MODEL SETUP I
OVERVIEW

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CE-QUAL-W2 Workshop

August 16 - 18, 2022

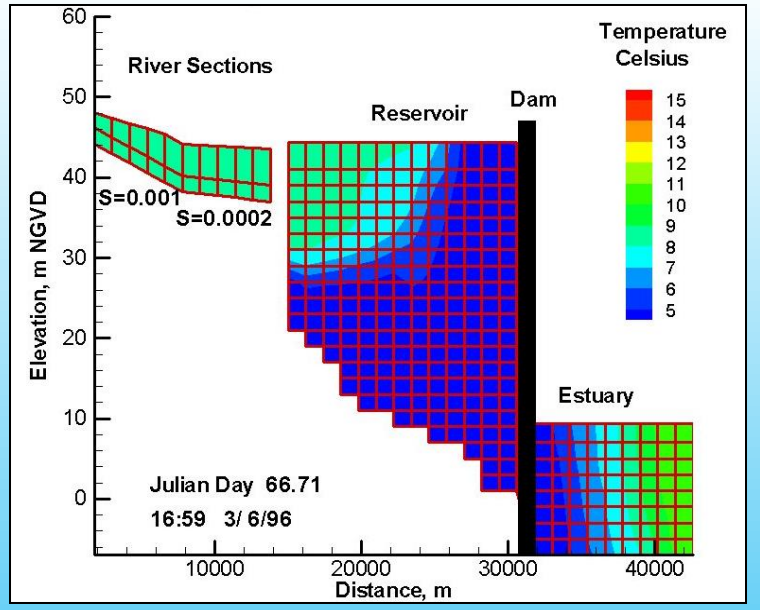
Outline

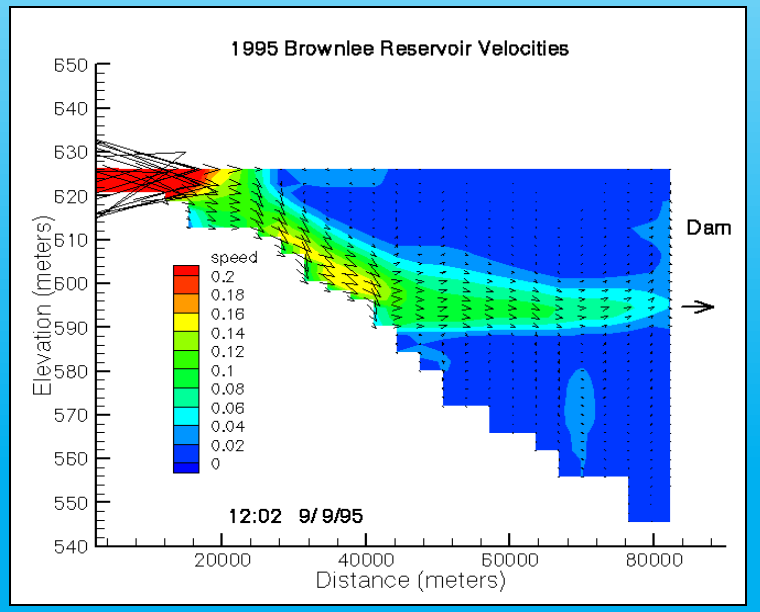
- Background
- Definition of problem
- Required Information
  - Bathymetry
  - Flow
  - Meteorology
  - Observations
  - Other
- Output

Detroit Dam, Oregon

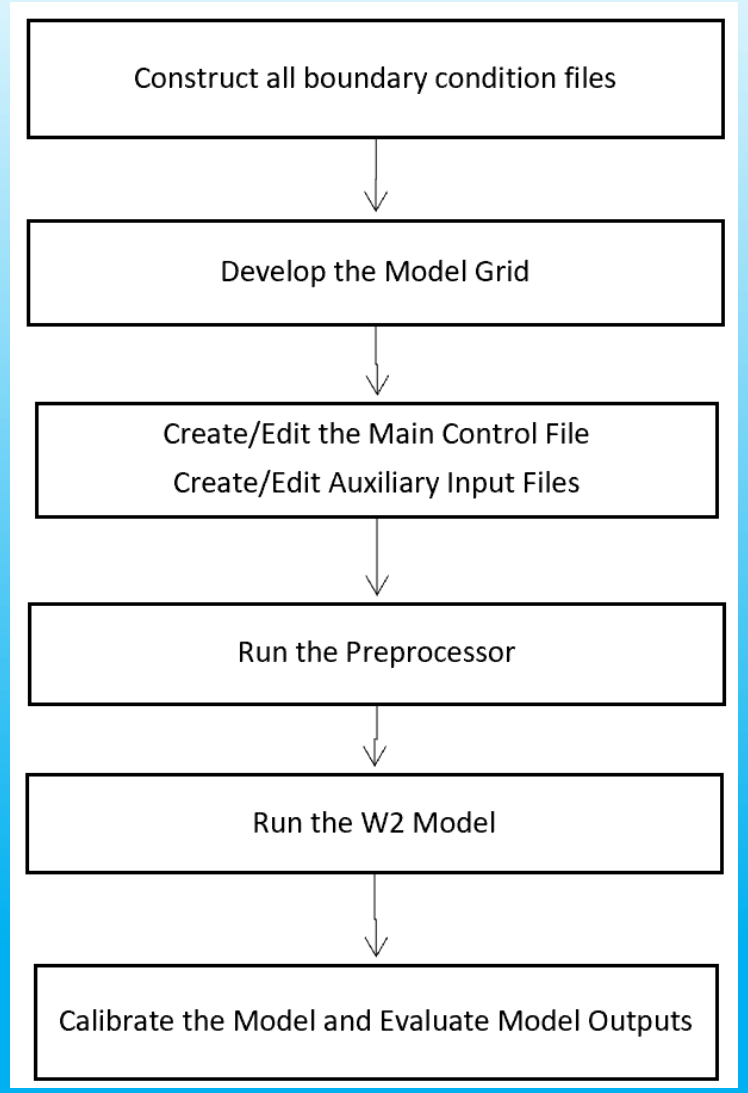
Background

- Setting up a computational model is an effort to create a computational approximation of a real system.
- A model enables one to investigate past behavior or future conditions with regard to changes in conditions.
- Approximations, simplifications, and omissions are necessary but must be balanced with regards to the model's ability to accurately capture the behavior of the real system.





