates to error checks	7/1/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

34	PREW2	Consolidation	Update to checking code in sediment diagenesis for consolidation. New code:
			`Read(5000,*)MessageTemp, LayerAddThkFrac`
			`Read(5000,*)MessageTemp, NumConsolidRegns`
			`if(IncludeBedConsolidation .and. NumConsolidRegns == 0)then    ! CB 7/9/2018 changed .or. to .and.`
			`CALL ERRORS`
				7/9/2018

35	W2	Sediment	The sediment model allows for first order sediment decay in the layers above the bottom layer. If a modeler set as an initial condition a finite value for the initial concentration of sediment, then the amount in layer kb would be there and not transfer eventually to the sediment diagenesis layer as downward sloughing occurs. Hence, if the model user sets an initial concentration of the first order sediment model and has turned on sediment diagenesis, then the code sets the value of sediment in layer kb to zero.
			
			The code fixe for SED is shown below:
			`SED(KT,I)      = SED(KT,I)/H2(KT,I)`
			`If(CEMARelatedCode .and. IncludeCEMASedDiagenesis)then   ! cb 07/23/18`
			`SED(KT+1:KB(I)-1,I) = SED(KT+1:KB(I)-1,I)/H2(KT+1:KB(I)-1,I)`
			`sed(kb(i),i)=0.0`
			`else`
			`SED(KT+1:KB(I),I) = SED(KT+1:KB(I),I)/H2(KT+1:KB(I),I)`
			`end if`
			`END DO`
			Similar code fixes were applied to SEDP, SEDC and SEDN.
				7/23/2018

36	W2	TSR output	When a branch goes inactive, the TSR output file continued to write output information even though the segment was not hydrated. Logic was added to skip output for a TSR file if the segment was inactive or if the fixed layer was above the surface layer.
			`DO J=1,NIKTSR`
			`I = ITSR(J)`
			`! find out if segment is inactive OR cell is inactive for fixed layer - do not write out tsr file  ! SW 7/24/2018`
			`IF(BR_INACTIVE(JBTSR(J)))CYCLE`
			`IF(CUS(JBTSR(J)) > I)CYCLE`
			`DO JW=1,NWB`
			`IF (I >= US(BS(JW))-1 .AND. I <= DS(BE(JW))+1) EXIT`
			`END DO`
			`IF(ETSR(J) < 0)THEN                  ! SW 7/24/2018`
			`IF(INT(ABS(ETSR(J))) < KTWB(JW))CYCLE`
			`ENDIF`
				7/24/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
37	W2	WRN	When a branch becomes ACTIVE, it is now written out to the WRN file (this was previously written out to the SNP file and only when INACTIVE to the WRN file).	7/24/2018
38	W2	SO4 in Sediment	The code was updated to compute SO4 in both the aerobic and anaerobic layers and to allow diffusion from the water column to the sediment. This was previously not implemented. Also, updates were made to the bed consolidation routine in the sediment diagenesis model.	8/1/2018
39	W2, PREW2	Constriction	This is a model enhancement: The model user can specify a maximum width between segments by specifying that in a new input file called 'constriction.csv'. This does not affect the volume of the segments – it only affects the right hand side face width. Whereas an internal weir blocks all the flow, this allows for a reduced area and eliminates the need to insert a short segment of small width that can cause stability and lowered time step issues. The new input file is 'constiction.csv' and has the following format: Line 1: Comment Line 2: # of constrictions Line 3: Comment Line 4: [Repeated by # of constrictions] Segment # of constriction, Maximum width in m of constriction # of Constrictions 1 Seg # Max width, m 10 115 The W2 code looks for 'constriction.csv' – if it is found, then it reads the file and applies this to the right hand side width between 2 segments. Updates were made to the User Manual, Preprocessor and W2 Executables	8/3/2018
40	W2	Restart	If there were WDO output files, the RESTART option may not have worked properly. A code fix was implemented for a RESTART with WDO output files.	8/3/2018
41	W2	Envir Perf	The environmental performance output was updated to include the descriptive terms: 'Sum of fractions' and 'Average'. The User Manual was updated.	8/6/2018
42	W2	Particle Transport	Tracking the time history of temperature, velocity and depth of particles was added to the particle transport algorithm. The file 'particle.csv' now includes information on histogram output for each particle released into the waterbody. The User Manual and Preprocessor were also updated for this new feature.	8/6/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
43	W2	Layer subtract	When the W2 model adds a deep slot in shallow rivers, the variable AVHR in layeraddsub.f90 was defined for an inactive segment incorrectly. This code was cleaned up. New code is shown below: <pre> DEPTHM(KTWB(JW),I)=(H1(KTWB(JW),I)-
(EL(KBI(I)+1,I)-EL(KB(I)+1,I)))*0.5   ! SW 1/23/06
IF(I<=DS(JB))THEN ! SW 8/6/2018
AVHR(KT,I)=(H1(KT,I)-
(EL(KBI(I)+1,I)-EL(KB(I)+1,I)))   +(H1(KT,I+1)-
(EL(KBI(I)+1,I+1)-EL(KB(I)+1,I+1))&
-H1(KT,I)+(EL(KBI(I)+1,I)-
EL(KB(I)+1,I)))/(0.5*(DLX(I)+DLX(I+1)))*0.5*DLX(I)
ELSE
AVHR(KT,I)=AVHR(KT,I-1)
ENDIF</pre>	8/6/2018
44	W2	Input bathymetry	If the model user in the bathymetry input file gives the water surface (or FRIC, or PHI0, or DLX) of inactive segments a '0', the code in the first time step may set the KT layer incorrectly because of using ELWS of an inactive segment. The code though fixes it on the 2nd time step. This does not really affect the model run as it gets started other than an unnecessary change in the surface layer designation. If the model user gave the inactive segments the same values as the active ones, the code ran normally from the first time step. In order to standardize this and allow the model user to keep inactive segment ELWS, DLX, FRIC, and PHI0 set to zero, these values are initialized with the neighboring segment value. <pre> READ (BTH(JW),'(///(10F8.0))') (DLX(I),
I=US(BS(JW))-1,DS(BE(JW))+1)
READ (BTH(JW),'(///(10F8.0))') (ELWS(I),
I=US(BS(JW))-1,DS(BE(JW))+1)
READ (BTH(JW),'(///(10F8.0))') (PHI0(I),
I=US(BS(JW))-1,DS(BE(JW))+1)
READ (BTH(JW),'(///(10F8.0))') (FRIC(I),
I=US(BS(JW))-1,DS(BE(JW))+1)
READ (BTH(JW),'(///(10F8.0))') (H(K,JW), K=1,KMX)
DO I=US(BS(JW))-1,DS(BE(JW))+1
READ (BTH(JW),'(///(10F8.0))') (B(K,I),
K=1,KMX)
H2(:,I) = H(:,JW)
END DO
endif
! Set water surface of inactive segments to
those active cells next to them   SW 8/6/2018
DO JB=BS(JW),BE(JW)
ELWS(US(JB)-1)=ELWS(US(JB))
ELWS(DS(JB)+1)=ELWS(DS(JB))
DLX(US(JB)-1)=DLX(US(JB))
DLX(DS(JB)+1)=DLX(DS(JB))
PHI0(US(JB)-1)=PHI0(US(JB))
PHI0(DS(JB)+1)=PHI0(DS(JB))
FRIC(US(JB)-1)=FRIC(US(JB))
FRIC(DS(JB)+1)=FRIC(DS(JB))
END DO</pre>	8/6/2018
45	W2	Particle	Added the ability of particles to be passed to other branches by connections of gates, pumps or spillways between upstream and downstream branches aligned linearly along a river.	8/7/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
46	W2	Flow Balance Output	The flow balance output file, flowbalance.csv, output was affected by Branches becoming active or inactive. Code was revised in balances.f90 to allow for the flow balances to properly account for cumulative flow sources/sinks. ```IF (VOLUME_BALANCE(JW)) THEN
  DO JB=BS(JW),BE(JW)
    IF(.NOT.BR_INACTIVE(JB))THEN   ! SW 8/8/2018
      VOLSBR(JB) = VOLSBR(JB)+DLVOL(JB)
      VOLTBR(JB) =
VOLEV(JB)+VOLPR(JB)+VOLTRB(JB)+VOLDT(JB)+VOLWD(JB)+VOLUH(JB)+VOLDH(JB)+VOLIN(JB)+VOLOUT(JB)+VOLICE(JB)
      if(sediment_diagenesis)then
        If(CEMARelatedCode .and. IncludeBedConsolidation)Then
          VOLTBR(JB) = VOLTBR(JB)+ VOLCEMA(JB)
        End If
      ENDIF

  IF (ENERGY_BALANCE(JW)) THEN
    ESR(JW) = 0.0
    ETR(JW) = 0.0
    DO JB=BS(JW),BE(JW)
      IF(BR_INACTIVE(JB))CYCLE   ! SW 8/8/2018

 IF (MASS_BALANCE(JW)) THEN
   DO JB=BS(JW),BE(JW)
     IF(BR_INACTIVE(JB))CYCLE   ! SW 8/8/2018
       DO JC=1,NAC``` | 8/8/2018 |
| 47 | W2 | Particle Transport | In the particle tracking algorithm, the depth statistics of are now based on the particle depth. Before this, the depth statistics of a particle were based on water depth not particle depth. | 8/24/2018 |

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Fixed or Enhance-ment added

48	W2	Long Profile Output	The volume weighted temperature was added to the longitudinal profile output. The User Manual was also updated.
			`WRITE(NUNIT,'(1000(A,","))')'Seg#','ElevWaterSurf(m)','Q(m3/s)','SurfaceT-emp(oC)','Depth(m)','Width(m)','VolWeighTemp(oC)',(CNAME2(CN(JC)),JC=1,NAC),(CDNAME2(CDN(JD,JW)),JD=1,NACD(JW))`
			`ELSE`
			`WRITE(NUNIT,'(1000(A,","))')'Seg#','ElevWaterSurf(m)','Q(m3/s)','SurfaceT-emp(oC)','Depth(m)','Width(m)','VolWeighTemp(oC)'`
			`ENDIF`
			`DO JJ=1,NWB`
			`K=KTWB(JJ)`
			`DO JB=BS(JJ),BE(JJ)`
			`DO I=CUS(JB),DS(JB)`
			`! TEMP VOL WEIGHTED AVERAGE  SW 8/30/2018`
			`TVOLAVG=0.0      ! SW 8/30/2018`
			`VOLTOT=0.0`
			`DO KK=KTWB(JW),KB(I)`
			`VOLTOT=VOLTOT+VOL(KK,I)`
			`TVOLAVG=TVOLAVG+T1(KK,I)*VOL(KK,I)`
			`ENDDO`
			`IF(KB(I)>=KTWB(JW))tvolavg=tvolavg/voltot`
			`IF(CONSTITUENTS)THEN`
			`WRITE(NUNIT,'(I5,",",100(F12.3,","))')I,ELWS(I),QC(I),T2(K,I),DEPTHB(KB(I),I),B(KTI(I),I),TVOLAVG,(C2(K,I,CN(JAC))*CMULT(CN(JAC)),JAC=1,NAC),(CD(K,I,CDN(JD,JW))*CDMULT(CDN(JD,JW)),JD=1,NACD(JW))`
			`ELSE`
			`WRITE(NUNIT,'(I5,",",100(F12.3,","))')I,ELWS(I),QC(I),T2(K,I),DEPTHB(KB(I),I),B(KTI(I),I),TVOLAVG`
				8/30/2018

49	W2	SPR output	The spreadsheet output file now has an option to out-put volume weighted values at the locations and times specified. If the user enters 'ONV' in the control file in the following line:
			`SPR PLOT    SPRC    NSPR    NISPR`
			`WB 1        ONV      1       2`
			the output will include the regular SPR output and a separate file with the suffix '_volw.csv' for the volume weighted output. The User Manual has also been up-dated with the new feature.
				9/28/2018

50	W2	User Manual	Updated the LPOM, LPOM-P, and LPOM-N source sink equations and the LPOM source sink stencil to be in agreement with the model code. These were old and did not reflect the addition of zooplankton ingestion and excretion/mortality.	10/9/2018
51	W2	Particle Tracking	Added an enhancement to add monitoring segments that record when the particle goes by the monitor or sensor. This would be useful for comparing to a dye study in a river for example.	11/14/2018
52	W2	SPR output	A volume weighted output bug for item 49 was fixed.	11/14/2018
53	W2	TSR flux out-put units	If flux output was ON, the instantaneous flux values for TSR output were in the incorrect units. These units were corrected to kg/day. Thanks to Binglei Gong at Anchor! All other flux files units were not affected.	12/10/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
54	W2	Volume balance	The volume balance when segments were added and subtracted because of a shallow location in the grid, caused the code to incorrectly compute the volume balance (if VBC is ON). This was corrected.	12/18/2018
55	W2	Internal solar radiation and angle of sun for shading	The internal solar radiation algorithm had a bug that if one used reference years many years from your simulation or made a simulation over 20 years, the solar maximum each year drifts. If you read in solar radiation, there are no issues or if one makes runs from 1-10 years – the drift is probably minimal. This mainly affects those who use a reference year far from the start date or run simulations over 20 years or longer while using the internal short wave solar algorithm. Fix from Dan Turner at USACE and Stewart Rounds USGS – many kudos!!	12/18/2018
56	W2	Energy and mass balance	For a simulation with an initial BRANCH INACTIVE, the energy and mass balance if ON (EBC and MBC set to ON) starts off incorrectly. The layer subtraction algorithm when segments were subtracted in some cases where there were deeper holes followed by shallows incorrectly computed the energy and constituent mass balance. Also, a couple changes were made for the heat balance and mass balance for constituents when branches were changed from active to inactive.	12/18/2018
57	W2	Particle tracking	Fixed a bug when a particle was in the "air" above the water surface when in a river a 'deep slot' was added to the river bathymetry to keep it hydrated. Also, fixed a reflection error off the surface for vertical movement of the particle.	12/26/2018
58	W2	Particle tracking	For file output for finalparticle.csv, adjusted header so that it would be general for any number of monitoring stations. Previously the header was hard-wired to write only 3 monitoring locations in the title. This does not affect prior model output information only the title header.	1/3/2019
59	PREW2	Pipe invert	The preprocessor gave a 'false' error for an invert elevation being below the grid in some rare cases. This has been fixed. The model was not affected.	1/21/2019
60	W2	TN	There was a bug in the calculation of TN when large concentrations of zooplankton were present. If zooplankton were not simulated or they were a small population, there would be no impact of this TN bug. Bug fixed.	1/29/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
61	W2	Epiphyton periphyton burial and conversion to LPOM and sediments	The User Manual showed that the epiphyton parameter EB, burial rate, was in units of m/day. The model implemented this and also computed the cell layer burial rate as EB*EC(concentration of biomass per cell volume)*Surface area/Volume of a cell or EB*EC/H where H is the layer thickness. In reality though it should be the thickness of the periphyton layer. But that layer thickness is not predicted by the model. Hence, the decision was to change the burial rate to units of 1/day such that the loss of epiphyton by burial would follow a first order decay process (similar to the first order sediment model) as EB*EC. Hence, this burial rate is no longer a function of the grid. Also, there was the conversion of organic matter and nutrients at death to the sediment P, N and C compartments whereas they should go directly to LPOM first. Hence only burial goes directly into the sediment compartments.	3/5/2019
62	W2	Output files	Code was written to print the initial condition in output files at time t=0 at the start of the simulation.	3/5/2019
63	W2	Restart with Sediment Diagenesis	Prior to this date, the restart option did not work with sediment diagenesis turned ON. This enhancement has been coded and debugged and is now working.	3/5/2019
64	W2	Dynamic loading	This is a new feature in CE-QUAL-W2 and applies to linear waterbodies in series. For example, if one has a river system with 9 waterbodies, the model user can break the model into 9 separate models and run them all in parallel where the downstream model dynamically updates its boundary conditions as the upstream model moves forward in time. This has resulted in significant time savings for model runs (90%). Documentation for this will be provided shortly.	3/5/2019
65	W2	User Manual	The existing User Manual will be frozen in its current version until a newly updated user manual will be released in the next couple months. Hence, the dynamic loading described above will be described in the new User Manual.	3/5/2019

W2 V4.0 Bug Fixes, Enhancements, and User Manual Changes

Table 5. Bug fixes and enhancements for Version 4.0.

