**LOWER SUSQUEHANNA RIVER WATERSHED ASSESSMENT**
**QUARTERLY TEAM MEETING**

**MDE Aqua Conference Room, Baltimore, Maryland**
**August 15, 2013**

**Meeting Agenda**

**Lead**

10:00 Welcome and Introductions ........................................ All

10:05 Review of Action Items from Prior Meetings ........................................ O'Neill
Funding Update
Communication and Coordination Updates for Situational Awareness

10:20 Conowingo Re-licensing Update ........................................ Michael

LSRWA Technical Analyses
10:30 Update on Reservoir Sediment Management Strategies – Costs ........................................ O'Neill/Laczo

10:45 Watershed Sediment Management Strategies ........................................ Michael

10:55 Reservoir Transport ........................................ Langland

11:10 Sediment Management Modeling – one-time 3Mcy removal, 26Mcy removal (1996 bathymetry), intermediate removal volume, bypassing
11:10 Sediment Transport Results ........................................ Scott
Sediment Management
Bypassing
Model Summary

11:40 Water Quality Results ........................................ Cerco

12:10 What Does All This Mean? Stoplight Plots ........................................ Linker/Cerco

12:40 Future Modeling Scenarios ........................................ Compton

12:45 Meeting Wrap-Up ........................................ O'Neill
Schedule Ahead
Action Items/Summary
Review of Team Calendar
Next Meeting

**Call-In Information**: (877) 336-1839, access code = 6452843#, security code = 1234#

**Expected Attendees:**

MDE: Herb Sachs; Tim Fox, Matt Rowe
MDNR: Bruce Michael, Bob Sadzinski, Shawn Seaman
MGS: Rich Ortt
SRBC: John Balay, Andrew Gavin, Dave Ladd
USACE: Anna Compton, Bob Blama, Chris Spaur, Claire O'Neill, Tom Laczo, Dan Bierly
ERDC: Carl Cerco, Steve Scott
TNC: Mark Bryer, Kathy Boomer
USEPA: Gary Shenk, Lewis Linker
USGS: Mike Langland, Joel Blomquist
NOAA: Chris Boelke
Exelon: Mary Helen Marsh, Kimberly Long, Gary LeMay
Lower Susquehanna Riverkeeper: Michael Helfrich
PA Agencies: Patricia Buckley, Raymond Zomok

Action Items from Previous Meetings:

a. Michael Helfrich will forward info to Danielle Aloisio on Funkhauser Quarry. *Status: Completed. No point of contact is available due to abandoned condition, but see response to "d" below.*
b. Claire will coordinate the next quarterly meeting for August 2013. *Status: Complete. Meeting was scheduled for 15 August 2013.*
c. Anna will distribute NMFS agency letter discussing concerns over sediment bypassing management strategy to group and have it posted on website. *Status: Complete.*
d. Bob Blama will call the Funkhauser Quarry to get more information on utilizing this as a placement option. *Status: Completed. While no POC was provided, USACE did some preliminary calculations; volume is very limited (only 3 million cubic yards) and access to the quarry is a big concern. Spreadsheet for potential alternatives is being updated.*
e. Michael Helfrich will touch base with Jeff Cornwell (UMCES) to get his opinion on phosphorus bioavailability in sediments as it relates to the LSRWA study. *Status: Complete. Chris Spaur to update the group at the meeting.*
f. The group will review the baseline and future conditions summary spreadsheet (Enclosure 3) and provide comments back to Anna Compton and Carl Cerco. *Status: Complete. Anna Compton to update the group at the meeting.*
g. Lewis Linker and Carl Cerco will work with CBP partners to integrate the CBP's assessment procedure ("Stoplight plots") into the LSRWA key modeling scenarios to provide a means to communicate/explain impacts to Chesapeake Bay from the various full reservoir and storm scouring scenarios. *Status: Ongoing. Discussion item for August meeting.*
h. The LSRWA agency group will develop a screening process for reservoir sediment management options that are worth developing further. *Status: Ongoing. Once we get the modeling outputs, screening process can be further refined and lead to recommendations.*
i. The LSRWA agency group will direct any questions on sediment bypass tunneling to Kathy Boomer. *Status: Complete.*
j. Kathy Boomer will write up a section on sediment bypass tunneling for the LSRWA report. *Status: Complete.*
k. Exelon will review and provide comments on SRBC's write-up of altering reservoir operations as a sediment management strategy (Enclosure 9). Exelon will comment on the write-up to make sure dam operations are adequately covered. *Status: Ongoing. SRBC to update at the meeting.*

<u>Ongoing Action Items from Previous Meetings</u>:

A. The MDE FTP website will be utilized to share internal draft documents within the team; Matt will be the point of contact for this FTP site. *Status: Ongoing. Sharing of future documents will go through the MDE ftp website.*

B. Shawn will notify team when most recent Exelon study reports are released. *Status: Ongoing. Tom Sullivan, a contractor of Exelon noted that the Exelon has filed the license for Conowingo Dam with FERC.*

C. Anna will update PowerPoint slides after each quarterly meeting to be utilized by anyone on the team providing updates to other Chesapeake Bay groups. *Status: Ongoing.*

D. Anna will send out an update via the large email distribution list that started with the original Sediment Task Force (includes academia, general public, federal, non-government organization (NGO), and state and counties representatives) notifying the group of updates from the quarterly meeting. *Status: Ongoing.*

E. Matt will keep team informed on innovative re-use committee findings to potentially incorporate ideas/innovative techniques into LSRWA strategies. *Status: Ongoing.*

F. Anna will send out the spreadsheet tracking all stakeholder coordination to the group. Anyone making a presentation on LSRWA should let her know so the spreadsheet can be kept up to date; if any specific comments/concerns are raised, this should be noted as well. *Status: Ongoing*

*G.* Bruce Michael will work with CBP on potential "no-till" acres available in the watershed and evaluate impacts to sediment loads if all no-till acres were implemented in the watershed via modeling as well as develop costs. *Status: Ongoing. Bruce Michael to update the group at the meeting.*

H. Carl Cerco, Steve Scott and Lewis Linker will work together to determine where nutrients are scoured from in the reservoir (at what depths) and will conduct a sensitivity analysis looking at bioavailability of nutrients in various forms (species) by Berner activity class or other means). *Status: Ongoing.*

*I.* Modeling efforts cannot predict impacts to SAV from physical burial by sediments. These impacts should be considered and described by other means, perhaps qualitatively, by the LSRWA agency group. *Status: Ongoing. Bruce Michael has provided the UMCES (Mike Kemp) SAV historical mapping and trends over last 10 years in Susquehanna Flats. This information will need to be incorporated into to the assessment to provide a qualitative discussion of impacts.*

*J.* The LSRWA agency group needs to determine next steps for developing reservoir sediment management options. *Status: Completed. Representative alternatives identified for costs; some alternatives identified for transport/WQ modeling; results to be discussed at the August meeting.*

*K.* The LSRWA agency group should quantify any habitat restored or enhanced downstream in the Bay or elsewhere (e.g., terrestrial) as a project benefit; considerations should be given on how to do this. *Status: Ongoing. But opportunities for quantification are very limited.*

*L.* Bruce Michael and Claire O'Neill will keep the LSRWA agency group updated on the Susquehanna policy group put together by Governor O'Malley. *Status: Ongoing.*

# PRELIMINARY INFORMATION -- NOT FOR PUBLIC RELEASE

**Lower Susquehanna River Watershed Assessment**
**Summary of Representative Sediment Management Alternatives**

| | Innovative Reuse | Open Water Placement | | | Upland Placement | | | | Watershed Management |
|---|---|---|---|---|---|---|---|---|---|
| | Alternative 1 | Alternative 2A | Alternative 2B | Alternative 2C | Alternative 3A | Alternative 3B | Alternative 3C | Alternative 3D | Alternative 4 |
| **Physical Description** | | | | | | | | | |
| Sediment to be removed, cubic yards | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 |
| Sediment to be removed, tons | 810,000 | 810,000 | 810,000 | 810,000 | 810,000 | 810,000 | 810,000 | 810,000 | 810,000 |
| Type of dredging | Hydraulic | Hydraulic | Hydraulic | Hydraulic | Hydraulic | Mechanical | Hydraulic | Hydraulic | N/A |
| Transportation method | Pipeline | Pipeline + barge | Pipeline | Pipeline | Pipeline | Barge + transfer + trucking | Pipeline + dike + trucking | Pipeline + discharge pipe | N/A |
| Distance to be transported, miles | 10 | 8+32 | 3 | 3 | 13 | 0+0+14 | 3+0+12 | 14 + 4 | N/A |
| Location/type of containment site | Bainbridge, slurry screened, water returned, solids stockpiled | Drying/transfer site near Susquehanna State Park, with dike construction | N/A | N/A | Will need dike construction at quarry for dewatering to extend project life | Shoreline transfer site | Nearby drying site required with dike construction | Will need dike construction at quarry for dewatering to extend project life | N/A |
| Final destination of material | Concrete block market | Pooles Island | Susquehanna River, approximately 1 mile d/s of Conowingo Dam | Susquehanna River, approximately 1 mile d/s of Conowingo Dam | Stancills Quarry | Mason-Dixon Quarry (Belvidere site) | Mason-Dixon Quarry (Belvidere site) | Mason-Dixon Quarry (Belvidere site) | N/A |
| Number of dredging cycles that facility could be used before capacity is reached | Facility has a useful life of more than 40 years | Unknown, due to local sediment transport | No limitation | No limitation | 5 | 29 | 23 | 23 | |
| Land to be purchased, acres | 100 | 420 | 1-2 | 1-2 | 2-5 | 15 | 420 | 2-5 | N/A |
| **Production Calculations** | | | | | | | | | |
| Volume to be removed, cubic yards | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 | 1,000,000 | |
| Volume in pipeline, cubic yards | 4,000,000 | 4,000,000 | 4,000,000 | 4,000,000 | 4,000,000 | N/A | 4,000,000 | 4,000,000 | N/A |
| Volume to be disposed of, cubic yards | N/A | 1,500,000 | N/A | N/A | 1,500,000 | 1,200,000 | 1,500,000 | 1,500,000 | N/A |
| Number of dredges | 1 | 1 | 3 | 2 | 1 | 8 | 1 | 1 | N/A |
| Number of pipelines | 1 | 1 | 3 | 2 | 1 | 0 | 1 | 1 | N/A |
| Number of barge loads per day | N/A | 2 | N/A | N/A | N/A | 10 | N/A | N/A | N/A |
| Number of truck loads per day | N/A | N/A | N/A | N/A | N/A | 400 | 500 | N/A | N/A |
| Dike volume, cubic yards | N/A | 140,000 | N/A | N/A | 140,000 | N/A | 140,000 | 140,000 | N/A |
| Booster pumps required | 9 | 7 | 6 | 4 | 12 | 0 | 2 | 14 | N/A |
| Months of operation | Year-round | Year-round | October-February (5 months) | July-March (9 months) | Year-round | Year-round | Year-round | Year-round | N/A |
| Actual operational time, days per year | 330 | 250 | 83 | 125 | 250 | 250 | 250 | 250 | N/A |
| Total sediment removal capacity, cubic yards per day | 4,000 | 4,000 | 12,000 | 8,000 | 4,000 | 4,000 | 4,000 | 4,000 | N/A |

| | Alt 1 Low | Alt 1 High | Alt 2A Low | Alt 2A High | Alt 2B Low | Alt 2B High | Alt 2C Low | Alt 2C High | Alt 3A Low | Alt 3A High | Alt 3B Low | Alt 3B High | Alt 3C Low | Alt 3C High | Alt 3D Low | Alt 3D High | Alt 4 Low | Alt 4 High |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **One-Time Investment Costs** | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High |
| Real estate/land purchase | All costs included in Harbor Rock annual removal cost ??? | | $4,200,000 | $8,400,000 | $10,000 | $40,000 | $10,000 | $40,000 | $20,000 | $100,000 | $150,000 | $300,000 | $4,200,000 | $8,400,000 | $20,000 | $100,000 | May need to add some lines to account for management activities | |
| Design and study costs | | | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | | |
| Booster pump construction | | | $2,100,000 | $2,100,000 | $1,800,000 | $1,800,000 | $1,200,000 | $1,200,000 | $3,600,000 | $3,600,000 | $0 | $0 | $600,000 | $600,000 | $4,200,000 | $4,200,000 | | |
| Permanent pipeline construction | | | $1,300,000 | $2,100,000 | $1,400,000 | $2,300,000 | $1,000,000 | $1,600,000 | $2,100,000 | $3,400,000 | $0 | $0 | $500,000 | $800,000 | $2,900,000 | $4,700,000 | | |
| Transfer site/dike construction | | | $1,100,000 | $2,200,000 | $0 | $0 | $0 | $0 | $1,100,000 | $2,200,000 | $0 | $0 | $1,100,000 | $2,200,000 | $1,100,000 | $2,200,000 | | |
| Reuse manufacturing plant | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | |
| Subtotal | $0 | $0 | $10,700,000 | $19,800,000 | $5,210,000 | $9,140,000 | $4,210,000 | $7,840,000 | $8,820,000 | $14,300,000 | $2,150,000 | $5,300,000 | $8,400,000 | $17,000,000 | $10,220,000 | $16,200,000 | $0 | $0 |
| Annualized, $/year | $0 | $0 | $477,000 | $883,000 | $232,000 | $407,000 | $188,000 | $349,000 | $393,000 | $637,000 | $96,000 | $236,000 | $374,000 | $758,000 | $456,000 | $722,000 | $0 | $0 |
| **O&M/Removal Costs** | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High |
| Tipping fee | | | $0 | $0 | $0 | $0 | $0 | $0 | $1,500,000 | $7,500,000 | $12,000,000 | $18,000,000 | $15,000,000 | $22,500,000 | $15,000,000 | $22,500,000 | May need to add some lines to account for management activities | |
| Dredging + transportation | $0 | $0 | $15,000,000 | $20,000,000 | $10,000,000 | $15,000,000 | $5,000,000 | $10,000,000 | $20,000,000 | $25,000,000 | $40,000,000 | $70,000,000 | $20,000,000 | $30,000,000 | $20,000,000 | $25,000,000 | | |
| Manufacturing processing | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | |
| Construction design and management | $0 | $0 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | | |
| Subtotal | $0 | $0 | $16,000,000 | $22,000,000 | $11,000,000 | $17,000,000 | $6,000,000 | $12,000,000 | $22,500,000 | $34,500,000 | $53,000,000 | $90,000,000 | $36,000,000 | $54,500,000 | $36,000,000 | $49,500,000 | $0 | $0 |
| **Cost per Cubic Yard (assumes yearly removal)** | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High |
| One-time investment cost, $/cy | $0 | $0 | $11 | $20 | $5 | $9 | $4 | $8 | $9 | $14 | $2 | $5 | $8 | $17 | $10 | $16 | $0 | $0 |
| Annualized investment cost, $/cy/year | $0 | $0 | $0 | $1 | $0 | $0 | $0 | $0 | $0 | $1 | $0 | $0 | $0 | $1 | $0 | $1 | $0 | $0 |
| Annual removal cost, $/cy/year | $0 | $0 | $16 | $22 | $11 | $17 | $6 | $12 | $23 | $35 | $53 | $90 | $36 | $55 | $36 | $50 | $0 | $0 |
| Total annual cost, $/cy/year | $0 | $0 | $16 | $23 | $11 | $17 | $6 | $12 | $23 | $35 | $53 | $90 | $36 | $55 | $36 | $50 | $0 | $0 |

| | Alternative 1 | Alternative 2A | Alternative 2B | Alternative 2C | Alternative 3A | Alternative 3B | Alternative 3C | Alternative 3D | Alternative 4 |
|---|---|---|---|---|---|---|---|---|---|
| **Major Limitations** | | Currently not allowed by law; large parcels adjacent to the river may be very difficult to find | Environmental impacts; NMFS concerns | Environmental impacts; NMFS concerns | | Large parcels adjacent to the reservoir may be difficult to find | Large parcels expected to be difficult to find nearby | Effluent from dewatering will need to be pumped back to the Susquehanna River | |

**General Assumptions:**

**These are concept-level costs for planning purposes only. Detailed design and cost estimate would be required for any future studies investigation implementation of any of these alternatives.**
**All alternatives assume the dredging of a location in Conowingo Reservoir which currently has the highest amounts of deposition in the entire lower Susquehanna reservoir system; similar costs could be developed for the other lower Susquehanna**

**Technical Assumptions:**

Real estate cost = farmland cost in Harford/Cecil County, MD; range of cost = $10,000 to $20,000 per acre; based on Internet search of agricultural land June 2013; assume large tracts of land available.
Annualization factor = 22.434 for interest = 3.750% and project life of 50 years Rounding factor for annualization = 3
Each hydraulic dredge has its own separate pipeline and associated booster pump system, with a production capacity of 4,000 cubic yards per day; cost per booster pump = $300,000
Hydraulic dredging process will add a signficant amount of volume to the pipeline; assume pipeline will contain 4 times the dredging volume.
Drying process will be able to remove a signficant amount of the water that is pumped in with the dredged material; assume that material to be transported after drying is 1.5 times the original dredging volume.
Production capacity for one mechanical dredge = 500 cubic yards per day; material volume is increased by 20%, a factor of 1.2 (compared to original dredged volume), during dredging process
Barge capacity varies; for transport to Pooles Island, each barge is expected to hold 2,500 cubic yards; for in-reservoir dredging, the capacity would be much smaller, only 500 cubic yards/barge.
Permanent pipeline cost = $160,000 to $260,000 per mile ($30-50 per linear foot).
Transfer site/dike construction cost = 5-foot high dike for 3 feet of material, assume 2 cycles per year, $8-16/cy construction cost
Tipping fee for Stancils Quarry is assumed to be $1-5/cy with a total volume available of 9Mcy; tipping fee for Mason-Dixon Quarry is based on $10-15/cy and a total volume available of 35Mcy; the tipping fees are applied to the dredged amount for pipeline delivery and to the trucked amount for truck delivery; outright purchase of quarry could be another option to tipping fees.
Universal conversion factor; 1 cubic yard of dredged material = 0.81 tons of sediment based on bulk density value of 1600 kilograms/meter$^3$.

**Lower Susquehanna River Watershed Assessment**
**Summary of Representative Sediment Management Alternatives**

| | Innovative Reuse | Open Water Placement | | | Upland Placement | | | | Watershed Management |
|---|---|---|---|---|---|---|---|---|---|
| | Alternative 1 | Alternative 2A | Alternative 2B | Alternative 2C | Alternative 3A | Alternative 3B | Alternative 3C | Alternative 3D | Alternative 4 |
| **Physical Description** | | | | | | | | | |
| Sediment to be removed, cubic yards | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 |
| Sediment to be removed, tons | 2,430,000 | 2,430,000 | 2,430,000 | 2,430,000 | 2,430,000 | 2,430,000 | 2,430,000 | 2,430,000 | 2,430,000 |
| Type of dredging | Hydraulic | Hydraulic | Hydraulic | Hydraulic | Hydraulic | Mechanical | Hydraulic | Hydraulic | N/A |
| Transportation method | Pipeline | Pipeline + barge | Pipeline | Pipeline | Pipeline | Barge + transfer + trucking | Pipeline + dike + trucking | Pipeline + discharge pipe | N/A |
| Distance to be transported, miles | 10 | 8+32 | 3 | 3 | 13 | 0+0+14 | 3+0+12 | 14 + 4 | N/A |
| Location/type of containment site | Bainbridge, slurry screened, water returned, solids stockpiled | Drying/transfer site near Susquehanna State Park, with dike construction | N/A | N/A | Will need dike construction at quarry for dewatering to extend project life | Shoreline transfer site | Nearby drying site required with dike construction | Will need dike construction at quarry for dewatering to extend project life | N/A |
| Final destination of material | Concrete block market | Pooles Island | Susquehanna River, approximately 1 mile d/s of Conowingo Dam | Susquehanna River, approximately 1 mile d/s of Conowingo Dam | Stancills Quarry | Mason-Dixon Quarry | Mason-Dixon Quarry | Mason-Dixon Quarry (Belvidere site) | N/A |
| Number of dredging cycles that facility could be used before capacity is reached | Facility has a useful life of more than 40 years | Unknown, due to local sediment transport | No limitation | No limitation | 2 | 10 | 8 | 8 | |
| Land to be purchased, acres | 100 | 1,250 | 1-2 | 1-2 | 2-5 | 44 | 1,250 | 2-5 | N/A |
| **Production Calculations** | | | | | | | | | |
| Volume to be removed, cubic yards | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | N/A |
| Volume in pipeline (4X), cubic yards | 12,000,000 | 12,000,000 | 12,000,000 | 12,000,000 | 12,000,000 | N/A | 12,000,000 | 12,000,000 | N/A |
| Volume to be disposed of, cubic yards | N/A | 4,500,000 | N/A | N/A | 4,500,000 | 3,600,000 | 4,500,000 | 4,500,000 | N/A |
| Number of dredges | 1 | 3 | 8 | 4 | 3 | 24 | 3 | 3 | N/A |
| Number of pipelines | 1 | 3 | 8 | 4 | 3 | 0 | 3 | 3 | N/A |
| Number of barge loads per day | N/A | 7 | N/A | N/A | N/A | 29 | N/A | N/A | N/A |
| Number of truck loads per day | N/A | N/A | N/A | N/A | N/A | 1,200 | 1,500 | N/A | N/A |
| Dike volume, cubic yards | N/A | 420,000 | N/A | N/A | 420,000 | N/A | 420,000 | 420,000 | N/A |
| Booster pumps required | 9 | 21 | 16 | 8 | 36 | 0 | 6 | 42 | N/A |
| Months of operation | Year-round | Year-round | October-February (5 months) | July-March (9 months) | Year-round | Year-round | Year-round | Year-round | N/A |
| Actual operational time, days per year | 330 | 250 | 94 | 188 | 250 | 250 | 250 | 250 | N/A |
| Total sediment removal capacity, cubic yards per day | 4,000 | 12,000 | 32,000 | 16,000 | 12,000 | 12,000 | 12,000 | 12,000 | N/A |

| | Alt 1 Low | Alt 1 High | Alt 2A Low | Alt 2A High | Alt 2B Low | Alt 2B High | Alt 2C Low | Alt 2C High | Alt 3A Low | Alt 3A High | Alt 3B Low | Alt 3B High | Alt 3C Low | Alt 3C High | Alt 3D Low | Alt 3D High | Alt 4 Low | Alt 4 High |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **One-Time Investment Costs** | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High |
| Real estate/land purchase | All costs included in Harbor Rock annual removal cost ??? | | $12,500,000 | $25,000,000 | $10,000 | $40,000 | $10,000 | $40,000 | $20,000 | $100,000 | $440,000 | $880,000 | $12,500,000 | $25,000,000 | $20,000 | $100,000 | May need to add some lines to account for management activities | |
| Design and study costs | | | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | | |
| Booster pump construction | | | $6,300,000 | $6,300,000 | $4,800,000 | $4,800,000 | $2,400,000 | $2,400,000 | $10,800,000 | $10,800,000 | $0 | $0 | $1,800,000 | $1,800,000 | $12,600,000 | $12,600,000 | | |
| Permanent pipeline construction | | | $3,800,000 | $6,200,000 | $3,800,000 | $6,200,000 | $1,900,000 | $3,100,000 | $6,200,000 | $10,100,000 | $0 | $0 | $1,400,000 | $2,300,000 | $8,600,000 | $14,000,000 | | |
| Transfer site/dike construction | | | $3,400,000 | $6,700,000 | $0 | $0 | $0 | $0 | $3,400,000 | $6,700,000 | $0 | $0 | $3,400,000 | $6,700,000 | $3,400,000 | $6,700,000 | | |
| Reuse manufacturing plant | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | |
| Subtotal | $0 | $0 | $28,000,000 | $49,200,000 | $10,610,000 | $16,040,000 | $6,310,000 | $10,540,000 | $22,420,000 | $32,700,000 | $2,440,000 | $5,880,000 | $21,100,000 | $40,800,000 | $26,620,000 | $38,400,000 | $0 | $0 |
| Annualized, $/year | $0 | $0 | $1,248,000 | $2,193,000 | $473,000 | $715,000 | $281,000 | $470,000 | $999,000 | $1,458,000 | $109,000 | $262,000 | $941,000 | $1,819,000 | $1,187,000 | $1,712,000 | $0 | $0 |
| **O&M/Removal Costs** | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High |
| Tipping fee | | | $0 | $0 | $0 | $0 | $0 | $0 | $4,500,000 | $22,500,000 | $36,000,000 | $54,000,000 | $45,000,000 | $67,500,000 | $45,000,000 | $67,500,000 | May need to add some lines to account for management activities | |
| Dredging + transportation | $0 | $0 | $45,000,000 | $60,000,000 | $30,000,000 | $45,000,000 | $15,000,000 | $30,000,000 | $60,000,000 | $75,000,000 | $120,000,000 | $210,000,000 | $60,000,000 | $90,000,000 | $60,000,000 | $75,000,000 | | |
| Manufacturing processing | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | |
| Construction design and management | $0 | $0 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | | |
| Subtotal | $0 | $0 | $46,000,000 | $62,000,000 | $31,000,000 | $47,000,000 | $16,000,000 | $32,000,000 | $65,500,000 | $99,500,000 | $157,000,000 | $266,000,000 | $106,000,000 | $159,500,000 | $106,000,000 | $144,500,000 | $0 | $0 |
| **Cost per Cubic Yard (assumes yearly removal)** | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High |
| One-time investment cost, $/cy | $0 | $0 | $9 | $16 | $4 | $5 | $2 | $4 | $7 | $11 | $1 | $2 | $7 | $14 | $9 | $13 | $0 | $0 |
| Annualized investment cost, $/cy/year | $0 | $0 | $0 | $1 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1 | $0 | $1 | $0 | $0 |
| Annual removal cost, $/cy/year | $0 | $0 | $15 | $21 | $10 | $16 | $5 | $11 | $22 | $33 | $52 | $89 | $35 | $53 | $35 | $48 | $0 | $0 |
| Total annual cost, $/cy/year | $0 | $0 | $16 | $21 | $10 | $16 | $5 | $11 | $22 | $34 | $52 | $89 | $36 | $54 | $36 | $49 | $0 | $0 |
| **Major Limitations** | | | Currently not allowed by law; large parcels adjacent to the river may be very difficult to find | | Environmental impacts; NMFS concerns | | Environmental impacts; NMFS concerns | | | | Large parcels adjacent to the reservoir may be difficult to find | | Large parcels expected to be difficult to find nearby | | Effluent from dewatering will need to be pumped back to the Susquehanna River | | | |

**General Assumptions:**

**These are concept-level costs for planning purposes only. Detailed design and cost estimate would be required for any future studies investigation implementation of any of these alternatives.**
**All alternatives assume the dredging of a location in Conowingo Reservoir which currently has the highest amounts of deposition in the entire lower Susquehanna reservoir system; similar costs could be developed for the other lower Susquehanna**

**Technical Assumptions:**

Real estate cost = farmland cost in Harford/Cecil County, MD; range of cost = $10,000 to $20,000 per acre; based on Internet search of agricultural land June 2013; assume large tracts of land available.
Annualization factor = 22.434 for interest = 3.750% and project life of 50 years Rounding factor for annualization = 3
Each hydraulic dredge has its own separate pipeline and associated booster pump system, with a production capacity of 4,000 cubic yards per day; cost per booster pump = $300,000
Hydraulic dredging process will add a signficant amount of volume to the pipeline; assume pipeline will contain 4 times the dredging volume.
Drying process will be able to remove a signficant amount of the water that is pumped in with the dredged material; assume that material to be transported after drying is 1.5 times the original dredging volume.
Production capacity for one mechanical dredge = 500 cubic yards per day; material volume is increased by 20%, a factor of 1.2 , during dredging process
Barge capacity varies; for transport to Pooles Island, each barge is expected to hold 2,500 cubic yards; for in-reservoir dredging, the capacity would be much smaller, only 500 cubic yards/barge.
Permanent pipeline cost = $160,000 to $260,000 per mile ($30-50 per linear foot).
Transfer site/dike construction cost = 5-foot high dike for 3 feet of material, drying time of 2 months per cell, $8-16/cy construction cost
Tipping fee for Stancils Quarry is assumed to be $1-5/cy with a total volume available of 9Mcy; tipping fee for Mason-Dixon Quarry is based on $10-15/cy and a total volume available of 35Mcy; the tipping fees are applied to the dredged amount for pipeline delivery and to the trucked amount for truck delivery; outright purchase of quarry could be another option to tipping fees.
Universal conversion factor; 1 cubic yard of dredged material = 0.81 tons of sediment based on bulk density value of 1600 kilograms/meter$^3$.

