Modeling the Spokane River System

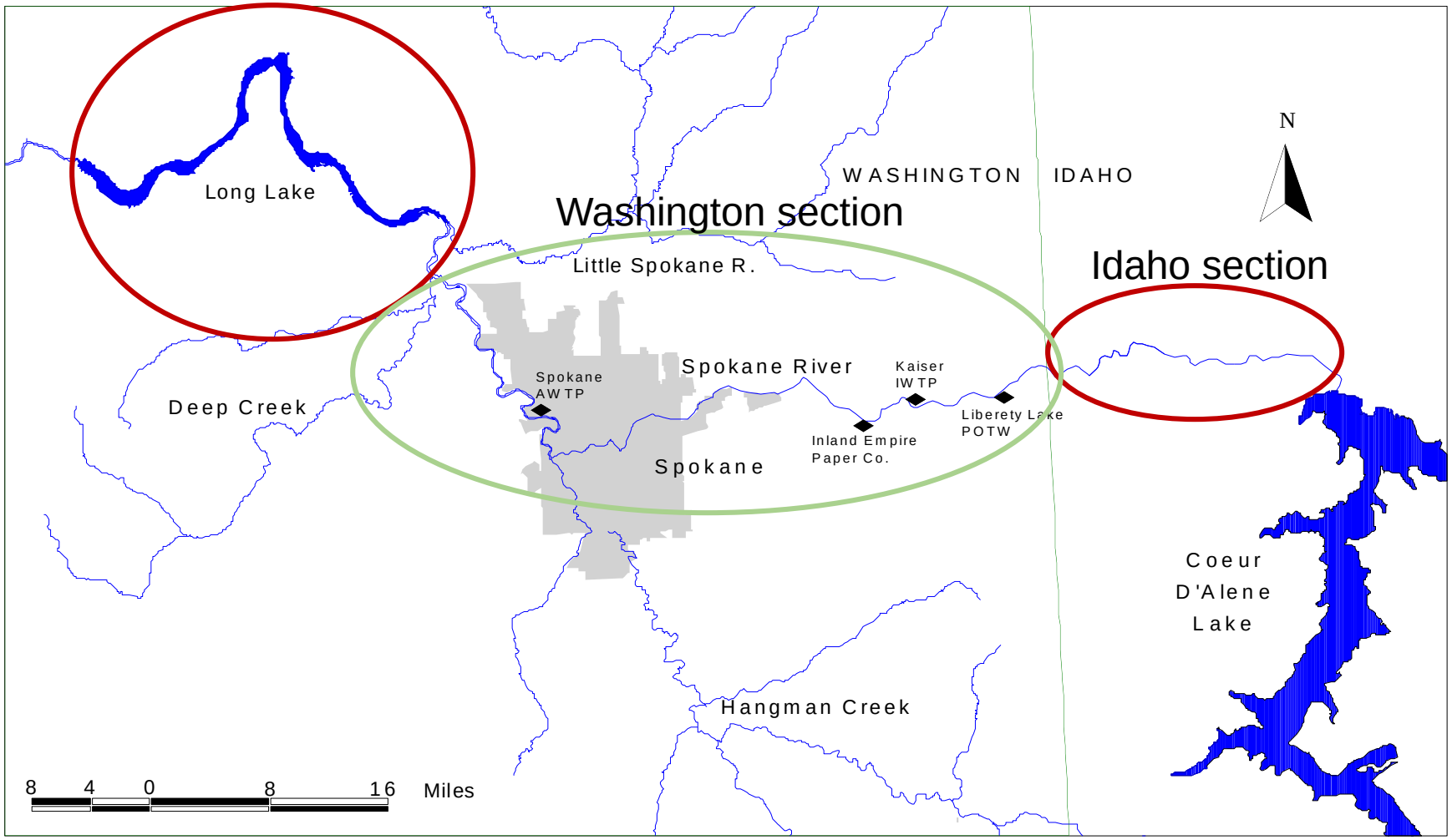
Scott A. Wells

Dept. of Civil and Environmental Engineering

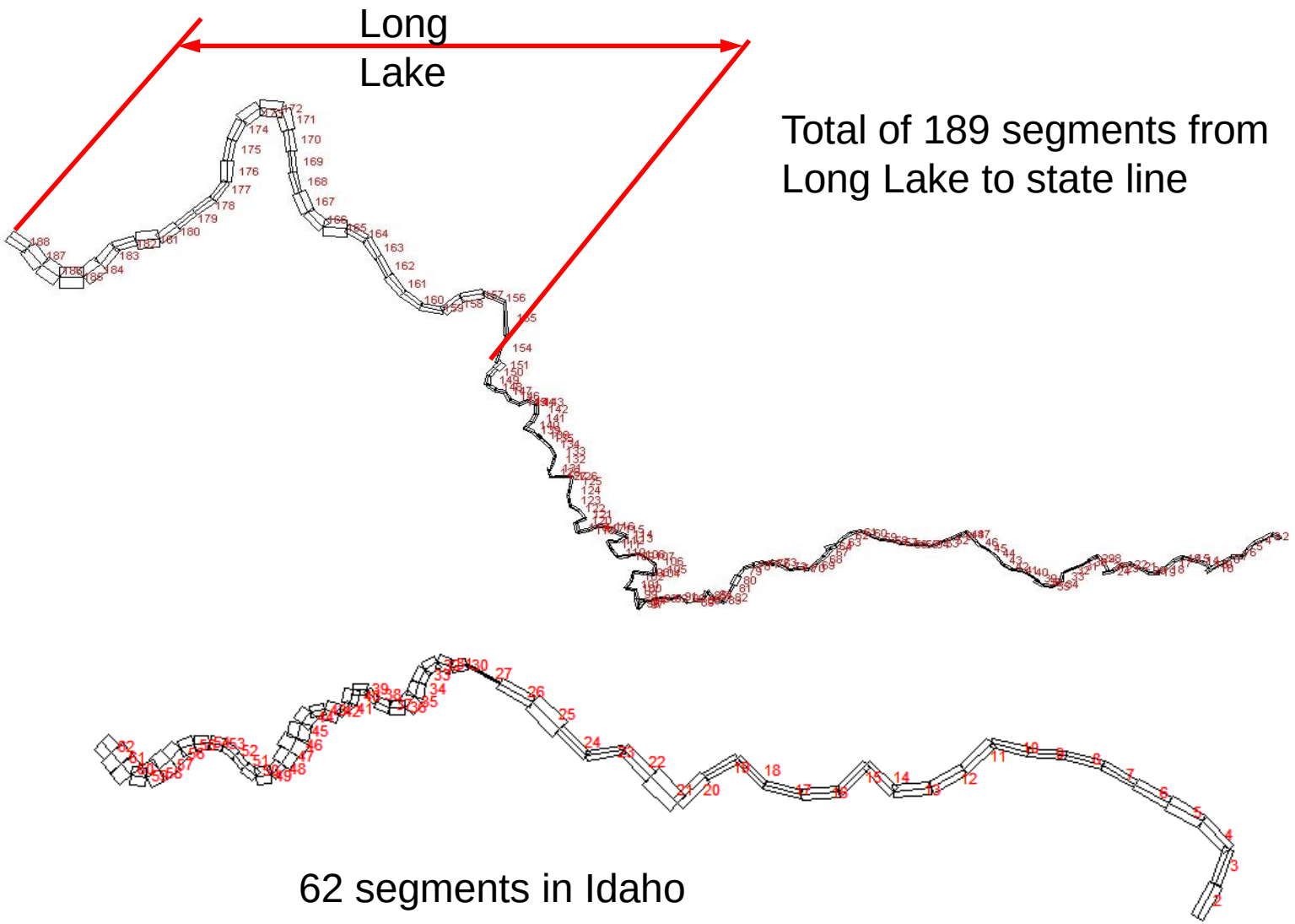
Portland State University

Spokane River System Model

Spokane Lake or Long Lake



Spokane River Model Grid

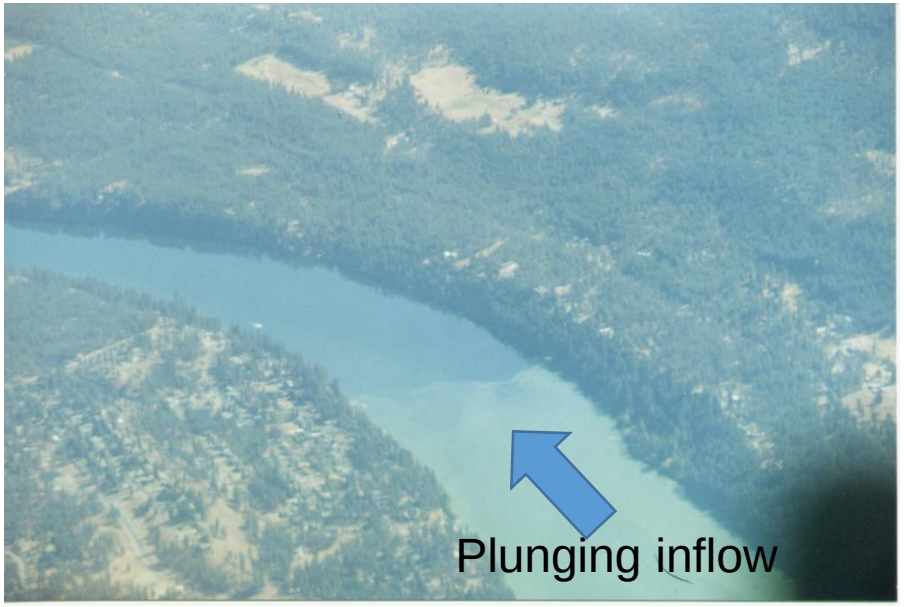


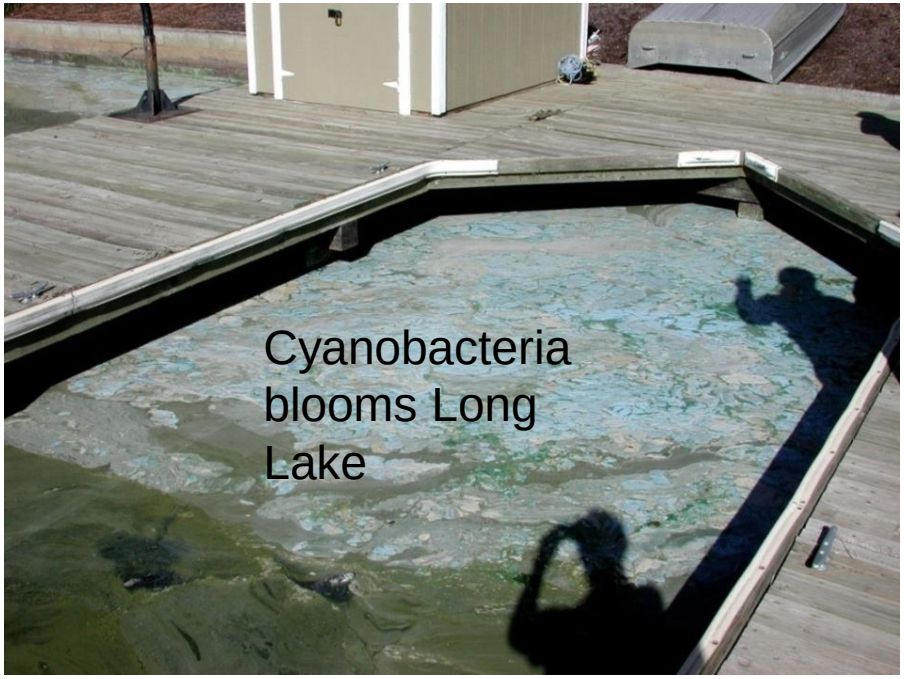
Total of 189 segments from Long Lake to state line

