Significance of Historical Changes in Bed Shear Stress On Sediment Transport Potential in Conowingo Reservoir

- Reservoir capability to store sediments is at a maximum after construction
- Over time sedimentation changes the hydrodynamics of the reservoir
- As the reservoir becomes more shallow velocities increase
- Increased velocity results in higher bed shear stress and scour potential
- Turbulence increases at lower discharges increasing sediment transport

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Bed Scour Potential

$$\tau_b = \frac{\gamma\, v^2\, n^2}{1.49^2 y^{1/3}}$$

Bed Shear Stress - force per unit area on the bed due to fluid flow

γ = Specific Weight
v = Velocity
n = Manning n Roughness Coefficient
y = Depth

Turbulence Intensity

$$U_* = \sqrt{\frac{\tau_b}{\rho}}$$

Shear Velocity - indicator of turbulence intensity

Sediment Transport Potential

$$R = \frac{w_s}{U_*}$$

Rouse Number - turbulence intensity for maintaining sediment in suspension

w_s = Sediment Fall Velocity
U_* = Shear Velocity

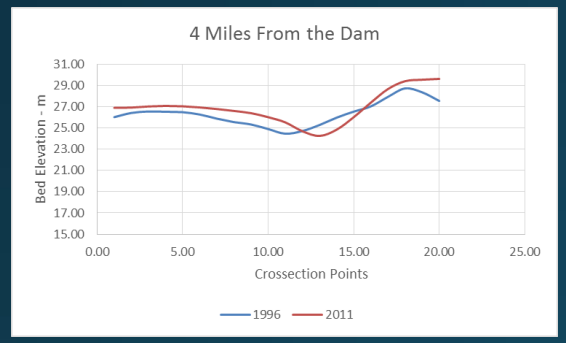
Significance of Historical Changes in Bed Shear Stress On Sediment Transport Potential in Conowingo Reservoir

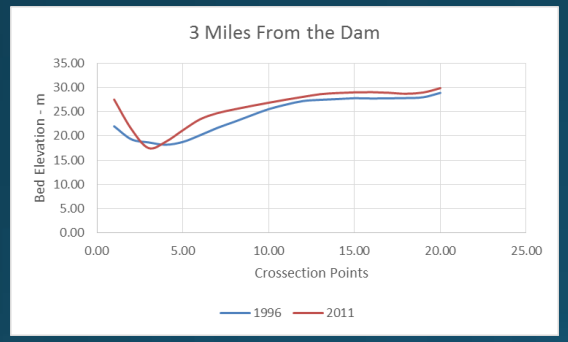
Study Goal

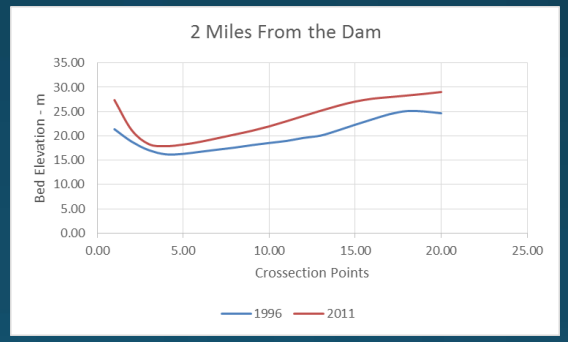
- Evaluate Changes in Bathymetry and Hydrodynamics for 1996 – 2011
- Emphasize the Lower 4 Miles of Conowingo Reservoir
- Compare Bathymetry Changes for Miles 1 – 4 From the Dam
- Simulate Hydrodynamics for Range of Flows: 300,000 – 400,000 cfs
- Use the University of Mississippi Model CCHE2D for the Simulations
- Evaluate the Changes in Velocity and Bed Shear Stress
- Present Results from AdH Calculations of Excess Sediment Load Due to Bathymetry Changes Between 1996 and 2011