**Lower Susquehanna River Watershed Assessment**
**Summary of Representative Sediment Management Alternatives**

| | Innovative Reuse | Open Water Placement | | | Upland Placement | | | | Watershed Management |
|---|---|---|---|---|---|---|---|---|---|
| | Alternative 1 | Alternative 2A | Alternative 2B | Alternative 2C | Alternative 3A | Alternative 3B | Alternative 3C | Alternative 3D | Alternative 4 |
| **Physical Description** | | | | | | | | | |
| Sediment to be removed, cubic yards | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 |
| Sediment to be removed, tons | 4,050,000 | 4,050,000 | 4,050,000 | 4,050,000 | 4,050,000 | 4,050,000 | 4,050,000 | 4,050,000 | 4,050,000 |
| Type of dredging | Hydraulic | Hydraulic | Hydraulic | Hydraulic | Hydraulic | Mechanical | Hydraulic | Hydraulic | N/A |
| Transportation method | Pipeline | Pipeline + barge | Pipeline | Pipeline | Pipeline | Barge + transfer + trucking | Pipeline + dike + trucking | Pipeline + discharge pipe | N/A |
| Distance to be transported, miles | 10 | 8+32 | 3 | 3 | 13 | 0+0+14 | 3+0+12 | 14 + 4 | N/A |
| Location/type of containment site | Bainbridge, slurry screened, water returned, solids stockpiled | Drying/transfer site near Susquehanna State Park, with dike construction | N/A | N/A | Will need dike construction at quarry for dewatering to extend project life | Shoreline transfer site | Nearby drying site required with dike construction | Will need dike construction at quarry for dewatering to extend project life | N/A |
| Final destination of material | Concrete block market | Pooles Island | Susquehanna River, approximately 1 mile d/s of Conowingo Dam | Susquehanna River, approximately 1 mile d/s of Conowingo Dam | Stancills Quarry | Mason-Dixon Quarry | Mason-Dixon Quarry | Mason-Dixon Quarry (Belvidere site) | N/A |
| Number of dredging cycles that facility could be used before capacity is reached | Facility has a useful life of more than 40 years | Unknown, due to local sediment transport | No limitation | No limitation | 1 | 6 | 5 | 5 | |
| Land to be purchased, acres | 130 | 2,080 | 1-2 | 1-2 | 2-5 | 72 | 2,080 | 2-5 | N/A |
| **Production Calculations** | | | | | | | | | |
| Volume to be removed, cubic yards | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 | 5,000,000 | N/A |
| Volume in pipeline (4X), cubic yards | 20,000,000 | 20,000,000 | 20,000,000 | 20,000,000 | 20,000,000 | N/A | 20,000,000 | 20,000,000 | N/A |
| Volume to be disposed of, cubic yards | N/A | 7,500,000 | N/A | N/A | 7,500,000 | 6,000,000 | 7,500,000 | 7,500,000 | N/A |
| Number of dredges | 1 | 5 | 12 | 7 | 5 | 40 | 5 | 5 | N/A |
| Number of pipelines | 1 | 5 | 12 | 7 | 5 | 0 | 5 | 5 | N/A |
| Number of barge loads per day | N/A | 12 | N/A | N/A | N/A | 48 | N/A | N/A | N/A |
| Number of truck loads per day | N/A | N/A | N/A | N/A | N/A | 2,000 | 2,500 | N/A | N/A |
| Dike volume, cubic yards | N/A | 700,000 | N/A | N/A | 700,000 | N/A | 700,000 | 700,000 | N/A |
| Booster pumps required | 9 | 35 | 24 | 14 | 60 | 0 | 10 | 70 | N/A |
| Months of operation | Year-round | Year-round | October-February (5 months) | July-March (9 months) | Year-round | Year-round | Year-round | Year-round | N/A |
| Actual operational time, days per year | 330 | 250 | 104 | 179 | 250 | 250 | 250 | 250 | N/A |
| Total sediment removal capacity, cubic yards per day | 4,000 | 20,000 | 48,000 | 28,000 | 20,000 | 20,000 | 20,000 | 20,000 | N/A |

| | Alt. 1 Low | Alt. 1 High | Alt. 2A Low | Alt. 2A High | Alt. 2B Low | Alt. 2B High | Alt. 2C Low | Alt. 2C High | Alt. 3A Low | Alt. 3A High | Alt. 3B Low | Alt. 3B High | Alt. 3C Low | Alt. 3C High | Alt. 3D Low | Alt. 3D High | Alt. 4 Low | Alt. 4 High |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **One-Time Investment Costs** | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High |
| Real estate/land purchase | All costs included in Harbor Rock annual removal cost ??? | | $20,800,000 | $41,600,000 | $10,000 | $40,000 | $10,000 | $40,000 | $20,000 | $100,000 | $720,000 | $1,440,000 | $20,800,000 | $41,600,000 | $20,000 | $100,000 | May need to add some lines to account for management activities | |
| Design and study costs | | | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | $2,000,000 | $5,000,000 | | |
| Booster pump construction | | | $10,500,000 | $10,500,000 | $7,200,000 | $7,200,000 | $4,200,000 | $4,200,000 | $18,000,000 | $18,000,000 | $0 | $0 | $3,000,000 | $3,000,000 | $21,000,000 | $21,000,000 | | |
| Permanent pipeline construction | | | $6,400,000 | $10,400,000 | $5,800,000 | $9,400,000 | $3,400,000 | $5,500,000 | $10,400,000 | $16,900,000 | $0 | $0 | $2,400,000 | $3,900,000 | $14,400,000 | $23,400,000 | | |
| Transfer site/dike construction | | | $5,600,000 | $11,200,000 | $0 | $0 | $0 | $0 | $5,600,000 | $11,200,000 | $0 | $0 | $5,600,000 | $11,200,000 | $5,600,000 | $11,200,000 | | |
| Reuse manufacturing plant | | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | |
| Subtotal | $0 | $0 | $45,300,000 | $78,700,000 | $15,010,000 | $21,640,000 | $9,610,000 | $14,740,000 | $36,020,000 | $51,200,000 | $2,720,000 | $6,440,000 | $33,800,000 | $64,700,000 | $43,020,000 | $60,700,000 | $0 | $0 |
| Annualized, $/year | $0 | $0 | $2,019,000 | $3,508,000 | $669,000 | $965,000 | $428,000 | $657,000 | $1,606,000 | $2,282,000 | $121,000 | $287,000 | $1,507,000 | $2,884,000 | $1,918,000 | $2,706,000 | $0 | $0 |
| **O&M/Removal Costs** | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High |
| Tipping fee | | | $0 | $0 | $0 | $0 | $0 | $0 | $7,500,000 | $37,500,000 | $60,000,000 | $90,000,000 | $75,000,000 | $112,500,000 | $75,000,000 | $112,500,000 | May need to add some lines to account for management activities | |
| Dredging + transportation | $0 | $0 | $75,000,000 | $100,000,000 | $50,000,000 | $75,000,000 | $25,000,000 | $50,000,000 | $100,000,000 | $125,000,000 | $200,000,000 | $350,000,000 | $100,000,000 | $150,000,000 | $100,000,000 | $125,000,000 | | |
| Manufacturing processing | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | |
| Construction design and management | $0 | $0 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | $1,000,000 | $2,000,000 | | |
| Subtotal | $0 | $0 | $76,000,000 | $102,000,000 | $51,000,000 | $77,000,000 | $26,000,000 | $52,000,000 | $108,500,000 | $164,500,000 | $261,000,000 | $442,000,000 | $176,000,000 | $264,500,000 | $176,000,000 | $239,500,000 | $0 | $0 |
| **Cost per Cubic Yard (assumes yearly removal)** | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High |
| One-time investment cost, $/cy | $0 | $0 | $9 | $16 | $3 | $4 | $2 | $3 | $7 | $10 | $1 | $1 | $7 | $13 | $9 | $12 | $0 | $0 |
| Annualized investment cost, $/cy/year | $0 | $0 | $0 | $1 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1 | $0 | $1 | $0 | $0 |
| Annual removal cost, $/cy/year | $0 | $0 | $15 | $20 | $10 | $15 | $5 | $10 | $22 | $33 | $52 | $88 | $35 | $53 | $35 | $48 | $0 | $0 |
| Total annual cost, $/cy/year | $0 | $0 | $16 | $21 | $10 | $16 | $5 | $11 | $22 | $33 | $52 | $88 | $36 | $53 | $36 | $48 | $0 | $0 |
| **Major Limitations** | | | Currently not allowed by law; large parcels adjacent to the river may be very difficult to find | | Environmental impacts; NMFS concerns | | Environmental impacts; NMFS concerns | | | | Large parcels adjacent to the reservoir may be difficult to find | | Large parcels expected to be difficult to find nearby | | Effluent from dewatering will need to be pumped back to the Susquehanna River | | | |

**General Assumptions:**

**These are concept-level costs for planning purposes only. Detailed design and cost estimate would be required for any future studies investigation implementation of any of these alternatives.**
**All alternatives assume the dredging of a location in Conowingo Reservoir which currently has the highest amounts of deposition in the entire lower Susquehanna reservoir system; similar costs could be developed for the other lower Susquehanna**

**Technical Assumptions:**

Real estate cost = farmland cost in Harford/Cecil County, MD; range of cost = $10,000 to $20,000 per acre; based on Internet search of agricultural land June 2013; assume large tracts of land available.
Annualization factor = 22.434 for interest = 3.750% and project life of 50 years Rounding factor for annualization = 3
Each hydraulic dredge has its own separate pipeline and associated booster pump system, with a production capacity of 4,000 cubic yards per day; cost per booster pump = $300,000
Hydraulic dredging process will add a signficant amount of volume to the pipeline; assume pipeline will contain 4 times the dredging volume.
Drying process will be able to remove a signficant amount of the water that is pumped in with the dredged material; assume that material to be transported after drying is 1.5 times the original dredging volume.
Production capacity for one mechanical dredge = 500 cubic yards per day; material volume is increased by 20%, a factor of 1.2, during dredging process
Barge capacity varies; for transport to Pooles Island, each barge is expected to hold 2,500 cubic yards; for in-reservoir dredging, the capacity would be much smaller, only 500 cubic yards/barge.
Permanent pipeline cost = $160,000 to $260,000 per mile ($30-50 per linear foot).
Transfer site/dike construction cost = 5-foot high dike for 3 feet of material, drying time of 2 months per cell, $8-16/cy construction cost
Tipping fee for Stancils Quarry is assumed to be $1-5/cy; tipping fee for Mason-Dixon Quarry is based on $10-15/cy; the tipping fees are applied to the dredged amount for pipeline delivery and to the trucked amount for truck delivery; outright purchase of quarry could be another option to tipping fees.
Universal conversion factor; 1 cubic yard of dredged material = 0.81 tons of sediment based on bulk density value of 1600 kilograms/meter$^3$.

## SCREENING LEVEL ESTIMATE

**2A - Open Water Placement**

Pooles Island Open Water Placement

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

**SCENARIO**

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped downstream to a temporary placement site that is available near Port Deposit. At this location material can be dewatered and loaded into barges. Once the dredged material is placed onto the barges it will be moved to a placement site at Pooles Island, Md.

**ASSUMPTIONS/BASIS FOR ESTIMATE:**

1) The Pooles Island placement area is assumed to be 350 acres, the expansion of the Pooles Island site connects G-West to Site 92. Allowable fill would be to a depth to -11' MLLW.

2) The 350 ac site is identified as having 4.7 mcy of capacity which would result in an 8.3 ft placement thickness (4,700,000cy x 27cf/cy /350 ac / 43560 cf/ac = 8.32 ft thick). The assumption holds that Pooles Island capacity to handle new material recharges yearly allowing for 4.7 CY of material to be placed every year.

3) Assume 1 cy of sediment contains 0.81 tons of solids.

4) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

5) This estimate will be based on the assumption that there are 250 work days per year and up to 10 work hours days.

6) Approximately 7 boosters per pipe at $300,000 per booster will be needed to get hydraulically dredged material to a temporary placement site that is assumed to be available across the river from Port Deposit (circled in green in the picture below) the dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

7) The Legislative restrictions for open water placement at Pooles Island would be lifted or suspended. Opposition from the fishing community will be assuaged.

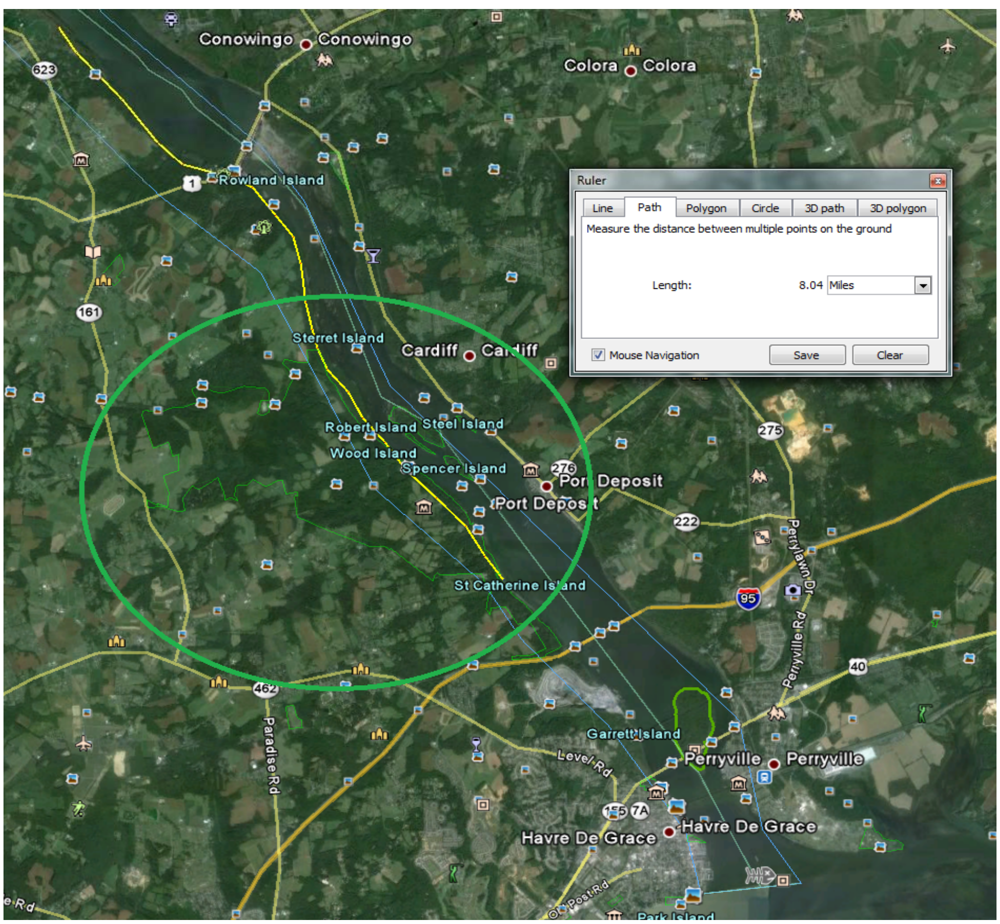
8) Dredged material would first be removed from the reservoir via hydraulic dredging and pumped to a temporary holding site near Port Deposit. This site would be a number of acres surrounded by a sediment holding dike which will contain the dredged material while it is dewatered by working and trenching the material with bulldozers. Drying the material will take approximately 4 months per cell.

9) After the sediment is dewatered the material will then be mechanically loaded into barges via clam shell dredge or large excavators and transported to the Pooles Island placement site ~30 Miles by barge The material would then be pumped from the barge into the Pooles Island open water site.

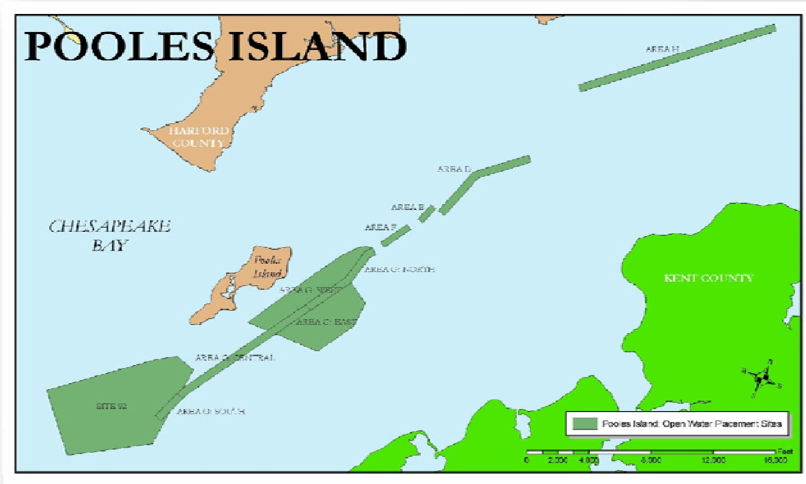
10) We are assuming a 2500 cy / barge will have access to transfer sites at our temporary dewatering site

11) Equipment needed: Dredge's, Pipe, Booster Pumps, Excavators (enough to remove the same amount of material that the dredge pumps per hour), Bulldozers (to trench and move material for drying), Barges.

**Potential temporary placement sites across river from Port Deposit in the Susquehanna St Park with access to River.**



Location of Pooles island




***Evaluation of Available Capacity:***

| Total Amount of Material to be dredged (CY) | Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day or 1000000 CY/yr) per Dredge | Number of days to dredge amount at given number of dredges. | Actual CY of Sediment Plus Water Volume Hydraulically Dredged | Distance to be Piped (miles) | Number of Pipes | Number of Booster pumps | Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth |
|---|---|---|---|---|---|---|---|
| 1,000,000 | 1 | 250 | 4,000,000 | 8 | 1 | 7 | 800 |
| 3,000,000 | 3 | 250 | 12,000,000 | 8 | 3 | 21 | 2,500 |
| 5,000,000 | 5 | 250 | 20,000,000 | 8 | 5 | 35 | 4,100 |

| Total (CY) of Sediment Plus Water Volume Placed into Temporary Holding Cells During One Year | Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth | Acreage needed for 6 drying Cells which are used 2 times per year for temporary placement | Area of one Drying Cell (acres) | Dike Length in Feet for 6 cells | Dike Volume in CY for 6 cells at 5 ft elevation | Dewatered Volume of Material (1.5 times original amount dredged) |
|---|---|---|---|---|---|---|
| 4,000,000 | 800 | 420 | 70 | 33,200 | 140,000 | 1,500,000 |
| 12,000,000 | 2,500 | 1,250 | 210 | 99,600 | 420,000 | 4,500,000 |
| 20,000,000 | 4,100 | 2,080 | 350 | 166,000 | 700,000 | 7,500,000 |

Temporary Dewatering Sediment Cells and Associated Months of Handling

| | Cell 1 | Cell 2 | Cell 3 | Cell 4 | Cell 5 | Cell 6 | |
|---|---|---|---|---|---|---|---|
| Pump | 1 | 2 | 3 | 4 | 5 | 6 | Cycle 1 |
| Dry | 2,3,4,5 | 3,4,5,6 | 4,5,6,7 | 6,7,8,9 | 7,8,9,10 | 8,9,10,11 | |
| Remove | 6 | 7 | 8 | 9 | 10 | 11 | |
| Pump | 7 | 8 | 9 | 10 | 11 | 12 | Cycle 2 |
| Dry | 8,9,10,11 | 9,10,11,12 | 10,11,12,1 | 11,12,1,2, | 12,1,2,3 | 1,2,3,4 | |
| Remove | 12 | 1 | 2 | 3 | 4 | 5 | |

| Volume of Material to be barged to Pooles Island After Drying (CY) | Volume of Dried Material per Drying Cell (CY) | Area of one Drying Cell (acres) | Transfer pads and associated 400 Cy/hr transfer excavators per Drying Cell | Number of barge loads per day | Number of loads per year at 2500 cy/barge | Percentage of Material Dredged per year that Pooles island can Handle per year (%) | # of dredging cycles that facility could be used before capacity is reached |
|---|---|---|---|---|---|---|---|
| 1,500,000 | 130,000 | 70 | 1 | 2 | 600 | 100 | Unknown |
| 4,500,000 | 380,000 | 210 | 4 | 7 | 1,800 | 100 | Unknown |
| 7,500,000 | 630,000 | 350 | 7 | 12 | 3,000 | 63 | Unknown |

**SCREENING LEVEL ESTIMATE**

**2B - Open Water Placement**

5 Months of Sediment Bypassing

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

**SCENARIO**

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped past Conowingo Dam downstream to a release point bypassing sediment over 5 months from October - February.

**ASSUMPTIONS/BASIS FOR ESTIMATE:**

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

3) This estimate will be based on the assumption that there are approximately 105 work days in five months and up to 10 work hours days.

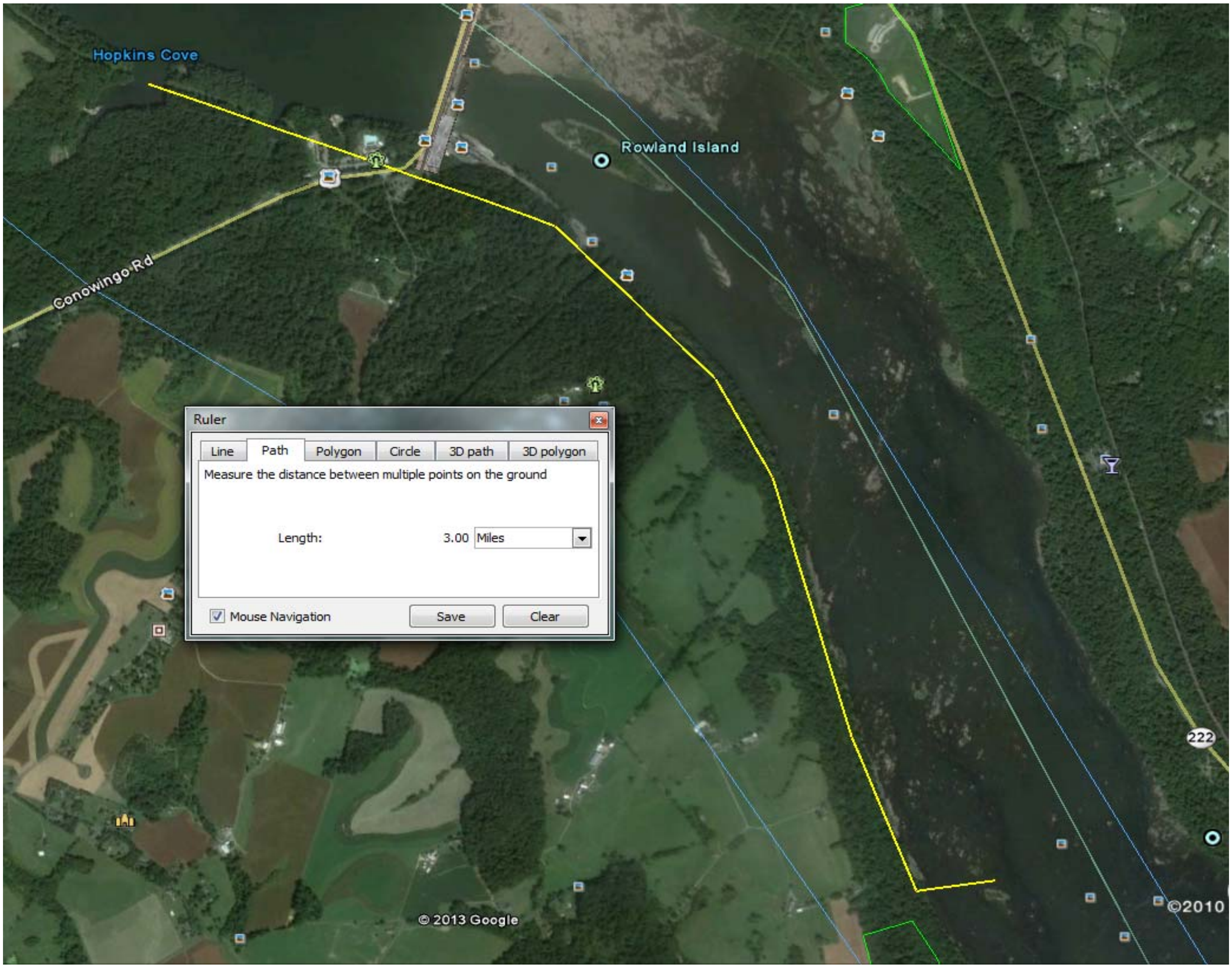
4) A sediment release point can be found down stream of the dam where channel hydraulics would promote sustainable sediment transport.

5) Approximately 2 boosters per pipe at $300,000 per booster are needed to get hydraulically dredged material past Conowingo Dam. The dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

6) The Legislative restrictions for open water placement would be lifted or suspended. Opposition from the fishing community will be assuaged.

7) Equipment needed: Dredge's, Pipe, Booster Pumps.

**Sediment Pipe around Conowingo Dam and location of Down Stream Release point in the Susquehanna River.**



***Evaluation of Available Capacity:***

| Total Amount of Material to be dredged (CY) | Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day per Dredge at 21 days per month or 84000 CY per month | Number of days to dredge amount at given number of dredges. | Actual CY of Sediment Plus Water Volume Hydraulically Dredged | Distance to be piped (miles) | Number of Pipes | Number of Booster pumps | Percentage of Material Dredged per year that can be Bypassed per year (%) (No Total Capacity Limit) |
|---|---|---|---|---|---|---|---|
| 1,000,000 | 3 | 83 | 4,000,000 | 3 | 3 | 6 | 100 |
| 3,000,000 | 8 | 94 | 12,000,000 | 3 | 8 | 16 | 100 |
| 5,000,000 | 12 | 104 | 20,000,000 | 3 | 12 | 24 | 100 |

## SCREENING LEVEL ESTIMATE

**2C - Open Water Placement**

9 Months of Sediment Bypassing

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

**SCENARIO**

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped past Conowingo Dam downstream to a release point bypassing sediment over 9 months from July-March.

**ASSUMPTIONS/BASIS FOR ESTIMATE:**

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

3) This estimate will be based on the assumption that there are approximately 190 work days in nine months and up to 10 work hours days.

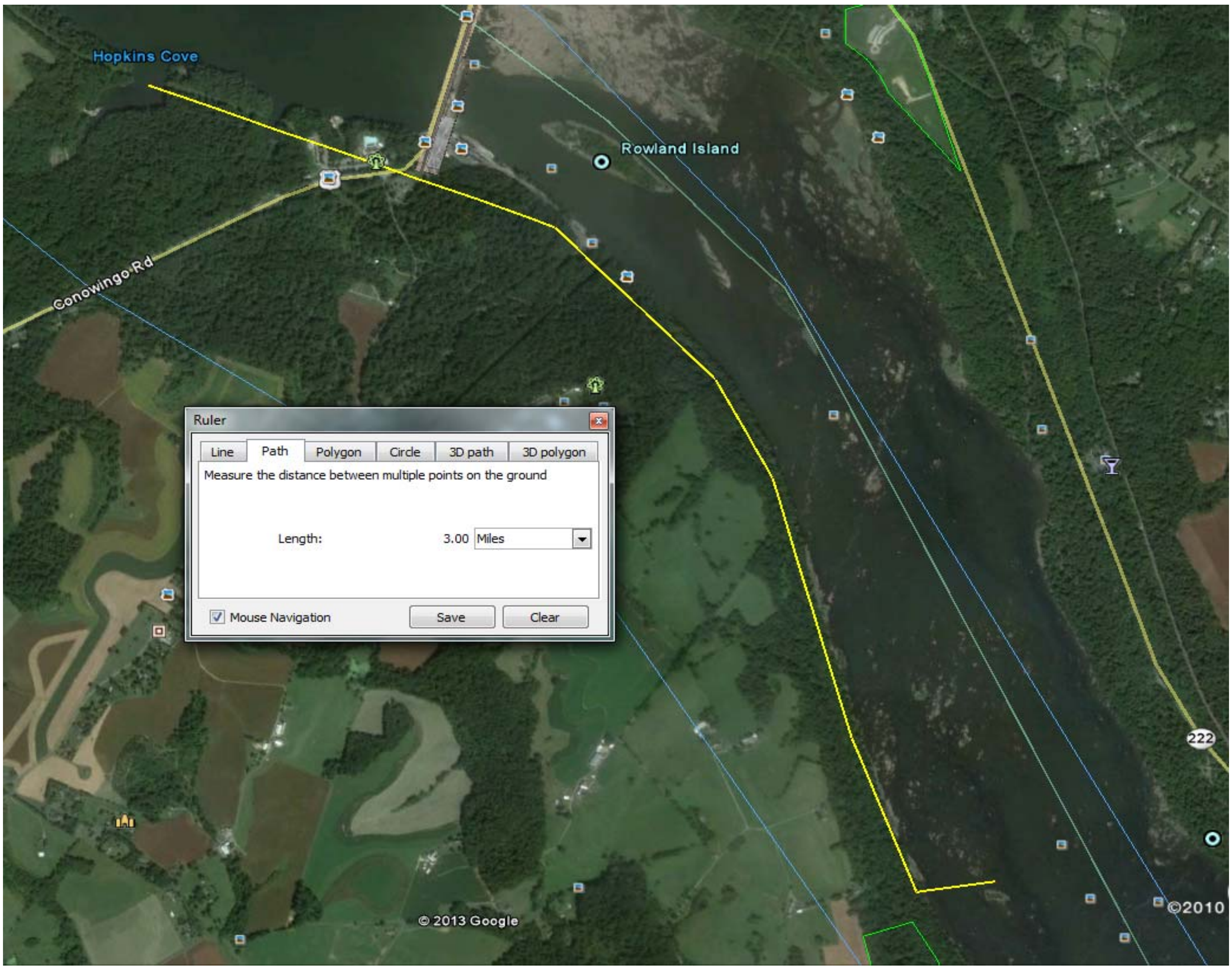
4) A sediment release point can be found down stream of the dam where channel hydraulics would promote sustainable sediment transport.

5) Approximately 2 boosters per pipe at $300,000 per booster are needed to get hydraulically dredged material past Conowingo Dam. The dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

6) The Legislative restrictions for open water placement would be lifted or suspended. Opposition from the fishing community will be assuaged.

7) Equipment needed: Dredge's, Pipe, Booster Pumps.

**Sediment Pipe around Conowingo Dam and location of Down Stream Release point in the Susquehanna Rive**



***Evaluation of Available Capacity:***

| Total Amount of Material to be dredged (CY) | Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day per Dredge at 21 days per month or 84000 CY per month | Number of days to dredge amount at given number of dredges. | Actual CY of Sediment Plus Water Volume Hydraulically Dredged | Distance to be piped (miles) | Number of Pipes | Number of Booster pumps | Percentage of Material Dredged per year that can be Bypassed per year (%) (No Total Capacity Limit) |
|---|---|---|---|---|---|---|---|
| 1,000,000 | 2 | 125 | 4,000,000 | 3 | 2 | 4 | 100 |
| 3,000,000 | 4 | 188 | 12,000,000 | 3 | 4 | 8 | 100 |
| 5,000,000 | 7 | 179 | 20,000,000 | 3 | 7 | 14 | 100 |

## SCREENING LEVEL ESTIMATE

**3A - Upland Placement**

Stancil Quarry Upland Placement

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

**SCENARIO**

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped downstream to a dewatering site at Stancil Quarry before it is placed in a permanent site that is available at Stancil Quarry.

**ASSUMPTIONS/BASIS FOR ESTIMATE:**

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

3) This estimate will be based on the assumption that there are 250 work days per year and up to 10 work hours days.