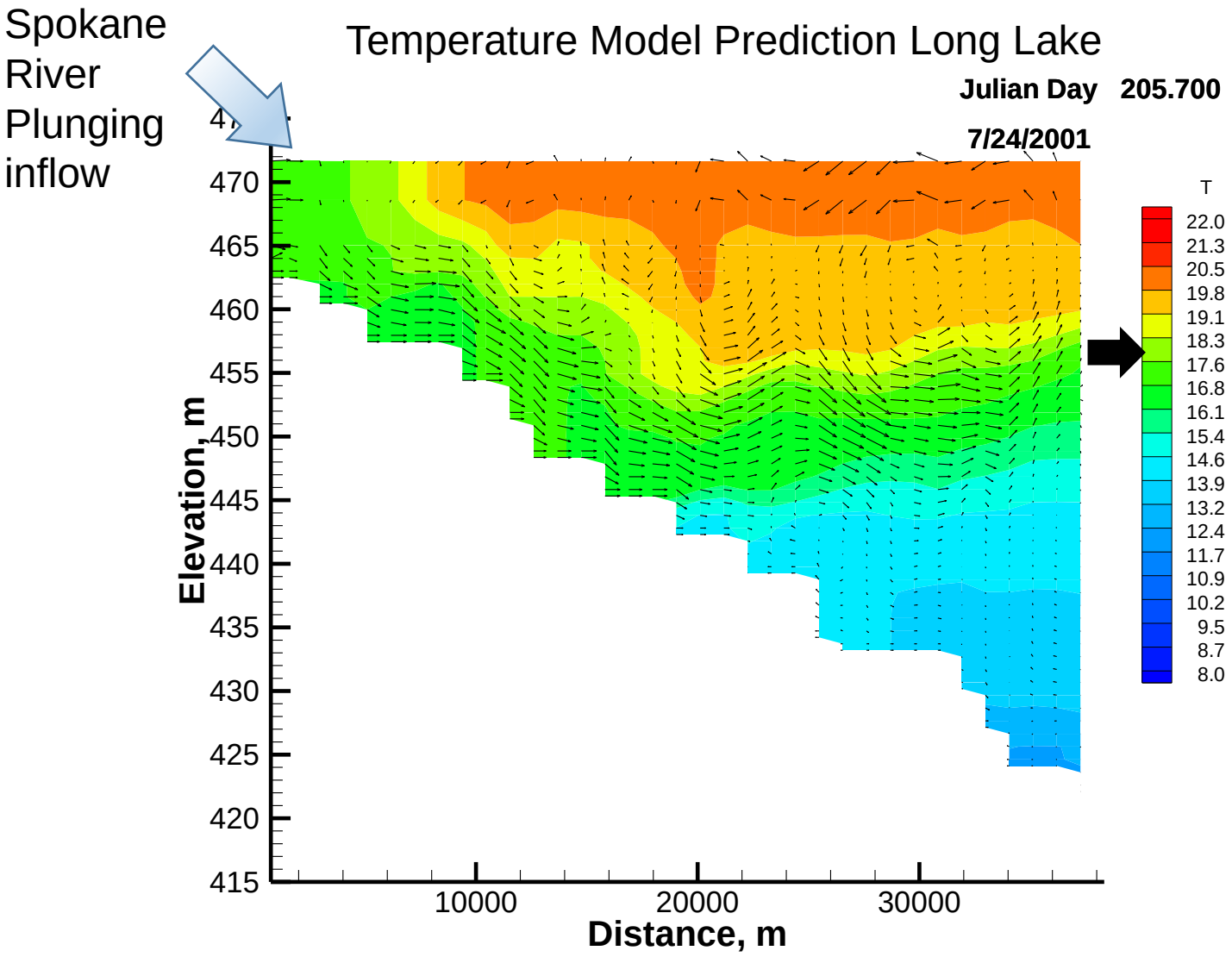
62 segments in Idaho

Periphyton

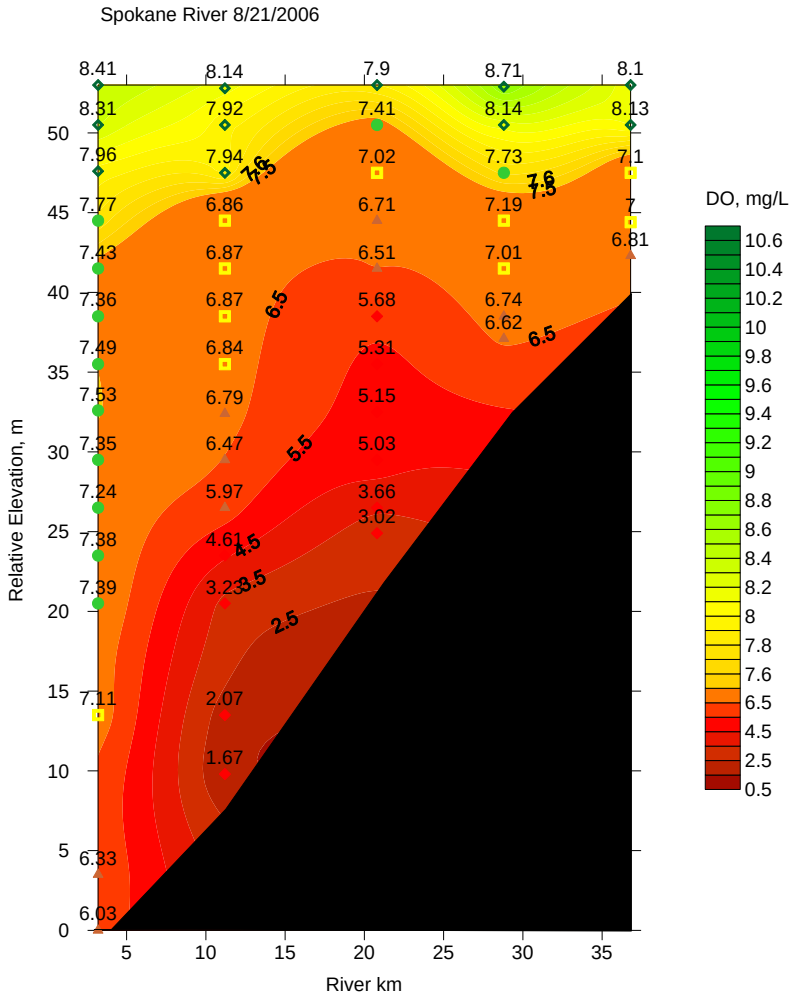
Spokane River – Long Lake



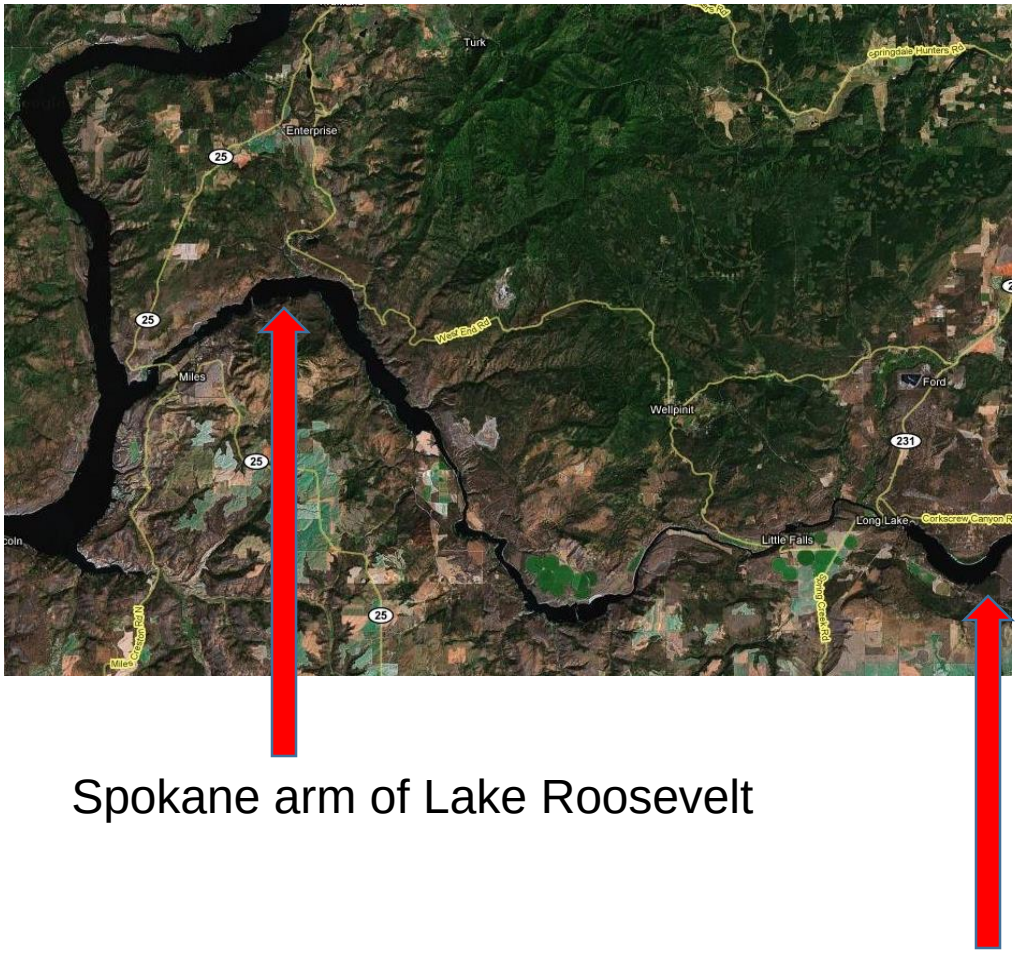



Spokane River Plunging inflow
Temperature Model Prediction Long Lake
Julian Day 205.700
7/24/2001
T
22.0
21.3
20.5
19.8
19.1
18.3
17.6
16.8
16.1
15.4
14.6
13.9
13.2
12.4
11.7
10.9
10.2
9.5
8.7
8.0
Elevation, m
470
465
460
455
450
445
440
435
430
425
420
415
10000
20000
30000
Distance, m