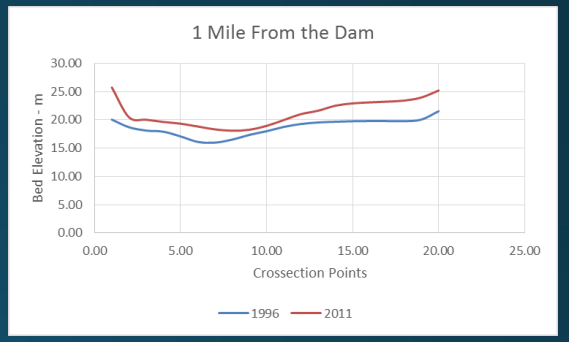
Significance of Historical Changes in Bed Shear Stress On Sediment Transport Potential in Conowingo Reservoir

Model Results: Bed Elevation Comparisons – 1996 – 2011
All Views Looking Upstream





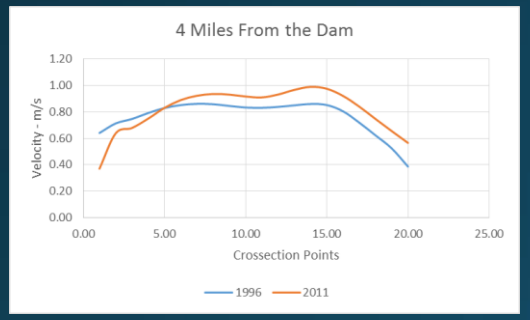


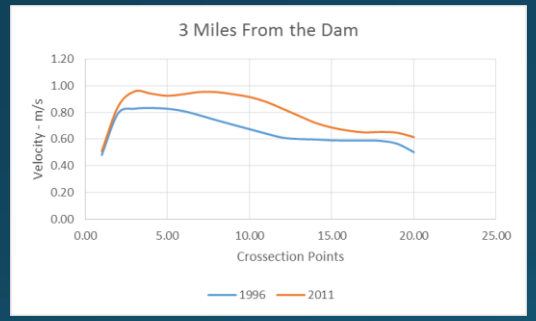


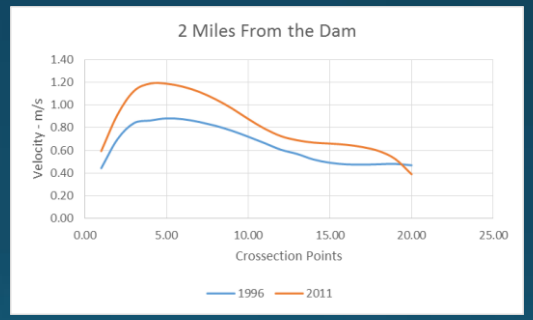
Significance of Historical Changes in Bed Shear Stress On Sediment Transport Potential in Conowingo Reservoir

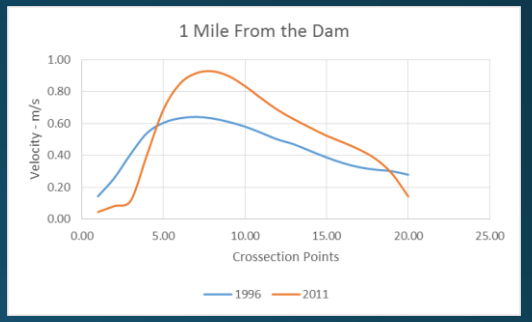
Model Results: Velocity and Bed Shear Comparisons – 1996 - 2011