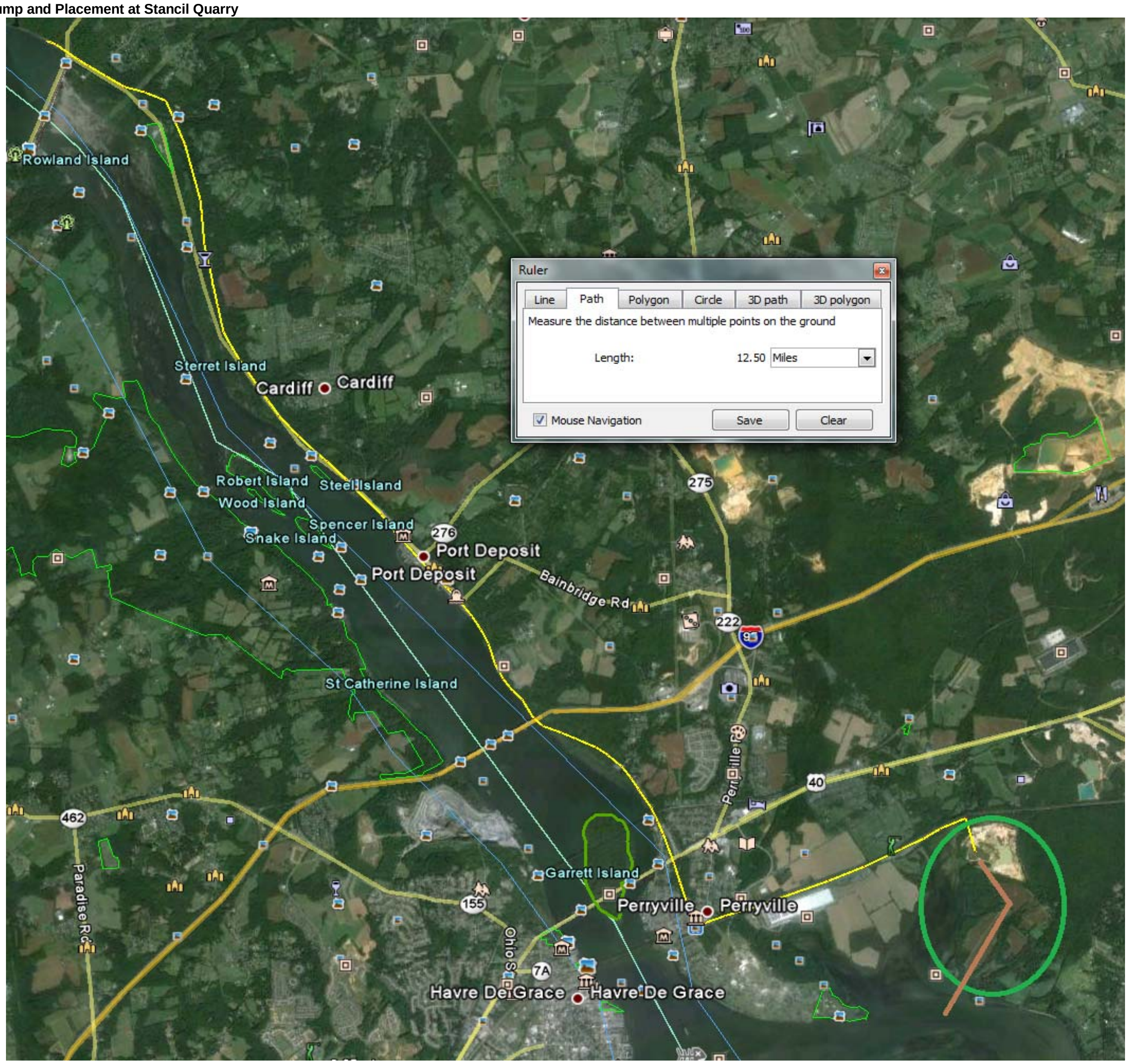
4) Approximately 12 boosters per pipe at $300,000 per booster will be needed to get hydraulically dredged material to Stancil Quarry. The dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

5) Dredged material would first be removed from the reservoir via hydraulic dredging and pumped 13 miles to a holding area at Stancil Quarry where it can be dewatered to the Susquehanna flats. Once the material is dewatered it can be placed perminantly in final fill areas at the quarry. The dewatering site at the quarry would be a number of acres surrounded by a sediment holding dike which will contain the dredged material while it is dewatered by working and trenching the material with bulldozers. Drying the material will take approximately 4 months per cell.

6) After the sediment is dewatered the material will then be pushed and moved via bulldozer and excavator to a final fill location within Stancil Quarry.

7) Equipment needed: Dredge's, Pipe, Booster Pumps, Excavators, Bulldozers (to trench and move material for drying).

**Pump and Placement at Stancil Quarry**



***Evaluation of Available Capacity:***

| Total Amount of Material to be dredged (CY) | Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day or 1000000 CY/yr) per Dredge | Number of days to dredge amount at given number of dredges. | Actual CY of Sediment Plus Water Volume Hydraulically Dredged | Distance to be Piped (miles) | Number of Pipes | Number of Booster pumps | Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth |
|---|---|---|---|---|---|---|---|
| 1,000,000 | 1 | 250 | 4,000,000 | 13 | 1 | 12 | 800 |
| 3,000,000 | 3 | 250 | 12,000,000 | 13 | 3 | 36 | 2,500 |
| 5,000,000 | 5 | 250 | 20,000,000 | 13 | 5 | 60 | 4,100 |

| Total (CY) of Sediment Plus Water Volume Placed into Temporary Holding Cells During One Year | Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth | Acreage needed for 6 drying Cells which are used 2 times per year for temporary placement | Area of one Drying Cell (acres) | Dike Length in Feet for 6 cells | Dike Volume in CY for 6 cells at 5 ft elevation | Dewatered Volume of Material (1.5 times original amount dredged) |
|---|---|---|---|---|---|---|
| 4,000,000 | 800 | 420 | 70 | 33,200 | 140,000 | 1,500,000 |
| 12,000,000 | 2,500 | 1,250 | 210 | 99,600 | 420,000 | 4,500,000 |
| 20,000,000 | 4,100 | 2,080 | 350 | 166,000 | 700,000 | 7,500,000 |

Temporary Dewatering Sediment Cells and Associated Months of Handling

| | Cell 1 | Cell 2 | Cell 3 | Cell 4 | Cell 5 | Cell 6 | |
|---|---|---|---|---|---|---|---|
| Pump | 1 | 2 | 3 | 4 | 5 | 6 | Cycle 1 |
| Dry | 2,3,4,5 | 3,4,5,6 | 4,5,6,7 | 6,7,8,9 | 7,8,9,10 | 8,9,10,11 | |
| Remove | 6 | 7 | 8 | 9 | 10 | 11 | |
| Pump | 7 | 8 | 9 | 10 | 11 | 12 | Cycle 2 |
| Dry | 8,9,10,11 | 9,10,11,12 | 10,11,12,1 | 11,12,1,2, | 12,1,2,3 | 1,2,3,4 | |
| Remove | 12 | 1 | 2 | 3 | 4 | 5 | |

| Volume of Material for Permanent placement at Stancil Quarry After Drying (CY) | Volume of Dried Material per Drying Cell (CY) | Area of one Drying Cell (acres) | Percentage of Material Dredged per year that Stancil Quarry can Handle per year (%) | # of dredging cycles that facility could be used till capacity is reached |
|---|---|---|---|---|
| 1,500,000 | 130,000 | 70 | Unknown | 6 |
| 4,500,000 | 380,000 | 210 | Unknown | 2 |
| 7,500,000 | 630,000 | 350 | Unknown | 1 |

## SCREENING LEVEL ESTIMATE

**3B - Upland Placement**

Mason Dixon Quarry Upland Placement - Mechanical Dredge

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

**SCENARIO**

Mechanical dredges will be used to remove sediment from the Conowingo Reservoir and place that sediment into barges, then the barges will circulate between the dredges and the southern shoreline where their contents will be offloaded via excavators. The southern shoreline was chosen due to the rail line on the northern shoreline, which would make offloading the barges too expensive or potentially unfeasible. There will be staging areas on the southern shoreline for the transfer of dredge material from each barge to the trucks An excavator at each transfer site will then place the wet material into trucks able to hall 12 cy of wet material. Each staging area will have one excavator which will unload the barge and transfer its contents to the trucks at a assumed rate of one truck every 10 minutes. The trucks will then cross the Conowingo Bridge and drive to Mason Dixon Quarry where they will unload their contents, and return to be filled again.

**ASSUMPTIONS/BASIS FOR ESTIMATE:**

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate of the sizing of a mechanical dredge for Conowingo reservoir suggested a mechanical dredge capable of removing remove 500 CY / day would be the minimum size dredge needed..

3) This estimate will be based on the assumption that there are 250 work days per year and up to 10 work hours days.

4) Pipes or pumping of sediment infrastructure are not needed for the logistics of this example.

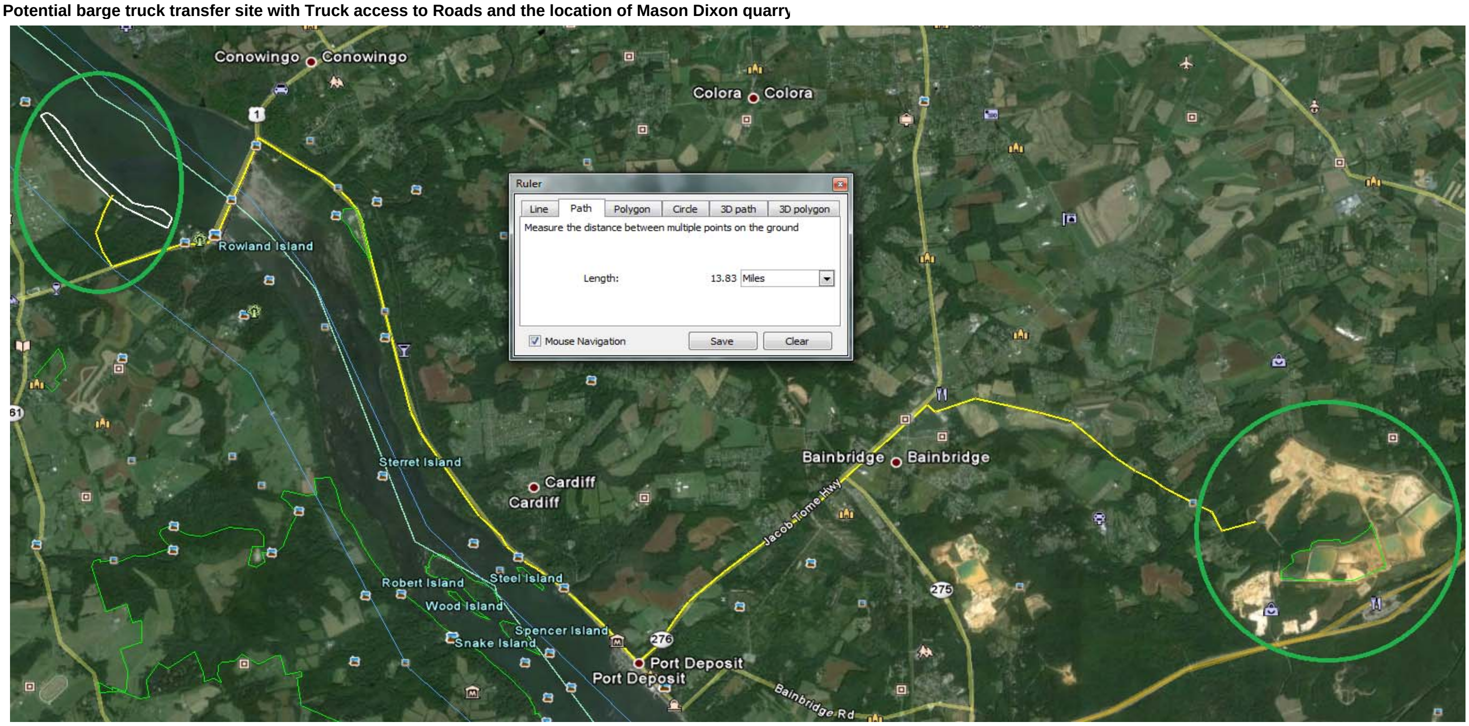
5) Dredged material would first be removed from the reservoir via mechanical dredging and barged to a transfer sites on the Conowingo Reservoir southern shore. There the wet material will be transferred to trucks via excavators. The material will then be trucked to Mason Dixon Quarry for final placement.

6) The depth necessary to move the required number of 500 CY barges is present or can be dredged, and the dock structure to allow excavators to transfer sediment from barge to truck will be able to be constructed.

7) Any temporary to permanent road structures to allow sediment trucks to access state, or county roads and highways will be built, and all road access for the large number of trucks will be approved.

8) Equipment needed: Mechanical Dredge, Barges, Trucks, Excavators, and Bulldozers (to move material at Mason Dixon Quarry).

**Potential barge truck transfer site with Truck access to Roads and the location of Mason Dixon quarry**



***Evaluation of Available Capacity: Based on Mechanical Dredging***

| Total Amount of Material to be dredged (CY) | Number of Dredges at 500 CY/day per Dredge | Number of days to dredge amount at given number of dredges. | Actual CY of Sediment Plus Water Volume Mechanically Dredged (1.2 times original amt.) | Number of Barge Loads per day at 500 CY per barge | ~ Total Number of Truck Loads Per Day @ ~42 Truck Loads per Barge | ~ Total Number of Truck Loads Per Year | Number of Transfer sites at 6 trucks per hour per transfer site |
|---|---|---|---|---|---|---|---|
| 1,000,000 | 8 | 250 | 1,200,000 | 9.6 | 400 | 100000 | 10 |
| 3,000,000 | 24 | 250 | 3,600,000 | 28.8 | 1200 | 300000 | 29 |
| 5,000,000 | 40 | 250 | 6,000,000 | 48.0 | 2000 | 500000 | 48 |

| Transfer Area Acreage needed at 1.5 acres per Transfer Site | Volume of Material for Permanent placement at Mason Dixon Quarry (CY) | Percentage of Material Dredged per year that Mason Dixon can Handle per year (%) | # of dredging cycles that facility could be used till capacity is reached |
|---|---|---|---|
| 15 | 1,200,000 | Unknown | 29 |
| 44 | 3,600,000 | Unknown | 10 |
| 72 | 6,000,000 | Unknown | 6 |

## SCREENING LEVEL ESTIMATE

**3C - Upland Placement**

Mason Dixon Quarry Upland Placement - Hydraulic Dredge

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

**SCENARIO**

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped downstream to a dewatering site that is across the Susquehanna River from Port Deposit. At this location material can be dewatered then once dried the material can be placed onto the trucks via excavators to be moved to a final placement site at Mason Dixon Quarry.

**ASSUMPTIONS/BASIS FOR ESTIMATE:**

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

3) This estimate will be based on the assumption that there are 250 work days per year and up to 10 work hours days.

4) Approximately 2 boosters per pipe at $300,000 per booster will be needed to get hydraulically dredged material to past Conowingo Dam 3 miles to a temporary placement site assumed to be available (the area outlined in white in picture below) across the Susquehanna River from Port Deposit . The dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

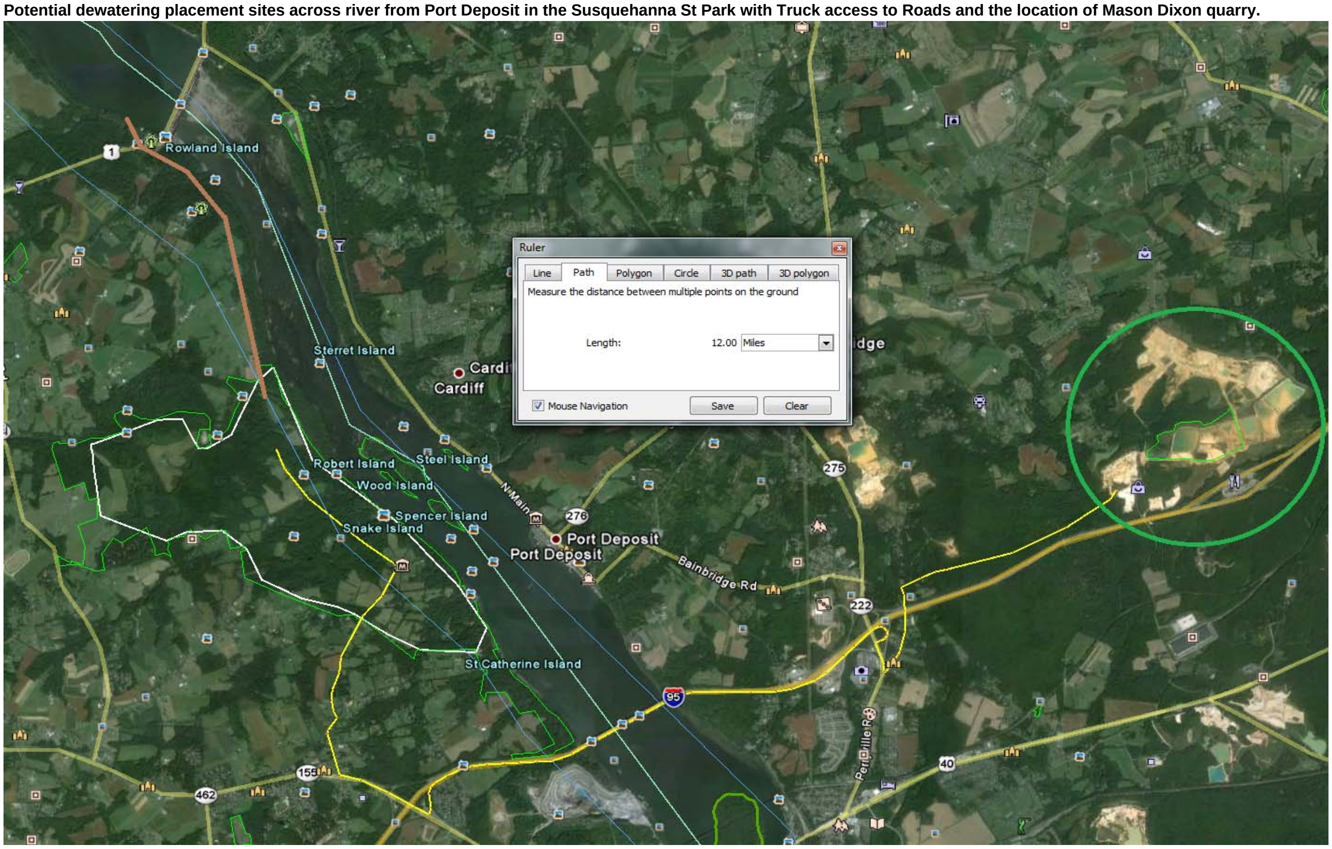
5) Dredged material would first be removed from the reservoir via hydraulic dredging and pumped 3 miles to a holding area across the river from Port Deposit, where it can be dewatered. Once the material is dewatered it can be loaded onto trucks to be transported to Mason Dixon Quarry. The dewatering site would be a number of acres surrounded by a sediment holding dike which will contain the dredged material while it is dewatered by working and trenching the material with bulldozers. Drying the material will take approximately 4 months per cell.

6) After the sediment is dewatered the material will then be mechanically loaded into trucks via excavators and transported to the Mason Dixon Quarry final placement site ~12 Miles by truck and going over the Millard E. Tydings Bridge which is part of interstate 95 and driving on other state and Local Roads roads and some temporary roads created for this project. The material would then be offloaded from the trucks to the final placement site at the quarry.

7) Any temporary to permanent road structures to allow sediment trucks to access state, or county roads and highways will be built, and all road access for the large number of trucks will be approved.

8) Equipment needed: Dredge's, Pipe, Booster Pumps, Excavators, Bulldozers (to trench and move material for drying), and Trucks.

**Potential dewatering placement sites across river from Port Deposit in the Susquehanna St Park with Truck access to Roads and the location of Mason Dixon quarry.**



***Evaluation of Available Capacity:***

| Total Amount of Material to be dredged (CY) | Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day or 1000000 CY/yr) per Dredge | Number of days to dredge amount at given number of dredges. | Actual CY of Sediment Plus Water Volume Hydraulically Dredged | Distance to be Piped (miles) | Number of Pipes | Number of Booster pumps | Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth |
|---|---|---|---|---|---|---|---|
| 1,000,000 | 1 | 250 | 4,000,000 | 3 | 1 | 2 | 800 |
| 3,000,000 | 3 | 250 | 12,000,000 | 3 | 3 | 6 | 2,500 |
| 5,000,000 | 5 | 250 | 20,000,000 | 3 | 5 | 10 | 4,100 |

| Total (CY) of Sediment Plus Water Volume Placed into Temporary Holding Cells During One Year | Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth | Acreage needed for 6 drying Cells which are used 2 times per year for temporary placement | Area of one Drying Cell (acres) | Dike Length in Feet for 6 cells | Dike Volume in CY for 6 cells at 5 ft elevation | Dewatered Volume of Material (1.5 times original amount dredged) |
|---|---|---|---|---|---|---|
| 4,000,000 | 800 | 420 | 70 | 33,200 | 140,000 | 1,500,000 |
| 12,000,000 | 2,500 | 1,250 | 210 | 99,600 | 420,000 | 4,500,000 |
| 20,000,000 | 4,100 | 2,080 | 350 | 166,000 | 700,000 | 7,500,000 |

Temporary Dewatering Sediment Cells and Associated Months of Handling

| | Cell 1 | Cell 2 | Cell 3 | Cell 4 | Cell 5 | Cell 6 | |
|---|---|---|---|---|---|---|---|
| Pump | 1 | 2 | 3 | 4 | 5 | 6 | Cycle 1 |
| Dry | 2,3,4,5 | 3,4,5,6 | 4,5,6,7 | 6,7,8,9 | 7,8,9,10 | 8,9,10,11 | |
| Remove | 6 | 7 | 8 | 9 | 10 | 11 | |
| Pump | 7 | 8 | 9 | 10 | 11 | 12 | Cycle 2 |
| Dry | 8,9,10,11 | 9,10,11,12 | 10,11,12,1 | 11,12,1,2, | 12,1,2,3 | 1,2,3,4 | |
| Remove | 12 | 1 | 2 | 3 | 4 | 5 | |

| Volume of Material for Permanent placement at Stancil Quarry After Drying (CY) | Volume of Dried Material per Drying Cell (CY) | Area of one Drying Cell (acres) | ~ Total Number of Truck Loads Per Year | Number of Transfer sites at 6 trucks per hour over 10 hours per transfer site | Percentage of Material Dredged per year that Mason Dixon Quarry can Handle per year (%) | # of dredging cycles that facility could be used till capacity is reached |
|---|---|---|---|---|---|---|
| 1,500,000 | 130,000 | 70 | 125000 | 9.0 | Unknown | 23 |
| 4,500,000 | 380,000 | 210 | 375000 | 25.0 | Unknown | 8 |
| 7,500,000 | 630,000 | 350 | 625000 | 42.0 | Unknown | 5 |

## SCREENING LEVEL COST ESTIMATE

**3D - Upland Placement**

Mason Dixon Belvidere Quarry Upland Placement - Hydraulic Dredge

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

**SCENARIO**

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped downstream directly to the Mason Dixon (Belvidere Plant) Quarry in Cecil County Md., where it can be dewatered and permanently placed at the site.

**ASSUMPTIONS/BASIS FOR ESTIMATE:**

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

3) This estimate will be based on the assumption that there are 250 work days per year and up to 10 work hours days.

4) Approximately 13 boosters per pipe at $300,000 per booster will be needed to get hydraulically dredged material to Mason Dixon Belvidere Quarry. The dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

5) Dredged material would first be removed from the reservoir via hydraulic dredging and pumped over 13 miles to a holding area at Mason Dixon Belvidere Quarry where it can be dewatered to ***the Susquehanna River or to the Susquehanna flats approximately 5 miles away .*** Once the material is dewatered it can be placed permanently in final fill areas at the quarry. ***The dewatering site will be a number of acres surrounded by a sediment holding dike which will contain the dredged material while it is dewatered by working and trenching the material with bulldozers. Drying the material will take approximately 4 months per cell.***

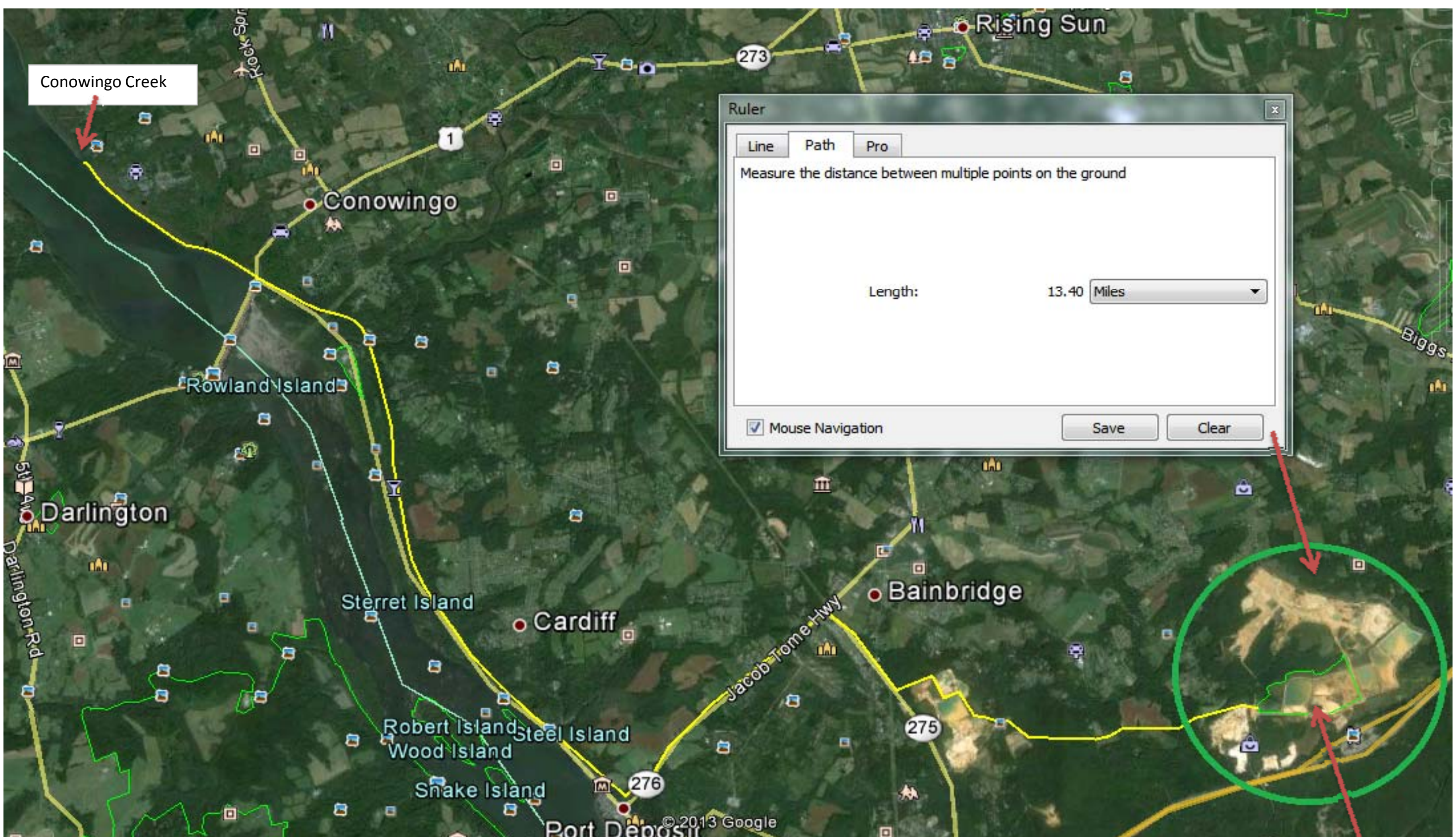
6) Where needed the pipeline can be constructed along roads, rail lines and thru areas of farm land or forest.

7) Initially the dredges will pump sediment under the train trestle on Old Conowingo Creek in order to cross under the rail lines, and move the material in the pipeline from water to land.

8) Cells will be set up to dewater the sediment at the Quarry and Effluent will be pumped back to the Susquehanna River or the Susquehanna Flats area 5 miles away. After the sediment is dewatered the material will then be pushed and moved via bulldozer and excavator to a final fill location within the Quarry.

9) Equipment needed: Dredge's, Pipe, Booster Pumps, Excavators, Bulldozers (to trench and move material for drying).