How to Set Up and Run a Model Application



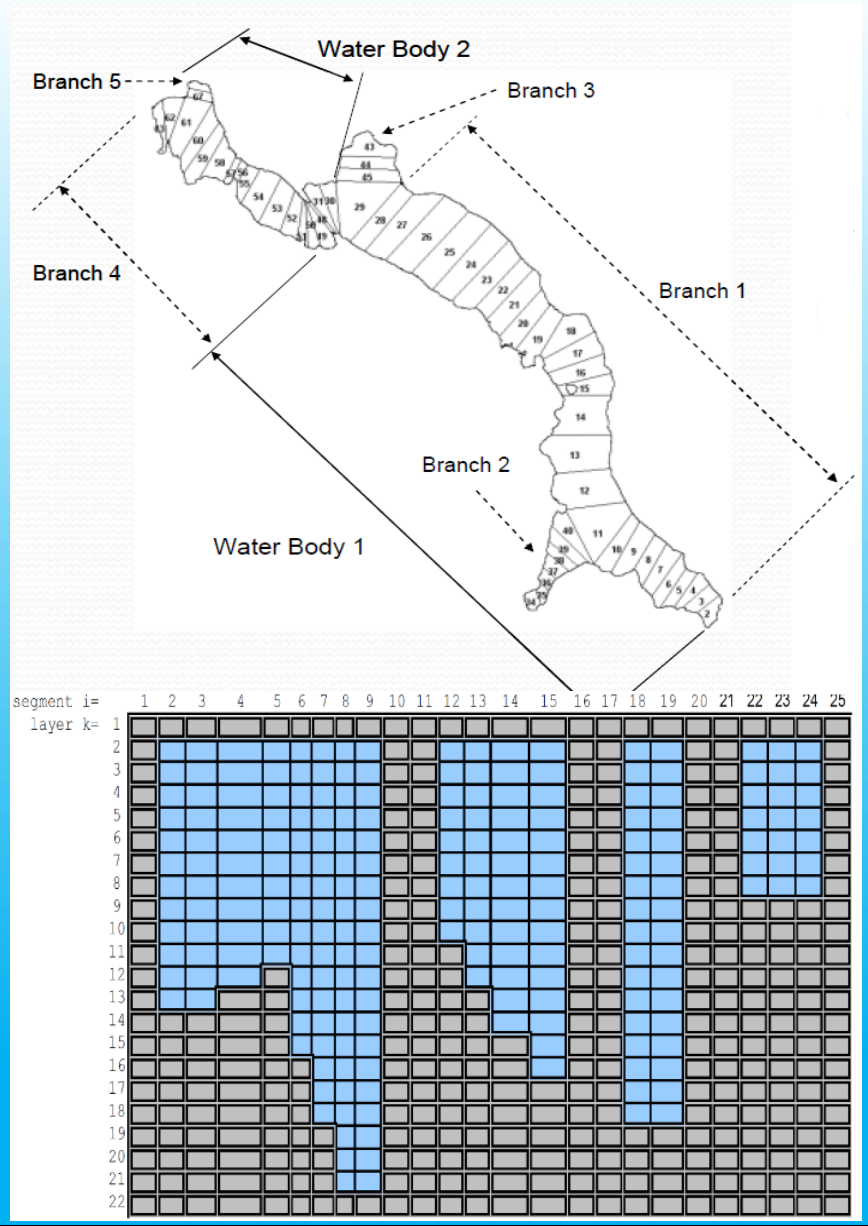
Definition of Problem

- What are water quality issues occurring in system that warrant a model?
- Are they the result of:
  - Flow alterations?
  - Operations?
  - Boundary Loadings?
  - Intermediate loadings?
  - Meteorology?
  - Altered system conditions?
  - Anticipated future changes in any of above?
  - Other?
- What information is required to set up a model to capture the behavior in question?

Source: https://www.erdc.usace.army.mil/Media/Images/igphoto/2002471393/

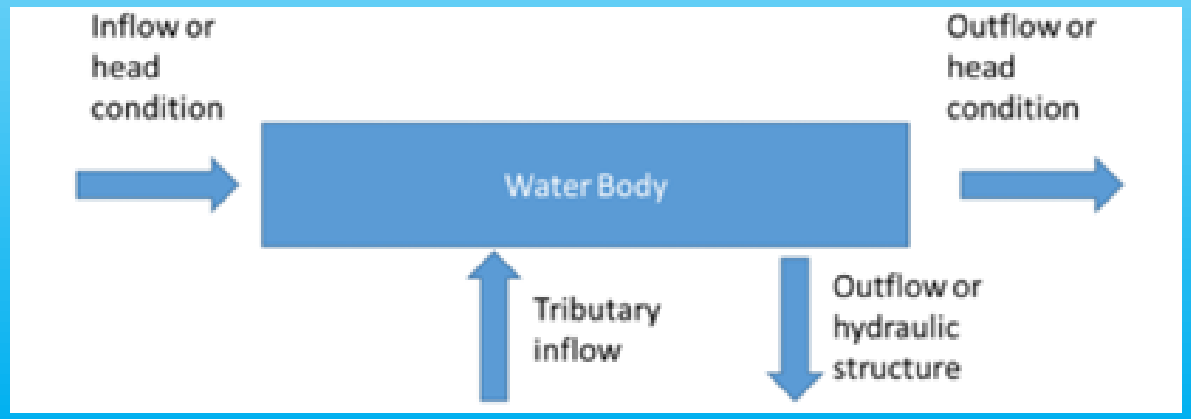
Bathymetry

- Defines the physical structure of the natural system for the model
- Sources
  - Sediment range surveys
  - Cross Sections
  - Pre-impoundment surveys for reservoirs
- Extent
  - All of area of concern and beyond
  - Reaching upstream to control point
- Resolution
  - Horizontal (across system) – meters
  - Longitudinal (along system) – 10s or meters or more
  - Vertical (through water column) – meter or less