#	Code: W2 or PREW2 or GUI	Fix or En- hancement Type	Description of Bug/Enhancement	Date Fixed or Enhance- ment added
1	PREW2	Additional model checks	Additional model checks were added for Profile and Spreadsheet output model seg- ments	6/7/16
2	User Man- ual	Updated	User Manual Rev 6 was released with many minor updates and better explanatory text	6/7/16
3	W2	Restart	Fixed restart to work for epiphyton and mac- rophytes. This was broken in case a model user used RESTART. Fixed restart for mass balance for nutrients output in the file mass- bal.opt.	6/7/16
4	W2	Location of compiler info file	Fixed location of W2 compiler information in case of using command line aware directory. File was written to the location of the model executable rather than the command line aware directory.	6/7/16
5	Waterbal- ance	Update for Version 4	The waterbalance utility uses a model tsr file for reading in water level over time. Since the Version 4 file format was updated with comma delimeted output files, the waterbal- ance utility has been updated. This utility is not compatible with earlier versions.	6/10/16
6	W2	Sediment Di- agenesis	Initialized the sediment width (sedcellwidth) in subroutine `CEMASedimentDiagenesis.`	6/11/16
7	W2	Screen out- put	The text fields in the Windows dialog box may 'overflow' if you have more than 160 tributaries. The field size was increased to avoid this possibility. Old code: CHARACTER(1000) :: TEXT1 New code: CHARACTER(1700) :: TEXT1	6/24/16
8	W2	Profile out- put	The longitudinal profile output added depth at a segment as part of the longitudinal output. User Manual updated also.	7/11/2016
9	W2	Profile out- put	Changed file name of longitudinal file output from integer of the Julian day to Julian day in F8.2 format in case of multiple outputs on one day	7/16/2016

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
10	W2	TSR output	Changed TSR file so that the first 11 lines of header are eliminated to facilitate graphing. Also, the name of the filetype in the control file is now read and used for the output file. Hence, using the TSR FILENAME of 'tsr.csv' will produce csv files that are immediately opened in Excel for viewing again making it easier for post-processing.	8/1/2016
11	PRE	Met file checks	The preprocessor has been enhanced with more model file checks. This program now has summaries of meteorological data (min, max, average) for each waterbody in the pre.opt file as well as further logical checks on values of these averages. These summaries are another check on the correctness of the input met data file. A typical result in pre.opt is shown below: ```Meteorological Data Input Summary
  Parameter   Waterbody   Average Value   Maximum   Minimum

  TAIR(C)   1   10.553   37.780   -11.940
  TDEW(C)   1   6.935   19.500   -17.670
  WIND(m/s)   1   1.337   12.440   0.000
  PHI(rad)   1   3.426   6.280   0.000
  CLOUD(0-10)   1   7.367   9.720   0.000
  SRO(W/m2)   1   0.000   0.000   0.000

  TAIR(C)   2   10.553   37.780   -11.940
  TDEW(C)   2   6.935   19.500   -17.670
  WIND(m/s)   2   1.337   12.440   0.000
  PHI(rad)   2   3.426   6.280   0.000
  CLOUD(0-10)   2   7.367   9.720   0.000
  SRO(W/m2)   2   0.000   0.000   0.000``` | 10/30/16 |
12	PRE	Distributed concentration checks	Added checks for average, min, and max inflow concentrations for all distributed tributaries. These are written out to the pre.opt file	11/1/16
13	PRE	LPR input	For LPR file inputs for temperature, the preprocessor reports an error when using LPR input. The code incorrectly used KT rather than KTWB(JW). [This also affects V3.7 preprocessor.]	11/9/2016
14	W2	Model update	The model executables were updated from Intel Fortran Compiler # 14 to Intel Fortran compiler # 17. Also, the flag to initialize all variables to zero was enforced. There are many variables in the new sediment diagenesis model that need to be explicitly set to zero. These initializations will be made in the code in the future so that setting this flag will be unnecessary.	11/17/2016
15	W2 and PRE	Code updates	A couple code updates were made as a result of using the Intel Fortran Version 17 compiler. The new compiler did not like some of the older implementations. These were minor updates.	11/22/2016
16	W2	Output	Improved clarity of output headers for flux outputs, including units of kg/d in all header titles	11/28/2016

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
17	W2	Output header	The order of the flux headings in the file 'kflux_jwX.opt' were switched. The header showed DOAP, DOAR, DOEP, DOER but it should have been DOAP, DOEP, DOAR, DOER. This is determined from the order in the example problem control files and the User Manual. The example problems and User Manual have all been updated.	11/28/2016
18	W2	Example problems	Updated example problems using FIX #10 above where tsr.opt filename was changed to tsr.csv allowing tsr files to open directly in Excel.	11/28/2016

19	W2	Algae-Si	The flux of Si from dying algae was incorrectly computed. This bug has existed since Version 3.0 when the algorithm was first added to W2. Below is the code fix:
			
			`ENTRY PARTICULATE_SILICA`
			`  PSIAM(:,IU:ID) = 0.0`
			`  DO I=IU,ID`
			`    DO K=KT,KB(I)`
			`      DO JA=1,NAL`
			`      IF(ALG_CALC(JA))THEN`
			`        PSIAM(K,I) =`
			`PSIAM(K,I)+AMR(K,I,JA)*ALG(K,I,JA)*ASI(JA)   !`
			`PSI(K,I)  HA-Z  12/2016`
			`        ENDIF`
				12/5/2016

20	W2	WDO output	Enhancement: The Withdrawal output file name WDOFN was unused in the main program. Now the model reads this file and uses the file type for all WDO output files. Previously this was hard-wired to 'opt' output. Now if the user sets WDOFN to 'wdo.csv' all the files will be written with the 'csv' file type facilitating opening in Excel. The files are already in comma delimited format.	12/8/2016
21	W2	DLT INTER	There was a problem computing the interpolated value of DLTMAX and DLTF when the first value of DLTD was earlier than the start date of the model. This bug was fixed.	12/9/2016
22	User Manual	Updates	Assorted typos fixed, better explanatory text added, and added definitions and units of model parameters. This is REV8.	1/6/2017, 2/10/2017
23	W2	Output format	Output format changed for Bioenergetics output file	1/6/2017
24	W2	TECPLOT output	Added derived variables to TECPLOT output files (See Contour Plot in User Manual). User Manual updated.	1/17/2017
25	PREW2	ENVIRPC	Checks were added for the ENVIRPC input file in the preprocessor.	2/16/2017
25	W2	ENVIRPC	Fixed several minor bugs in the ENVIRPC subroutine and added an enhancement to perform a histogram analysis of water depth. The User Manual was updated to reflect this new enhancement as well as the new csv output format and file names. The example problems were updated with new w2_envirprf.npt files.	2/16/2017

Model Utilities

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
26	W2	Head BC input files	For head boundary condition input files (both upstream and downstream), the W2 code was updated to include new file formats for these boundary conditions (BCs). They include the older format, a new csv format and a new csv format in case conditions are not stratified at the BC. The User Manual was updated to show these new file formats.	3/3/2017
27	PREW2	Head BC checks	With the new file format for head BCs in #26 above, the preprocessor was updated to check these new input file formats. Also, additional checks were added to the head BCs.	3/3/2017
28	Water-balance	Bug fixes/updates	The water balance utility was updated because of the new input format of TSR output files. See fix #10. Also, a bug was fixed in this code that affected cases when the water level was above the top of the grid.	3/17/2017
29	W2	CPL Tecplot	The CPL Tecplot output sometimes did not update the month in the contour plot text files. This has been fixed – thanks to Jung Ma, Hubei University of Technology in Wuhan, for finding it!	4/4/2017
30	Water-balance	Waterbalance manual	The waterbalance manual was updated for Version 4.	4/14/2017
31	W2	TSR output	Refined the TSR output so that flux terms that were not specified are no longer written out. This cleans up the TSR output and reduces the active number of flux variables when sediment diagenesis is not on.	4/15/2017
32	W2	Derived variables	Fixed a code regression for derived variable TDG when the user stopped the code and pressed restart	4/15/2017
33	W2	Withdrawal output	When a user pressed restart and he/she specified withdrawal output files, the restarted files ignored the filetype of the WDO specification in the control file and used 'opt'.	4/15/2017

W2 V3.7 Bug Fixes, Enhancements and User Manual Changes

Table 6. Bug fixes and enhancements for Version 3.7.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
1	W2	Fish habitat limits	Changed temperature and DO criteria from `t2(k,i)<fisht-emph(ii).and.t2(k,i)>fishtempl(ii).and.o2(k,i)>fishdo(ii)` to `t2(k,i)<=fisht-emph(ii).and.t2(k,i)>fishtempl(ii).and.o2(k,i)>=fishdo(ii)` This update is reflected in the manual. Hence the high temperature limit and the dissolved oxygen minimum is less than or equal to given value rather than less than.	8/7/2012

2	W2	Structure, gate, pump, pipe, withdrawal output files	Added code to ensure that if flow is '0' in an outlet structure, that the corresponding temperature and concentration in the outlet file is written as '-99.0'. Previously this was not fully implemented in the code. Code such as this was inserted in several places in the subroutine outputa2.f90:
			`IF(QGT(JS)==0.0)THEN`
			`        TAVGW(JWD)=-99.0`
			`        CAVGW(JWD,:)=-99.0`
			`        CDAVGW(JWD,:)=-`
			`99.0`
			`        ENDIF`
				8/13/2012

3	PREW2	Format updates	Several output updates were made for warnings and errors	8/16/2012
4	Resource files for W2	Compiling files	Updated some corrupted resource files that were used to compile the source code. Also, zipped up source code and compiler settings together so that file locations are correct for using the Intel compiler.	9/12/2012

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
5	W2 and PREW2	Read csv files	By inserting the character '$' as the first character of the first line, the following files can now be read in free-format or csv format: met, lpr, vpr, wsc, met, cin, ctr, cdtr, cpre, qot, and qwd. This is described in a Word document that accompanies the download package. The preprocessor has also been updated for file checks. This is part of the Version 3.71 update.	9/12/2012

6	W2	Read input file	An input format bug was fixed for a system with more than 9 waterbodies.
			
			``
			  DO JD=1,NDC
			    !READ (CON,'(A8,(:9A8))')
			CDNAME2(JD),(CDWBC(JD,JW), JW=1,NWB)
			    READ (CON,'(A8,(:9A8):/(8X,(:9A8)))')
			CDNAME2(JD),(CDWBC(JD,JW), JW=1,NWB)
			!cb 9/13/12
			  END DO
			  READ (CON,'(/)')
			! DO JF=1,NFL
			  do jf=1,73 ! Fix this later
			    !READ (CON,'(A8,(:9A8))')
			KFNAME2(JF),(KFWBC(JF,JW), JW=1,NWB)
			    READ (CON,'(A8,(:9A8):/(8X,(:9A8)))')
			KFNAME2(JF),(KFWBC(JF,JW), JW=1,NWB)
			!cb 9/13/12
			  END DO
			``
			
			This had the effect of turning OFF output for derived constituents for waterbody 10.
				9/13/2012

7	GUI	Time series elevation	The GUI read in values of ETSR as integers rather than real numbers. This was fixed.	10/30/12
8	W2	Spillways Lateral	Lateral spillways when connected to other model segments were sometimes not connecting as a tributary to the downstream segment. This has been fixed.	10/30/12
9	W2	W2Tools output	In place of the Vector Plot Output (VPL), a new output was added that allows use of the W2Tools post-processing package. This is part of the Version 3.71 update.	10/30/12
10	W2	User Manual	The User Manual has been updated with the new model features as shown in 5 and 9 above. In addition a separate user manual file shows how to use the w2tools post-processor. This is in the directory for W2tools. This is the version 3.71 update.	10/30/12

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
11	W2	Water quality and temperature	A new calculation technique was added that eliminates calling the Tri-diagonal subroutine. These were built into the temperature and water quality subroutines. This change results in improvements in computational speed of from less than 5% to over 20% for water quality models with lots of water quality state variables.	10/30/2012
12	PREW2	More checks	Added more error trapping for input files. This is an effort for the error trapping to occur before the code bombs. Fixed a couple of regression errors as a result of this fix.	11/2/2012, 11/5/2012
13	Excel macro utility		Added an Excel macro utility to aid in writing out input files to CE-QUAL-W2	11/5/2012

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Bug Fixed or En-hancement added
14	W2	Withdrawal subroutine	Fixed an IF test that used the wrong variable in the dy-namic port allocation algorithm. Also added code to allow the code to test for temperatures at the outlet levels specified. Deleted line of code is underlined followed by the fix. ```\n DO J=1,NUMTSPLT !REODERING OUTLETS SO\nTHAT HIGHEST ELEVATION STRUCTURE ON TOP\n(ASSUMING 2 SPLIT OUTLETS)\n! IF(TCNTR(J) == ' ST')THEN\n IF(TSPLTCNTR(J) == ' ST')THEN\n! cb 11/11/12\n IF(ESTR(JSTSPLTT(J,1),TSPLTJB(J)) <\nESTR(JSTSPLTT(J,2),TSPLTJB(J)))THEN\n JSTSPLT(J,1)=JSTSPLTT(J,2)\n JSTSPLT(J,2)=JSTSPLTT(J,1)\n END IF\n! ELSE IF(TCNTR(J) == ' WD')THEN\n ELSE IF(TSPLTCNTR(J) == ' WD')THEN\n! cb 11/11/12\n IF(EWD(JSTSPLTT(J,1)) <\nEWD(JSTSPLTT(J,2)))THEN\n\n\n…\n IF(TSPLTJB(J) == JB .AND. TSPLTCNTR(J) == '\nST')THEN\n QALL=0.0\n DO JJ=1,NOUTS(J)\n\nQALL=QALL+QSTR(JSTSPLT(J,JJ),TSPLTJB(J)) !\nSUM UP ALL THE FLOWS\n ELR = SINA(JB)*DLX(DS(JB))*0.5\n DO K=KTWB(JW),KB(DS(JB))\n IF (EL(K,DS(JB))-ELR <\nESTR(JSTSPLT(J,JJ),TSPLTJB(J))) EXIT\n!SW 10/17/01\n END DO\n KSTR = K-1\n KSTRSPLT(JJ) =\nMIN(KSTR,KB(DS(JB)))\n ENDDO\n DO JJ=1,NOUTS(J) !\ncb 11/11/12 dividing total flow between outlets\nfor temperature test\n\nQSTR(JSTSPLT(J,JJ),TSPLTJB(J)) =\nqall/real(nouts(j))\n ENDDO\n```	11/13/12

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

15	W2	Reading in names of WQ variables	In case a user does not enter the units in graph.npt, the code improperly parses the WQ variable name. In this case the output name is a blank. To avoid this issue, extra code was added to preserve the variable name even if no units were added to the graph.npt list.
			
			``
			L1 = SCAN (CNAME(JC),',')+2
			    IF(L1 == 2)L1=43 ! SW
			12/3/2012 Implies no comma found
			    L2 = SCAN (CNAME(JC)(L1:43),'
			')+L1
			    IF(L2 > 43)L2=43 ! SW
			12/3/2012
			    CUNIT(JC) = CNAME(JC)(L1:L2)
			    CNAME1(JC) = CNAME(JC)(1:L1-3)
			    CNAME3(JC) = CNAME1(JC)
			    DO WHILE (L3 < L1-3)
			``
				12/3/2012

16	PREW2	SEDS and SEDK	The variable names were switched in reading the control file in the preprocessor perhaps leading to incorrect warnings/errors being tagged.
			