**Location of Proposed Pipeline and Mason Dixon Belvidere Quarry in Cecil County Md.**




**Belvidere Quarry**

# PRELIMINARY DRAFT -- NOT FOR PUBLIC RELEASE, SUBJECT TO CHANGE

***Evaluation of Available Capacity:***

| Total Amount of Material to be dredged (CY) | Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day or 1000000 CY/yr.) per Dredge | Number of days to dredge amount at given number of dredges. | Actual CY of Sediment Plus Water Volume Hydraulically Dredged | Distance to be Piped (miles) | Number of Pipes | Number of Booster pumps | Equivalent Acreage of Hydraulically Dredged Material @ 3 ft. or 1 yd. depth |
|---|---|---|---|---|---|---|---|
| 1,000,000 | 1 | 250 | 4,000,000 | 14 | 1 | 13 | 800 |
| 3,000,000 | 3 | 250 | 12,000,000 | 14 | 3 | 39 | 2,500 |
| 5,000,000 | 5 | 250 | 20,000,000 | 14 | 5 | 65 | 4,100 |

| Total (CY) of Sediment Plus Water Volume Placed into Temporary Holding Cells During One Year | Equivalent Acreage of Hydraulically Dredged Material @ 3 ft. or 1 yd. depth | Acreage needed for 6 drying Cells which are used 2 times per year for temporary placement | Area of one Drying Cell (acres) | Dike Length in Feet for 6 cells | Dike Volume in CY for 6 cells at 5 ft. elevation | Dewatered Volume of Material (1.5 times original amount dredged) | Distance to Pipe Effluent from Dewatering Operation (miles) using 2 pumps |
|---|---|---|---|---|---|---|---|
| 4,000,000 | 800 | 420 | 70 | 33,200 | 140,000 | 1,500,000 | 5 |
| 12,000,000 | 2,500 | 1,250 | 210 | 99,600 | 420,000 | 4,500,000 | 5 |
| 20,000,000 | 4,100 | 2,080 | 350 | 166,000 | 700,000 | 7,500,000 | 5 |

***Temporary Dewatering Sediment Cells and Associated Months of Handling***

| | Cell 1 | Cell 2 | Cell 3 | Cell 4 | Cell 5 | Cell 6 | |
|---|---|---|---|---|---|---|---|
| Pump | 1 | 2 | 3 | 4 | 5 | 6 | |
| Dry | 2,3,4,5 | 3,4,5,6 | 4,5,6,7 | 6,7,8,9 | 7,8,9,10 | 8,9,10,11 | Cycle 1 |
| Remove | 6 | 7 | 8 | 9 | 10 | 11 | |
| Pump | 7 | 8 | 9 | 10 | 11 | 12 | |
| Dry | 8,9,10,11 | 9,10,11,12 | 10,11,12,1 | 11,12,1,2, | 12,1,2,3 | 1,2,3,4 | Cycle 2 |
| Remove | 12 | 1 | 2 | 3 | 4 | 5 | |

| Volume of Material for Permanent placement at Mason Dixon Belvidere Quarry After Drying (CY) | Volume of Dried Material per Drying Cell (CY) | Area of one Drying Cell (acres) | Percentage of Material Dredged per year that Mason Dixon Belvidere Quarry can Handle per year (%) | # of dredging cycles that facility could be used before capacity is reached |
|---|---|---|---|---|
| 1,500,000 | 130,000 | 70 | Unknown | 23 |
| 4,500,000 | 380,000 | 210 | Unknown | 8 |
| 7,500,000 | 630,000 | 350 | Unknown | 5 |

# Lower Susquehanna River Watershed Assessment

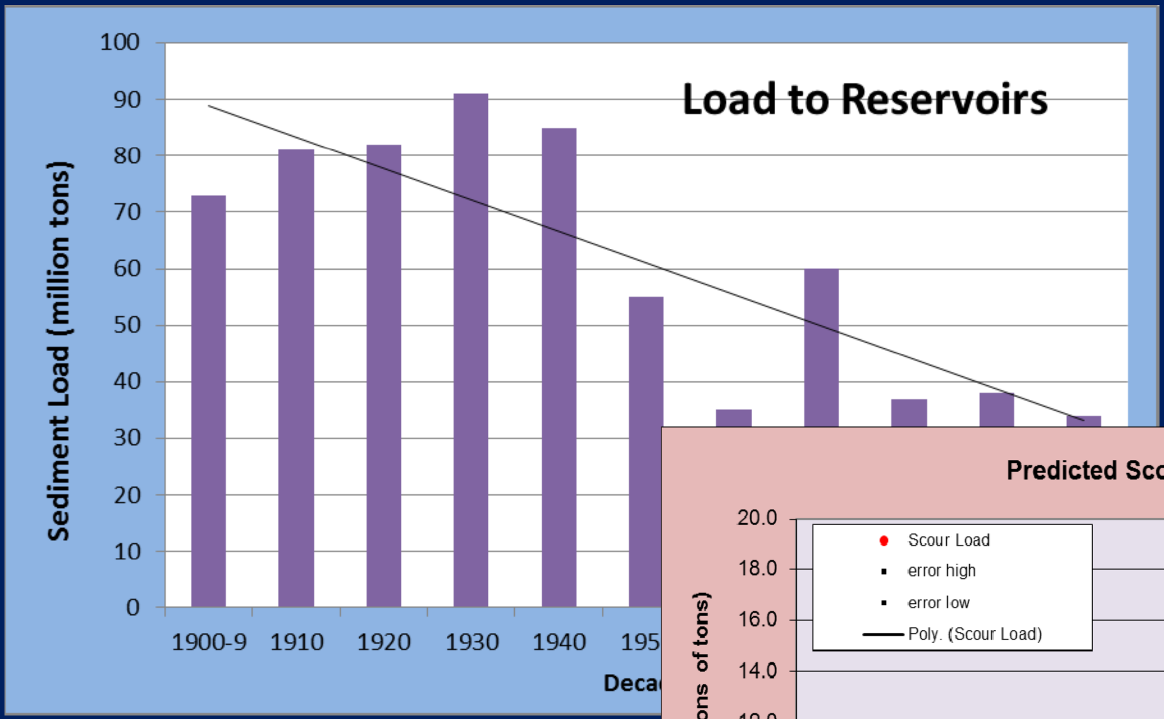
Mike Langland – USGS
August 15, 2013

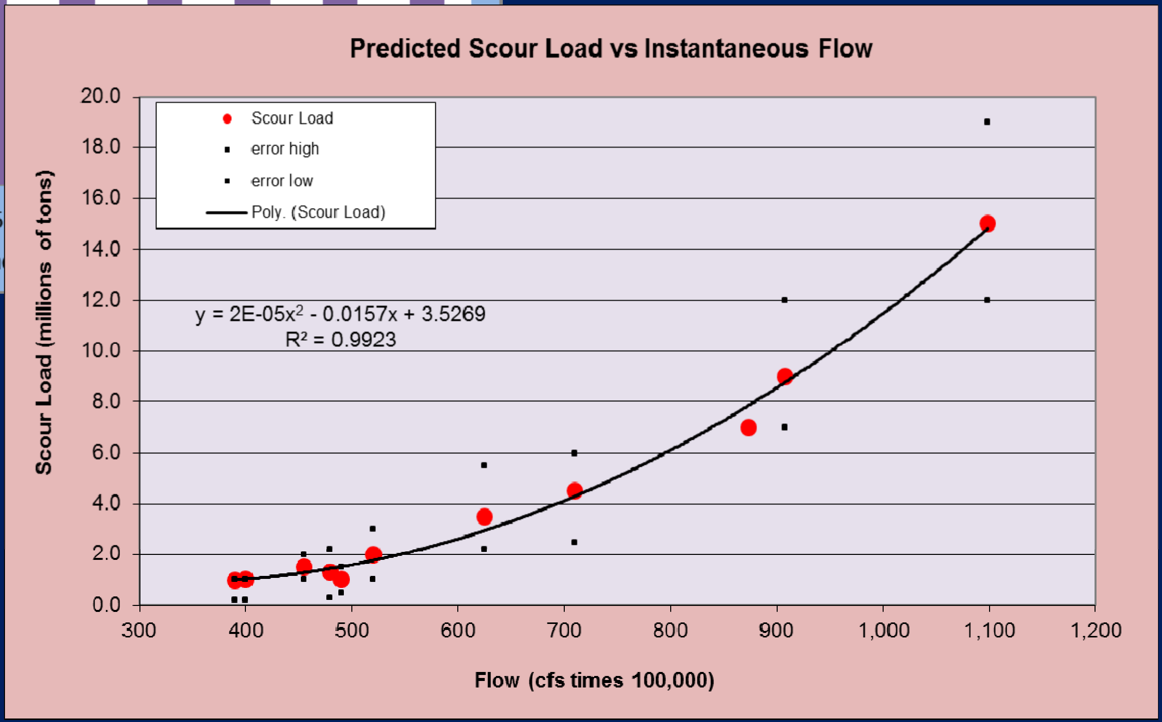
USGS

# Goals – Information on 3 topics

1. Sediment Transport - (flood frequencies, sediment transport rates, trapping, and delivery, etc.)
2. Present information on particle size distribution and location
3. Scour – Model vs. Actual

# Load and scour predictions for Susquehanna River at Conowingo based on the following --




USGS

# Flow and load predictions for Susquehanna River at Conowingo for selected discharges

| Flow (cubic feet per second) | Recurrence Interval (years) | Number of days in 100 years | Predicted scour above 400,000 cfs (tons)[1] | Predicted total load scour plus watershed (tons)[2] | Percent scour to total load |
|---|---|---|---|---|---|
| **1,000,000** | 80 | 1.25 | 12,000,000 | 28,000,000 | 43 |
| **900,000** | 45 | 2.2 | 8,000,000 | 20,200,000 | 40 |
| **800,000** | 25 | 4 | 5,800,000 | 18,000,000 | 32 |
| **700,000** | 15 | 6.5 | 4,000,000 | 16,000,000 | 25 |
| **600,000** | 10 | 10 | 3,000,000 | 13,400,000 | 22 |
| **500,000** | 6.25 | 16 | 1,600,000 | 7,400,000 | 22 |
| **400,000** | 4 | 25 | 1,000,000 | 4,500,000 | 22 |
| **300,000** | 1.5 | 68 | 0 | 1,000,000 | 0 |

1 – predicted scour from USGS scour equation, bathymetry change, and literature estimates.
2 – predicted total load based on regression equation, bathymetry change, and literature estimates.



USGS

# Annual Sediment Loads and Trapping Over Time

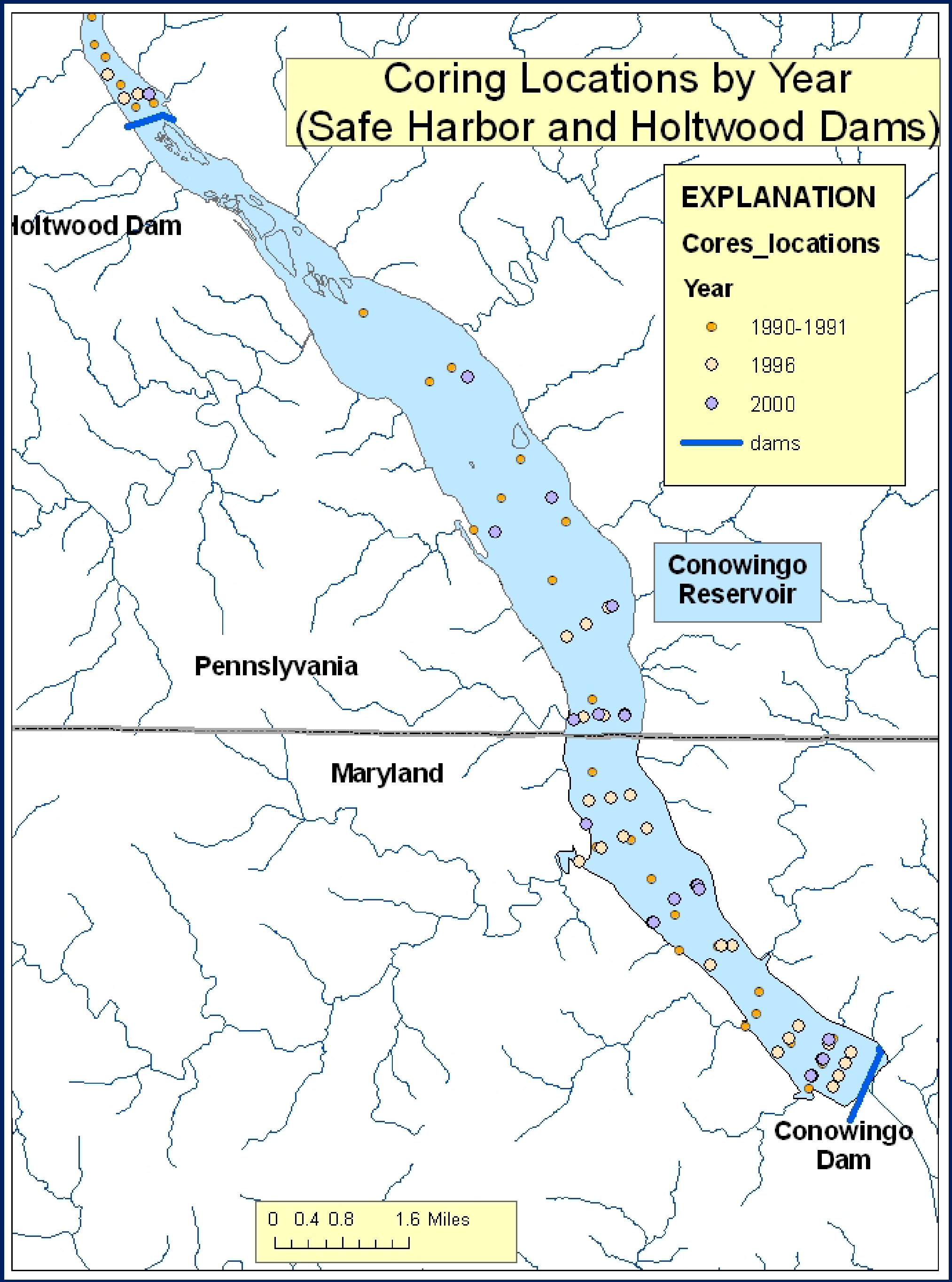
| Time Period | Average Annual Load to Reservoirs (million tons/yr) | Reservoir Trapping % | Average Annual Load Trapped (tons) | Average Annual Load to Bay (million tons/yr) |
|---|---|---|---|---|
| 1928-1940 | 8.7 | 75-80 | 6.7 | 2.0 |
| 1941-1950 | 8.5 | 70-75 | 6.2 | 2.3 |
| 1951-1971 | 5.7 | 65-70 | 3.9 | 1.8 |
| 1973-1992 | 4.8 | 60-65 | 3.0 | 1.8 |
| 1993-2011 | 3.4 | 55-60 | 1.9 | 1.5 |

| | | | | |
|---|---|---|---|---|
| **1972** | **15** | **0** | **(-15)** | **30** |

USGS

# Conowingo Cores

| | |
|---|---|
| 1990-91 | 21 locations |
| 1996 | 22 locations |
| 2000 | 16 locations |
| Total | 58 cores |




USGS

# Conowingo Cores

1990

Upper – 80% sand

Middle – 39% sand

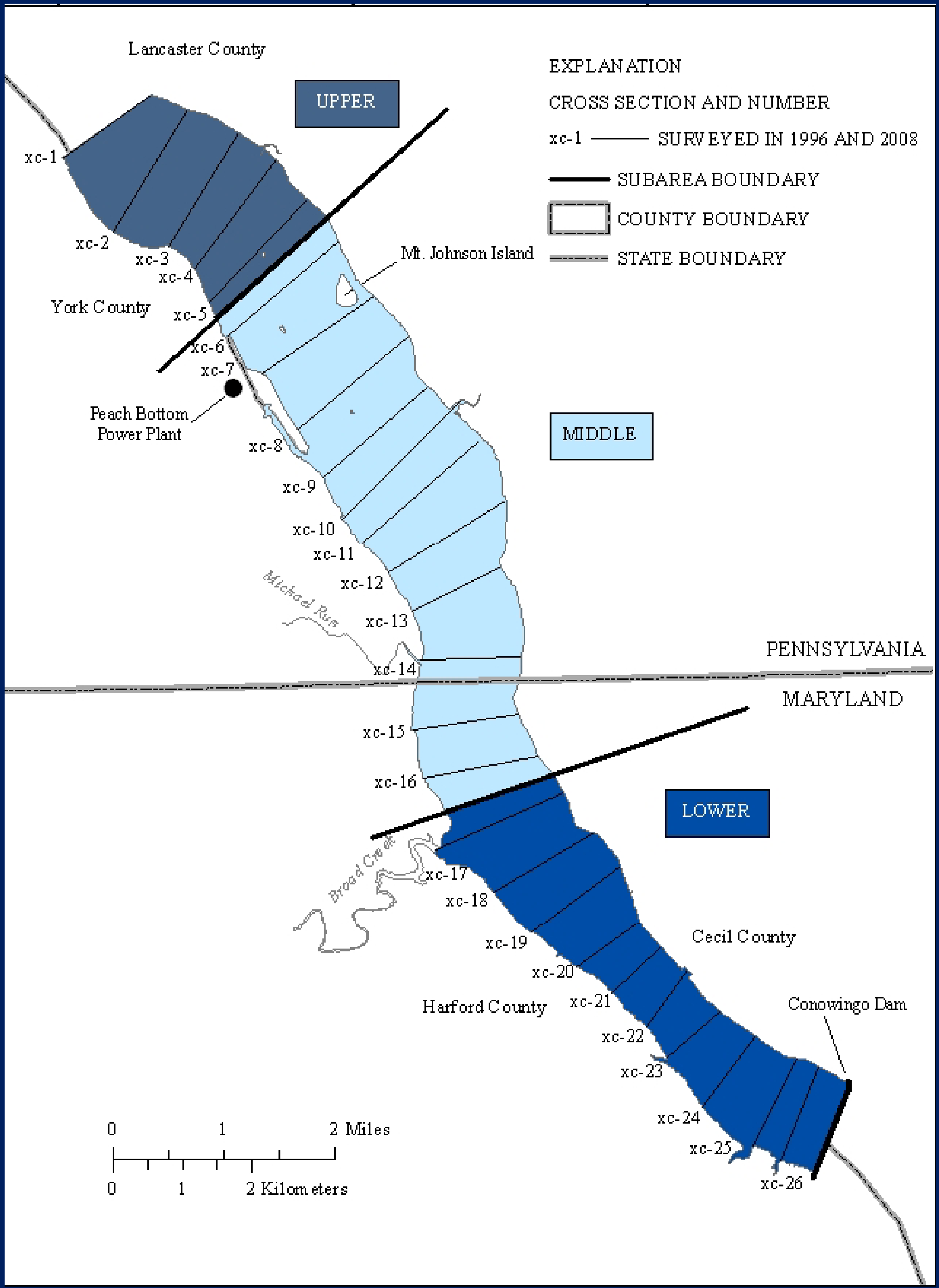
Lower – 5% sand (35% clay)

2000

Upper – 83% sand

Middle – 43% sand

Lower – 15% sand (12% clay)



# Total Mass of Sand in Conowingo Reservoir

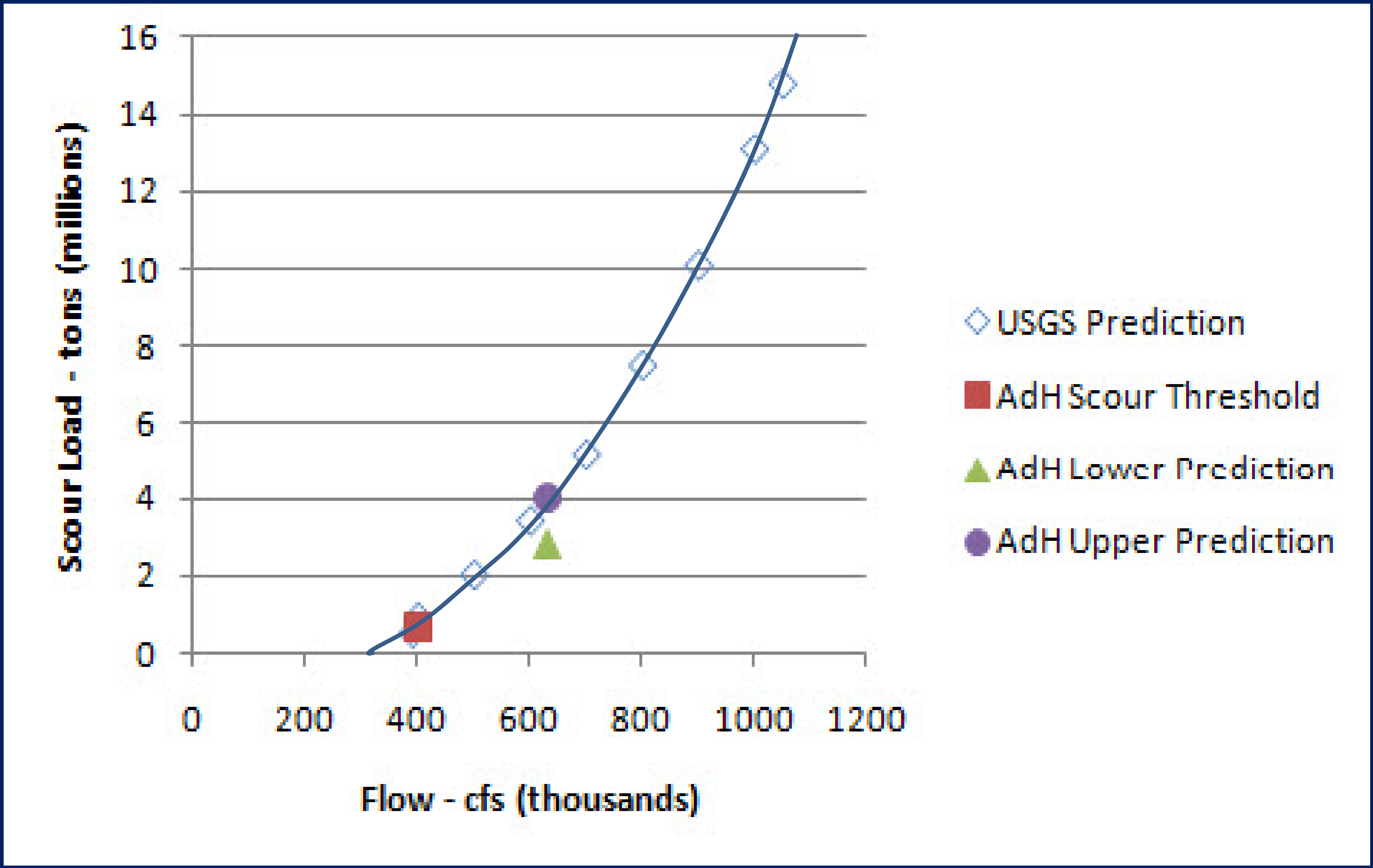
| Location | Total Sediment Deposition (tons) | % Sand | Total Sand deposition (tons) |
|---|---|---|---|
| 1990-Upper | 11,000,000 | 80 | 8,800,000 |
| 1990-Middle | 64,000,000 | 39 | 24,000,000 |
| 1990-Lower | 80,500,000 | 5 | 4,000,000 |
| 2000-Upper | 11,500,000 | 83 | 9,500,000 |
| 2000-Middle | 60,000,000 | 43 | 25,000,000 |
| 2000-Lower | 103,000,000 | 15 | 15,500,000 |
| 2012-Upper (projected) | 11,000,000 | 84 | 9,600,000 |
| 2012-Middle (projected) | 64,000,000 | 45 | 27,500,000 |
| 2012-Lower (projected) | 108,000,000 | 20 | 21,600,000 |

USGS

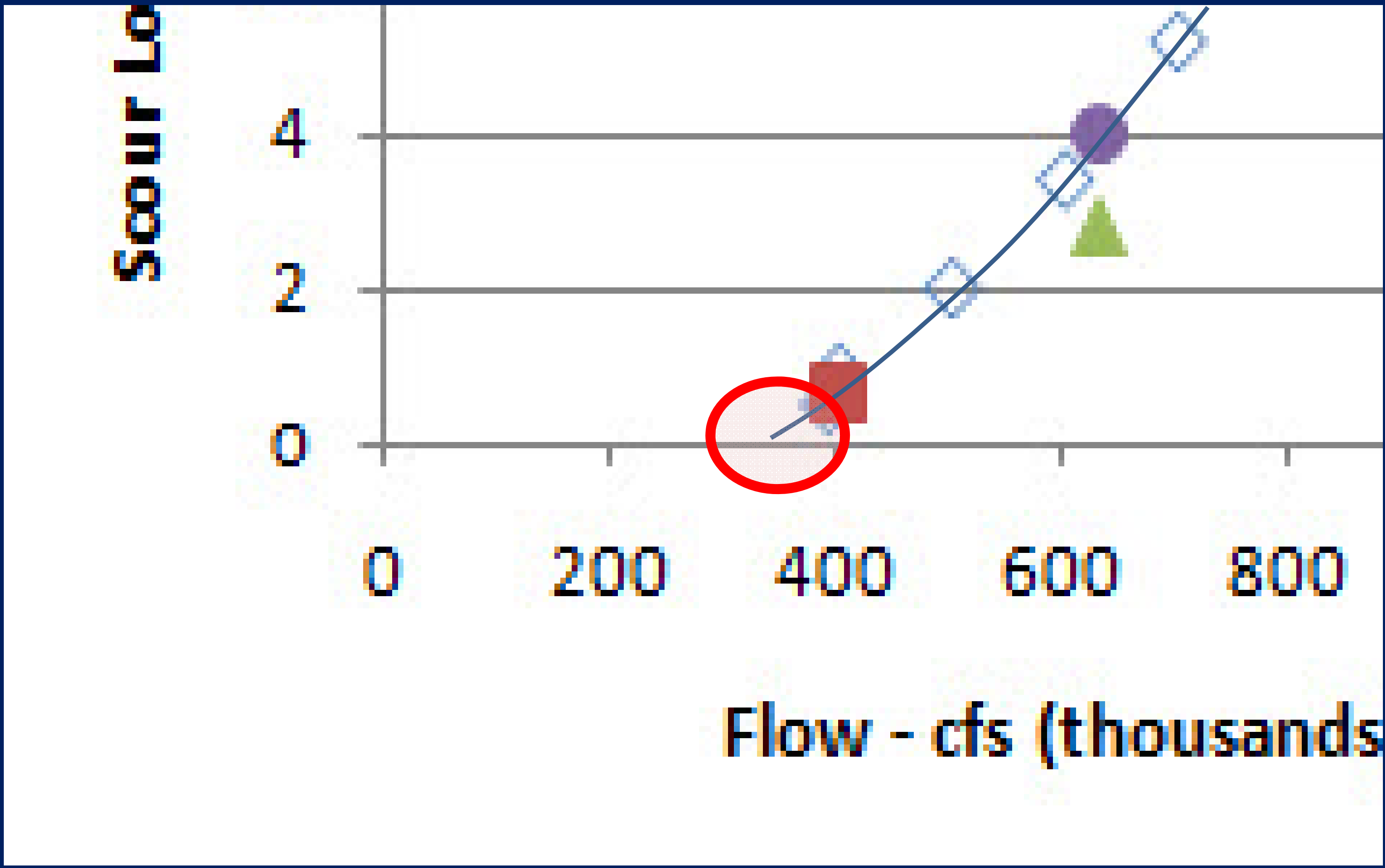
# Summary

- Long-term sediment transport rates into/out of reservoirs declining
- Historical data indicates decreasing trapping efficiency over time
- Increasing discharge results in increasing scour (400-700,000 cfs, ~23%)
- Sand is moving and displacing fines down gradient in Conowingo Reservoir
- Conowingo Reservoir is in or close to equilibrium phase (~93% filled)

# Estimated Scour vs. Modeled Scour (Adh)



# Estimated Scour Threshold



# Lower Susquehanna River Watershed Assessment S1

## SEDIMENT MANAGEMENT SCENARIOS

*Agitation Dredging*

***Goal:*** ***Transport bed sediments through the dam by re-suspending reservoir bed sediments through agitation dredging***

**Requirements**

- **High pressure water jets or diffusers to re-suspend bed sediments upstream of dam**
- **Adequate flow velocity to transport re-suspended sediment through Conowingo Dam (function of sediment particle size and bed shear stress**

# Lower Susquehanna River Watershed Assessment S2

## SEDIMENT MANAGEMENT SCENARIOS

*Agitation Dredging*

***Goal: Transport bed sediments through the dam by re-suspending reservoir bed sediments through agitation dredging***

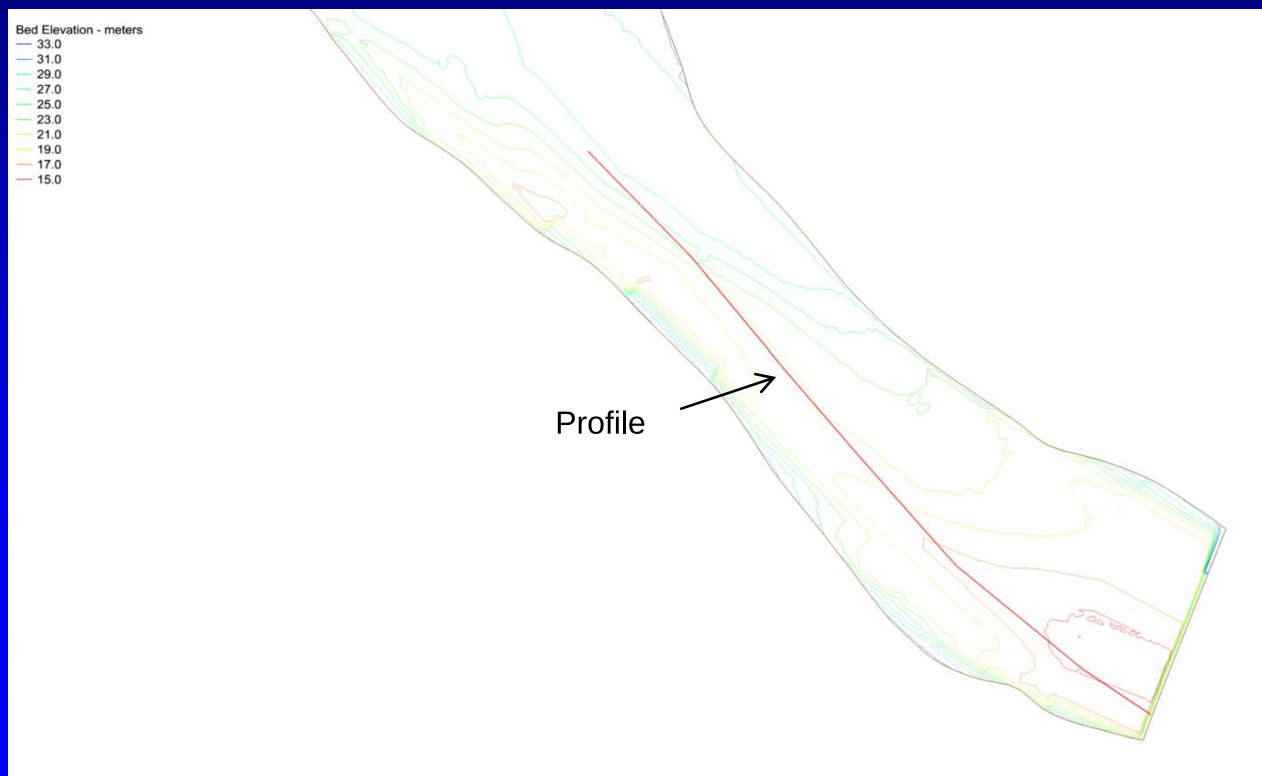
## Analysis Method

- **Used the 2D model to Compute bed shear stress for varying flows through Conowingo**
- **Computed shear velocity to evaluate turbulence required to maintain sediment in suspension**
- **Computed percentage of sediment remaining in suspension as a function of flow**