Spokane River Arm of Lake Roosevelt



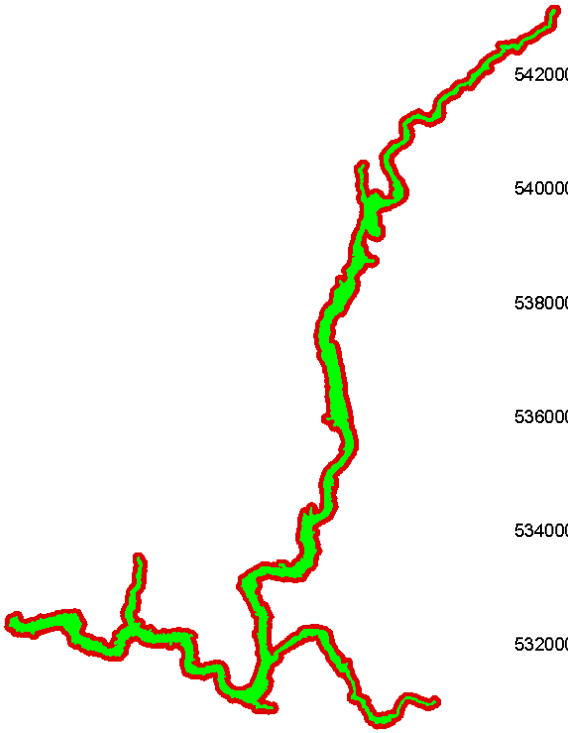
Dissolved oxygen along Spokane arm



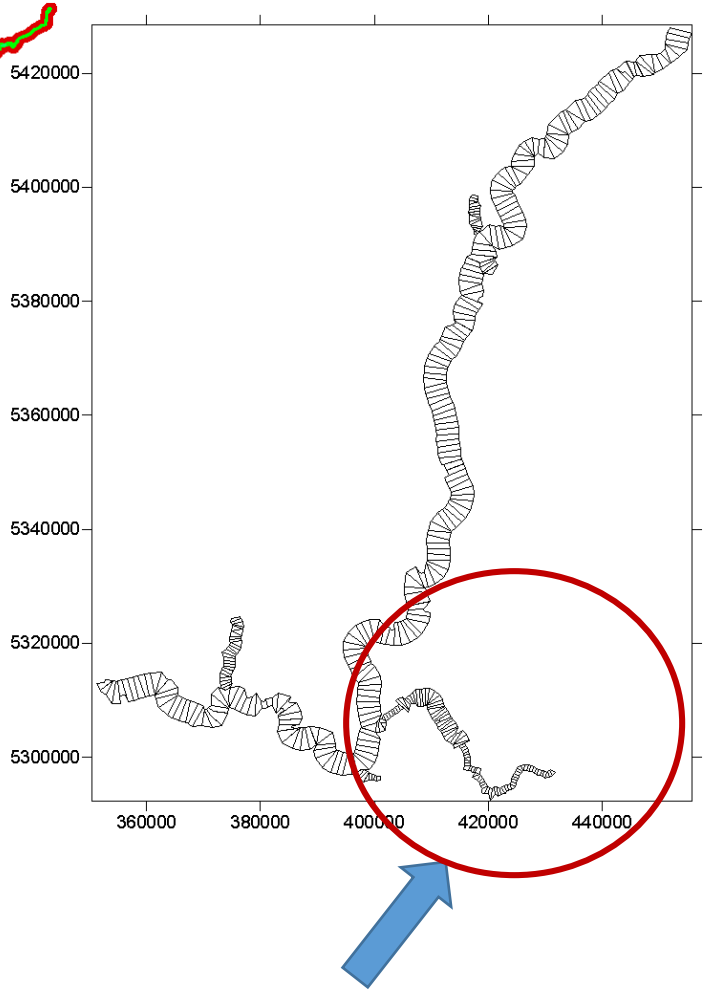
Spokane arm of Lake Roosevelt

Long Lake

Bathymetry and Grid for Lake Roosevelt

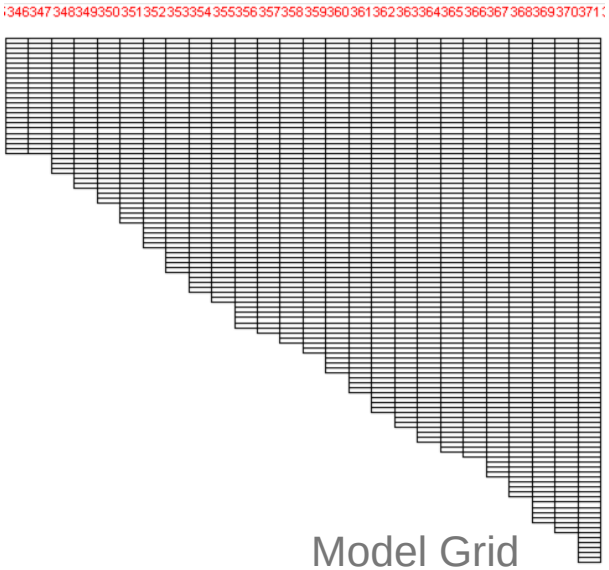


Model segments



Spokane arm of Lake Roosevelt

Side view of grid

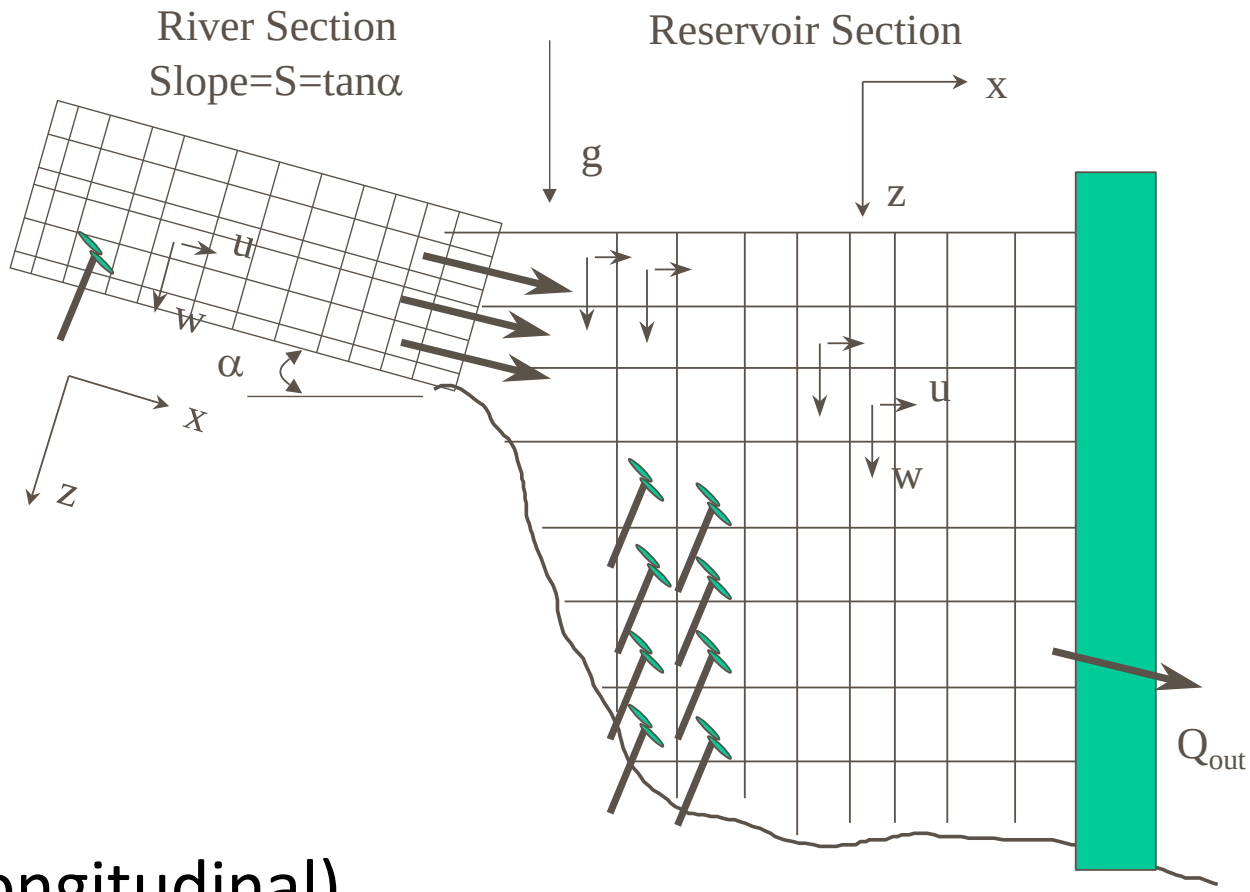


Model Grid
(1 m vertical)
(~ 500, 1000 m, longitudinal)

533 active segments

Timeline of Upper Spokane River Model

Year	Milestone	CE-QUAL-W2 Model
2002	Completed Development and Calibration of Washington Upper Spokane River Model for Years 1991 (Feb 1-Oct 31) and 2000 (Jan 1-Oct 31)	Version 3.1
2003	Completed Development and Calibration of Washington Upper Spokane River Model for Year 2001 (low-flow critical year between April 30-September 30)	Version 3.1
2005	Completed Development and Calibration of Idaho Upper Spokane River Model for Years 2001 and 2004	Version 3.1