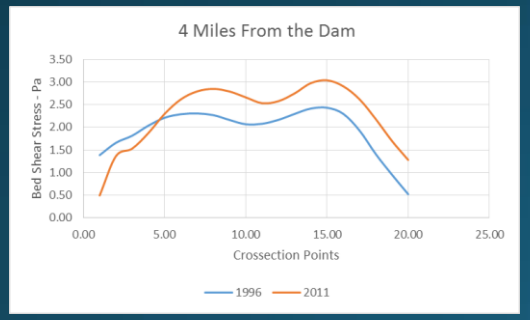
300,000 cfs

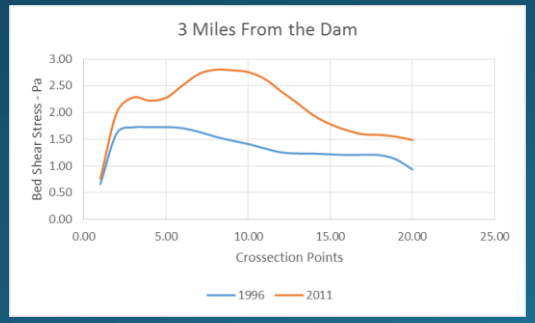


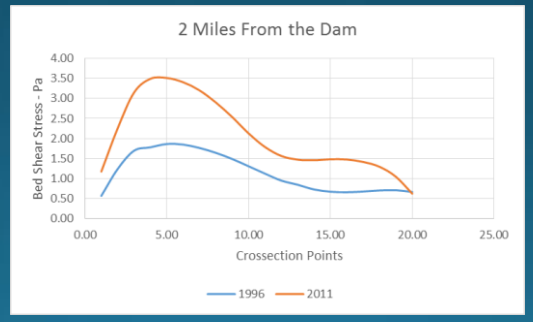


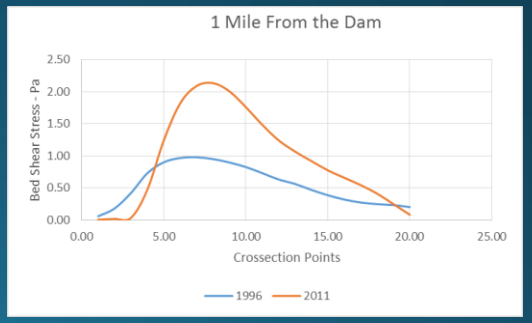








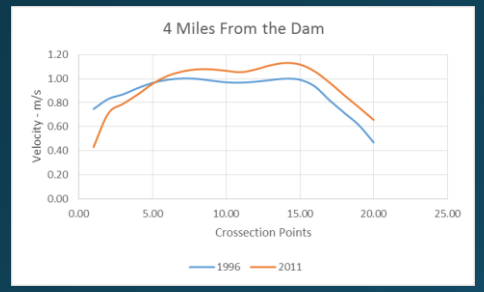


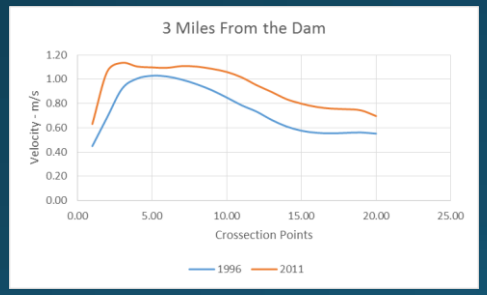


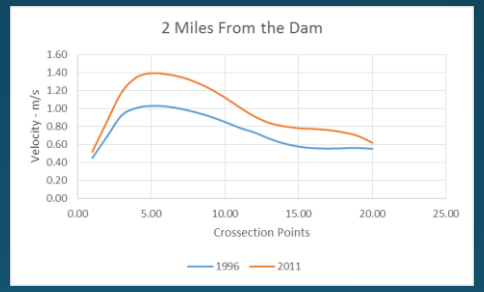
Significance of Historical Changes in Bed Shear Stress On Sediment Transport Potential in Conowingo Reservoir

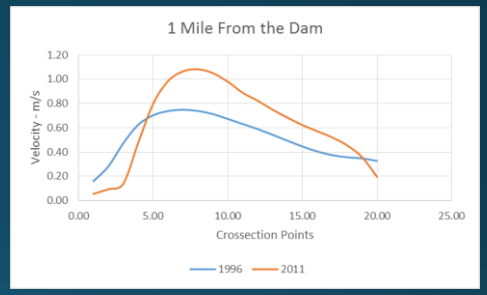
Model Results: Velocity and Bed Shear Comparisons – 1996 - 2011