# Lower Susquehanna River Watershed Assessment S3

## SEDIMENT MANAGEMENT SCENARIOS

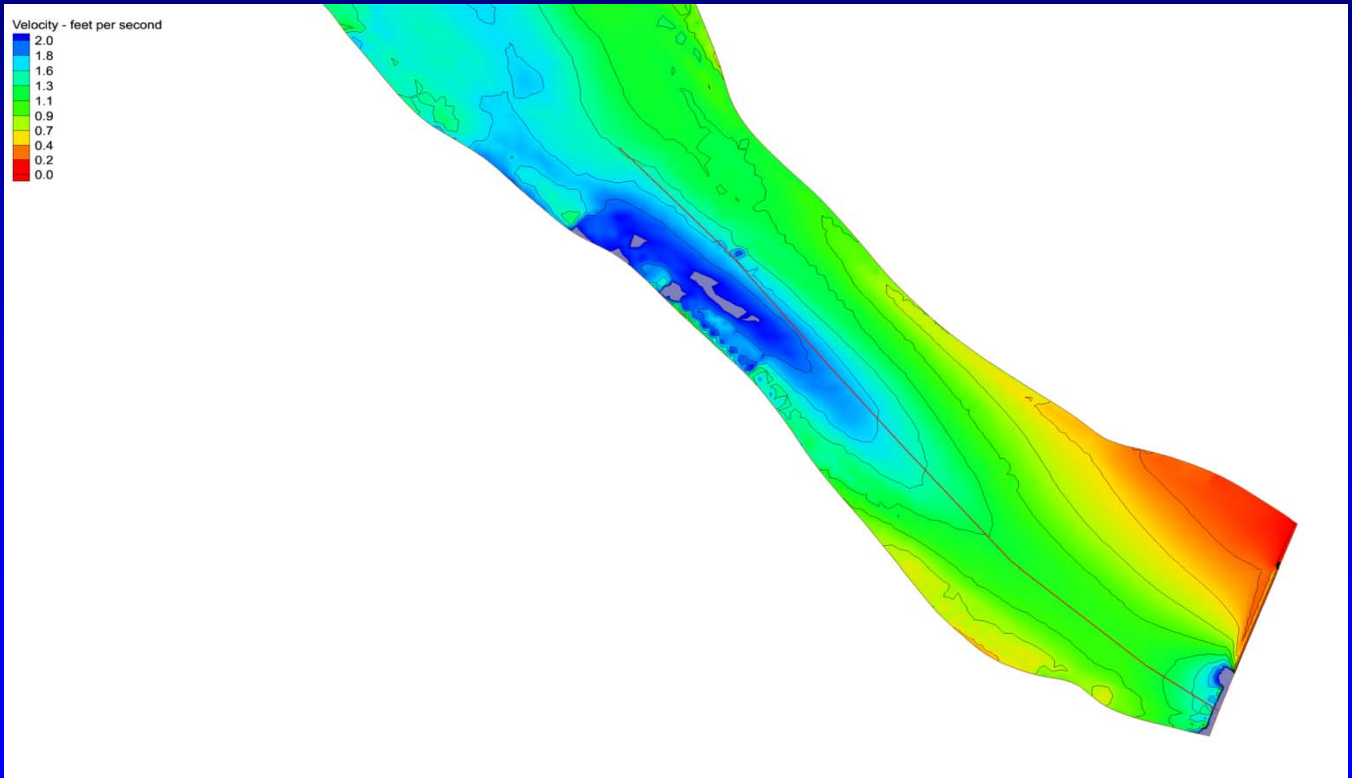
### Analysis Profile Through Lower Reservoir



# Lower Susquehanna River Watershed Assessment S4

## SEDIMENT MANAGEMENT SCENARIOS

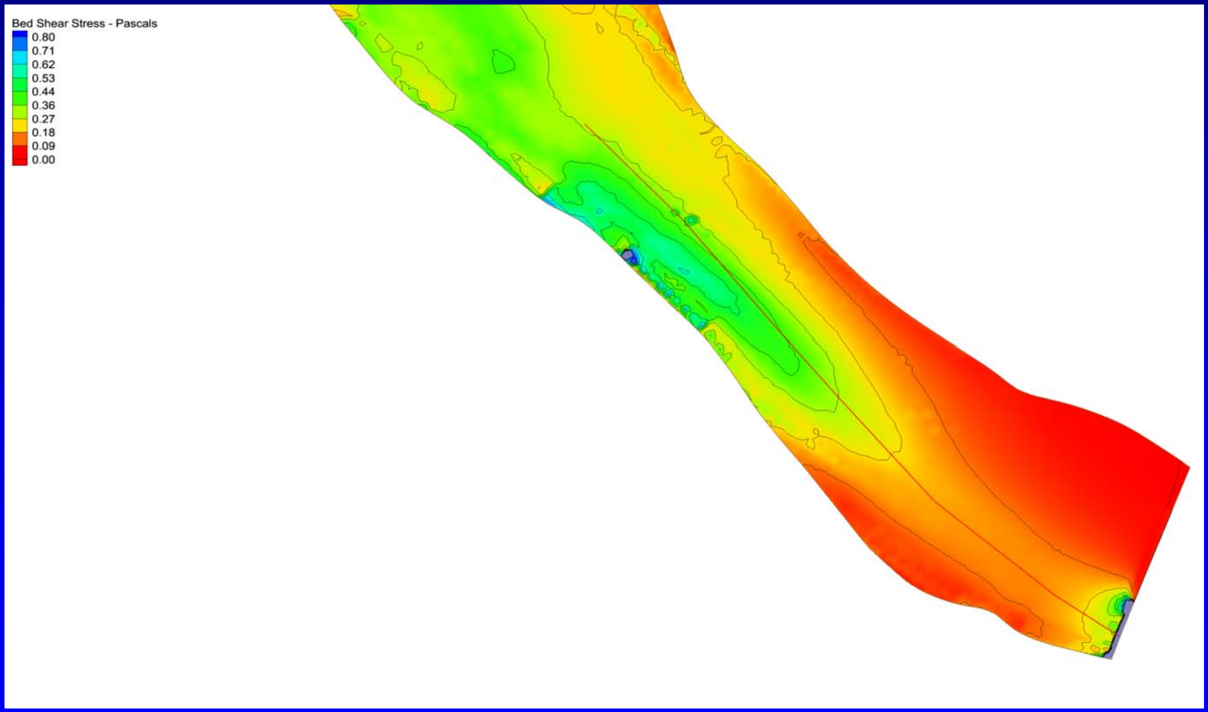
### Velocity Profile Through Lower Reservoir – 150,000 cfs



# Lower Susquehanna River Watershed Assessment S5

## SEDIMENT MANAGEMENT SCENARIOS

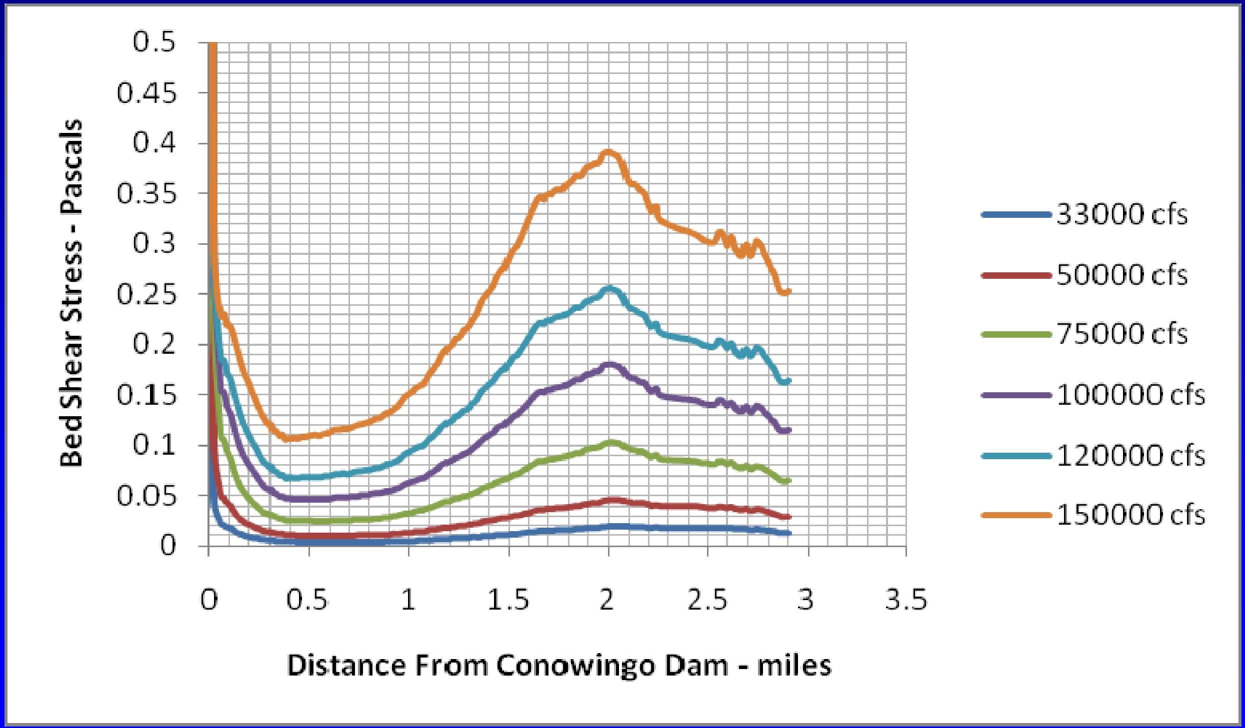
### Bed Shear Stress Profile Through Lower Reservoir – 150,000 cfs



# Lower Susquehanna River Watershed Assessment S6

## SEDIMENT MANAGEMENT SCENARIOS

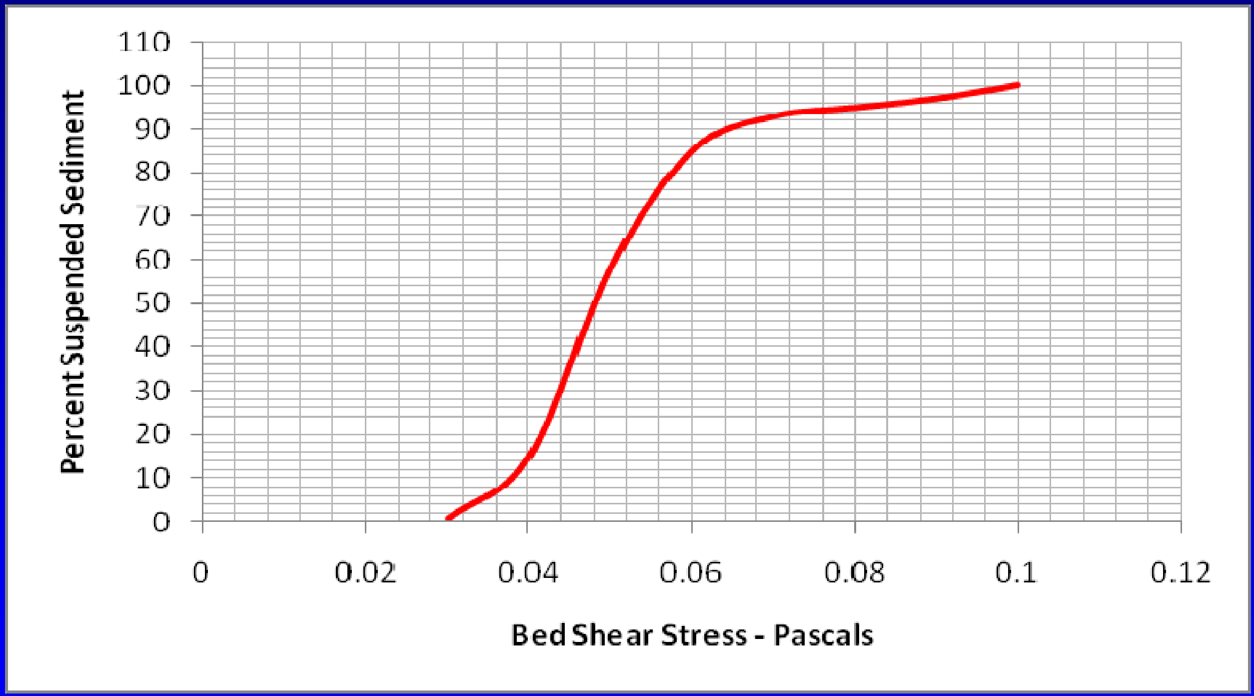
**Bed Shear Stress as a Function of Flow Through Lower Reservoir – 150,000 cfs**



# Lower Susquehanna River Watershed Assessment S7

## SEDIMENT MANAGEMENT SCENARIOS

**Percent of Suspended Sediment as a Function of Bed Shear Stress**



# Lower Susquehanna River Watershed Assessment S8

## SEDIMENT MANAGEMENT SCENARIOS

### Percent Suspended Sediment as a Function of Flow

| Flow Event – cubic feet per second | Percent Suspended Sediment |
|---|---|
| | |
| 33,000 | 0.0 |
| 50,000 | 0.0 |
| 75,000 | 1.0 |
| 100,000 | 58.0 |
| 120,000 | 92.0 |
| 150,000 | 100.0 |

**Conclusion:** A minimum Discharge of 150,000 cfs is Required To insure Transport of Agitated Sediment Through the Dam

Flows $\geq$ 150,000 cfs occur on the average 12 days per year

# Lower Susquehanna River Watershed Assessment S9

## SEDIMENT MANAGEMENT SCENARIOS

*Dredging*

***Goal: Reduce Scour Potential and Increase Sedimentation in reservoir***

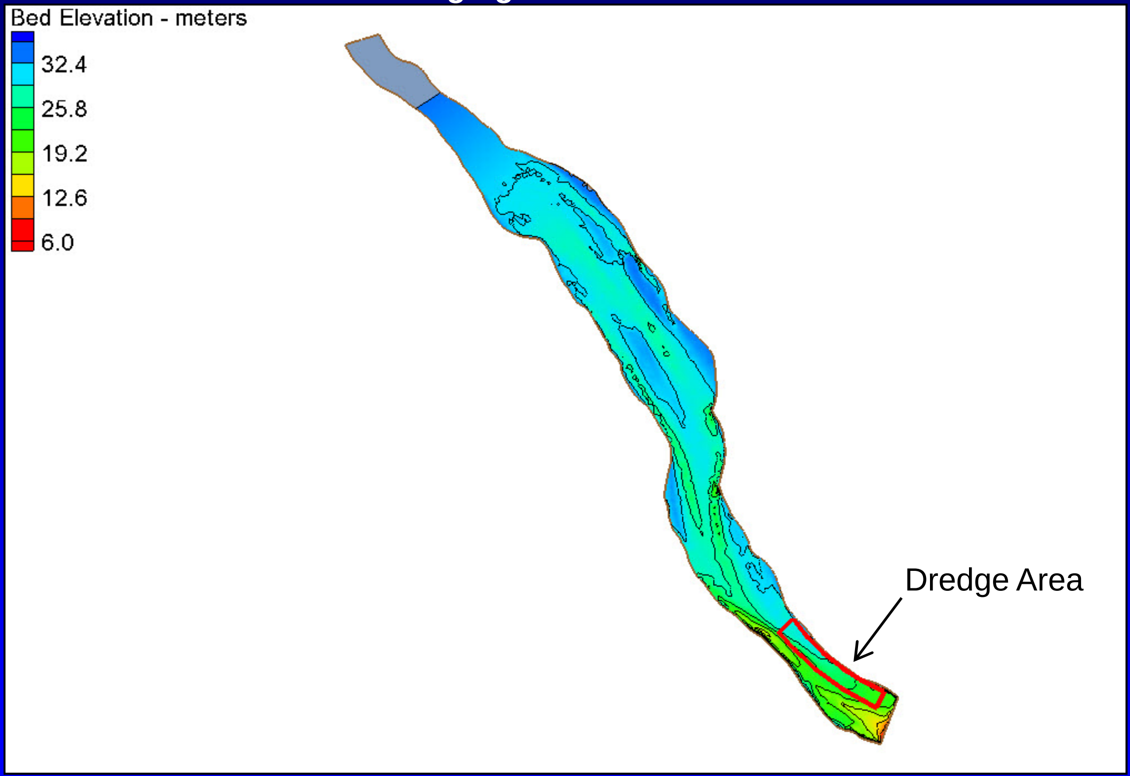
## Analysis Method

- **Used the 2D model to Compute Sediment Transport Through Conowingo with Current (2011) bathymetry for 2008 – 2011 Susquehanna River Flows**
- **Remove 3 million cubic yards from depositional area 1.0 – 1.5 miles above the dam**
- **Re- Compute Sediment Transport with dredged area**
- **Compare simulation results (2011 bathymetry vs 2011 bathymetry with dredged area)**

# Lower Susquehanna River Watershed Assessment S10

## SEDIMENT MANAGEMENT SCENARIOS

**Dredging Location**



# Lower Susquehanna River Watershed Assessment S11

## SEDIMENT MANAGEMENT SCENARIOS

## *Dredging*

***Results For Dredging 3 million Cubic Yards:***

- **Dredging Results in a 3 percent reduction in scour (2.98 million tons to 2.71 million tons) over the four year flow record**
- **Dredging Results in a 6 percent increase in sedimentation (4.02 to 4.28 million tons)**

# Lower Susquehanna River Watershed Assessment S1

## Sediment Bypassing Analysis

## GOAL

**Evaluate the impact of sediment bypassing operations on water quality below Conowingo Dam**

## ANALYSIS SCENARIOS

- **2.4 million tons bypassed over 3 months time (90 days)**
- **2.4 million tons bypassed over 9 months time (270 days)**

# Lower Susquehanna River Watershed Assessment S2

## Sediment Bypassing Analysis

*Two Components of Bypass Stream*

1. Dredged material slurry discharge below Conowingo Dam
2. Susquehanna River flow through the dam

*Assumptions*

- Mean winter Susquehanna River flow of 60,000 cfs
- Suspended sediment concentration of 12 mg/l in river
- Dredged material consisting of 20% Sand, 72% Silt, 8% clay
- Steady state flow conditions
- Average concentration by weight in dredge slurry of six percent
- Average bed density of 1600 kg / cubic meters

# Lower Susquehanna River Watershed Assessment S3

## Sediment Bypassing Analysis

### Impact on Suspended Sediment Load Below Dam:

- Increase in suspended sediment concentration from 12 to 176 mg/l for 90 day bypassing operation

- Increase in suspended sediment concentration from 12 to 66 mg/l for 270 day bypassing operation

# Lower Susquehanna River Watershed Assessment S1

## Summary of AdH 2D Model Runs
## 2008 – 2011 Simulation

All Loads in Millions of Tons

| Bathymetry | Inflow Load | Outflow Load | Scour Load | Net Deposition |
|---|---|---|---|---|
| 1996 | 26.3 | 20.3 | 1.8 | 6.0 |
| 2008 | 26.3 | 21.9 | 2.9 | 4.4 |
| 2011 | 26.3 | 22.3 | 3.0 | 4.0 |
| Full Condition | 26.3 | 22.2 | 3.0 | 4.1 |
| 2011 Dredge 3 mcy | 26.3 | 22.0 | 2.7 | 4.3 |

**Note: 31 million cubic yards of sediment (25 million tons) deposited in Conowingo from 1996 to 2011**
**Outflow load contains watershed load plus scour load**

# Lower Susquehanna River Watershed Assessment S2

## Summary of AdH 2D Model Runs
## 2008 – 2011 Simulation

### *TS Lee Statistics – Loads out of Conowingo*

All Loads in Millions of Tons

| Bathymetry | Outflow Load | Total Lee load | Lee percent of outflow | Scour Load | Scour percent of Lee |
|---|---|---|---|---|---|
| 1996 | 20.3 | 13.1 | 65 | 1.8 | 14 |
| 2008 | 21.9 | 14.4 | 66 | 2.9 | 20 |
| 2011 | 22.3 | 14.5 | 65 | 3.0 | 21 |
| Full Condition | 22.2 | 14.6 | 66 | 3.0 | 21 |
| 2011 Dredged 3 mcy | 22.0 | 14.2 | 65 | 2.7 | 19 |

Note: Total Lee outflow load consists of inflowing load plus bed scour load

# Lower Susquehanna River Watershed Assessment S3

## SUMMARY

*For the Period or Record Simulated (2008 – 2011):*

- Scour in Conowingo increased from 1.8 to 3 million tons from 1996 - 2011
- Deposition in Conowingo decreased from 6 to 4 million tons from 1996 – 2011
- Comparison of the 2011 simulation to the full condition simulation indicates very little change in sediment transport – near full capacity
- Dredging 3 million cubic yards resulted in a scour reduction of 10 percent (3 percent per million cubic yards removed)
- Dredging 3 million cubic yards resulted in a 1.3 percent reduction of outflow load to the bay (0.44 percent per million cubic yards removed)

# Lower Susquehanna River Watershed Assessment S4

## SUMMARY OF TS LEE STATISTICS

*For the Period or Record Simulated (2008 – 2011):*

- TS Lee contributed 65 percent of the Conowingo Dam outflow load (Inflowing load and scour load)
- Bed scour during TS Lee comprised approximately 20 percent of the total TS Lee load, with 80 percent the inflowing load from the watershed

# Lower Susquehanna River Watershed Assessment S5

## CONCLUSIONS BASED ON MODELING RESULTS

***For the Period or Record Simulated (1996 – 2011):***

***Based on comparisons between the 1996 and 2011 simulations:***

- **For every million cubic yards dredged, the scour potential is reduced by three percent and the deposition potential increases by six percent**
- **Net benefit of dredging to the Bay is reduction of scour plus increase in reservoir sedimentation**
- **Dredging reservoir back to 1996 conditions has a net benefit of 2 million tons or load reduction to the Bay of 9% (removal of 31 million cubic yards)**

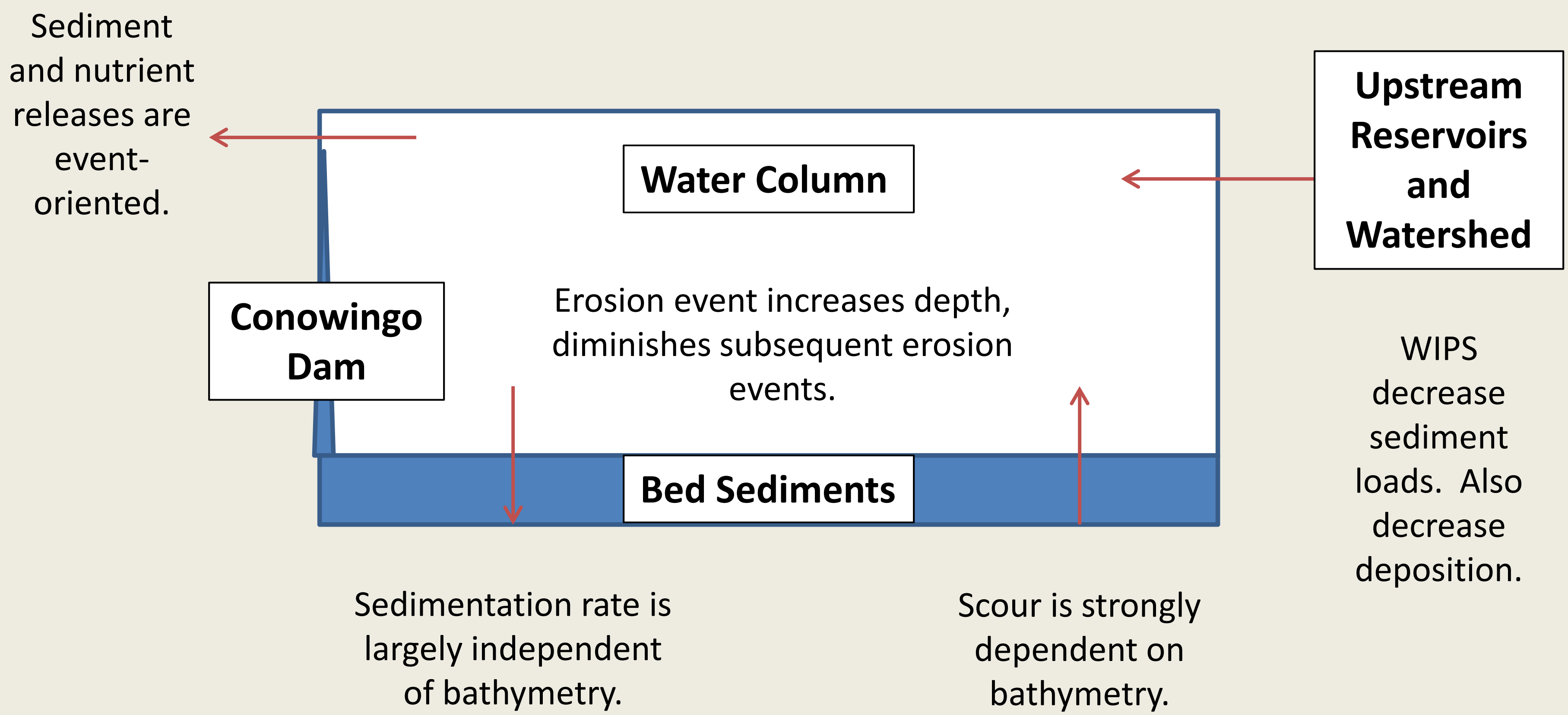
# Status

- Nearly 30 scenarios completed for NAB and CBP over a year's effort.
- Report on application of CBEMP in preparation. October time frame for draft.
- Targeted management scenarios in progress:
  - Dredging, remove 3 mcy. Completed.
  - Dredging, remove 3 mcy with sediment bypass. Mid-September.
  - Dredging, remove 31 mcy, equivalent to 1996 bathymetry. Completed.

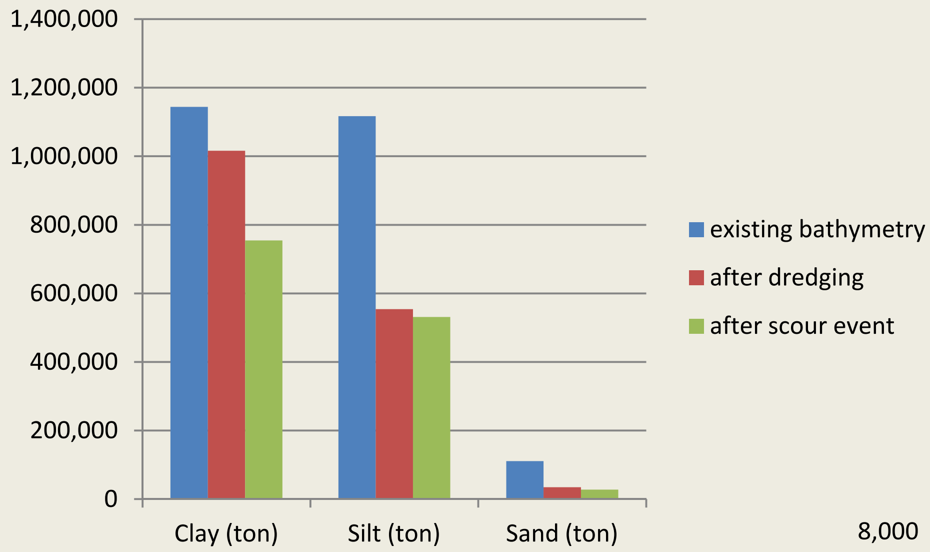
# Scenario Procedure

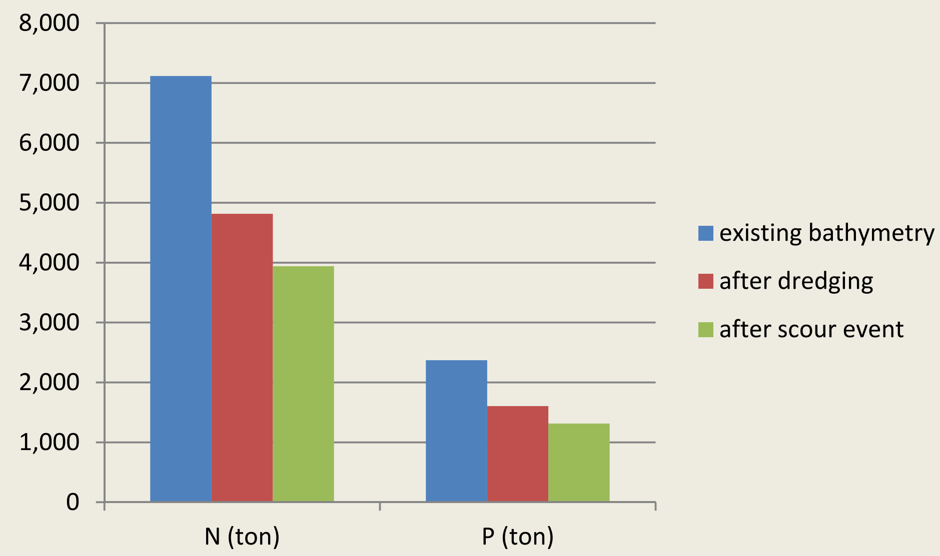
- The CBEMP is run for 1991 – 2001.
- Today's runs are based on Chesapeake Bay TMDL loadings.
- Loads from a major scour event in January 1996 are added to the WSM loads.
- Scour is computed by ADH applied to 2008 – 2011 hydrology including TS Lee. We obtain 1996 scour by a scaling procedure.
- Nutrient composition of solids is based on observations during TS Lee.