			The proper order was restored:
			``
			!READ (CON,'(/A8/(8X,2A8,6F8.0,A8))',
			ERR=400) AID, (SEDC(JW), PRNSC(JW),
			SEDCI(JW), seds(jw), SEDDK(JW),
			FSOD(JW), &
			  !
			FSED(JW), sedbr(jw), DYNSEDK(JW),
			JW=1,NWB)
			! SW 6/1/07
			  READ (CON,'(/A8/(8X,2A8,6F8.0,A8))',
			ERR=400) AID, (SEDC(JW), PRNSC(JW),
			SEDCI(JW), SEDDK(JW),seds(jw),
			FSOD(JW), &
			
			FSED(JW), sedbr(jw), DYNSEDK(JW),
			JW=1,NWB)
			! cb 12/30/12
			``
				12/30/12

17	Excel macro utility w2tool	Integer/Long variables	Some loose ends were corrected in the Visual Basic code built into the Excel macros.	1/2/2013
18	W2	TDG output	A series of code changes were made to fix some issues that arose for computing the impact of a structure on downstream TDG. These fixes were made in subroutines Withdrawal, outputa2w2tools, w2modules, and hydroinout. These affected calculation of output of dissolved gas concentration for output files for spillways or gates that had dissolved gas equation.	1/23/2013

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

19	W2	Reading in dynamic extinction coefficient	For temperature only studies, the model did not update the dynamic light extinction coefficient correctly. This has been fixed by the added code below:
			
			``
			DO JW=1,NWB
			    IF
			(READ_EXTINCTION(JW))GAMMA(:,US(BS(JW)):D
			S(BE(JW))) = EXH2O(JW) ! SW 1/28/13
			      KT = KTWB(JW)
			      IF (.NOT. NO_HEAT(JW)) THEN
			``
				1/28/2013

20	W2	Input format when 9 WBs	A specific input read error occurred when 9 waterbodies were present as a result of an earlier bug fix: The new read statements occur in 2 places: ``` READ (CON,'(A8,9A8,/(:8X,9A8)))') CDNAME2(JD),(CDWBC(JD,JW), JW=1,NWB) !cb 9/13/12 sw 2/18/13 READ (CON,'(A8,9A8,/(:8X,9A8)))') KFNAME2(JF),(KFWBC(JF,JW), JW=1,NWB) !cb 9/13/12 sw2/18/13 ```	2/18/13
21	PREW2	More checks added	Additional checks were added to warn users of gaps in meteorological data when interpolation may be inappropriate.	2/20/2013
22	W2 User Manual	Updated	Updated User Manual – many small additions and edits – REV3.	2/20/2013
23	PREW2	Improved an error check	Updated an error check for choosing inactive segments for ISNP output	3/21/2013
24	PREW2	More checks added	Added checks for inflow temperature and tributary temperatures	3/28/2013

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

25	W2	Initial WL Calculation	Changed SLOPE to SLOPEC in init—u-elws.f90 routine since the normal depth should be based on SLOPEC.
			
			`END IF`
			`      FUNCVALUE=FLOW-`
			`XAREA*HRAD**0.6667*SLOPEC(JB)**0.5/FMANN`
			`! SW 4/5/2013`
			
			`      RETURN`
			`      END SUBROUTINE MANNINGS_EQN`
			
			Also changed KB(I)-1 to KB(I)+1 for ELWS:
			
			`  IF(ABS(DX).LT.XACC .OR. FMID.EQ.0.)THEN`
			`      ELWS(I)=RTBIS+EL(KB(I)+1,I)`
			`! SW 4/5/13`
			`      RETURN`
			
			Also changed KTTOP from REAL to an INTEGER:
			`    REAL :: XAREA, WSURF      ! 4/5/13 SW`
			`    INTEGER :: KTTOP          ! 4/5/13 SW`
				4/5/2013

25	W2	Output for pumps, spillways, gates	If the LAT option was chosen, the output files index for JWD was incorrect. This may have affected output temperatures and concentrations.	5/17/2013
26	PRE-W2	Mass loading calculation	There were cases where the preprocessor bombed while calculating the mass loading for output to the pre.opt file. This error has been fixed.	6/21./2013

27	W2	Assorted code updates	Minor format errors (that were ignored by compiler), update to code comments, and faster code initializations to speed up model performance were performed in several subroutines: input_PAR.f90, temperature_PAR.f90, transport_PAR.f90, update.f90, and w2_37_win.f90.
			
			An example of an initialization code speed up from temperature_PAR.f90:
			
			New code:
			`    DO K=KT,KB(I)`
			`    AT(K,I) = 0.0D0; CT(K,I) = 0.0D0; VT(K,I) = 0.0D0`
			`!  SW CODE SPEEDUP 6/15/13`
			`    ENDDO`
			
			Old code
			`    AT(:,I) = 0.0D0; CT(:,I) = 0.0D0; VT(:,I) = 0.0D0`
				6/21/2013

28	W2 tools Excel macro	Update	More robust tools release	6/21/2013
29	PRE-W2	Label error	A label error for one spillway error was fixed. It mistakenly used 'gate'.	7/2/2013

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Bug Fixed or En-hancement added

30	W2	CPL output	A slight change in output format for the 'raw' cpl out-put file format was made. No change was made in the tecplot output format.
			
			``
			            DO I=CUS(JB),DS(JB)
			                    WRITE
			(CPL(JW),'(A38/(9(F10.3,2X)))')
			CDNAME(CDN(JD,JW)),(CD(K,I,CDN(JD,JW))*CDMULT(C
			DN(JD,JW)), K=KTWB(JW),KB(I)) ! cb 6/28/13
			                    end do
			                    !WRITE
			(CPL(JW),'(A38/(9(F10.3,2X)))')
			CDNAME(CDN(JD,JW)),((CD(K,I,CDN(JD,JW))*CDMULT(
			CDN(JD,JW)), & ! SW 8/12/06
			
			!K=KTWB(JW),KB(I)),I=CUS(JB),DS(JB)) ! CB
			1/03/05
			``
				7/31/13

31	W2	Read input file	A regression error that cropped up when there were 9 or greater than 10 waterbodies has been fixed. This had to do with reading in derived and flux variables in the control file.
			
			``
			DO JD=1,NDC
			   If(nwb < 10)READ (CON,'(A8,(:9A8))')
			CDNAME2(JD),(CDWBC(JD,JW), JW=1,NWB)
			   If(nwb >= 10) READ
			(CON,'(A8,9A8,/(:8X,9A8))')
			CDNAME2(JD),(CDWBC(JD,JW), JW=1,NWB)
			!cb 9/13/12 sw 2/18/13 6/16/13
			     END DO
			  READ (CON,'(/)')
			! DO JF=1,NFL
			  do jf=1,73 ! Fix this later
			   If(nwb < 10)READ (CON,'(A8,(:9A8))')
			KFNAME2(JF),(KFWBC(JF,JW), JW=1,NWB)
			   If(nwb >= 10) READ
			(CON,'(A8,9A8,/(:8X,9A8))')
			KFNAME2(JF),(KFWBC(JF,JW), JW=1,NWB)
			!cb 9/13/12 sw2/18/13 6/16/13
			``
				8/13/13

32	W2	New com-piler	Upgraded to the Intel XE 13.1.3.198 compiler. New W2 executables for 32 bit and 64 bit.	8/13/13

33	W2	INIT WL	An error was fixed in the initial water level computa-tion program for rivers. The code below should have the subscript JB instead of J.
			
			``
			            DO JJW=1,NWB
			                DO JJB=BS(JJW),BE(JJW)
			                    IF(DHS(JB) > US(JJB) .AND.
			DHS(J) < DS(JJB))THEN
			                        JBD=JJB
			                    END IF
			                END DO
			``
				8/20/13

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Bug Fixed or En-hancement added

34	W2	INIT WL	There was an index error with gates in the initial water level computation. The old code is shown below:
			
			``
			IF(ELWS(ID) < WSUP)THEN
			                    IF(ELWS(IDSP(JS)) > WSUP)
			WSUP = ELWS(IDSP(JS)) ! CHECKING TO SEE IF
			DOWNSTREAM WS ELEVATION ISN'T ALREADY 'HIGH'
			                    ELWS(ID)=WSUP
			``
			
			The new code is
			
			``
			                    IF(ELWS(IDGT(JG)) > WSUP)
			WSUP = ELWS(IDGT(JG)) ! CHECKING TO SEE IF
			DOWNSTREAM WS ELEVATION ISN'T ALREADY 'HIGH'
			WX 8/21/13
			``
				8/21/2013

35	W2	GATE	Cleaning up some code in the gate algorithm.
			Old code:
			
			``
			     IF (A2GT(JG) /= 0.0 .AND. IDGT(JG)
			/= 0.0) THEN
			``
			
			New code:
			
			``
			     IF (A2GT(JG) /= 0.0 .AND. IDGT(JG)
			/= 0) THEN
			``
				8/21/2013

36	W2	TSS compu-tation	Updated the computation for the derived variable TSS to include zooplankton and the particulate form of CBOD. A formula was added to the User Manual re-flecting this change. New code includes
			
			``
			          IF(CBODS(IBOD)>0.0)TOTSS(K,I)
			= TOTSS(K,I)+CBOD(K,I,IBOD)/O2OM(JW)
			! SW 9/5/13 Added particulate CBOD to
			TSS computation
			
			          TOTSS(K,I) =
			TOTSS(K,I)+ZOO(K,I,JZ) ! SW
			9/5/13 Added zooplankton to TSS computa-
			tion
			``
				9/6/2013

37	W2	Spillway-LAT	When a spillway was defined with IDSP=0 and LAT, a tributary was defined incorrectly. The new code is shown below:
			
			``
			IF (IDSP(JS) /= 0)then ! cb 9/11/13
			          JTT = JTT+1
			            QTR(JTT) = QSP(JS)
			            ITR(JTT) = IDSP(JS)
			            PLACE_QTR(JTT) = PDSPC(JS) == '
			DENSITY'
			            SPECIFY_QTR(JTT) = PDSPC(JS) == '
			SPECIFY'
			            IF (SPECIFY_QTR(JTT)) THEN
			              ELTRT(JTT) = ETDSP(JS)
			              ELTRB(JTT) = EBDSP(JS)
			            END IF
			            JBTR(JTT) = JBD
			end if ! cb 9/11/13
			``
				9/11/2013

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
38	W2	32 bit exe on XP	Recompiled with new settings from Visual Studio 2012 to (hopefully) run on XP systems with 32 bit OS	9/11/2013
39	W2	End Simulation	Added new close open files in the end_simulation sub-routine. This is merely cleaning up the code to be consistent in closing all open files when a 'Stop' is executed. This should have no effect on the end user. Part of this new code is shown below:	9/25/13

```
IF(SELECTC == '     ON')then          ! SW
9/25/13 New Section on closing files
  ifile=1949
  do jb=1,nbr
      if(nstr(jb) > 0)then
          ifile=ifile+1
          close(ifile)
      endif
  enddo
  if(nwd > 0)then
      ifile=ifile+1
      close(ifile)
  endif
endif

      IF (DOWNSTREAM_OUTFLOW) THEN
      JFILE=0
      DO JWD=1,NIWDO
        CLOSE(WDO(JWD,1))
        CLOSE(WDO(JWD,2))
        IF (CONSTITUENTS) THEN
          CLOSE (WDO(JWD,3))
        END IF
        IF (DERIVED_CALC) THEN
          CLOSE(WDO(JWD,4))
        END IF
```

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
40	W2	Pumps – Lateral	Fixed several sections of code in the PUMP algorithm in the hydroinout.f90 routine. Under some conditions such as specifying "Lateral", the PUMP algorithm may not have moved the water from the upstream to the downstream segment correctly. This has been fixed and tested. Part of the code changes are shown below:	9/25/13

```
IF (LATERAL_PUMP(JP)) THEN
        ELW = EL(KTWB(JWU),IUPU(JP))-
Z(IUPU(JP))*COSA(JBU)
            !    JWW     = JWW+1     ! SW 9/25/13
            !   JBWD(JWW) = JBU
            !   IWD(JWW)  = IUPU(JP)
            ELSE
        ELW = EL(KTWB(JWU),IUPU(JP))-
Z(IUPU(JP))*COSA(JBU)-
SINA(JBU)*DLX(IUPU(JP))*0.5
            !   JSS(JBU)                =
JSS(JBU)+1     ! SW 9/25/13
            END IF
…
        IF (PUMPON(JP)) THEN
          IF (LATERAL_PUMP(JP)) THEN
            JLAT     = 1
            JWW      = JWW+1
! SW 9/25/13
…
        CALL LATERAL_WITHDRAWAL       ! (JWW)
            DO K=KTW(JWW),KBW(JWW)
              QSS(K,I) = QSS(K,I)-QSW(K,JWW)
            END DO
            IF (IDPU(JP) /= 0) THEN
! MOVED CODE SW 9/25/13
                JTT               = JTT+1
…
ELSE
            JSS(JBU)                =
JSS(JBU)+1     ! SW 9/25/13
            KTSW(JSS(JBU),JBU)      =
KTPU(JP)
…
```

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
| 41 | W2 | Clean up memory issues | A series of minor memory issues were cleaned up. This should have no impacts on current model runs. These were usually uninitialized memory. Code changes made include:<br><br>```
READ (CON,'(/)')
  KFNAME2='       '   ! SW 9/27/13 INITIALIZE
ENTIRE ARRAY
  KFWBC  ='       '   ! SW 9/27/13 INITIALIZE
ENTIRE ARRAY

READ (CON,'(//(:8X,9I8))')          (KBWD(JW),
JW=1,NWD); TRC= '       ' ! SW 9/27/13
INITIALIZATION SINCE ALLOCATION IS TO NTRT
  READ (CON,'(//(:8X,9A8))')          (TRC(JT),
JT=1,NTR)

   EHSN(JE),   EHSSI(JE),
JE=1,NEPT)        !JE=1,NEP)  SW 9/27/13
  READ (CON,'(//(8X,2F8.0,I8,F8.0))') (ESAT(JE),
EHS(JE),    ENEQN(JE),   ENPR(JE),
JE=1,NEPT)        !JE=1,NEP)  SW 9/27/13
  READ (CON,'(//(8X,8F8.0))')         (ET1(JE),
ET2(JE),   ET3(JE),    ET4(JE),    EK1(JE),
EK2(JE),                         &
                                      EK3(JE),
EK4(JE),
JE=1,NEPT)        !JE=1,NEP)  SW 9/27/13
  READ (CON,'(//(8X,6F8.0))')          (EP(JE),
EN(JE),     EC(JE),      ESI(JE),     ECHLA(JE),
EPOM(JE),    JE=1,NEPT)        !JE=1,NEP)  SW
9/27/13

READ (CON,'(//8X,A8,I8,A8)')          RSOC,
NRSO,    RSIC; RSOD=0.0 ! SW 9/27/13 INITIALIZE
SINCE ALLOCATED AS NOD BUT ONLY NRSO USED
  READ (CON,'(//(:8X,9F8.0))')         (RSOD(J),
J=1,NRSO)

  READ (CON,'(//8X,I8,F8.0,a8)')          NDLT,
DLTMIN, DLTINTER; DLTD=0.0  ! SW 9/28/13
INITIALIZE ARRAY TO NOD SINCE ONLY NDLT ASSIGNED
  READ (CON,'(//(:8X,9F8.0))')         (DLTD(J),
J =1,NDLT)

  SINKC(1:NSTR(JB),JB) = SINKCT(1:NSTR(JB),JB)
  POINT_SINK(1:NSTR(JB),JB) =
SINKC(1:NSTR(JB),JB) == '   POINT'  ! SW
9/27/13
  END DO
! POINT_SINK = SINKC == '   POINT'

  COLDEP=ELWS(I)-COLB
  !    MACT(J,KT,I)=MACT(J,KT+1,I)
  IF(MACROPHYTE_ON)MACT(J,KT,I)=MACT(J,KT+1,I)
! SW 9/28/13

!    SDKV(:,US(JB):DS(JB))=SDK(JW)
     SDKV(:,US(JB)-1:DS(JB)+1)=SDK(JW)     !
SW 9/28/13
``` | 9/27/13 |

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| 42 | W2 | CPL output | Code was added to eliminate writing out the habitat index to the CPL file for Tecplot when HABITATC is OFF.