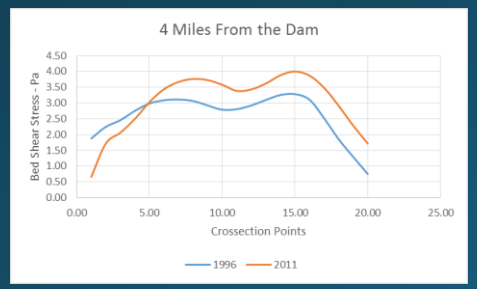
350,000 cfs

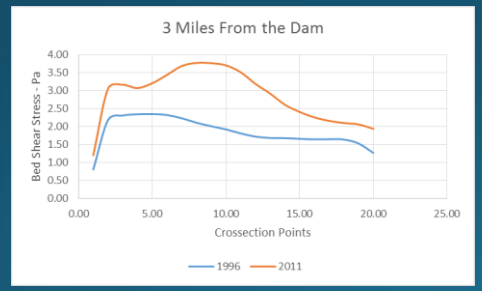


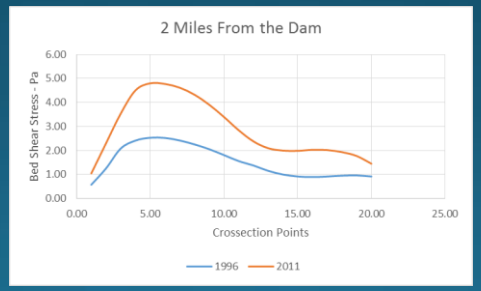


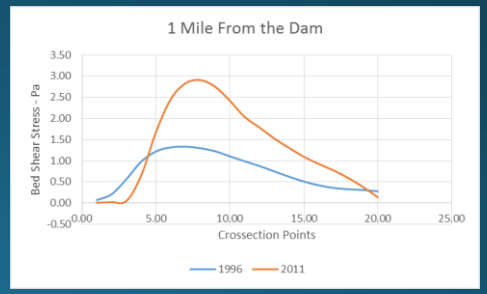








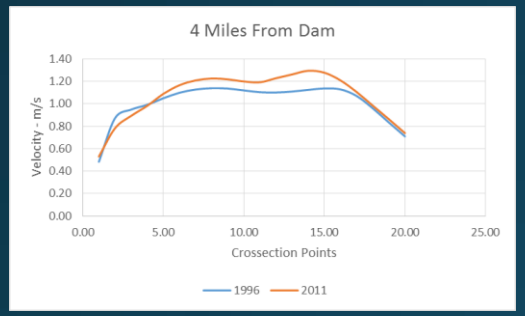


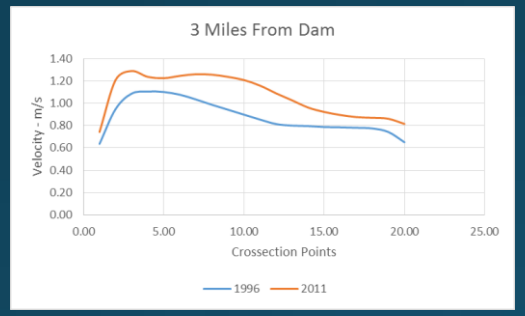


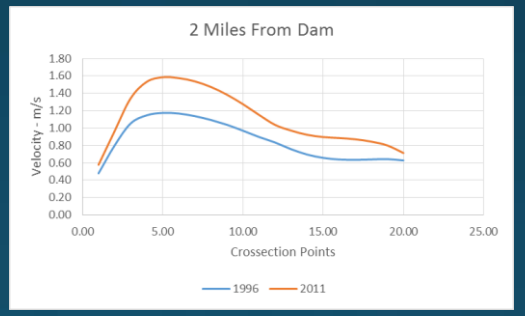
Significance of Historical Changes in Bed Shear Stress On Sediment Transport Potential in Conowingo Reservoir

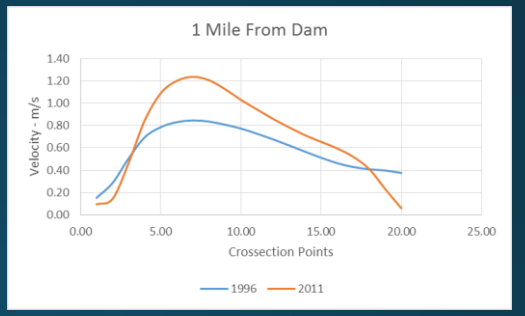
Model Results: Velocity and Bed Shear Comparisons – 1996 - 2011

