MEMORANDUM FOR THE RECORD

SUBJECT: Lower Susquehanna River Watershed Assessment
Quarterly Meeting, November 19, 2012

1. On November 19, 2012 agency team members met to discuss ongoing and completed activities for the Lower Susquehanna River Watershed Assessment (LSRWA). The meeting was hosted by the Maryland Department of the Environment (MDE) in their Terra Conference Room at the Montgomery Park Building in Baltimore, Maryland. The meeting started at 10:00 am and continued through 1:00 pm. The meeting attendees are listed in the table below.

2.

Lower Susquehanna River Watershed Assessment Team Meeting Sign-In Sheet			
November 19, 2012			
Agency	**Name**	**Email Address**	**Phone**
Exelon -- Gomez and Sullivan	Gary Lemay	glemay@gomezandsullivan.com	603-428-4960
Exelon -- URS Corp.	Marjorie Zeff	marjorie.zeff@urs.com	215-367-2549
Lower Susquehanna Riverkeeper	Michael Helfrich	LowSusRiver@hotmail.com	717-779-7915
MDE	Herb Sachs	sachsh@verizon.net	
MDE	John Smith	jsmith@mde.state.md.us	410-537-4109
MDE	Matt Rowe	mrowe@mde.state.md.us	410-537-3578
MDE	Tim Fox	tfox@mde.state.md.us	410-537-3958
MDNR	Bruce Michael	bmichael@dnr.state.md.us	410-260-8627
MDNR	Shawn Seaman	sseaman@dnr.state.md.us	410-260-8662
MGS	Jeff Halka	jhalka@dnr.state.md.us	410-554-5503
SRBC	John Balay	jbalay@srbc.net	717-238-0423 x217
TNC	Kathy Boomer	kboomer@tnc.org	607-280-3720
USACE	Anna Compton	anna.m.compton@usace.army.mil	410-962-4633
USACE	Tom Lazco	thomas.d.lazco@usace.army.mil	410-962-6773
USACE	Chris Spaur	christopher.c.spaur@usace.army.mil	410-962-6134
USACE	Claire O'Neill	claire.d.o'neill@usace.army.mil	410-962-0876
USACE	Ashley Williams	ashley.a.williams@usace.army.mil	410-962-6139
USACE-ERDC	Carl Cerco	carl.f.cerco@erdc.usace.army.mil	601-634-4207
USACE-ERDC	Steve Scott	steve.h.scott@usace.army.mil	601-634-2371
USGS	Mike Langland	langland@usgs.gov	717-730-6953
The Conservation Fund	Bill Crouch	bcrouch@conservationfund.org	410-274-8427
DNR	Bob Sadzinksi	bsadzinski@dnr.state.md.us	
Exelon	Mary Helen Marsh	maryhelen.marsh@exeloncorp.com	610-765-5572
Exelon-Gomez and Sullivan	Tom Sullivan	tsullivan@gomezandsullivan.com	603-428-4960
USACE-ERDC	Carl Cerco	carl.f.cerco@erdc.usace.army.mil	601-634-4207
USACE-ERDC	Steve Scott	steve.h.scott@usace.army.mil	601-634-2371
NOAA-NMFS	John Nichols	john.nichols@noaa.gov	410-267-5675
PADEP	Patricia Buckley	pbuckley@pa.gov	717-772-1675
EPA, Chesapeake Bay Program	Lew Linker	llinker@chesapeakebay.net	
NMFS	John Nichols	john.nichols@noaa.gov	410-267-5675
Chesapeake Bay Commission	Bevin Buchheister	bevinb@chesbay.us	410-730-9030

The meeting agenda is provided as enclosure 1 to this memorandum.

Action Items from August Quarterly Meeting:

A. Anna will email out the draft mission statement to the team and the team will provide any further comments to the statement. *Status: Complete.*

B. Anna will revise goals and objectives to state "three" vs. "four" hydroelectric dams to accurately reflect the study area of the assessment. *Status: Complete.*

C. Mike will resolve issues with HEC-RAS modeling and will have a workable boundary condition file by the end of August. *Status: Complete. Mike gave a presentation with results at today's meeting which is included as Enclosure 2 to this memorandum.*

D. Bruce will invite Harbor Rock to the September sediment management strategy brainstorming meeting. *Status: Complete.*

E. Bob Hirsch will share draft press release on recent TS Lee study findings by USGS with selected agencies for review and input. *Status: Complete. Press release was published in September 2012.*

F. Claire will coordinate a sediment management strategy brainstorming meeting for September. *Status: Complete. Brainstorm meeting was held on September 24, 2012.*

G. Claire will coordinate the next quarterly meeting for sometime in late October/early November. *Status: Complete.*

H. Herb and Bruce to draft preliminary statement regarding Conowingo's time as an effective sediment trap running out to be reviewed by LSRWA team and posted to project website. *Status: Complete. Statement located on project website: http://mddnr.chesapeakebay.net/LSRWA/agendas.cfm under the "News" header.*

Action Items from September (Brainstorming) Meeting:

A. Matt Rowe will compare the results from the analysis of sediment cores taken from behind the Conowingo dam in 2006 to the decision framework criteria laid out in the 2007 IRC report to help the team better understand the suitability of the sediments in the lower Susquehanna river watershed for innovative reuse options. *Status: Complete. Tim gave a presentation with results which is included as Enclosure 6 to this memorandum.*

B. Claire will compile questions from the group on floating islands, post-meeting and she will transmit to Brinjac Engineering to respond. *Status: Complete. Carl Cerco was the only one who sent questions in for Brinjac; those questions were forwarded to Steve Zeller on 25 September, and Steve responded directly back to Carl.*

C. Anna will create a spreadsheet of compiled sediment management strategies so this group can begin evaluating and screening sediment management strategies in more detail at the next meeting. *Status: Complete. Spreadsheet was distributed to all stakeholders via email and input was requested by November 29, 2012.*

<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.*

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.*

<u>Action Items</u> –

a. Michael Helfrich will coordinate with MD, CBP and the MD county coalition to set up a meeting to present dam implications to TMDL to MD counties.
b. Mike Langland will let Claire know if his final report will be a stand- alone document or if it will be written collaboratively with Steve Scott to be included with the ADH modeling report.
c. Carl Cerco will have CBP WSM modeling runs of existing/baseline conditions completed by mid-December.
d. UMCES report entitled "Effect of Timing of Extreme Storms on Chesapeake Bay Submerged aquatic vegetation" will be saved on LSRWA website. *Status: Complete. Document saved here here:* http://mddnr.chesapeakebay.net/LSRWA/Docs/Wang%20and%20Linker.pdf

3. <u>Welcome</u> – After a brief introduction of the meeting attendees, Claire O'Neill welcomed the LSRWA agency group and noted that the purpose of the meeting was to provide updates on recent activities within the LSRWA. Herb noted that communication of what study activities to all stakeholders is very important especially as we enter the legislative session in January. The more progress and information we provide, the more we will be able to garner public/political support. Bruce added that our study along with Bay-wide TMDL and FERC relicensing of Conowingo dam has a lot of interest. The LSRWA website has proven to be an effective tool to keep the public informed. Many state and regional groups as well as well as the governor of Maryland wants to know what can be done to accelerate this study's efforts.

   There was discussion on local government outreach. Michael Helfrich noted that there are several MD counties forming a coalition with lawyers out of concern about the sediments behind the dams on the lower Susquehanna River and whether the efforts required by the Maryland counties under the Maryland County WIPs will be effective due to increased scouring and loads from the Susquehanna. Currently the law firm Funk and Bolton is proposing and accepting money from counties for a study to be conducted by this law firm on Bay TMDL.

Michael added that there has been concern raised by this coalition that MD has county WIPs while PA does not. Pat Buckley noted that PA has "WIP planning targets" in lieu of "county WIPs," Bruce added that for the 2017 CBP Mid Point Assessment of the Bay TMDL, the CBP Water Quality Goal Implementation Team (WQGIT) has recognized/prioritized Conowingo filling impacts as one of the top issues to be addressed by the 2017 Mid Point Assessment. Michael noted that he attended the Cecil County Commissioners' meeting and they requested to be educated on dam implications to TMDL and WIPs. Bruce noted that he, or other Maryland state agency representatives, could participate in a meeting with the counties. Michael will determine who from this Maryland county coalition should be contacted to coordinate a meeting and will let Bruce know. In addition to this, Michael will contact CBP to determine if CBP wishes to follow through on reaching out to the counties.

4. HEC-RAS Modeling Update – Mike Langland provided a presentation on building a HEC-RAS model to simulate sediment transport through the three lower Susquehanna River reservoirs. Mike's presentation is included as enclosure 2 to this memorandum.

   Mike noted that Conowingo Dam was constructed in 1929 and since then the Conowingo reservoir has been filling with sediment and has 10 to 15 percent storage capacity remaining. Overall sediment from the watershed has been decreasing (about 2/3 less).

   The objectives of his efforts were to construct, calibrate, and validate a 1-D sediment model for the entire Reservoir system (~33 miles). The goal is to simulate the loads in and out of reservoirs, show bed-form change, and particle size distribution. Ultimately the outputs of this modeling effort will produce input boundary condition files for Conowingo Reservoir for the USACE 2-D ADH model

   There are two models, one showing long-term depositional changes and one showing short-term scouring. The two models provide a range of uncertainty in the boundary condition files. Mike noted that there is more sand upstream and silts and clays are more prevalent closer to the dam for all three reservoirs. Also during TS Lee, scour occurred in all three reservoirs. Both models indicate that the upper two reservoirs still play a "role" in sediment transport. The estimated total sediment transport from the modeling was most likely underestimated but reasonable.

   Mike was trying to calibrate the scour model to TS Lee and the depositional model to Bob Hirsch's modeling/USGS estimator. There is still some fundamental things wrong with the predictions of the model. HEC-RAS is not simulating silts and clays well and it does not show interaction with the bed well. Overall, he couldn't get the model to deposit enough sediment generally, and couldn't get enough scour from TS Lee. Additionally, the HEC-RAS model is not sensitive to gate operations. More specifically:

   - 2008-2011 bathymetry data indicates both deposition and scour in the same cross section, however the model simulates only one occurrence;
   - silts and clay were modeled about two times lower (lack of deposition) than expected based on the literature values and the 2-D model, and could not adjust values;
   - the model only allows one critical shear stress (force of water acting on the channel sides and bed required to mobilize sediments), SEDFLUME data (collected earlier this year by ERDC) indicates wide variability (8x); and finally,

- the model shows that increasing the critical shear results in an increase in scour which is a contradictory effect.

The model is 99% built and Mike continues to work with the HEC group to work out bugs. Right now this is the product we have to work with.

Mike noted he is preparing the report (the presentation he gave is an overview of what report will include) and that he and Steve might prepare a joint report for their modeling efforts. He will let Claire know the format of the final report.

5. <u>2D ADH Modeling Update</u>– Steve Scott provided a presentation on his 2D ADH modeling efforts. Recent tasks have focused on model validation to ensure that the model can adequately replicate sediment transport characteristics representative of the lower Susquehanna River system. Steve's presentation is included as enclosure 3 to this memorandum.

The validation criteria he used were USGS' studies on the Conowingo Reservoir (annual load and scour predictions); measured suspended sediment concentrations out of Conowingo; and trap efficiency calculations.

The simulations he ran to validate the model included (1) 2008 – 2011 simulation of flows through Conowingo Reservoir and (2) inflowing sediment concentrations provided by USGS (HEC-RAS) output. Two HEC-RAS simulations were run: (1) minimum scour load from upper two reservoirs and (2) maximum scour load from upper two reservoirs.

The USGS validation criteria included (1) an estimation of 3 – 4 million tons of scour for TS Lee (2) an estimation of 1.5 million tons of sediment deposited per year and (3) a trap efficiency range of 50 to 70%.

For the first simulation AdH results for sediment inflow /outflow predicted a total inflow of 22 million tons, 50 percent from TS Lee. The AdH results for sediment storage predicted a total of 1.5 million tons/year, deposition up to 3.7 years, scour at 3.5 million tons during the TS Lee event and deposition of 3 million tons. The AdH results for trap efficiency predicted a total of 60 percent trap efficiency during depositional flows. The AdH results for maximum critical shear stress was 1.4 million tons/year, deposition up to 3.7 year, scour 2 million tons (Lee Event), and deposition of 3.5 million tons.

For the second simulations AdH results for sediment inflow /outflow predicted a total inflow of 25 million tons, 50 percent from TS Lee. The AdH results for sediment storage predicted a total of 1.7 million tons/year; deposition up to 3.7 years; scour at 3.5 million tons during TS Lee event and deposition of 4 million tons. The AdH results predicted a total of 60 percent trap efficiency during depositional flows.

In conclusion, USGS predictions included scour: of 3.0 to 4.0 million tons, a deposition rate at 1.5 million tons per year while the AdH results identified a scour of 2.0 -3.5 million tons; deposition rate at 1.4 to 1.7 tons per year and a trap efficiency at approximately 60 percent.

Steve noted that the bottom line is that at this time, the 2D ADH model is up and running and is an accurate representation of the system. He noted that he has considered input loads that will be provided to him from Mike Langland's work (HEC-RAS); despite the bugs that Mike mentioned, simulations will provide an accurate representation of relative changes to the system.

6. CBEMP Modeling Update – Carl Cerco provided a presentation on the estimated effects of Conowingo infill on the current conditions in Chesapeake Bay utilizing the CBP Watershed Model (WSM). This effort is establishing existing conditions and future conditions to assist in answering the question of what will happen to Chesapeake Bay when reservoirs are full and no longer trapping solids? Carl noted that it is a very preliminary look and any results should be shared with discretion in that results are still very rough. Carl's presentation is included as enclosure 4 to this memorandum.

Carl found through his efforts that in general on any day, outflow volume, solids concentration, and solids load can be greater or less than inflow. On average, outflow exceeds inflow by 18 m^3/s; inflowing solids concentration exceeds outflow by 3.3 mg/L; and 711 tonnes/day (260,000 tonnes/year) solids are retained by Conowingo reservoir (Note that 1 tonne= 1 metric ton=1,000 kilograms= 2,204.6 pounds). The variation in outflow vs. inflow occurs at flows less than 3,000 m^3/s. At higher flows, the relationship is 1-to-1. Overall, the inflowing solids concentration is approximately 33 percent greater than the out-flowing concentration, meaning that the Conowingo Reservoir is still retaining solids. The inflowing solids load is approximately 20 percent larger than the out -flowing load. The difference between inflowing and out-flowing concentrations is unrelated to flow. At this stage of WSM calibration, scouring does not occur. Few scouring events (flow > 400,000 ft3/s) are expected during the model application period, in any event."

The basic assumptions that were used for scenarios run with the model include (1) no scouring occurs in the model (2) limited scouring during the application period (1991-2000 hydrology) is expected in any event; (3) the reservoir acting as a sink for solids (and nutrients in solid form); (4) the first approach to examining the effect of Conowingo infill is to eliminate it from the WSM system; and (5) the water quality model (WQM) receives loads directly from the Susquehanna River as it enters Conowingo.

Conditions that were used for this modeling run (future once Conowingo is no longer trapping solids) were: (1) ten years of hydrology, 1991-2000; (2)base conditions from the 2010 CBP progress run (land use, point sources, atmospheric loads etc.); (3) phase 5.3.2 Watershed Model (same phase of the WSM and same calibration status of the WQM as used for TMDL determination); and (4) Conowingo Reservoir eliminated (direct loads to Conowingo also eliminated).

Taking those assumptions and conditions into account Carl ran the model and examined the effects of key water quality constituents (SAV, DO, chlorophyll, light extinction) at four mainstem stations.

After running the model and analyzing results, Carl reported that CB1 (segment of Northern Bay just below Conowingo Dam) showed the greatest impact on chlorophyll (increases up to 4 to 5 μg/L during summer). CB2 showed a lot of fluctuations but, on first impression, little net change. Carl concluded that light limitation is the dominant factor here. CB3 and CB4 show less chlorophyll in spring, possibly indicating increased light limitation. Increases of approximately 0.5 μg/L characterize these stations in summer. In general, as you travel down the Bay the loads disperse and impacts to light decrease.

Carl noted that he observed decreases in bottom dissolved oxygen of 0.1-0.2 mg/L at CB2.2, CB3.3C and CB4.2C. Larger decreases occur in CB1.1, but this station in general, exhibited few DO problems. Station CB3 is by the Chesapeake Bay Bridge; this is currently the worst place for DO in the Bay. Any drop in DO at this location is a serious problem.

Increases in light attenuation are "flashy" reflecting loading events. Increases range over two orders of magnitude. Range is 10 m^{-1} in CB1 (uncommon) to 0.1 m^{-1} at CB4.2.

Results revealed that SAV at CB-1 in particular, showed a loss of 4 sq km or 7percent (losses are largely confined to this region) and system-wide the modeling predicted a loss of 5.7 sq km or 1percent.

Carl noted that the next steps for his modeling efforts are: (1) to conduct a complete examination of 2010 CBP Progress Run scenario (re-run with direct loads to Conowingo reservoir); (2) run TMDL scenario with Conowingo storage eliminated (i.e,. once WIPs are implemented how will this impact Conowingo infill and Chesapeake Bay); (3)to run results of the TMDL scenario through the CBP processor which examines water quality standards; (4) to perform one or two scenarios with a storm event during SAV growing season; and (5) time and resources permitting, to examine scour and deposition using ADH (bathymetry circa 1991 – 2000, present bathymetry, reservoir full).

There was discussion on the impacts of reservoir operations on loading. Lew Linker noted that WSM should show some scouring. The WSM has a "good to excellent" calibration of sediment over the entire range of observed loading from 1985 to 2005; achieving this is due to user-specified model parameters for both scour and deposition, and M, the erosion rate for scour. So on the few occasions when we do have very high flows, we see in the observed data and in the simulation that the TSS loads are higher at Conowingo than they are for all the inputs to the Conowingo Reservoir; this is evidence that scour is occurring in the simulation. Carl explained that indeed WSM is applied over the period 1985-2005. For this project, we are looking at 1991-2000 hydrology. During this shorter period, there is only one instance, of a few days duration, when flows are high enough to generate scour. Carl did not see evidence of scour during this 3 or 4 day event although scour may be present during high-flow intervals outside the 1991-2000 period. In summary, Carl did not see evidence of scour in the WSM loads during the 1991-2000 interval, nor was significant scour expected.

Michael Helfrich expressed concern over using 260,000 tons per year solids being retained by Conowingo. Is this too conservative? Carl noted that the CBP WSM has a crude representation of scour/deposition. Michael expressed concern that if we only have money for a few more model runs by CBP, they must be done using the 1.5 million tons per year of current sediment trapping. This figure does not need to be calculated in a model, it should be easily extrapolated from the bathymetric measurements. He respects the efforts to build models that represent reality so that we can input BMP's for evaluation, but he is concerned about limited funds being used to run models using figures that do not represent reality. He also raised concerns about this information being shared publicly, as misinformation of this type can easily be confused and misused by members of the public. Anna/Claire noted that any material posted on the website will have draft/preliminary clearly stated so that the public knows these are still working numbers. Also Carl's presentation will be an enclosure to this memorandum and won't be a stand-alone document distributed publicly.

Carl noted that CBP is revisiting Conowingo scour. Carl noted that the WSM is providing us a sense of magnitude and is an initial run. He will have more runs completed by mid-December.

There was discussion on the volatile suspended solids (organic/living or previously living solids) that the CBP WSM modeling run predicted. Carl noted that VSS are produced in the reservoir itself under low-flow conditions because of long water residence time facilitating this. We can assume that the quantity of VSS produced is reduced if there is no reservoir. With reduced residence time, there's less time to form VSS. Michael noted that the system will never really be full due to scouring so there will always be time for VSS to form.

7. Review of Modeling Scenarios – Claire O'Neill provided a modeling scenario handout to the group which is included as enclosure 5 to this memorandum. Claire noted that due to limited funds and time there has been much discussion on which modeling scenarios should be prioritized and run first, and how those scenarios would be run. This handout lays out team discussion on the various modeling input options and resolution. After reviewing the options, it was agreed that using the CBP WSM input would provide a big picture or macro view of the problem right now. This input can be done relatively simply and in a short timeframe. The primary focus of this work is to assess the sediment impacts on the upper Bay area. The four scenarios to run by Carl are as follows:

1. 2010 land uses with 1991-2000 flow values and 1991-2000 Conowingo capacity;
2. Watershed implementation plans (WIPs) in place with 1991-2000 flow values and 1991-2000 Conowingo capacity;
3. 2010 land uses with 1991-2000 flow values and Conowingo storage full; and
4. WIPs in place with 1991-2000 flow values and Conowingo storage full

For the purposes of evaluating the effectiveness of alternatives, the HEC-RAS/AdH input is required (i.e., micro view). The HEC-RAS/AdH input is focused on 2008-2011 flow values and current bathymetry so it is a more accurate representation of the existing conditions. Using this input will result in more detailed information about the geographic distribution of sediments as well as the impacts to the upper Bay area.

8. Sediment Core Composition – Tim Fox provided a presentation on Susquehanna River sediment and metals screening thresholds. Tim's presentation is included as enclosure 6 to this memorandum.

At the last LSRWA meeting there was discussion on the 2009 report. *Sediment in Baltimore Harbor: Quality and Suitability for Innovative Reuse. An Independent Technical Review.* This effort involved a national team of independent experts examining historical data for levels of metals and organic contamination in sediments that may be dredged from Baltimore Harbor shipping channels, including off-channel sites and harbor approach channels in the Chesapeake Bay. Summarizing this data helps the regional agencies as they manage large amounts of sediment taken from these channels. This independent team evaluated the suitability of dredged sediments for innovative reuse to provide managers with a scientifically sound basis for determining potential innovative reuse options. In this evaluation, the team assembled data and information to construct a framework for risk analysis and decision-making.

There was discussion at the last LSRWA meeting that the results from the analysis of sediment cores taken from behind the Conowingo dam in 2006 need to be compared to the decision framework criteria laid out by this 2009 IRC report. This way the suitability of the sediments in the lower Susquehanna River watershed for innovative reuse options could be better understood (i.e., do ~~sediments behind dams meet beneficial reuse standards?).~~

Tim noted that MDE conducted a comparison between the results of the two reports. The assumptions they made were that they did not take depth into account and if any core exceeded a use threshold at any depth, then the site did not meet that use threshold (i.e., this analysis was very conservative).

MDE's analysis revealed that most metals in the sediment cores were below MD residential reuse thresholds which include uses such as upland reclamation and manufactured topsoil for landscaping. There were some instances where arsenic, chromium and cadmium were above MD residential reuse thresholds meaning that some of the sediments from behind Conowingo would not be acceptable for this kind of reuse. MDE's; findings were similar to the IRC (2009) report in that site specific assessments may be needed for sediment reuse potential and there could be some regulatory issues.

There was not much time for discussion results will be discussed further in future meetings.

9. Strategy for Alternative Development- Anna noted a spreadsheet of compiled sediment management strategies was developed so this group can begin evaluating and screening sediment management strategies in more detail at the next meeting. This spreadsheet is included as enclosure 7 to this memorandum.

This spreadsheet was distributed to all stakeholders via email and input was requested by November 29, 2012. The LSRWA team will use this document as a starting point to develop, evaluate, compare and screen sediment management strategies.

Once we know baseline conditions and future conditions if no action is taken, we can begin to screen strategies. Management strategies are organized into three categories: watershed (e.g. BMP's); routing sediments (e.g., by-passing/reservoir operations); and recovering volume (e.g., dredging).

The team will need to determine the viable options through a screening process; then the viable options will need to be modeled and compared. Collaboration on these strategies is critical. Strategies ultimately will have costs identified and recommendations for implementation as well as entities to implement. Currently, the strategies listed in this spreadsheet are very generic. It will take time to create more specific strategies.

There was discussion about by-passing during less critical times, such as during the winter. We know that Tropical Storm Agnes had big, negative impacts on SAV because the storm hit during the SAV growing season. However the 1996 winter event and the more recent Tropical Storm Lee event which were outside of the SAV growing season, did not appear to have the same negative impacts. Lew noted that the Bay TMDL water quality standards trump TMDL load requirements so even though loads added during the winter would contradict Bay TMDL they would positively impact water quality standards (in comparison to loads entering system during spring/summer). Bruce mentioned a report done by UMCES entitled *"Effect of Timing of Extreme Storms on Chesapeake Bay Submerged Aquatic Vegetation"* which discussed storm impacts on SAV. It is on the LSRWA website here: http://mddnr.chesapeakebay.net/LSRWA/Docs/Wang%20and%20Linker.pdf

Wrap Up – Anna will draft up notes for the group's review. Following this, the notes and presentations will be posted to the project website. The next quarterly meeting date will be February 11, 2013.

Anna Compton,
Study Manager

Enclosures:
1. Meeting Agenda
2. Mike Langland Presentation
3. Steve Scott Presentation
4. Carl Cerco Presentation
5. Modeling scenario summary
6. Tim Fox presentation
7. Sediment Management Strategy Spreadsheet

LOWER SUSQUEHANNA RIVER WATERSHED ASSESSMENT
QUARTERLY TEAM MEETING

MDE, Montgomery Park Building, Terra Conference Room
November 19, 2012

Meeting Agenda

		Lead
10:00	Welcome and Introductions	All
10:05	Review of Action Items from August/September Meetings	O'Neill
LSRWA Technical Analyses		
10:15	HEC-RAS Modeling Update	Langland
10:45	Sediment Transport Modeling Update	Scott
11:15	CBEMP Modeling Update	Cerco
12:15	Review of Modeling Scenarios	O'Neill
12:25	Sediment Core Comparison	Rowe
12:35	Strategy for Alternative Development	Compton
12:45	Communication and Coordination Updates	Compton
12:50	Review of Schedule/Budget for 2012-13	O'Neill
12:55	Wrap Up Action Items/Summary Next Meeting	O'Neill

Call-In Information: (410) 537- 4281 (no password required)

Expected Attendees:

MDE: Herb Sachs; Tim Fox, Matt Rowe, John Smith (phone)
MDNR: Bruce Michael, Shawn Seaman
MGS: Jeff Halka
SRBC: John Balay, Andrew Gavin
USACE: Anna Compton, Bob Blama, Chris Spaur, Claire O'Neill, Ashley Williams, Danielle Aloisio, Tom Laczo
ERDC: Carl Cerco, Steve Scott
TNC: Mark Bryer, Kathy Boomer
USEPA: Gary Shenk, Lewis Linker
USGS: Mike Langland

Exelon: Mary Helen Marsh, Kimberly Long, Bob Matty
Lower Susquehanna Riverkeeper: Michael Helfrich
PA Agencies: Patricia Buckley, Raymond Zomok

Action Items from August Meeting:

A. Anna will email out the draft mission statement to the team and the team will provide any further comments to the statement.
B. Anna will revise goals and objectives to state "three" vs. "four" hydroelectric dams to accurately reflect the study area of the assessment.
C. Mike will resolve issues with HEC-RAS modeling and will have a workable boundary condition file by the end of August.
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E. Bob Hirsch will share draft press release on recent TS Lee study findings by USGS with selected agencies for review and input.
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B. Claire will compile questions from the group on floating islands, post-meeting and she will transmit to Brinjac Engineering to respond. [Note: Carl Cerco was the only one who sent questions in for Brinjac; those questions were forwarded to Steve Zeller on 25 September, and Steve responded directly back to Carl.]
C. Anna noted that the group needs to begin making decisions on what sediment management strategies we want to focus on for this effort. She will create a spreadsheet of compiled sediment management strategies so this group can begin evaluating and screening sediment management strategies in more detail at the next meeting.

Ongoing Action Items from Previous Meetings:

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 – Recent report was sent out to team; ongoing action.
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.
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.
E. Matt will keep team informed on innovative re-use committee findings to potentially incorporate ideas/innovative techniques into LSRWA strategies.

