MEMORANDUM FOR THE RECORD

SUBJECT: Lower Susquehanna River Watershed Assessment
Brainstorming Meeting, 24 September 2012

1. On September 24, 2012 agency team members met to discuss and brainstorm ideas for potential sediment management strategies for the Lower Susquehanna River Watershed Assessment (LSRWA). The meeting was hosted by the Maryland Department of the Environment (MDE) at the Montgomery Park Building in Baltimore, Maryland. The meeting attendees are listed below.

2.

Team Meeting Sign-In Sheet			
24 September 2012			
Agency	**Name**	**Email Address**	**Phone**
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
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	
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
USGS	Mike Langland	langland@usgs.gov	717-730-6953
Chesapeake Conservancy	Jeff Allenby	jallenby@chesapeakeconservancy.org	443-321-3160
The Conservation Fund	Bill Crouch	bcrouch@conservationfund.org	410-274-8427
Exelon	Mary Helen Marsh	maryhelen.marsh@exeloncorp.com	610-765-5572
Exelon	Kimberly Long	kimberly.long@exeloncorp.com	717-629-4198
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
Gomez and Sullivan	Kirk Smith	ksmith@gomezandsullivan.com	
Pat Noonan	Conservation Fund	P.noonan@conservationfund.org	
Fran Flanigan	Consultant-MPA	frances.flanigan@verizon.net	
Jeff Otto	HarborRock	info@HarborRock.com	
Danielle Aloisio	USACE	danielle.m.aloisio@usace.army.mil	
Harry Kleiser	Terranear	Hkleiser@terranearpmc.com	
Lake Savers	John Tucci	jtucci@lake-savers.com	269-383-3400
Brinjac	Steve Zeller	szeller@brinjac.com	717-233-4502
Clean Flo	Brian Kling	bkling@clean-flo.com	1-800-328-6656
Loon Landing, LLC	Jeri Epstein	jepstein@loonlandingadvisors.com	202-467-4832

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

Action Items –

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.
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.

3. Welcome – 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 hear about potential sediment strategies that could be applied to the Lower Susquehanna River watershed and brainstorm ideas.

4. Results of Literature Search – Anna noted that a literature search was conducted on managing watershed/reservoir sedimentation. Findings and lessons learned from the literature will be incorporated into refining sediment/nutrient management strategies for the study. Anna noted that this search is considered "preliminary" due to the fact that as the study moves forwards certain strategies may warrant further research if there is an interest in evaluating the strategy in more detail.

   The Sediment Task Force (original group that convened in 1999-2001 to investigate this issue) findings were summarized. The task force primarily recommended sediment management strategies in the watershed (BMPs, etc.) however the group did recommend a dredging feasibility study to deal with the large amounts of sediments existing behind the dams on the Susquehanna. The sediment task force ruled out bypassing because this would result in a base load condition that exceeds the current base load into the Bay which is counter to the currently accepted goal of reducing sediment input to the Bay. The sediment task force also ruled out modifying dam operations because of potential impacts to the their primary purpose of hydropower and because it was unclear if modified operation could accomplish anything in the interest of sediment management other than as a form of bypassing.

   Anna noted that a database literature search was also done. In general, sediment management strategies fell into three categories: (1) reducing sediment yield from the watershed (reducing sediment inflow from upstream of reservoirs); (2) minimizing sediment deposition (routing sediments around or through storage); and (3) increasing or recovering volume (recover, increase or reallocate storage volume of reservoir.) Common factors that sediment management managers around the world look at when evaluating and implementing sediment management solutions are the goals, what is in the sediment, effectiveness of strategies, capital costs and maintenance costs, how to optimize sediment management strategies, environmental impacts, implementation sequence (short- and long-term solutions), benefits, and combining strategies to be successful.

The sediment management strategy of dredging has been implemented. However it is often seen a last resort, because dredging is expensive and often creates new social and environmental problems.

The technology to bypass and transport sediments has been developed and has many pros and cons, and there are a variety of methods available. Normally, an upper limit of sediment concentration (that would be bypassed) is defined by managers to account for ecological aspects (how much sediment can the receiving water body tolerate) and operational aspects (how much sediment can the bypassing system handle moving). Anna noted that we should keep the goals and objectives in mind to frame how we evaluate sediment management strategies and determine which ones we ultimately recommend.

The presentation of literature search findings is included as enclosure 2 to this memorandum.

5. Harbor Rock, Presentation and Q&A – Jeff Otto provided a presentation on a potential sediment management solution: innovative reuse of dredged material. Specifically dredging sediments from behind the dams on the lower Susquehanna River and converting the material to lightweight aggregate (LWA) to be sold commercially as construction material. After Jeff's presentation, there was much discussion and questions.