Flow

- Required
  - Headwater
  - Downstream
  - Tributary
  - Withdrawals
- Water surface elevations

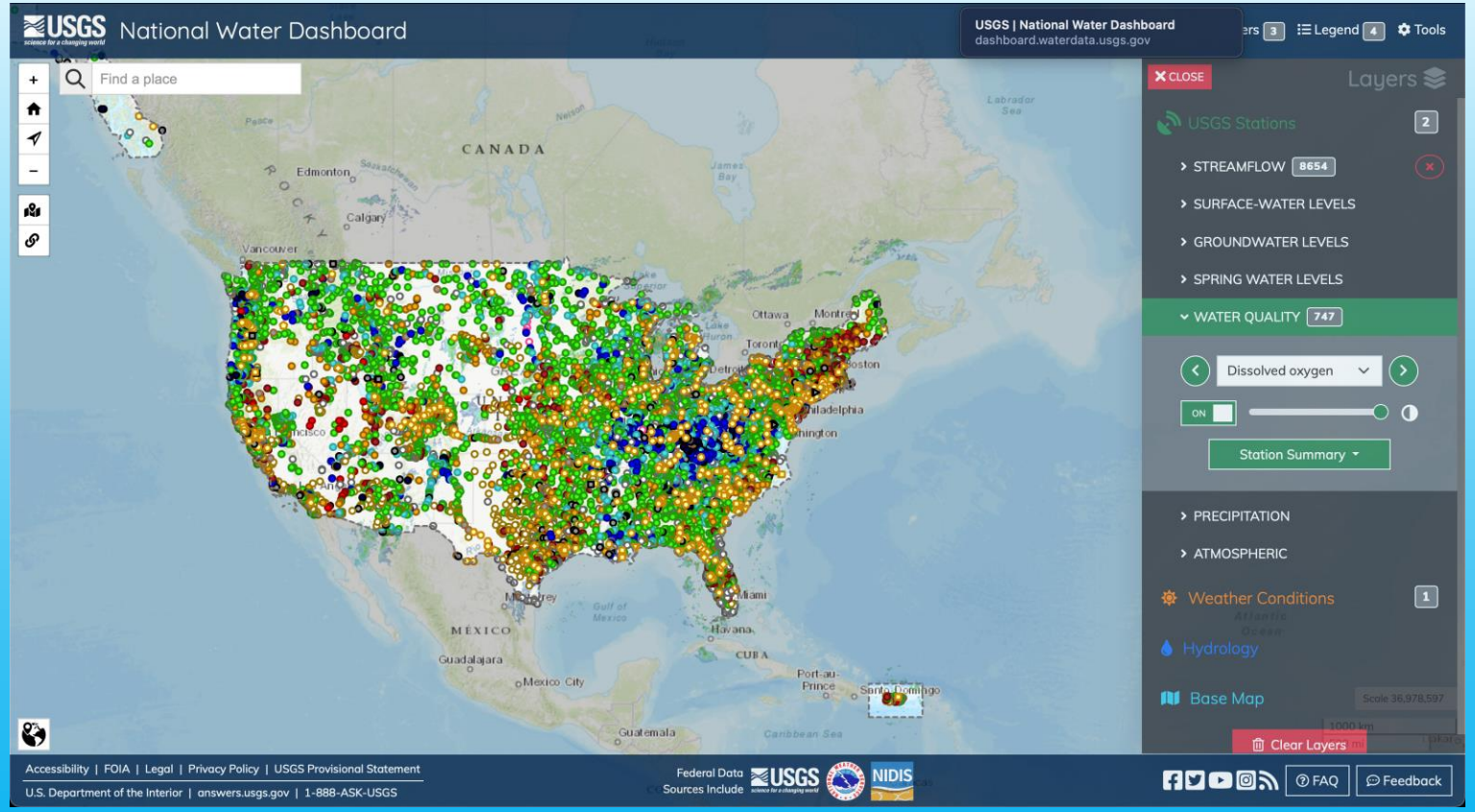


Meteorology

- Reliable data is essential to model performance, accuracy of model results, and validity of any concepts developed from model.
- There is no substitute for good met data.
- Typical sources are airports in vicinity of project.
- If available multiple airports may be used to evaluate model sensitivity.
- Class A
- Required information:
  - Air Temperature
  - Dew Point Temperature
  - Wind Speed
  - Wind Direction
  - Cloud Cover
  - Solar Radiation

Observations

- Observed data
  - For all water quality constituents
  - Provides Boundary conditions
  - Calibration
- Analysis provides insight as to what is occurring in system PRIOR to modeling.
- Aids in refinement of modeling approach.