HEC-RAS Reservoir Transport Simulation of Three Reservoirs in the Lower Susquehanna River Basin

Mike Langland and Ed Koerkle

Topics

- Background / Project Objectives
- Data Selection
  - Sediment and Geometric Input Data
- Sediment transport calibration / simulation
- Model results / issues

USGS

Background

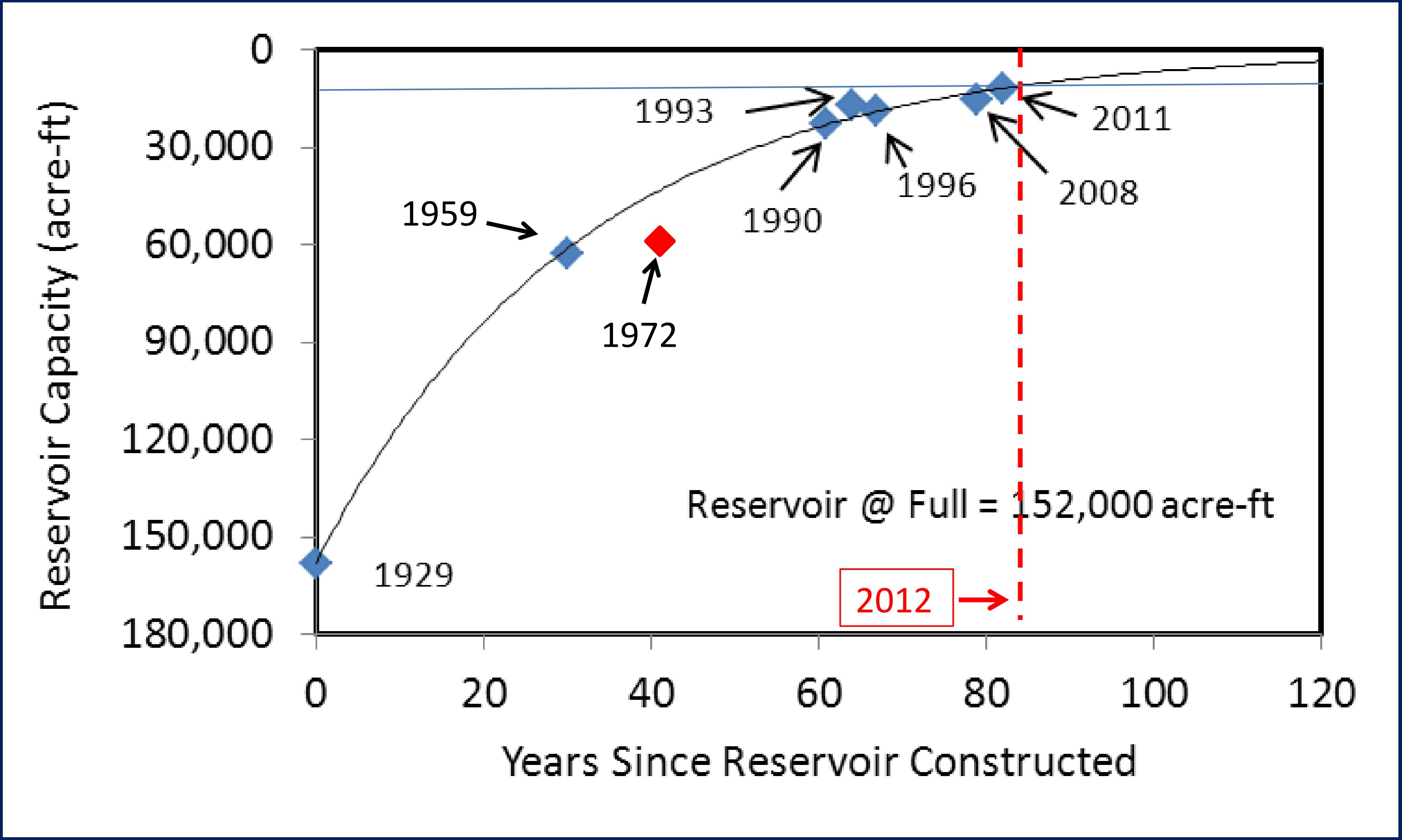
- USGS collected bathymetry and cores in 1990, 1993, 1996, 2001, and 2008
- Document change in sediment storage capacity and size composition
- Previous USGS HEC-6 Model (1995)
- Remaining Capacity – Implications

  - Chesapeake Watershed TMDL

  - PA/NY reduce more to meet goals

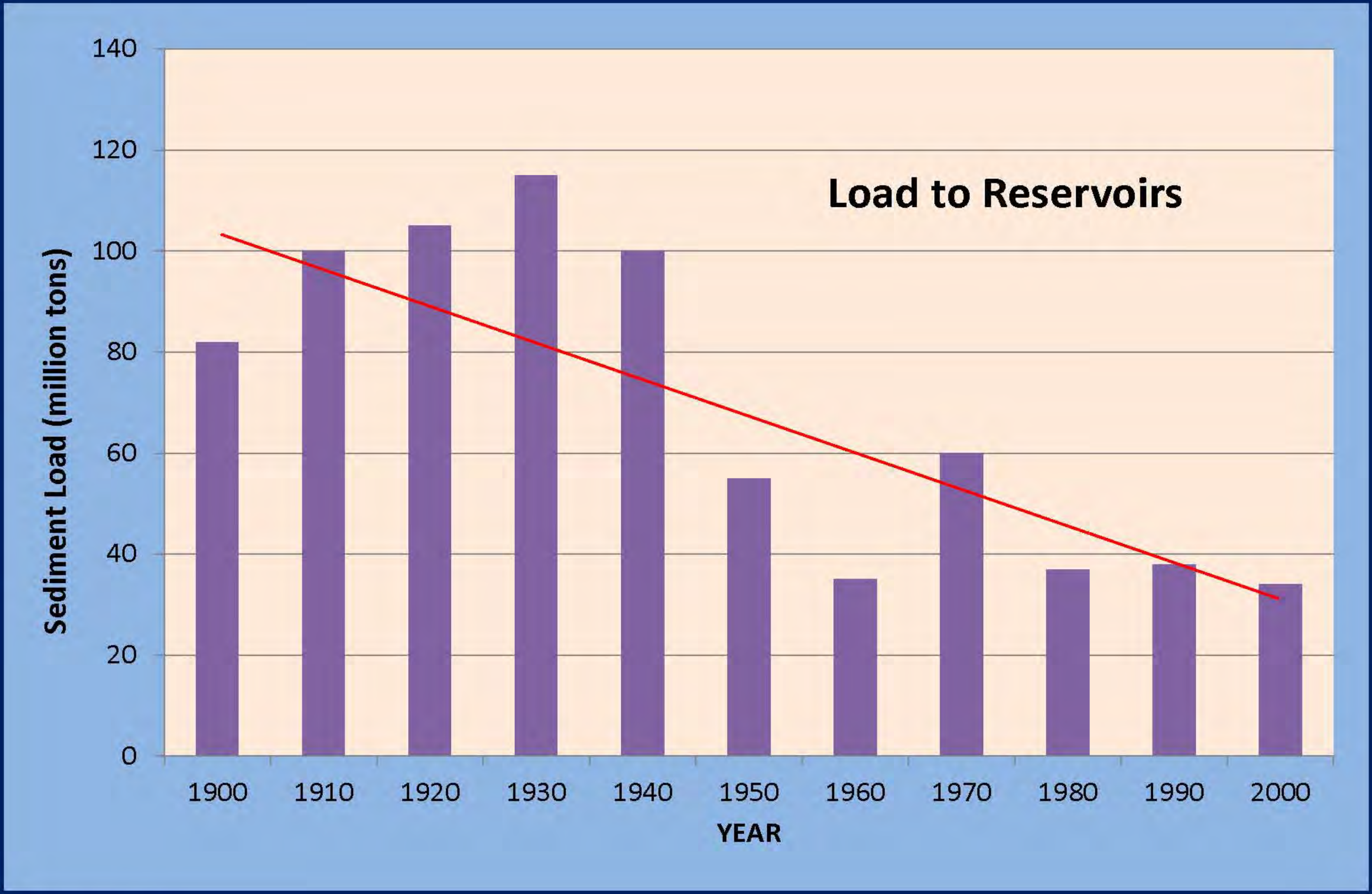
USGS

Changes in Bathymetry with Time



2012 – only 10-15% of original volume remains to fill to capacity

Sediment inputs have been decreasing (about 2/3 less)



Objectives

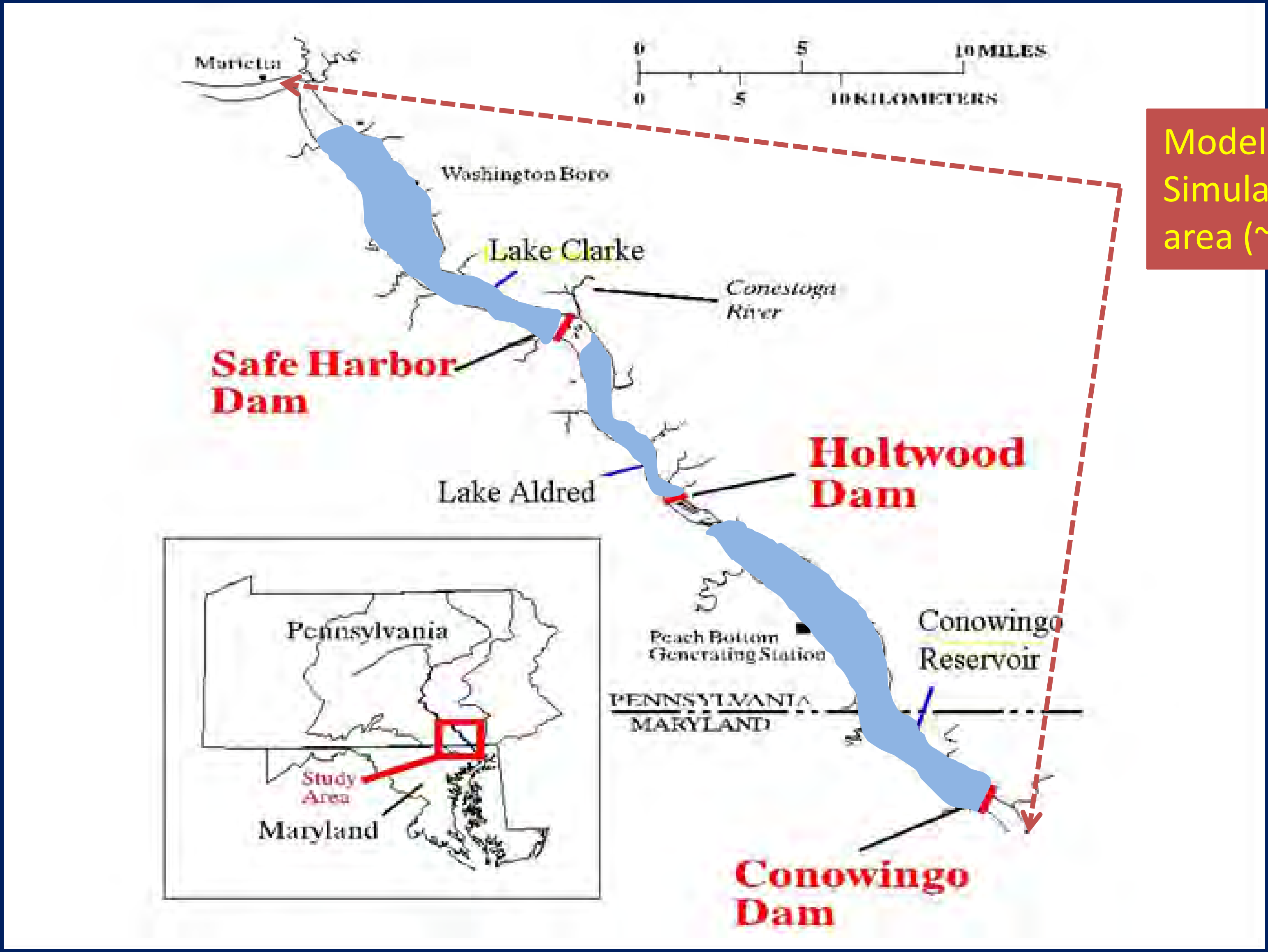
- Construct, calibrate, and validate a 1-D sediment model for the entire Reservoir system (~33 miles)
- GOAL - Simulate the loads in and out, bed-form change, and particle size distribution
- Product - Produce input boundary condition files for Conowingo Reservoir for USACE 2-D model

USGS

Definitions

- 1-D sediment model – model either erodes OR deposits, not both on same transect
- Shear stress (SS) – force of water acting on the channel sides and bed (different for each particle size)
- Critical Shear Stress (CSS) – shear stress required to mobilize sediments
- Generally, if SS < CSS, then deposition, if SS = CSS, then “equilibrium”, if SS > SCC, then degradation (scour)

Susquehanna River Reservoirs



Model Simulation area (~33 m)

HEC-RAS Model – 3 main steps

1) Prepare Input data – sediment and flow

2) Construct Geometric and Hydraulic framework

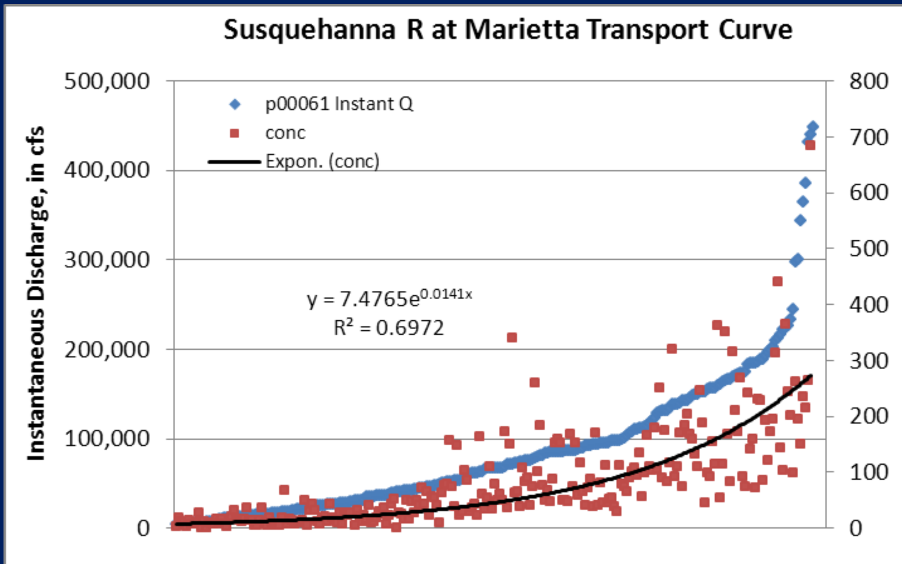
3) Calibrate to observed data

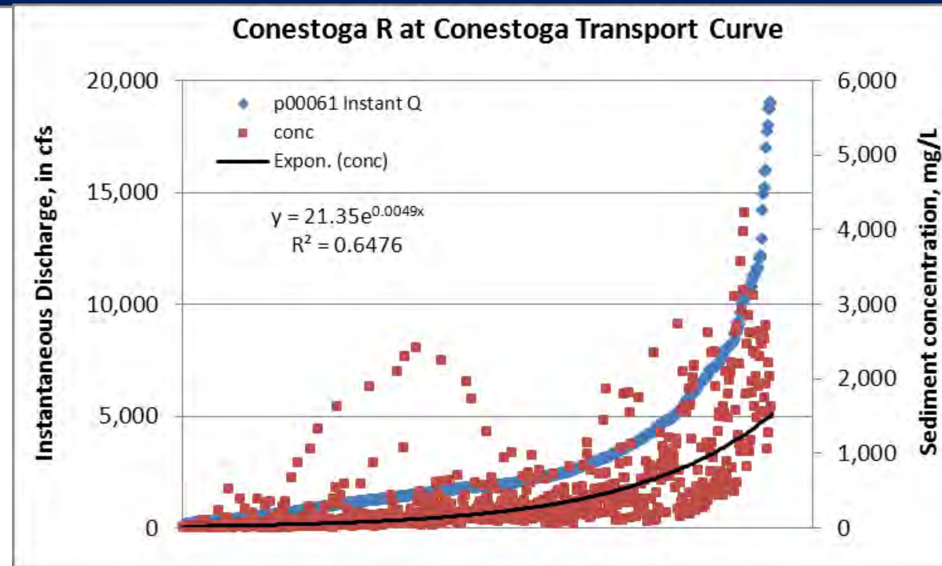
Input Data

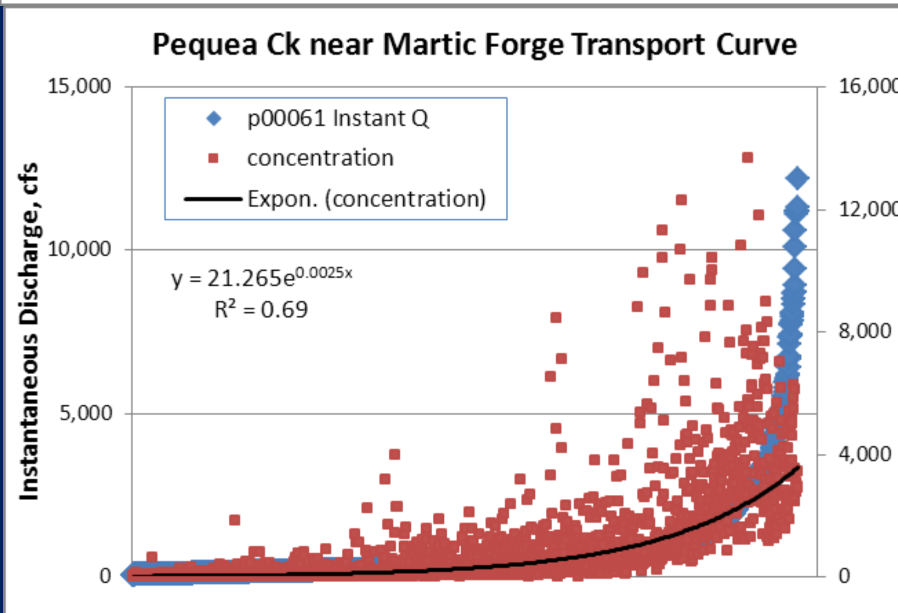
Sediment - transport curves or estimated daily sediment loads and core data

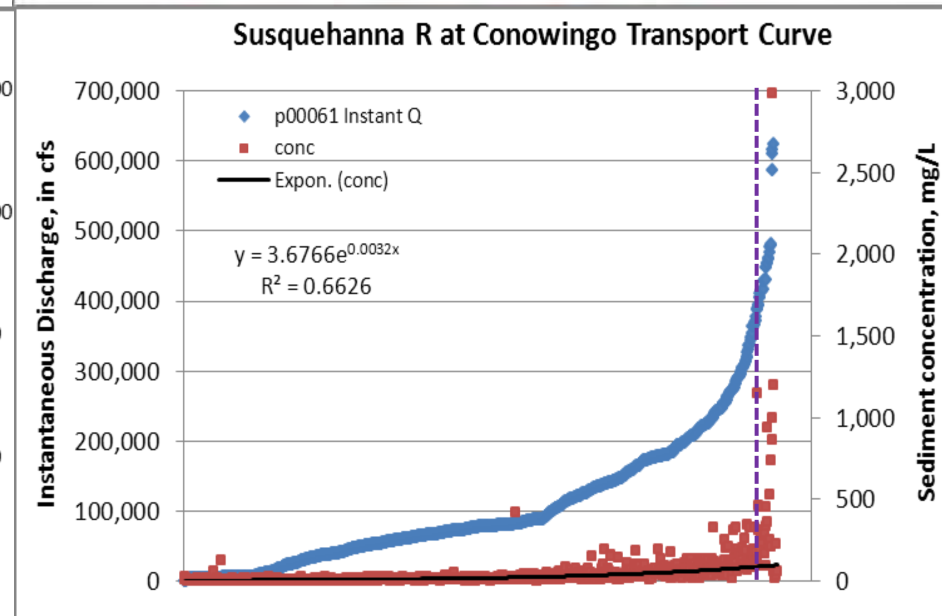
Flow – rating curve or actual daily flow data

Sediment Transport Curves





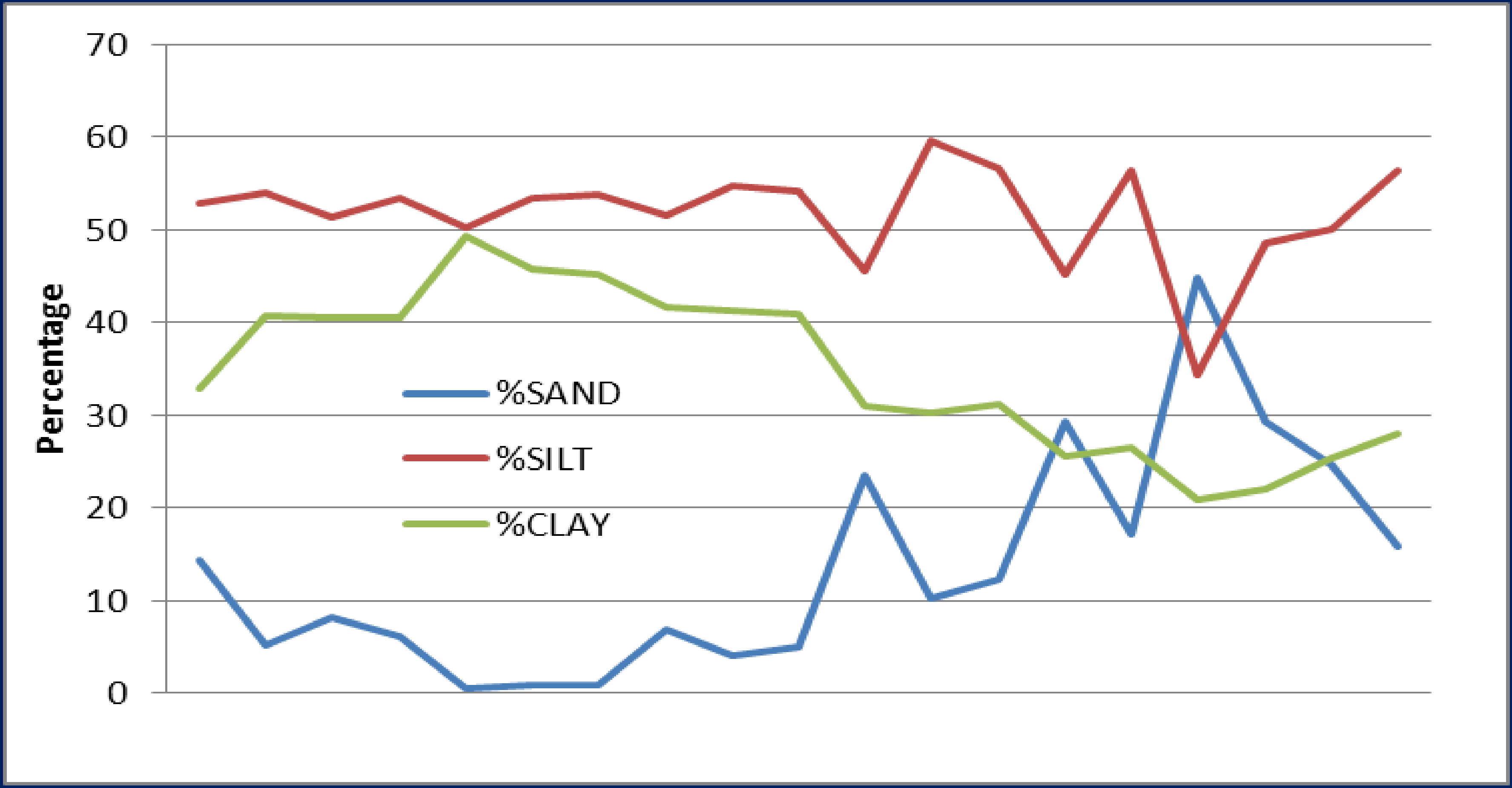




*Transport curves yielded low mass, used actual sediment data

Bed Material Particle Size (cores)

Generally, more sand, less silt and clay as upstream distance increases. (19 locations in Conowingo)

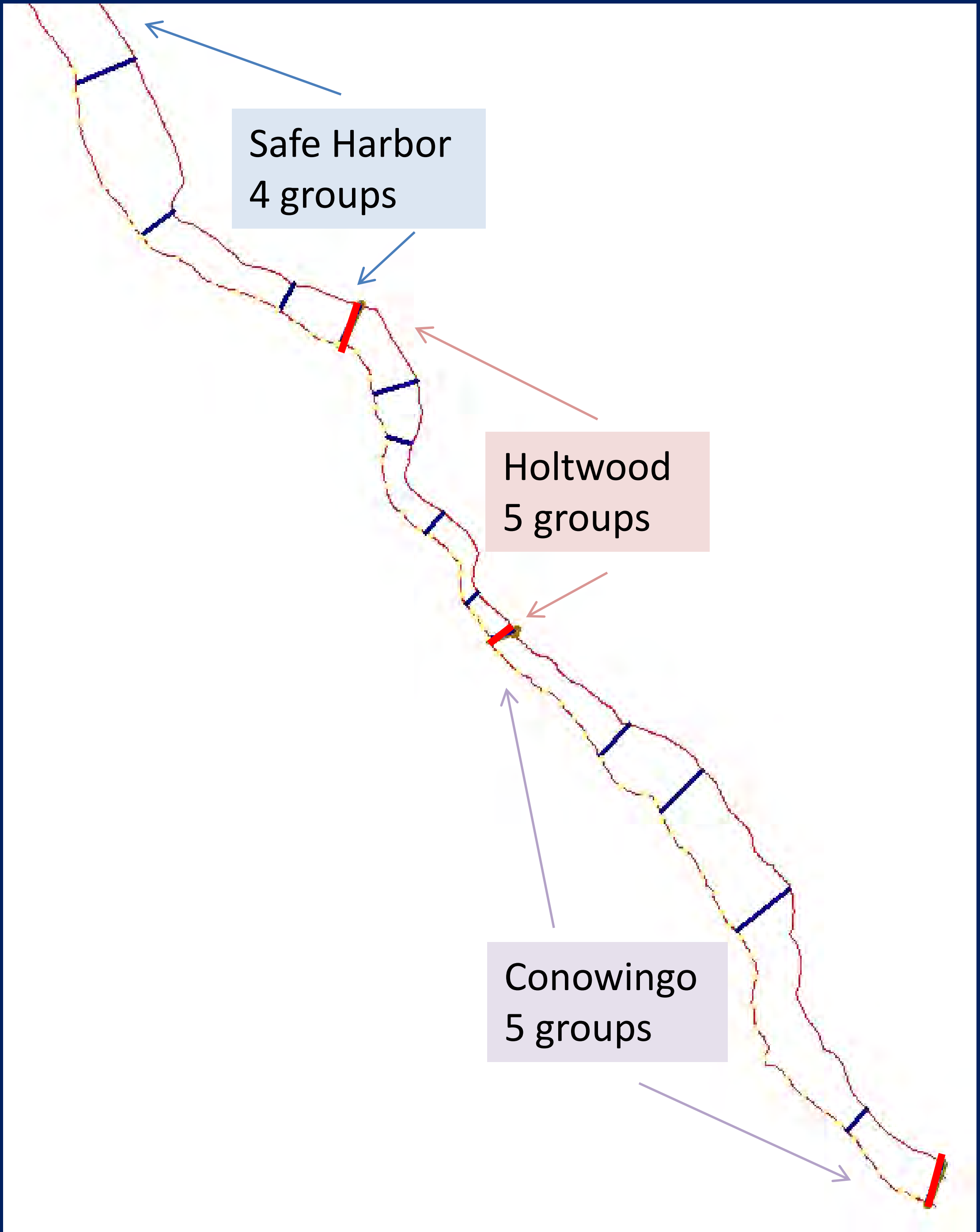


DOWN STREAM UPSTREAM

Bed Material Grouping (cores)

Based on particle size and bed thickness

Assigned average shear stress based on USACE Sediment Flume data



HEC-RAS Model – 3 main steps

1) Prepare Input data – sediment and flow

2) Construct Geometric and Hydraulic framework

3) Calibrate to observed data

USGS

Model Geometry

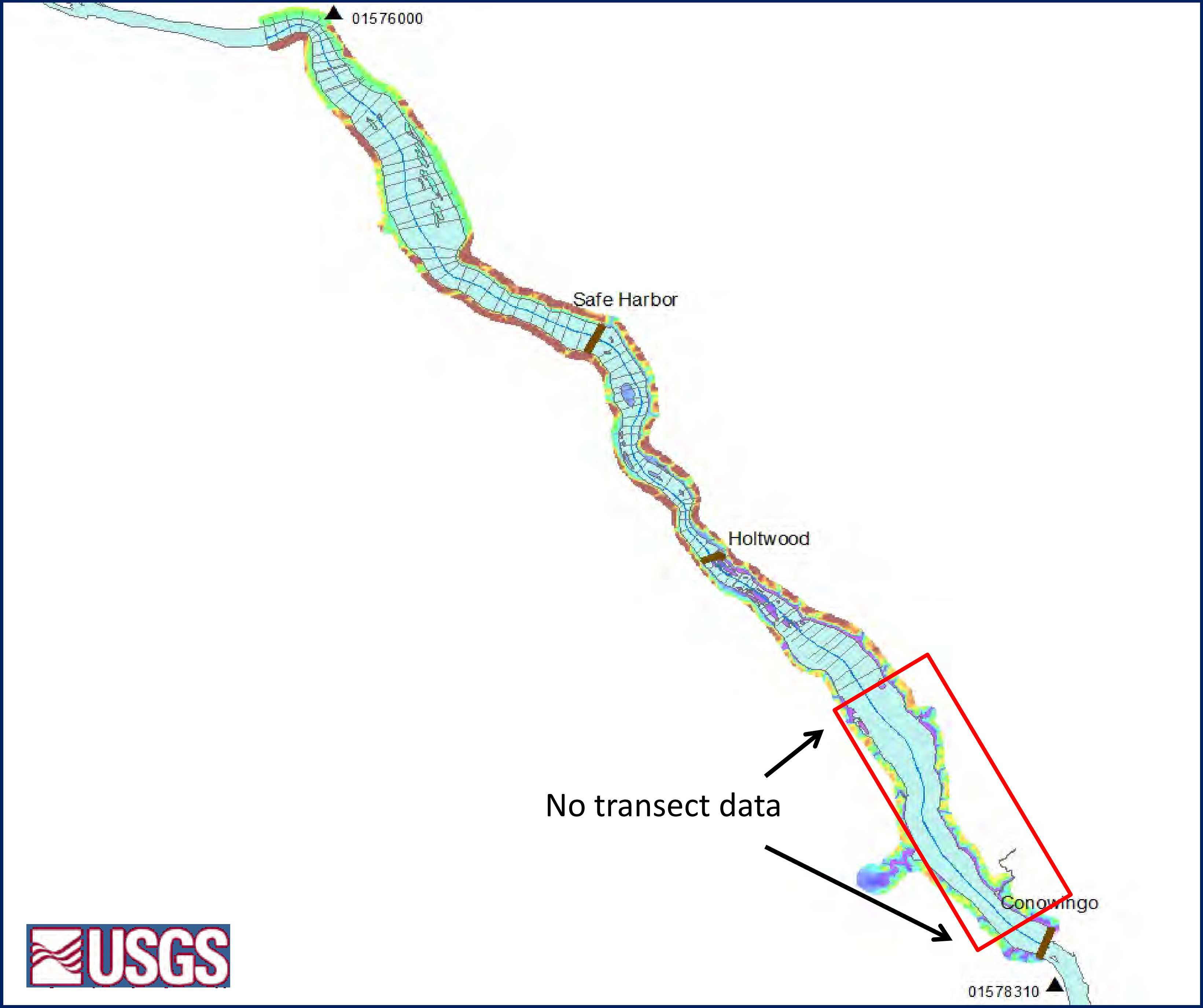
Geometric Options :

- Adapt previous HEC-6 model (USGS, 1995)
- Convert HEC-2 (FIS) model to RAS sediment model
- Construct new RAS sediment model

USGS

Options :

- Adapt HEC-6 model (USGS, 1995)
  - Performed poorly, no digital files
- Convert HEC-2 (FIS) model to RAS sed model
  - Covers 75% of reach, XS stationing errors, no XS bathymetry, and poor alignment current bathymetry
- Construct new RAS model
  - Alignment of XS cut lines with current bathymetry
  - Model geometry better suited for sediment model (i.e., no structures, fewer XS)
  - Use Lidar-derived topography for channel banks



01576000
Safe Harbor
Holtwood
No transect data
Conowingo
01578310

Options :

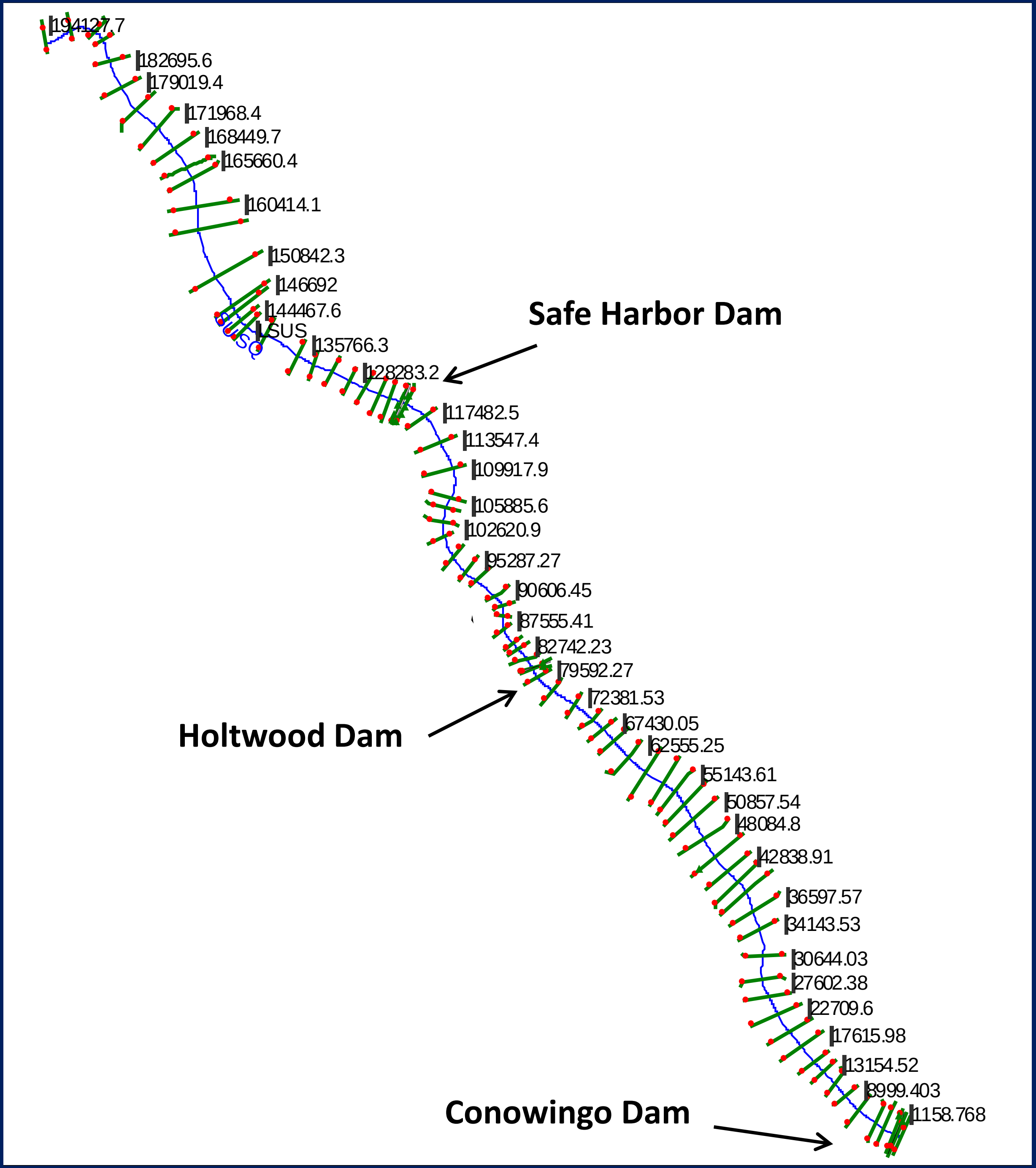
- Adapt HEC-6 model (USGS, 1995)
  - Performed poorly, no digital files
- Convert HEC-2 (FIS) model to RAS sed model
  - Covers 75% of reach, XS stationing errors, no XS bathymetry, and poor alignment current bathymetry
- Construct new RAS model
  - Alignment of XS cut lines with current bathymetry
  - Model geometry better suited for sediment model (i.e., no structures, fewer XS)
  - Use Lidar-derived topography for channel banks