2009	Converted Washington and Idaho Upper Spokane River Models to Version 3.6	Version 3.6 (Variable Stoichiometry)
2010	Completed Final Scenarios Report for EPA	Version 3.6



CE-QUAL-W2

- A 2-D (vertical-longitudinal),

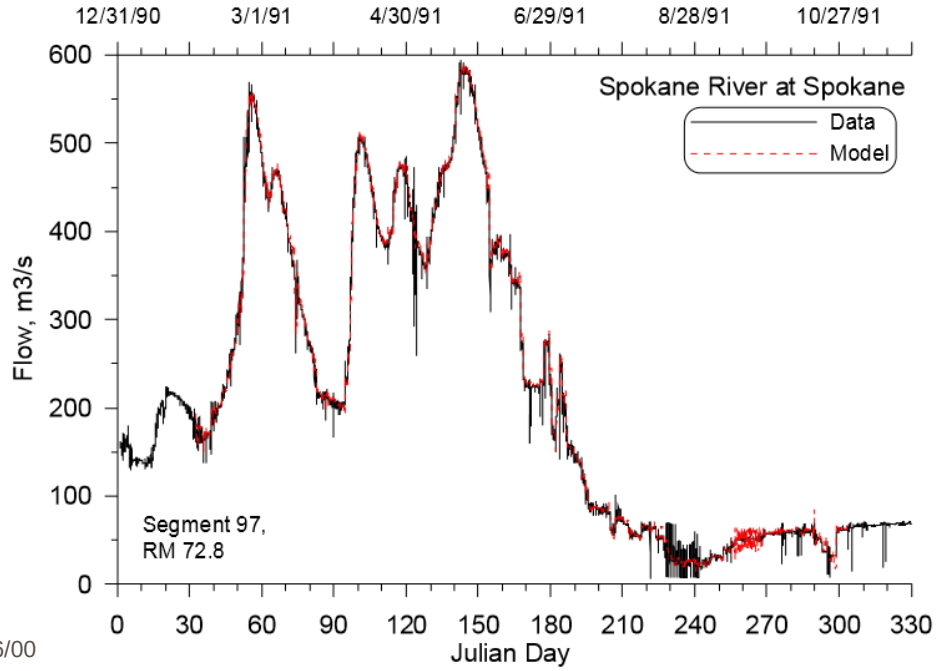
  unsteady finite difference model for hydrodynamics and water quality for rivers, reservoirs, lakes, estuaries

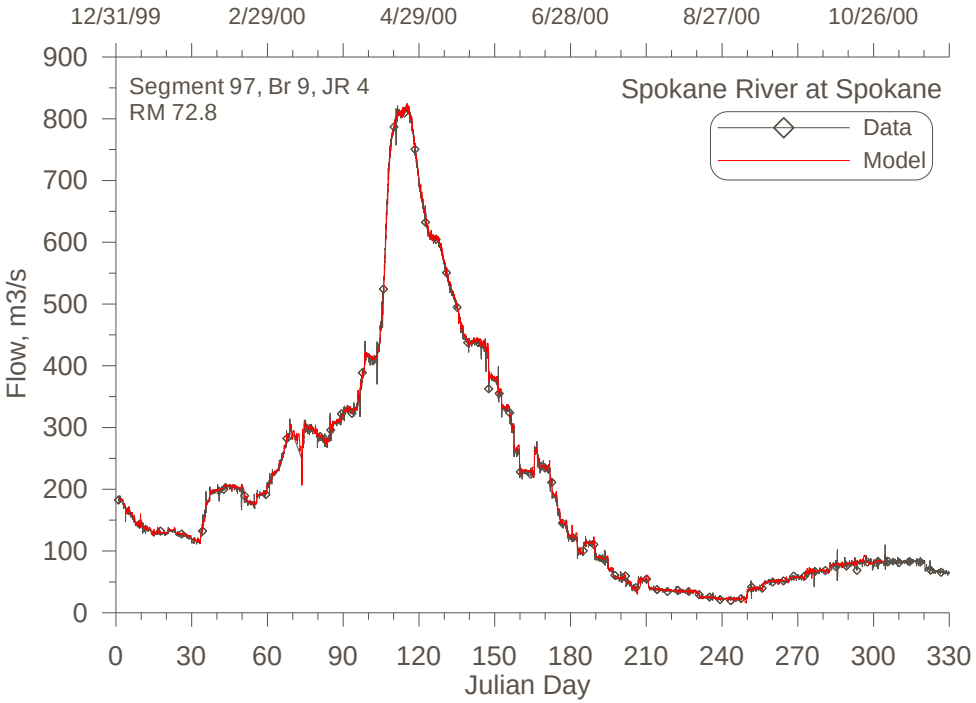
CE-QUAL-W2 State Variables

- Temperature, velocity (U, W), Water surface elevation
- TDS
- # Arbitrary Constituents (such as bacteria, tracer, water age, toxics)
- # Inorganic suspended solids groups
- labile and refractory dissolved organic matter groups
- Dissolved and particulate silica
- Total inorganic carbon
- labile and refractory particulate organic matter fractions
- # different algal groups
- # different periphyton groups
- zooplankton
- NH_4-N
- PO_4-P
- NO_3-N+NO_2-N
- Iron
- # CBOD groups
- Alkalinity
- pH and carbonate system (HCO_3, CO_3, H_2CO_3)
- Sediment Model

