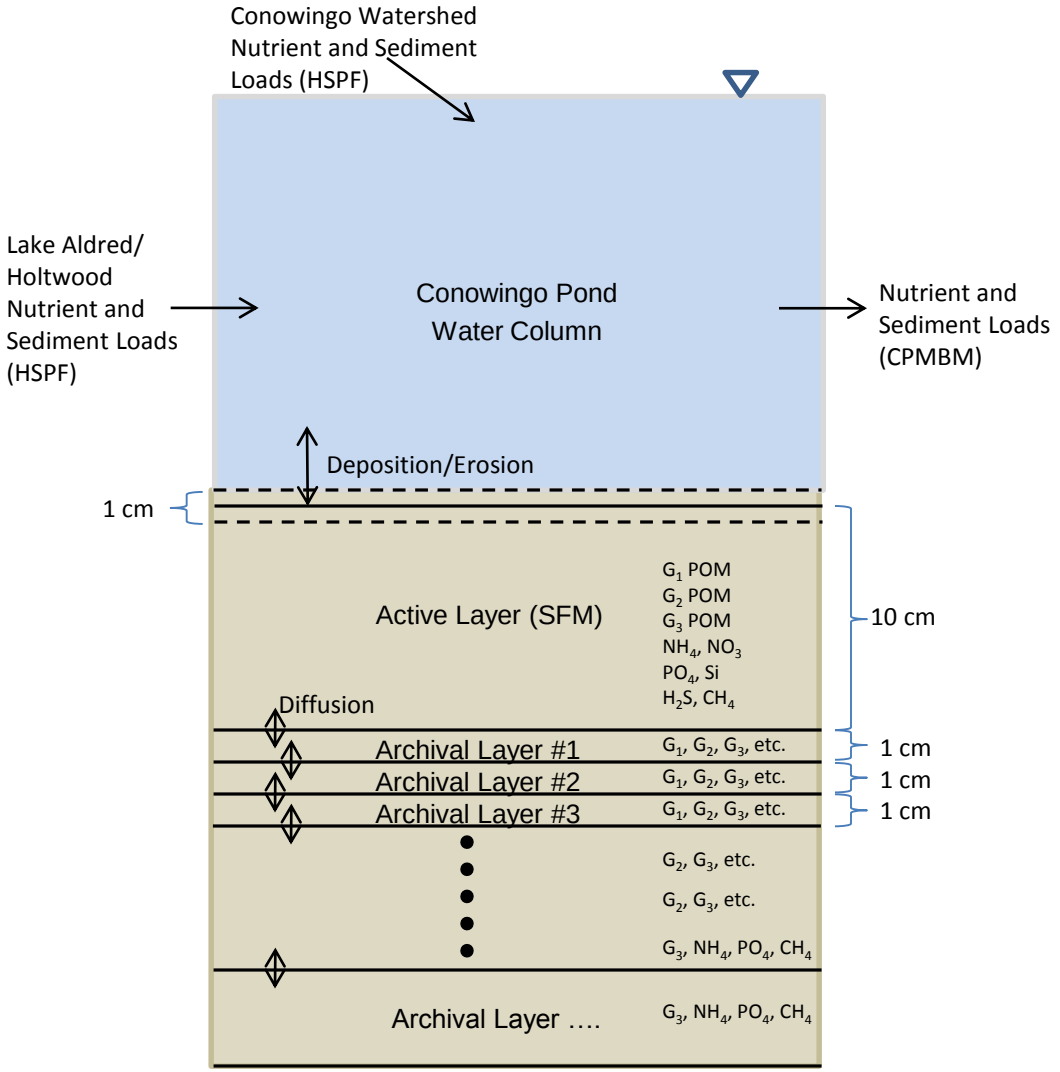
Conowingo Pond Mass Balance Model

Approach

- Combine WSM + hydro/sediment transport + WQ/SFM
- WSM provides TSS and nutrient loads
- Hydro/sediment transport model provides transport, areal deposition/erosion and changes in bed elevation
- SFM + archival bed layering tracks G_1, G_2, G_3 POM and inorganic nutrients
- Standalone model – facilitates calibration