Safe Harbor
Holtwood
USGS

Final Model Cross-sections

34 in Conowingo
18 In Holtwood
28 in Safe Harbor
80 X-sections

Avg one X-section every 0.4 mile



Hydraulics

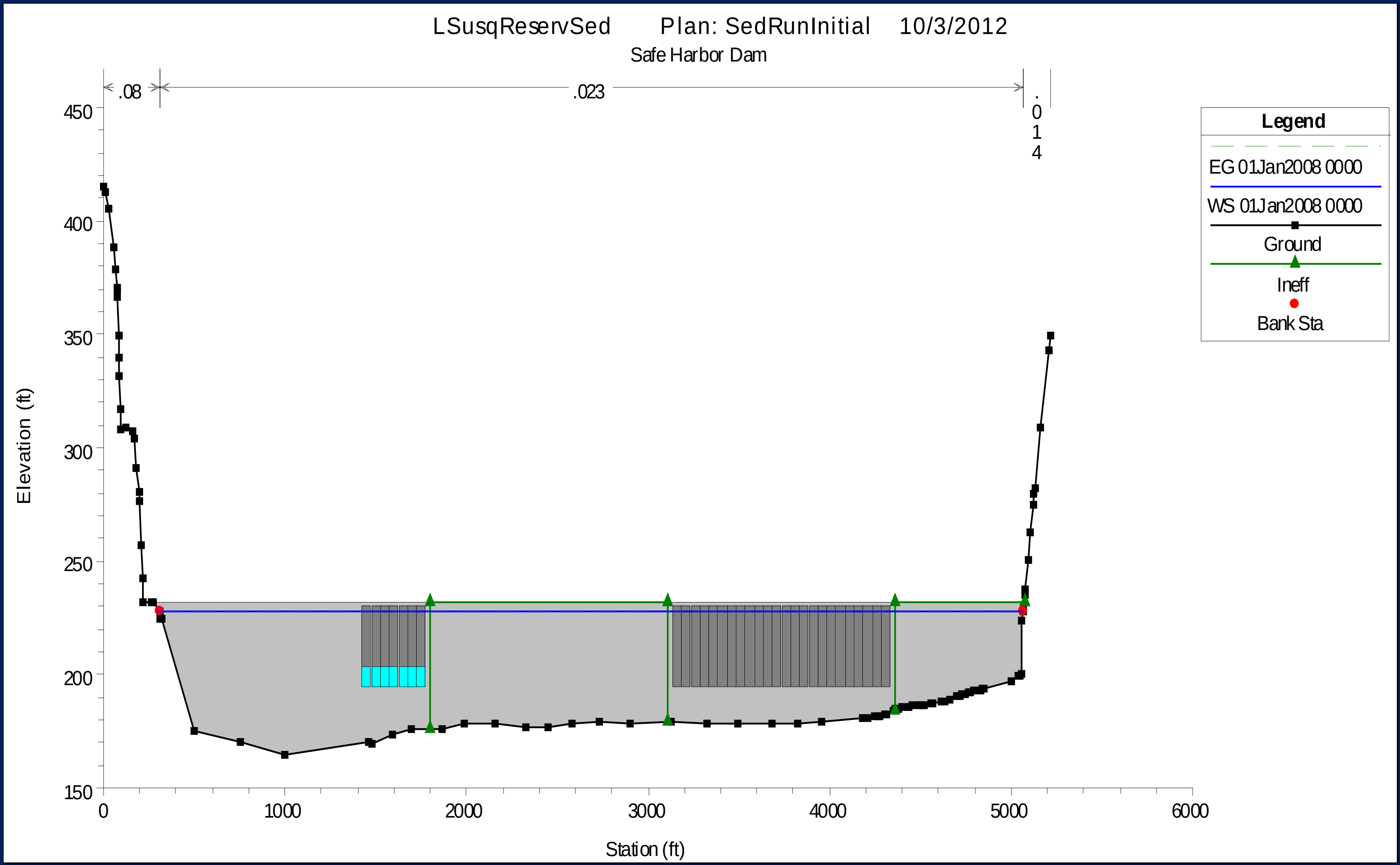
Hydraulic Options :

- Discharge Rating Curve
- Actual daily value discharge

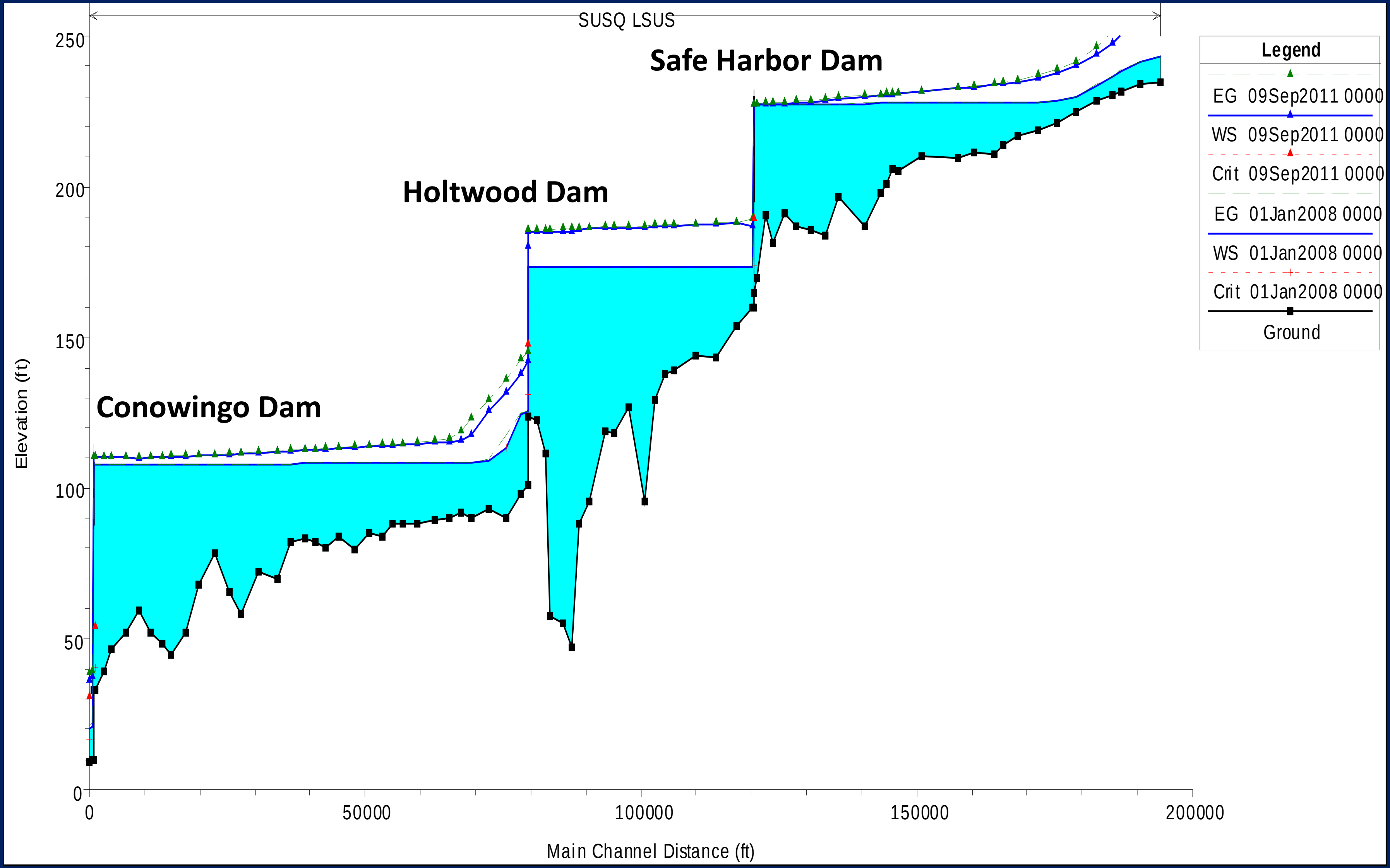
Gate and Spillway Simulation

USGS

Gate Representation (Safe Harbor)



Reservoir System Hydraulic Representation



HEC-RAS Model – 3 main steps

1) Prepare Input data – sediment and flow

2) Construct Geometric and Hydraulic framework

3) Calibrate to observed data

USGS

Simulation targets ("calibration" data)

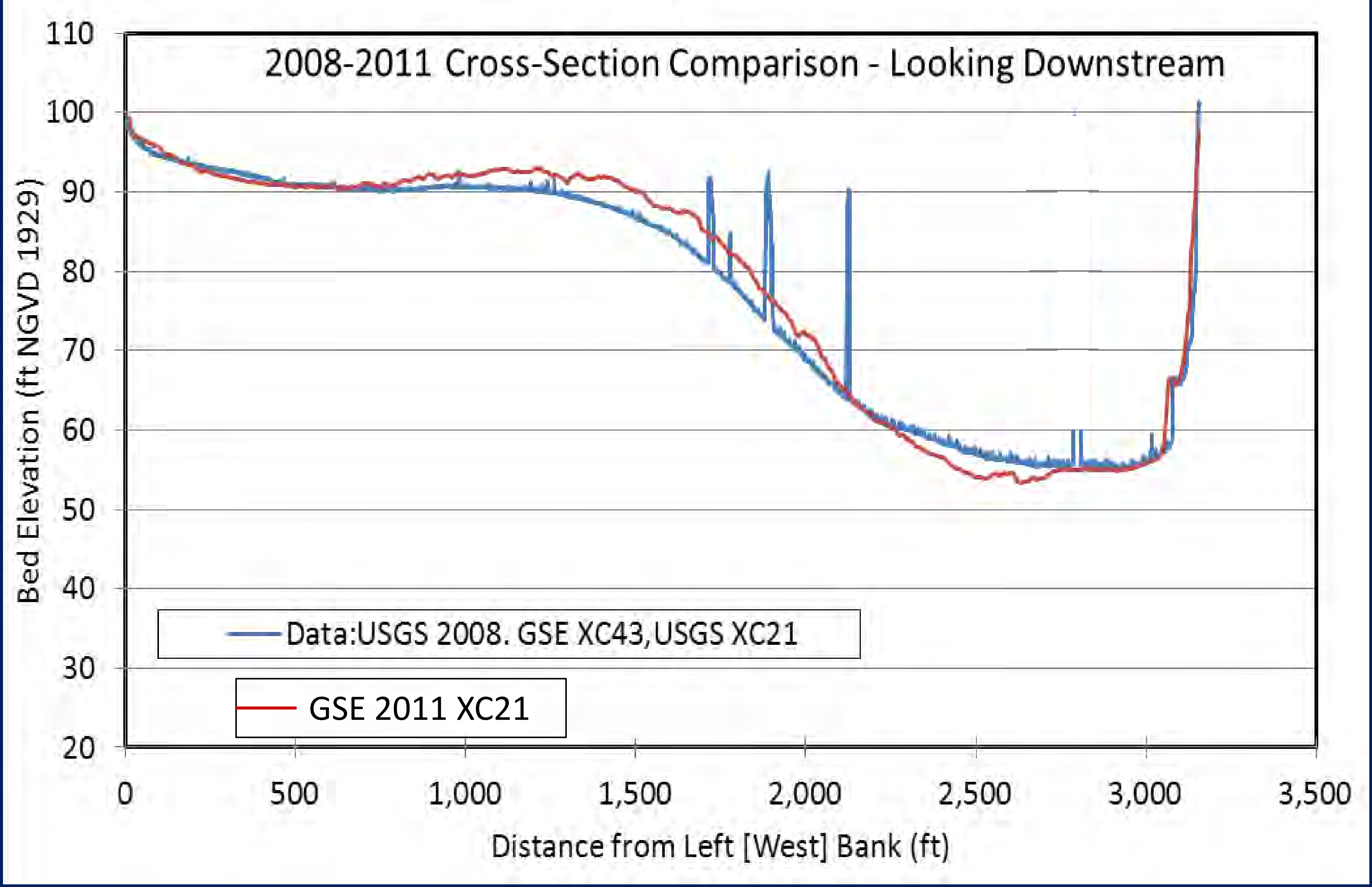
- Reasonable estimates of particle size distributions and sediment depth's in the Reservoir System.
- Bathymetry from 2008 and 2011 surveys
- Daily streamflow and sediment loads for 2008-2012
- More detailed sediment load from Sept. 2011 flood (Tropical storm Lee)

USGS

Model Calibration Issues

- 2008-2011 Bathymetry data indicates both deposition and scour in same X-Section, 1-D model simulates only one occurrence
- Modeled "fall velocity" (silts and clays) about 2X lower (lack of deposition) then expected from literature values and 2-D model, and could not adjust values
- Model only allows one critical shear stress value, SEDFLUME data indicates wide variability (8x)
- Increasing the critical shear resulted in an increase in scour (contradictory effect)

USGS



2008-2011 Cross-Section Comparison - Looking Downstream
Bed Elevation (ft NGVD 1929)
110
100
90
80
70
60
50
40
30
20
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Distance from Left [West] Bank (ft)
Data:USGS 2008. GSE XC43,USGS XC21
GSE 2011 XC21

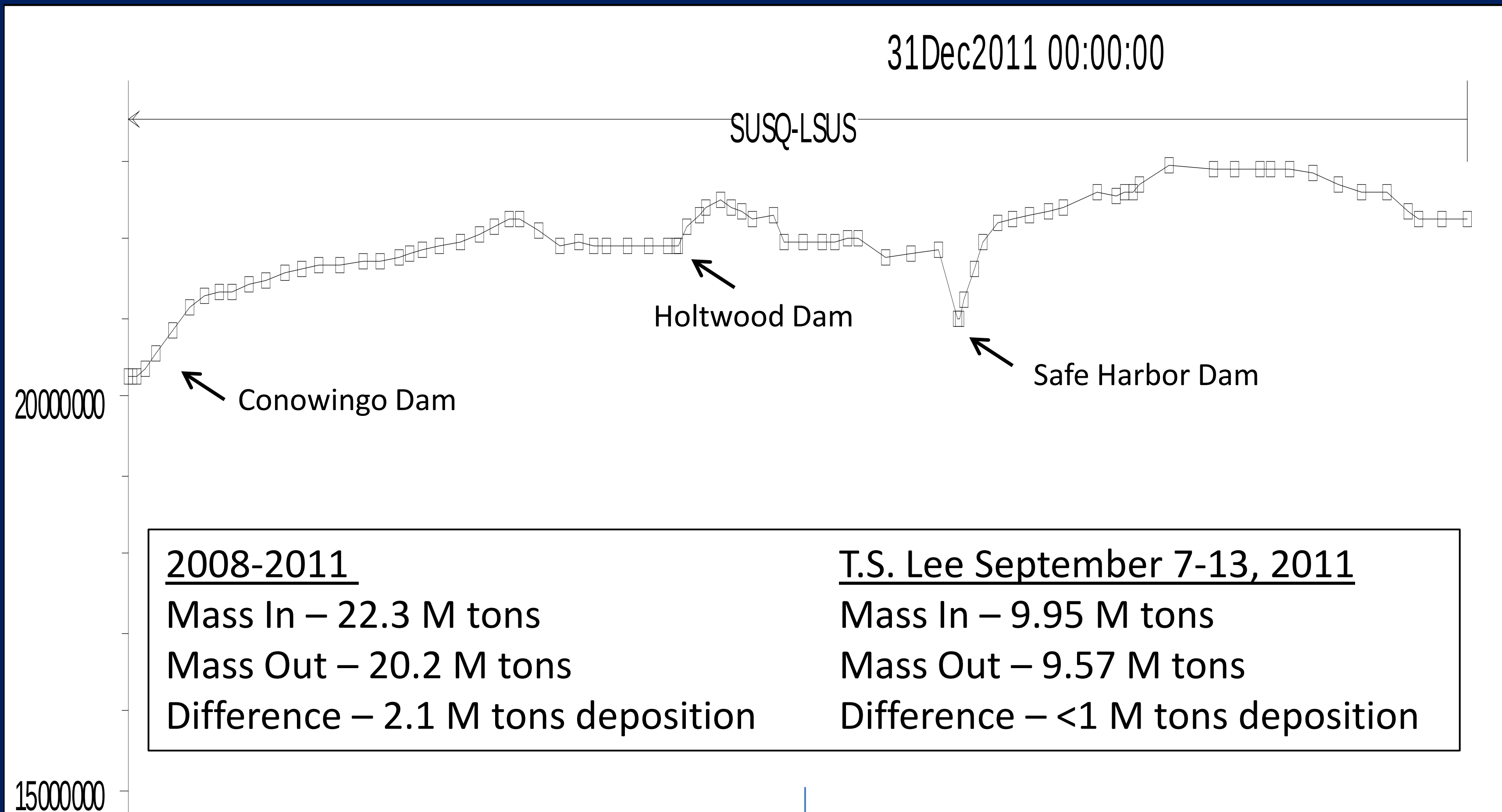
Results – Model Development

- Due to uncertainty (fall-velocity and bed sorting), built and verified 2 models, one net "depositional" one net "scour"
- Both boundary condition outputs delivered to Steve for 2-D model
- "Depositional" model recommended and produced "best" overall results
- "Scour" model performed better for T.S. Lee and other short-term high flow scour events
- Allows for range in uncertainty

USGS

HEC-RAS Deposition Model

(Transport Function – *Laursen (Copeland)*, Sorting Method – *Exner5*, Fall Velocity Method – *Ruby*, Cohesive shear – *0.018 lbs/sqft*))

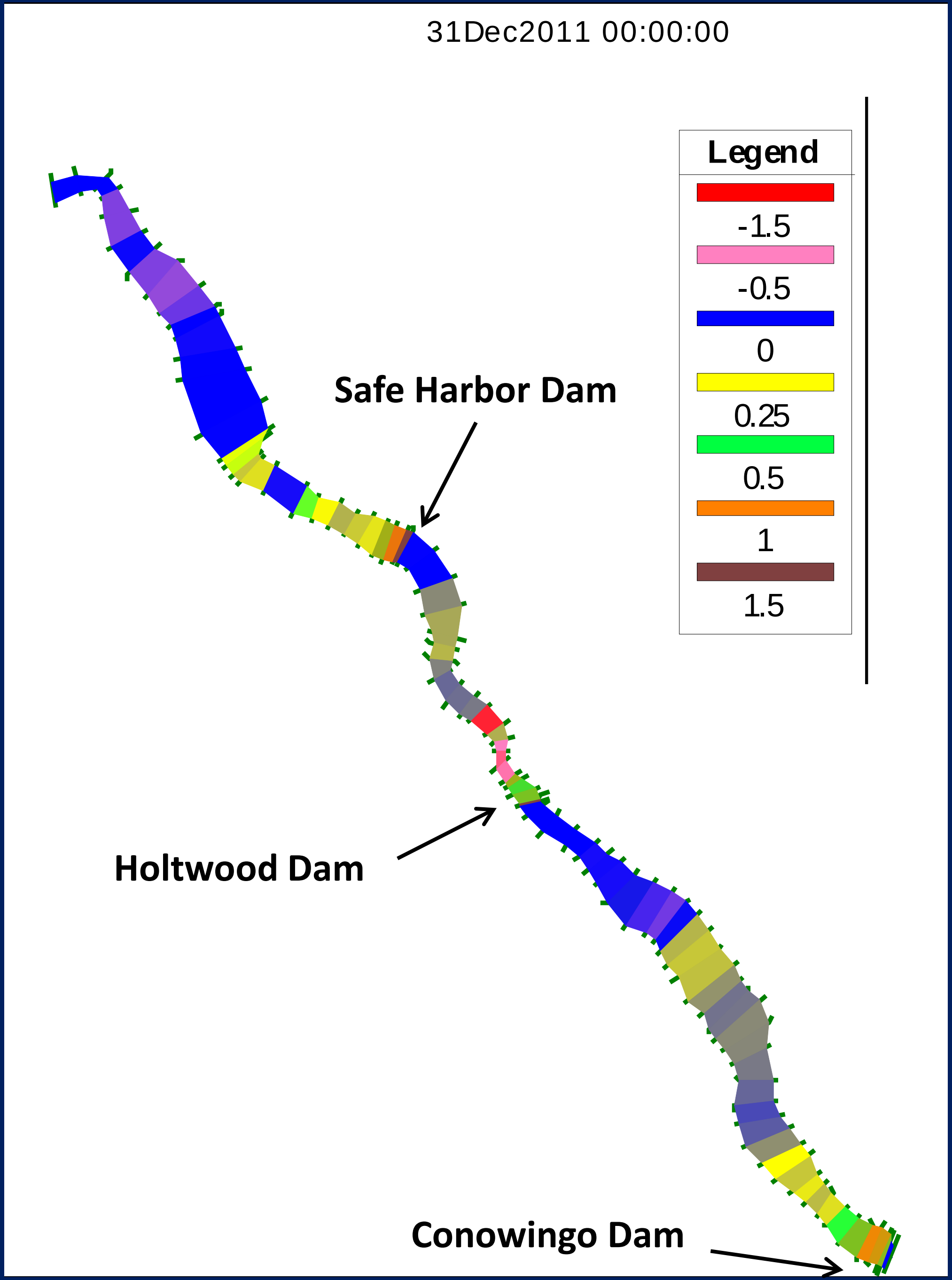


0 10,000 200,000

Distance Upstream (ft)

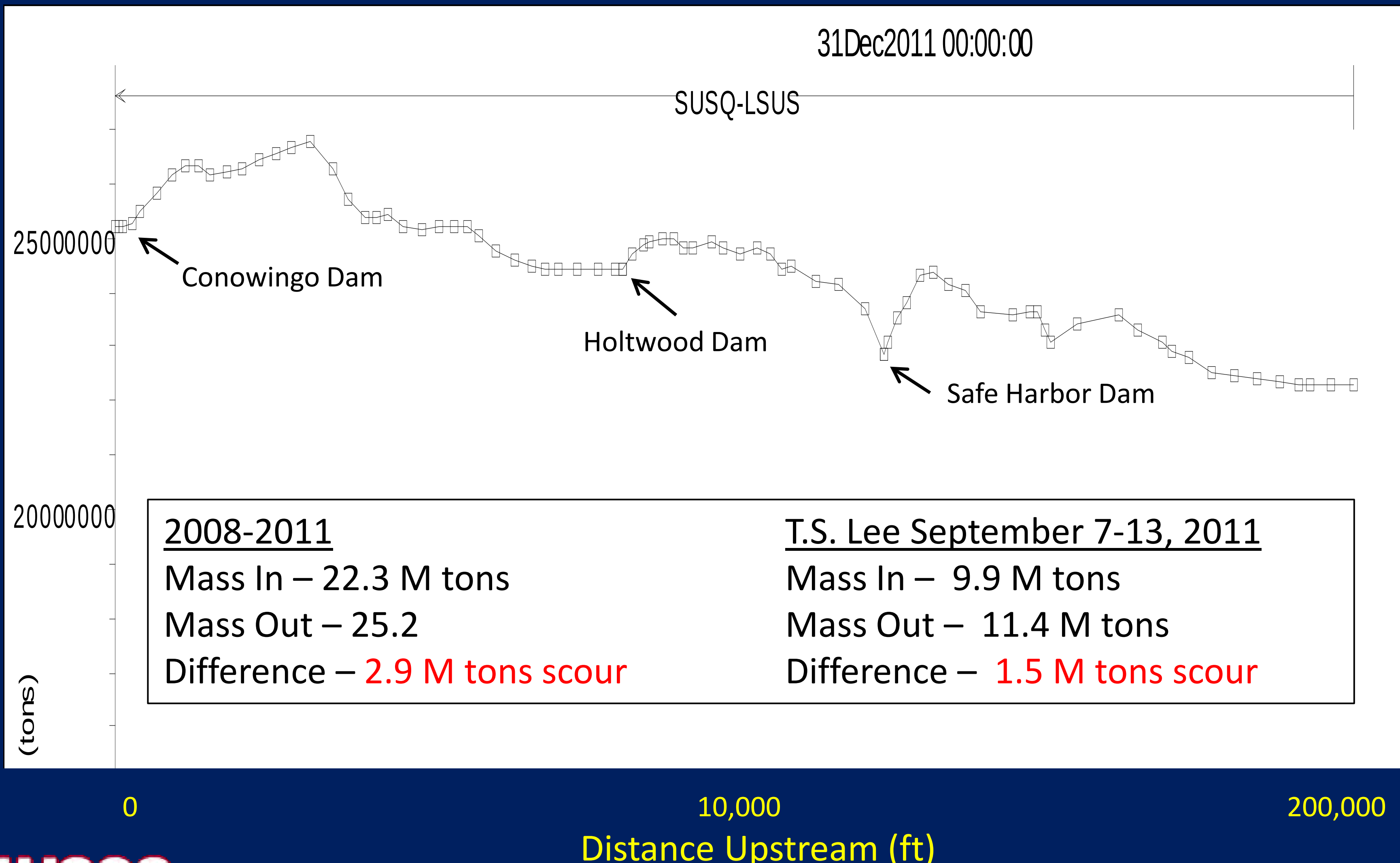
USGS

HEC-RAS Deposition Model – Bed Elevation Change (ft)

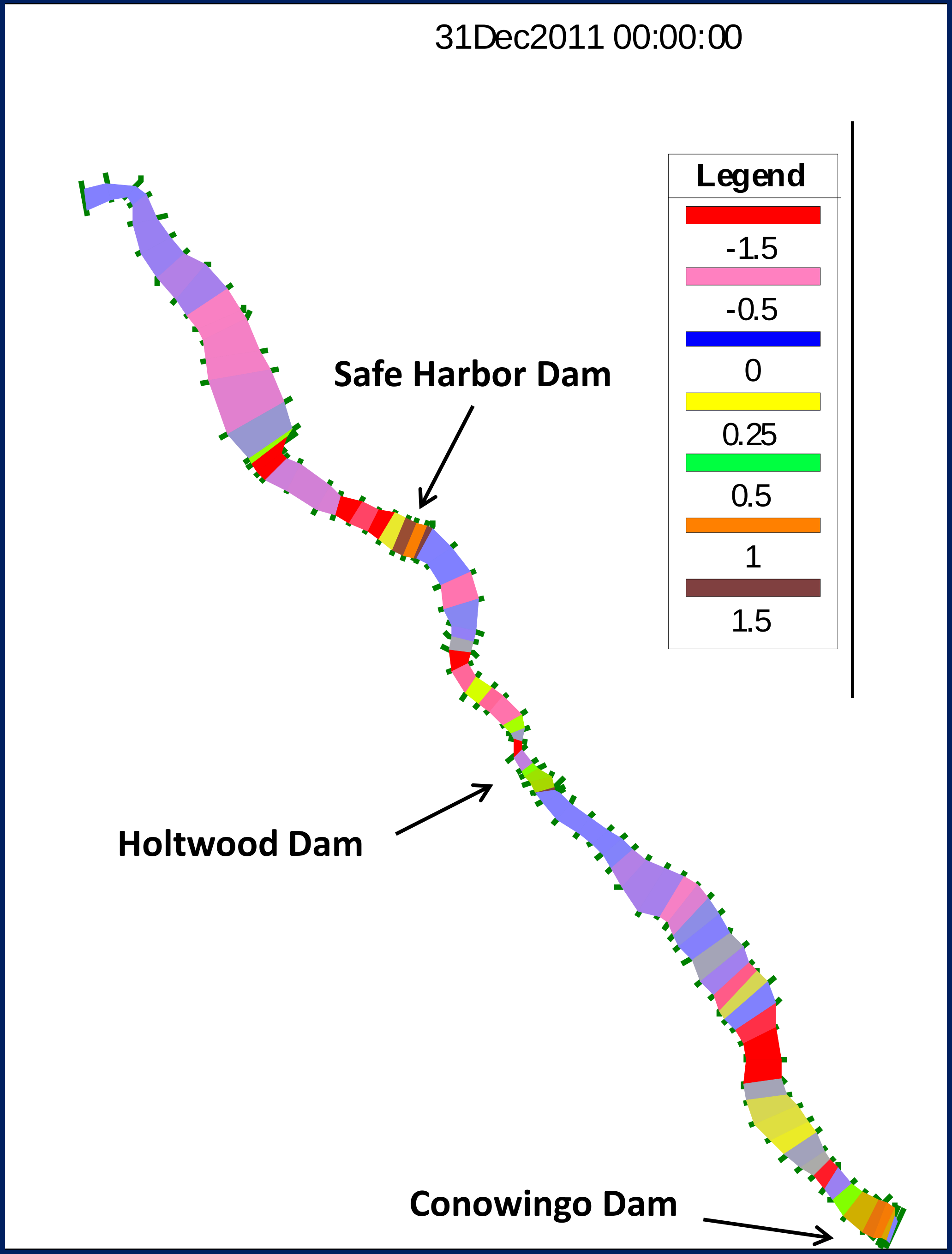


HEC-RAS Scour Model

(Transport Function – *Laursen (Copeland)*), **Sorting Method - *Active Layer***, **Fall Velocity Method – *Van Rijn***, Cohesive shear – *0.018 lbs/sq ft*))



HEC-RAS Scour Model – Bed Elevation Change (ft)



Model Results – Sediment Transport (tons)

	Loads (tons)			
HEC-RAS (depositional)	CY 2008-2011	difference	TS Lee (Sept 7-13, 2011)	difference
Marietta IN	22,300,000		9,950,000	
Conowingo IN	22,100,000	200,000	10,100,000	-150,000
Conowingo OUT	20,200,000	2,100,000	9,570,000	530,000
HEC-RAS (scour)				
Marietta IN	22,300,000		9,950,000	
Conowingo IN	24,400,000	-2,100,000	10,300,000	-350,000
Conowingo OUT	25,200,000	-800,000	11,400,000	-1,100,000
USGS ESTIMATOR				
Marietta IN	22,300,000	--	9,950,000	--
Conowingo OUT	21,100,000	1,200,000	13,500,000	-3,500,000
WRTDS (B. Hirsch)	WY 2008-11		TS Lee	
Conowingo OUT	27,500,000	--	18,800,000	--