Calibration

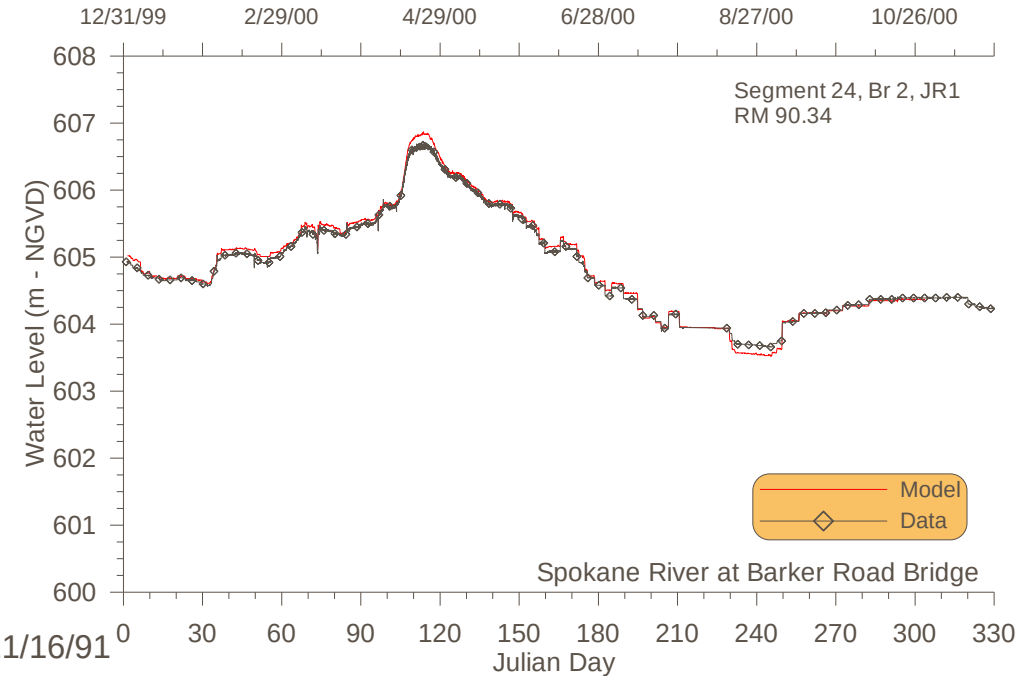
- Flow rate at gaging station sites

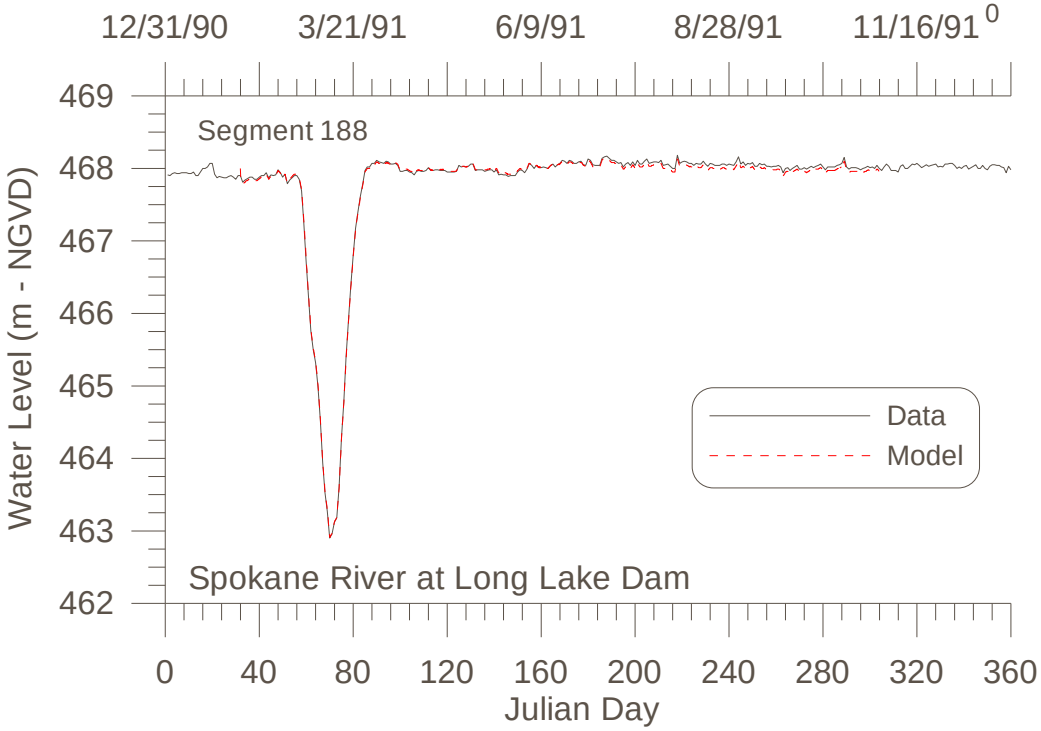




Calibration

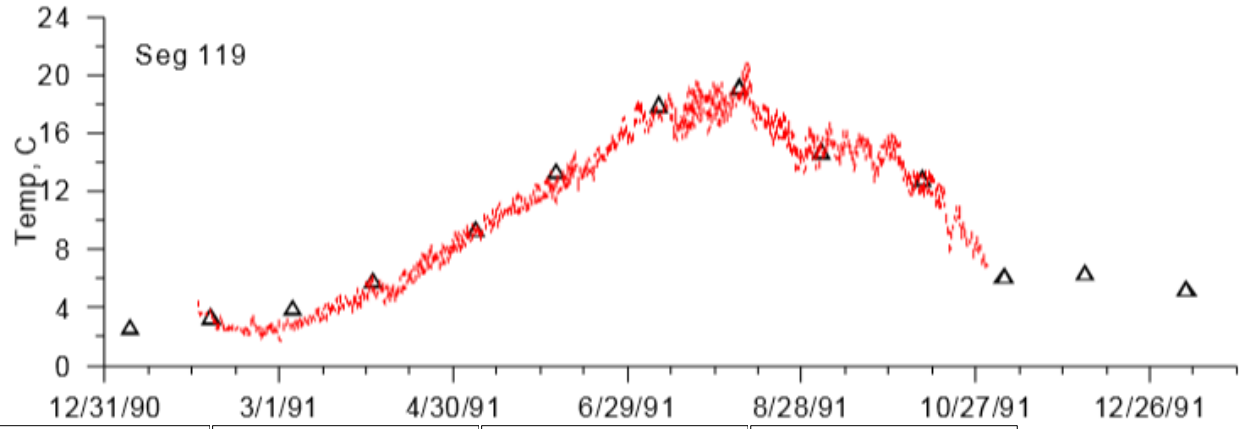
- Water level at gaging station sites

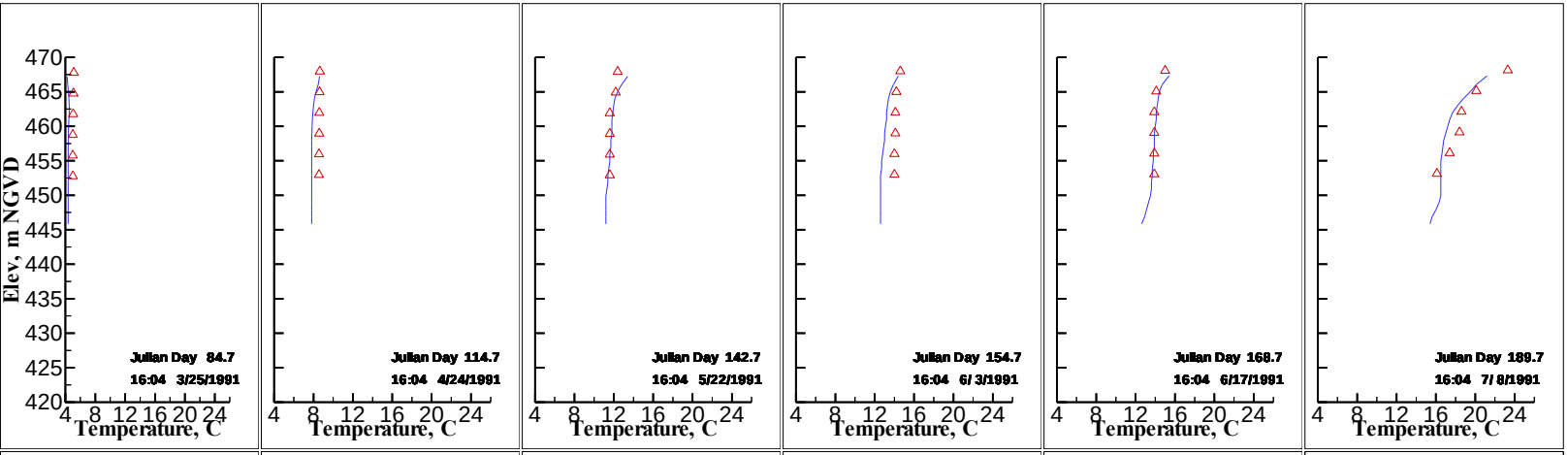


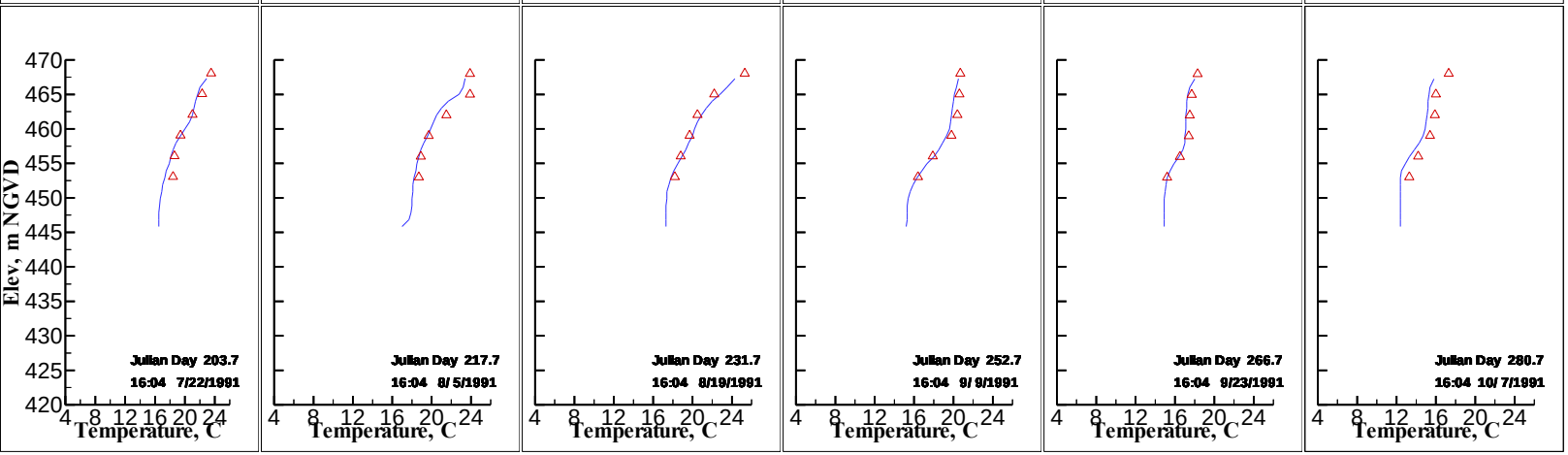


Calibration

- Temperature

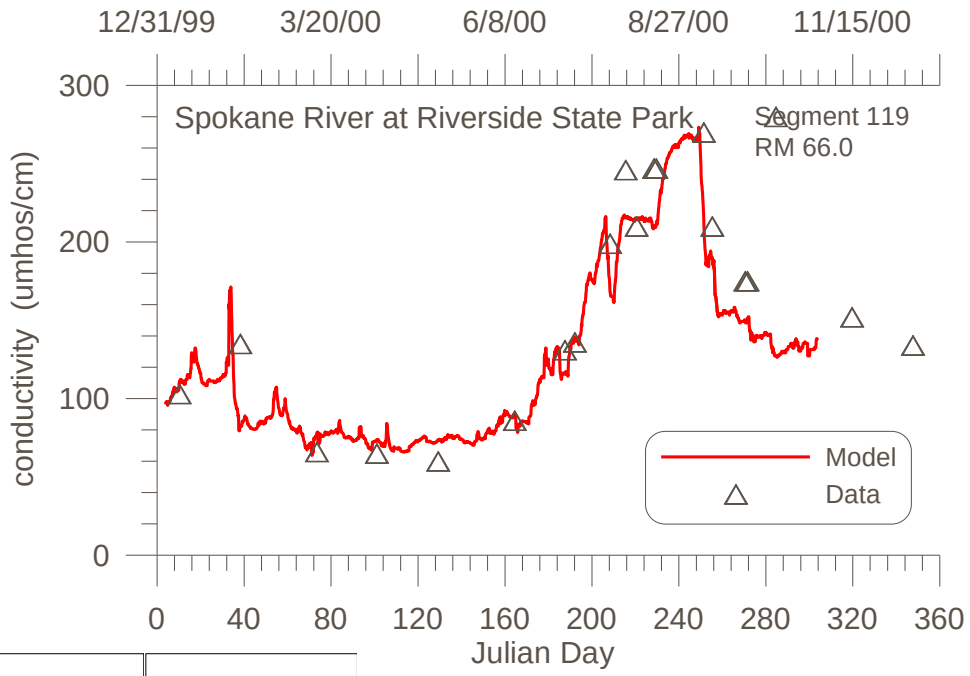


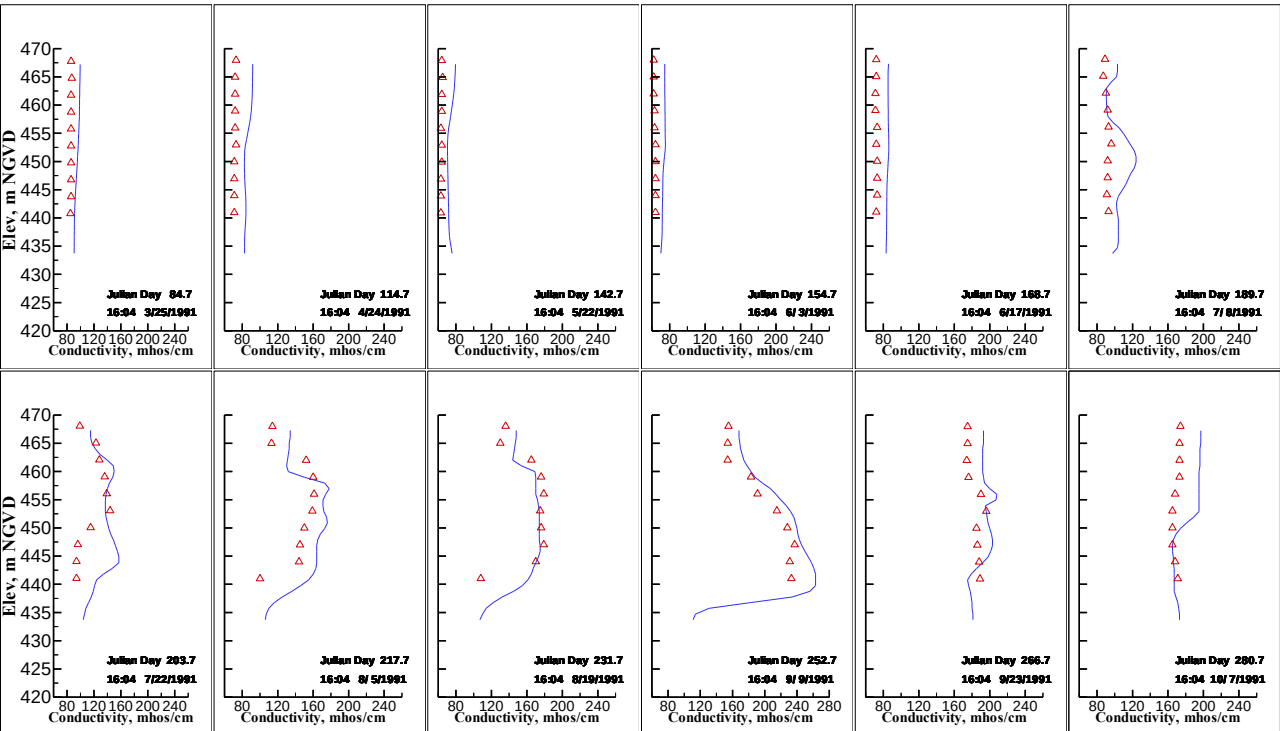