- SFM active layer varies in depth from 9.5-10.5 cm
- When deposition builds active layer of SFM up to 10.5 cm, one cm of mass of POM and nutrients get pushed down to the first layer of the archive, layer 1 gets pushed down to layer 2, etc.
- Erosion is the reverse of deposition -> active layer of SFM "erodes" to water column and archive layers pushed up
- G_1, G_2 continue to react in the archive layers building up inorganic nutrients
- Output – loads of G_1, G_2, G_3 POM and inorganic nutrients



Conowingo Pond Mass Balance Model

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Mass Balance

$$V\frac{dTP_{CP}}{dt} = Q_H \cdot \left(P_{org} + PO_4 + PIP\right)_H + Q_{CW} \cdot \left(P_{org} + PO_4 + PIP\right)_{CW}$$ Incoming loads

$$- v_{s1} \cdot SA \cdot (f \cdot P_{org})_{CP} - v_{s2} \cdot SA \cdot (PIP)_{CP}$$ Settling to the bed

$$\pm J_{PO4} \cdot SA$$ Flux from the bed

$$+ v_r \cdot SA \cdot (G_{1Pbed} + G_{2Pbed} + G_{3Pbed} + PO_{4bed} + PIP_{bed})$$ Erosion from the bed

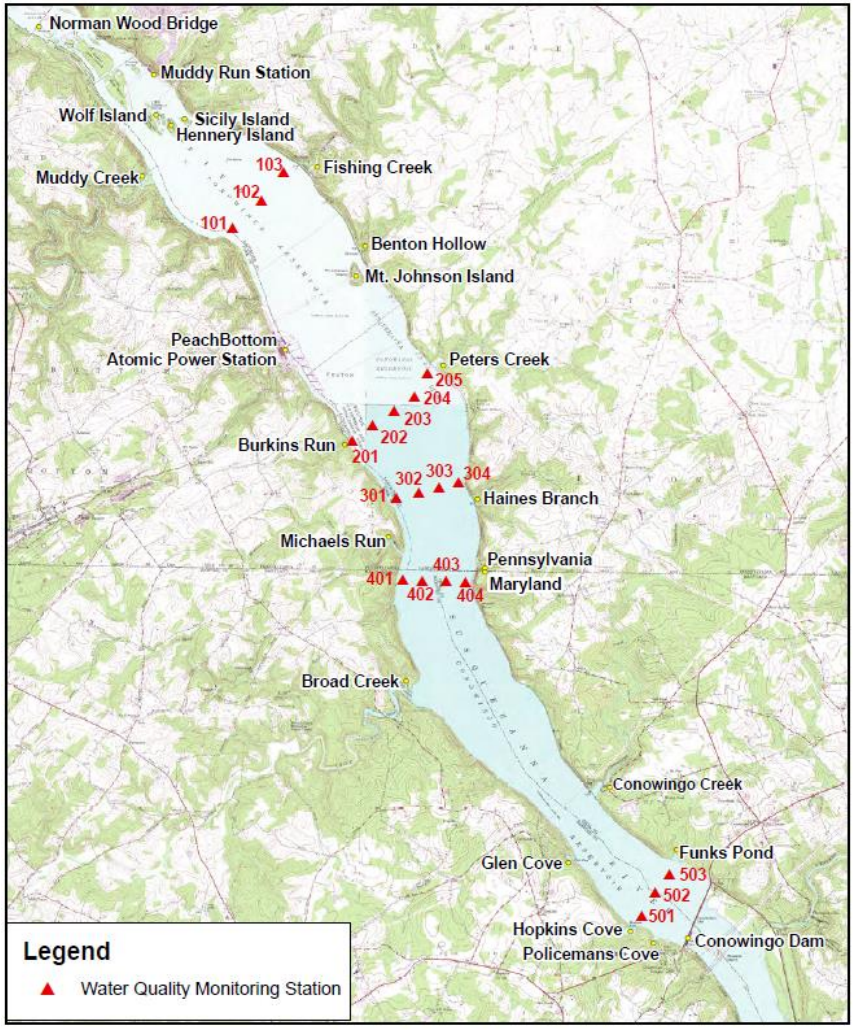
$$- Q_{H+CW} \cdot \left(P_{org} + PO_4 + PIP\right)_{CP}$$ Outflow from the dam