USGS

Model results – Particle Size

HEC-RAS (depositional)	Particle Size		Historic Particle Size
	2008-2011	TS Lee	
	Sand/Silt/Clay	Sand/Silt/Clay	Sand/Silt/Clay
Marietta IN	10 / 47 / 42	10 / 47 / 42	9 / 47 / 44
Conowingo IN	3 / 47 / 50	5 / 50 / 45	n/a
Conowingo OUT	1 / 32 / 67	2 / 50 / 48	1 / 51 / 48
HEC-RAS (Scour)	2008-2011	TS Lee	Historic P.S.
	Sand/Silt/Clay	Sand/Silt/Clay	Sand/Silt/Clay
Marietta IN	10 / 47 / 42	10 / 47 / 42	9 / 47 / 44
Conowingo IN	2 / 48 / 50	5 / 51 / 44	n/a
Conowingo OUT	1 / 45 / 54	2 / 52 / 46	1 / 51 / 48

- Minor differences between models
- Good correspondence with historic particle size

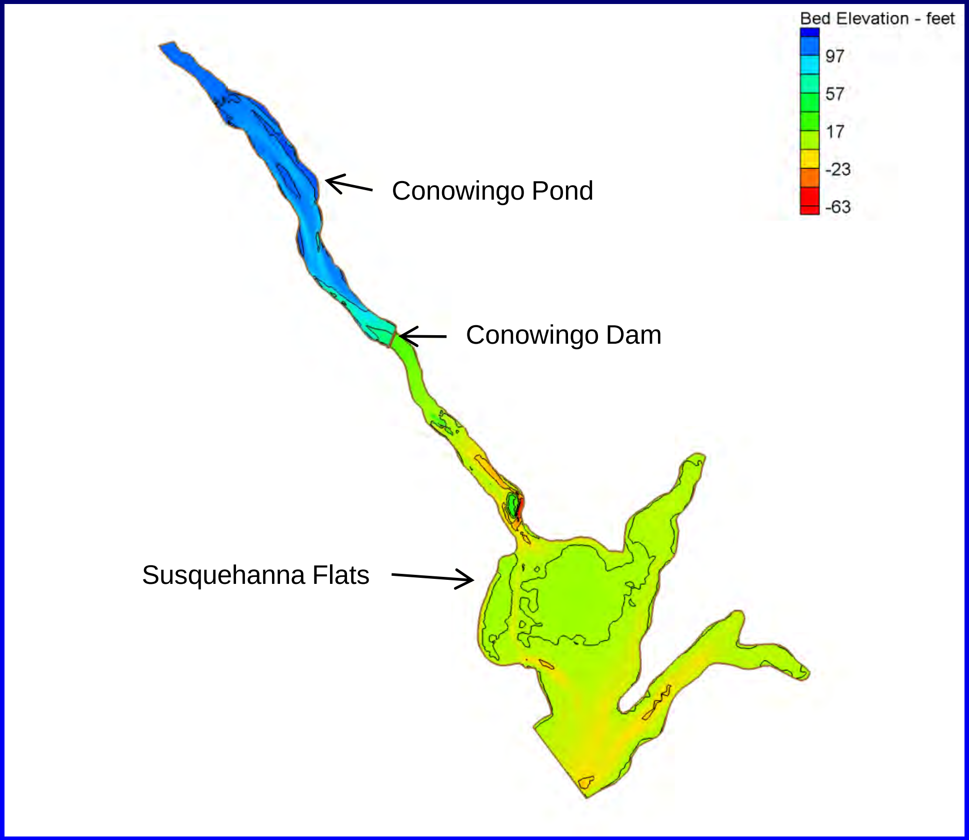
Summary

- HEC-RAS generally not condusive for cohesive (silts/clays) simulations
- The 2 models provide a range of uncertainty in the boundary condition files
- Estimated total sediment transport most likely underestimated but “reasonable”
- Both models indicate upper 2 reservoirs still play a “role” in sediment transport

USGS

Lower Susquehanna River Watershed Assessment

Two Dimensional Modeling Studies – Model Validation



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Two Dimensional Modeling Studies – Model Validation

MODEL VALIDATION

"Insuring That The Model Can Adequately

Replicate Sediment Transport Characteristics Representative Of The System"

Lower Susquehanna River Watershed Assessment

Two Dimensional Modeling Studies – Model Validation

VALIDATION CRITERIA

- USGS Studies on Conowingo Reservoir (Annual Load and Scour Predictions)
- Measured Suspended Sediment Concentrations out of Conowingo
- Reasonable Trap Efficiency Calculations

Lower Susquehanna River Watershed Assessment

Two Dimensional Modeling Studies – Model Validation

2D MODEL VALIDATION SIMULATIONS

- 2008 – 2011 Simulation of Flows Through Conowingo Reservoir
- Inflowing Sediment Concentrations Provided by USGS (HECRAS Output)
  - Two HECRAS Simulations Conducted

    1) Minimum Scour Load From Upper Two Reservoirs (HECRAS 1)

    2) Scour Load From Upper Two Reservoirs (HECRAS 2)

Lower Susquehanna River Watershed Assessment

Two Dimensional Modeling Studies – Model Validation

USGS VALIDATION CRITERIA

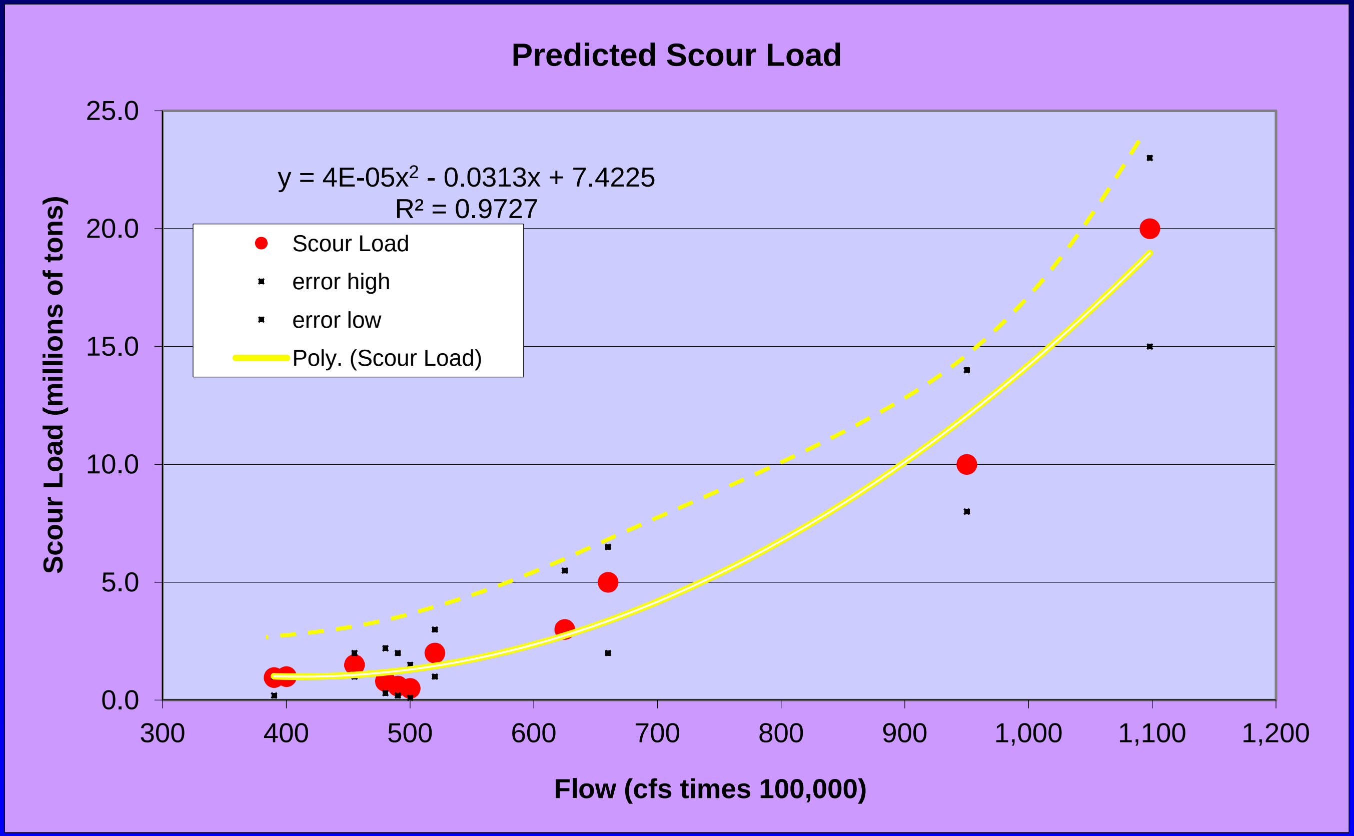
- **Estimation of 3 – 4 Million Tons of Scour for Tropical Storm Lee**
- **Estimation of 1.5 Million Tons of Sediment Deposited Per Year**

TRAP EFFICIENCY RANGE

- **Between 70% - 50% Considering Some Sediment Retention Capacity Remains**

Lower Susquehanna River Watershed Assessment

USGS Predicted Scour Load



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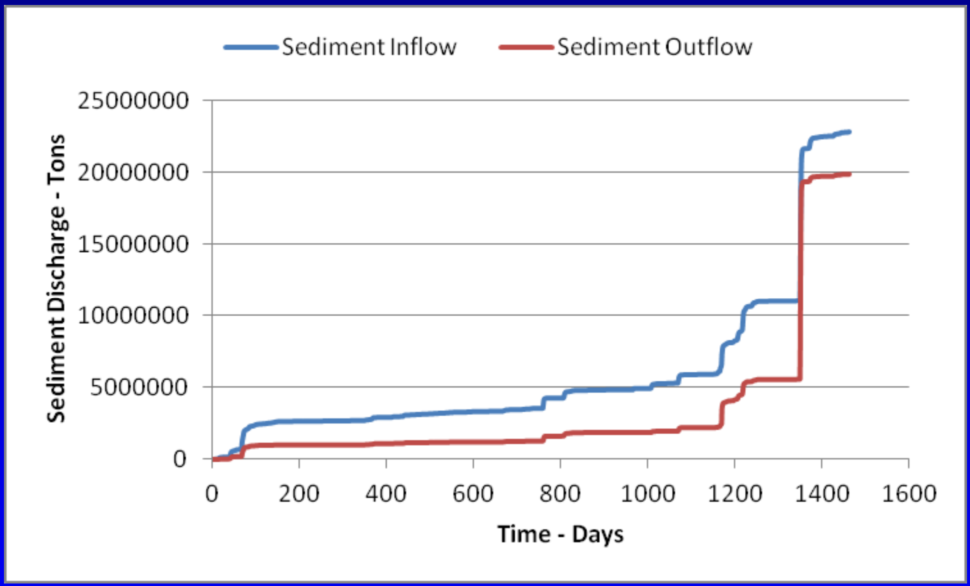
AdH Results

AdH Results with HECRAS 1 Boundary Conditions – Sediment Inflow /Outflow



Total Inflow = 22 M tons

50% From TS Lee

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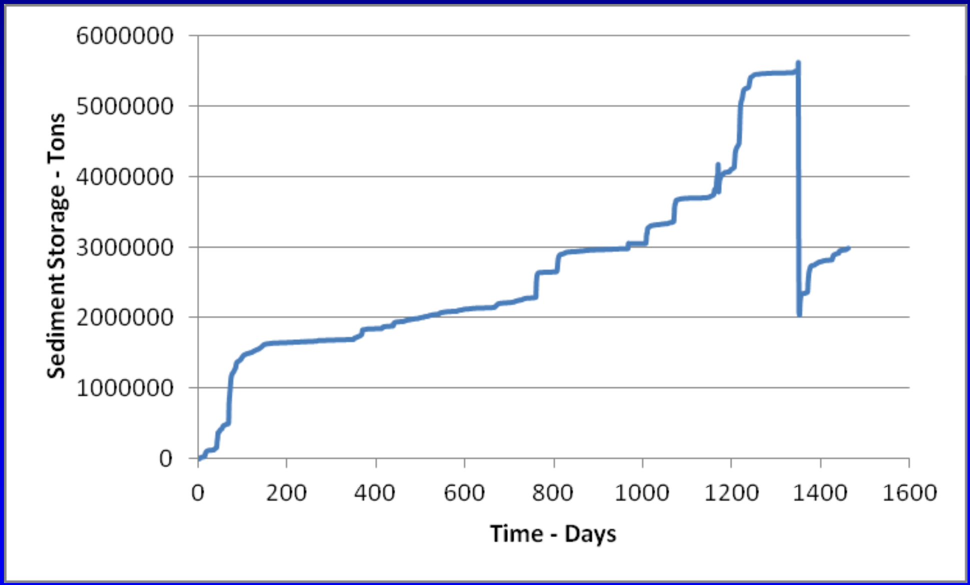
AdH Results

AdH Results with HECRAS 1 Boundary Conditions – Sediment Storage



1.5 M tons / year Deposition up to 3.7 years

Scour : 3.5 M tons – Lee Event

Deposition: 3 M tons

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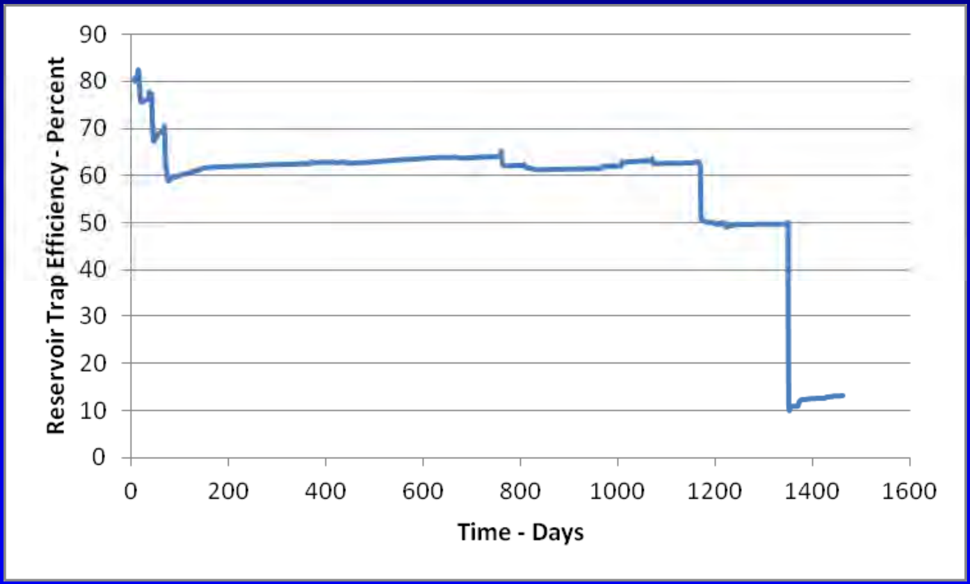
AdH Results

AdH Results with HECRAS 1 Boundary Conditions – Trap Efficiency



Sediment Storage / Sediment Inflow

60% Trap Efficiency During Depositional Flows

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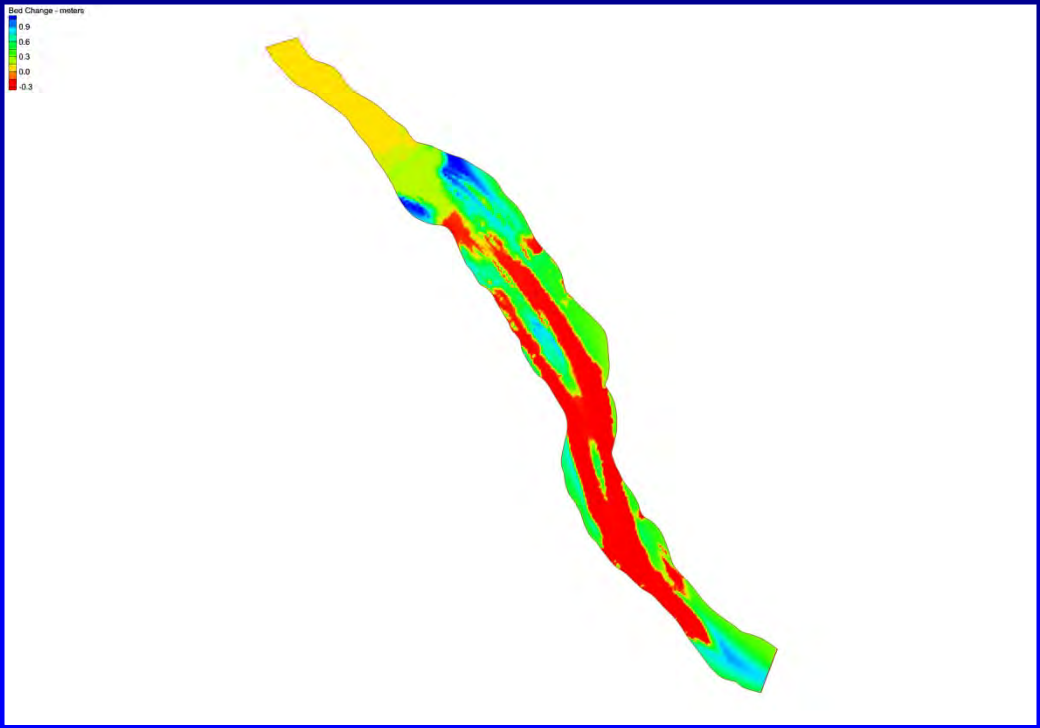
AdH Bed Change with HECRAS 1 Boundary Conditions



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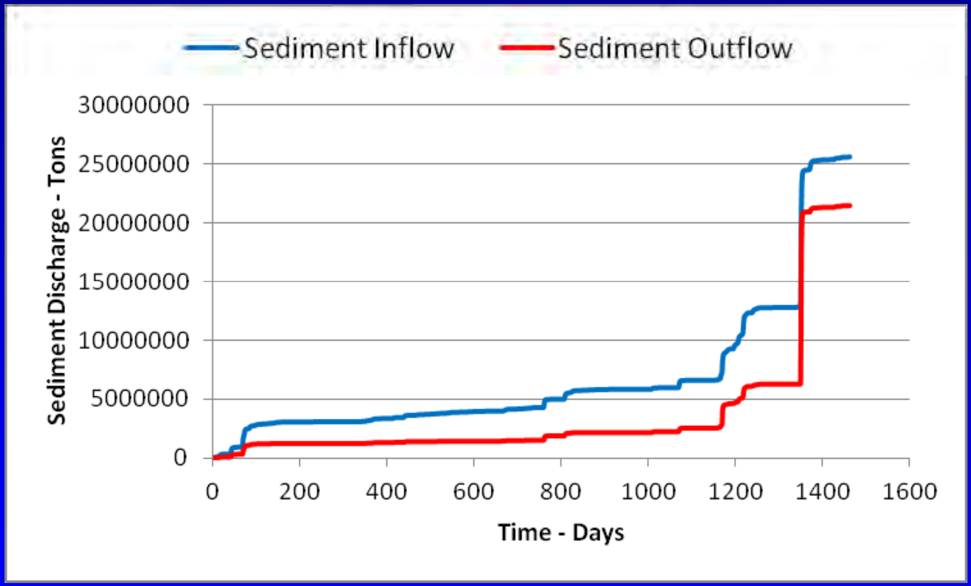
AdH Results with HECRAS 2 Boundary Conditions – Sediment Inflow/Outflow



Total Inflow = 25 M tons

50% From TS Lee

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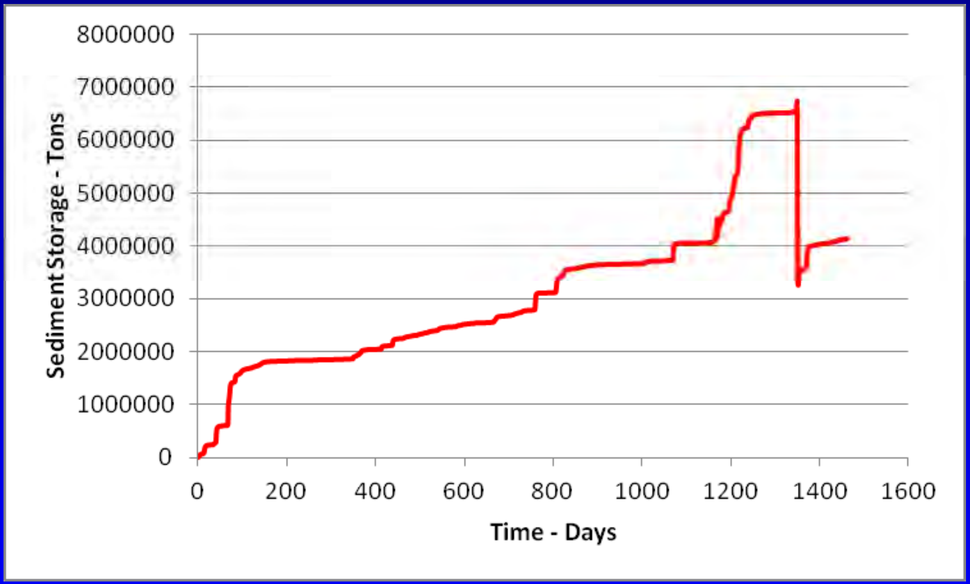
AdH Results with HECRAS 2 Boundary Conditions – Sediment Storage



1.7 M tons / year Deposition up to 3.7 years

Scour : 3.5 M tons – Lee Event

Deposition: 4 M tons

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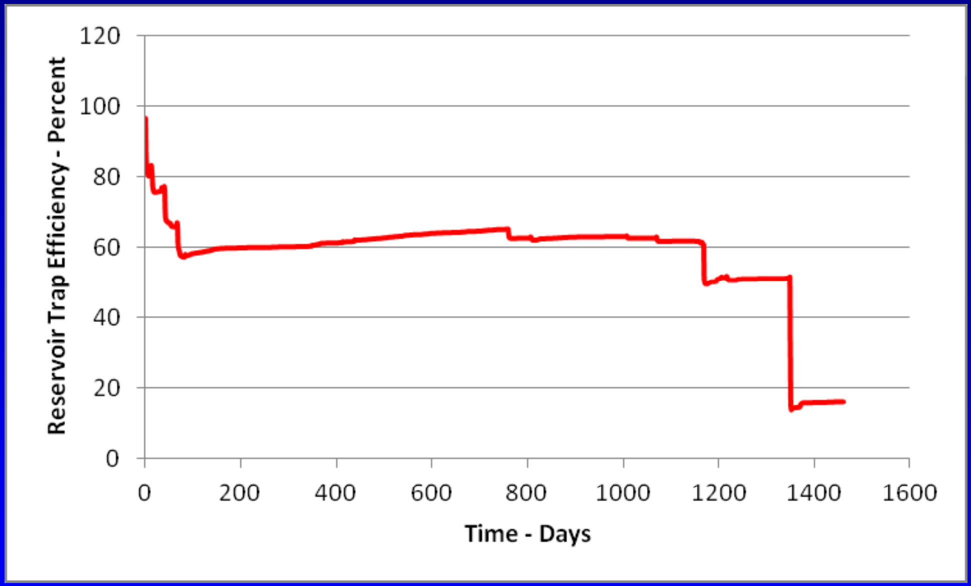
AdH Results with HECRAS 2 Boundary Conditions – Trap Efficiency



Sediment Storage / Sediment Inflow

60% Trap Efficiency During Depositional Flows

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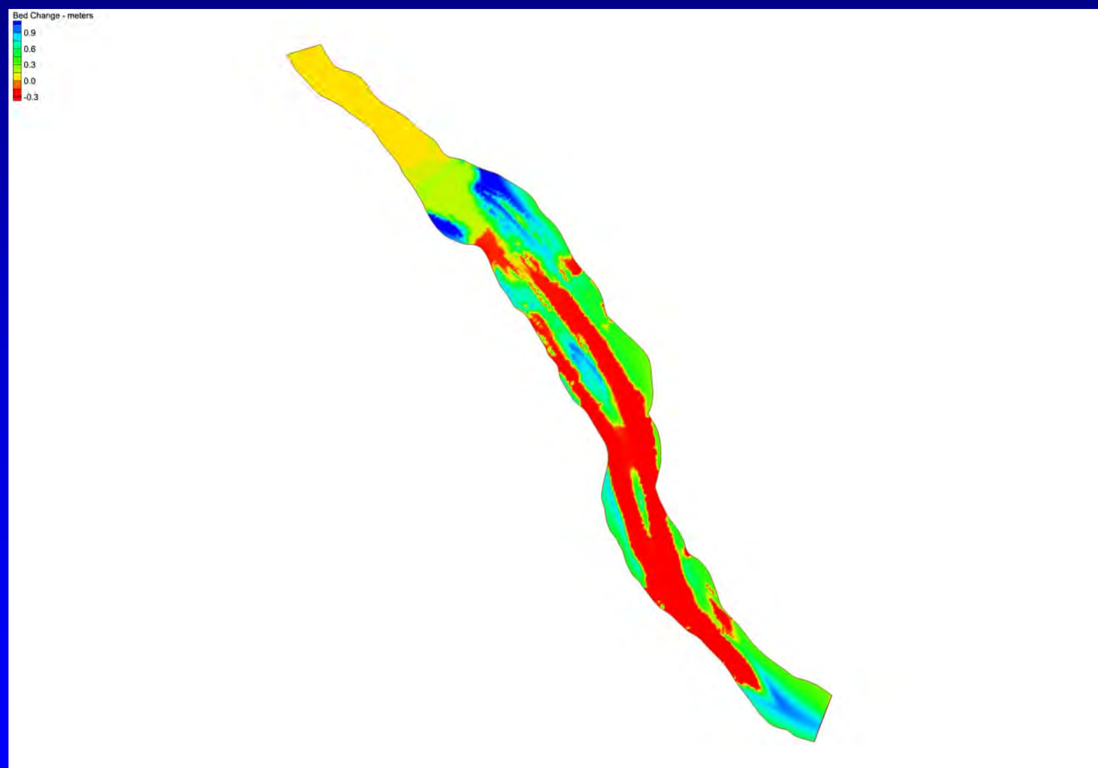
AdH Bed Change with HECRAS 2 Boundary Conditions



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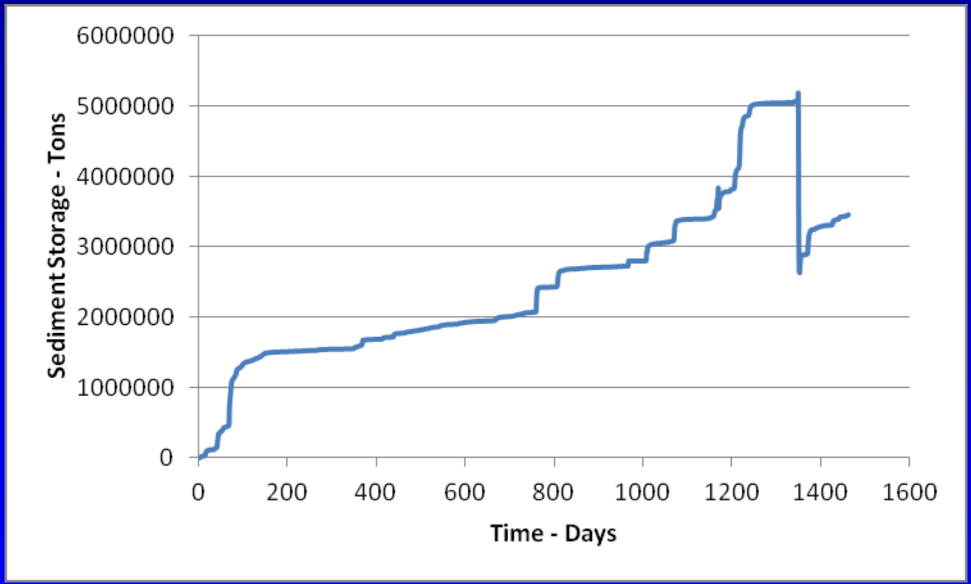
AdH Results with HECRAS 1 Boundary Conditions – Maximum Critical Shear



1.4 M tons / year Deposition up to 3.7 years

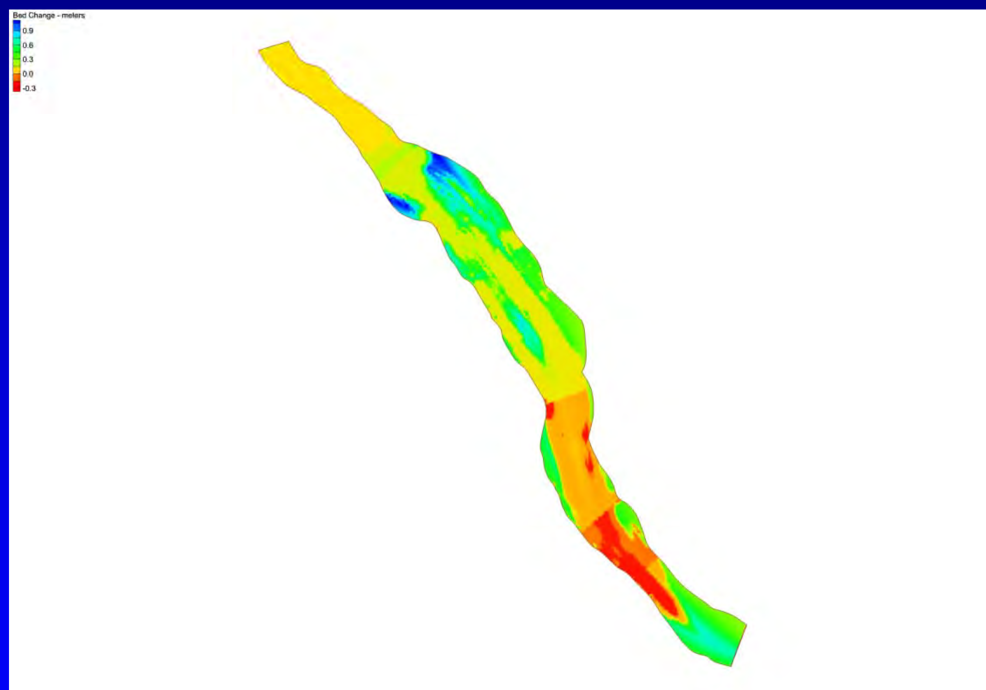
Scour : 2.0 M tons – Lee Event

Deposition: 3.5 M tons

Lower Susquehanna River Watershed Assessment

AdH Results

AdH Bed Change with HECRAS 1 Boundary Conditions - Maximum Critical Shear



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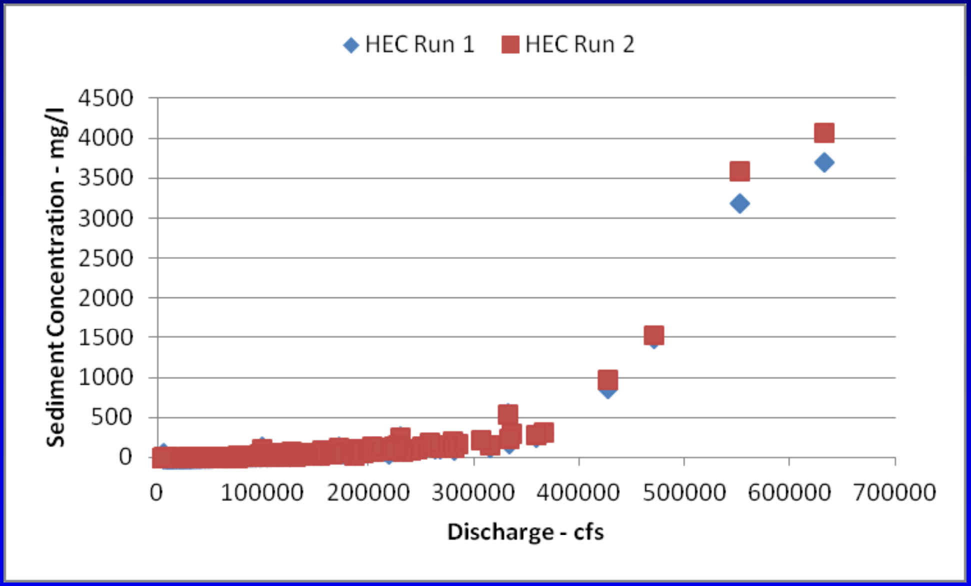
Lower Susquehanna River Watershed Assessment