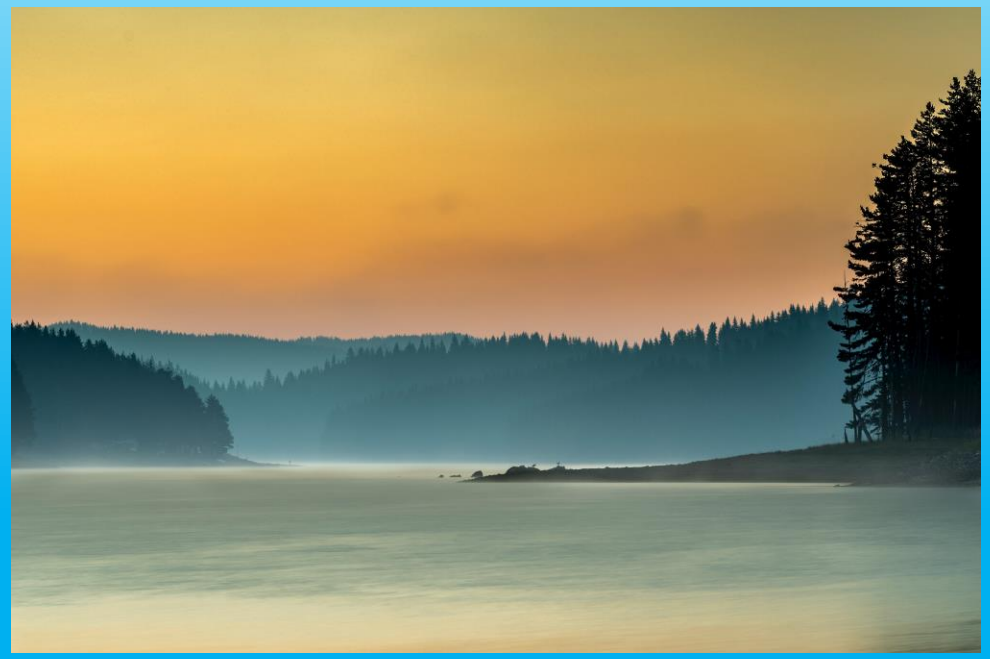


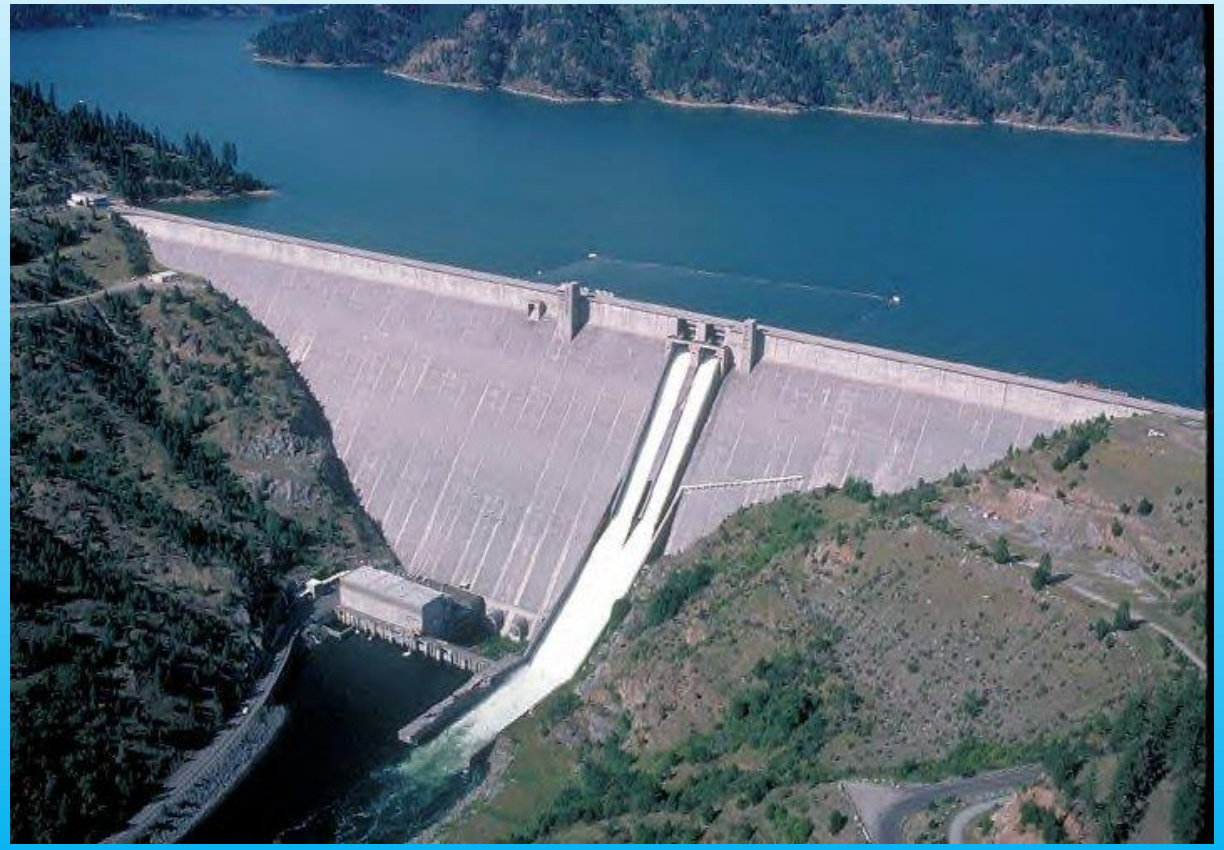
Other

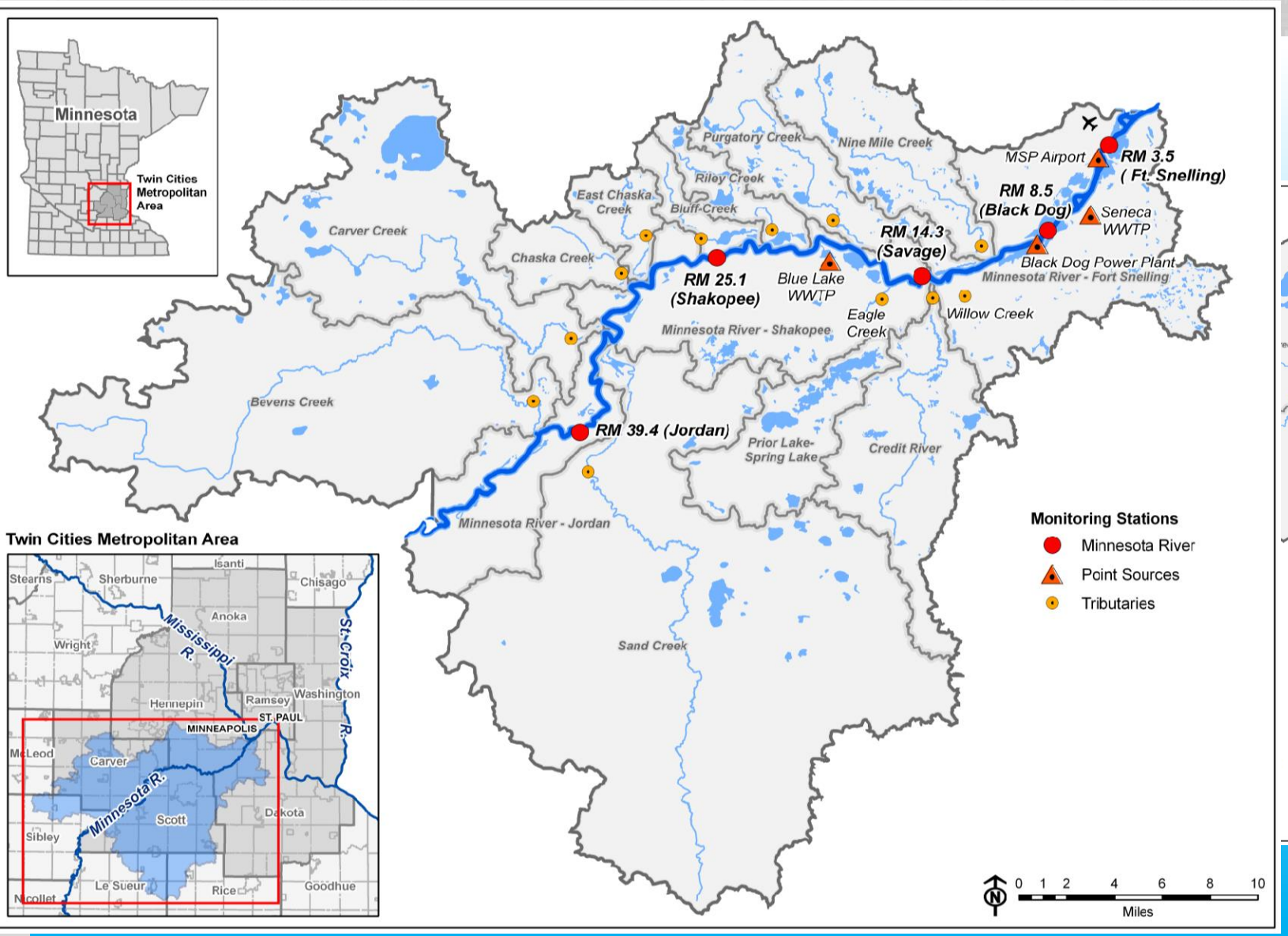
- Loadings
  - Point source
  - Non-point source/runoff
  - Other forms of water quality constituent loads
- Sediment
- Operations records
  - Which gates used for how long
  - Power generation
  - Spills
  - Anything else that impacts water movement

Output

- Identify what information is desired from model output.
- Ensure that it is being output at times and locations desired.
- Process and evaluate model output and compare to applicable observations.