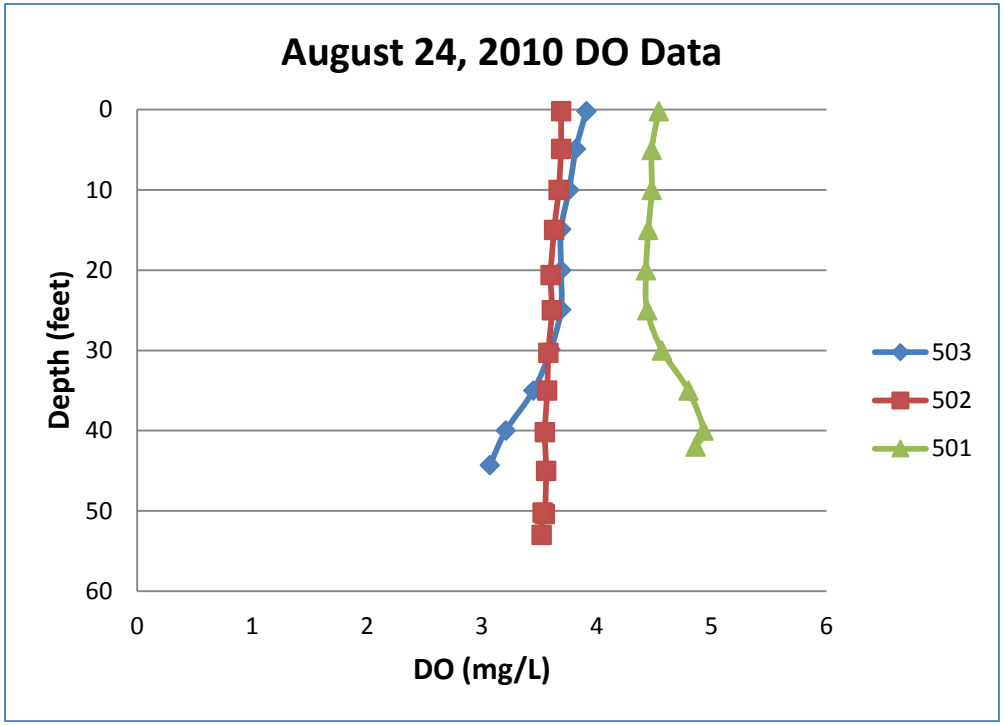
Build similar equations for nitrogen, carbon and oxygen demanding material

Conowingo Pond Mass Balance Model

Assumptions

- Utilize WSM outputs (flows, SS and nutrients)
- Apportion nutrients as currently implemented in WQSTM (ex. WSM ON => PON and DON)
- Utilize WSM Conowingo Pond computed algal biomass as a source of “labile” matter to SFM
- Utilize a Exelon 2010 study data set to specify water column DO; 5 transects with weekly depth profiles Apr-Oct


Norman Wood Bridge
Muddy Run Station
Wolf Island
Sicily Island
Hennery Island
Muddy Creek
103
Fishing Creek
102
101
Benton Hollow
Mt. Johnson Island
PeachBottom
Atomic Power Station
Peters Creek
205
204
203
202
Burkins Run
201
302
303
304
301
Haines Branch
Michaels Run
Pennsylvania
403
401
Maryland
402
404
Broad Creek
Conowingo Creek
Funks Pond
Glen Cove
503
502
501
Hopkins Cove
Policemans Cove
Conowingo Dam
Legend
Water Quality Monitoring Station


August 24, 2010 DO Data
Depth (feet)
0
10
20
30
40
50
60
0
1
2
3
4
5
6
DO (mg/L)
503
502
501

Conowingo Pond Mass Balance Model

Data/Calibration

- Hydrodynamic Model – 2010 temperature data set – 5 transects with weekly depth profiles Apr-Oct
- Sediment Transport Model - Bathymetry/bed elevation changes – USGS and Exelon surveys
- Water Quality/SFM - Current UMCES/Exelon/USGS field program (fluxes, diagenesis, settling, radionuclide dating, sediment and water chemisty)
  - Some historical data sets/modeling for qualitative calibration (Boynton et al. 1981-1984, USGS, 1991, Hamrick and Mills, 2000, etc.)