AdH Results

AdH Conowingo Outflow Suspended Sediment Concentration



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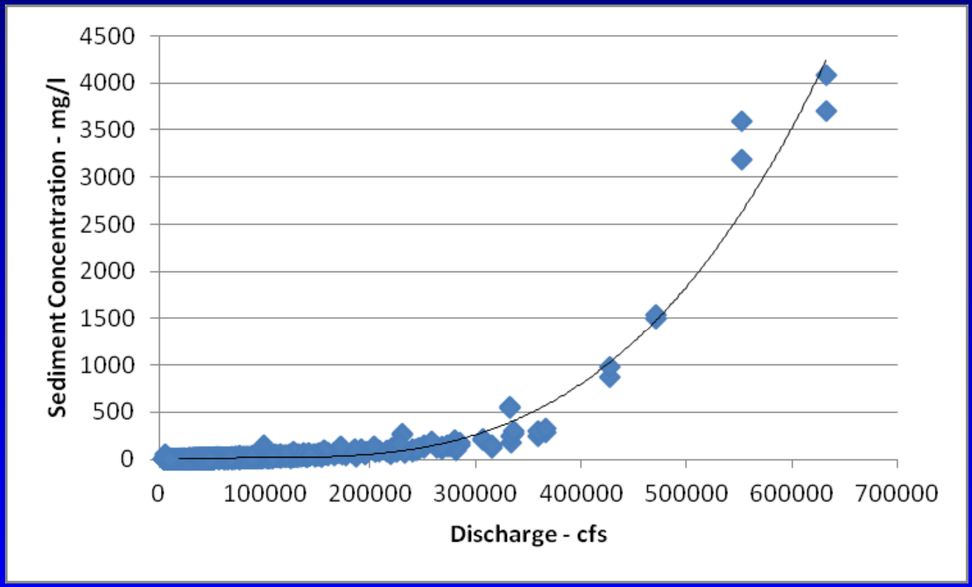
Lower Susquehanna River Watershed Assessment

AdH Results

AdH Computed Conowingo Outflow Suspended Sediment Concentration



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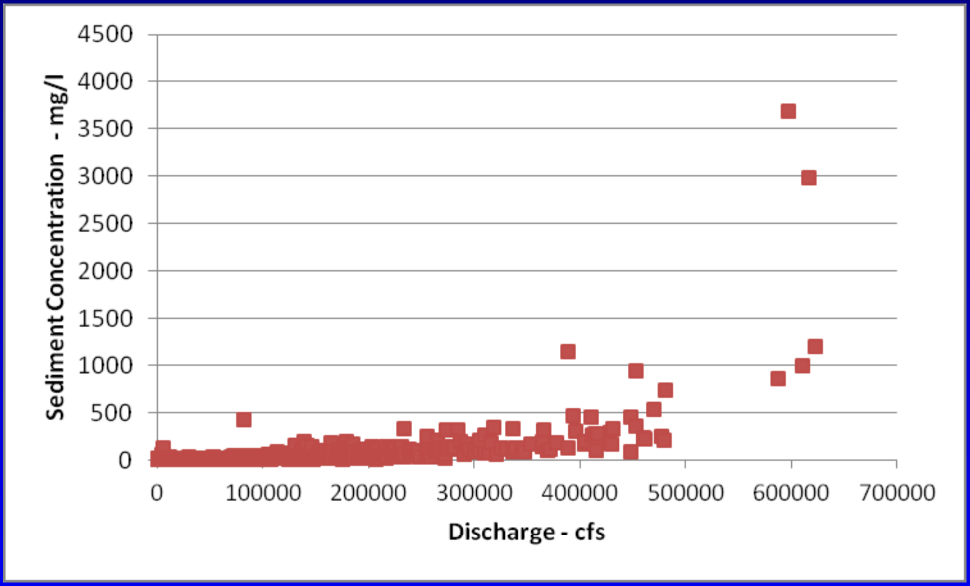
Lower Susquehanna River Watershed Assessment

Measured Conowingo Outflow Suspended Sediment Concentration



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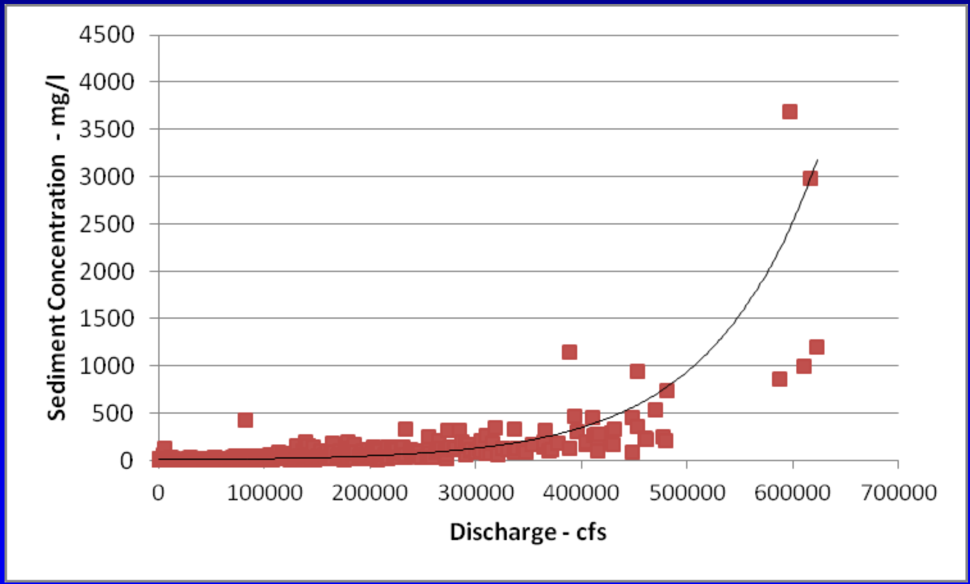
Lower Susquehanna River Watershed Assessment

Measured Conowingo Outflow Suspended Sediment Concentration



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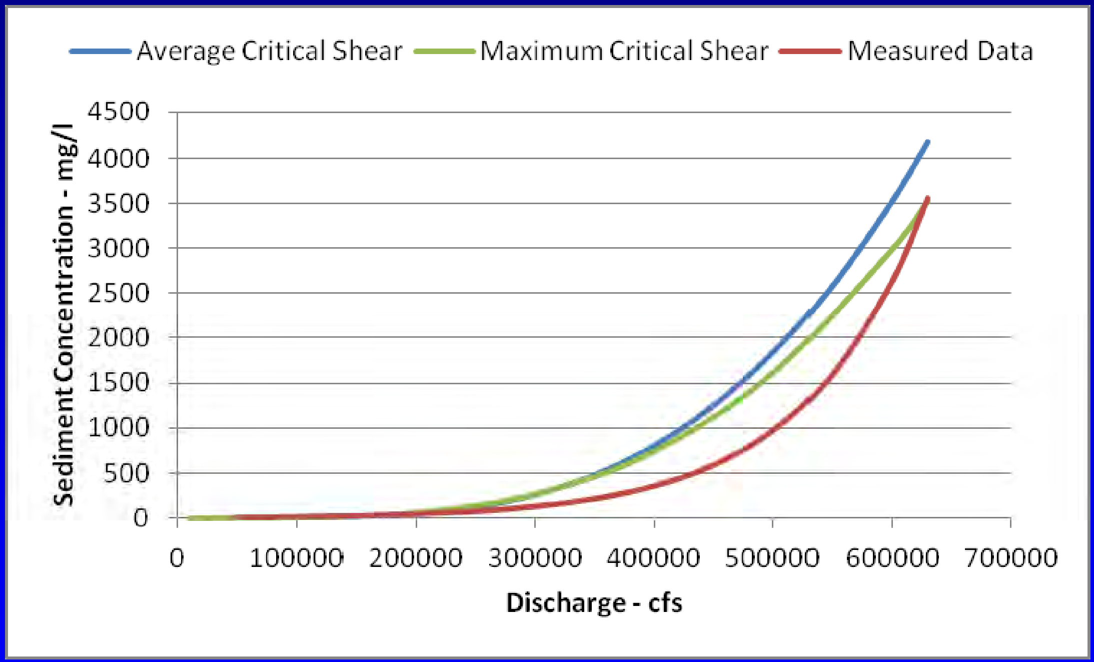
Lower Susquehanna River Watershed Assessment

Conowingo Outflow Suspended Sediment Concentration Comparisons



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Lower Susquehanna River Watershed Assessment

CONCLUSIONS

USGS Predictions:

Scour: 3.0 – 4.0 Million Tons
Deposition Rate: 1.5 Million Tons Per Year

AdH Results:

Scour: 2.0 – 3.5 Million Tons
Deposition Rate: 1.4 – 1.7 Tons Per Year
Trap Efficiency ~ 60%

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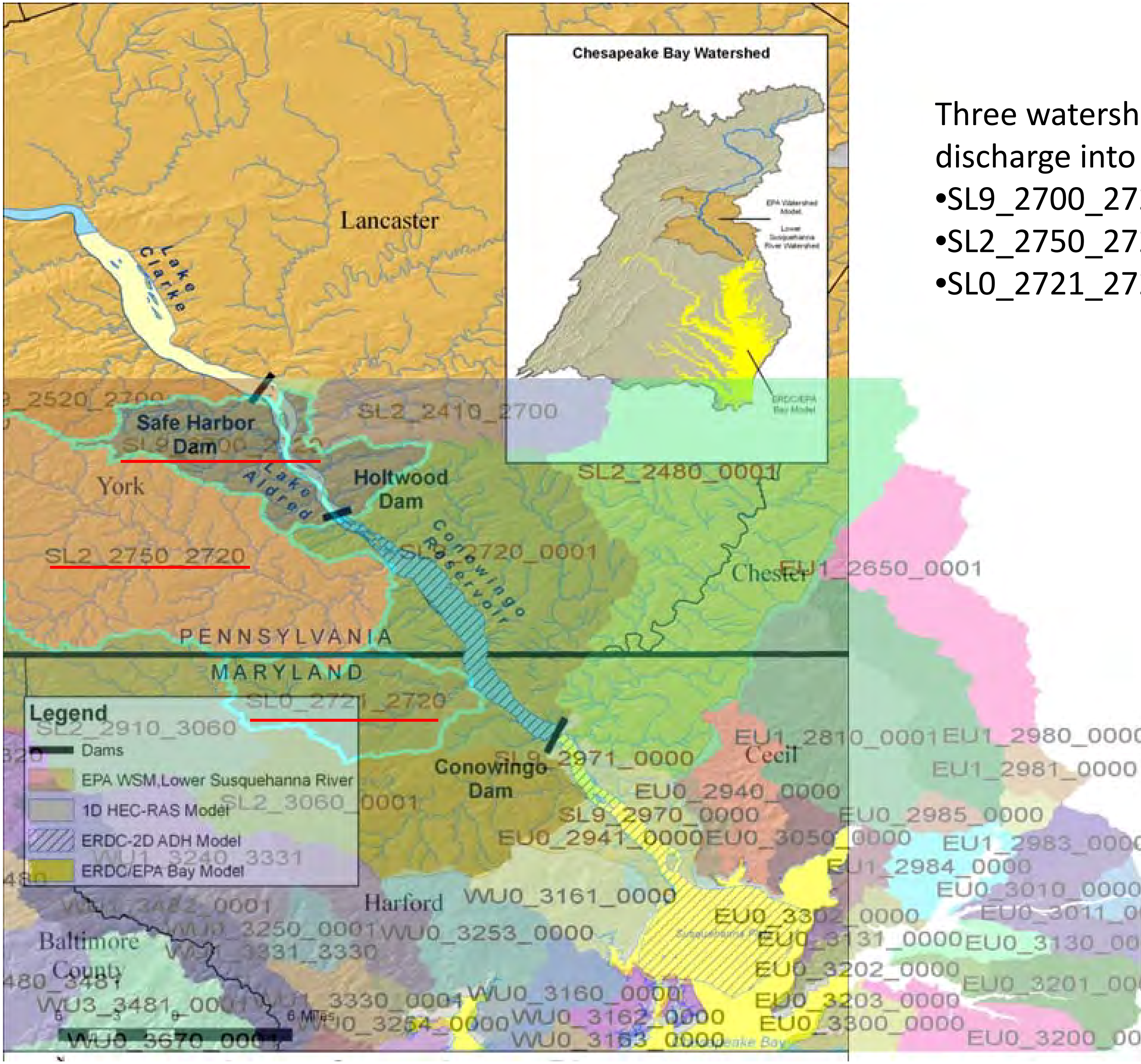
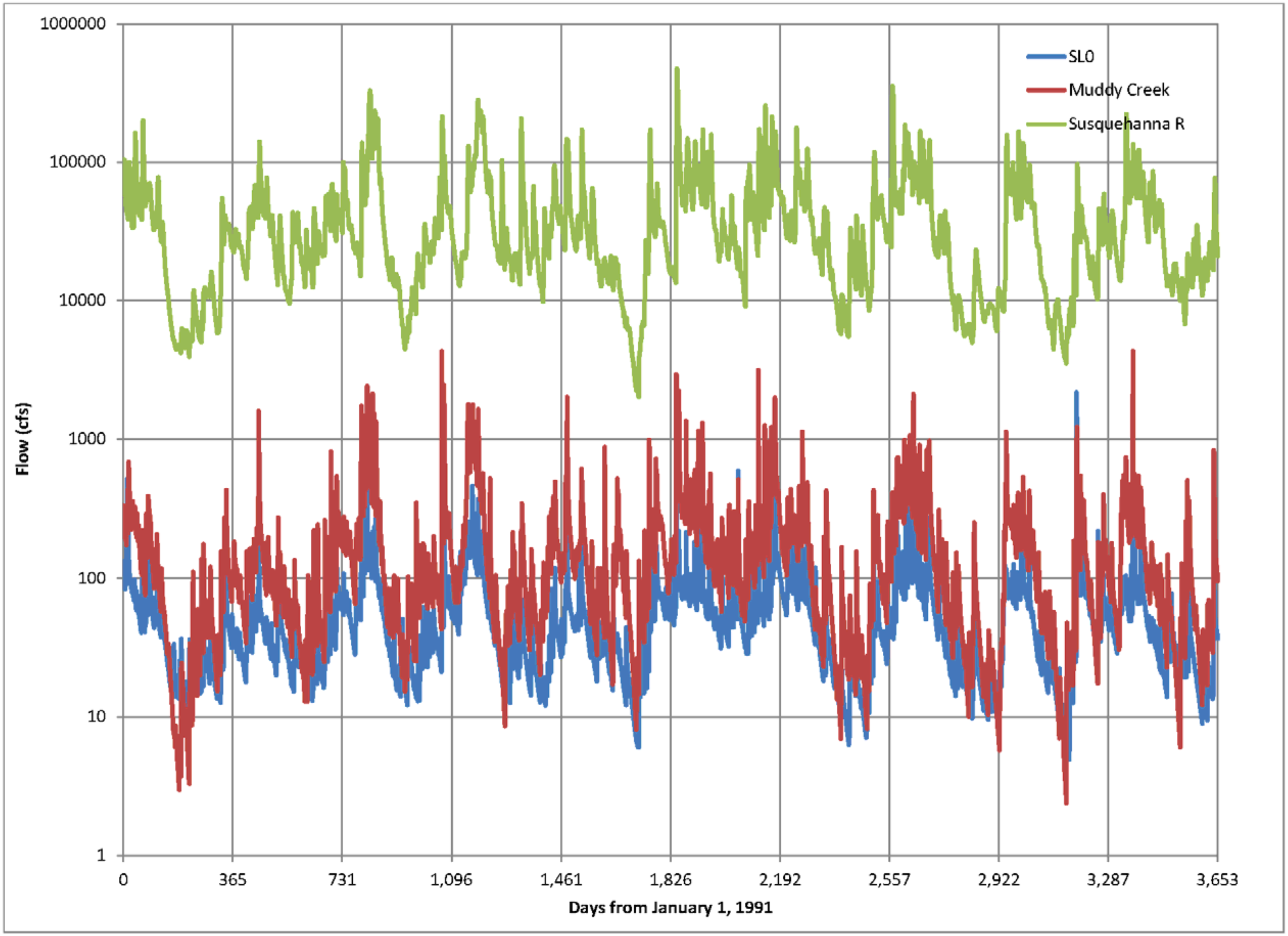
Estimate of the Effect of Conowingo Infill on Current Conditions in Chesapeake Bay – A First Look

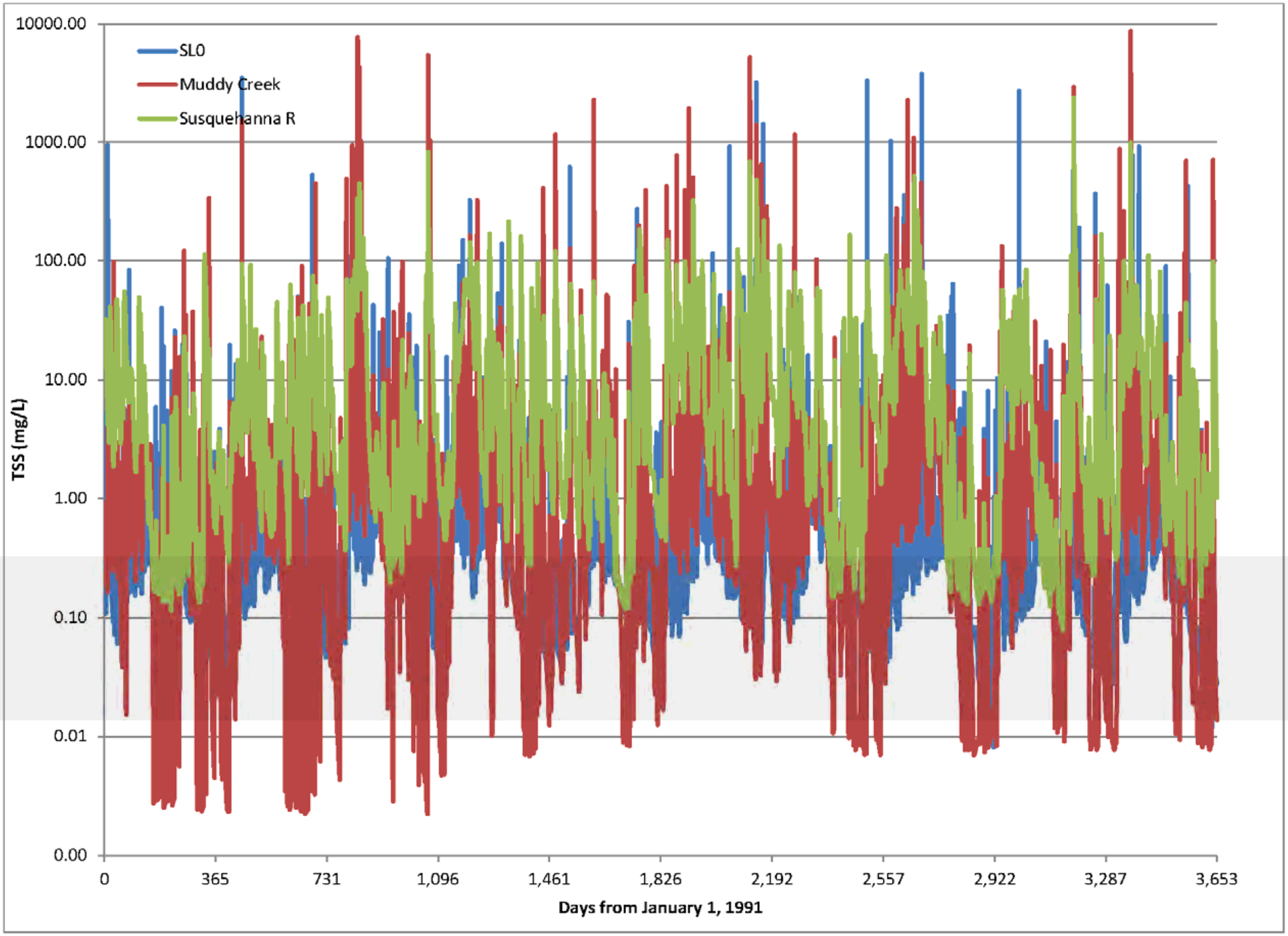
Carl F. Cerco and the crew at CBP
Annapolis

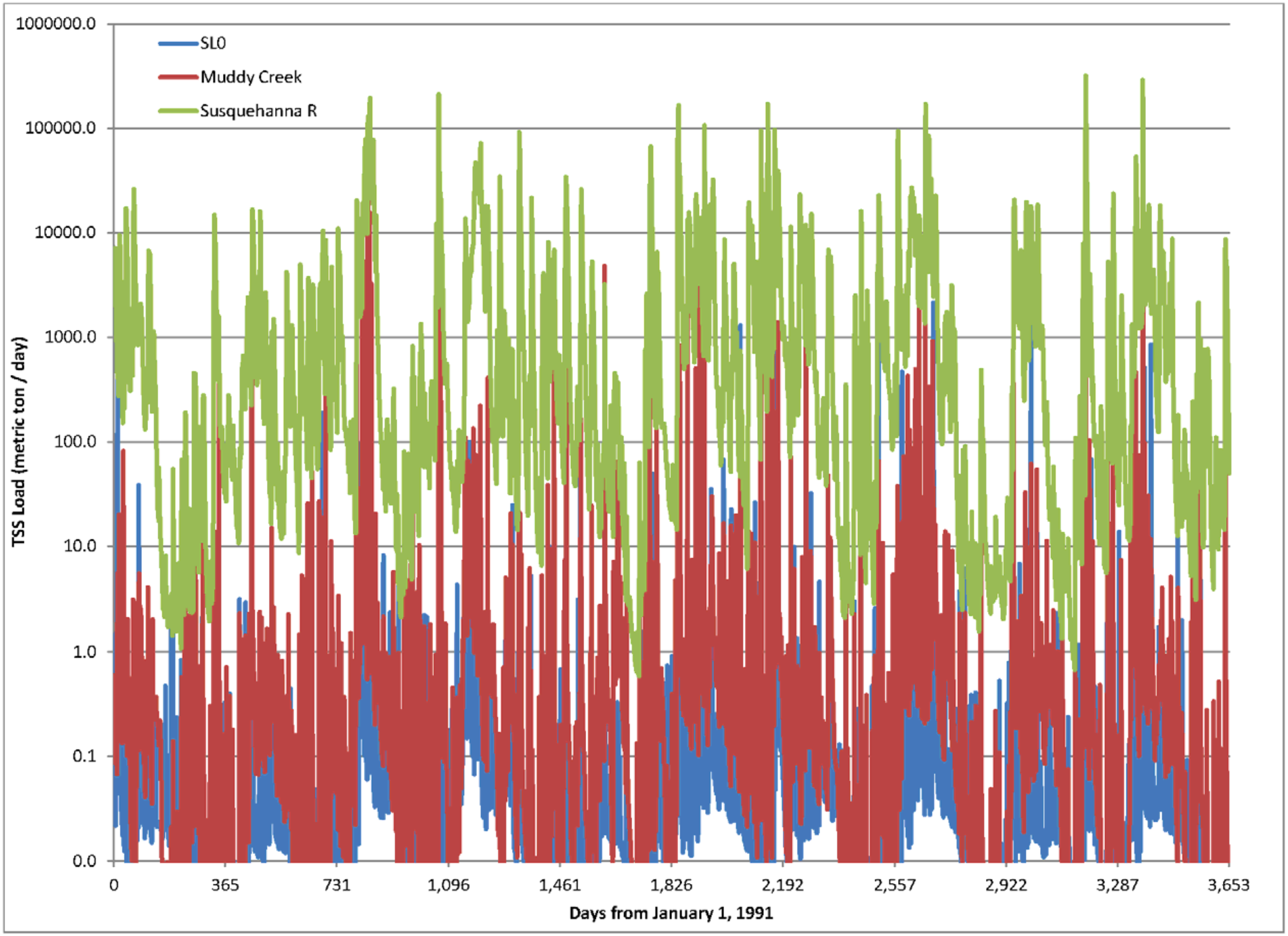


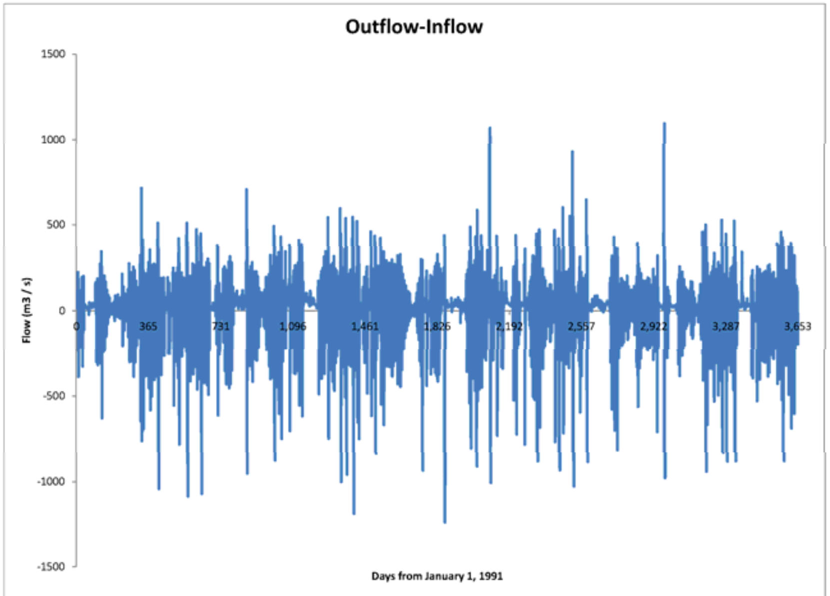
Three watersheds discharge into Conowingo:

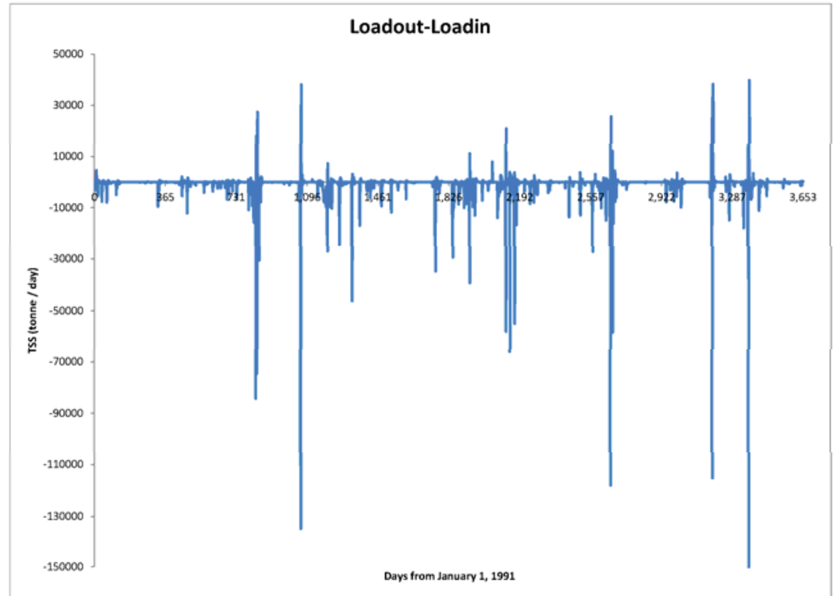
- SL9_2700_2720
- SL2_2750_2720
- SL0_2721_2720

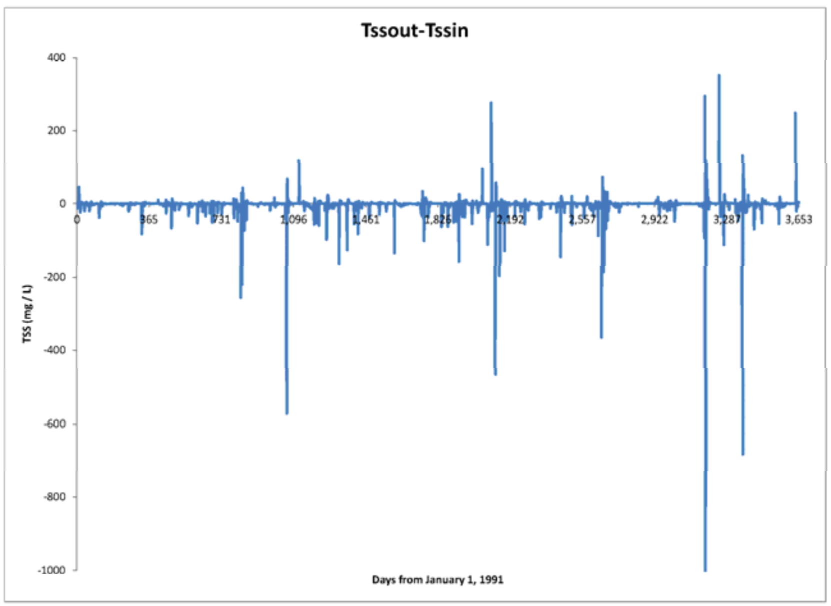

1000000
100000
10000
1000
100
10
1
Flow (cfs)
0
365
731
1,096
1,461
1,826
2,192
2,557
2,922
3,287
3,653
Days from January 1, 1991
SLO
Muddy Creek
Susquehanna R


10000.00
1000.00
100.00
10.00
1.00
0.10
0.01
0.00
TSS (mg/L)
SLO
Muddy Creek
Susquehanna R
0
365
731
1,096
1,461
1,826
2,192
2,557
2,922
3,287
3,653
Days from January 1, 1991