Calibration

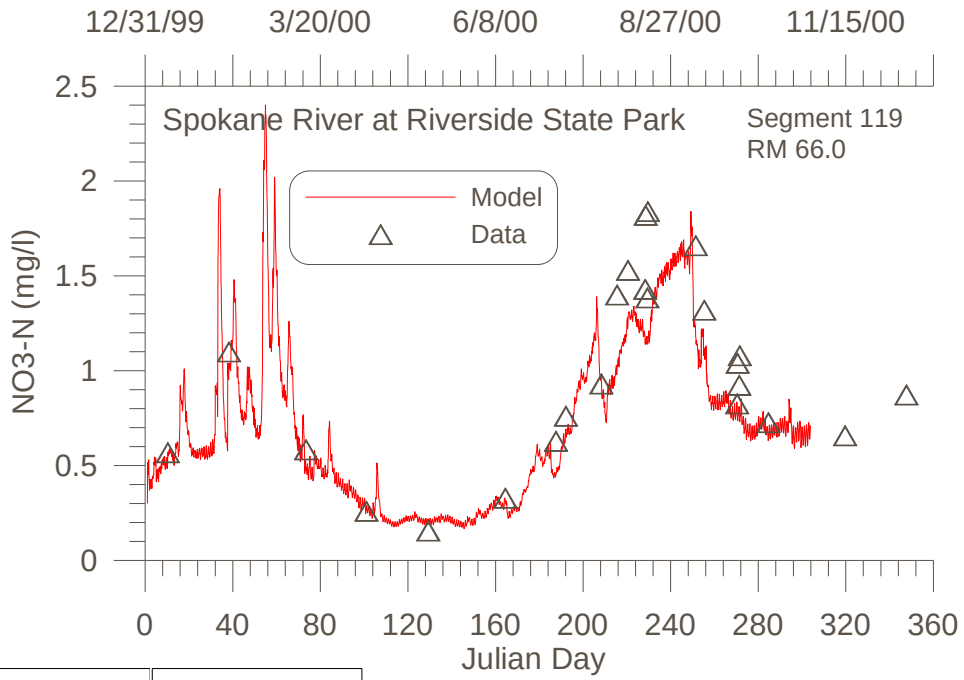
- Water quality – Conductivity

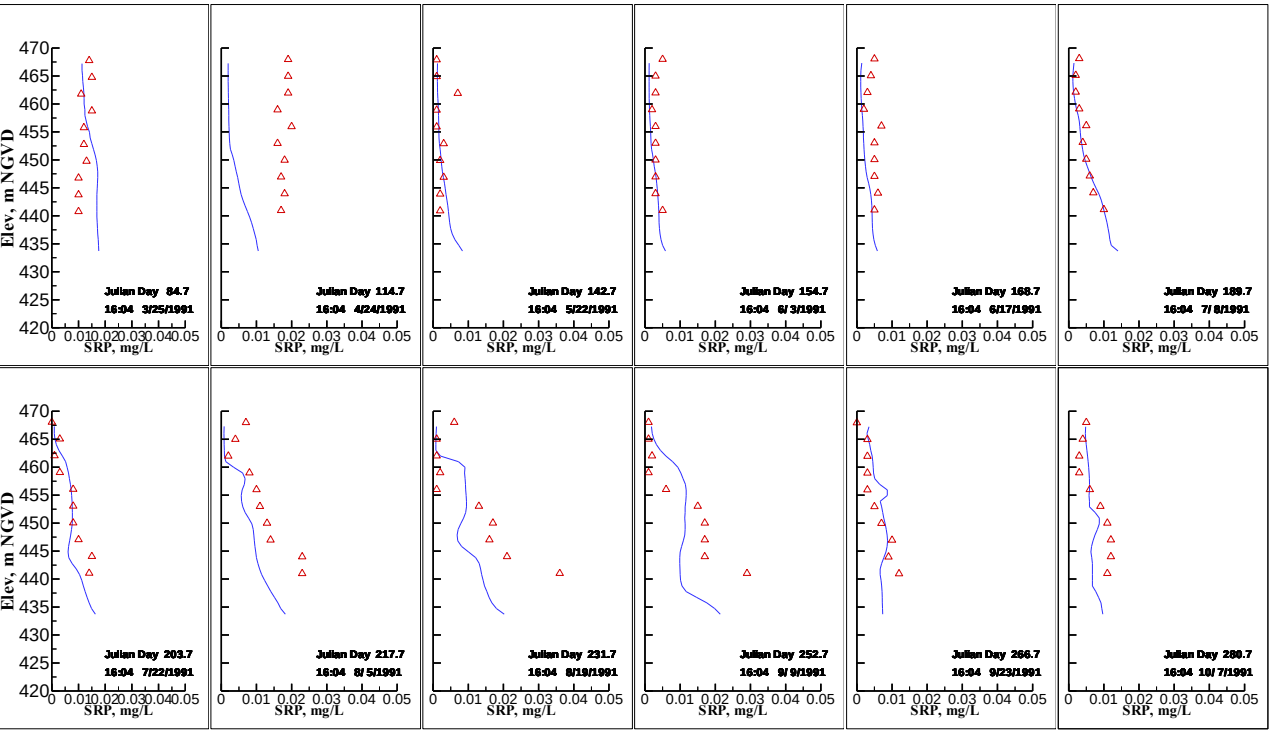




Calibration

- Water quality – PO4

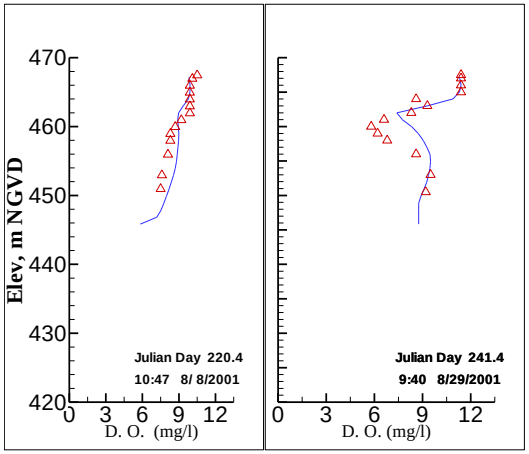




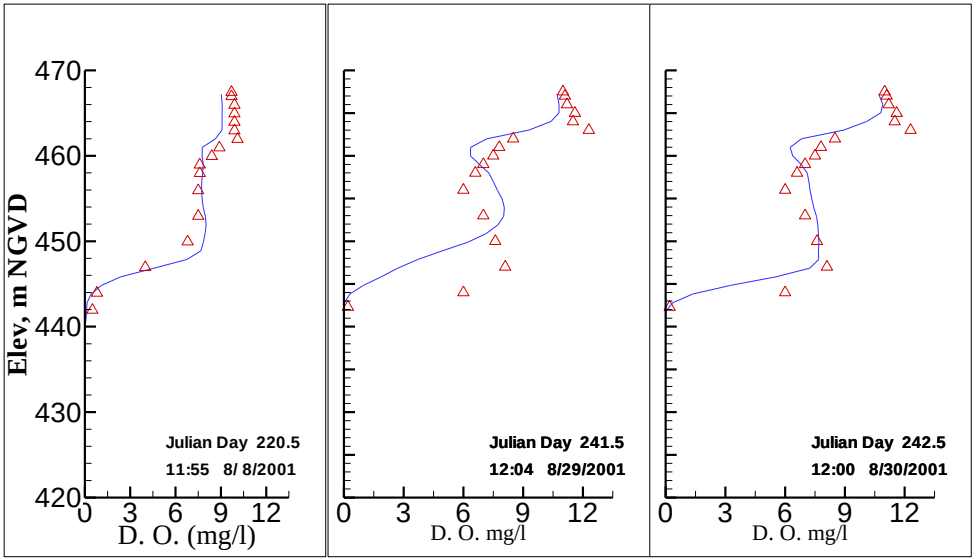
Calibration

- Water quality – dissolved oxygen

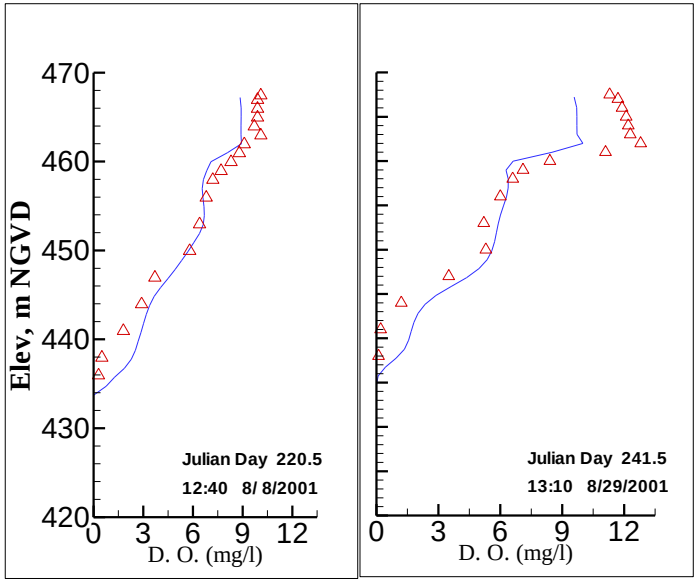
Station 2



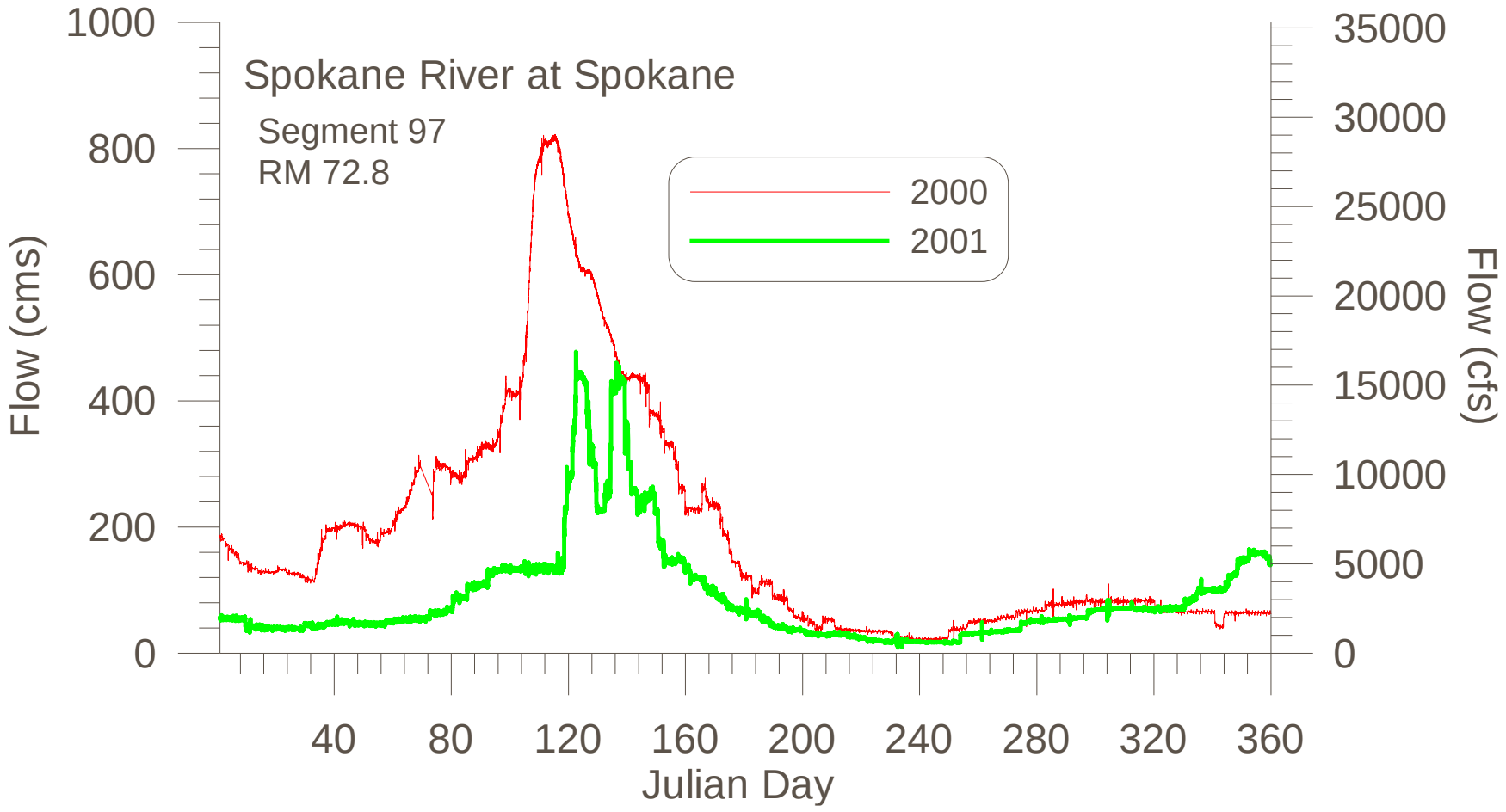