```
IF(I /= DS(JB)+1)THEN
                    IF(HABTATC == '      ON')THEN
                      WRITE (CPL(JW),9999)
X1(I),ELWS(I),U(K,I),-
W(K,I),T1(K,I),RHO(K,I),HAB(K,I),(C2(K,I,CN(JC))
,JC=1,NAC)
                    ELSE
                      WRITE (CPL(JW),9999)
X1(I),ELWS(I),U(K,I),-
W(K,I),T1(K,I),RHO(K,I),(C2(K,I,CN(JC)),JC=1,NAC
)
                    ENDIF

                  ELSE
                    XDUM=-99.0
                    WRITE (CPL(JW),9999)
X1(I),ELWS(I),XDUM,XDUM,XDUM,XDUM,XDUM,(XDUM,
JJ=1,NAC)
                  ENDIF
                  DO K=KTWB(JW),KMX-1
                    IF(I /= DS(JB)+1 .AND. K <=
KB(I))THEN
                      IF(HABTATC == '      ON')THEN
                      WRITE (CPL(JW),9999)
X1(I),ELWS(I)-DEPTHM(K,I),U(K,I),-
W(K,I),T1(K,I),RHO(K,I),HAB(K,I),(C2(K,I,CN(JC))
,JC=1,NAC)
                      ELSE
                      WRITE (CPL(JW),9999)
X1(I),ELWS(I)-DEPTHM(K,I),U(K,I),-
W(K,I),T1(K,I),RHO(K,I),(C2(K,I,CN(JC)),JC=1,NAC
)
                      ENDIF

                      IF(K == KB(I))THEN
                          IF(HABTATC  == '
ON')THEN
                          WRITE (CPL(JW),9999)
X1(I),ELWS(I)-DEPTHB(K,I),U(K,I), -
W(K,I),T1(K,I),RHO(K,I),HAB(K,I),(C2(K,I,CN(JC))
,JC=1,NAC)
                          ELSE
                          WRITE (CPL(JW),9999)
X1(I),ELWS(I)-DEPTHB(K,I),U(K,I), -
W(K,I),T1(K,I),RHO(K,I),(C2(K,I,CN(JC)),JC=1,NAC
)
                          ENDIF

WRITE (CPL(JW), *)'TITLE="CE-QUAL-W2"'
            IF(HABTATC  == '      ON')THEN
                  WRITE
(CPL(JW),19233)(CNAME2(CN(JN)),JN=1,NAC)
                ELSE
                  WRITE
(CPL(JW),19234)(CNAME2(CN(JN)),JN=1,NAC)
                ENDIF ! sw 9/28/13
                  19233
FORMAT('VARIABLES="Distance, m","Elevation,
m","U","W","T","RHO", "HABITAT"
',<NAC>(',"',A8,'"'))
            19234 FORMAT('VARIABLES="Distance,
m","Elevation, m","U","W","T","RHO"
',<NAC>(',"',A8,'"')) ! sw 9/28/13
``` | 9/28/13 |
| 43 | W2 | SPECIFY TRIB | In specifying the elevation between top and bottom for an inflow tributary, the code put the inflow 1 layer | 10/3/2013 |

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

			below it should have been in many cases. This has been fixed by the additional code shown below:
			
			``
			IF (SPECIFY_QTR(JT)) THEN
			    KTTR(JT) = 2
			! DO WHILE (EL(KTTR(JT),I) >
			ELTRT(JT))
			      DO WHILE (EL(KTTR(JT),I) >
			ELTRT(JT) .and. EL(KTTR(JT)+1,I) > ELTRT(JT)) !
			SW 10/3/13
			        KTTR(JT) = KTTR(JT)+1
			      END DO
			``	

44	W2	CWO or CWDO output	Fixed a format overflow in writing out concentrations in a withdrawal output file.
			
			``
			      IF (QWDO(J) /= 0.0) CWDO(CN(JC),J) =
			CWDO(CN(JC),J)/QWDO(J)
			      WRITE (CWDOC(CN(JC)),'(F8.3)')
			CWDO(CN(JC),J) ! SW
			9/23/13 Changed format from G8.3 to F8.3 to
			avoid format overflow
			      CWDOC(CN(JC)) = ADJUSTR(CWDOC(CN(JC)))
			
			IF (QWDO(J) /= 0.0) CDWDO(CDN(JD,JW),J) =
			CDWDO(CDN(JD,JW),J)/QWDO(J)
			      WRITE (CDWDOC(CDN(JD,JW)),'(F8.3)')
			CDWDO(CDN(JD,JW),J) ! SW 9/23/13
			Changed format from G8.3 to F8.3 to avoid format
			overflow
			      CDWDOC(CDN(JD,JW)) =
			ADJUSTR(CDWDOC(CDN(JD,JW)))
			``
				10/4/2013

45	W2 and PREW2	Inflow, Tributary, Distributary and Shade inputs	Added csv file format as a new file input format for flow and temperature files for inflows, tributaries and distributed tributaries. Also, the shade file is now in csv file format. This enhancement includes updates to the preprocessor and W2 codes. Also several minor bug fixes were made on the Preprocessor.	7/15/14

46	W2	Resuspension of inorganic solids	A resuspension formula was corrected. See the code change below:
			
			``
			  HS = 0.283
			*U2/G*0.283*TANH(COEF1)*TANH(COEF2/TANH(COEF1))
			    !TS = 2.0*PI*U2/G*1.2*
			TANH(COEF3)*TANH(COEF4/TANH(COEF3))
			    TS = 2.0*PI*sqrt(U2)/G*1.2*
			TANH(COEF3)*TANH(COEF4/TANH(COEF3)) ! cb
			5/9/14
			``
				7/15/14

47	W2	Tecplot output	When the user sets CPL output for Tecplot, the output format when HABITAC=OFF was incorrect. This has been fixed.	7/15/14

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

48	PREW2	Warnings	Fixed a name inconsistency for developing warnings for input concentrations
			
			``
			! IF (NAME /= 'Residence time' .AND. NAME /= 'Water age') THEN
			            IF (NAME /= 'Residence time' .AND. NAME /= 'AGE') THEN ! SW 7/15/14
			                CALL WARNINGS
			``
				7/15/14

49	W2	TSR filename	The filename in w2_con.npt for TSR is used for the output filenames. In order to account for complex paths that include more than one '.', the following change was made with the BACK=.TRUE. command which checks from the right-hand-side rather than left-hand-side of the character string ``` ! L1 = SCAN(TSRFN,'.') L1 = SCAN(TSRFN,'.',BACK=.TRUE.) ```	8/22/14
50	PREW2	Hydraulic structure warnings	Added many new hydraulic structure warnings (gates, spillways, pumps, pipes, internal weirs) for cases where KBSTR was less than KB and fixed a few error messages for these structure checks.	9/10/14
51	W2	TSR output	The time series file has added the surface heat flux terms (net, short wave solar net, long wave radiation net, back radiation heat flux, evaporation heat flux, conductive heat flux) to the output. The manual was also updated.	1/15/15

52	W2	Interpolation of wind direction	In some cases, the wind direction interpolation was incorrect. Code was added to reduce the wind direction angle to less than 2*pi before the interpolation is performed and to consider another possible interpolation case. Thanks to Wenwei Xu for pointing this out. New code is shown below:
			
			``
			    ! CONVERT PHIO AND PHINX TO LESS THAN 2*PI SW 2/13/15
			    DO WHILE(PHIO(JW)>2.*PI)
			        PHIO(JW)=PHIO(JW)-2.*PI
			    ENDDO
			    DO WHILE(PHINX(JW)>2.*PI)
			        PHINX(JW)=PHINX(JW)-2.*PI
			    ENDDO
			    IF (PHIO(JW)-PHINX(JW) > PI) THEN
			      PHI(JW) = (1.0-RATIO)*(PHINX(JW)+2.0*PI)+RATIO*PHIO(JW)
			    ELSEIF (PHIO(JW)-PHINX(JW) < -PI) THEN ! WX 2/13/15
			      PHI(JW) = (1.0-RATIO)*PHINX(JW)+RATIO*(PHIO(JW) +2.0*PI) ! WX 2/13/15
			    ELSE
			      PHI(JW) = (1.0-RATIO)*PHINX(JW)+RATIO*PHIO(JW)
			    END IF
			``
				2/13/15

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Bug Fixed or En-hancement added

53	W2	Withdrawal	Stewart Rounds: Extra check to avoid divide by zero in withdrawal algorithm (this or similar code occurs in 4 subroutines in withdrawal.f90)
			
			IF ((ELSTR-HSWB) > EL(KBOT+1,ID)) THEN
			  DLRHOB = ABS(RHO(KSTR,ID)-RHO(KBOT,ID))
			 ELSE IF ((EL(KBOT+1,ID)-ELR) == ELSTR) THEN
			!SR 03/24/13
			  DLRHOB = NONZERO
			!SR 03/24/13
			 ELSE
			  DLRHOB = ABS(RHO(KSTR,ID)-
			RHO(KBOT,ID))*HSWB/(ELSTR-(EL(KBOT+1,ID)-ELR))
				4/9/2015

54	W2	SELECTC	The USGS has developed a new automatic port selec-tion algorithm. In the control file, w2_con.npt, one can use the new algorithm by setting SELECTC='USGS'. The old algorithm is used when this is set to SELECTC= 'ON'. There is new documentation in the User Manual for this new algorithm.	4/9/2015
55	W2	Restart out-put	Added code to write out a restart file (rso.opt) at the end of a run if restart_output is ON.	4/9/15
56	W2 Exam-ples	Added exam-ple problems	Added new example problem for the Spokane River using new csv file inputs and 4 example problems for using the USGS auto-port algorithm	4/9/15

57	W2	Restart for file vol-ume_wbX.op t	The file handler was not closed properly for vol-ume_wbX.opt. Fixed it with additional code in endsimualtion.f90:
			if(nwd > 0)then
			    ifile=ifile+1
			    close(ifile)
			  endif
			  do jw=1,nwb ! sw 4/20/15
			    ifile=ifile+1 ! sw 4/20/15
			    close(ifile) ! sw 4/20/15
			  enddo ! sw 4/20/15
				4/20/15

58	W2	W2selec-tive.npt	Changed input format for critical temperatures for the output file volume_wbX.opt from a maximum of 10 waterbodies to 100. READ(1010,'(8X,100F8.0)')(TEMPCRIT(JW, J),JW=1,NWB) ! NOTE MAX OF 100 WATERBODIES sw 4/20/15	4/20/15
59	W2	Resuspen-sion of SS	Changed DO loop index in suspended solids resuspen-sion in water_quality.f90 from DO K=KT-1,KB(I)-1 to DO K=KT+1,KB(I)-1 ! cb 9/29/14	5/14/2015

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
60	W2	Wind at 2 m	The W2 model computes the wind at a 2 m height based on the used defined measurement height of the wind for evaporation computations. The formula for computing this variable was using a step function of the wind data rather than interpolation of the wind data when the user chose to interpolate meteorological data. For meteorological input data at short time intervals this is a very minor change. For meteorological data at large time intervals (like a day), this could affect the amount of evaporation. Hence, the calculation below was moved from the TVDS routine to the main routine so that the interpolated wind would be used. `WIND2(I)=WIND(JW)*WSC(I)*DLOG(2.0D0/Z0(JW))/DLOG(WINDH(JW)/Z0(JW))`	5/21/15
61	W2	TSR output	The TSR file output now also includes a volume weighted vertical average temperature for the segment that the TSR file is located. The manual has been updated also.	6/1/15

62	W2	Writing over output files	In some intermittent cases, when the dialog box closes, the model reinitializes some of the output files (effectively deleting the output). The following line of code was adding at the beginning of the main W2 code to prevent this:
			
			``
			!**
			Task 1: Inputs
			**
			!***
			***
			***************************
			
			INTEGER(4) length,istatus
			character*255 dirc
			! call omp_set_num_threads(4) ! set # of processors to NPROC Moved to INPUT subroutine
			IF(END_RUN)STOP ! SW 6/26/15 Added code to prevent a thread from reinitializing output files as dialog box is closing...intermittant error
			``
				6/26/15

63	W2	Output order for kinetic fluxes	The output columns for DOAR and DOER were switched in the output file kflux_jw*.opt. The model code was changed to fix this. ! DOAR => KF(:,:,56); DOEP => KF(:,:,57); DOER => KF(:,:,58); DOPOM => KF(:,:,59); DODOM => KF(:,:,60) DOEP => KF(:,:,56); DOAR => KF(:,:,57); DOER => KF(:,:,58); DOPOM => KF(:,:,59); DODOM => KF(:,:,60) ! cb 9/16/2015	9/16/15

W2 V3.6 Bug Fixes, Enhancements, and User Manual Changes

Table 7. Bug fixes and enhancements for Version 3.6.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
1	W2	TKE1 model	The variable STRICK was incorrectly allocated as an INTEGER rather than REAL.	10/11/2008
2	W2	PIPE	Code was streamlined in the subroutine ZBRENT where calls were made directly to CDFUNC rather than through the dummy function FUNC	10/11/2008
3	W2 Manual	Z0	The User Manual had Z0 in an incorrect line in the control file (w2_con.npt). The write up and example control file in the User Manual were corrected.	10/28/2008
4	W2	Longitudinal profile input	The W2 program did not read initial constituent concentrations in the longitudinal profile file when CCC was 'OFF'. This has been fixed.	12/4/2008
5	W2	TECPLOT output	When using TECPLOT output for multiple waterbodies, the output format did not allow loading the information into TECPLOT. Fixed.	1/26/2009
6	W2	Epiphyton input	For entering vertical profile data for periphyton, there was an index error: OLD CODE: IF (VERT_EPIPHYTON(JW,JE)) EPD(:,I,JE) = EPIVP(K,JW,JE) NEW CODE: IF (VERT_EPIPHYTON(JW,JE)) EPD(:,I,JE) = EPIVP(:,JW,JE)	5/21/2009
7	PreW2	Constituent loads	An enhancement was added to the Preprocessor to compute loads in kg/day for all inflow, tributary and distributed tributaries. Also, these are summed up for the model application. These are shown in the file "pre.opt". These are approximate loads since the concentration data are used to set the frequency of loading update. Flow rates at the time of the concentration input data are used to compute load.	5/21/2009

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

8	W2	Gas transfer at spillways	A couple code fixes in the hydroinout.f90 subroutine:
			(1) CGAS needed to be initialized in some cases to CGAS=C2(K,ID,CN(JC)) prior to calling the subroutine TOTAL_DISSOLVED_GAS
			for use in the Butts and Evans (1983) equation:
			NEW CODE:
			`CGAS=C2(K,ID,CN(JC))  ! MM 5/21/2009`
			
			(2) Change logic in several lines from
			IF(CAC(NDO) == ' ON' to
			IF(CAC(NDO) == ' ON' .and. CN(JC)==NDO
			NEW CODE:
			`IF (CN(JC)==NDO .AND. CAC(NDO) == '    ON' .AND. GASSPC(JS) == '      ON' .AND. QSP(JS) > 0.0) THEN`
			`! MM 5/21/2009`
				5/21/2009

9	W2	Reaeration from dams	An error was found in the formulae from Butts and Evans (1983).
			OLD CODE:
			`    DB = SAT-C`
			`    DA =`
			`DB*(1.0+0.38*AGASGT(N)*BGASGT(N)*CGASGT(N)*(1.0-0.11*CGASGT(N))*(1.0+0.046*T))`
			`    C  = SAT-DA`
			NEW CODE:
			`    DA = SAT-C`
			`! MM 5/21/2009 DA: Deficit upstream`
			`    DB =`
			`DA/(1.0+0.38*AGASSP(N)*BGASSP(N)*CGASSP(N)*(1.0-0.11*CGASSP(N))*(1.0+0.046*T))`
			`! DB: deficit downstream`
			`    C  = SAT-DB`
				5/21/2009

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

10	W2	Order of flux parameters	The order of flux parameters in the User Manual and output were incorrect. The control file has them in this order:
			`RPOMSET`
			`CBODDK`
			`DOAP`
			`DOAR`
			`DOEP`
			`DOER`
			`DOPOM`
			`DODOM`
			`DOOM`
			
			`whereas the code assumed they were in`
			`this order:`
			`RPOMSET`
			`CBODDK`
			`DOAP`
			`DOEP`
			`DOAR`
			`DOER`
			`DOPOM`
			`DODOM`
			`DOOM`
			`This has been corrected. The User Manual and control file order is now reflected in the W2 code.`
				6/2/2009

11	Pre	False errors for inflow location	The preprocessor sometimes gave false errors in the pre.err for tributary, internal weirs, pipes, and other hydraulic features saying that the pipe or tributary was below the elevation of the bottom of the segment. The W2 model ran fine even with this error message given in the preprocessor. This has been fixed.
			
			Example of OLD CODE:
			`IF (EBTR(JT) < EL(KB(ITR(JT)+1),ITR(JT))) THEN`
			`CALL ERRORS`
			`WRITE (ERR,FMTFI) 'Inflow placement bottom elevation [EBTR=',EBTR(JT),'] < bottom active cell elevation for tributary ',JT`
			
			New CODE:
			`IF (EBTR(JT) < EL(KB(ITR(JT))+1,ITR(JT))) THEN`
			`CALL ERRORS`
			`WRITE (ERR,FMTFI) 'Inflow placement bottom elevation [EBTR=',EBTR(JT),'] < bottom active cell elevation for tributary ',JT`
				6/18/09

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
12	Pre	Additional error checking	Additional error checking was added to help debug an error in the bathymetry file when the problem was in the branch connectivity specifically BS and BE. Also, a false error was given when the temperature had an isothermal initial condition, constituents were OFF, and an initial concentration was set to "-2". This was fixed.	6/22/09
13	Pre	Command line processing and working directory displayed for windows	In the windows version of the preprocessor, the user can now supply a command line argument that sets the working directory of the code. Hence, one does not need to copy the preprocessor into every directory. In a batch file, for example, one can execute the following command: `preW2_ivf.exe "C:\scott\w2workshop\2009 workshop\waterqual\problem3"` The preprocessor now uses the supplied directory (in double quotes) as the working directory for all the files. The command line argument has one blank space between the end of the executable and the first quote. Also, the working directory is now displayed at the top of the window. Additional checks were also added for checking the grid linkage.	9/12/09
14	W2	# of processors	The model user can now control the # of physical processors the model uses. At this point, dual-processor model runs have shown an improvement of about 20% over a single processor. But, QUAD processors usually are slower. It is recommended that NPROC be set to 2 in the control file. The user can experiment on his/her own system. If this is not set by the user or is left blank, the model still runs but sets it to 2 processors. ```\nGRID NWB NBR IMX KMX\nNPROC CLOSEC\n 1 1 23 22\n2 ON\n```	9/12/09

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
15	W2	Command line processing for windows	In the windows version of the w2 model, the user can now supply a command line argument that sets the working directory of the code. Hence, one does not need to copy the model executable into every directory. In a batch file, for example, one can execute the following command: `W2_ivf.exe "C:\scott\w2workshop\2009 workshop\waterqual\problem3"` The w2 model now uses the supplied directory (in double quotes) as the working directory for all the files. The command line argument has one blank space between the end of the executable and the first quote. The working directory is displayed in a text box in the window.	9/12/09

16	W2	W2 window closed at end of successful execution	At the end of a windows run, the windows dialog box waits for the user to press 'close' to exit the window. This allows the user to examine the final run parameters. In the w2_con.npt file there is now an option to close this window when the run has completed. If this option is not set, then the dialog box will stay until the user clicks 'close'.
			
			This allows for efficient batch processing of the model, especially if user in conjunction with command line processing mentioned in #15.
			
			`GRID        NWB      NBR      IMX      KMX`
			`NPROC  CLOSEC`
			`               1        1        23        22`
			`0      ON`
			
			When CLOSEC is set to ON, then the dialog box will disappear once the run finishes. If it is set to OFF, then the dialog box will remain until the user clicks 'close'.
				9/12/09

17	User Manual	Updates	Updates and changes to the control file (#13-#16) were reflected in an updated User Manual.	9/12/09

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
18	GUI	Updates	The GUI was updated with the following: (1) new control file parameters NPROC and CLOSEC were added (see #14 and 16). There is also a SELECTC that will be used in V3.7 that has been included – ignore it for now. (2) The GUI also can be controlled by command line passing of the working directory and file. In a batch program or from the command line in a DOS box you can execute the GUI as follows: `"C:\scott\research\corps of engineers\tomcole\w2code\GUI36\w2control\w2control36.exe" C:\scott\w2workshop\2009 workshop\waterqual\problem1\w2_con.npt` The first string in quotes executes the GUI. The command line argument is NOT in quotes. This program was developed in VB6 and does not take quotes around the command line. Note that this is different than the FORTRAN command line argument. So the above command will open the GUI and load the control file automatically. (3) A text box now shows the file path and name of the file that you are working on (4) In file open, earlier all *.npt files were shown. Since only "w2_con.npt" files are loaded into the GUI, only the "w2_con.npt" file was shown for opening.	9/12/09

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

19	W2	Gates, spillways, pipes	Whenever DOWN was specified for a gate, spillway or pump, the model estimated the water level at the end of the segment, rather than using the branch center water level. This is important in sloping river systems where a long segment may have a water surface elevation drop between the segment center and the edge. In the past this was computed assuming the slope of the channel. This was updated to estimate the water surface elevation using linear interpolation rather than the grid slope. Below is an example of the code fix – in this case for GATES:
			
			OLD CODE:
			`ELIU=ELWS(IUGT(JG))-`
			`SINA(JBUGT(JG))*DLX(IUGT(JG))*0.5`
			
			NEW CODE:
			`ELIU= ELWS(IUGT(JG)) + (ELWS(IUGT(JG))-`
			`ELWS(IUGT(JG)-`
			`1))/(0.5*(DLX(IUGT(JG))+DLX(IUGT(JG)-`
			`1)))*DLX(IUGT(JG))*0.5`
				9/25/09

20	W2	New executable	A new executable was made using a new release of Intel Version 11 compiler that corrected problems with Windows 7 applications.	9/25/09

21	W2	ICE cover algorithm	There were a couple logic errors in the ice cover algorithm. These were corrected below:	10/20/09