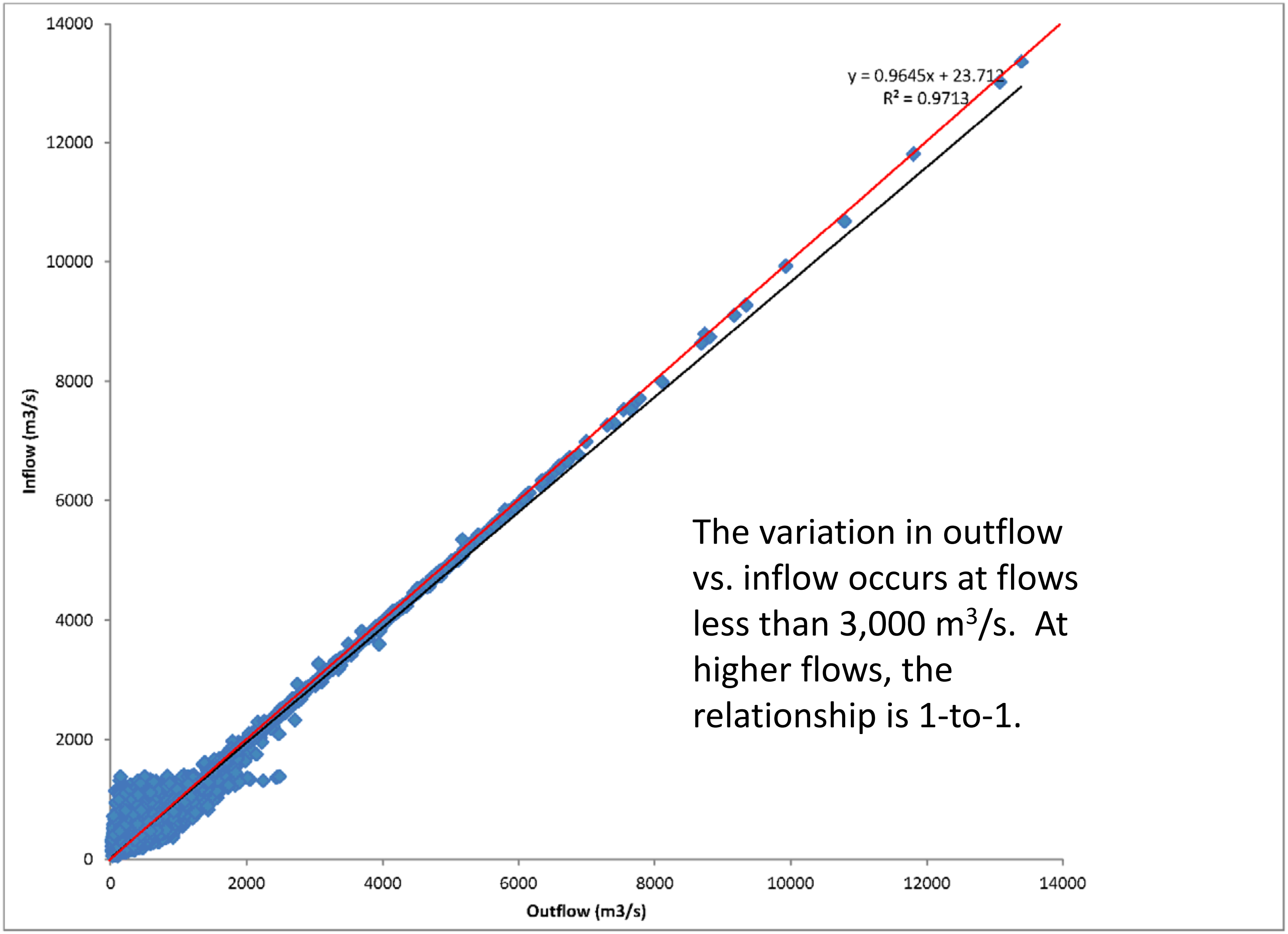

1000000.0
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
0.0
SL0
Muddy Creek
Susquehanna R
TSS Load (metric ton / day)
0
365
731
1,096
1,461
1,826
2,192
2,557
2,922
3,287
3,653
Days from January 1, 1991

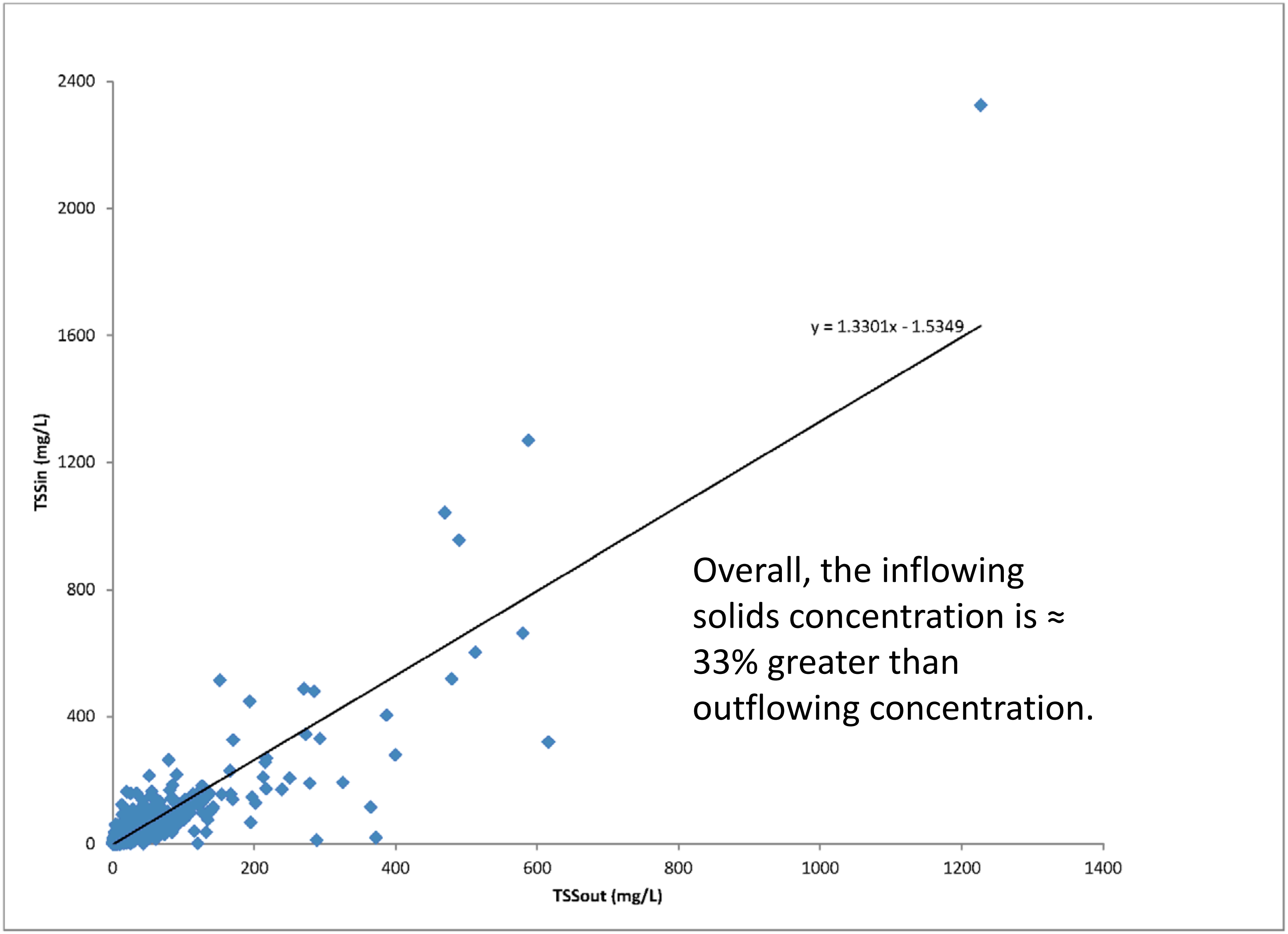


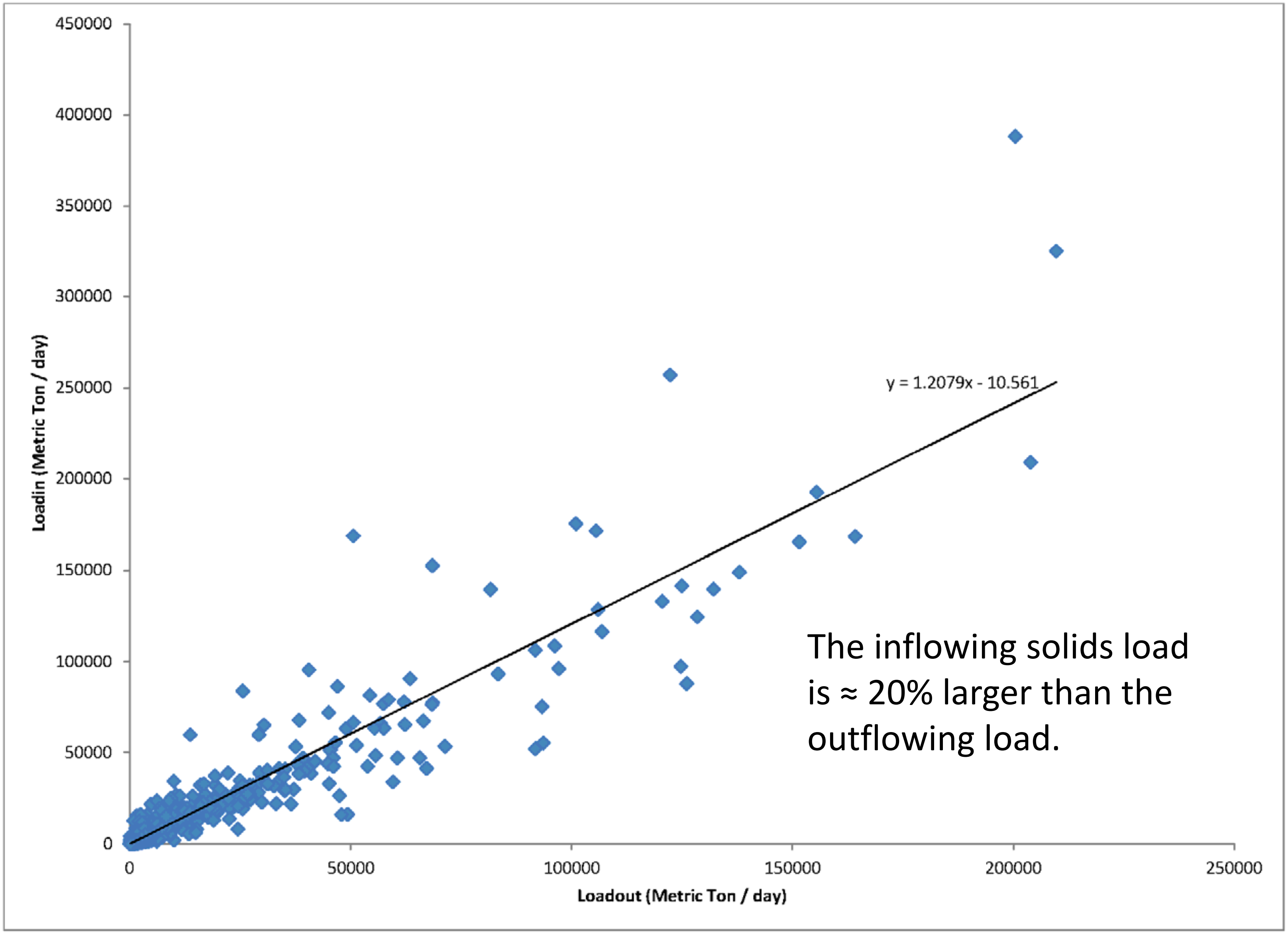


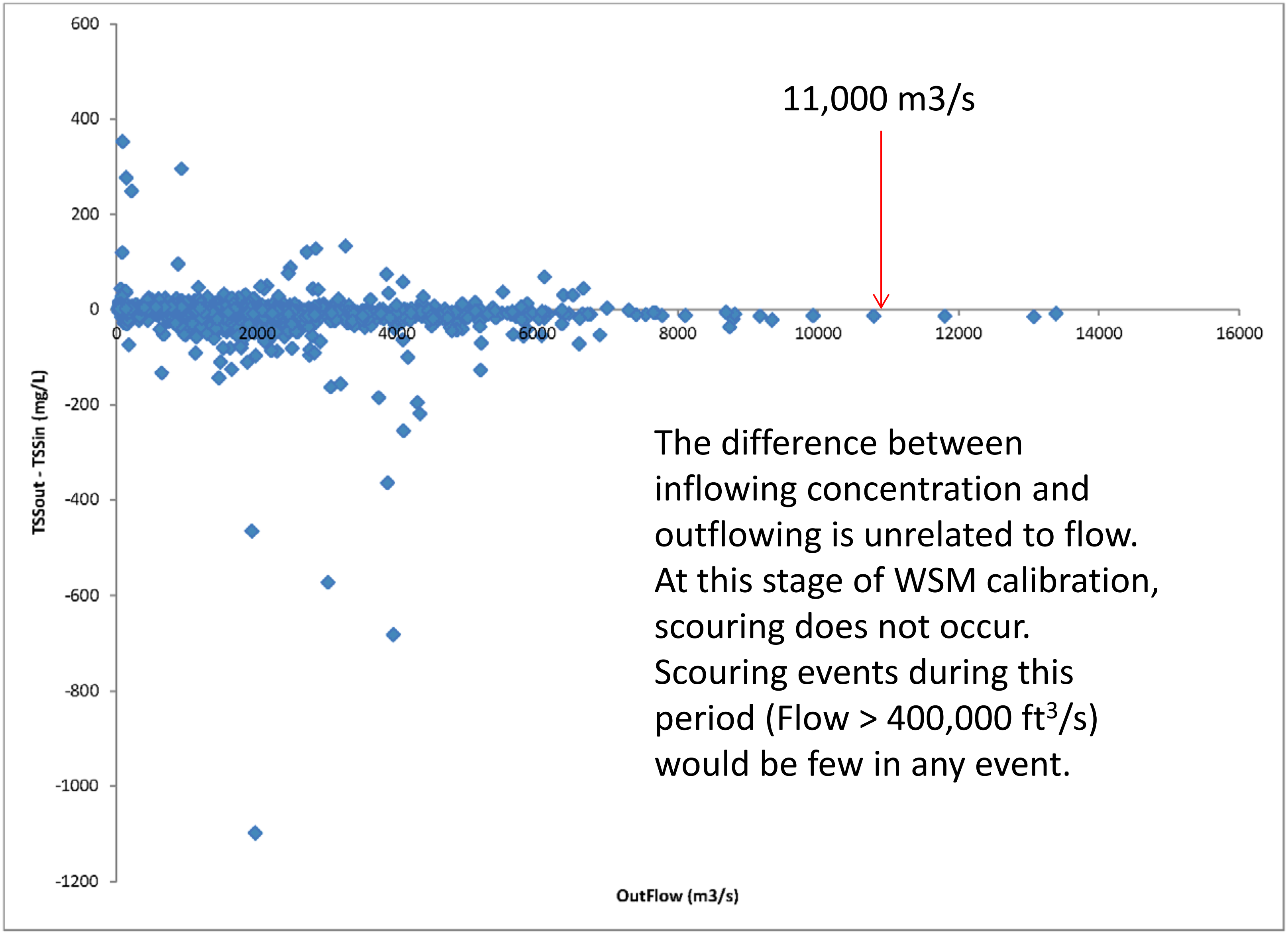


- On any day, outflow volume, solids concentration, solids load can be greater or less than inflow.
- On average, outflow exceeds inflow by 18 m^3/s.
- On average inflowing solids concentration exceeds outflow by 3.3 mg/L.
- On average, 711 tonnes/day solids are retained by reservoir.


y = 0.9645x + 23.712
R² = 0.9713
Inflow (m3/s)
Outflow (m3/s)
0
2000
4000
6000
8000
10000
12000
14000
The variation in outflow vs. inflow occurs at flows less than 3,000 m³/s. At higher flows, the relationship is 1-to-1.


2400
2000
1600
1200
800
400
0
TSSin (mg/L)
y = 1.3301x - 1.5349
0
200
400
600
800
1000
1200
1400
TSSout (mg/L)
Overall, the inflowing solids concentration is ≈ 33% greater than outflowing concentration.


450000
400000
350000
300000
250000
200000
150000
100000
50000
0
Loadin (Metric Ton / day)
y = 1.2079x - 10.561
0
50000
100000
150000
200000
250000
Loadout (Metric Ton / day)
The inflowing solids load is ≈ 20% larger than the outflowing load.

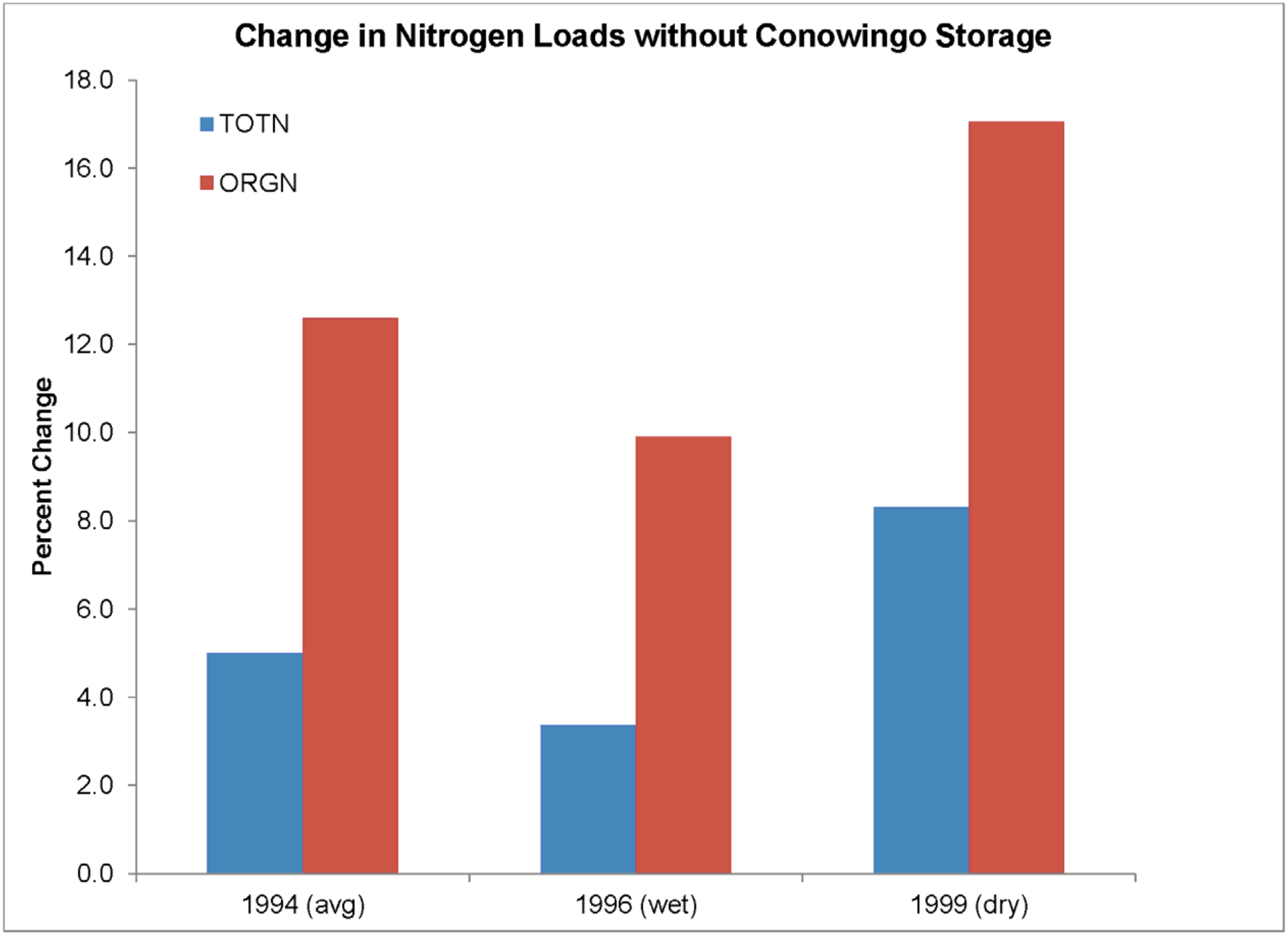

11,000 m3/s
TSSout - TSSin (mg/L)
OutFlow (m3/s)
600
400
200
0
-200
-400
-600
-800
-1000
-1200
0
2000
4000
6000
8000
10000
12000
14000
16000
The difference between inflowing concentration and outflowing is unrelated to flow. At this stage of WSM calibration, scouring does not occur. Scouring events during this period (Flow > 400,000 ft³/s) would be few in any event.

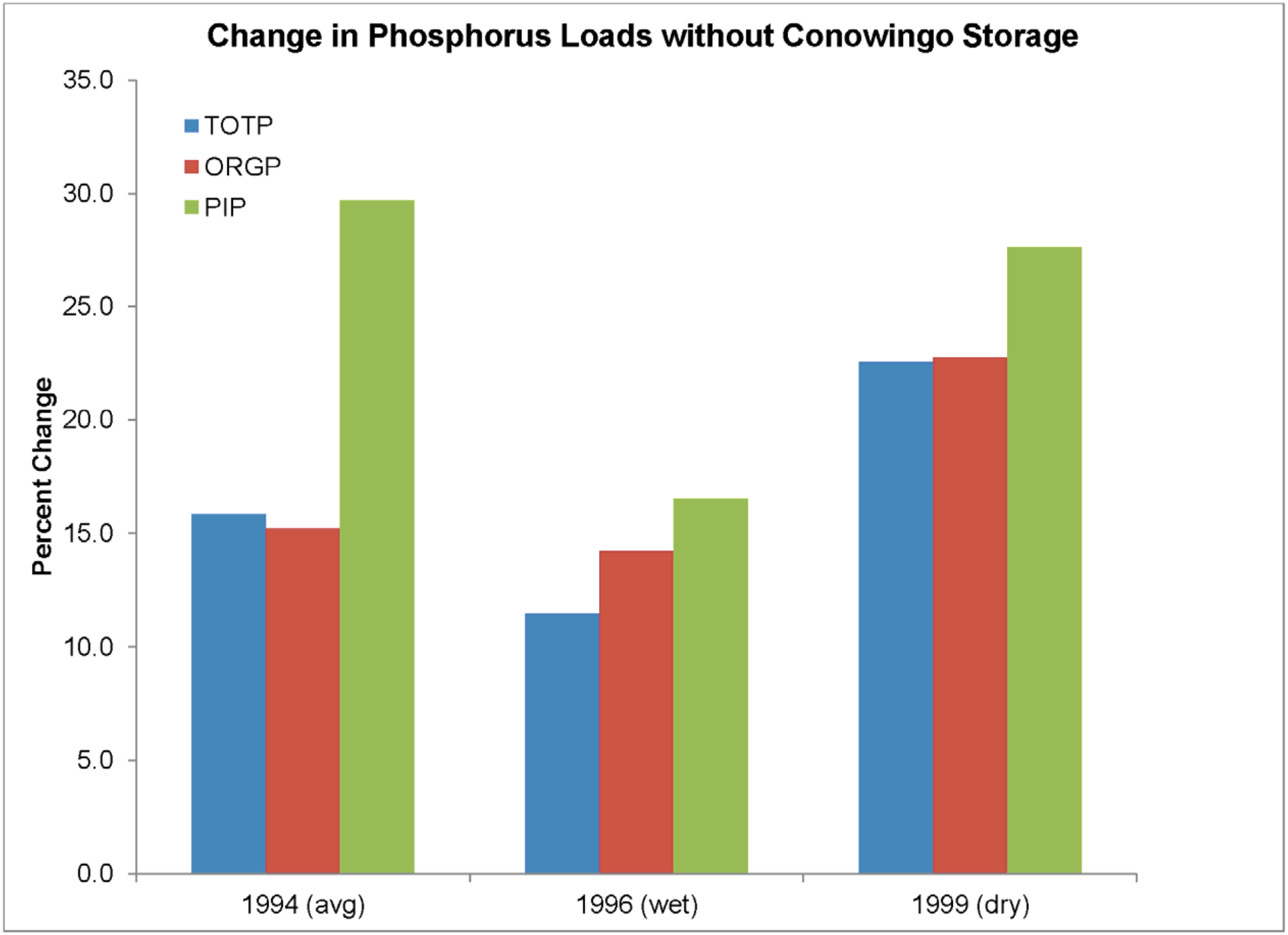
Basis for Scenarios

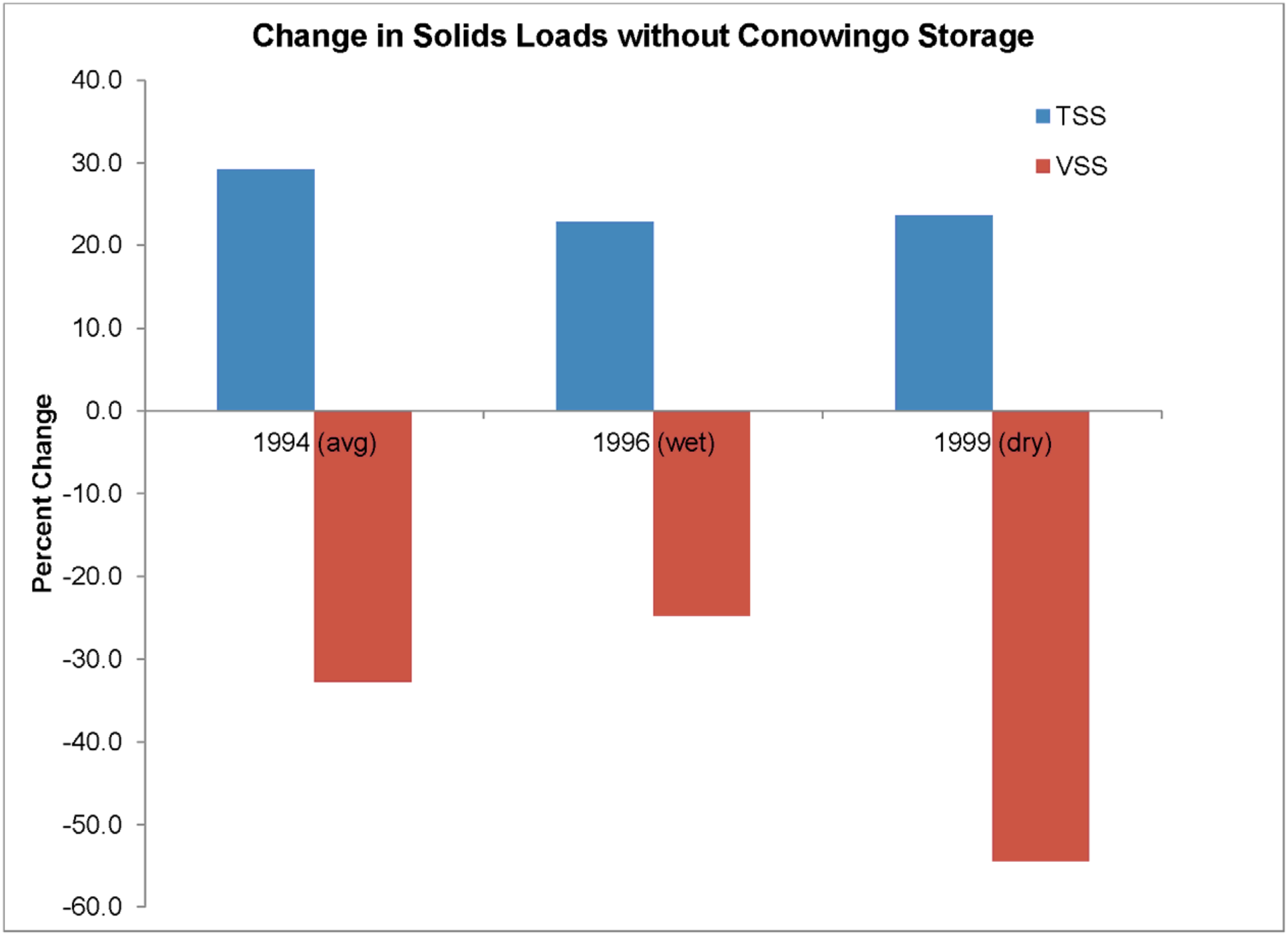
- No scouring occurs in the model. Limited scouring during the application period is expected in any event.
- The reservoir acts as a sink for solids (and nutrients in solid form).
- Our first approach to examining the effect of Conowingo infill is to eliminate it from the WSM system.
- The WQM receives loads directly from the Susquehanna River as it enters Conowingo.

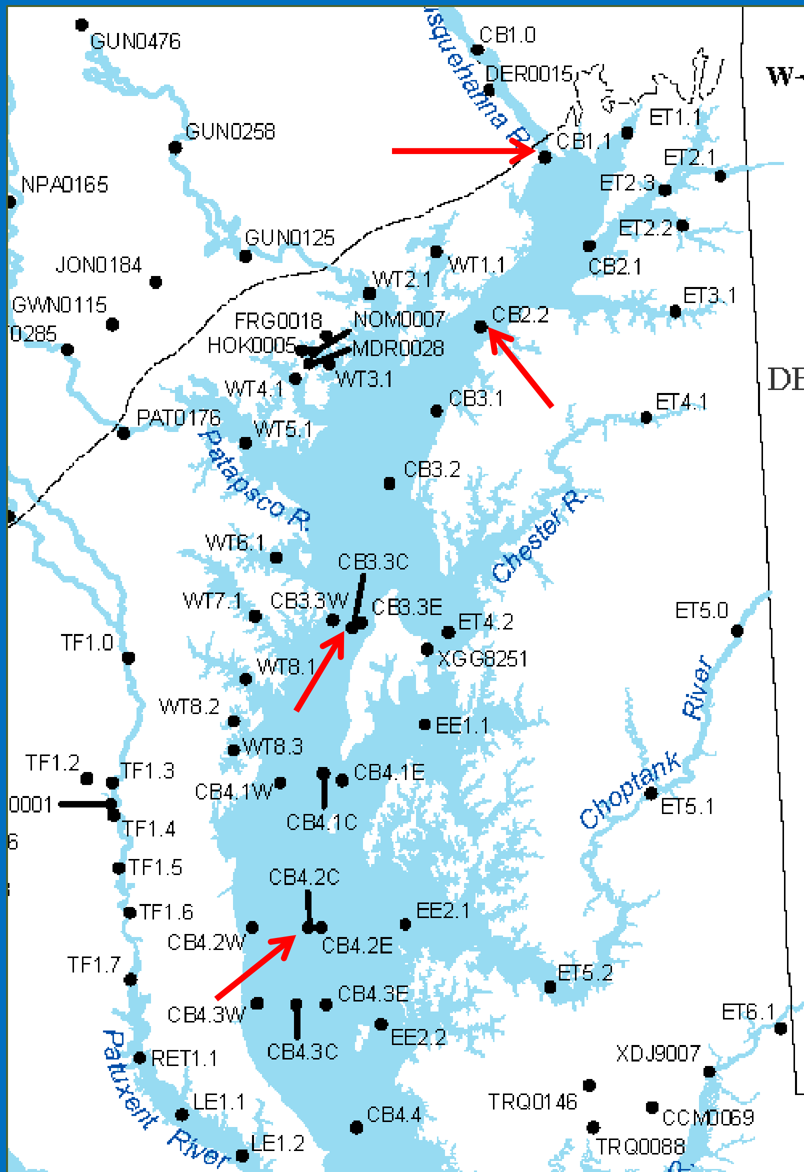
Scenario Conditions

- Ten years hydrology, 1991 – 2000.
- Base conditions from the 2010 Progress Run (land use, point sources, atmospheric loads etc.).
- Phase 5.3.2 Watershed Model
- The same phase of the WSM and same calibration status of the WQM as used for TMDL determination.
- Scenario conditions eliminate Conowingo Reservoir (at this minute, direct loads to Conowingo also eliminated).