# Conceptual Model of Sediment Movement through Conowingo Reservoir

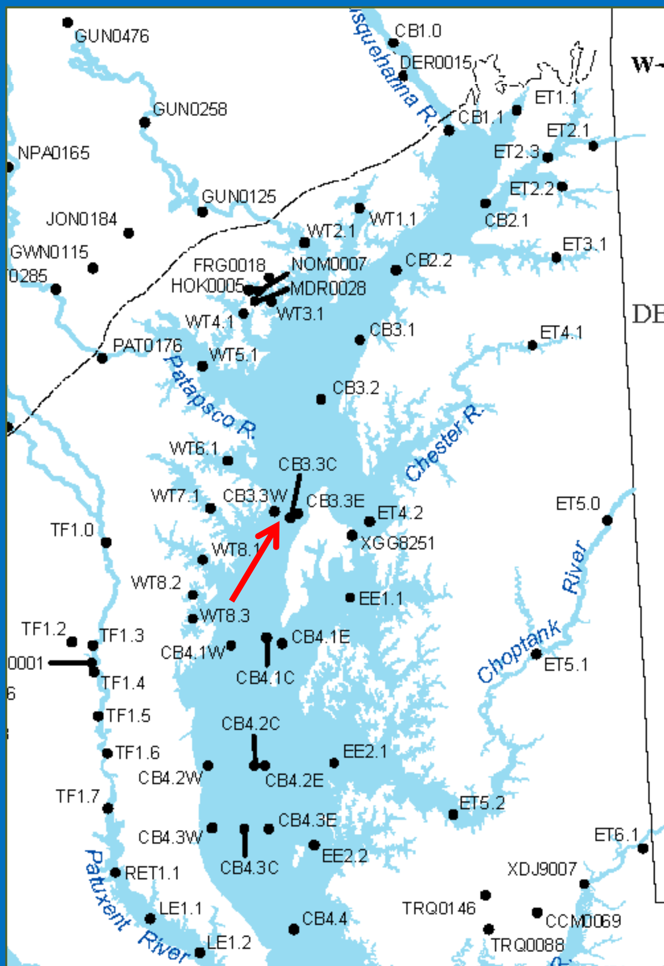


# 1996 Scour Loads for Three Bathymetries



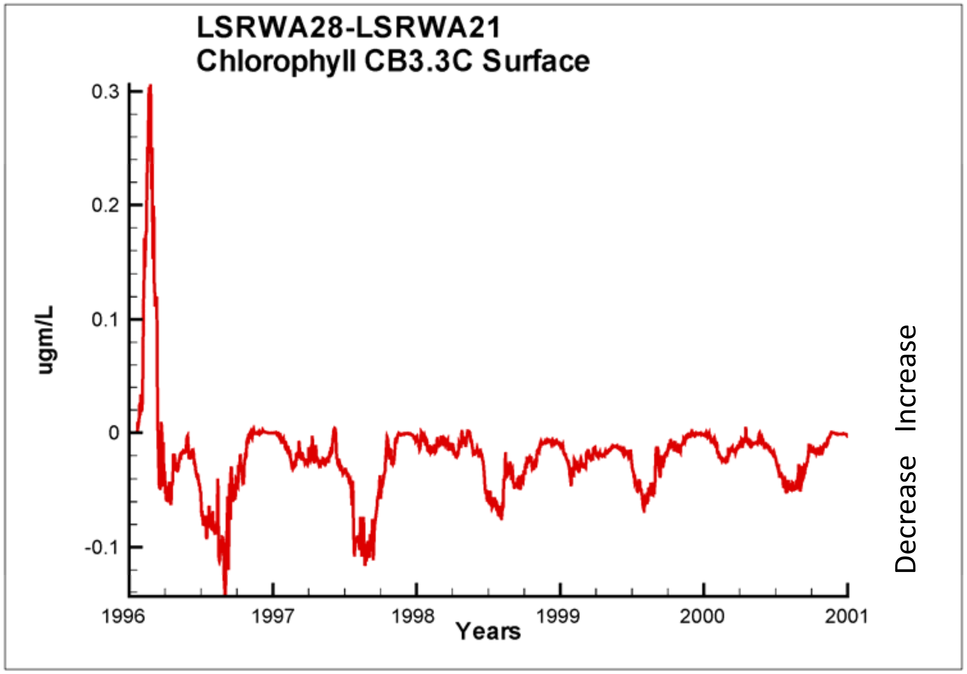



# Model Results



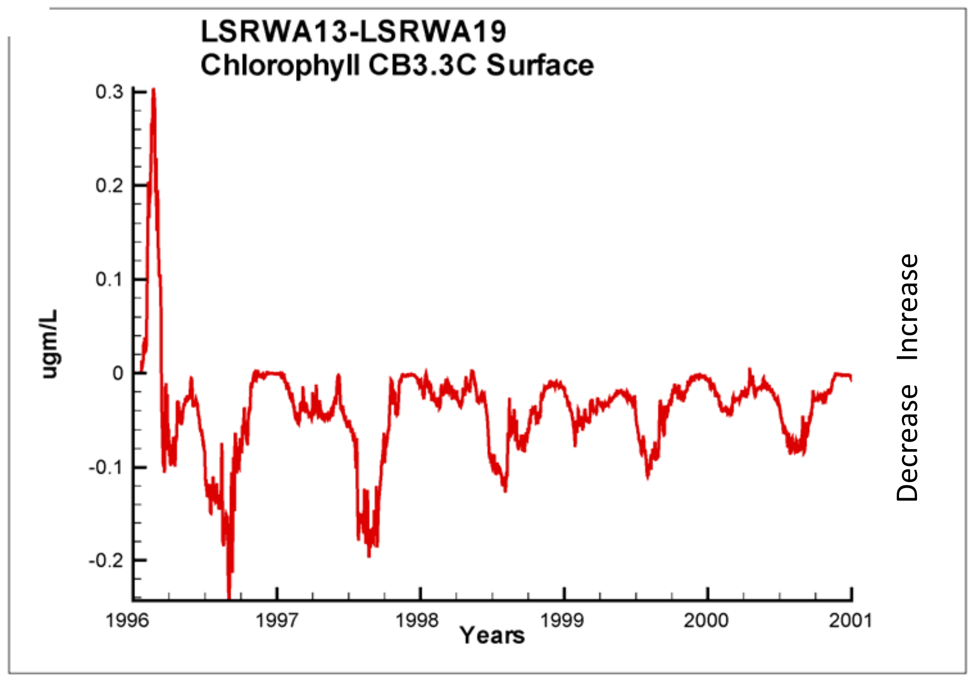
- We're going to concentrate on difference plots.
- Dredging 3 mcy (LSWRA28) – TMDL with existing bathymetry (LSRWA21).
- Dredging 31 mcy (LSRWA13) – TMDL with equilibrium bathymetry (LSWRA19).

PRELIMINARY DRAFT -- NOT FOR PUBLIC RELEASE, SUBJECT TO CHANGE




Dredge 3 mcy

Dredge 31 mcy



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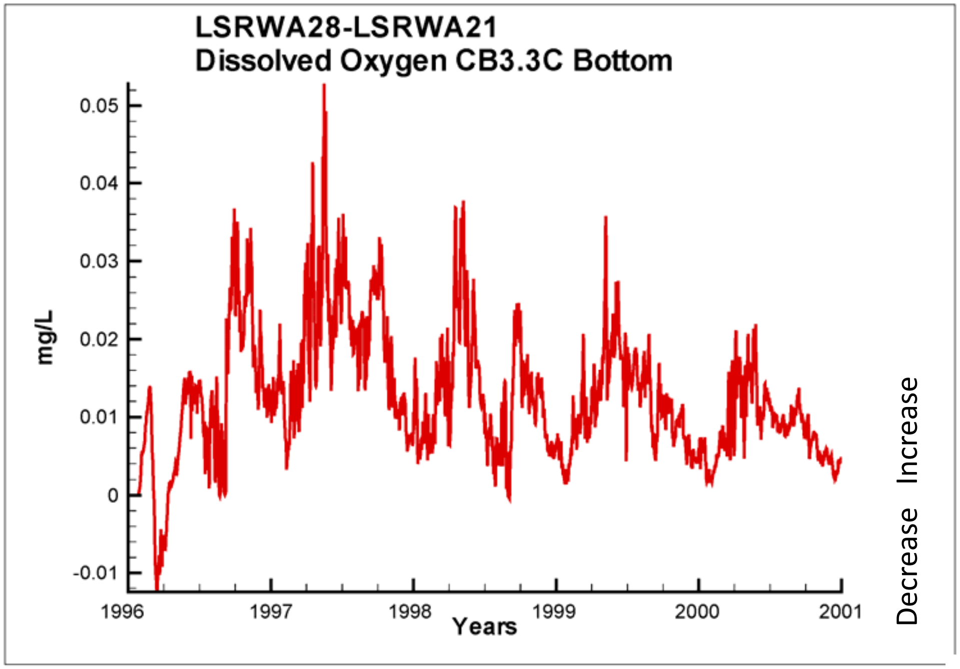
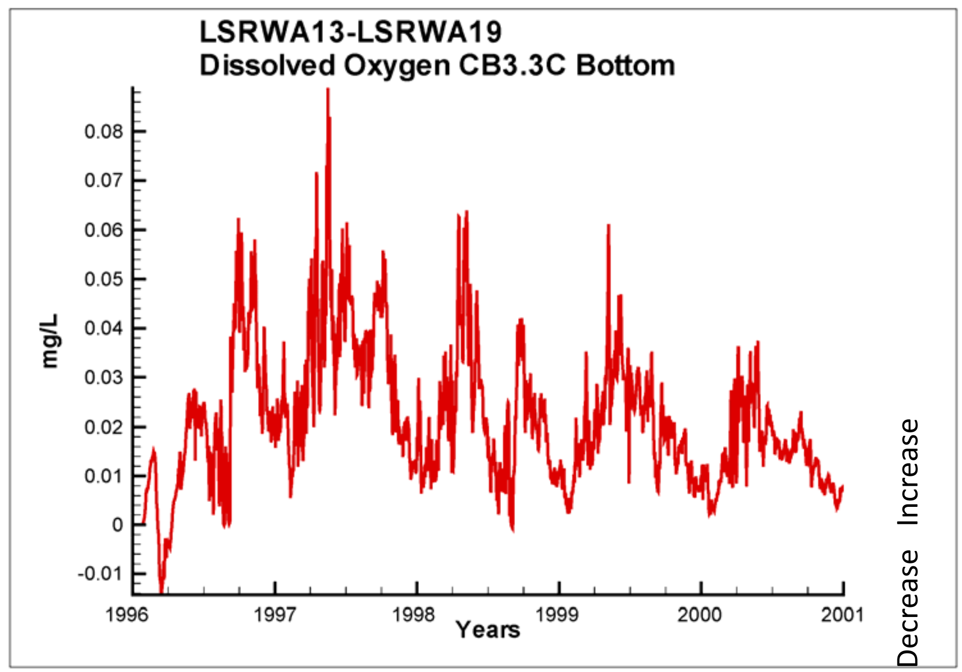
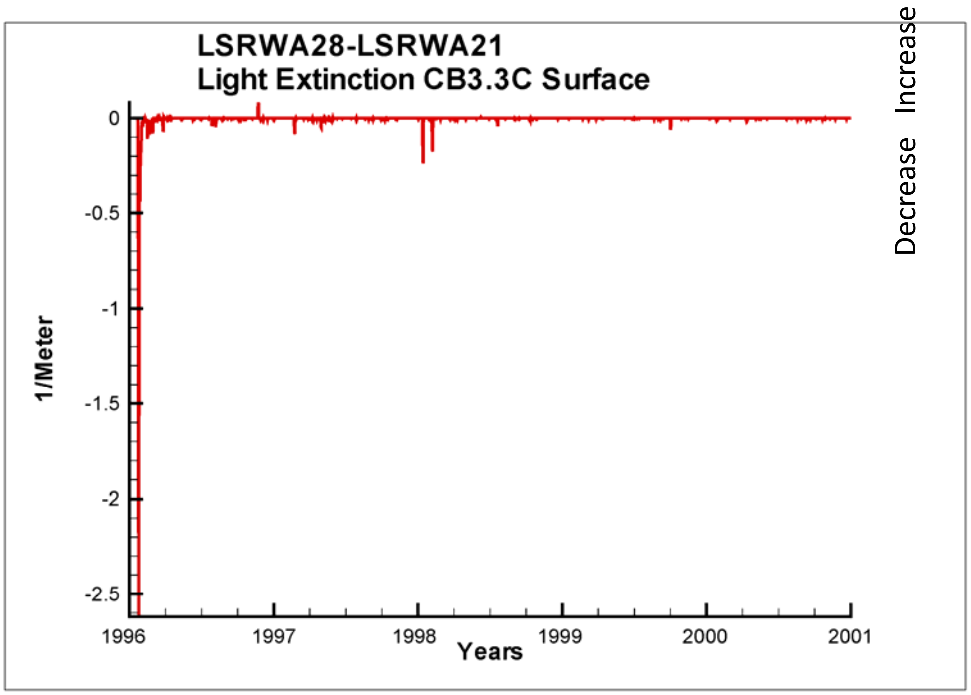



Dredge 3 mcy ←

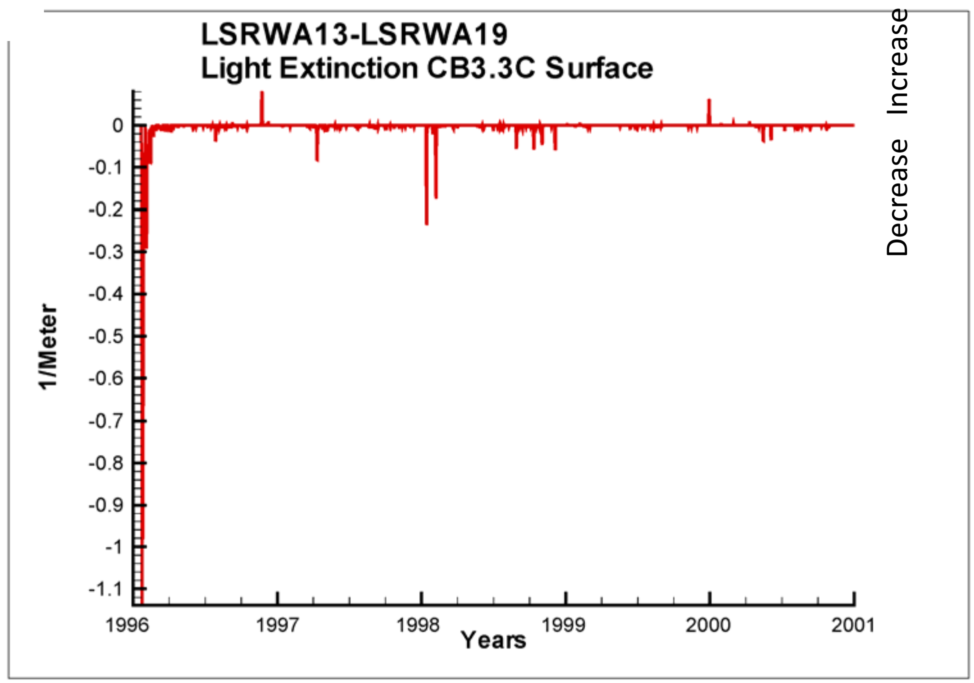
Dredge 31 mcy →

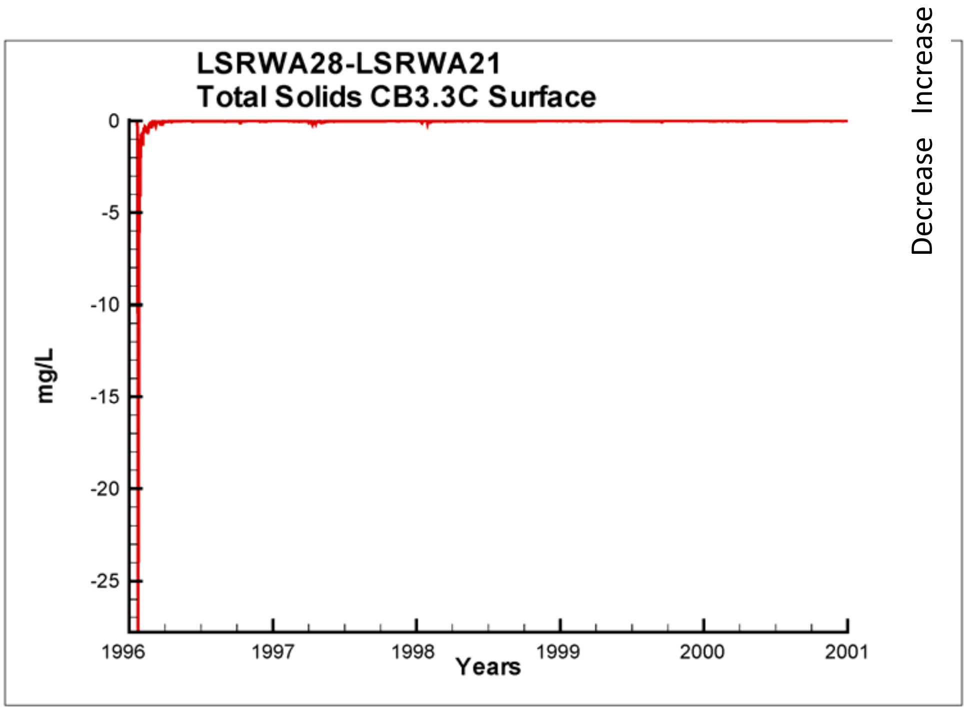





Dredge 3 mcy

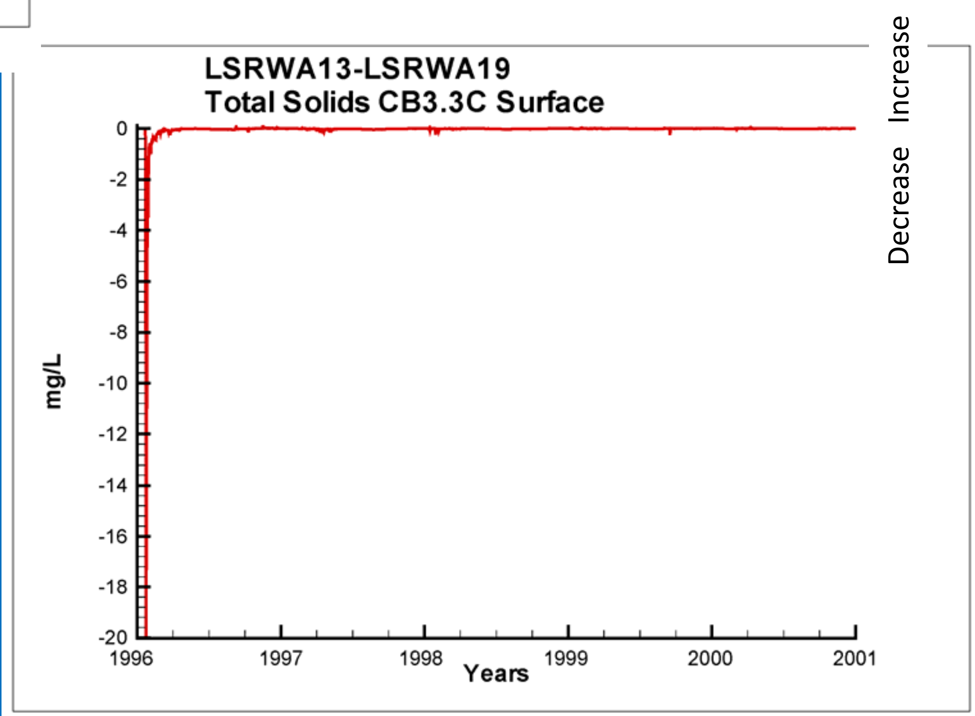
Dredge 31 mcy






Dredge 3 mcy

Dredge 31 mcy



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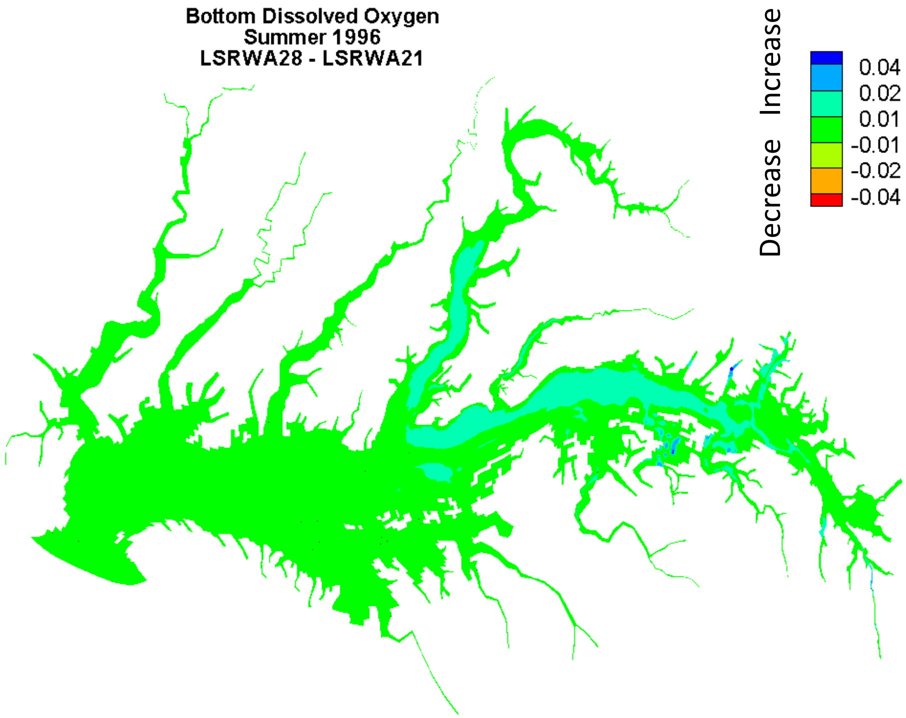
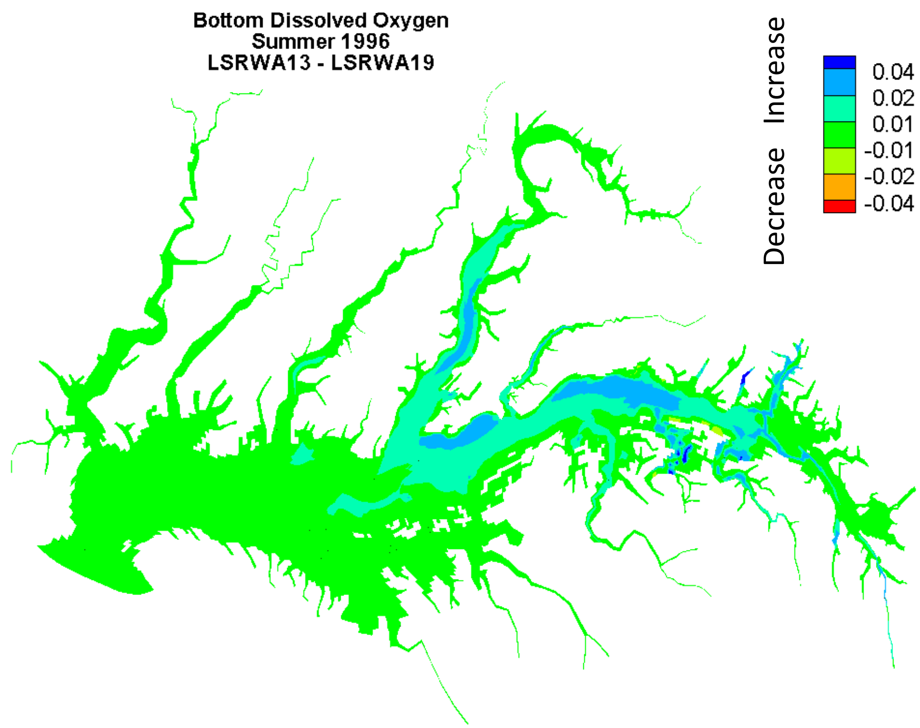



Dredge 3 mcy

Dredge 31 mcy



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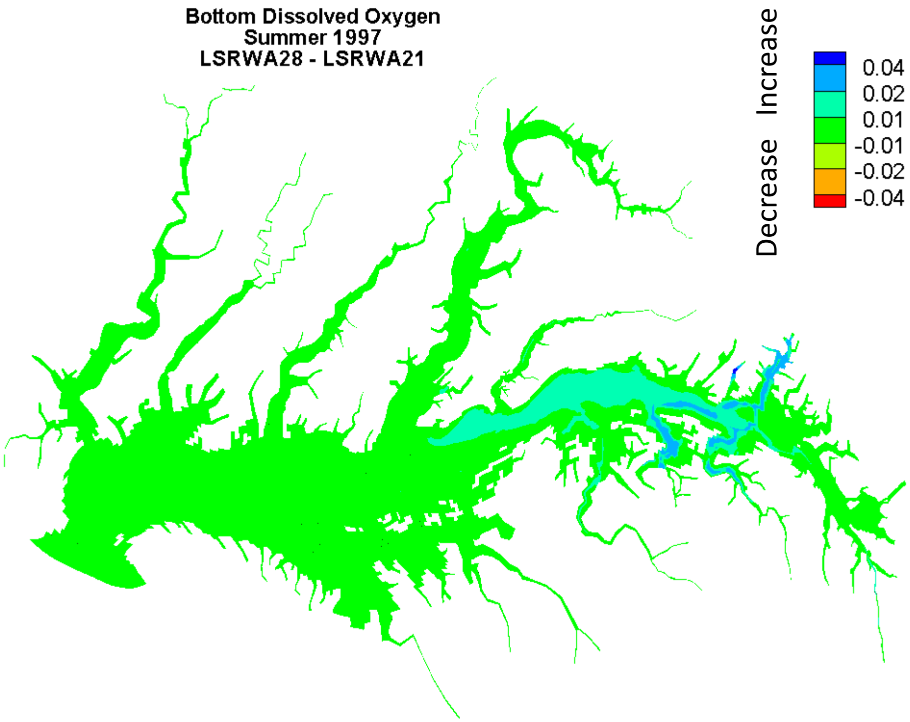
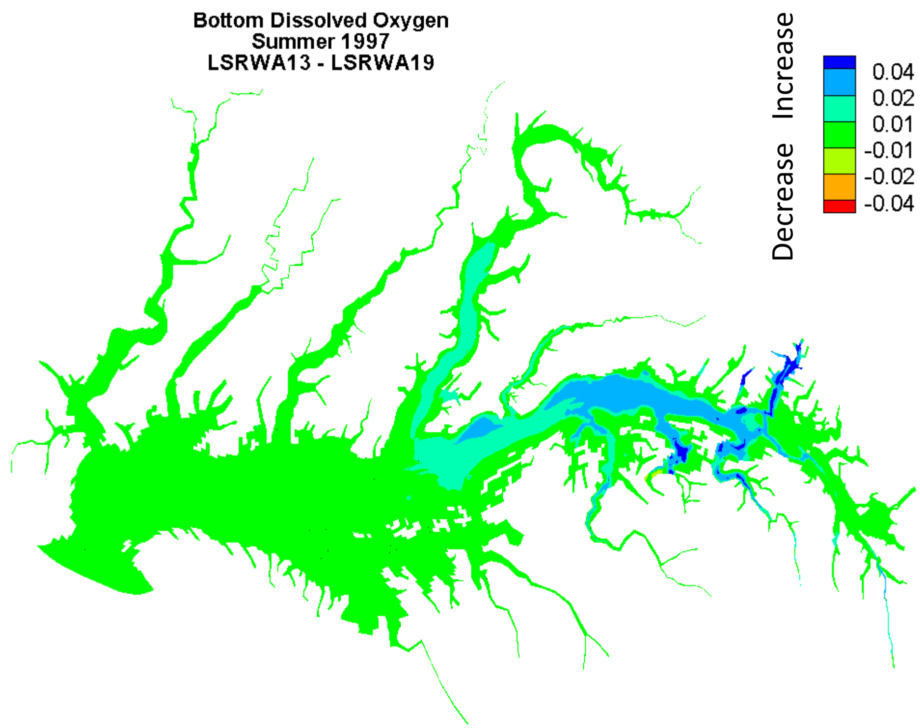
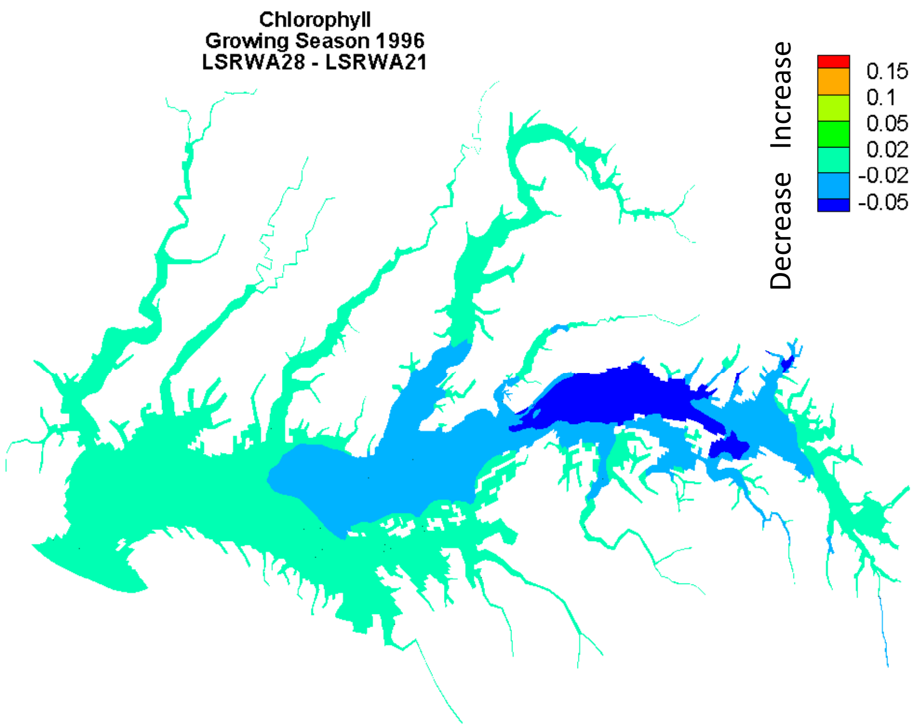