Jeff noted that during the processing of dredged material to LWA (firing in a kiln at high temperatures) the organic content of the sediment is vaporized while metal content remains bound to the aggregate (below amounts deemed harmful to the environment); therefore, the costs of disposal of unusable material is essentially zero. In the lower Susquehanna River, it is estimated that 3 million tons of sediment travel down the Susquehanna annually and their estimate is that this could be converted into 2.7 million tons of LWA (the difference would be organic material that is vaporized – a 10-perent loss). Costs are estimated to be $60-75 million a year which includes capital repayment. A facility to process the dredged material can vary in size based on the amount of material that managers want to process. Jeff noted that bigger is often better because regardless of the amount of material, you would need the same amount of operators working at the processing facility. A demonstration project at the Cox Creek dredged material containment facility (DMCF), has been up and running since 2007. It would take approximately 4-5 years to permit and build a Susquehanna sediment management facility. There was also discussion on the legal aspect of the government subsidizing a commercial operation and if this would be cause for concern.

The HarborRock presentation is included as enclosure 3 to this memorandum.

6. Brinjac Engineering, Biological Dredging and Floating Islands, Presentation and Q&A - Stephen Zeller provided a presentation on the concept of Biological Dredging to augment/optimize any dredging sediment management strategy that is implemented. This technology would

complement a dredging solution, if implemented. Once installed this system could provide impacts to the sediment in 9-15 months. The biological dredging system can be installed in approximately 6-9 months to begin impacting sediments through reduction and compaction. The cost estimate is a capital investment of about $18 million and annual operations and maintenance cost of $1.011 million. There is potential for nutrient credits of about $1 million which could assist in offsetting annual operations and maintenance and/or capital costs.

The concept involves a three-fold approach: floating and submerged coral islands, laminar-flow diffusers and bacterial augmentation. Total area impacted would be 2 square miles with diffusers and 1 square mile with diffusers and floating wetlands/coral. The biological dredging system (coral/diffusers/bacteria) would be anchored to the river bottom along with large floating islands placed on the surface near dredging operations and this system would biologically dredge the sediments to uptake nutrients and pollutants reducing and compacting organic sediments to reduce the release of these constituents into the water column. This system would thereby reduce the impacts of dredging, by acting as an in-situ water quality treatment system and provide a compaction and reduction to the sediment layer, before dredging, so that dredging is ultimately more efficient and cost-effective.

The islands utilize an artificial wetland matrix made of inert recycled plastic that supports/allows biofilm growth and this along with the diffusers would support the establishment of biofilm and periphyton growth which benefits aquatic life. This biological dredging system can effectively reduce sediment overflows by compacting the sediment layer and potentially reducing the organic sediment layer making sediments less likely to move during storm events (not withstanding extreme storm events like Hurricanes Lee and Sandy). The primary benefit of this technology is during non-storm flow periods and the reduction of the sediment layer pre-and-post storm events to reduce overall sediment movement to the Bay.

The islands would require regular harvesting and the diffusers would require annual maintenance along with annual bacteria dosing to stimulate periphyton growth all of which incurs an annual operations and maintenance cost. A heavily laden storm flow with silt in it would overwhelm this system as the entire river itself is laden with silt.

Carl had several questions in regards to what data is available on the floating island technology and its impacts on nutrients/sedimentation in the water column.

Discussion ensued on the size/amount of islands that would be required for the amount of sediments that could potentially be dredged from this large river system (6000 acres or 250 Million sq ft of wetlands coral and 12,500 ft^2 of Leviathan Floating Wetlands) for the Conowingo Dam is estimated.

Steve noted that the biggest concern is not the size of the river but the flow. High velocities could impact the anchors of the floating islands (hydraulic analysis for this component is included in the estimated capital costs). As far as potential areas where islands could be placed, it could be anywhere in the lower Susquehanna River system, not just behind Conowingo dam. The benefits of biological dredging also include restoration of major fisheries, reduced water treatment costs for major water utilities on the river by improving water quality, reducing pollutants in the river, reducing TSS/TDS and increasing DO in the water column.

Claire noted that due to time, anyone with specific questions on the floating islands should be sent to her and she will work up a list of questions to transmit to Brinjac Engineering.

The Brinjac Engineering presentation is too large to include as an enclosure to this memorandum, however, it is posted on the LSRWA website at the following location: http://mddnr.chesapeakebay.net/LSRWA/Docs/Brinjac%20presentation%20092412%20and%20more.pdf

Data on nutrient removal capabilities of this technology and engineering studies to support the efficacy of this technology are included in the Brinjac Engineering presentation. A factsheet with additional information is included as enclosure 4 to this memorandum.