Change in Nitrogen Loads without Conowingo Storage
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Percent Change
TOTN
ORGN
1994 (avg)
1996 (wet)
1999 (dry)

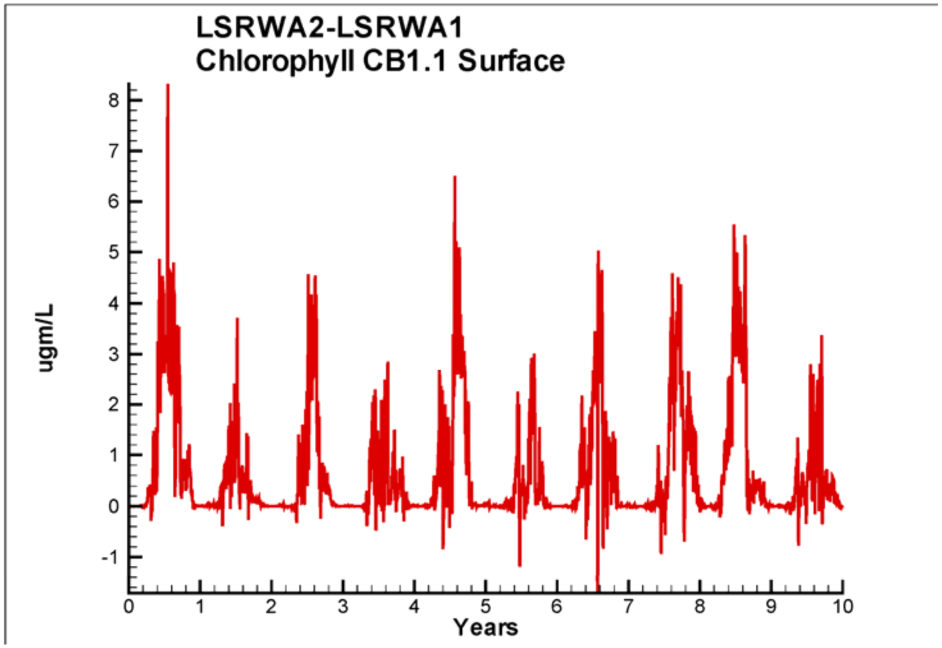

Change in Phosphorus Loads without Conowingo Storage
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Percent Change
TOTP
ORGP
PIP
1994 (avg)
1996 (wet)
1999 (dry)

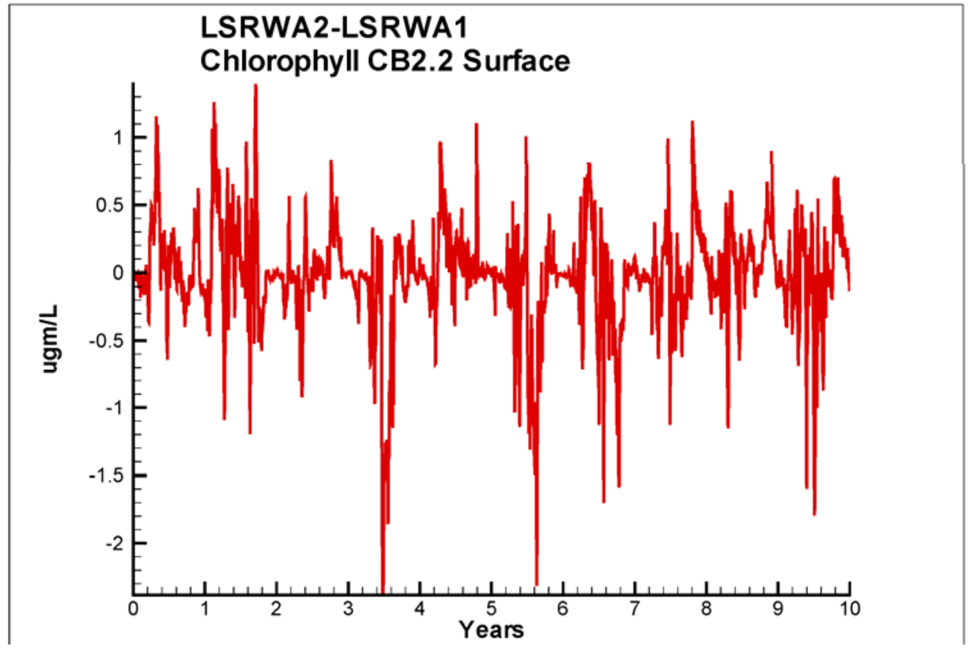

Change in Solids Loads without Conowingo Storage
Percent Change
40.0
30.0
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
1994 (avg)
1996 (wet)
1999 (dry)
TSS
VSS

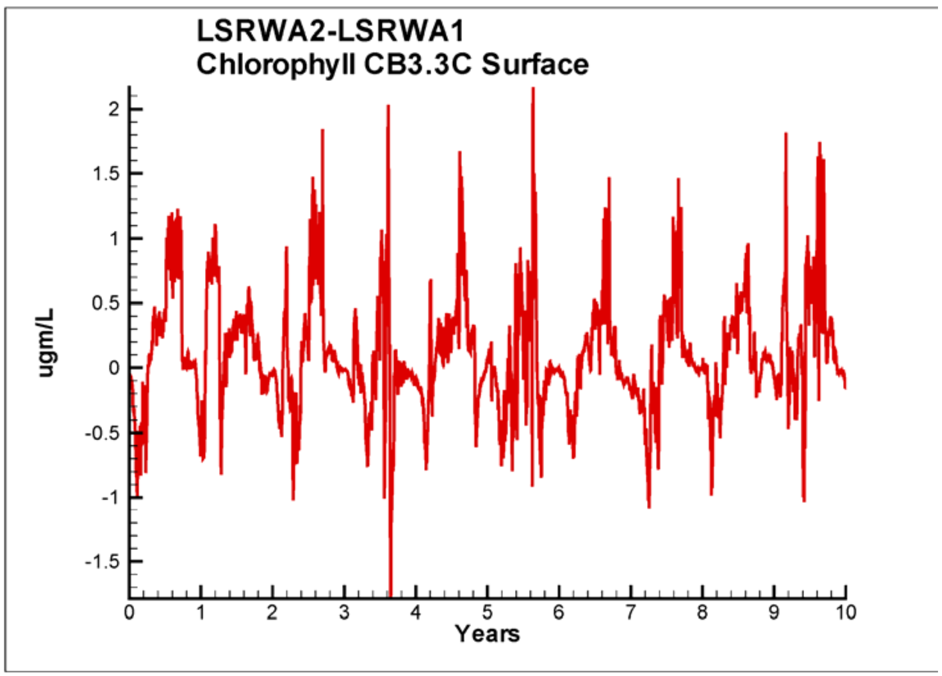


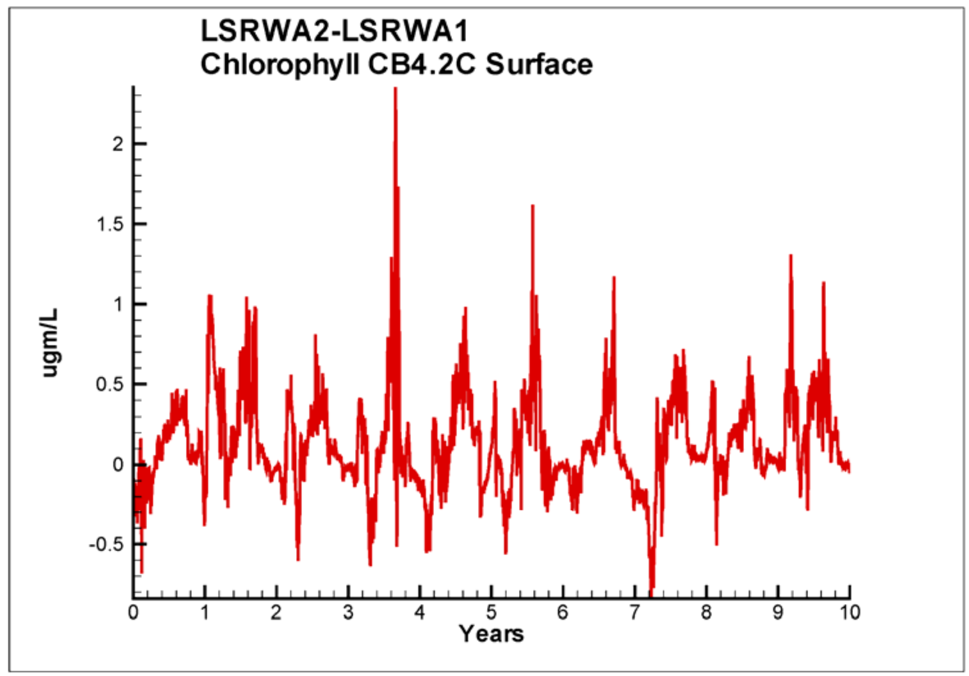
Examine key water quality constituents at four mainstem stations.

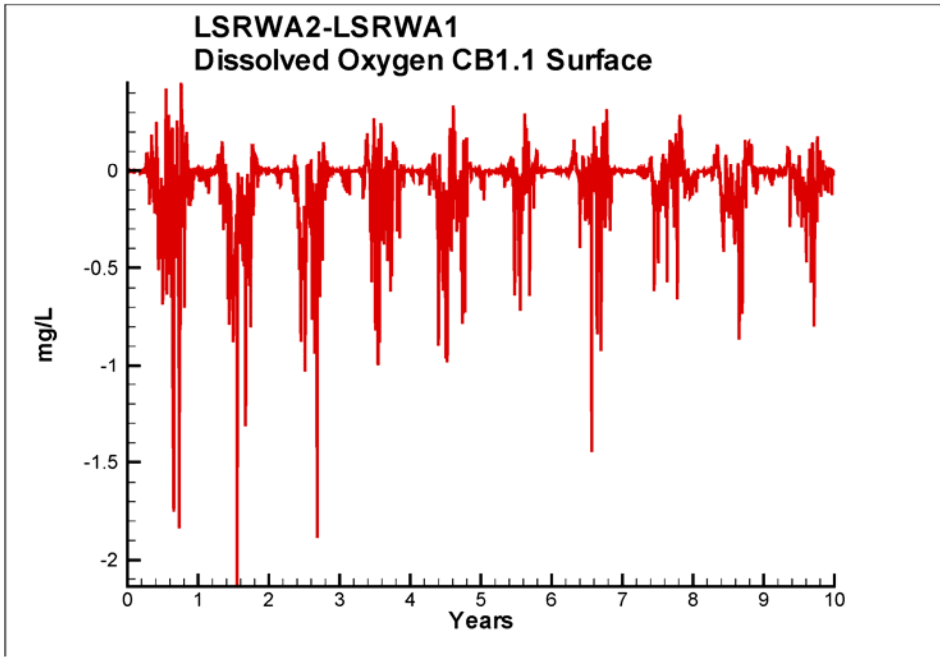
Focus on differences: Scenario – Base.

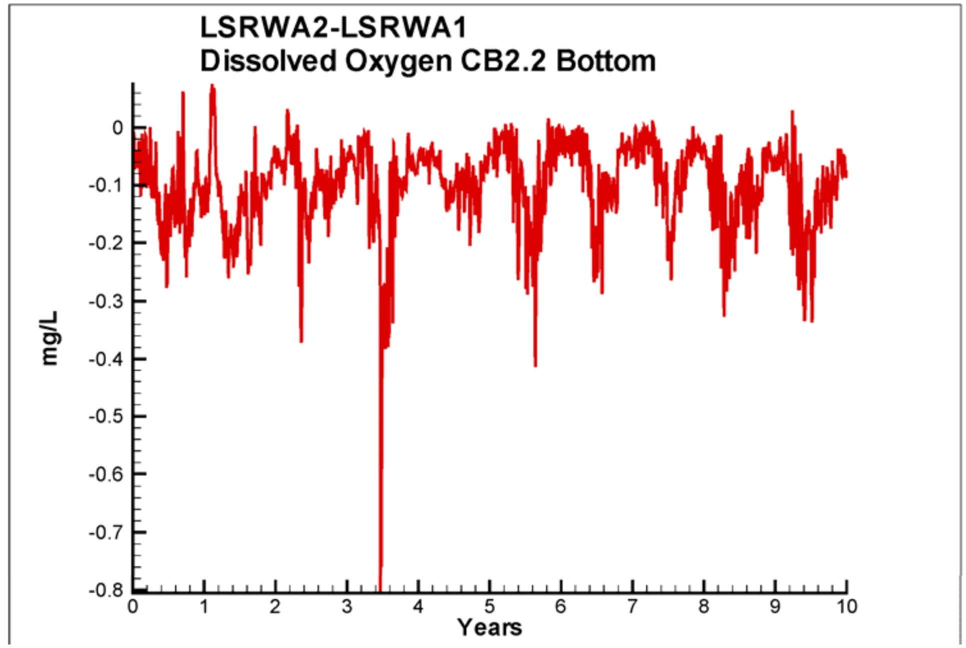

LSRWA2-LSRWA1
Chlorophyll CB1.1 Surface
ugm/L
Years

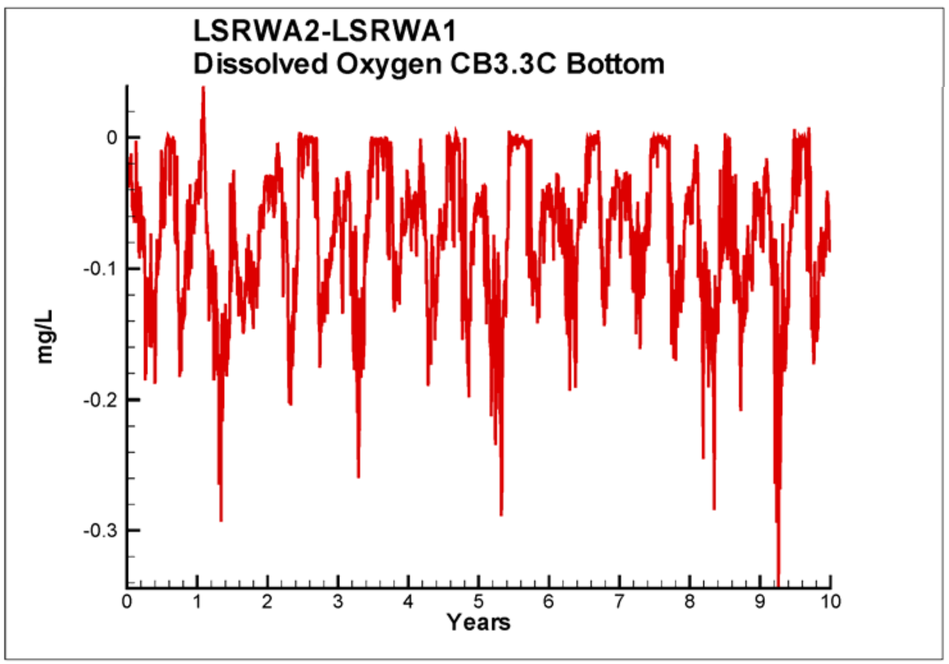

LSRWA2-LSRWA1
Chlorophyll CB2.2 Surface
ugm/L
Years

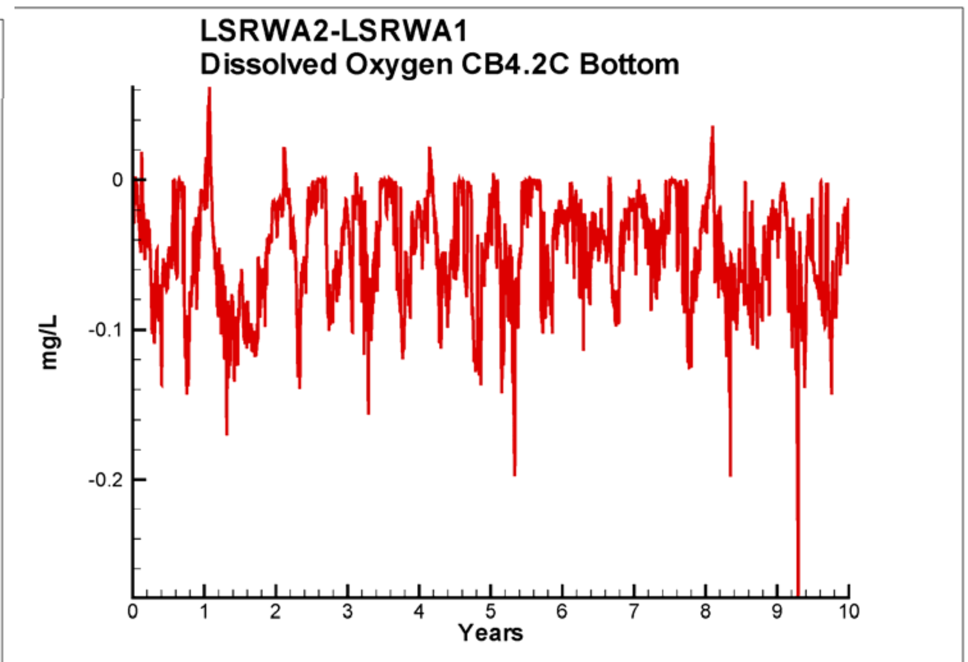

LSRWA2-LSRWA1
Chlorophyll CB3.3C Surface
ugm/L
Years

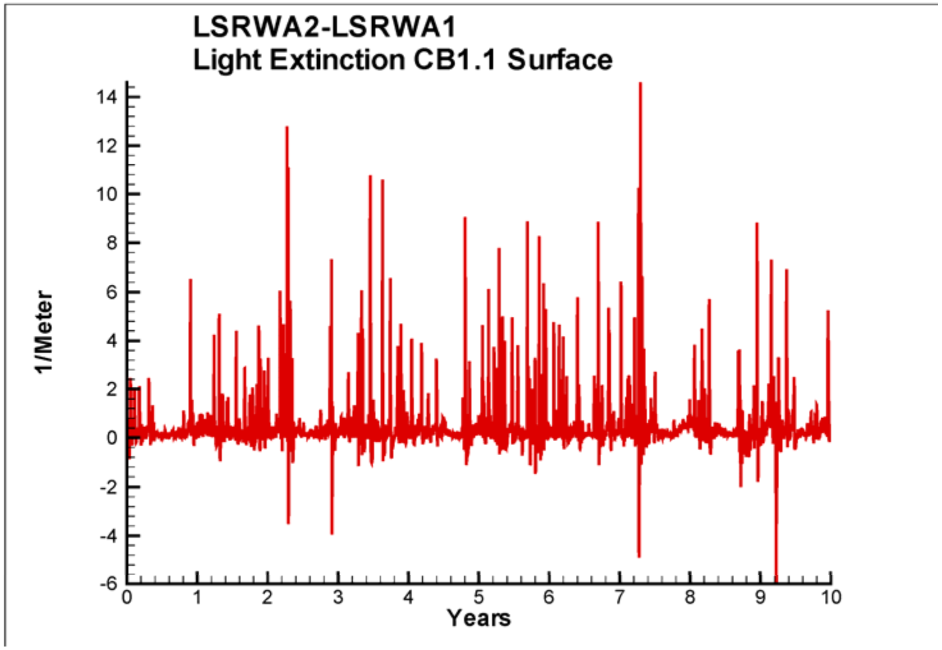

LSRWA2-LSRWA1
Chlorophyll CB4.2C Surface
ugm/L
Years

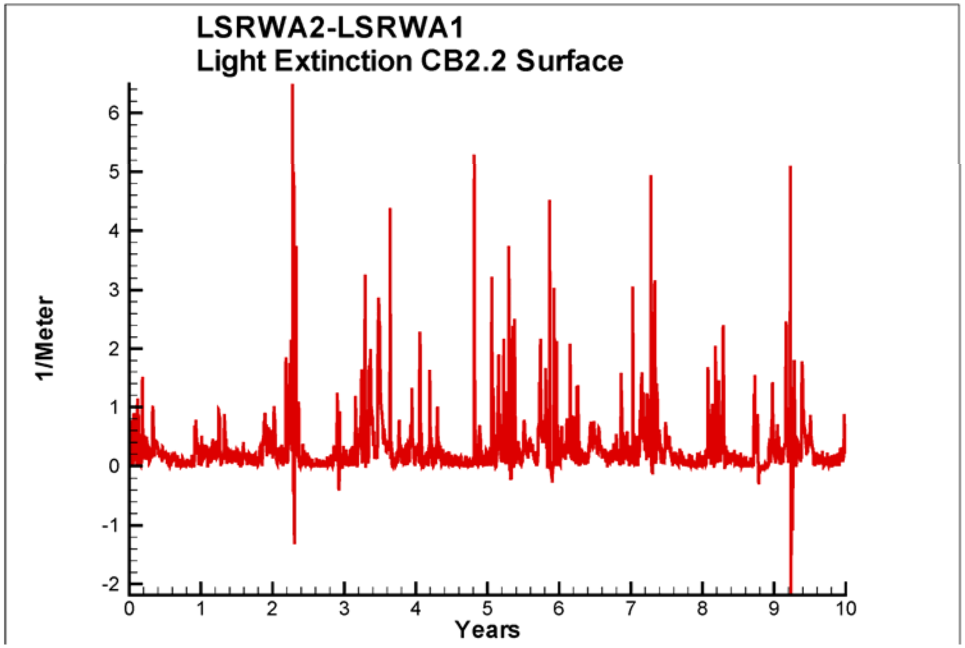

LSRWA2-LSRWA1
Dissolved Oxygen CB1.1 Surface
mg/L
Years
0
-0.5
-1
-1.5
-2
0 1 2 3 4 5 6 7 8 9 10

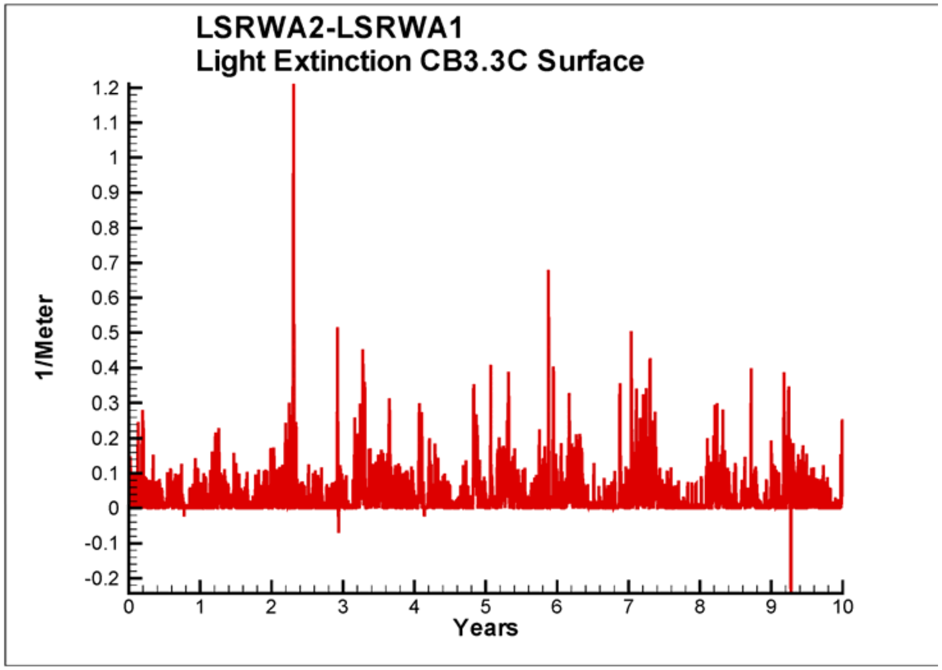

LSRWA2-LSRWA1
Dissolved Oxygen CB2.2 Bottom
mg/L
Years
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
0 1 2 3 4 5 6 7 8 9 10

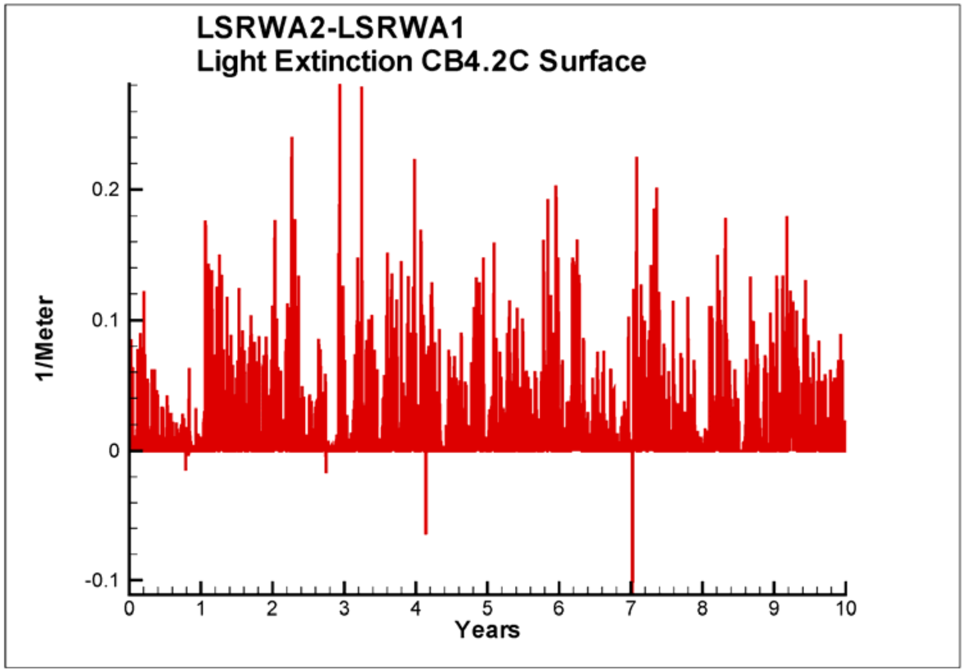

LSRWA2-LSRWA1
Dissolved Oxygen CB3.3C Bottom
mg/L
Years
0
-0.1
-0.2
-0.3
0 1 2 3 4 5 6 7 8 9 10

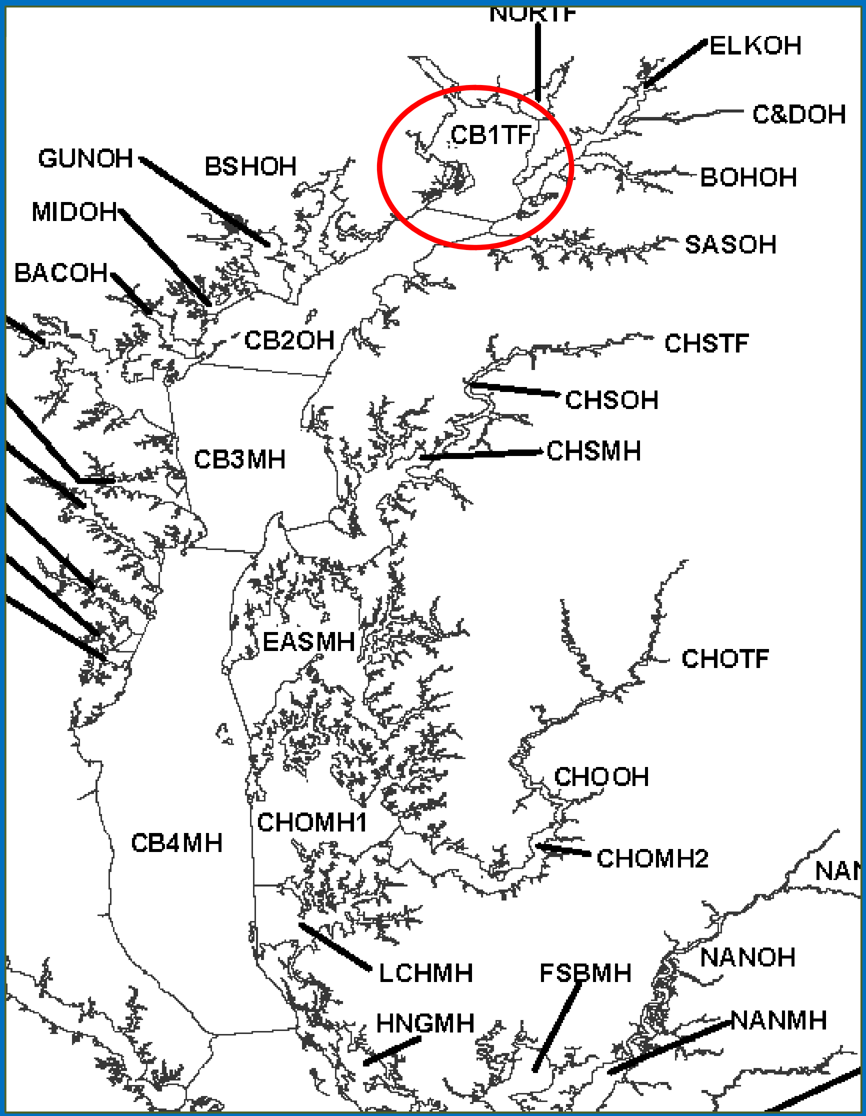

LSRWA2-LSRWA1
Dissolved Oxygen CB4.2C Bottom
mg/L
Years
0
-0.1
-0.2
0 1 2 3 4 5 6 7 8 9 10


LSRWA2-LSRWA1
Light Extinction CB1.1 Surface
1/Meter
Years

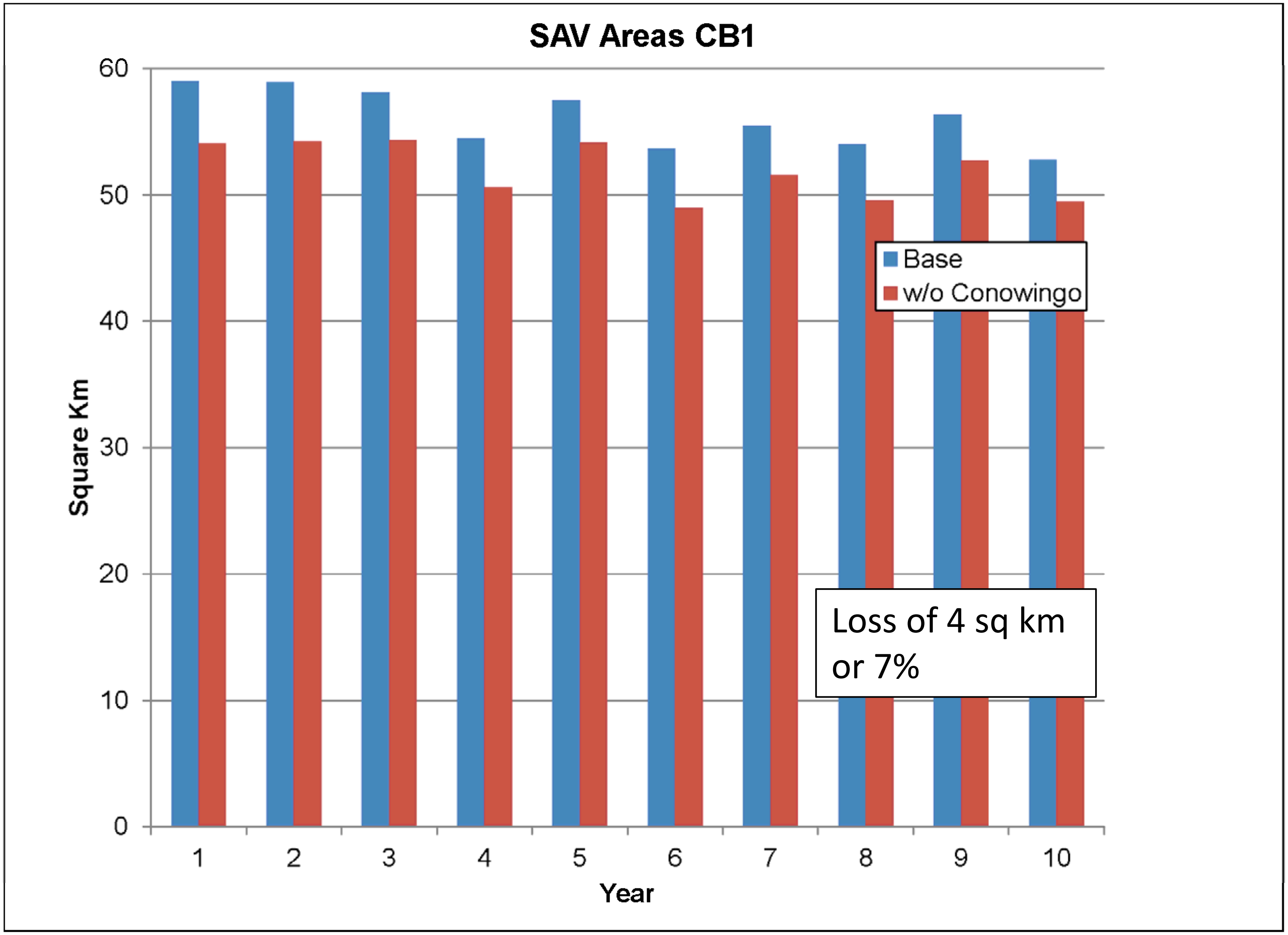

LSRWA2-LSRWA1
Light Extinction CB2.2 Surface
1/Meter
Years

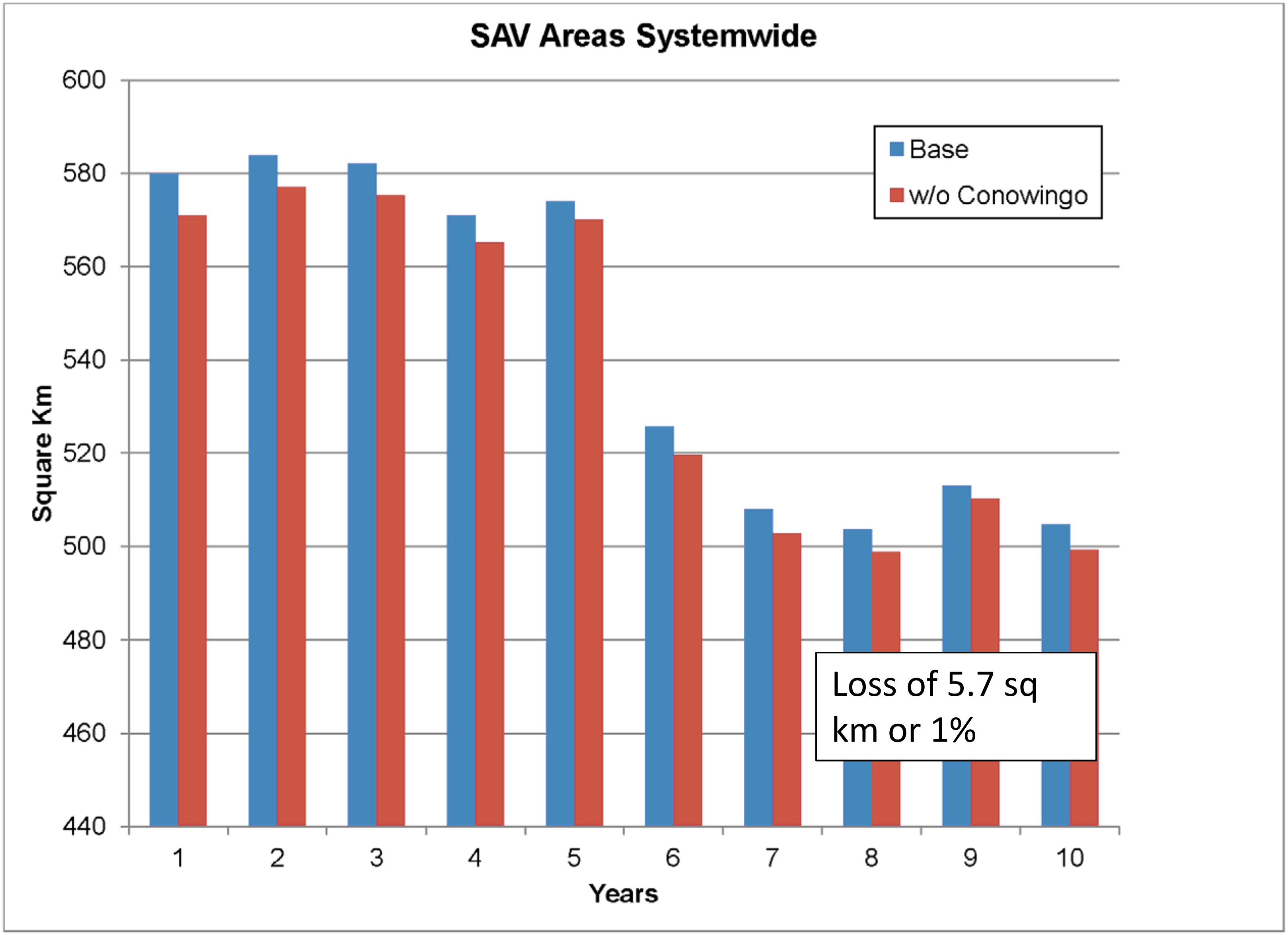

LSRWA2-LSRWA1
Light Extinction CB3.3C Surface
1/Meter
Years


LSRWA2-LSRWA1
Light Extinction CB4.2C Surface
1/Meter
Years



Examine equilibrium SAV area in CB1TF and system-wide.