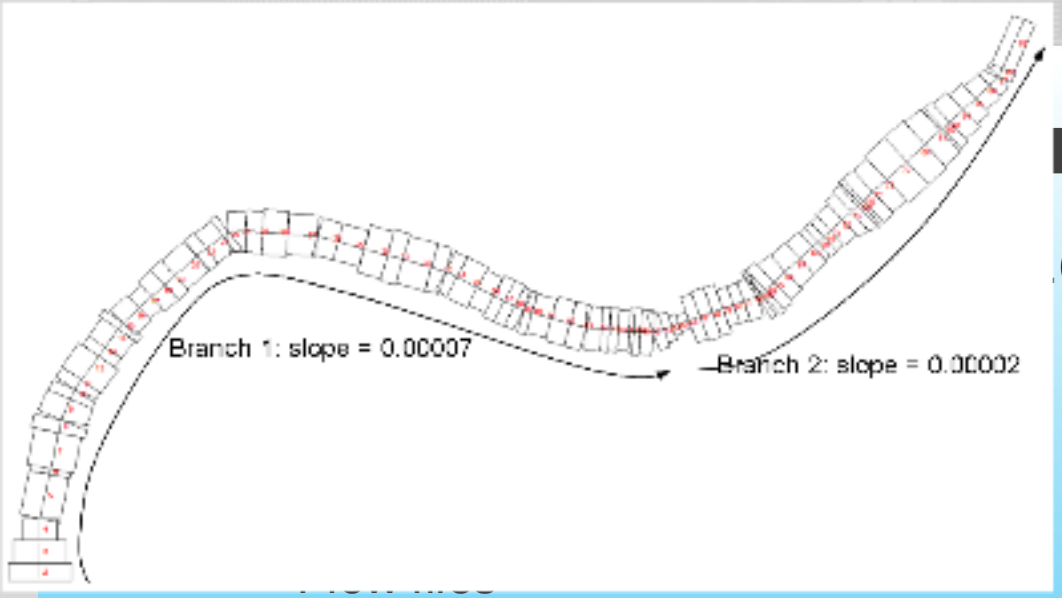




Model Setup

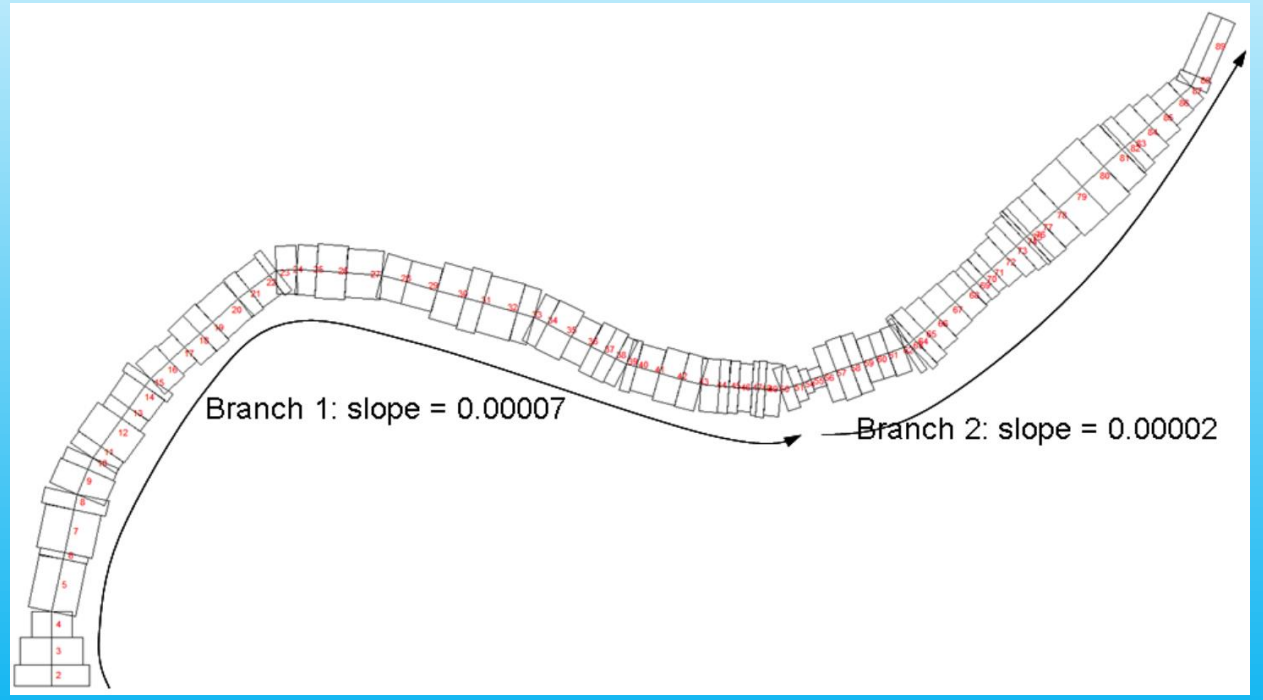
nesota River – CE-QUAL-W2

6,



- Meteorological file
- Control File

- Each of the above may require modification/revision for application at a different time or under different conditions.
- May want to work in a copy to prevent overwriting existing files

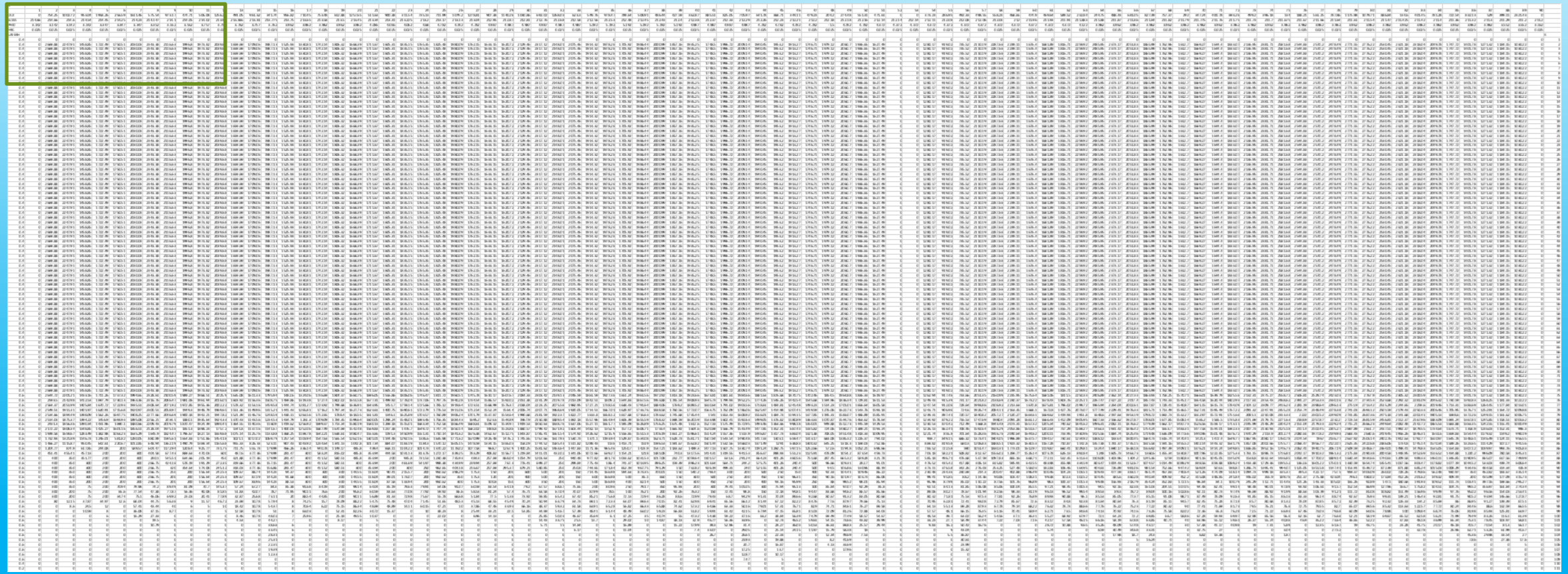


Bathymetry File

- Typically, the bathymetry file is the first file to be developed.
- Identifies the various geophysical components of model
- Segment
  - Cross-sectional widths and heights
  - Bottom Elevation
  - Directional Orientation
  - Initial Water Surface Elevation
  - Friction
- Reaches
  - Grouping of Segments

$										
	1	2	3	4	5	6	7	8	9	10
DLX	0	754.25	1002.72	953.04	1958.26	256.59	1611.46	575.54	973.17	474.71