Additionally, a published article on floating islands entitled, "The ability of vegetated floating islands to improve water quality in natural and constructed wetlands: a review" and can be found at the following location: www.iwaponline.com

7. Innovative Reuse Committee (IRC) Update - Fran Flanigan noted that she is a consultant for the MPA and facilitates the Innovative Reuse Committee (IRC) which is a group that meets to evaluate ways to innovatively reuse dredged material from the shipping channels in Chesapeake Bay. She noted that in 2001, the MD legislature enacted a law banning open water placement of dredged material after 2010. Any material from the Baltimore Harbor is considered "contaminated" and must be treated as such when dealing with disposal and use of dredged material. Approximately 500,000 cubic yards of material needs to be managed annually. MPA is required to have 20 years of placement lined up.

Fran noted that HarborRock is first in line for innovative reuse implementation to process dredged material. A demonstration project has been set up at Cox Creek DMCF (as discussed in Section 5.) No major technical issues have arisen yet. Toxin levels look good and a minor air quality permit would be required.

Fran noted that there is a report available, *Independent Technical Review Team (2009). Sediment in Baltimore Harbor: Quality and Suitability for Innovative Reuse. An Independent Technical Review*, which the IRC uses as a guide. 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 authorities 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, the team assembled data and information to construct a frame for risk analysis and decision-making. The document has been uploaded to the LSRWA website located here:
http://mddnr.chesapeakebay.net/LSRWA/Docs/Dredge_ReportandAppendices_Print.pdf

There was discussion 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

2007 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?). Matt Rowe said that he could do this comparison between the results of the two reports.

Discussion ensued on sediment management options that could be evaluated including agricultural applications and landfill cover. There was also consensus that the entire lower Susquehanna River watershed including areas further upstream need to be focused on when thinking about where and how to manage sediments. The group agreed that bypassing needs to be evaluated in more detail as well as island restoration in the Bay or island expansion within Conowingo Reservoir. Fran noted that MD legislation limits this concept to the restoration of historic islands not the creation of new islands. A diversified/combination approach for sediment management should be evaluated. Agitation dredging and tactical dredging were also mentioned as potentially viable strategies.

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 sediment management strategies compiled from the literature search and discussion today so that this group can begin evaluating and screening sediment management strategies in more detail at the next meeting.

8. 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 coordinated by Claire for sometime in November.

Anna Compton,
Study Manager

Enclosures:
1. Meeting Agenda
2. Anna Compton Presentation
3. Jeff Otto Presentation
4. Brinjac Engineering- Biological Dredging Summary

LOWER SUSQUEHANNA RIVER WATERSHED ASSESSMENT
ALTERNATIVE BRAINSTORMING MEETING

MDE, Montgomery Park Building, Terra Conference Room
September 24, 2012

Meeting Agenda

		Lead
10:00	Welcome	O'Neill
10:05	Results of Literature Search	Compton/Bryer
10:20	Harbor Rock, Presentation and Q&A	Jeff Otto
10:50	Brinjack Engineering, Floating Islands, Presentation and Q&A	Stephen Zeller
11:20	Innovative Re-Use Committee Update	Flanigan/Blazer
11:30	Brainstorming	All
12:30	Next Steps	O'Neill
12:45	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
MDNR: Bruce Michael, Shawn Seaman
MGS: Jeff Halka
SRBC: John Balay, Andrew Gavin
USACE: Chris Spaur, Claire O'Neill, Anna Compton, Tom Laczo, Dan Bierly, Danielle Aloisio
ERDC: Carl Cerco, Steve Scott
TNC: Mark Bryer, Kathy Boomer
USEPA:
USGS: Mike Langland

Exelon: Gary LeMay, Kimberly Long, Tom Sullivan, Marjorie Zeff
Lower Susquehanna Riverkeeper: Michael Helfrich
PA Agencies: Patricia Buckley
Alliance for the Chesapeake Bay: Fran Flanigan
MPA: Dave Blazer
Harbor Rock: Jeff Otto

Lower Susquehanna River Watershed Assessment

Watershed/Reservoir Sediment Management Literature Search

Preliminary Findings

Date: September 24, 2012

Anna Compton

US Army Corps of Engineers
BUILDING STRONG®

Literature Search Purpose

- Review, analyze, and synthesize literature on managing watershed/reservoir sedimentation.
- Findings and lessons learned will be incorporated into refining sediment/nutrient management strategies for LSRWA.
- Help us Brainstorm Ideas.