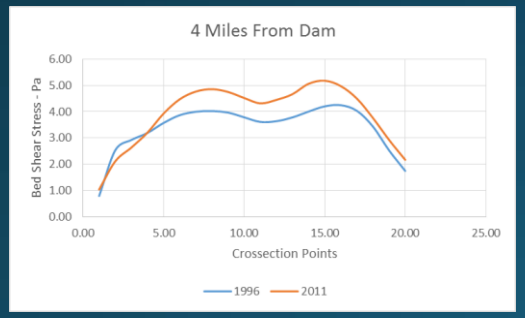
400,000 cfs

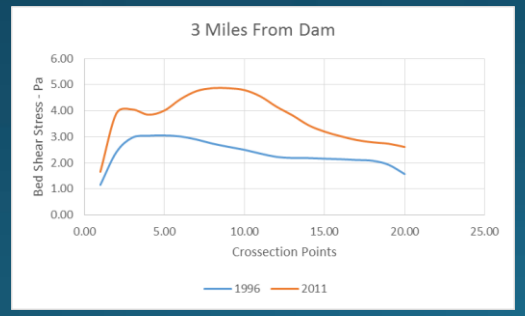


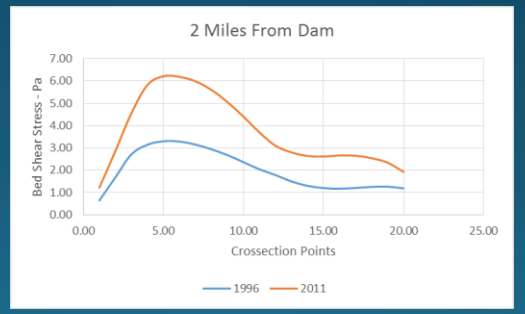


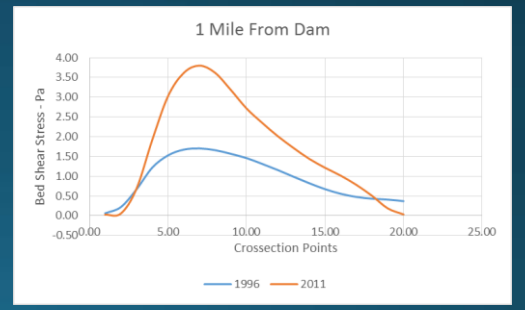












Significance of Historical Changes in Bed Shear Stress On Sediment Transport Potential in Conowingo Reservoir

AdH Simulation of Sediment Bed Scour Due to Bathymetry Change – 1996-2011 (LSRWA)

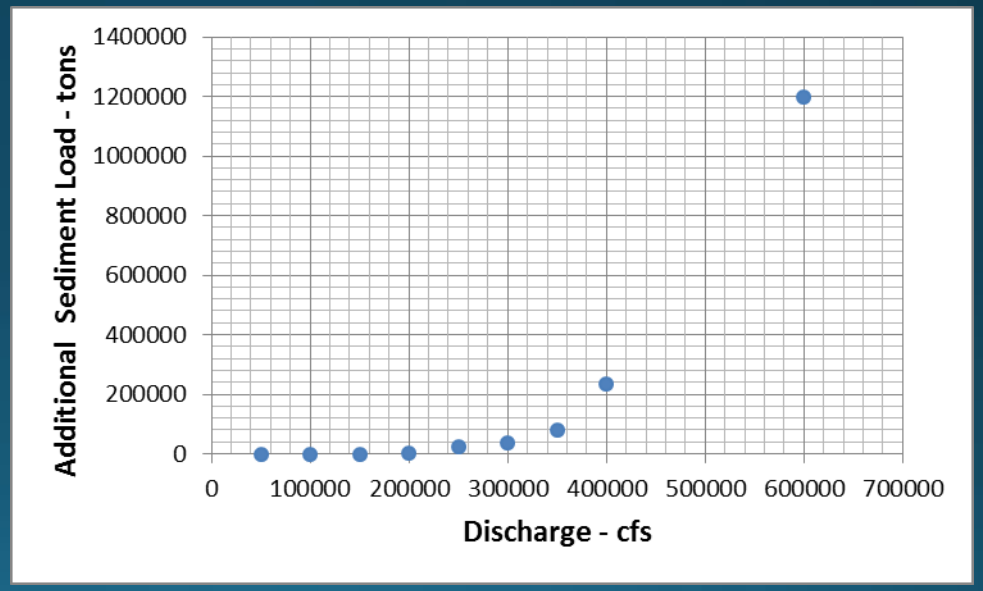
GOAL: Simulate a number of hydrographs to evaluate bed scour differences between the 1996 and 2011 bathymetries

Significance of Historical Changes in Bed Shear Stress On Sediment Transport Potential in Conowingo Reservoir