SAV Areas CB1
60
50
40
30
20
10
0
Square Km
1
2
3
4
5
6
7
8
9
10
Year
Base
w/o Conowingo
Loss of 4 sq km
or 7%


SAV Areas Systemwide
Square Km
600
580
560
540
520
500
480
460
440
1
2
3
4
5
6
7
8
9
10
Years
Base
w/o Conowingo
Loss of 5.7 sq km or 1%

First Impressions

- CB1 shows the greatest impact on chlorophyll. Increases up to 4 to 5 µg/L during summer. CB2 shows a lot of fluctuations but, on first impression, little net change. Likely light limitation is the dominant factor here. CB3 and CB4 show less chlorophyll in spring, possibly indicating increased light limitation. Increases ≈ 0.5 µg/L characterize these stations in summer.
- Decreases in bottom dissolved oxygen of 0.1 to 0.2 mg/L at CB2.2, CB3.3C, CB4.2C. Larger decreases occur in CB1.1 but this station exhibits few DO problems.

First Impressions

- Increases in light attenuation are “flashy” reflecting loading events. Increases range over two orders of magnitude. Up to 10 m^{-1} in CB1 (uncommon) down to 0.1 m^{-1} at CB4.2.
- Roughly 7% loss in equilibrium SAV area in CB1 region. Losses are largely confined to this region.

Lots More to Do

- Complete examination of 2010 Progress Run scenario. Re-run with direct loads to Conowingo reservoir.
- Run TMDL scenario with Conowingo storage eliminated.
- Run results of TMDL scenario through CBP processor which examines water quality standards.

Lots More to Do

- Perform one or two scenarios with a storm event during SAV growing season.
- Time and resources permitting, we would like to examine scour and deposition using ADH.
  - Bathymetry circa 1991 – 2000
  - Present bathymetry
  - Reservoir full

1 November 2012

Lower Susquehanna River Watershed Assessment
Initial Modeling Runs to be Conducted

Discussions:

- Carl Cerco with the assistance of Steve Scott and Mike Langland put together a white paper discussing the various modeling input options for his CBEMP/WQSTM model (enclosure 1).
- After reviewing the options, it was agreed that using the Chesapeake Bay Program's watershed model (WSM) input would provide a big picture or macro view of the problem right now. This input can be done relatively simply and in a short timeframe. The primary focus of this work is to assess the sediment impacts on the upper Bay area.
- Carl has agreed to accomplish four scenario runs (schedule still to be determined):
    1. 2010 land uses with 1991-2000 flow values and 1991-2000 Conowingo capacity
    2. Watershed implementation plans (WIPs) in place with 1991-2000 flow values and 1991-2000 Conowingo capacity
    3. 2010 land uses with 1991-2000 flow values and Conowingo storage full
    4. WIPs in place with 1991-2000 flow values and Conowingo storage full
- For the purposes of evaluating the effectiveness of alternatives, the HEC-RAS/AdH input is required. The input is focused on 2008-11 flow values and current bathymetry so it is a more accurate representation of the existing conditions. Using this input will result in more detailed information about the geographic distribution of sediments as well as the impacts to the upper Bay area.
- These modeling runs have been coordinated with MDE (Sachs, Rowe), MDNR (Michael), ERDC (Scott, Cerco), and USACE-Baltimore (Compton, O'Neill)
- Table below summarizes the imminent (macro) runs and eventual (micro) runs:

Question to be Answered by Modeling Run	MACRO WSM Input	MICRO HEC-RAS/ AdH Input	Notes
1. What is the system's current condition?	√	√	Establish baseline for comparing alternatives
2. What is the system's condition if the WIPs are in full effect?	√	?	Watershed management alternative; TMDL focus
3. What happens when the reservoir fills?	√	√	Establish future without condition
4. What happens when the reservoir fills and WIPs are in full effect?	√	?	
5. What is impact of alternative TBD?		√	
6. What is impact of alternative TBD?		√	
7. What is impact of alternative TBD?		√	
8. What is impact of alternative TBD?		√	
9. What is impact of alternative TBD?		√	
10. What is impact of alternative TBD?		√	
Hydrology / flow values	1991-2000	2008-2011	
Reservoir condition	1991-2000	2008-2011	

Questions and Answers about the Scenarios and the Attached Modeling White Paper:

- **Have any runs already been made? See reference in Table 3 of the PMP for scenarios 1 and 2.** No. EPA has a ton of versions of the WSM running around. ERDC has not completed runs with the revised TMDL's or the 2010 land use versions. They need to make the two base runs.
- **Is the WQSTM model the same as the CBEMP package?** Yes, it is somewhat. WQSTM is part of CBEMP. WQSTM includes water quality and sediment transport; CBEMP also includes an air quality segment, for example.
- **Is the CBP WSM team on board with recalibration for the Conowingo full run?** Carl Cerco and Lewis Linker have been in communication; EPA is 100 percent on board with doing this. But, Gary, Carl, and Lewis have not come to a full understanding of the approach. Simple approach could be that EPA gives him sediment loads incoming to Conowingo system as the representative of the full reservoir scenario. Carl was concerned about the preliminary nature of the results if presented at the November 19th meeting. We will need to make sure that ALL understand that it is not for publication (any presentation will be off the record).
- **How long will it take to get the CBP WSM recalibration completed?** 2 to 4 weeks (from 23 October) maybe. That is Carl's guess. He hopes to get more feedback from Gary and Lewis.
- **How soon can he complete all four runs? Will this be done before November 19th?** At this time, Carl thinks they can only complete two preliminary runs – the 2010 progress run (current conditions) with and without the reservoir full.
- **The way we understand it, WSM uses different flow values and reservoir conditions from our HEC-RAS/AdH models. What does this impact? The validity of the results?** AdH simulation is based on short-term timeframes. The CBP models tend to be more long-term timeframe. Steve's outgoing rating curve = sediment concentrations vs. flow is what Carl needs for the CBEMP. They will need to check that the values derived from WSM vs. HEC-RAS/AdH to see if the calibration gives good results. The hope is that the relationship of sediment concentration vs. flow is the same with the 1990's flows as with the 2008-11 flows. The WSM model has come under a lot of scrutiny throughout the years so it has been fully vetted and is respected.
- **Will we need to re-run questions 3 and 4 with the HEC-RAS/AdH input? Note reference in Table 3 of the PMP for scenario 3.** Probably. We will need to look at results. Carl thinks it is possible that we might not need to do additional runs for scenarios #2 and #4 in table above (hence the question marks in the third column). Given that we didn't do the phosphorus component, we have $30,000 of unspoken funds in his scope. We could use that to do more runs in the future.
- **Do we really need to have a separate model run for question 4? Can the answer be deduced from looking at 1 vs. 2 output and 1 vs. 3 output?** Not necessarily. Carl recommends doing all four runs.
- **As I remember, ERDC had enough funds to run six scenarios? Is this right? If so, should we run a winter scouring event with reservoirs no longer trapping and a summer scouring event with reservoirs no longer trapping to see any changes to the downstream impacts?** Yes, they have funds in hand to do six runs. Until we see the results, Carl recommends waiting to make any decisions on runs 5 and 6.
- **How does Bob Hirsch's analyses enter into the picture? Does his conclusion of lower flows provoking scour influence the CBEMP analyses?** We can and should do a comparison between EPA WSM results and Bob Hirsch's results.

Options for Running Initial Chesapeake Bay Scenarios – October 5, 2012

Scenarios

Consensus exists on the first four scenarios to be run for Chesapeake Bay:

- Present land uses (2010) using 1991 – 2000 hydrology. Conowingo storage capacity consistent with 1991 – 2000 period.
- Watershed Implementation Plans (WIPs) in place, 1991 – 2000 hydrology. Conowingo storage capacity consistent with 1991 – 2000 period.
- Present land uses (2010) using 1991 – 2000 hydrology. Conowingo reservoir full.
- Watershed Implementation Plans (WIPs) in place, 1991 – 2000 hydrology. Conowingo reservoir full.

The Chesapeake Bay Water Quality and Sediment Transport Model (WQSTM) requires specification of flow, solids loads, and nutrient loads at the Conowingo outfall. Flows and nutrient loads come from the Chesapeake Bay Program Watershed Model (WSM). There are multiple options for the solids loads. Depending on the option selected, the portion of the nutrient loads attached to solids may be affected.

ADH

The ADH model provides high spatial resolution of processes in Conowingo Reservoir and high levels of detail in the predicted loads flowing over the dam. The model also provides the opportunity to represent the bathymetry of the filled-in reservoir and the influence of the new bathymetry on sediment scour. There are numerous factors to consider in the use of ADH to provide loads:

Application Period – ADH is undergoing calibration for the 2008 – 2011 period. The WQSTM scenarios are planned for 1991 – 2000 hydrology. This hydrologic period is required to match previous TMDL scenarios. Consequently, new ADH input decks must be constructed to represent the 1991 – 2000 period.

Upstream Boundary Conditions – ADH requires flows and solids loads at the upper entrance to Conowingo Reservoir. For 2008 – 2011, these come from the HEC-RAS model. However, for the 1991 – 2000 period, flows and loads must come from the CBP WSM. The WSM is the only source of projected WIP flows and loads. For ultimate fidelity to the WSM, we should also include in ADH the estimated loads directly to the Conowingo reservoir. There is a risk if we calibrate ADH to loads from HEC-RAS and then switch to the WSM for scenarios. If HEC-RAS and the WSM diverge greatly in the boundary conditions provided to ADH, the loads routed by ADH through Conowingo reservoir may not be reliable.

Particulate Nutrient Loads – Portions of the nutrient loads flowing over Conowingo are in particulate form. These particulate nutrients are an element of the loads from the WSM but not of the loads from ADH. If we use ADH, we will have to find a way to adjust the WSM nutrient loads for the nutrients associated with solids deposition and scour computed by ADH.

Computational Burden – The ADH model code, associated with the highly-resolved computational mesh, requires execution on a high-performance computer. The ten-year scenario runs are projected to consume 60 hours of computer time. This resource demand leaves little margin for errors, repeated runs, power outages, etc.

HEC-RAS

The primary intent for the HEC-RAS modeling is to provide boundary conditions to the ADH model at the upper end of Conowingo. HEC-RAS takes loads at Marietta and routes them through the upper two reservoirs. The HEC-RAS model also incorporates a one-dimensional representation of the Conowingo reservoir. Because HEC-RAS represents Conowingo, it provides an alternative to using ADH to provide flows and loads to the WQSTM. Factors to consider in the potential use of HEC-RAS include:

Application Period – HEC-RAS is undergoing calibration for the 2008 – 2011 period. The WQSTM scenarios are planned for 1991 – 2000 hydrology. This hydrologic period is required to match previous TMDL scenarios. Consequently, new HEC-RAS input decks must be constructed to represent the 1991 – 2000 period.

Upstream Boundary Conditions – HEC-RAS requires, as inputs, flows and solids loads at the entrance to the reservoir system. Several alternatives have been examined for the solids loads from 2008 - 2011. The latest approach is to use the USGS Estimator (a regression program) for the loads. Flows are based on observations. However, for the 1991 – 2000 period, flows and loads must come from the CBP WSM. The WSM is the only source of projected WIP flows and loads. HEC-RAS must also include the solids loads directly from the adjacent watershed to the reservoir system. There is a risk if we calibrate HEC-RAS to loads from the USGS Estimator and then switch to the WSM for scenarios. If the Estimator and the WSM diverge greatly in their results at the head of the reservoir system, the loads routed by HEC-RAS to the bay may not be reliable.

Particulate Nutrient Loads – Portions of the nutrient loads flowing over Conowingo are in particulate form. These particulate nutrients are an element of the loads from the WSM but not of the loads from HEC-RAS. If we use HEC-RAS, we will have to find a way to adjust the WSM nutrient loads for the nutrients associated with solids deposition and scour computed by HEC-RAS.

Computational Burden – The HEC-RAS model runs rapidly on desktop computers. The rapid execution provides advantages over ADH. There should be reasonable margin for errors and repeated runs, if necessary.

CBP WSM

The WSM is immediately available to provide flows and loads to the WQSTM for scenarios with Conowingo at its 1991 – 2000 storage capacity. The WSM incorporates Conowingo reservoir so the model could be configured to represent a filled-in reservoir although the methodology to do this is undecided. Also, the representations of deposition and scour in the WSM are less sophisticated than in ADH or HEC-RAS so the predictions may be less reliable. One option to represent the filled-in reservoir is to change the bathymetry in the model input deck. A second option, currently favored by the CBP WSM team, is to re-calibrate the deposition and scour to reproduce the loads vs. flow relationship derived from recent data by Robert Hirsch of the USGS. These loads are purported to represent a nearly-full reservoir. The WSM offers the following advantages over ADH and HEC-RAS:

Application Period – The WSM is calibrated and validated for the 1991 – 2000 scenario period.

Upstream Boundary Conditions – The WSM is calibrated and validated using computed boundary conditions at the upper end of the reservoir system. There is no risk of calibrating to one set of conditions and running scenarios based on an alternate set.

Particulate Nutrient Loads – The partitioning of nutrient loads into dissolved and solid forms is retained from the original WSM values.

Computational Burden – The burden is moderate compared to ADH but requires much more time and a more sophisticated computer system than HEC-RAS. Considerable time and effort is required to set up and execute a WSM run. These resources will be provided by CBP.

A Potential Resolution

There are multiple trade-offs to consider in selecting a model to provide boundary conditions for the WQSTM. The major advantage of the WSM is its availability right now. We can provide management insights within a few weeks of today. The advantages of ADH or HEC-RAS are high accuracy in solids transport although the time frame for results is longer than for the WSM. The PMP calls for up to ten WQSTM scenarios. One path forward is to proceed with four scenarios immediately using the WSM. Then re-run these scenarios based on ADH or HEC-RAS in the future to re-examine results using more accurate sediment transport modeling capacity.

Susquehanna River Sediment and Metals Screening Thresholds

Sediment comparison

- SRBC (2006)[1]
  - Approximately 34 core samples were analyzed behind the three lower dams on the Susquehanna River at different depth intervals;
  - Presented data on metals, nutrients, PAH, PCB, and pesticides at different depth;
- IRC (2009)[2]
  - Summarized soil thresholds and standards for certain constituents.
  - Used these thresholds to evaluate potential uses for sediments in Baltimore Harbor.

1. Robert E. Edwards, "Comprehensive Analysis of the Sediments Retained Behind Hydroelectric Dams On the Lower Susquehanna River" Susquehanna River Basin Commission, February 28, 2006. http://www.srbc.net/pubinfo/techdocs/Publication_239/techreport239.htm

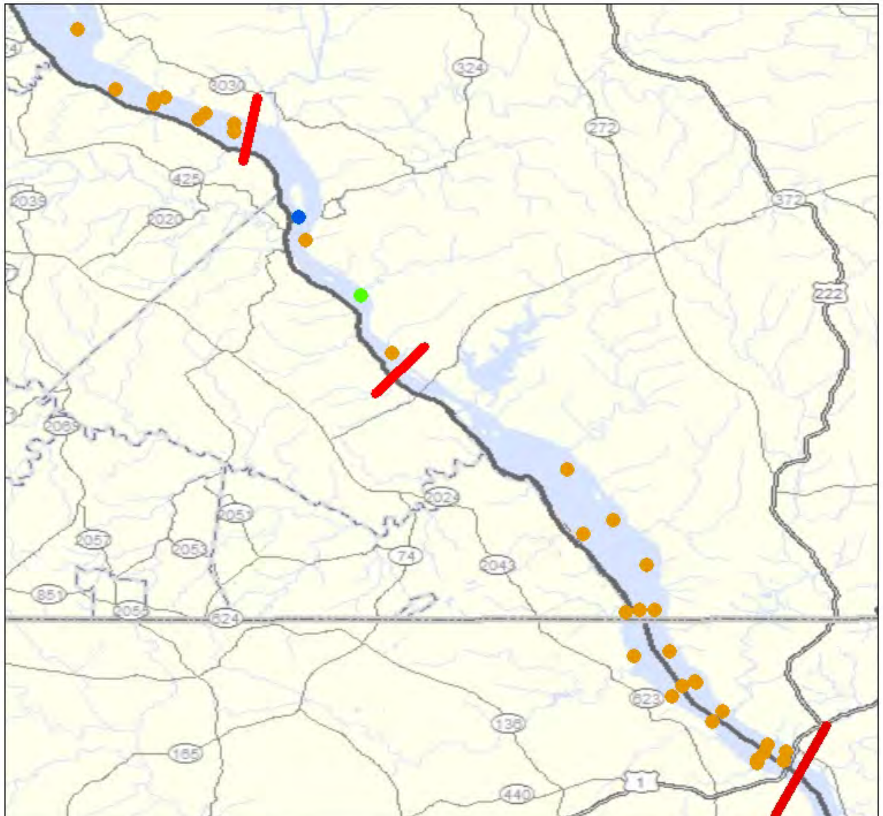
2. Jonathan G. Kramer, Jessica Smits, and Kevin G Sellner ed. Sediment in Baltimore Harbor: Quality and Suitability for Innovative Reuse. An Independent Technical Review, October 2009. http://mddnr.chesapeakebay.net/LSRWA/Docs/Dredge_ReportandAppendices_Print.pdf

Potential Use Categories

- <TEL (Threshold Effects Level).
  - e.g. Aquatic Habitat Restoration, Upland habitat restoration.
- <MD Residential Reuse Criteria.
  - e.g. Upland reclamation, manufactured topsoil for landscaping.
- <MD Non-Residential Reuse (Industrial) Criteria.
  - e.g. Upland reclamation for industrial sites, fill for landfill.
- >MD Non-Residential Reuse (Industrial) Criteria.
  - e.g. Fill for land fill with containment, leave undisturbed.

Assumptions

- Did not take depth into account.
- If at any core exceeded a Use Threshold at any depth, than the site did not meet that Use Threshold.



Summary of Potential Sesquehanna River Sediment Reuse based on Maryland Geological Survey Core data and IRC Sediment Screening Guidelines

N

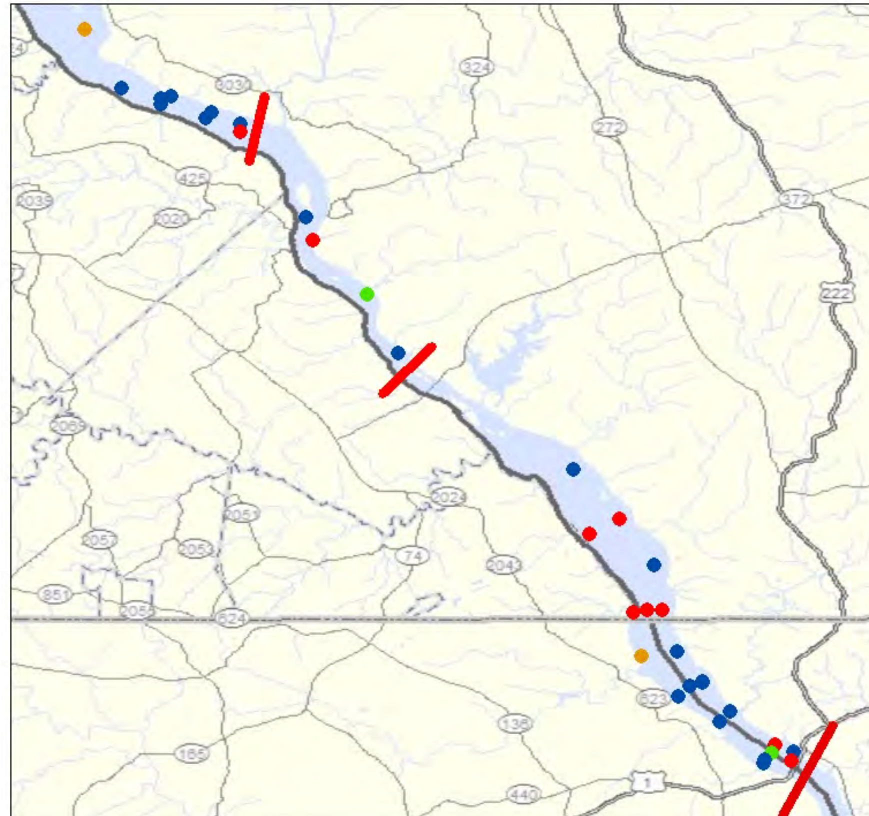
MGS Data

MGS

- <TEL
- <MD Residential Soil Clean Up Criteria
- <MD NonResidential Soil Clean Up Criteria
- Dam

Metals
Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn

0 1.75 3.5 7 Miles



Summary of Potential Sesquehanna River Sediment Reuse based on University of Maryland CBL Core data and IRC Sediment Screening Guidelines

N

UMD CBL

UMD

- <TEL
- <MD Residential Soil Clean Up Criteria
- <MD NonResidential Soil Clean Up Criteria
- >MD NonResidential Soil Clean Up Criteria
- Dam

Metals
Ag, As, Cd, Hg, Pb, Se

0 1.75 3.5 7 Miles

Summary

- Most metals were below MD Residential Reuse Thresholds.
- Arsenic, chromium, and in some cases cadmium were above MD Residential Reuse Thresholds.
- Findings similar to IRC (2009).
- Site specific assessments may be needed for sediment reuse potential.
  - Regulatory issue?

	Strategy	**Description**	**Meets Goals and Objectives: All, Some, None**	**Capital Costs: High, Medium, Low?**	**Annual Costs: High, Medium, Low?**	**Negative Impacts High, Medium, Low?**	**Positive Impacts (Benefits) High, Medium, or Low?**	**Evaluate Further Yes or No?**	**Notes**
A. Reduce Sediment Yield from the Watershed - Reduce Sediment Inflow from Upstream									
1	Agricultural BMP's	Reduce field soil loss and retain field losses at the edge of field before delivery to stream systems. Promote clean water practices, educate, encourage partnerships, emphasize agricultural management plans that address enhanced sediment/nutrient management							2001 Sediment Task Force recommendation. Will TMDL activities in states cover this strategy?
2	Urban BMP's	Minimize sediment disturbance, stabilize sediments as soon as possible, provide adequate erosion and sediment control measures for active construction projects, and maintain predevelopment runoff characteristics. Increase awareness , promote non-structural BMP's (rain gardens, disconnected roof, sheet flow, vegetative filters/channels.)							2001 Sediment Task Force (STF) recommendation. Will TMDL activities in states cover this strategy?

3	Transportation BMP's	Minimize sediment and road maintenance additives in roadway, railway and highway construction runoff . Sediment and erosion control during construction, landscape-based stormwater management, ditch management, by minimizing exposed soil, stormwater and erosion control measures appropriate to road system types (dirt road, secondary, railways, etc.)							2001 Sediment Task Force recommendation. Will TMDL activities in states cover this strategy?
4	Forestry	Implement forest-harvesting BMP's; encourage forest expansion, fund out reach programs.							2001 Sediment Task Force recommendation. Will TMDL activities in states cover this strategy?
5	Mining BMP's	Minimize the impacts that abandoned mine land has on receiving streams Meet revegetation requirements, reforest AML's., fund programs that reclaim AML's.							2001 Sediment Task Force recommendation. Will TMDL activities in states cover this strategy?
6	Stream Restoration & Stabilization	Minimize sources of sediments eroding from stream banks and degradation of stream channels							2001 Sediment Task Force recommendation. Will TMDL activities in states cover this strategy?
7	Sediment Trapping Structures	Sediment trapping of water impoundment structures/dams.							2001 Sediment Task Force recommendation. Will TMDL activities in states cover this strategy?
8	Riparian Buffers	Increase buffer width, to maximize sediment retention and mitigate storm flows Increase stream miles with buffers, build for long-term (e.g. woody plants), build to be sustainable, integrate with natural landscape.							2001 Sediment Task Force recommendation. Will TMDL activities in states cover this strategy?

9	Wetlands	Increase the wetland acreage (especially in flood plains) Continue “no net loss” philosophy Integrate riparian buffers and wetlands in floodplains							2001 Sediment Task Force recommendation. Will TMDL activities in states cover this strategy?
10	Nutrient Trading	Reducing sediments/nutrients elsewhere in the watershed to offset sediments/nutrients behind reservoirs.							
B. Minimize Sediment Deposition - Route Sediments around or Through Storage									
1	Sediment By-passing (general concept)	Pass sediments through the dams via a bypass system during less critical (non-storm, flow) periods so that the reservoirs maintain storage capacity for high-sediment transport storm events. This lessens the amount of sediment passed during these storm events.							STF opinion: This would result in a base load condition that exceeds the current base load into the Bay. This is counter to the currently accepted goal of reducing sediment input to the Bay. It would not greatly mitigate the effects of catastrophic storm events in which the flow is sufficient to scour in situ material and cause the net transport of sediment past the dams to be greater than the sediment load that the river carries into the dam.
2	Modify Dam Operations (general concept)	Pass sediments through the dams by altering operations during less critical (non-storm, flow) periods so that the reservoirs maintain storage capacity for high-sediment transport storm events. This lessens the amount of sediment passed during these storm events.							STF opinion: Same as by-passing.
3	Sediment Pass-through	Lower reservoir levels during floods to increase flow velocity and minimize sediment deposition							One method to modify dam operations

4	Release Turbidity Density currents	Opening bottom sluice gates to pass highly concentrated flows through reservoir. Fine sediments are usually transported downstream.								One method to modify dam operations
5	Off-stream reservoir	By-pass significant floods around reservoir								One method to by-pass
6	Tunnel By-pass	Pass course sediment around the dam by tunnel								One method to by-pass
C. Increase or Recover Volume - Recover, Increase, or Reallocate Storage Volume										
1	Dam Removal	Remove one or all three dams								
2	Enlarge Storage	Larger Dam/more dams								
3	Sediment Fixing	Placing clean dredged material over contaminated material so that the contaminated sediment is rendered harmless to nearby benthic communities.								STF opinion: this would not mitigate scouring or change the amount of sediment passing through the system or add capacity.
4	Floating islands	Artificial islands to uptake nutrients								
5	Dredging (General concept)	Preserves the reservoirs' abilities' to trap sediment as it is carried downstream, and if possible, to reduce the volume of sediment that is available for transport during high-flow episodic events.								STF Supports study to maintain/increase trapping capacity.

6	Hydraulic Dredging-Empty Flushing	Completely empty reservoir to remove large sediment volumes via flushing							
7	Hydraulic Dredging-Pressure flushing	Scour zone created by opening the bottom outlet while reservoir levels remain high.							
8	Mechanical Dredging	Using Siphon dredge, hydraulic dredge, airlift dredge, bucket dredge							
9	Innovative-re use: island restoration	Using dredged material to restore eroded islands							
10	Innovative-re use: soil amendment for agriculture	Using dredged material for agricultural fields.							
11	Innovative-re use: soil amendment for mining	Using dredged material for covering abandoned mines							
12	Innovative-re use: commercial-light weight aggregate	Using dredged material to create construction materials							
13	Innovative-re use: beach renourishment	Using dredged material to restore beaches.							

14	Innovative-re use: landfill cover	Using dredged material for agricultural fields.							