Methodology

- Reviewed Sediment Task Force Findings
- Conducted Database Literature Search
  - Findings
  - Trends
  - Conclusions

Sediment Task Force

Sediment Task Force

Who were they?

- Met from 1999 - 2001
- Chaired by Susquehanna River Basin Commission
- Multi-agency, Multijurisdictional group
- Tasks:
  - *Review of existing studies*- Susquehanna sediment transport and storage;
  - Make *recommendations on management options* to address the issues;
  - *Symposium* of experts and policy makers; and
  - Recommend areas of *study, research, or demonstration*

Sediment Task Force
Findings (Dec, 2000)

1. Human influenced sediment loading is a problem.
2. Loads in early 1900's were 2-3 times larger (land use, BMP's, dams).
3. Benefits of dams will be lost once at steady state:
   - Increased loads
   - More scouring
4. Steady State ~ 20 years???
5. Sediment transport is a natural process that has been aggravated by human activity. Management focus: reduce human impacts.

Sediment Task Force

Findings Cont'd (Dec, 2000)

6. Sediment transport - aggravated by catastrophic storm events.
7. Reducing loads to local streams, rivers and lakes has value.
8. Decreasing loads over time will restore water quality and habitats
9. Need more knowledge of sediment and effectiveness of management options to support a comprehensive management strategy.

Sediment Task Force
Recommendations

Upland Management

- ► Agriculture Uplands
- ► Urban Uplands
- ► Transportation Systems
- ► Forestry
- ► Mining Uplands
  - • Reclaim/reforest abandoned mine land

Sediment Task Force
Recommendations

Riverine Management

- Stream Restoration & Stabilization
- Sediment Trapping Structures (Impoundments/dams)
- Sediment Transport Assessments (Monitoring and Modeling)
- Stream Bank/Channel Stability Assessments (Monitoring and Modeling)
- Riparian Buffers
- Natural & Reconstructed Wetlands

Sediment Task Force
Recommendations

Reservoir Management

- ~~***Sediment Bypassing***: ~~Would result in a base load condition that exceeds the current base load into the Bay. Counter to the currently accepted goal of reducing sediment input to the Bay.

- ~~***Sediment Fixing***~~: Would not mitigate scouring or change the amount of sediment passing through the system or add capacity.

- ~~***Modified Dam operations***~~: Unclear if this would accomplish anything in the interest of sediment control other than as a form of bypassing.

- ***Dredging:*** Supports study to maintain/increase trapping capacity.

Database Literature Search

Research Databases Used

- Google Scholar
- The Wall Street Journal
- ProQuest
- Academic Search Premier (EBSCO)
- ScienceDirect
- GreenFile (EBSCO)
- EnvironetBASE
- Agricola
- GEOBASE