```
!************** Ice thickness
              ICETH(I) =
ICETH(I)+ICETHU+ICETH1+ICETH2
              IF (ICETH(I) < ICE_TOL)
ICETH(I) = 0.0
              IF (WINTER .AND. (.NOT.
ICE_IN(JB))) THEN
                IF (.NOT. ALLOW_ICE(I))
ICETH(I) = 0.0
              END IF
              ICE(I)   = ICETH(I) > 0.0
              IF (ICE(I))THEN      !
3/27/08 SW
                ICESW(I) = 0.0
              ELSE
                ICESW(I) = 1.0
              ENDIF
              ICETHU   = 0.0
              ICETH1   = 0.0
              ICETH2   = 0.0
              IF (ICETH(I) < ICE_TOL
.AND. ICETH(I) > 0.0) ICETH(I) = ICE_TOL
            ELSE
              IF(TERM_BY_TERM(JW))CALL
EQUILIBRIUM_TEMPERATURE            ! SW
10/20/09 Must call this first otherwise
ET and CSHE are 0
              HIA      =
0.2367*CSHE(I)/5.65E-8
! JM 11/08 convert SI units of m/s to
English (btu/ft2/d/F) and then back to SI
W/m2/C
!             ICETH(I) =
MAX(0.0,ICETH(I)+DLT*((RIMT-
ET(I))/(ICETH(I)/RK1+1.0/HIA)-(T2(KT,I)-
RIMT))/RHOIRL1)    ! OLD CODE
              ICETH(I) =
MAX(0.0,ICETH(I)+DLT*((RIMT-
ET(I))/(ICETH(I)/RK1+1.0/HIA)-
HWI(JW)*(T2(KT,I)-RIMT))/RHOIRL1)   ! SW
10/20/09 Revised missing HWI(JW)
              ICE(I)   = ICETH(I) > 0.0
              ICESW(I) = 1.0
              IF (ICE(I)) THEN
!             TFLUX    = 2.392E-
7*(RIMT-T2(KT,I))*BI(KT,I)*DLX(I)  ! OLD
CODE
              TFLUX    = 2.392E-
7*HWI(JW)*(RIMT-T2(KT,I))*BI(KT,I)*DLX(I)
! SW 10/20/09 Revised missing HWI(JW)
              TSS(KT,I)  = TSS(KT,I)
+TFLUX
              TSSICE(JB) =
TSSICE(JB)+TFLUX*DLT
              ICESW(I) = 0.0
            END IF
          END IF
        END DO
      END IF
    END IF
```

22	W2	Gates output in QWD file	The following bug was found in defining which branch a gate was located. This affected the output for the	3/24/10

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Bug Fixed or En-hancement added

			withdrawals at a location where there were gates that were not tied to other branches.
			
			Old code:
			<pre>JWUGT(JG) = JW
			      IF (IDGT(JG) > 0) THEN
			        DO JB=1,NBR
			          IF (IDGT(JG) >= US(JB) .AND.
			IDGT(JG) <= DS(JB)) EXIT
			        END DO
			        JBDGT(JG) = JB
			        DO JW=1,NWB
			          IF (JB >= BS(JW) .AND. JB <=
			BE(JW)) EXIT
			        END DO
			        JWDGT(JG) = JW
			      else ! BUG FIX 9/27/07
			        jbdgt(jp)=1
			        jwdgt(jp)=1
			      END IF</pre>
			New code:
			<pre>JWUGT(JG) = JW
			      IF (IDGT(JG) > 0) THEN
			        DO JB=1,NBR
			          IF (IDGT(JG) >= US(JB) .AND.
			IDGT(JG) <= DS(JB)) EXIT
			        END DO
			        JBDGT(JG) = JB
			        DO JW=1,NWB
			          IF (JB >= BS(JW) .AND. JB <=
			BE(JW)) EXIT
			        END DO
			        JWDGT(JG) = JW
			      else ! BUG FIX 9/27/07
			        jbdgt(jg)=1 ! SW 3/24/10
			        jwdgt(jg)=1 ! SW 3/24/10
			      END IF</pre>	

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

23	PreW2	Reading of WSC	Reading in of the WSC file was limited to only 100 dates in the preprocessor. This limitation was fixed by the code shown below:
			<pre>! DO J=1,100
			  28995 continue ! cb 3/26/10
			  READ
			(NPT,'(10F8.0:/(8X,9F8.0))',END=29000)
			SDAY,(WSC(I),I=1,IMX)
			          IF (SDAY <= SDAYO) THEN
			          CALL ERRORS
			          WRITE (ERR,'(3(A,F0.3))')
			'Julian date ',SDAY,' <= previous date of
			',SDAYO,' in '//WSCFN
			          END IF
			          DO I=1,IMX
			          IF(WSC(I) <= 0.0)THEN
			          CALL ERRORS
			          WRITE (ERR,'(A,F0.3,A,I4,A)')
			'Julian date ',SDAY,': WSC AT
			SEG(I)=',I,' <= 0.0 in '//WSCFN
			          ENDIF
			          IF (WSC(I) > 2.0) THEN
			            CALL WARNINGS
			            WRITE (WRN,'(A,F0.3,A,I4,A)')
			'Julian day ',SDAY,': WSC(I) AT
			SEG(I)=',I,' > 2.0 in '//WSCFN
			          END IF
			          IF (WSC(I) > 0.0 .and. wsc(i) <
			0.5) THEN
			            CALL WARNINGS
			            WRITE (WRN,'(A,F0.3,A,I4,A)')
			'Julian day ',SDAY,': WSC(I) AT
			SEG(I)=',I,' < 0.5 in '//WSCFN
			          END IF
			          ENDDO
			          SDAYO=SDAY
			  ! ENDDO
			
			  go to 28995 ! cb 3/26/10</pre>
				3/26/10

24	PreW2	Check on LAT or DOWN	Added an enhancement to do a check in case a spill-way, pipe, pump, or gate was specified as 'DOWN'. In all cases where 'DOWN' is specified, the segment that the hydraulic structure originates must be at the end of a branch. Additional logic was added to check for this in all the hydraulic structures.	3/26/10
25	W2 Manual	Light extinction, ice	Added more text to the section on computation of light extinction and inserted a missing reference. Revised an equation for clarity in ICE algorithm and added more explanation on how to estimate HICE.	4/13/2010
26	W2 Manual	Precipitation input file	The units of precipitation are in m/s. The example precipitation input file was changed to more realistic values.	4/14/2010

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Bug Fixed or En-hancement added

27	W2	ICE	Added code to account for the need to compute long wave radiation in case user chose the equilibrium tem-perature approach. Fixed subscript error in ice melt computation. Also, made the variable TICE double pre-cision since it is assumed double precision in the call to Surface_terms.
			
			New code:
			<pre>IF (ICE(I)) THEN
			                        TICE = TAIR(JW)
			                        DEL = 2.0
			                        J = 1
			
			if(tair(jw).ge.5.0)then ! SW 4/19/10
			RANLW(JW) = 5.31E-
			13*(273.15+TAIR(JW))**6*(1.0+0.0017*CLOUD
			(JW)**2)*0.97
			                        else
			                        RANLW(JW) = 5.62E-
			8*(273.15+TAIR(JW))**4*(1.-0.261*exp(-
			7.77E-
			4*TAIR(JW)**2))*(1.0+0.0017*CLOUD(JW)**2)
			*0.97
			                        endif
			
			RN1=SRON(JW)/(REFL*RHOWCP)*SHADE(I)*(1.0-
			ALBEDO(JW))*BETAI(JW)+RANLW(JW)
			! SW 4/19/10
			                        DO WHILE (DEL > 1.0
			.AND. J < 500)
			                        CALL SURFACE_TERMS
			(TICE)
			                        RN(I) = RN1-RB(I)-
			RE(I)-RC(I) ! 4/19/10
			! RN(I) =
			SRON(JW)/(REFL*RHOWCP)*SHADE(I)*(1.0-
			ALBEDO(JW))*BETAI(JW)+RANLW(JW)-RB(I)-
			RE(JW)-RC(I) ! OLD CODE
			                        DEL =
			RN(I)+RK1*(RIMT-TICE)/ICETH(I)
			                        IF (ABS(DEL) > 1.0)
			TICE = TICE+DEL/500.0
			                        J = J+1
			                        END DO</pre>
				4/19/10

28	W2	Evaporation	Units for EV in the SNP file were given in m/s but were actually m^3/s	4/21/10

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Bug Fixed or En-hancement added

29	W2	Ice	In the ice melt algorithm, SRON should not have been divided by RHOCP in computing RN1 and DEL in the DO WHILE loop should have been ABS(DEL) rather than DEL:
			
			`RN1=SRON(JW)/REFL*SHADE(I)*(1.0-`
			`ALBEDO(JW))*BETAI(JW)+RANLW(JW)`
			`! SW 4/19/10 eliminate spurious divsion`
			`of SRO by RHOCP`
			`        DO WHILE (ABS(DEL) > 1.0 .AND. J <`
			`500)`
			`! SW 4/21/10 Should have been ABS of DEL`
			`        CALL SURFACE_TERMS (TICE)`
				4/21/2010

30	PRE	Constituent loading	The output from the preprocessor in the pre.opt file for constituent loading was in kg rather than the out-put header of kg/day. The output was updated to kg/day by adding the following lines of code:
			
			`cdtload(incdt(1:NACdt(Jb),Jb),jb)=cdtload`
			`(incdt(1:NACdt(Jb),Jb),jb)/(jday-tstart)`
			`! CB 5/10/10 Change units to kg/day`
			
			`ctrload(trcn(1:NACtr(Jt),Jt),jt)=ctrload(`
			`trcn(1:NACtr(Jt),Jt),jt)/(JDAY-TSTART)`
			`!CB 5/11/10 convert to units of kg/day`
				5/10/10

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

31	W2	Gate, spillways, pipes	In the case where the user has specified that the flow is DOWN, in the case of reverse flow, the model did not assign the flow correctly if the user had no other tributaries or withdrawals specified in the control file. For this rare event, additional code was written to account for this fact. Also, a logic error was discovered in reverse flow for spillways and gates. This was corrected.
			
			New code added to hydroinout.f90:
			
			``
			JWW = NWD
			  withdrawals = jww > 0 ! 6/4/10 SW
			  JTT = NTR
			  tributaries = jtt > 0 ! 6/4/10 SW
			  JSS = NSTR
			  IF (SPILLWAY) THEN
			…
			  END IF
			  tributaries = jtt > 0 ! 6/4/10 SW
			  withdrawals = jww > 0 ! 6/4/10 SW
			
			  DO JW=1,NWB
			    KT = KTWB(JW)
			    DO JB=BS(JW),BE(JW)
			``
			
			New code in gate-spill-pipe.f90:
			
			For spillway:
			``
			  IF (ISUB == 0) THEN
			  DLEL = ELIU-ESP(JS)
			  IF (ELID > ESP(JS)) DLEL = ELIU-ELID
			! SW 6/7/10
			  IF (DLEL < 0.0) THEN
			        DLEL = -DLEL
			``
			For gates:
			``
			      IF (A2GT(JG) == 0.0 .AND. G2GT(JG) /=
			0.0) DLEL = ELIU-G2GT(JG)
			      IF (ELID > EGT(JG)) DLEL = ELIU-ELID
			! SW 6/7/10
			            IF (DLEL < 0.0) THEN
			``
				6/4/10

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

32	W2	Branch intersections with multiple waterbodies	In cases where there are branch intersections between waterbodies, it was possible that the variable KBI and KB were incorrectly set. Here is the fix: Move the statement defining KBI in the subroutine init-geom.f90 to the place shown below (delete the earlier reference):
			
			 ```IF (B(K,ID+1) == 0.0) B(K-1,ID+1) = B(K-1,ID+1)```
			``` IF (IEXIT == 1) EXIT```
			``` END IF```
			``` END IF```
			``` END IF```
			``` END DO```
			``` END DO ! SW 1/23/06```
			``` END DO ! SW 1/23/06```
			``` bnew=b ! SW 1/23/06```
			``` KBI = KB ! SW 10/30/2010```
			