ELWS	214.66	214.66	214.6	214.54	214.45	214.25	214.23	214.147	214.1	214.05
PHI0	3.142	3.142	3.142	3.142	3.347	3.347	3.347	3.352	3.552	3.552
FRIC	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
LAYERH										
0.4	0	0	0	0	0	0	0	0	0	0
0.4	0	2669.88	2247.91	1458.85	1722.49	1750.51	2030.03	2343.38	2116.63	1996.8
0.4	0	2669.88	2247.91	1458.85	1722.49	1750.51	2030.03	2343.38	2116.63	1996.8
0.4	0	2669.88	2247.91	1458.85	1722.49	1750.51	2030.03	2343.38	2116.63	1996.8
0.4	0	2669.88	2247.91	1458.85	1722.49	1750.51	2030.03	2343.38	2116.63	1996.8
0.4	0	2669.88	2247.91	1458.85	1722.49	1750.51	2030.03	2343.38	2116.63	1996.8
0.4	0	2669.88	2247.91	1458.85	1722.49	1750.51	2030.03	2343.38	2116.63	1996.8
0.4	0	2669.88	2247.91	1458.85	1722.49	1750.51	2030.03	2343.38	2116.63	1996.8
0.4	0	2669.88	2247.91	1458.85	1722.49	1750.51	2030.03	2343.38	2116.63	1996.8