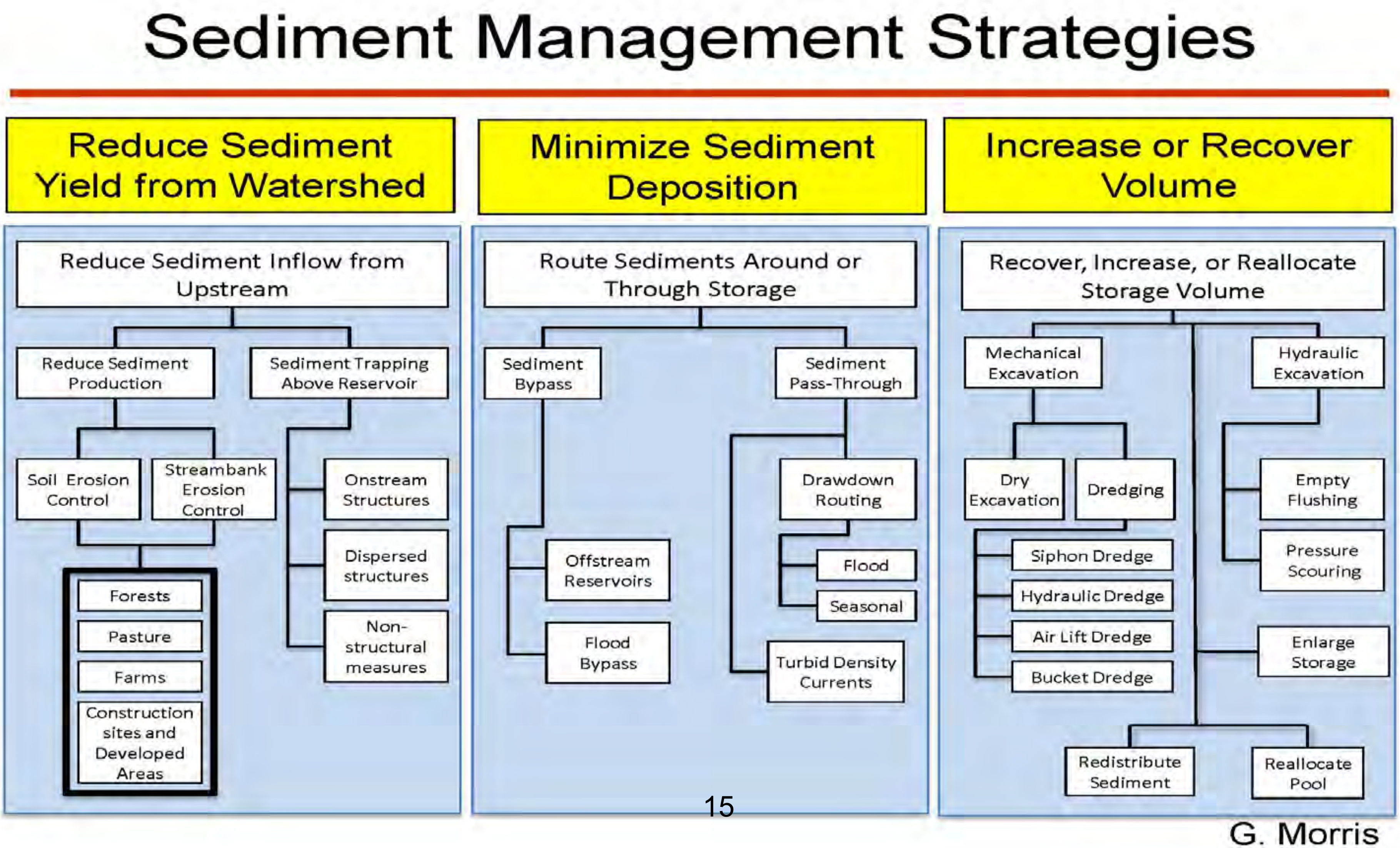
Literature Search Findings

- **100+ articles (National and International) were reviewed**
- **A sub-set were determined to be most relevant to sediment management and were summarized:**
  - **Studies/Modeling**
  - **Technology**
  - **Alternative Analysis**
  - **Recommendations**
  - **Implemented Actions**

Lit Search
Themes, Findings, Conclusions

- Reservoir sedimentation (declining storage) is a worldwide problem.
- Trends like climate change and population growth are exacerbating problem.
- Comprehensive, long-term sediment management is needed EVERYWHERE.
- New dams, have sediment management built in.

Lit Search
Themes, Findings, Conclusions



Lit Search
Themes, Findings, Conclusions

- **<u>Goals</u>** - What is driving the need for sediment management drives the solution:
  - Losing purpose/function of the dam (economics)?
  - Restoring natural sediment flow (environmental)?
- **<u>It's all about the sediment</u> -**
  - Where they are coming from?
  - Where they are depositing?
  - Sediment size and chemical characterization?
  - Contaminants; land-use history?
  - Erodability rate
  - Location and magnitude of sediment deposition downstream?
  - Value of sediments behind the dam?
  - Precipitation patterns: when is sediment transported?

Lit Search
Themes, Findings, Conclusions

- **Effectiveness** - How effective is strategy at improving sedimentation?
- **Economic** -
  - Capital costs for strategy?
  - Future operation and maintenance requirements?
- **Optimization/Adaptive Management** -
  - ✓ Modeling before implementation
  - ✓ Monitor effects after implementation
  - ✓ Adjust activities to optimize effectiveness
  - ✓ Continuously improve system performance

Lit Search
Themes, Findings, Conclusions

- **<u>Environmental</u>** -
  - Permitting requirements?
  - Impacts?
- **<u>Schedule</u>** -
  - How much time is required for solution to be implemented?
  - Long-term problems often need long-term solutions.
  - Implementation sequence: long and short-term implementation?
- **<u>Integrated sediment system management</u>**-
  - Multi-faceted problem requires multi-faceted solution; most have combinations.
- **<u>Benefits</u>** -
  - Costs incurred worthwhile?