			```!**** Upstream active segment and single```
			```layer ! 1/23/06 entire section moved SW```
			``` DO JW=1,NWB```
			``` KT = KTWB(JW)```
			``` DO JB=BS(JW),BE(JW)```
				10/30/2010

33	W2	SS resuspension	The code index was incorrect in the loop for computing resuspension. This led in some compilers to an infinite loop.
			The corrected code is shown below:
			
			``` SSSS(KT,I,J) = -```
			```SSS(J)*SS(KT,I,J)*BI(KT,I)/BH2(KT,I)+SSR```
			``` ! DO K=KT-1,KB(I)-1```
			``` DO K=KT,KB(I)-1```
			```! JP 2/3/12```
			``` IF (SEDIMENT_RESUSPENSION(J)) THEN```
			
			Thanks to James Pasley for this bug report/fix.
				2/3/2012

W2 V3.5 Bug Fixes, Enhancements, and User Manual Changes

Table 8. Bug fixes and enhancements for Version 3.5.

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
1	W2	Zooplank-ton-algae	Sign error in the zooplankton grazing on algae term	8/23/06
2	W2	Input/output	Format for I/O was changed to allow bet-ter decimal precision of output	8/23/06

3	W2	Sediment settling rate	The sediment settling rate was acci-dentally used for POM settling. This was fixed. The old and new code lines are shown below:
			OLD:
			`    sedsum = sed-`
			`sum+seds(JW)*(LPOM(K,I)*lpomdk(jw)+RPO`
			`M(K,I)*rpomdk(jw))*BI(K,I)/BH2(K,I)*(1`
			`.0-BI(K+1,I)/BI(K,I))`
			NEW:
			`    sedsum = sed-`
			`sum+poms(JW)*(LPOM(K,I)*lpomdk(jw)+RPO`
			`M(K,I)*rpomdk(jw))*BI(K,I)/BH2(K,I)*(1`
			`.0-BI(K+1,I)/BI(K,I))  ! cb 10/22/06`
			
			This was an issue in the SEDIMENT, SEDIMENT C, SEDIMENT P, SEDIMENT N, and SEDIMENT DECAY RATE subroutines.
				10/26/06

4	W2	Sediment burial	An algorithm was added for sediment burial. This is now a new parameter in the sediment part of the control file. An updated user manual description is forth-coming. The sediment burial rate SEDB (day^{-1}) can be specified in the "SEDIMENT" card section of the control file. A different burial rate can be speci-fied for each water body.
			
			OLD/NEW line (example):
			`!      SED(K,I)     =`
			`MAX(SED(K,I)+(LPOMEP(K,I)+SEDAS(K,I)+S`
			`EDOMS(K,I)+SEDNS(K,I)-`
			`SEDD(K,I))*DLT,0.0)`
			`      SED(K,I)     =`
			`MAX(SED(K,I)+(sedem+SEDAS(K,I)+sedcb(k`
			`,i)+SEDOMS(K,I)+SEDNS(K,I)-SEDD(K,I)-`
			`sedbr(k,i))*DLT,0.0)    ! cb 11/30/06`
				11/30/06

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
5	Control File	Add burial rate for sedi-ment model	This is the change in #4 above imple-mented in the control file. The new varia-ble SEDBR is added in f8 format after the FSED variable. SEDBR: sediment burial rate in units of per day. ```\nSEDIMENT SEDC SEDPRC SEDCI\nSEDK SEDS FSOD FSED SEDBR\nWB 1 ON ON 0.00000\n0.10000 0.1 1.00000 1.00000\n1.0\n```	

6	W2	Sediment heating and sediment processes	If a model added and subtracted layers that resulted in segment addition and subtraction, there was the possibility that sediment fluxes were incorrectly com-puted.
			In the NO3 subroutine:
			Old code:
			```\n NO3SED(K,I) =\nNO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I)\n-BI(K+1,I))/BH2(K,I)\n```
			New code:
			```\nif(k == kb(i)) then\n NO3SED(K,I) =\nNO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I))/BH2(K,I)\n else\n NO3SED(K,I) =\nNO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I)-\nBI(K+1,I))/BH2(K,I)\n endif\n```
			
			New code added in sediment routine:
			```\nif(k == kb(i))then ! SW 4/18/07\n SODD(K,I) =\nSOD(I)/BH2(K,I)*SODTRM(K,I)*BI(K,I)\n else\n SODD(K,I) =\nSOD(I)/BH2(K,I)*SODTRM(K,I)*(BI(K,I)-\nBI(K+1,I))\n Endif\n```
			New code added in suspended solids rou-tine:
			```\nif(k == kb(i))then\n SSR =\nEPSILON*DLX(I)*BI(K,I)/VOL(K,I)\n else\n SSR = EPSILON*DLX(I)*(BI(K,I)-\nBI(K+1,I))/VOL(K,I)\n Endif\n```
				4/18/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
| 6 | W2 | (see above) | New code added for heat flux to channel bottom:<br><br>```
if(kt == kb(i))then    ! SW 4/18/07
            SROSED      =
SROOUT*TSEDF(JW)
            else
            SROSED      =
SROOUT*(1.0-
BI(KT+1,I)/BI(KT,I))*TSEDF(JW)
            Endif

if(k==kb(i))then                ! SW
4/18/07
            TFLUX      =
CBHE(JW)/RHOWCP*(TSED(JW)-
T2(K,I))*BI(K,I)*DLX(I)
            else
            TFLUX      =
CBHE(JW)/RHOWCP*(TSED(JW)-
T2(K,I))*(BI(K,I)-BI(K+1,I))*DLX(I)
            endif
```<br><br>New code added for sediment subrou-tine:<br><br>```
if(k == kb(i))then    ! SW 4/18/07
        SEDAS(K,I) =
SEDAS(K,I)+MAX(AS(JA),0.0)*ALG(K,I,JA)
*BI(K,I)/BH2(K,I)*(1.0-
BI(K+1,I)/BI(K,I))
else
        SEDAS(K,I) =
SEDAS(K,I)+MAX(AS(JA),0.0)*ALG(K,I,JA)
*BI(K,I)/BH2(K,I)*(1.0-
BI(K+1,I)/BI(K,I))
            endif
if(k == kb(i))then    ! SW 4/18/07
            SEDOMS(K,I) =
POMS(JW)*(LPOM(K,I)+RPOM(K,I))*BI(K,I)
/BH2(K,I)
        SEDSO        =
POMS(JW)*SED(K,I)*BI(K+1,I)/BH2(K,I)
            else
        SEDOMS(K,I) =
POMS(JW)*(LPOM(K,I)+RPOM(K,I))*BI(K,I)
/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))
        SEDSO        =
POMS(JW)*SED(K,I)*BI(K+1,I)/BH2(K,I)*(
1.0-BI(K+1,I)/BI(K,I))
            endif
``` | 4/18/07 |

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

7	W2	Zoo-plankton fixes	Several fixes in the zooplankton routine were made. Many thanks to Dr. Kellie Vache, Institute for Landscape Ecology and Resources Management (ILR) Justus-Liebig-University Giessen Heinrich-Buff-Ring 26 35392 Giessen, Germany, for finding these which are documented below:
			
			``DO K=KT,KB(I)
			        do jz = 1, nzp
			      zgztot=0.0
			!kv 5/9/2007
			        do jjz = 1,nzp
			! zooss(k,i,jz)=
			(zmu(k,i,jz)*zeff(jz)-zrt(k,i,jz)-
			zmt(k,i,jz))*zoo(k,i,jz) -
			zgz(k,i,jz,jjz)*zoo(k,i,jz) ! omniv-
			orous zooplankton
			
			zgztot=zgztot+zgz(k,i,jz,jjz)*zoo(k,i,
			jz) !kv
			5/9/2007
			      end do
			      zooss(k,i,jz)=
			(zmu(k,i,jz)*zeff(jz)-zrt(k,i,jz)-
			zmt(k,i,jz))*zoo(k,i,jz) - zgztot
			! kv 5/9/2007
			        end do
			
			do jjz = 1, nzp
			! tgraze(k,i,jz) =
			tgraze(k,i,jz) +
			prefz(jz,jjz)*zoo(k,i,jjz)
			        tgraze(k,i,jz) =
			tgraze(k,i,jz) +
			prefz(jjz,jz)*zoo(k,i,jjz)
			!cb 5/17/2007
			        end do
			
			do jjz = 1,nzp ! omnivorous zooplank-
			ton
			! ZGZ(k,i,jjz,jz)
			=
			Zmu(K,I,jz)*ZOO(K,I,jz)*prefZ(jz,jjz)/
			tgraze(K,I,jz)
			             ZGZ(k,i,jjz,jz)
			=
			Zmu(K,I,jz)*ZOO(K,I,jz)*prefZ(jjz,jz)/
			tgraze(K,I,jz) !kv 5/9/2007
			        end do```
				5/21/07

8	PRE	More checks	Added checks for Sediment burial rate and some further checks on grid geometry; added output on SEDS and SEDBR to the pre.opt file; fixed condition where NZP had to equal 1 to work.	6/2/2007

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
9	W2	Array dealloca-tion	The deallocate command on line 7557 was commented out to avoid a dealloca-tion error when the 'STOP' button is pushed during execution on a PC. `! deallocate (sedbr,sedbrp,sedbrn,sed-brc)   ! SW 6/4/07 No need to deallo-cate pointers`	6/4/2007

10	W2	Initialization of IUT	For code setting up an external head BC, the variable IUT was not initialized before it was used. This was fixed below:
			
			``
			!**** Boundary bottom layers
			
			! IF (UH_EXTERNAL(JB)) KB(IUT-1)
			= KB(IUT)
			      IF (UH_EXTERNAL(JB)) KB(IU-1) =
			KB(IU) !cb
			6/12/07
			
			    IF (UH_INTERNAL(JB)) THEN
			        IF (JBUH(JB) >= BS(JW) .AND.
			JBUH(JB) <= BE(JW)) THEN
			! KB(IUT-1) =
			MIN(KB(UHS(JB)),KB(IUT))
			          KB(IU-1) =
			MIN(KB(UHS(JB)),KB(IU))
			!cb 6/12/07
			        ELSE
			! IF (EL(KB(IUT),IUT) >=
			EL(KB(UHS(JB)),UHS(JB))) THEN
			          IF (EL(KB(IU),IU) >=
			EL(KB(UHS(JB)),UHS(JB))) THEN !cb
			6/12/07
			! KB(IUT-1) = KB(IUT)
			            KB(IU-1) = KB(IU)
			          ELSE
			! DO K=KT,KB(IUT)
			! IF
			(EL(KB(UHS(JB)),UHS(JB)) >= EL(K,IUT))
			THEN
			! KB(IUT-1) = K; EXIT
			          DO K=KT,KB(IU)
			!cb 6/12/07
			            IF
			(EL(KB(UHS(JB)),UHS(JB)) >= EL(K,IU))
			THEN !cb 6/12/07
			              KB(IU-1) = K; EXIT
			!cb 6/12/07
			            END IF
			``
				6/17/2007

11	W2	CBOD set-tling	The CBOD settling rate earlier was not converted from m/d in the control file to m/s in the code. Added code: `cbods  = cbods/day   !cb 7/23/07`	7/23/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
12	W2	TSR output	The surface width was not correctly being output. Changed BI(KT) to BI(KTWB(JW)). ``` FIX: BI(KTWB(JW),I),SHADE(I),ICETH(I),(ADJU STR(C2CH(JAC)),JAC=1,NAC), & ! CB 7/26/07 ```	7/26/07
13	PREW2	Pumps	The pump control for DOWN or LAT was not being checked properly, also a check on IUPUC was incorrect. Fixed.	8/14/07
14	W2	Algae	The logic for negative settling velocities for algae had an error. Old code: ``` ! ASR(K,I,JA) = - AS(JA)*(ALG(K+1,I,JA)*B(K+1,I)/(B(K,I) *H2(K,I))- ALG(K,I,JA))*BI(K,I)/BH2(K,I) ``` New code: ``` ASR(K,I,JA) = - AS(JA)*(ALG(K+1,I,JA)*BI(K+1,I)/BH2(K, I)-ALG(K,I,JA)*BI(K,I)/BH2(K,I)) !SP 8/27/07 ``` Shwet Prakash	8/27/07
15	GUI	NZOOP	When # of zooplankton was set equal to zero, there was an array dimensioning er-ror that caused the writing of the control file to only proceed part way. Fixed.	9/17/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

16	W2	Open chan-nel flow	Variable passed between subroutines had inconsistent declaration between rou-tines.
			`! REAL,    ALLOCATABLE, DIMENSION(:) :: Y,    D,  B,   V,   CAREA, TOPW, BELEV, Q, VOLD, YOLD`
			
			`REAL,    ALLOCATABLE, DIMENSION(:) :: Y,  B,   V,    CAREA, TOPW,  BELEV, Q, VOLD, YOLD        ! cb 10/1/07`
			
			`!  ALLOCATE (Y(NN),    V(NN), CAREA(NN),  TOPW(NN),   BELEV(NN), Q(NN),      VOLD(NN), YOLD(NN), D(NN), B(NN))`
			
			`  ALLOCATE (Y(NN),    V(NN), CAREA(NN),  TOPW(NN),   BELEV(NN), Q(NN),      VOLD(NN), YOLD(NN), B(NN)) ! cb 10/1/07`
			
			`!  DEALLOCATE (Y, V, CAREA, TOPW, BELEV, Q, VOLD, YOLD, D, B, YT, VT, VPR, YPR, TAREA, TOPWT, RT, INDX, AL, DAA)`
			
			`  DEALLOCATE (Y, V, CAREA, TOPW, BELEV, Q, VOLD, YOLD, B, YT, VT, VPR, YPR, TAREA, TOPWT, RT, INDX, AL, DAA) ! cb 10/1/07`
				10/4/07

17	W2	TKE model	The TKE algorithm had several bugs that have been fixed, these included making the loop over layers go to KBMIN (rather than KB), the original code overwrote the boundary conditions when using the Thomas algorithm, the original code overwrote vertical eddy viscosity at the bed during the averaging process, Δz_k changed to $\Delta z_{k+1/2}$, TKE array was initial-ized to zero, TKE was implemented in add/sub layers like AZ. Many of these fixes are a result of the work of Sam Gould (Gould, 2006) who wrote an MS project report at PSU entitled "k-e Turbu-lence Model." Further recommendations by Gould (2006) will be incorporated into the next version of CE-QUAL-W2. The old code is shown below as a refer-ence to the new code in the release ver-sion.	10/4/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
			OLD CODE ```ENTRY CALCULATE_TKE```	

OLD CODE
```
ENTRY CALCULATE_TKE
  USTAR =
SQRT(1.25*CZ(I)*WIND10(I)**2/RHO(KT,I)
)
  IF (MANNINGS_N(JW)) THEN
    HRAD = BHR1(KT,I)/(BR(KTI(I),I)-
BR(KT+1,I)+2.*AVH1(KT,I))
if(macrophyte_on.and.mannings_n(jw))th
en
      call
macrophyte_friction(hrad,fric(i),effri
c,kt,i)
gc2=g*effric*effric/hrad**0.33333333
      else
if(.not.macrophyte_on.and.mannings_n(j
w))then
gc2=g*fric(i)*fric(i)/hrad**0.33333333
    end if
  ELSE
    GC2 = 0.0
    IF (FRIC(I) /= 0.0) GC2 =
G/(FRIC(I)*FRIC(I))
  END IF
  USTARB      =
SQRT(GC2)*ABS(0.5*(U(KT,I)+U(KT,I-1)))
  TKE(KT,I,1) =
0.5*(3.33*(USTAR*USTAR+USTARB*USTARB)+
TKE(KT,I,1))*(BH2(KT,I)/BH1(KT,I))
  TKE(KT,I,2) =
0.5*(USTAR*USTAR*USTAR+USTARB*USTARB*U
STARB*5.0/H1(KT,I)+TKE(KT,I,2))*(BH2(K
T,I)/BH1(KT,I))
  DO K=KT+1,KB(I)-1
    BOUK = MAX(AZ(K,I)*G*(RHO(K+1,I)-
RHO(K,I))/(H(K,JW)*RHOW),0.0)
    PRDK = AZ(K,I)*(0.5*(U(K,I)+U(K,I-
1)-U(K+1,I)-U(K+1,I-1))/H(K,JW))**2.0
    PRHE =
10.0*GC2**1.25*ABS(0.5*(U(K,I)+U(K,I-
1)))**4.0/(0.5*B(K,I))**2.0
        IF (MANNINGS_N(JW)) THEN
! v3.5 start
      HRAD = BHR(K,I)/(BR(K,I)-
BR(K+1,I)+2.0*H(K,JW))
!      GC2  =
G*FRIC(I)*FRIC(I)/HRAD**0.333

if(macrophyte_on.and.mannings_n(jw))th
en
      call
macrophyte_friction(hrad,fric(i),effri
c,k,i)