Dredge 3 mcy

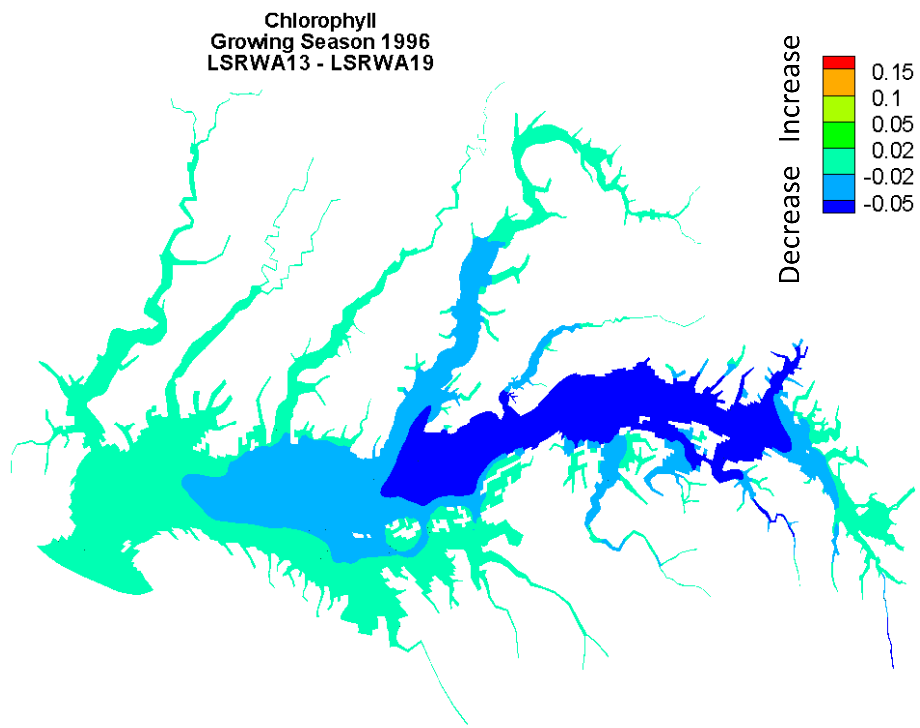
Dredge 31 mcy






Dredge 3 mcy

Dredge 31 mcy



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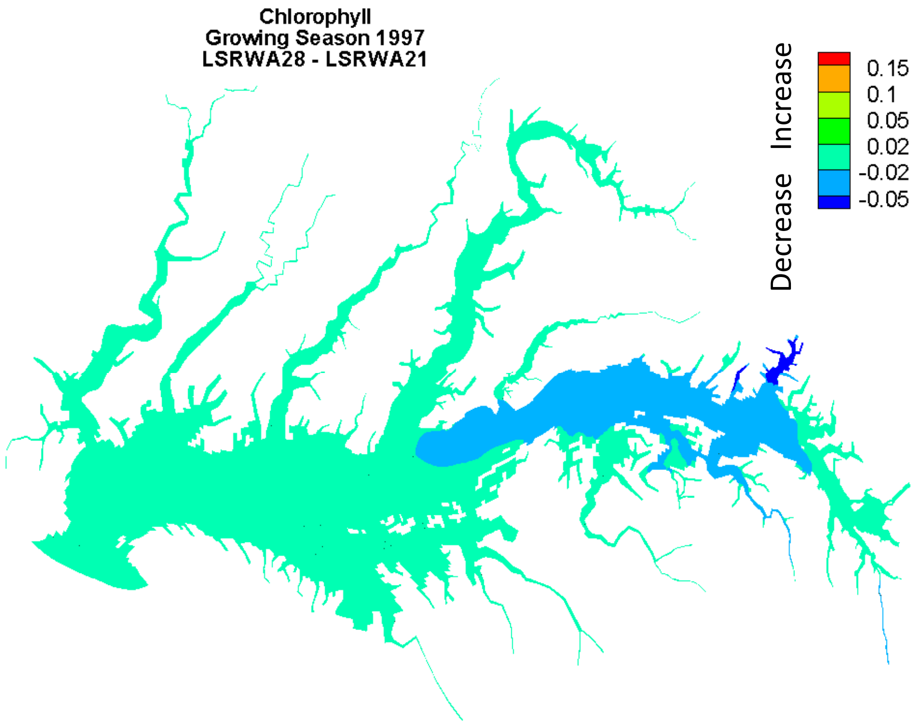
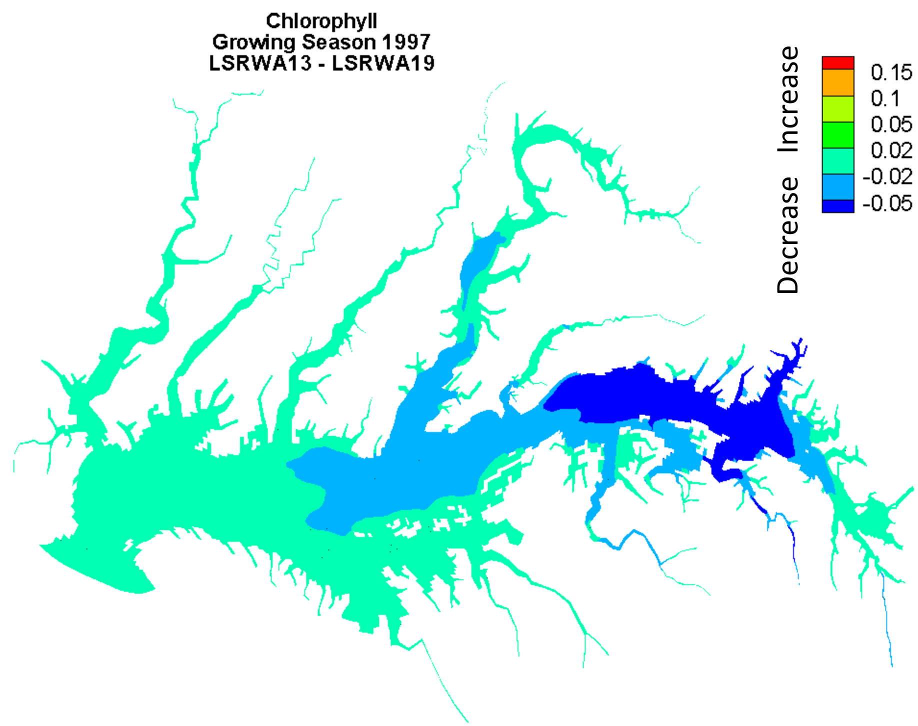



Dredge 3 mcy




Dredge 31 mcy

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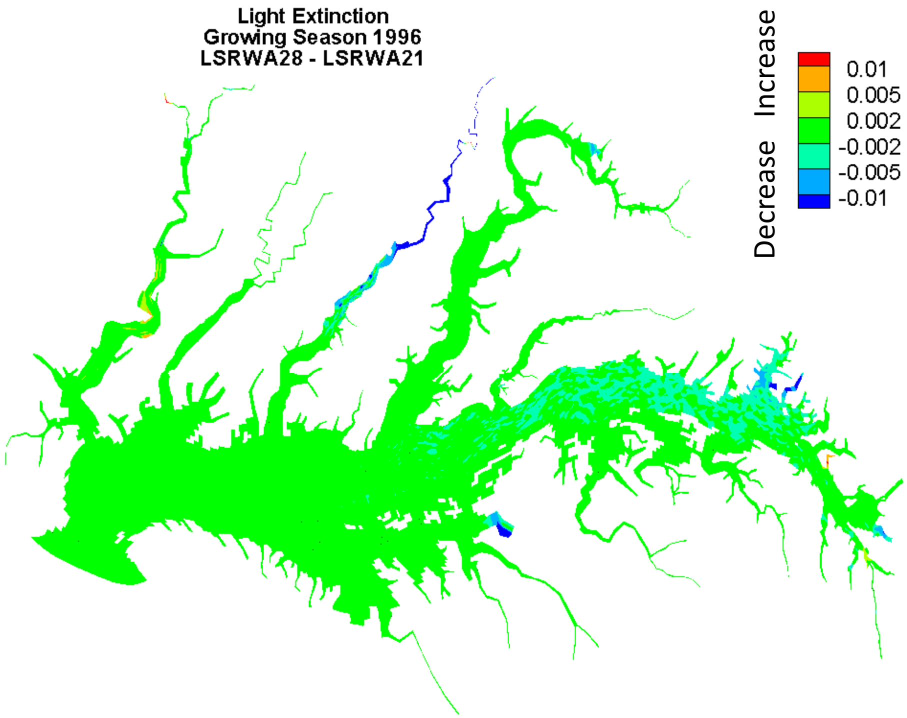
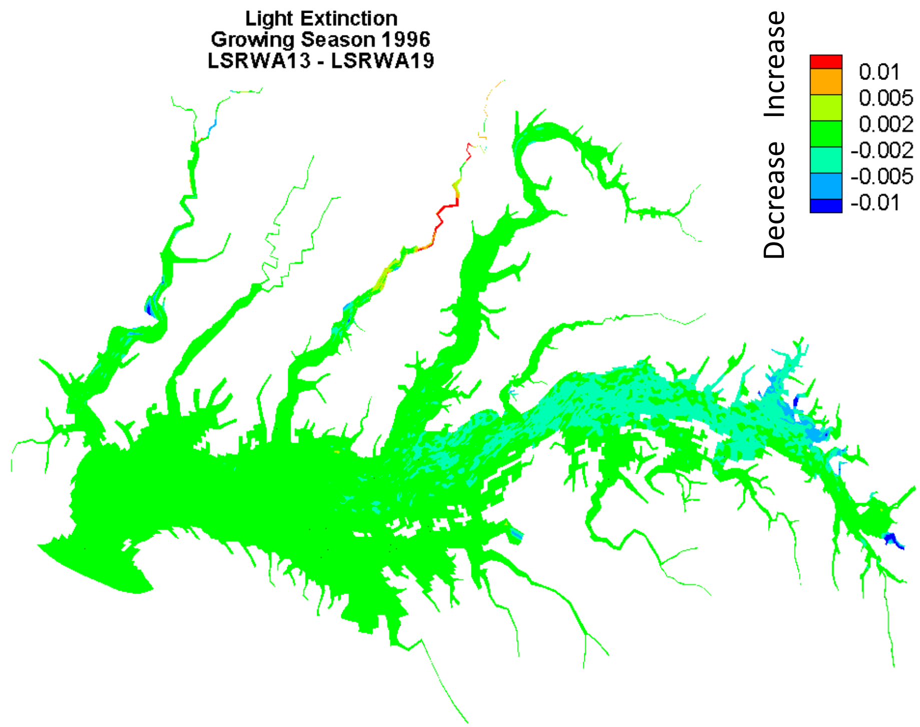
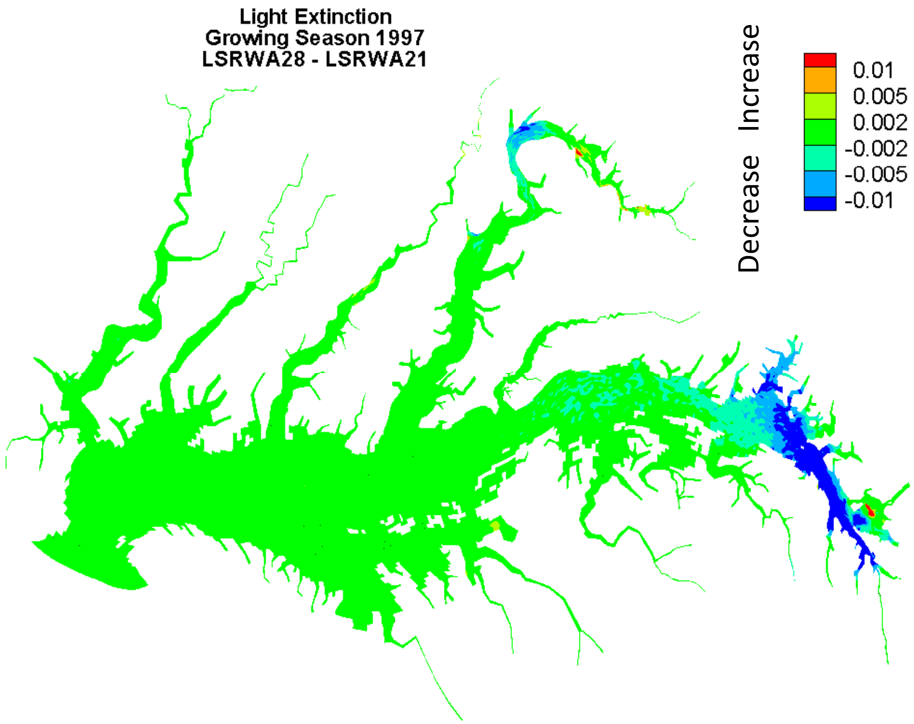



Dredge 3 mcy



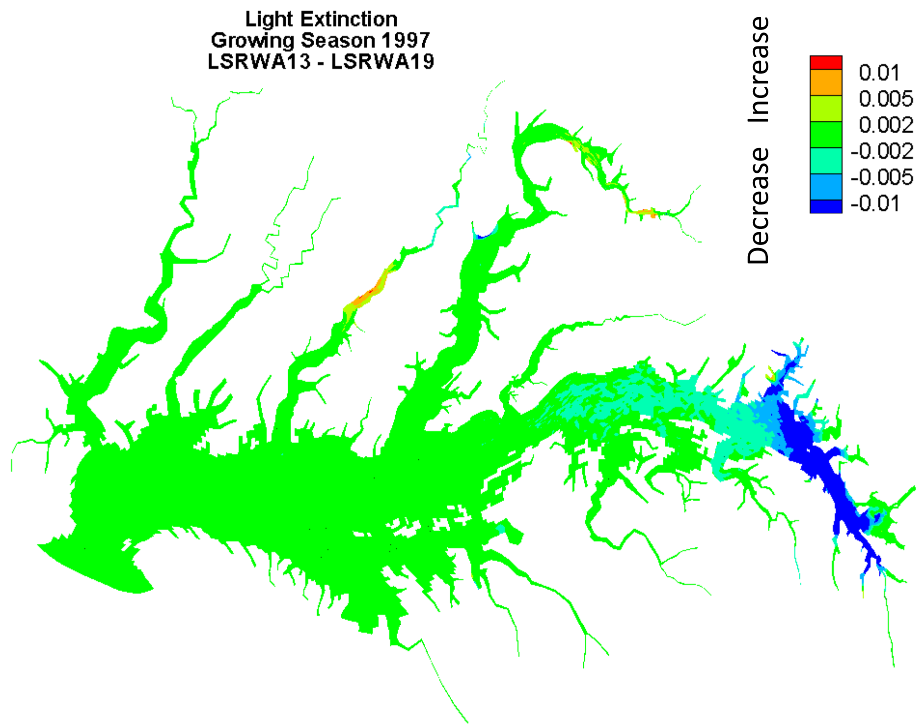

Dredge 31 mcy

PRELIMINARY DRAFT -- NOT FOR PUBLIC RELEASE, SUBJECT TO CHANGE




Dredge 3 mcy

Dredge 31 mcy



# Conclusions

- Dredging 3 mcy will improve summer-average bottom DO in the deep trench of the bay, Potomac River, and Baltimore Harbor by 0.02 to 0.04 mg/L based on a 1996 scour event.
- Dredging 31 mcy will improve summer-average bottom DO in the deep trench of the bay, Potomac River, and Baltimore Harbor by 0.04 to 0.06 mg/L based on a 1996 scour event.

# Conclusions

- Dredging 3 mcy will reduce SAV growing-season chlorophyll by 0.02 to 0.05 in a large expanse of the bay, extending from Baltimore harbor past the mouth of the Potomac River, based on a 1996 scour event.
- The magnitude of chlorophyll reduction from dredging 31 mcy is comparable to dredging 3 mcy, based on a 1996 scour event. The improvement is more extensive and prolonged, however.

# Conclusions

- Improvements in SAV growing-season light attenuation obtained by dredging are limited, generally less than 0.01 / m.
- These results are influenced by the timing of the scour event, January 1996. Most solids have settled out by the subsequent SAV growing season.

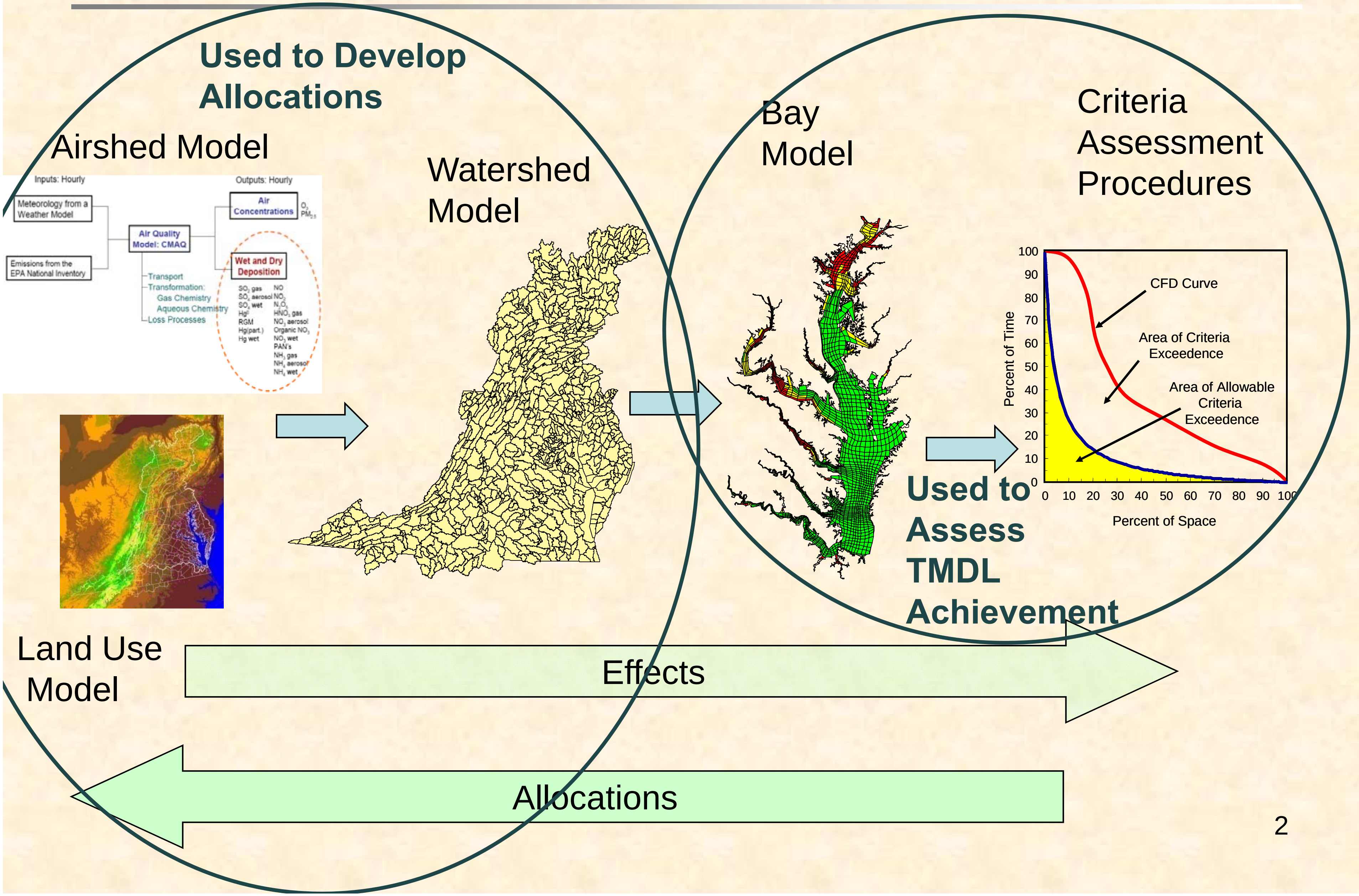
# DO Water Quality Standard Stoplight Analysis of the Estimated Influence of Conowingo Infill on Chesapeake DO Using Linked WSM, ADH, and WQSTM Simulations

**Lower Susquehanna River Watershed Assessment Quarterly Team Meeting**

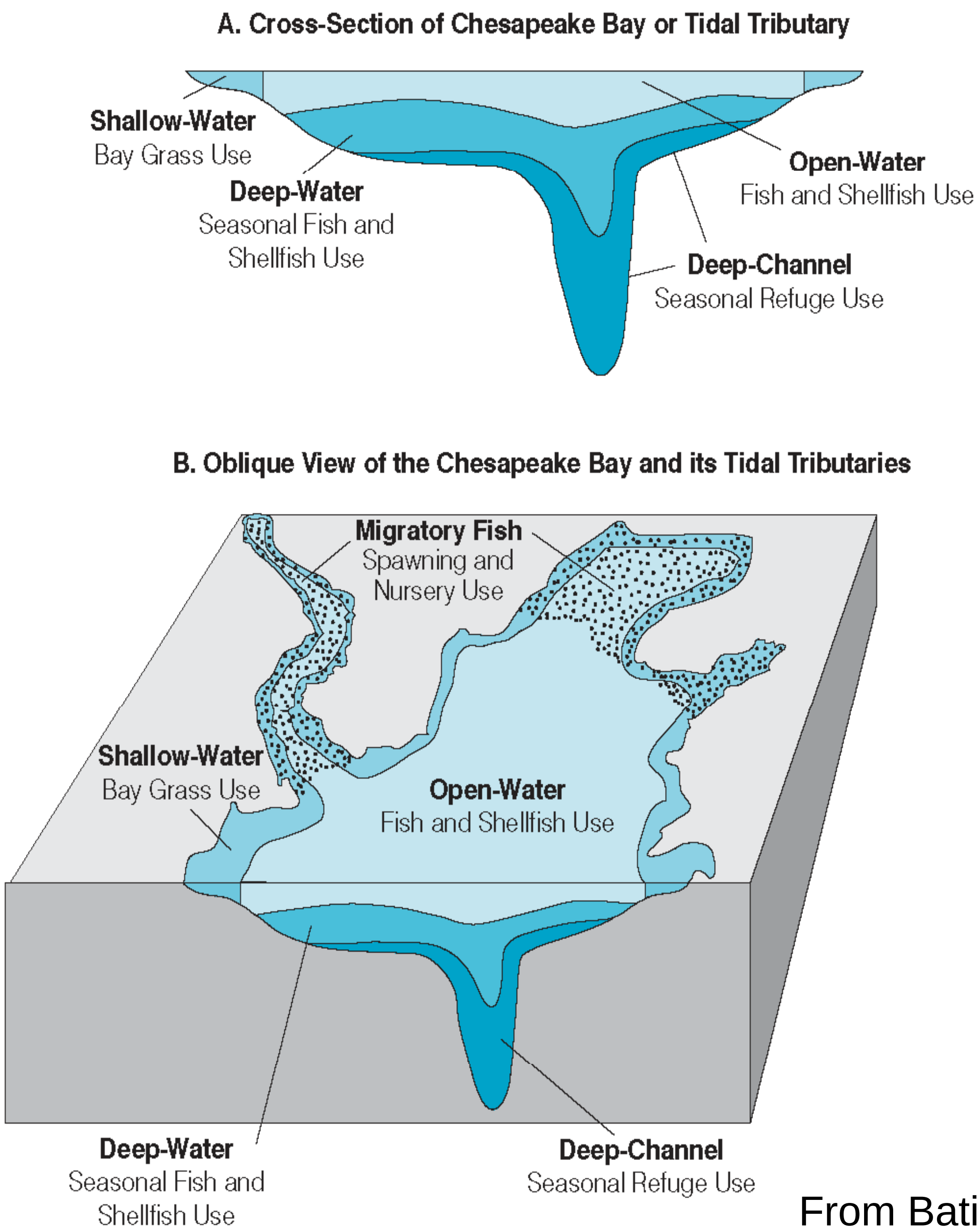
**August 15, 2013**

Lewis Linker and the CBP
Modeling Team
*linker.lewis@epa.gov*

# Nutrient Allocation Decision Support System

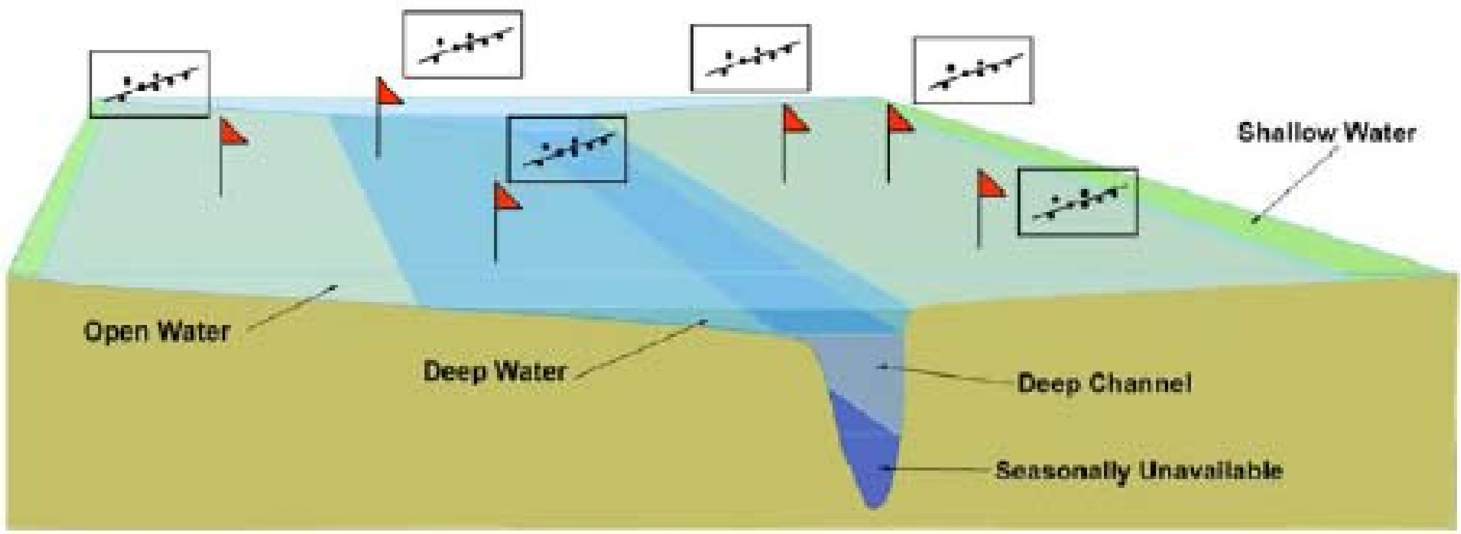


Water Quality Standards of Deep Water, Deep Channel, Open Water, and Shallow Water Dissolved Oxygen (DO) are key for protection of living resources. Chlorophyll and SAV/clarity standards are also designed to protect living resources.




From Batiuk (2003)

FIGURE 3: An individual regression equation is generated for each monitoring station and month. For DO, a regression equation is generated for each WQSTM cell that is matched to a vertical profile of monitoring observations. For CHL, a single equation is generated for the surface cell, which corresponds to a surface CHL monitoring observation.



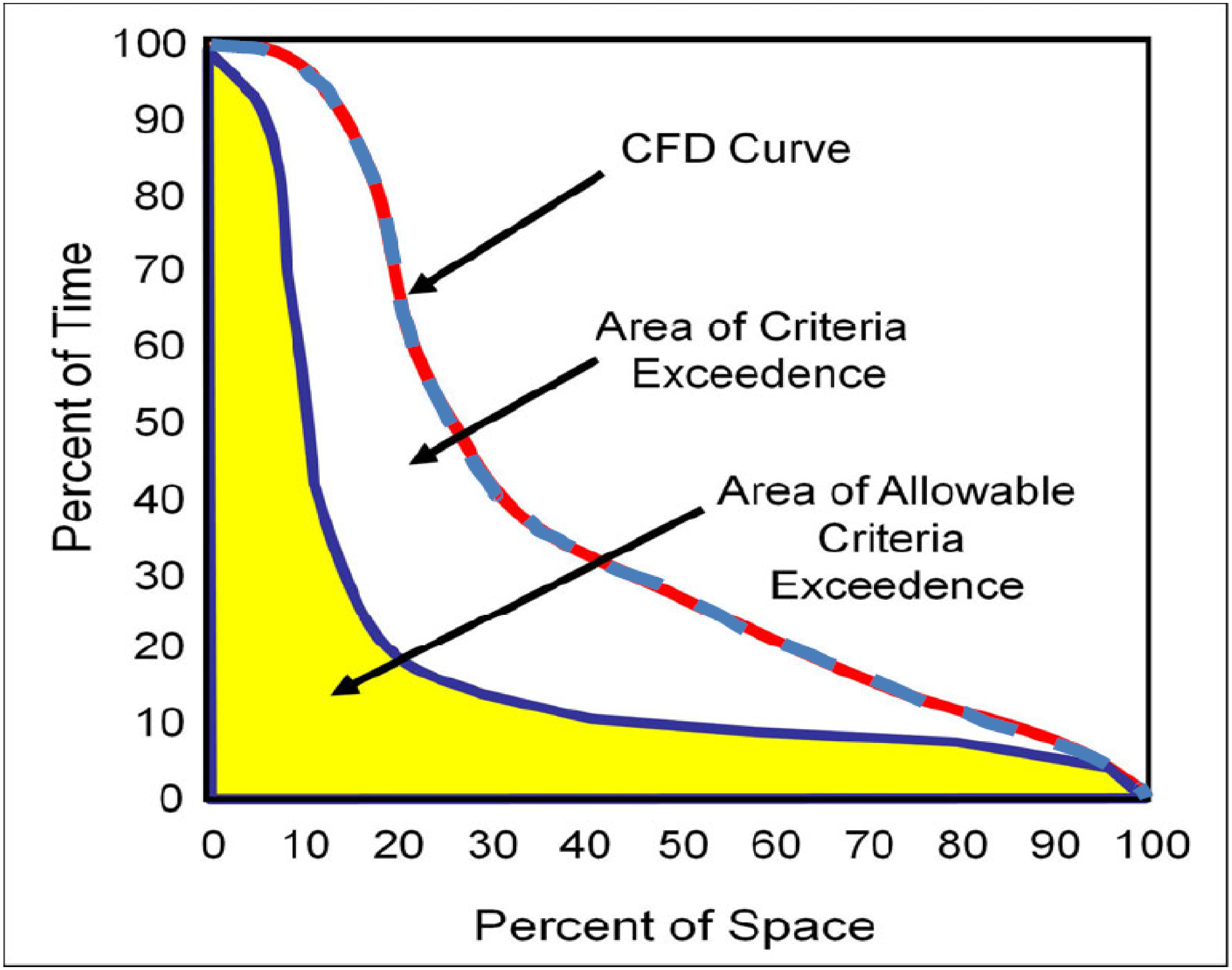



Figure 4. The analysis applied for each TMDL CB segment to determine the percent of time and space that the simulated Chesapeake Bay water quality results exceed the allowable concentration (USEPA 2003; 2008; 2010a).

# Scenarios Used in April, 2013 Analysis*

- 2010 No Action N-Based
- 1985 Scenario
- Base Case – Calibration
- 2007 Progress
- 2009 Progress
- 2010 Progress
- 2010 Progress w/ simulated deposition and scour of the Conowingo reservoir removed from WSM loads.
- 2010 Progress w/ 0% N, 50% P, 100% TSS increase in annual loads
- 2010 Progress w/ 0% N, 70% P, 250% TSS increase in annual loads
- TMDL (Level of Effort)
- TMDL (LoE) w/ simulated deposition and scour of the Conowingo reservoir removed from WSM loads.
- TMDL (LoE) w/ 0% N, 50% P, 100% TSS increase in annual loads
- TMDL (LoE) w/ 0% N, 70% P, 250% TSS increase in annual loads
- 2010 E3 N-Based
- All Forest

* All scenarios are based on Phase 5.3.2 loads.

# Scenarios Examined in This Analysis*

- TMDL (Level of Effort)
- TMDL w/ ADH Scour and Hurricane Lee Level of Scoured Particulate Organic Nutrients in January 1996
- TMDL w/ ADH Scour and 1996 Big Melt Level of Scoured Particulate Organic Nutrients in January 1996
- January 1996 Big Melt Storm Eliminated
- TMDL w/ ADH Scour and Hurricane Lee Level of Scoured Particulate Organic Nutrients w/ January Storm Moved to June
- TMDL w/ ADH Scour and Hurricane Lee Level of Scoured Particulate Organic Nutrients w/ January Storm Moved to October
- TMDL w/ ADH Scour and 1996 Big Melt Level of Scoured Particulate Organic Nutrients w/ January Storm Moved to June
- TMDL w/ ADH Scour and 1996 Big Melt Level of Scoured Particulate Organic Nutrients w/ January Storm Moved to October

For Comparison:

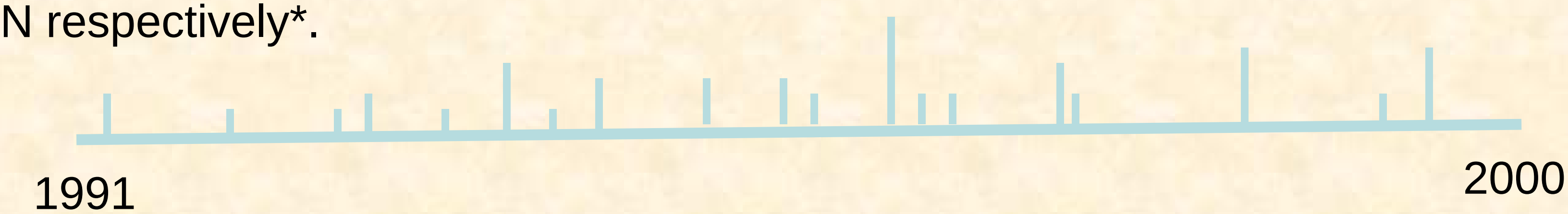
- 2010 E3 N-Based
- All Forest

* All scenarios are based on Phase 5.3.2 loads.