Lit Search
Themes, Findings, Conclusions

Dredging (i.e. increasing or recovering volume)

- ► Operations and Maintenance
- ► Contamination
- ► Dredging can be reduced by using BMP's and finding the critical sediment producing watersheds from upstream.
- ► Tactical Dredging
- ► Beneficial re-use
  - Soil amendments (agriculture, mining etc.)
  - Habitat development/beach nourishment
  - Commercial (bricks, geotextile container fill groins, landfill capping, tiles, glass, cement blocks
- ► **Dredging is very expensive normally is a last resort; often creates new social and environmental problems**

Lit Search
Themes, Findings, Conclusions

By-passing - Routing sediments around or through storage

- **The technology to by-pass and transport sediments has been developed**
- **Long Distance Conveyance** hydraulic transport of through pipelines (>10 miles)
- **Hydrosuction sediment removal**
  - Dredging equipment with hydrostatic head over a dam to create suction at the upstream end.
  - Difference between water levels upstream and downstream of dam to remove sediment through a floating or submerged pipeline.
  - **Hydrosuction dredging,** deposited sediment dredged and transported downstream or to a treatment basin.
  - **Hydrosuction bypassing**, incoming sediment is transported without deposition past the dam to the downstream receiving stream.

Lit Search
Themes, Findings, Conclusions

By-passing Continued

- Pipeline diameter selection, and head size
- Environmental Impacts
  - Increased turbidity levels downstream?
  - Changes in water chemistry?
  - Impacts of sediment-removal upstream?
  - Regulatory agencies contacted early
- Upper limit of sediment concentration defined
  - Ecological aspects
  - Operational aspects
- Out-flowing sediment concentration regularly monitored and controlled.

LSRWA Goals and Objectives

1. **Evaluate strategies to manage sediment and associated nutrient delivery to the Chesapeake Bay.**
   - Strategies will incorporate input from Maryland, New York, and Pennsylvania Total Maximum Daily Load (TMDL) Watershed Implementation Plans.
   - Strategies will incorporate evaluations of sediment storage capacity at the three hydroelectric dams on the Lower Susquehanna River.
   - Strategies will evaluate types of sediment delivered and associated effects on the Chesapeake Bay.

2. **Evaluate strategies to manage sediment and associated nutrients available for transport during high flow storm events to reduce impacts to the Chesapeake Bay.**

3. **Determine the effects to the Chesapeake Bay due to the loss of sediment and nutrient storage behind the hydroelectric dams on the Lower Susquehanna River.**

Sedimen Management Using Light Weight Aggregate (LWA) Manufacturing

An Effective Solution for the Susquehanna River

Presentation to the Lower Susquehanna River Watershed Assessment Working Group

September 24, 2012

HarborRock

Presentation Content

1. Summary of Susquehanna River Sediment Situation
2. HarborRock Overview
3. LWA Sediment Management for the Susquehanna River
4. Summary of the HarborRock Innovative Reuse Demonstration for the Maryland Port Administration
5. LWA Overview
6. Photographs

HarborRock

Summary of Need

Hurricane Irene and tropical storm Lee bruise the Chesapeake Bay

Muddy waters

When deluges produced by Tropical Storm Lee forced officials to open the gates of the Conowingo Hydroelectric Dam, 4 million tons of built-up sediment gushed into the Chesapeake Bay, coloring the upper half brown, as seen in this satellite image taken Sept. 12.

Over 160 million tons of sediments are currently stored behind the Conowingo Dam.

There is essentially no sediment retention capacity remaining behind the Conowingo Dam;

Consequently, 3 million tons per year of sediment will flow unchecked into the Chesapeake Bay and;