gc2=g*effric*effric/hrad**0.33333333
      else if
(.not.macrophyte_on.and.mannings_n(jw)
)then

gc2=g*fric(i)*fric(i)/hrad**0.33333333
      end if
```

Model Utilities

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
| | | | ```
! v3.5 end
    END IF
    PRHK       =
GC2/(0.5*B(K,I))*ABS(0.5*(U(K,I)+U(K,I
-1)))**3.0
    UNST       = PRDK-TKE(K,I,2)
    UNSE       =
1.44*TKE(K,I,2)/TKE(K,I,1)*PRDK-
1.92*(TKE(K,I,2)/TKE(K,I,1)*TKE(K,I,2)
)
    TKE(K,I,1) =
TKE(K,I,1)+DLT*(UNST+PRHK-BOUK)
    TKE(K,I,2) =
TKE(K,I,2)+DLT*(UNSE+PRHE)
  END DO
  USTARB           =
SQRT(GC2)*ABS(0.5*(U(KB(I),I)+U(KB(I),
I-1)))
  TKE(KB(I),I,1) =
0.5*(3.33*USTARB*USTARB+TKE(KB(I),I,1)
)
  TKE(KB(I),I,2) =
0.5*(USTARB*USTARB*USTARB*5.0/H(KB(I),
JW)+TKE(KB(I),I,2))
  AT = 0.0; CT = 0.0; VT = 0.0; DT =
0.0
  DO J=1,2
    DO K=KT,KB(I)
      AT(K,I) = -DLT/BH1(K,I)*BB(K-
1,I)/SIG(J)*AZ(K-1,I)/AVH1(K-1,I)
      CT(K,I) = -
DLT/BH1(K,I)*BB(K,I)/SIG(J)*AZ(K,I)/AV
H1(K,I)
      VT(K,I) =  1.0-AT(K,I)-CT(K,I)
      DT(K,I) =  TKE(K,I,J)
    END DO
    CALL
TRIDIAG(AT(:,I),VT(:,I),CT(:,I),DT(:,I
),KT,KB(I),KMX,TKE(:,I,J))
  END DO
  DO K=KT,KB(I)
    TKE(K,I,1) =
MAX(TKE(K,I,1),TKEMIN1)
    TKE(K,I,2) =
MAX(TKE(K,I,2),TKEMIN2)
    AZ(K,I)      =
0.09*TKE(K,I,1)*TKE(K,I,1)/TKE(K,I,2)
  END DO
! Center at cell faces
  DO K=KT,KB(I)-1
    AZ(K,I) = 0.5*(AZ(K,I)+AZ(K+1,I))
    AZ(K,I) = MAX(AZMIN,AZ(K,I))
    AZ(K,I) = MIN(AZMAX(JW),AZ(K,I))
    DZ(K,I) =
MAX(DZMIN,FRAZDZ*AZ(K,I))
  END DO
``` | |
| 18 | W2 | Restart | Added TKE to restart variables written out and read in. | 10/5/07 |

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
19	GUI	ET	The equilibrium temperature option in the drop down menu was 'EQT' rather than 'ET'. Fixed.	10/9/07
20	W2	Sediment	The SEDIMENT subroutine did not have any computational mistakes, just an error in assigning all array variables to the value at K,I. This resulted in excessive computational time. The fix is shown below: OLD sedbr = sedb(jw)*sed(k,i) NEW sedbr(K,I) = sedb(jw)*sed(k,i)	10/15/07

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

21	W2	TKE	Turbulence model had an improper averaging between layers. A new temporary variable was defined to temporarily store the values for AZ prior to averaging to the bottom/top of the layers and the horizontal layers. This also affected the computation of DZ. Fixed.
			
			New code defined AZT and allocated memory for it, such that
			`AZT(K,I)    = 0.09*TKE(K,I,1)*TKE(K,I,1)/TKE(K,I,2)`
			and
			`AZ(K,I) = 0.5*(AZT(K,I)+AZT(K+1,I))`
			
			Similarly for the horizontal averaging and for DZ. Also, the values of DZ were fixed to be at the bottom of a cell and AZ was fixed to be at the bottom right-hand edge of a cell as shown below:
			
				12/17/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

22	W2	SS settling	The incorrect cell width was used for SSSO. BI(KT,I) was changed to BI(K,I).
			
			OLD CODE:
			`      SSSO(K,I) =`
			`(TOTSS0+FES(JW)*FPFE(K,I))*B`
			`I(KT,I)/BH2(K,I)*DO1(K,I)`
			`      FPSS(K,I) =`
			`FPSS(K,I)*TISS(K,I)`
			`NEW CODE:`
			`      SSSO(K,I) =`
			`(TOTSS0+FES(JW)*FPFE(K,I))*B`
			`I(K,I)/BH2(K,I)*DO1(K,I)`
			`      FPSS(K,I) =`
			`FPSS(K,I)*TISS(K,I)`
				12/17/07

23	W2	Initial-ization of one-layer	The definition of KBMIN was not updated if the model started out in some seg-ments with only one_layer. This has been fixed.
			
			Added code highlighted:
			`      DO I=IU,ID`
			`        IF (KB(I)-KT <`
			`NL(JB)-1) IUT = I+1`
			`        ONE_LAYER(I) = KT ==`
			`KB(I)`
			`      END DO`
			`      CUS(JB) = IUT`
			`      ! reinitialize KBMIN`
			`      DO I=IU-1,ID`
			`        KBMIN(I) =`
			`MIN(KB(I),KB(I+1))`
			`      END DO`
			`      KBMIN(ID+1) =`
			`KBMIN(ID)`
			
			`!**** Areas and bottom`
			`widths`
			
			`      IF (.NOT.`
			`TRAPEZOIDAL(JW)) THEN`
				12/17/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

24	W2	Bottom pro-cesses	This is a couple more fixes related to bug fix #6 above. The Denitrification rate and epiphyton burial rates could be affected based on unique combinations of add-ing/subtracting segments that left the value of BI in an inactive layer below KB defined incorrectly. In order to prevent the possibility of problems, the following fixes were made:
			
			Old Code:
			`    sedNO3(K,I)  =`
			`NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I)`
			`-BI(K+1,I))/BH2(K,I)`
			
			`EPM(K,I,J) =  EPD(K,I,J)*(BI(K,I)-`
			`BI(K+1,I)+2.0*H1(K,I))*DLX(I)`
			
			New code:
			`if(k == kb(i)) then      ! SW 12/16/07`
			`    sedNO3(K,I)  =`
			`NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I)`
			`)/BH2(K,I)`
			`        else`
			`    sedNO3(K,I)  =`
			`NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I)`
			`-BI(K+1,I))/BH2(K,I)`
			`        endif`
			
			`    if(k == kb(i)) then      ! SW`
			`12/16/07`
			`    EPM(K,I,J) =`
			`EPD(K,I,J)*(BI(K,I)+2.0*H1(K,I))*DLX(I`
			`)`
			`        else`
			`    EPM(K,I,J) =`
			`EPD(K,I,J)*(BI(K,I)-`
			`BI(K+1,I)+2.0*H1(K,I))*DLX(I)`
			`        endif`
				12/17/2007

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

25	W2	CBODS	If the user defined particulate CBOD that settles to the bottom and had SED turned ON, the conversion from oxygen to or-ganic matter was missing in the accumu-lation on the channel bottom or sides.
			
			OLD
			<pre> do jd=1,nbod
			     SEDcb(K,I) =
			SEDcb(K,I)+MAX(cbods(jd),0.0)*cbod
			(K,I,Jd)*BI(K,I)/BH2(K,I)*(1.0-
			BI(K+1,I)/BI(K,I))
			     end do</pre>NEW
			<pre> do jd=1,nbod
			     SEDcb(K,I) =
			SEDcb(K,I)+MAX(cbods(jd),0.0)*(cbo
			d(K,I,Jd)/O2OM(JW))*BI(K,I)/BH2(K,
			I)*(1.0-BI(K+1,I)/BI(K,I))
			! 1/16/08
			     end do</pre>
				1/18/08

26	W2	SEDBR	Eliminated a redundant definition of SEDBR in the Sediment routine since it is already defined in the Kinetic rates sub-routine.	1/18/08

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

27	W2	SEDDK	The first order sediment decay rate is an average of the decay rates of all the in-fluxes of organic matter and their respec-tive decay rates. There was an error in computing this average decay rate for CBOD treated as particulate. Code fix is shown below:
			
			OLD
			<pre>do jd=1,nbod
			      sedsum = sed-
			sum+MAX(cbods(jd),0.0)*cbod(K,I,Jd
			)*BI(K,I)/BH2(K,I)*(1.0-
			BI(K+1,I)/BI(K,I))
			    end do</pre>
			
			NEW
			<pre>do jd=1,nbod
			      sedsum = sed-
			sum+MAX(cbods(jd),0.0)*cbod(K,I,Jd
			)*BI(K,I)/BH2(K,I)*(1.0-
			BI(K+1,I)/BI(K,I))*RBOD(JD)*CBODD(
			K,I,JD)/O2OM(JW)
			    end do</pre>
				1/18/08

28	W2	SRO	There are some cases when segments were added/subtracted that the value of BI was not correctly initialized. This code is a fix to prevent such occurrences:
			
			<pre>OLD CODE:
			SRONET = SROIN-SROOUT
			SROSED = SROOUT*(1.0-
			BI(K+1,I)/BI(K,I))*TSEDF(JW)
			
			NEW CODE:
			SRONET = SROIN-SROOUT
			 if(k /= kb(i))then ! SW 1/18/08
			SROSED = SROOUT*(1.0-
			BI(K+1,I)/BI(K,I))*TSEDF(JW)
			 else
			 SROSED = SROOUT*TSEDF(JW)
			endif</pre>
				1/18/2008

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

29	W2	Water Qual-ity	Added several calls to prevent computa-tion of kinetic variables if epiphyton are defined in the control file with NEP=1 or more but is not ACTIVE or turned ON. If the kinetic expressions are non-zero and the initial concentration is given, then this could add source/sink terms to the oxygen balance.
			
			This is typical of the code changes – since several of this type were made:
			
			OLD CODE:
			DO JE=1,NEP
			    PO4EG(K,I) = PO4EG(K,I)+EGR(K,I,JE)*EPC(K,I,JE)*EP(JE)
			    PO4ER(K,I) = PO4ER(K,I)+ERR(K,I,JE)*EPC(K,I,JE)*EP(JE)
			   END DO
			
			NEW CODE:
			   IF (EPIPHYTON_CALC(JW,JE))then ! SW 1/18/2008
			    PO4EG(K,I) = PO4EG(K,I)+EGR(K,I,JE)*EPC(K,I,JE)*EP(JE)
			    PO4ER(K,I) = PO4ER(K,I)+ERR(K,I,JE)*EPC(K,I,JE)*EP(JE)
			   endif
				1/18/2008

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

30	W2	Bottom pro-cesses	Continuation of bug fix #24 in such places as
			
			New code:
			<pre>IF(K == KB(I))THEN
			    xdum=BI(K,I)/BH2(K,I) ! SW
			1/18/08
			    ELSE
			    xdum=BI(K,I)/BH2(K,I)*(1.0-
			BI(K+1,I)/BI(K,I))
			    ENDIF
			
			                      SEDAS(K,I) =
			SEDAS(K,I)+MAX(AS(JA),0.0)*ALG(K,I,JA)
			*xdum ! SW 1/18/08
			
			SEDOMS(K,I) =
			pomS(JW)*(LPOM(K,I)+RPOM(K,I))*xdum
			!sw 1/18/08 cb 10/22/06
			    IF(K==KB(I))THEN ! SW 1/18/08
			     SEDSO = 0.0
			     ELSE
			     SEDSO =
			sedS(JW)*SED(K,I)*BI(K+1,I)/BH2(K,I)*(
			1.0-BI(K+1,I)/BI(K,I))
			     Endif
			
			DO K=KT,KB(I)
			    IF(K == KB(I))THEN
			    xdum=BI(K,I)/BH2(K,I) ! SW
			1/18/08
			    ELSE
			    xdum=BI(K,I)/BH2(K,I)*(1.0-
			BI(K+1,I)/BI(K,I))
			    ENDIF
			     DO JA=1,NAL
			      SEDASp(K,I) =
			SEDASp(K,I)+MAX(AS(JA),0.0)*ap(ja)*ALG
			(K,I,JA)*xdum ! SW 1/18/08
			     END DO
			     DO JE=1,NEP
			      IF
			(EPIPHYTON_CALC(JW,JE))LPOMEPp(K,I) =
			LPOMEPp(K,I)+EPOM(JE)*ep(je)*(EMR(K,I,
			JE)*EPC(K,I,JE))
			     END DO
			     do jd=1,nbod</pre>
			This code is repeated similarly in many of the sediment routines.
				1/18/2008

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

31	W2	Add segment initial-ization	The DEPTHM and DEPTHB were not ini-tialized correctly when a segment was added – this does not affect internal com-putations, just output for SPR and SNP files.
			OLD CODE:
			    BKT(I) = BH1(KT,I)/H1(KT,I)
			     DEPTHB(K,I) = H1(KT,I) !
			     DEPTHM(K,I) = H1(KT,I)*0.5
			NEW CODE:
			    BKT(I) = BH1(KT,I)/H1(KT,I)
			     DEPTHB(KT,I) = H1(KT,I) !
			SW 1/27/08
			     DEPTHM(KT,I) = H1(KT,I)*0.5
			! SW 1/27/08
				1/27/08

W2 V3.2 Bug Fixes, Enhancements, and User Manual Changes

Table 9. Bug fixes and enhancements for Version 3.2.

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
1	W2	Waterbody-waterbody connection	When there was negative velocities at a waterbody-waterbody connection, there was a possibility (dependent on the ba-thymetry of the connection at the water-body-waterbody intersection) that there could be temperature or concentration anomalies.	8/31/04

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
2	W2	Lateral_ withdrawal	Added limit to the DLRHOMAX func-tion: Old code: DLRHOMAX=MAX(DLRHOT,DLRHOB) New code: DLRHOMAX=MAX(DLRHOT,DLRHOB,1.0E-10)	1/25/05

3	W2	Branch con-nectivity	Logic in branch connectivity set-up was fixed
			Old code:
			IF(UHS(JB) == DS(JJJB))EXIT
			New code:
			IF(abs(UHS(JB)) == DS(JJJB))EXIT
				1/25/05

4	W2	Pumpback	Pumpback logic was corrected – this is legacy code that will probably be re-moved from later versions of W2
			Old code:
			  DO JB=1,NBR
			   IF (JB == JBP) JWBP = JW
			  END DO
			New code:
			  DO JW=1,NWB
			     DO JB=BS(JW),BE(JW)
			       IF(JB == JBP) JWBP = JW
			     END DO
			   END DO
				1/25/05

5	W2	CPL write	Switched order of implied DO loop on CPL write statement for output of constitu-ents	1/25/05
6	W2	PRF write	Changed output format for PRF output for constituents from f10.2 to e13.6	1/25/05

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
7	W2	Heat balance	Added the Idso and Jackson long wave radiation equation when air temperatures are below 5C. The Swinbank model underpredicts long wave incoming radiation at low air temperatures by as much as 10%. The computation of long wave atmospheric radiation is done using the approach of Swinbank (1963) unless air temperatures are less than 5°C, when the Idso and Jackson (1969) formula is used (Wells, et al., 1982). The Swingbank formula for clear sky long wave atmospheric radiation is $\phi_{ac} = 5.31\text{E-}13(T_a + 273)^6$ where units are W/m², °C at 2 m height. Below 40°F (5°C) the formula of Idso and Jackson is recommended (above 10°C both equations are almost identical): $\phi_{ac} = \sigma(T_a + 273)^4\left(1 - 0.261\exp(-7.77E - 4T_a^2)\right)$ where units are W/m² and T_a is in units of °C. The Stefan-Boltzmann constant = 5.62E-8 W/m²/(°K)⁴.	1/25/05