Bathymetry File: Full



Flow & Boundary Files

- Generate Time Series files for all potential external flows entering the model
- Frequency
- Each requires corresponding temperature and concentration boundary conditions file

- **01QT355.INP**
- **Mean daily flows, Sand Creek discharge near river mile 35.5, 10/01/00-9/30/01**
- **Source: MCES**
- **JDAY QIN Comment (e = estimated)**
- **275.0 .4475**
- **276.0 .4390**
- **277.0 .4786**
- **278.0 .2436**
- **279.0 .0283**
- **280.0 .0283**
- **281.0 .0283**

TRIB PLACEMENT and TRIB FILES	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TR10	
PTRC - Tributary inflow placement	DENSITY	DENSITY	DENSITY	DENSITY	DENSITY	DENSITY	DENSITY	DENSITY	DENSITY	DENSITY	DENSITY
TRIC - Interpolation control	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
ITR - Tributary inflow segment	2	4	30	49	55	61	71	76	81	82	84
ELTRT - Top elevation if trib placement	0	0	0	0	0	0	0	0	0	0	0
ELTRB - Bottom elevation if trib placement	0	0	0	0	0	0	0	0	0	0	0
QTRFN - tributary flow file	01QT355.INP	01QT341.INP	01QD205.I	01QT137.I	01QT125.I	01QD107H.I	01QD076H	01QD065.I	01QD041.I	01QD038.I	01QD030.I
TTRFN - tributary temperature file	01TT355H.INP	01TT341H.IN	01TD205D	01TT137H.	01TT125H.	01TD107H.I	01TD076H	01TD065D	01TD041.I	01TD038.I	01TD030.I
CTRFN - tributary concentration file	01CTR_355_RU	01CTR_341_I	01CTR_20	01CTR_137	01CTR_125	01CTR_107_	01CTR_076	01CTR_065	01CTR_041	01CTR_038	01CTR_030

Temperature Boundary Condition File

Mean hourly temperature, Sand Creek to MN river mile 35.5, 10/1/00-9/30/01
Source: No measurements so estimated via regression to Nine Mile Creek

JDAY	TIN	Comment (e=estimated via regression)
275.0000	15.50	e regression
275.0417	15.30	e regression
275.0833	15.10	e regression
275.1250	14.90	e regression
275.1667	14.60	e regression
275.2083	14.40	e regression
275.2500	14.10	e regression
275.2917	14.00	e regression
275.3333	13.90	e regression
275.3750	14.00	e regression
275.4167	14.60	e regression
275.4583	15.20	e regression
275.5000	15.60	e regression
275.5417	16.40	e regression
275.5833	16.80	e regression
275.6250	16.80	e regression
275.6667	16.90	e regression
275.7083	16.80	e regression
275.7500	16.60	e regression
275.7917	16.40	e regression
275.8333	16.10	e regression
275.8750	15.70	e regression
275.9167	15.40	e regression
275.9583	15.20	e regression
276.0000	15.00	e regression
276.0417	14.60	e regression

Water Quality Boundary Condition File

01CTR_355.NPT -- Sand Creek -- RM 35.5 -- WY01

Obtained from WY01_03 WQ Tributaries_TLT_RUN06.xls; updated LTI algal splits based on latest report

JDAY	TDS	ISS1	PO4	NH4	NO3	DSI	LDOM	RDOM	LPOM	RPOM	BODU 1C	2C	3C	4C	5C	6C	ALG1	ALG2	ALG3	DO	LDOP	RDOP	LPOP	RPOP	LDON	RDON	LPON	RPON
275.000	506.21	27.00	0.180	0.020	1.600	20.500	0.134	0.759	0.134	0.759	0.00	0.00	0.00	0.0	0.00	0.00	1.240	0.383	0.133	10.970	0.001	0.004	0.001	0.004	0.007	0.038	0.007	0.038
306.000	517.32	26.00	0.220	0.020	1.900	20.500	0.134	0.759	0.134	0.759	0.00	0.00	0.00	0.0	0.00	0.00	1.477	0.209	0.069	11.840	0.001	0.004	0.001	0.004	0.007	0.038	0.007	0.038
336.000	515.49	28.00	0.210	0.030	2.000	20.500	0.134	0.759	0.134	0.759	0.00	0.00	0.00	0.0	0.00	0.00	1.730	0.008	0.008	14.600	0.001	0.004	0.001	0.004	0.007	0.038	0.007	0.038
367.000	527.66	27.00	0.240	0.420	2.300	20.500	0.129	0.729	0.129	0.729	0.00	0.00	0.00	0.0	0.00	0.00	1.636	0.010	0.102	14.830	0.001	0.004	0.001	0.004	0.006	0.036	0.006	0.036
398.000	515.49	28.00	0.210	0.020	2.000	20.500	0.134	0.759	0.134	0.759	0.00	0.00	0.00	0.0	0.00	0.00	1.297	0.069	0.389	14.830	0.001	0.004	0.001	0.004	0.007	0.038	0.007	0.038
426.000	517.00	27.00	0.210	0.940	2.100	20.500	0.134	0.759	0.134	0.759	0.00	0.00	0.00	0.0	0.00	0.00	1.087	0.078	0.589	14.830	0.001	0.004	0.001	0.004	0.007	0.038	0.007	0.038
457.000	328.06	205.00	0.170	0.180	6.100	19.100	0.193	1.093	0.193	1.093	0.00	0.00	0.00	0.0	0.00	0.00	2.853	0.048	0.609	14.830	0.001	0.005	0.001	0.005	0.010	0.055	0.010	0.055
487.000	347.37	146.00	0.170	0.040	5.400	19.100	0.171	0.971	0.171	0.971	0.00	0.00	0.00	0.0	0.00	0.00	3.309	0.075	0.126	10.970	0.001	0.005	0.001	0.005	0.009	0.049	0.009	0.049
518.000	372.39	206.00	0.200	0.030	6.200	19.000	0.188	1.063	0.188	1.063	0.00	0.00	0.00	0.0	0.00	0.00	3.019	0.175	0.248	10.470	0.001	0.005	0.001	0.005	0.009	0.053	0.009	0.053
548.000	447.64	70.00	0.190	0.030	2.600	19.700	0.150	0.850	0.150	0.850	0.00	0.00	0.00	0.0	0.00	0.00	1.936	0.301	0.193	8.600	0.001	0.004	0.001	0.004	0.008	0.043	0.008	0.043
579.000	507.94	27.00	0.200	0.020	1.900	20.500	0.134	0.759	0.134	0.759	0.00	0.00	0.00	0.0	0.00	0.00	1.432	0.200	0.123	8.550	0.001	0.004	0.001	0.004	0.007	0.038	0.007	0.038
610.000	499.23	25.00	0.200	0.020	1.800	20.500	0.134	0.759	0.134	0.759	0.00	0.00	0.00	0.0	0.00	0.00	1.440	0.192	0.123	9.700	0.001	0.004	0.001	0.004	0.007	0.038	0.007	0.038
641.000	513.58	25.00	0.200	0.020	1.900	20.500	0.112	0.633	0.514	2.913	0.00	0.00	0.00	0.0	0.00	0.00	1.247	0.376	0.132	11.360	0.001	0.003	0.003	0.015	0.006	0.032	0.026	0.146