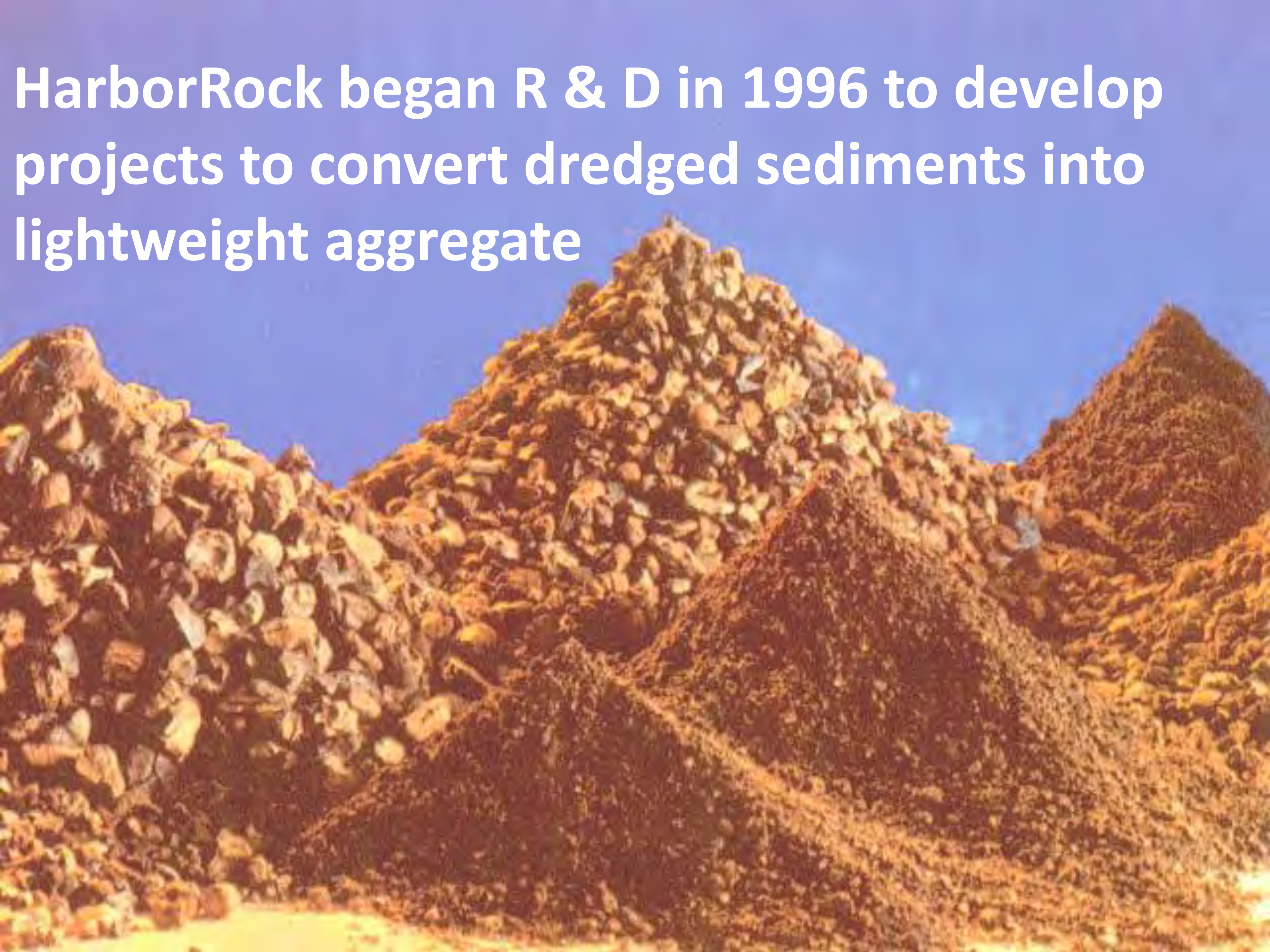
The nation's largest estuary and national treasure plus the region's economic vitality are in jeopardy

Unless immediate action is taken to stop sediments from reaching the Bay;

LWA Manufacturing is the most timely, practical and cost effective Sediment Management tool for this job.

HarborRock

HarborRock began R & D in 1996 to develop projects to convert dredged sediments into lightweight aggregate



HarborRock History with Sediment Reuse

Since 1996, HarborRock has Manufactured and Tested Structural Grade LWA Made from Dredged Materials at:

Technology and Business Plan Verification

Recommended by NJDEP's consultant, Louis Berger Inc., for disposal of materials dredged from Passaic River, NJ

Business model was validated in $500,000 Test Program funded in part by NJ Commission on Science & Technology using Delaware River dredged materials

"Best Alternative and Most Viable Business" for disposal of sediments from the Puget Sound, WA State Department of Natural Resources

Selected by Shaw Environmental Inc. as the preferred solution for the long term disposal of dredged material at Naval Station Mayport, Florida


HarborRock Holdings, Inc.

Executed $400,000 contract with Maryland Port Administration to prove reuse is a viable long term sediment management solution.

HarborRock

Technology and Business Partners

HarborRock has the resources needed to get the job done

ARCADIS U.S., Inc. (www.arcadis.com) Role: Development, Permitting, Engineering, Operations.

ARCADIS is an international company with 16,000 people worldwide and $2.7 billion in revenues and globally ranks among the top 10 management and engineering firms and top 3 in the environmental market.

Duane Morris, LLP (www.duanemorris.com) Role: Legal Advisor

Duane Morris LLP, a full-service law firm with more than 700 attorneys in the United States and around the world.

FLSmidth (www.flsmidth.com) Role: Process , Equipment Supplier and Process Efficacy Guarantor

FL Smidth is the leading supplier of equipment and services to the global cement and minerals industry. They employ over 10,000 people and have the largest installed base of kilns (over 3,000) of any company in the world.