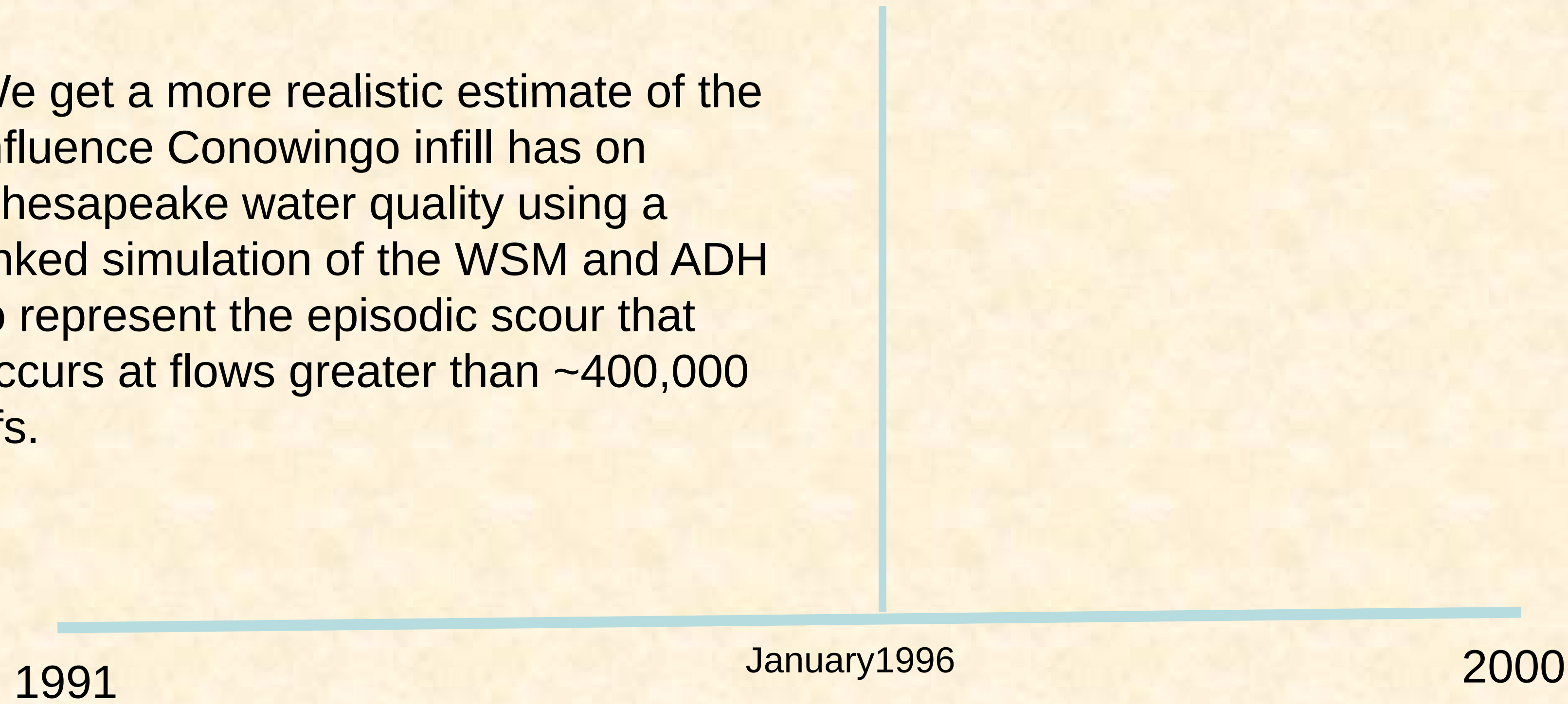
# DO Stoplight Decision Rules:

- Applied standard Phase I & II Allocation decision rules of rounding to the nearest whole number of nonattainment and allowing 1% nonattainment for uncertainties in overall analysis procedure.
- A CB4MH and PATMH Deep Water variance of 7%.
- A CB4MH and EASMH Deep Channel variance of 2%.
- A CHSMH Deep Chanel variance of 16%.

When we used the WSM alone to represent scour from the infill state of the Conowingo we set the loads to 100%, 50%, and 0% above Conowingo base to represent loads at the estimated current level of Conowingo infill for TSS, TP, and TN respectively*.




We get a more realistic estimate of the influence Conowingo infill has on Chesapeake water quality using a linked simulation of the WSM and ADH to represent the episodic scour that occurs at flows greater than ~400,000 cfs.




*Source: Hirsch, R.M., 2012, Flux of nitrogen, phosphorus, and suspended sediment from the Susquehanna River Basin to the Chesapeake Bay during Tropical Storm Lee, September 2011, as an indicator of the effects of reservoir sedimentation on water quality: U.S. Geological Survey Scientific Investigations Report 2012–5185, 17 p.

# DO Deep Channel

Where we were in April 2013 when we were using the WSM alone to represent Conowingo infill at 100% TSS increase (estimated current 90% Conowingo infill) and 250% TSS increase (estimated completely filled Conowingo pool).

| | Scenario → | 2010 No Action N-Based Scenario 371 TN, 37.6 TP, 10630TSS | 1985 Scenario 353 TN, 24.6 TP, 10100 TSS | '91 -'00 Base Scenario 318 TN, 20.3 TP, 9440 TSS | 2007 Scenario 269 TN, 19.5 TP, 8770 TSS | 2009 Scenario 266 TN, 19.1 TP, 8520 TSS | 2010 Scenario 263 TN 19.4 TP 8360 TSS | 2010 No Conowingo 272 TN 20 TP 9263 TSS | 2010 scour100% | 2010 scour250% | TMDL Scenario 191 TN 15 TP 6675 TSS | TMDL No Conowingo 200 TN 15 TP 7394 TSS | TMDL scour100% | TMDL scour250% | E3 2010 N-Based Scenario 135 TN, 10.4 TP, 4850 TSS | All Forest Scenario 54 TN, 2.6 TP, 1340 TSS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cbseg | Year → State | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel | '93-'95 DO Deep Channel |
| CB3MH | MD | 22% | 17% | 14% | 12% | 11% | 5% | 7% | 8% | 7% | 0% | 0% | 0% | 0% | 0% | 0% |
| CB4MH | MD | 54% | 49% | 46% | 40% | 38% | 23% | 26% | 30% | 30% | 1.49% | 2.73% | 3.39% | 4.25% | 0% | 0% |
| CB5MH | both | 22% | 17% | 15% | 10% | 9% | 0% | 1% | 2% | 3% | 0% | 0% | 0% | 0% | 0% | 0% |
| CHSMH | MD | 45% | 39% | 39% | 36% | 36% | 28% | 34% | 31% | 34% | 15.01% | 15.66% | 15.66% | 18.81% | 5% | 0% |
| EASMH | MD | 38% | 29% | 27% | 24% | 24% | 14% | 15% | 17% | 16% | 1.09% | 2.49% | 3.73% | 5.33% | 0% | 0% |
| MD5MH | MD | 31% | 25% | 24% | 19% | 17% | 2% | 4% | 8% | 8% | 0% | 0% | 0% | 0% | 0% | 0% |
| PATMH | MD | 46% | 42% | 28% | 25% | 25% | 18% | 24% | 23% | 23% | 0% | 0% | 0% | 0% | 0% | 0% |
| POMMH | MD | 27% | 20% | 20% | 13% | 10% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| POTMH | both | 27% | 20% | 20% | 13% | 10% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| RPPMH | VA | 29% | 23% | 19% | 6% | 4% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| VA5MH | VA | 12% | 7% | 4% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |

# DO Deep Channel

| Scenario<br>Year<br>Designated use | TMDL Scenario 191 TN 15 TP 6675 TSS<br>1993-1995<br>Deep channel | LSRWA_21 TMDL ADH scour Lee nutrient<br>1993-1995<br>Deep channel | LSRWA_22 ADH scour 1996 nutrient<br>1993-1995<br>Deep channel | LSRWA_23 No storm<br>1993-1995<br>Deep channel | LSRWA_24 June storm<br>1993-1995<br>Deep channel | LSRWA_25 October storm<br>1993-1995<br>Deep channel | LSRWA_26 June storm 1996 nutrient<br>1993-1995<br>Deep channel | LSRWA_27 October storm 1996 nutrient<br>1993-1995<br>Deep channel | E3 2010 N-Based Scenario 135 TN, 10.4 TP, 4850 TSS<br>1993-1995<br>Deep channel | All Forest Scenario 54 TN, 2.6 TP, 1340 TSS<br>1993-1995<br>Deep channel |
|---|---|---|---|---|---|---|---|---|---|---|
| CB3MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0% | 0% |
| CB4MH | 1.53% | 1.52% | 1.52% | 1.52% | 1.52% | 1.52% | 1.52% | 1.52% | 0% | 0% |
| CB5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0% | 0% |
| CHSMH | 15.01% | 15.01% | 15.01% | 15.01% | 15.01% | 15.01% | 15.01% | 15.01% | 2% | 0% |
| POTMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0% | 0% |
| POMMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0% | 0% |
| RPPMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0% | 0% |
| EASMH | 1.09% | 1.09% | 1.09% | 1.09% | 1.09% | 1.09% | 1.09% | 1.09% | 0% | 0% |
| MD5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0% | 0% |
| VA5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0% | 0% |
| PATMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0% | 0% |

# DO Deep Channel

| Scenario | TMDL Scenario 191 TN 15 TP 6675 TSS | LSRWA_21 TMDL ADH scour Lee nutrient | LSRWA_22 ADH scour 1996 nutrient | LSRWA_23 No storm | LSRWA_24 June storm | LSRWA_25 October storm | LSRWA_26 June storm 1996 nutrient | LSRWA_27 October storm 1996 nutrient | E3 2010 N-Based Scenario 135 TN, 10.4 TP, 4850 TSS | All Forest Scenario 54 TN, 2.6 TP, 1340 TSS |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 |
| Designated use | Deep channel | Deep channel | Deep channel | Deep channel | Deep channel | Deep channel | Deep channel | Deep channel | Deep channel | Deep channel |
| CB3MH | 1.10% | 1.40% | 1.09% | 0.40% | 1.47% | 0.50% | 1.47% | 0.50% | 0.00% | 0.00% |
| CB4MH | 0.47% | 1.56% | 0.73% | 0.07% | 3.85% | 0.20% | 2.53% | 0.17% | 0.00% | 0.00% |
| CB5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CHSMH | 4.13% | 5.27% | 5.27% | 2.84% | 10.50% | 5.27% | 10.50% | 4.13% | 2.06% | 0.00% |
| POTMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| POMMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| RPPMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| EASMH | 6.09% | 6.75% | 6.36% | 4.46% | 7.81% | 5.19% | 7.41% | 5.14% | 0.00% | 0.00% |
| MD5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| VA5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| PATMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

# DO Deep Channel

| Scenario Year Designated use | TMDL Scenario 191 TN 15 TP 6675 TSS 1998-2000 Deep channel | LSRWA_21 TMDL ADH scour Lee nutrient 1998-2000 Deep channel | LSRWA_22 ADH scour 1996 nutrient 1998-2000 Deep channel | LSRWA_23 No storm 1998-2000 Deep channel | LSRWA_24 June storm 1998-2000 Deep channel | LSRWA_25 October storm 1998-2000 Deep channel | LSRWA_26 June storm 1996 nutrient 1998-2000 Deep channel | LSRWA_27 October storm 1996 nutrient 1998-2000 Deep channel | E3 2010 N-Based Scenario 135 TN, 10.4 TP, 4850 TSS 1998-2000 Deep channel | All Forest Scenario 54 TN, 2.6 TP, 1340 TSS 1998-2000 Deep channel |
|---|---|---|---|---|---|---|---|---|---|---|
| CB3MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB4MH | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CHSMH | 26.46% | 26.46% | 26.46% | 22.31% | 26.46% | 26.46% | 26.46% | 26.46% | 1.28% | 0.00% |
| POTMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| POMMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| RPPMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| EASMH | 1.56% | 1.61% | 1.56% | 1.39% | 1.59% | 1.57% | 1.56% | 1.56% | 0.00% | 0.00% |
| MD5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| VA5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| PATMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

# Initial DO Findings – Deep Channel:

- The linked WSM-ADH-WQSTM simulation is an improved representation of the dynamic nature of Conowingo scour. No effects of Conowingo are seen before a 400,000 cfs storm, with greatest influence on water quality estimated during the contiguous 3-year period containing the storm, and a subdued to no-effect influence in the subsequent 3-year period.
- Estimates with the refined method are less detrimental in time and space than previous (April 2013) estimates)
- In CB4MH Deep Channel the estimated effect of the 400 cfs event of the January 1996 Big Melt was a decrease in DO attainment of 1% or less for the 3 years following the storm (using the 1996-1998 hydrology).

# Initial DO Findings – Deep Channel:

- The No-Storm Scenario Provides an estimate of the “large storm tax” on the CBP TMDL.
- The Big Melt event transposed to June is the most detrimental to DO water quality followed in decreasing influence by the January event, the October event, and the No-Storm event.

# DO Deep Water

Where we were in April 2013 when we were using the WSM alone to represent Conowingo infill at 100% TSS increase (estimated current 90% Conowingo infill) and 250% TSS increase (estimated completely filled Conowingo pool).

| Cbseg | Scenario → Year → State | 2010 No Action N-Based Scenario 371 TN, 37.6 TP, 10630 TSS '93-'95 DO Deep Water | 1985 Scenario 353 TN, 24.6 TP, 10100 TSS '93-'95 DO Deep Water | '91 -'00 Base Scenario 318 TN, 20.3 TP, 9440 TSS '93-'95 DO Deep Water | 2007 Scenario 269 TN, 19.5 TP, 8770 TSS '93-'95 DO Deep Water | 2009 Scenario 266 TN, 19.1 TP, 8520 TSS '93-'95 DO Deep Water | 2010 Scenario 263 TN 19.4 TP 8360 TSS '93-'95 DO Deep Water | 2010 No Conowingo 272 TN 20 TP 9263 TSS '93-'95 DO Deep Water | 2010 scour100% '93-'95 DO Deep Water | 2010 scour250% '93-'95 DO Deep Water | TMDL Scenario 191 TN 15 TP 6675 TSS '93-'95 DO Deep Water | TMDL No Conowingo 200 TN 15 TP 7394 TSS '93-'95 DO Deep Water | TMDL scour100% '93-'95 DO Deep Water | TMDL scour250% '93-'95 DO Deep Water | E3 2010 N-Based Scenario 135 TN, 10.4 TP, 4850 TSS '93-'95 DO Deep Water | All Forest Scenario 54 TN, 2.6 TP, 1340 TSS '93-'95 DO Deep Water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB3MH | MD | 4% | 2% | 2% | 2% | 2% | 1% | 1% | 1% | 1% | 0% | 0% | 0% | 0% | 0% | 0% |
| CB4MH | MD | 28% | 22% | 20% | 17% | 16% | 11% | 11% | 12% | 12% | 4.7% | 5.5% | 5.7% | 5.9% | 3% | 0% |
| CB5MH | both | 7% | 5% | 4% | 3% | 3% | 2% | 2% | 2% | 2% | 0% | 0% | 0% | 0% | 0% | 0% |
| CB6PH | VA | 1% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CHSMH | MD | 39% | 32% | 26% | 21% | 19% | 11% | 13% | 13% | 13% | 0% | 2.7% | 3.3% | 3.9% | 1% | 0% |
| EASMH | MD | 34% | 14% | 6% | 4% | 4% | 2% | 2% | 2% | 2% | 0.90% | 1.2% | 1.1% | 1.1% | 0% | 0% |
| | | | | | | | | | | | | | | | | |
| MD5MH | MD | 14% | 10% | 9% | 7% | 7% | 4% | 4% | 5% | 5% | 0.86% | 1.2% | 1.3% | 1.5% | 0% | 0% |
| PATMH | MD | 31% | 21% | 13% | 11% | 11% | 6% | 9% | 7% | 7% | 0% | 0.9% | 1.0% | 1.0% | 0% | 0% |
| PAXMH | MD | 23% | 12% | 7% | 4% | 3% | 0% | 1% | 4% | 3% | 0% | 0% | 0% | 0% | 0% | 0% |
| POMMH | MD | 10% | 5% | 4% | 2% | 2% | 0% | 1% | 1% | 1% | 0% | 0% | 0% | 0% | 0% | 0% |
| POTMH | both | 9% | 5% | 4% | 2% | 2% | 0% | 1% | 1% | 1% | 0% | 0% | 0% | 0% | 0% | 0% |
| RPPMH | VA | 13% | 8% | 6% | 3% | 1% | 0% | 0% | 1% | 1% | 0% | 0% | 0% | 0% | 0% | 0% |
| SBEMH | VA | 5% | 3% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| VA5MH | VA | 1% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| YRKPH | VA | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |

# DO Deep Water

| Scenario | TMDL Scenario 191 TN 15 TP 6675 TSS | LSRWA_21 TMDL ADH scour Lee nutrient | LSRWA_22 ADH scour 1996 nutrient | LSRWA_23 No storm | LSRWA_24 June storm | LSRWA_25 October storm | LSRWA_26 June storm 1996 nutrient | LSRWA_27 October storm 1996 nutrient | E3 2010 N-Based Scenario 135 TN, 10.4 TP, 4850 TSS | All Forest Scenario 54 TN, 2.6 TP, 1340 TSS |
|---|---|---|---|---|---|---|---|---|---|---|
| Years | 1993-1995 | 1993-1995 | 1993-1995 | 1993-1995 | 1993-1995 | 1993-1995 | 1993-1995 | 1993-1995 | 1993-1995 | 1993-1995 |
| Designated use | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water |
| CB3MH | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.0% | 0.0% |
| CB4MH | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% | 5.0% | 0.9% | 0.0% |
| CB5MH | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.0% | 0.0% |
| CB6PH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| CB7PH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| EASMH | 0.9% | 0.9% | 0.9% | 0.9% | 0.9% | 0.9% | 0.9% | 0.9% | 0.0% | 0.0% |
| PAXMH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| POTMH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| POMMH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| RPPMH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| SBEMH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| YRKPH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| MD5MH | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 1.0% | 0.0% | 0.0% |
| VA5MH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| PATMH | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.0% | 0.0% |
| SOUMH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| SEVMH | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |

# DO Deep Water

| Scenario | TMDL Scenario 191 TN 15 TP 6675 TSS | LSRWA_21 TMDL ADH scour Lee nutrient | LSRWA_22 ADH scour 1996 nutrient | LSRWA_23 No storm | LSRWA_24 June storm | LSRWA_25 October storm | LSRWA_26 June storm 1996 nutrient | LSRWA_27 October storm 1996 nutrient | E3 2010 N-Based Scenario 135 TN, 10.4 TP, 4850 TSS | All Forest Scenario 54 TN, 2.6 TP, 1340 TSS |
|---|---|---|---|---|---|---|---|---|---|---|
| Years | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 | 1996-1998 |
| Designated use | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water |
| CB3MH | 0.69% | 0.92% | 0.77% | 0.69% | 0.91% | 0.72% | 0.69% | 0.69% | 0.02% | 0.00% |
| CB4MH | 6.33% | 6.83% | 6.44% | 5.96% | 7.46% | 6.25% | 7.12% | 6.09% | 2.99% | 0.00% |
| CB5MH | 0.48% | 0.53% | 0.50% | 0.44% | 0.61% | 0.47% | 0.56% | 0.46% | 0.18% | 0.00% |
| CB6PH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB7PH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CHSMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| EASMH | 0.49% | 0.49% | 0.49% | 0.48% | 0.54% | 0.49% | 0.54% | 0.49% | 0.28% | 0.00% |
| PAXMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| POTMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| POMMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| RPPMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| SBEMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| YRKPH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| MD5MH | 1.37% | 1.46% | 1.41% | 1.29% | 1.62% | 1.36% | 1.52% | 1.33% | 0.48% | 0.00% |
| VA5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| PATMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| MAGMH | 50.41% | 50.41% | 50.41% | 50.41% | 50.41% | 50.41% | 50.41% | 50.41% | 0.00% | 0.00% |
| SOUMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| SEVMH | 5.38% | 5.38% | 5.38% | 4.39% | 5.38% | 5.38% | 5.38% | 5.38% | 0.00% | 0.00% |

# DO Deep Water

| Scenario | TMDL Scenario 191 TN 15 TP 6675 TSS | LSRWA_21 TMDL ADH scour Lee nutrient | LSRWA_22 ADH scour 1996 nutrient | LSRWA_23 No storm | LSRWA_24 June storm | LSRWA_25 October storm | LSRWA_26 June storm 1996 nutrient | LSRWA_27 October storm 1996 nutrient | E3 2010 N-Based Scenario 135 TN, 10.4 TP, 4850 TSS | All Forest Scenario 54 TN, 2.6 TP, 1340 TSS |
|---|---|---|---|---|---|---|---|---|---|---|
| Years | 1998-2000 | 1998-2000 | 1998-2000 | 1998-2000 | 1998-2000 | 1998-2000 | 1998-2000 | 1998-2000 | 1998-2000 | 1998-2000 |
| Designated use | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water | Deep water |
| CB3MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB4MH | 4.61% | 5.03% | 4.72% | 4.46% | 4.82% | 4.76% | 4.65% | 4.59% | 0.50% | 0.00% |
| CB5MH | 0.02% | 0.06% | 0.02% | 0.01% | 0.03% | 0.03% | 0.02% | 0.02% | 0.00% | 0.00% |
| CB6PH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB7PH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CHSMH | 0.75% | 0.75% | 0.75% | 0.75% | 0.75% | 0.75% | 0.75% | 0.75% | 0.75% | 0.00% |
| EASMH | 0.23% | 0.23% | 0.23% | 0.23% | 0.23% | 0.23% | 0.23% | 0.23% | 0.00% | 0.00% |
| PAXMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| POTMH | 0.00% | 0.13% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| POMMH | 0.00% | 0.13% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| RPPMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| SBEMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| YRKPH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| MD5MH | 0.41% | 0.53% | 0.41% | 0.35% | 0.44% | 0.44% | 0.41% | 0.39% | 0.00% | 0.00% |
| VA5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| PATMH | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.00% | 0.00% |
| MAGMH | 35.92% | 35.92% | 35.92% | 35.92% | 35.92% | 35.92% | 35.92% | 35.92% | 5.93% | 0.00% |
| SOUMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| SEVMH | 6.78% | 6.78% | 6.78% | 5.60% | 6.78% | 6.78% | 6.78% | 6.78% | 0.00% | 0.00% |

# Initial DO Findings – Deep Water:

- As in the case of Deep Channel, no effects of Conowingo infill are estimated before a 400,000 cfs storm event, with greatest influence on water quality estimated during the contiguous 3-year period containing the storm, and a subdued to no-effect influence in the subsequent 3-year period.
- Estimates with the refined method are less detrimental in time and space than previous (April 2013) estimates)
- In CB4MH Deep Water the estimated effect of the 400 cfs event of the January 1996 Big Melt was a decrease in DO attainment of 0.5% or less for the 3 years following the storm (using the 1996-1998 hydrology) followed by a decrease in DO attainment of about 0.4% in the subsequent 1998-2000 period.

# Open Water

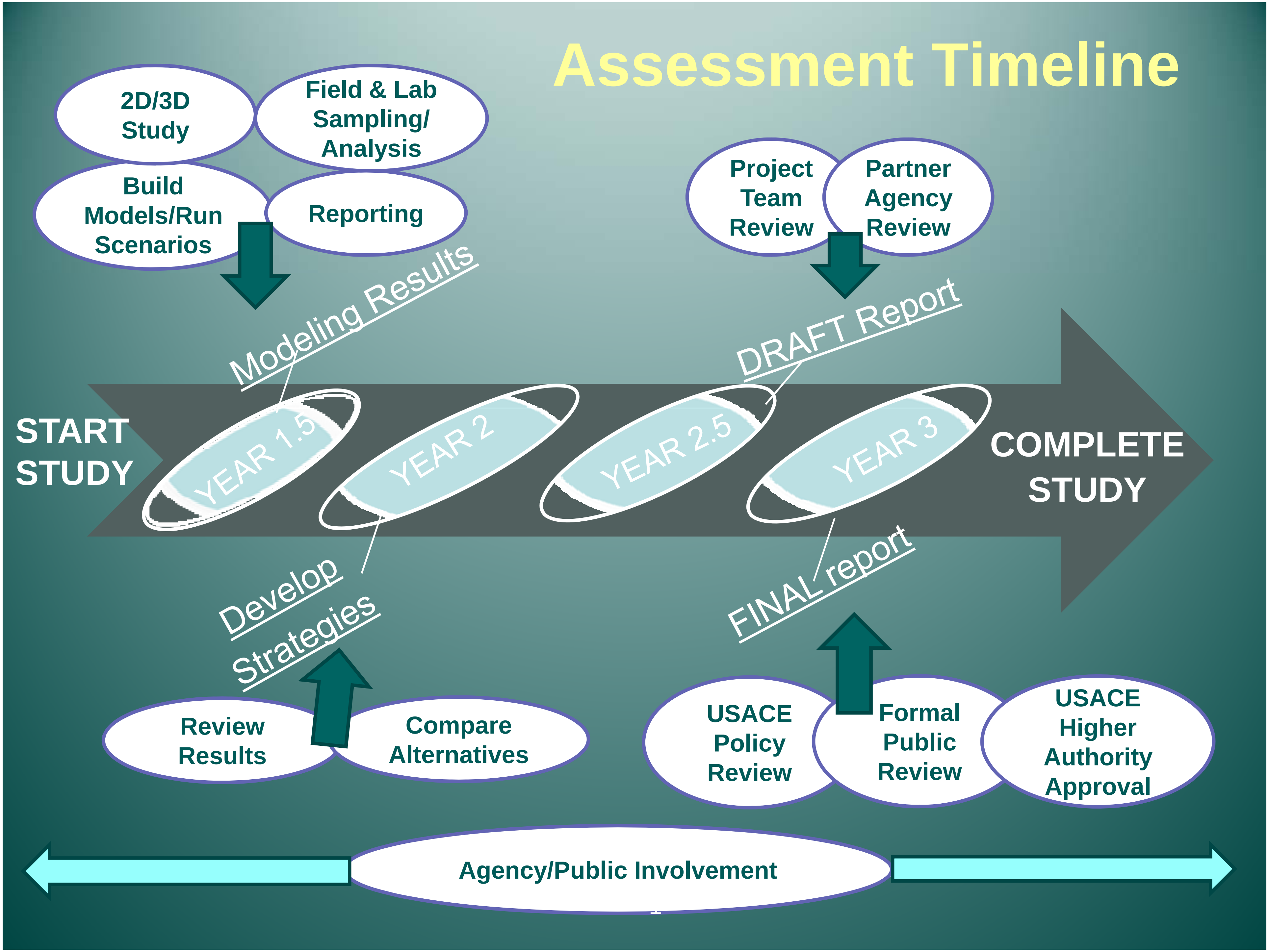
| Scenarios Years Designated Use | TMDL Scenario 191 TN 15 TP 6675 TSS 1996-1998 Open Water | LSRWA_21 TMDL ADH scour Lee nutrient 1996-1998 Open Water | LSRWA_22 ADH scour 1996 nutrient 1996-1998 Open Water | LSRWA_23 No storm 1996-1998 Open Water | LSRWA_24 June storm 1996-1998 Open Water | LSRWA_25 October storm 1996-1998 Open Water | LSRWA_26 June storm 1996 nutrient 1996-1998 Open Water | LSRWA_27 October storm 1996 nutrient 1996-1998 Open Water | E3 2010 N-Based Scenario 135 TN, 10.4 TP, 4850 TSS 1996-1998 Open Water | All Forest Scenario 54 TN, 2.6 TP, 1340 TSS 1996-1998 Open Water |
|---|---|---|---|---|---|---|---|---|---|---|
| CB1TF | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB2OH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB3MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB4MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB5MH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB6PH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB7PH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CB8PH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CHOMH1 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CHOMH2 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CHOOH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CHOTF | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CHSMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| CHSOH | 0.00% | 0.00% | 0.00% | 0.00% | 0.20% | 0.00% | 0.20% | 0.00% | 0.00% | 0.00% |
| CHSTF | 0.00% | 0.00% | 0.00% | 0.00% | 0.72% | 0.00% | 0.72% | 0.00% | 0.00% | 0.00% |
| EASMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| EBEMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| ELIPH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| JMSMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| JMSOH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| JMSPH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| JMSTF | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| JMSTFL | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| JMSTFU | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| LAFMH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| MOBPH | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

# Initial DO Findings – Open Water:

- Estimating an unchanged DO response and full attainment levels for Open Water DO at the TMDL level of reductions and for all Conowingo scoping scenarios.

# Conclusions:

- These are refined findings compared to the previous April results.
- The prvious scoping scenarios of 100% and 250% scour fail to represent the dynamic nature of large storm scour and should be discounted as an unrealistic representation of Conowingo infill's influence on Chesapeake water quality
- The scour of Conowingo Pool under current infill conditions is estimated to have an ephemeral detrimental influence of at most about 1% nonattainment for a few years.


Assessment Timeline
2D/3D Study
Field & Lab Sampling/ Analysis
Build Models/Run Scenarios
Reporting
Modeling Results
Project Team Review
Partner Agency Review
DRAFT Report
START STUDY
YEAR 1.5
YEAR 2
YEAR 2.5
YEAR 3
COMPLETE STUDY
Develop Strategies
FINAL report
Review Results
Compare Alternatives
USACE Policy Review
Formal Public Review
USACE Higher Authority Approval
Agency/Public Involvement

# Schedule of Upcoming Activities

| | |
|---|---|
| Modeling of Alternative Scenarios | Jun-Sep 2013 |
| Sediment Management Strategy Development | Jun-Sep 2013 |
| Completion of Technical Studies | 30 Sep 2013 |
| Completion of Draft Technical Appendices/Write-Ups | 11-15 Oct 2013 |
| Development of Recommendations | Oct-Nov 2013 |
| Internal Draft Compiled | Dec 2013 |
| Internal Team/Partner/Management Reviews | Jan-Feb 2014 |
| USACE Agency Technical Review | Mar 2014 |
| USACE Policy Compliance Review | May-Jun 2014 |
| Public Release of Report | Jul-Aug 2014 |
| Final Report Submitted to USACE Higher Authority | Sep 2014 |