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
7	W2	Layer addi-tion algo-rithm	Mistyped subscript K instead of I: Old code: <pre> IF (KB(I) > KBI(I)) THEN
B(KB(K),I) = 0.0
DX(KB(I),I) = 0.0
KB(I)   = KB(I)-1
IF (I /= DS(JB)+1)
KBMIN(I)   = MIN(KB(K),KB(I+1))
IF (I /= US(JB)-1)
KBMIN(I-1) = MIN(KB(I-1),KB(I))</pre>New Code: <pre>   IF (KB(I) > KBI(I)) THEN
B(KB(I),I) =
0.0
! SW 3/2/05
DX(KB(I),I) = 0.0
KB(I)   = KB(I)-1
IF (I /= DS(JB)+1)
KBMIN(I)   = MIN(KB(I),KB(I+1))
! SW 3/2/05
IF (I /= US(JB)-1)
KBMIN(I-1) = MIN(KB(I-1),KB(I))</pre>	3/2/05
8	W2	Variable ini-tialize-tion	In some cases when there was a layer subtraction and a time step violation im-mediately afterward, the variable SW was not initialized properly. This caused prob-lems in the Tomas Algorithm for the wa-ter surface computation. The following line of code was added to the SUB layer algorithm: <pre> SW(KT-1,IU-1:ID+1) = 0.0
!TC 3/9/05</pre>Also, the variable AVHR was defined in the Update variables for DS+1. The fol-lowing new code was added: <pre>AVHR(KT,DS(JB)+1)=H1(KT,DS(JB)+1)
!SW 03/08/05</pre>	3/9/05

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#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

9	W2	Interpola-tion multipli-ers	Possible index error if there are multiple waterbodies.
			Old code:
			``
			     RATZ(K,JW) = AVH2(K-
			1,I)/AVH2(K,I)
			     CURZ1(K,JW) =
			2.0*H(K,JW)**2/(AVH2(K-
			1,I)+AVH2(K,I))/AVH2(K-1,I)
			     CURZ2(K,JW) = -
			2.0*H(K,JW)**2/(AVH2(K-1,I)*AVH2(K,I))
			     CURZ3(K,JW) =
			2.0*H(K,JW)**2/(AVH2(K-
			1,I)+AVH2(K,I))/AVH2(K,I)
			   END DO
			``
			New code:
			``
			     RATZ(K,JW) = AVH2(K-
			1,DS(BE(JW)))/AVH2(K,DS(BE(JW)))
			     CURZ1(K,JW) =
			2.0*H(K,JW)**2/(AVH2(K-
			1,DS(BE(JW)))+AVH2(K,DS(BE(JW))))/AVH2
			(K-1,DS(BE(JW)))
			     CURZ2(K,JW) = -
			2.0*H(K,JW)**2/(AVH2(K-
			1,DS(BE(JW)))*AVH2(K,DS(BE(JW))))
			     CURZ3(K,JW) =
			2.0*H(K,JW)**2/(AVH2(K-
			1,DS(BE(JW)))+AVH2(K,DS(BE(JW))))/AVH2
			(K,DS(BE(JW)))
			``
				5/10/05

10	W2	Spillway and Gates	Older code in order to check if it was sub-merged or not used the elevation differ-ence relative to the channel bed on ei-ther side of the weir, rather than the weir crest. Also removed code line:
			``
			IF(ELDN>ESP(JS))DH+ELUP-ELDN
			``
				5/10/05

11	W2	Reaeration	Corrected formula errors in Thackston and Krenkel formula: Old code: ``` USTAR=SQRT(ADEPTH*SLOPE(JB)*32.2)**0.5 REAER(I) = 24.88*(1.0+SQRT(0.176*UAVG/SQRT(ADEPTH)))*USTAR ``` New code: ``` USTAR=SQRT(ADEPTH*SLOPE(JB)*32.2) REAER(I) = 24.88*(1.0+SQRT(0.176*UAVG/SQRT(ADEPTH)))*USTAR/ADEPTH ``` Similar changes were made to the updated Thackston model (Eqn 10)	5/10/05
12	W2	Violations NV	The variable BI and VOL was not initial-ized properly during a time-step viola-tion.	8/25/05

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
13	W2	ADD a layer	The variable BI was not initialized properly during an ADD layer.	8/25/05

14	W2	TRIDIAG sub-routine	<u>Insert Deallocate Statement in Tridiag</u>
			
			``
			SUBROUTINE TRIDIAG(A,V,C,D,S,E,N,U)
			  USE PREC
			  INTEGER, IN
			TENT(IN) :: S, E, N
			  REAL(R8), DIMENSION(:),
			INTENT(IN) :: A(E),V(E),C(E),D(E)
			  REAL, DIMENSION(:),
			INTENT(OUT) :: U(N)
			  REAL(R8), ALLOCATABLE,
			DIMENSION(:) :: BTA, GMA
			  ALLOCATE (BTA(N),GMA(N))
			
			  BTA(S) = V(S)
			  GMA(S) = D(S)
			  DO I=S+1,E
			    BTA(I) = V(I)-A(I)/BTA(I-1)*C(I-1)
			    GMA(I) = D(I)-A(I)/BTA(I-1)*GMA(I-1)
			  END DO
			  U(E) = GMA(E)/BTA(E)
			  DO I=E-1,S,-1
			    U(I) = (GMA(I)-C(I)*U(I+1))/BTA(I)
			  END DO
			  Deallocate (BTA, GMA) <----
			- ! SW
			10/17/05
			END SUBROUTINE TRIDIAG
			``
				10/17/05

15	W2	SUB layer	<u>In SUB Layer/Sub Seg - eliminate pa-renteses which caused a sign error</u>
			
			``
			        IF (.NOT. TRAPEZOIDAL(JW))
			THEN
			          BI(KT,IU-1) = B(KTI(IU-
			1),I)
			          H1(KT,IU-1) = H(KT,JW)-
			Z(IU-1)
			          BH1(KT,IU-1) = B(KTI(IU-
			1),IU-1)*(EL(KT,IU-1)-EL(KTI(IU-1)+1,IU-
			1)-Z(IU-1)*COSA(JB))/COSA(JB) <----
			-- ! SR 10/17/05
			          IF (KT >= KB(IU-1))
			BH1(KT,IU-1) = B(KT,IU-1)*H1(KT,IU-1)
			          DO K=KTI(IU-1)+1,KT
			            BH1(KT,IU-1) = BH1(KT,IU-
			1)+BH1(K,IU-1)
			          END DO
			        ELSE
			``
				10/17/05

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
16	W2	SUB layer for shallow sys-tems	Layer SUB - improve model running in shallow segments	10/17/05

<u>Layer SUB - improve model running in shallow segments</u>

```
!** Water surface minimum thickness
    DO JW=1,NWB
      KT       =  KTWB(JW)
      ZMIN(JW) = -1000.0
      KTMAX    =  2  <-----              !
SR 10/17/05
      DO JB=BS(JW),BE(JW)
        DO I=CUS(JB),DS(JB)
          IF(KB(I) > KTMAX) KTMAX =
KB(I)  <-----            ! SR 10/17/05
          IF (Z(I) > ZMIN(JW)) THEN
            IZMIN(JW) = I
            JBIZ      = JB
          END IF
          ZMIN(JW) = MAX(ZMIN(JW),Z(I))
        END DO
      END DO
      ADD_LAYER = ZMIN(JW) < -0.85*H(KT-
1,JW) .AND. KT /= 2
      SUB_LAYER = ZMIN(JW)
> 0.60*H(KT,JW)   .AND. KT < KTMAX   <--
-----    ! SR 10/17/05
....
!******** Upstream active segment
        IUT = US(JB)
        IF (SLOPE(JB) /= 0.0) THEN
          DO I=US(JB)-1,DS(JB)+1
            IF (KB(I) < KT )THEN  <----
--------------        ! SR 10/17/05
              KB(I)                =
KT
              B(KB(I),I)           =
0.000001
              DX(KB(I),I)          =
DXI(JW)
...
!****** Additional layer subtractions
        ZMIN(JW) = -1000.0
        DO JB=BS(JW),BE(JW)
          DO I=CUS(JB),DS(JB)
            ZMIN(JW) = MAX(ZMIN(JW),Z(I))
          END DO
        END DO
        SUB_LAYER = ZMIN(JW) >
0.60*H(KT,JW) .AND. KT < KTMAX   <-----
-  ! SR 10/17/05
      END DO
    END DO
```

<u>Also done for the initial set-up of the branch geometry:</u>

```
!**** Upstream active segment and single
layer

      IF (SLOPE(JB) /= 0.0) THEN
        DO I=US(JB)-1,DS(JB)+1
          IF (KB(I) < KT )
THEN            <-----            ! .AND. I
/= IZMIN(JW)  SW 10/17/05
            B(KT,I) = 0.000001
```

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

17	W2	Shade algo-rithm	<u>No errors just an improvement in com-putational efficiency</u>.
			<u>Delete this from the SHADING subroutine:</u>
			`!** Set the angles for which topographic`
			`shade data are available`
			`    DO II=1,IANG`
			`ANG(II)=((II-`
			`1)*(360.0/FLOAT(IANG)))*PI/180.0`
			`      END DO`
			`      GAMMA = (2*PI)/IANG`
			<u>and change the 2 occurrences of gamma to gama (only in shading subroutine) :</u>
			`      ANG2    = (TOPO(I,J+1)-`
			`TOPO(I,J))/GAMA   <----  ! SW 10/17/05`
			`        TOPOANG =  TOPO(I,J)+ANG2*ANG1`
			`     ENDIF`
			`     END DO`
			`     IF (AZ00 > ANG(IANG) .AND. AZ00 <=`
			`2*PI) THEN`
			`       ANG1    = AZ00-ANG(IANG)`
			`       ANG2    = (TOPO(I,1)-`
			`TOPO(I,IANG))/GAMA    <----! SW 10/17/05`
			<u>ADD a line to the module SHADEC:</u>
			`MODULE SHADEC`
			`  PARAMETER (IANG=18)`
			` REAL, PARAMETER             ::`
			`GAMA=(3.1415926*2.)/REAL(IANG) <--- ! SW`
			`10/17/05`
			`  REAL,                  DIMENSI`
			`ON(IANG):: ANG     <----! SW 10/17/05`
			`  REAL,          ALLOCATABLE,`
			`DIMENSION(:)   ::`
			`A00,   DECL,  HH,    TTLB,  TTRB,  C`
			`LLB,  CLRB  <------- ! SW 10/17/05`
			`  REAL,              ALLOCATABLE,`
			`DIMENSION(:)  ::`
			`SRLB1,  SRRB1,  SRLB2,  SRRB2,  SRFJD1,`
			`SRFJD2,SHADEI`
			`   REAL,ALLOCATABLE, DIMENSION(:,:) ::`
			`TOPO`
			` LOGICAL,  ALLOCATABLE, DIMENSION(:)   ::`
			`DYNAMIC_SHADE`
			`   DATA ANG  /0.00000, 0.34907, 0.69813,`
			`1.04720, 1.39626, 1.74533, 2.09440,`
			`2.44346,&`
			`2.79253, 3.14159, 3.49066, 3.83972,`
			`4.18879, 4.53786, 4.88692, 5.23599,`
			`5.58505, 5.93412/  <----- ! SW10/17/05`
			`END MODULE SHADEC`
			<u>Delete allocation statement for ang:</u>
			`  ALLOCATE`
			`(SRLB1(IMX),  SRRB1(IMX),  SRLB2(IMX),  S`
			`RRB2(IMX),  SRFJD1(IMX), SHADEI(IMX),`
			`SRFJD2(IMX))`
			`ALLOCATE (TOPO(IMX,IANG))  <---`
			`-     !SW10/17/05`
			` ALLOCATE (QSW(KMX,NWDT),  CTR(NCT,NTRT),`
			`HPRWBC(NHY,NWB))`
			<u>Delete ang from the deallocate statement:</u>
			`  DEALLOCATE(TTLB,   TTRB,   CLLB,   SRLB1`
			`, SRRB1,  SRLB2,  SRRB2,  SRFJD1,`
			`SHADEI,SRFJD2, TOPO,  QSW,    CTR)   <-`
			`---! SW 10/17/05`
				10/17/05

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
18	W2	Epiphyton al-gorithm	Several changes were made that cor-rected errors in shallow systems where adding and subtracting layers did not rei-nitialize macrophyte layers when the cur-rent KT was below KB; the epiphyton bur-ial rate was greater than specified in the control file; epiphyton that are buried be-come part of the 1st order organic sedi-ment (as before); epiphyton mortality now becomes part of the LPOM pool (based on the EPOM fraction) and is set-tled and transported downstream rather than going into the organic 1st order sedi-ment model directly. Currently this is non-photosynthesizing – but we will change in the next version.	5/26/06
19	W2	ADD/SUB layers	There was a bug in addition and subtrac-tion of layers that led to water quality variables not being initialized correctly during riverine shallow flow	5/26/06
20	User Man-ual	Typos cor-rected	The manual had a few typos that were corrected.	6/11/2006
21	W2	Waterbody-waterbody connection	The subroutine Upstream_velocity under specific conditions did not maintain flwo continuity across a waterbody-waterbody connection	6/29/2006
22	W2	SNP output	The algal limiting nutrient SNP output had a bug under specific conditions in writing out the information.	6/30/2006

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement Added

23	W2	Sediment heating and sediment processes	If a model added and subtracted layers that resulted in segment addition and subtraction, there was the possibility that sediment fluxes were incorrectly computed.
			
			In the NO3 subroutine:
			Old code:
			<pre> NO3SED(K,I) =
			NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I)
			-BI(K+1,I))/BH2(K,I)</pre>
			New code:
			<pre>if(k == kb(i)) then
			             NO3SED(K,I) =
			NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I))/BH2(K,I)
			         else
			   NO3SED(K,I) =
			NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I)-
			BI(K+1,I))/BH2(K,I)
			             endif</pre>
			New code added in sediment routine:
			<pre>if(k == kb(i))then ! SW 4/18/07
			         SODD(K,I) =
			SOD(I)/BH2(K,I)*SODTRM(K,I)*BI(K,I)
			         else
			     SODD(K,I) =
			SOD(I)/BH2(K,I)*SODTRM(K,I)*(BI(K,I)-
			BI(K+1,I))
			         Endif</pre>
			New code added in suspended solids routine:
			<pre>if(k == kb(i))then
			             SSR =
			EPSILON*DLX(I)*BI(K,I)/VOL(K,I)
			                 else
			        SSR = EPSILON*DLX(I)*(BI(K,I)-
			BI(K+1,I))/VOL(K,I)
			                 Endif</pre>
				4/18/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
23	W2	(see above)	New code added for heat flux to channel bottom: <pre>if(kt == kb(i))then ! SW 4/18/07
            SROSED   =
SROOUT*TSEDF(JW)
            else
            SROSED   =
SROOUT*(1.0-
BI(KT+1,I)/BI(KT,I))*TSEDF(JW)
            Endif

if(k==kb(i))then   ! SW
4/18/07
            TFLUX   =
CBHE(JW)/RHOWCP*(TSED(JW)-
T2(K,I))*BI(K,I)*DLX(I)
            else
            TFLUX   =
CBHE(JW)/RHOWCP*(TSED(JW)-
T2(K,I))*(BI(K,I)-BI(K+1,I))*DLX(I)
            endif</pre>
New code added for sediment subrou-tine:
<pre>if(k == kb(i))then   ! SW 4/18/07
      SEDAS(K,I) =
SEDAS(K,I)+MAX(AS(JA),0.0)*ALG(K,I,JA)
BI(K,I)/BH2(K,I)(1.0-
BI(K+1,I)/BI(K,I))
else
      SEDAS(K,I) =
SEDAS(K,I)+MAX(AS(JA),0.0)*ALG(K,I,JA)
BI(K,I)/BH2(K,I)(1.0-
BI(K+1,I)/BI(K,I))
             endif
if(k == kb(i))then   ! SW 4/18/07
       SEDOMS(K,I) =
POMS(JW)*(LPOM(K,I)+RPOM(K,I))*BI(K,I)
/BH2(K,I)
      SEDSO   =
POMS(JW)*SED(K,I)*BI(K+1,I)/BH2(K,I)
       else
      SEDOMS(K,I) =
POMS(JW)*(LPOM(K,I)+RPOM(K,I))*BI(K,I)
/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))
      SEDSO   =
POMS(JW)*SED(K,I)*BI(K+1,I)/BH2(K,I)*(
1.0-BI(K+1,I)/BI(K,I))
             endif</pre> | 4/18/07 |

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
24	W2	Algae	The logic for negative settling velocities for algae had an error. Old code: ``` ! ASR(K,I,JA) = - AS(JA)*(ALG(K+1,I,JA)*B(K+1,I)/(B(K,I) *H2(K,I))- ALG(K,I,JA))*BI(K,I)/BH2(K,I) ``` New code: ``` ASR(K,I,JA) = - AS(JA)*(ALG(K+1,I,JA)*BI(K+1,I)/BH2(K, I)-ALG(K,I,JA)*BI(K,I)/BH2(K,I)) !SP 8/27/07 ``` Shwet Prakash	8/27/07