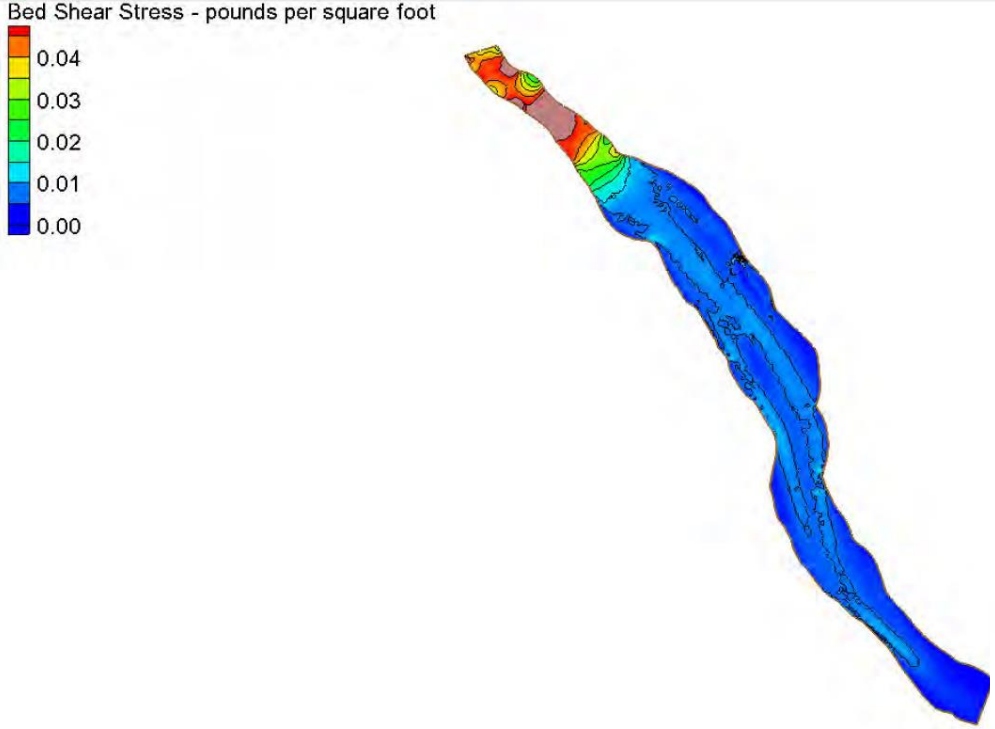


Figure 18 Conowingo Reservoir bed shear stress for a discharge of 150,000 cfs

Segmentation: laterally averaged, but may need some lateral segments in lower reservoir