Station LL2



Station LL1



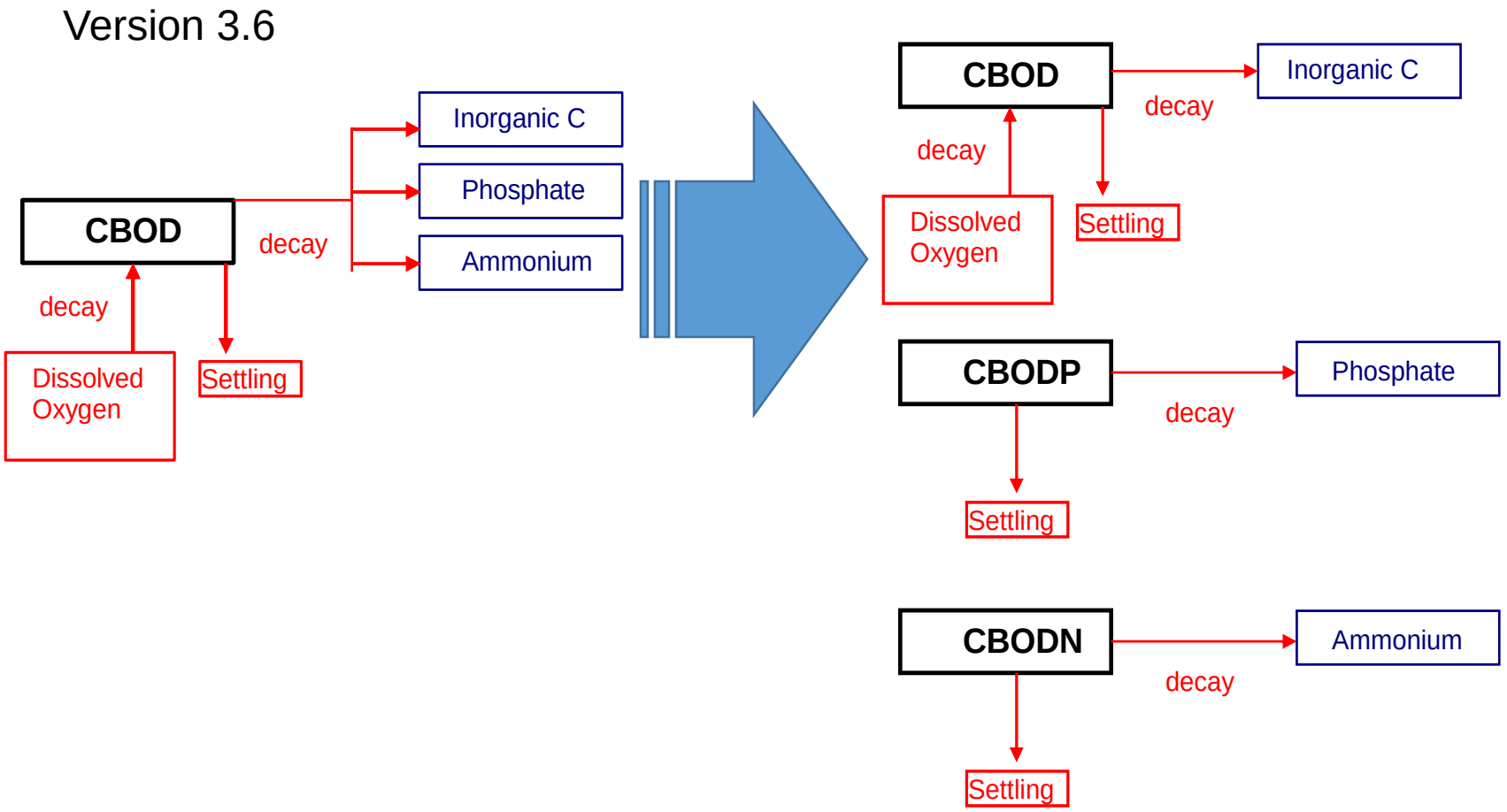
Why Include 2001?



Changes for 2001 model

- Changes from earlier calibration for 1991 and 2000
  - Epiphyton growth rate
  - Groundwater quality data updated based on field data
    - 1991,2000: NOx-N: 1 mg/l, DO: 7.5 mg/l, TIC: 29.6 mg/l, ALK: 118 mg/l
    - 2001: NOx-N: 0.89-1.44 mg/l, DO: 6.4-8.64 mg/l, TIC: 18.31-26.5 mg/l, ALK: 71-104 mg/l
  - Updated 2001 boundary conditions

Modeling CBOD of dischargers



Point Dischargers

- Each Discharger has separate CBOD decay rate

CBOD compartment # in Spokane model	Corresponding Source
1	Liberty Lake WWTP
2	Kaiser Aluminum
3	Inland Empire Paper
4	Spokane WWTP
5	Organic matter from Washington Tributaries
6	Coeur D'Alene WWTP
7	Hayden POTW
8	Post Falls STP
9	Lake Coeur D'Alene CBOD
10	Spokane County WWTP