Meteorological File

- One file
- Daily or more frequent, depending upon issues
- Important to capturing what is happening “in” the model at a given time

Hourly (plus) meteorological data, MSP Intl Airport near river mi 3; updated 06/01/2009
Source: MDNR except solar from UM, St. Paul Campus; TLT added cloud cover from 14WS

JDAY	TAIR	TDEW	WIND	PHI	CLOUD	SRO
275.000	23.900	10.000	3.600	2.600	8.0	0.000
275.037	22.800	8.900	5.100	2.600	8.3	0.000
275.079	22.800	8.900	6.200	3.000	8.6	0.000
275.120	22.200	8.900	6.700	3.100	8.9	0.000
275.162	21.100	9.400	6.700	3.500	9.1	0.000
275.204	21.700	9.400	7.700	3.700	9.4	0.000
275.245	21.100	8.900	5.700	3.700	9.7	0.000
275.250	21.100	9.400	6.200	3.700	10.0	23.012
275.287	20.000	10.000	6.200	3.700	9.9	23.012
275.329	18.900	10.000	5.100	3.700	9.7	88.560
275.370	17.200	10.000	3.600	3.700	9.6	128.307
275.412	16.100	10.000	1.500	3.050	9.4	355.633
275.454	14.400	10.000	3.600	2.400	9.3	433.733
275.495	13.900	10.000	3.100	2.300	9.1	278.231
275.500	14.400	10.000	3.100	2.300	9.0	370.974
275.537	13.900	10.600	3.100	2.400	9.0	370.974
275.579	15.000	10.600	3.100	2.600	9.0	175.725
275.620	16.100	10.600	4.100	3.100	9.0	149.924
275.662	18.300	11.100	4.100	2.600	9.0	56.483
275.704	20.000	11.100	4.600	3.000	9.0	28.590
275.745	21.100	11.100	3.050	2.720	9.0	9.763
275.750	20.600	11.100	1.500	2.440	9.0	0.000
275.787	22.200	11.700	3.100	2.160	9.0	0.000
275.829	22.200	11.700	0.000	1.880	9.0	0.000
275.870	23.300	11.700	5.100	1.600	9.0	0.000
275.912	22.200	11.700	2.600	3.000	9.0	0.000
275.954	22.800	11.700	2.600	1.950	9.0	0.000
275.995	22.200	12.200	3.600	0.900	9.0	0.000
276.000	21.700	12.200	3.600	0.900	9.0	0.000

Control File

This file contains specifications of much of the information that controls model operation

Fill in these with real date	**DLT CON**	**NDLT**	DLTMIN	DLTINTER
TMSTRT	Time step control parameters	7	0.1	OFF
10/1/2000 0:00				
TMEND	**DLT DATE**	DLTD	DLTD	DLTD
10/1/2001 0:00	Date of time step change in JDAY	275	277	457
275.000				
640.000	**DLT MAX**	DLTMAX	DLTMAX	DLTMAX
Year	Maximum time step in seconds	100	75	75
2000				
Go to Index of Sheets:	**DLT FRN**	**DLTF**	DLTF	DLTF
Index of Sheets'!A1	Fraction of maximum theoretical time step	0.4	0.4	0.4

After Model is Initially Set Up

- Run the W2 preprocessor
- Address what Errors the pre-processor identifies.
- Once addressed, re-run W2 pre-processor, and continue until there are no Errors.
- Evaluate Warnings to see if they warrant changes or modifications.
- Compare computed Volume Elevation curve to official curve if available.
    - If results are not satisfactory, adjust the bathymetry, and start the process again.

After W2 Preprocessor is Finished

- Run CE-QUAL-W2 model
- Review model output
- “w2.wrn” file
- Time Series files
- Evaluate model performance.
  - Did it appear to operate as you desired?
- Address issues that develop……..

Exercises: Model Simulation 1

Short Duration Simulation:

1. Modify W2 Control file to adjust model simulation duration to 3 months (90 days).
2. Adjust model time step in W2 Control file by changing DLTMIN from 0.1 to 1.

NDLT	DLTMIN
7	0.1

3. Change NDLT from 7 to 1.
4. Try different schemes.

TRANSPORT SCHEME	WB1
SLTRC - UPWIND, QUICKEST, ULTIMATE - use ULTIMATE	ULTIMATE
THETA - degree of implicitness - use 0.55 - Time-weighting for vertical advection scheme	0.5
HYD COEFFICIENTS	WB1
AX - Longitudinal eddy viscosity, m2/s	1
DX - Longitudinal eddy diffusivity/conductivity, m2/s	1

Questions?