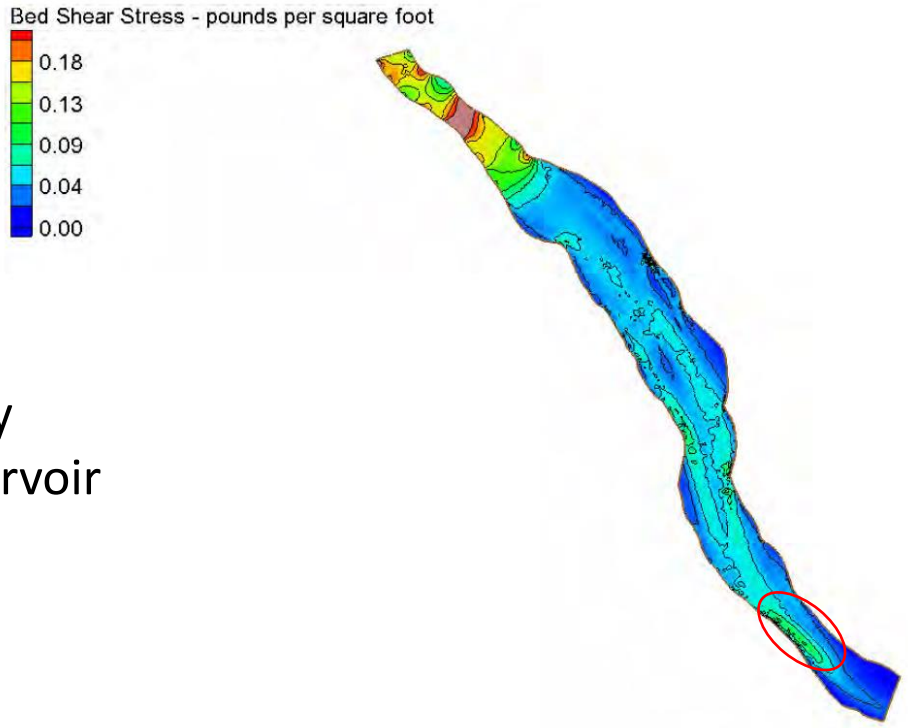
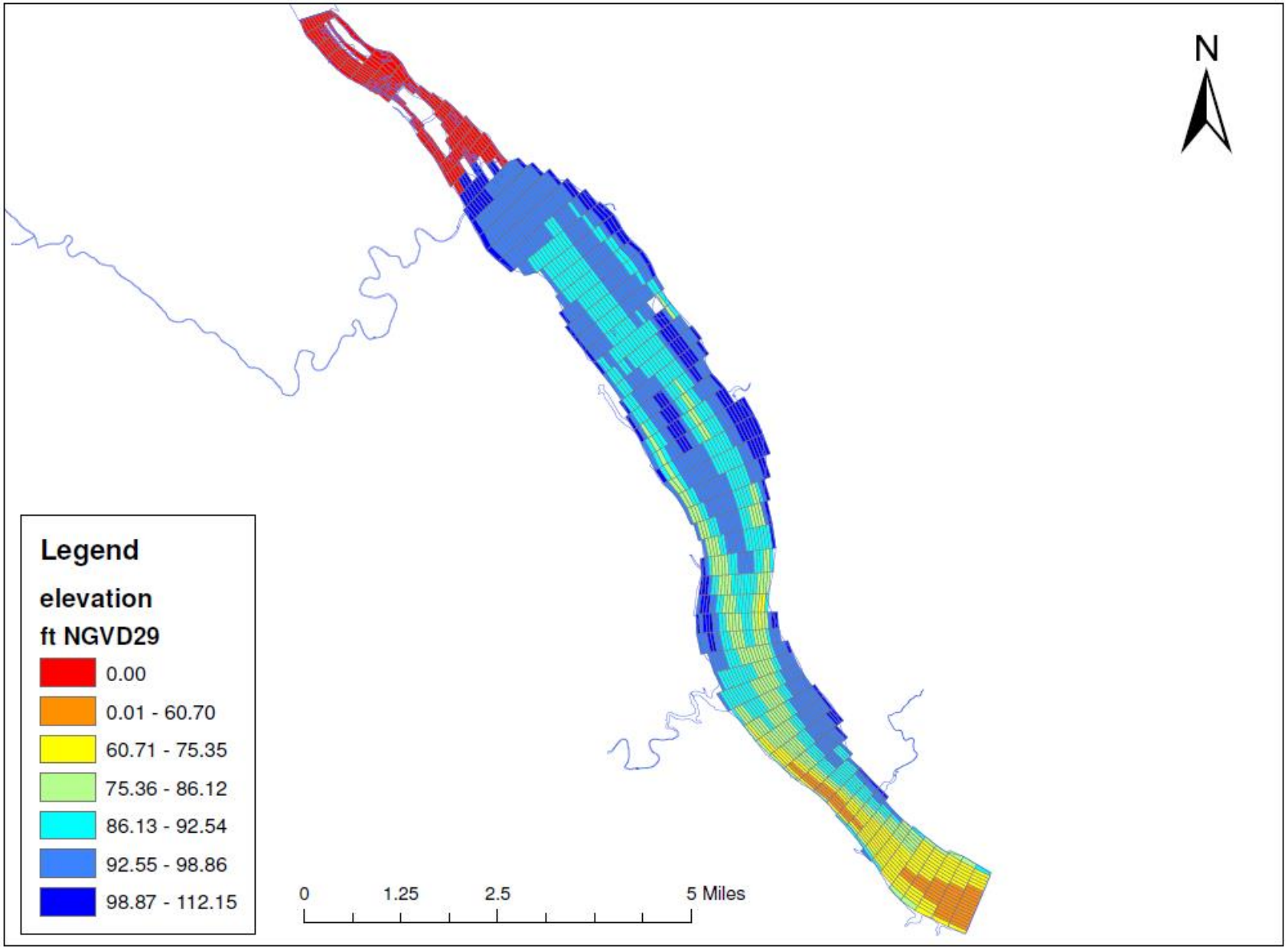


Figure 20 Conowingo Reservoir bed shear stress at a discharge of 400,000 cfs


N
Legend
elevation
ft NGVD29
0.00
0.01 - 60.70
60.71 - 75.35
75.36 - 86.12
86.13 - 92.54
92.55 - 98.86
98.87 - 112.15
0
1.25
2.5
5 Miles