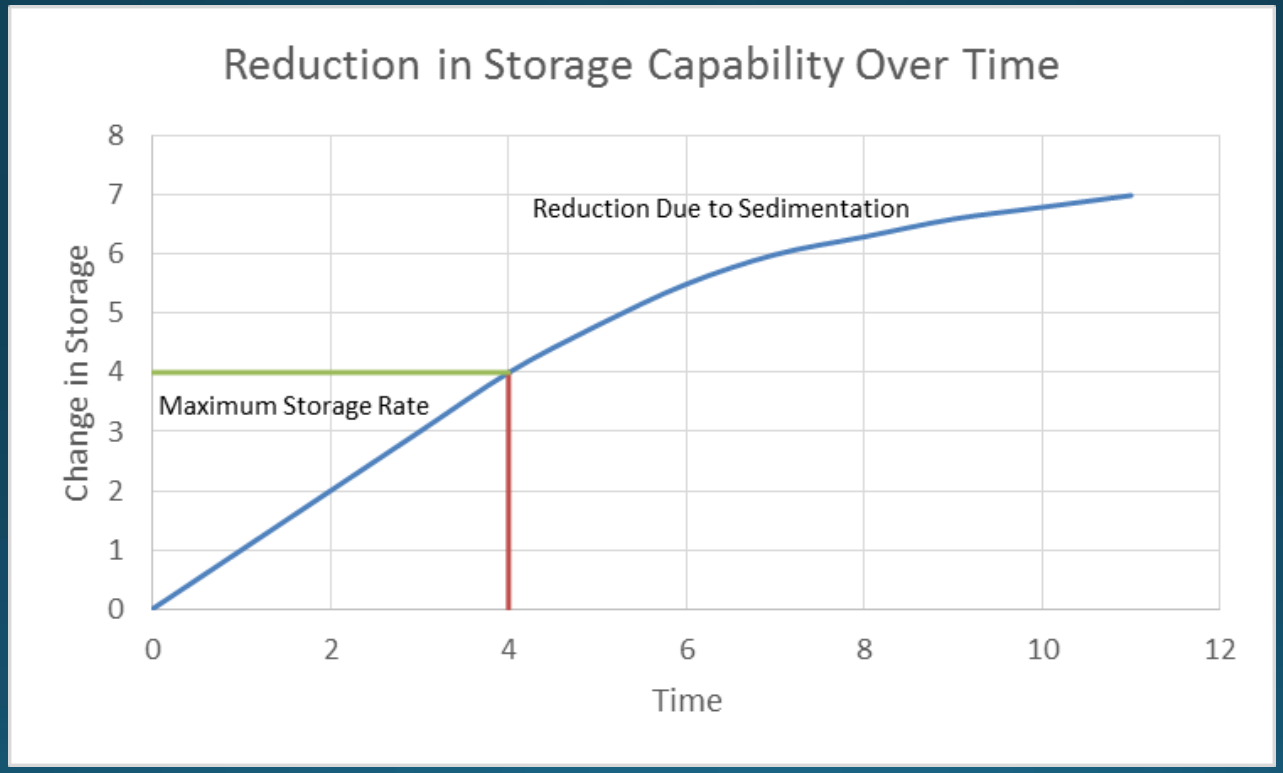
AdH Simulation of Sediment Bed Scour Due to Bathymetry Change – 1996-2011 (LSRWA)

Discharge - cfs	Sediment Load - tons
50000	0
100000	0
150000	74
200000	3,008
250000	21,957
300000	34,814
350000	79,194
400000	233,804
*600000	1,200,000

Note: Additional sediment load is ~ 5% of total hydrograph load passed below Conowingo Dam



Significance of Historical Changes in Bed Shear Stress On Sediment Transport Potential in Conowingo Reservoir



Significance of Historical Changes in Bed Shear Stress On Sediment Transport Potential in Conowingo Reservoir

Conclusions

- The trapping efficiency of Conowingo Reservoir is reduced due to sedimentation
- Decreased reservoir depth results in increased flow velocity and bed shear stress
- Sediment erosion, entrainment, and transport is potentially increasing for a given discharge
- A quasi-equilibrium condition exists in the reservoir with storage temporarily increased by large storms