Roberts & Schaefer Co. (ww.r-s.com) Role: Engineering, Procurement and Construction

R&S provides mechanical, civil, electrical, and process engineering services for mineral and energy industries globally. R&S is a KBK (www.kbr.com) company. KBR has 35,000 employees and over $9 billion in revenues.

Scully Capital Services Inc. (www.scullycapital.com) Role: Financial Advisor

Provide investment banking and advisory services in the environmental and infrastructure industries.

Video Summary of the Successful Conversion of Dredged Material to Lightweight Aggregate (LWA)

HarborRock

Why & How Sediment Management Using LWA Manufacturing is an Effective Solution for the Susquehanna River

HarborRock

LWA Sediment Management Qualifiers

1. **All Equipment and Methods Being Proposed are Commercially Available, Currently In Use, or Have Already Been Performed**

2. **HarborRock's Technology and Business Model have been Tested and Validated for Over a Decade**

3. **There are Guarantees Available for all Construction Costs and Process Inputs and Outputs**

4. **It Will Take 4-5 Years To Permit & Build a Susquehanna LWA Sediment Management Facility**

LWA Sediment Management Concept Summary

Use Sediments as the Raw Material to Make Aggregate that is Sold and the Revenue Earned is Used to Offset Costs

1. **Install Hydraulic Dredge in Conowingo Reservoir**
2. **Extract 3 Million Tons/Year of Sediments from the River and Transport Material Via Pipeline to LWA Manufacturing Plant**
3. **Produce 2.7 Million Tons/Year of LWA Using 3 Gas Fired Kilns**
4. **Return Water to the River Through Electricity Producing Turbines**
5. **Employ 160 Full Time in the LWA Facility**
6. **Transport LWA via Truck, Rail and Barge**

HarborRock

LWA Market Considerations

2.7 million tons of LWA will be produced per annum

The LWA will be marketed & priced to:

1. **Demonstrate LWA's enhanced performance over dense aggregates**
2. **Compete with dense aggregate in multiple market sectors: structural concrete, asphalt chip seal, etc.**
3. **Grow demand for LWA in developing applications (e.g. green roofs, horticulture)**
4. **Allow for freight costs to distant markets**

HarborRock

LWA Sediment Management Economics

The typical business model for a HarborRock LWA Sediment Management Facility consists of 2 Expenses and 2 Revenue Sources. Revenues must balance Expenses.

Expenses: **1) Operating Costs (fuel, labor, profit etc.)**
2) Capital Repayment (debt)

1. **Operating Costs are generally stable and predictable**
2. **Capital Repayment is dependent on how the project is structured & ownership. Generally public funds/ownership are less expensive than private funds**

Revenue : **1) LWA Sales**
2) Sediment Management Fee ($/ton)

1. **LWA Sales revenue is generally stable and predictable**
2. **The Sediment Management Fee makes up any revenue needs, <u>If Necessary</u>**

A conservative estimate of the Sediment Management Fee for the Susquehanna River is $20/ton - $25/ton.

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Comparative Economic Analysis

"Haul Away & Dump" is the only alternative to LWA Sediment Management as a 100% solution for management of the Susquehanna River sediments

"Haul Away & Dump" requires the addition of a "Binding Agent" to solidify the sediments for transport

Sediments requiring removal –	**3.0 millions tons/year**
Binding Agent @ 50% –	**1.5 million tons/year**
Total Disposal Amount -	**4.5 million tons/year**
Estimated All In "Haul Away & Dump" Cost -	**$100 per ton**
Total Annual Cost for "Haul Away & Dump"-	**$450 million/yr**
LWA Sediment Management Fee -	**$20 -$25/ton**
Sediments removed–	**3.0 millions tons/year**
Total Annual Cost for LWA Sediment Management	**$60 - 75 million/yr**

Over $1 Million/Day Savings Plus the Benefits of Jobs and Long-Term Capital Investment

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Potential Siting Area
Area available for facility sites is limited only by the hydraulic pumping distance
5 miles
Nominal Area for Sites
125 square miles – per side
Holtwood
15 miles
Conowingo
10 miles
Cecil
Havre De Grace
Harford
Image U.S. Geological Survey
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Image PA Department of Conservation and Natural Resources-PAMAP/USGS
Imagery Date: 10/7/2011
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Next Steps to Develop Susquehanna LWA

Immediate Actions, On Parallel Fronts, are Needed to Address The Critical Issue Upon Us or We Will Be Overtaken by Inevitable Events that have Catastrophic Consequences

1. **Form a Decision Making Committee to engage with HarborRock to establish budget, plan & source funds for project implementation**

2. **Undertake a comprehensive Demonstration Program comparable to the one HarborRock performed for the Maryland Port to:**
   a) **Obtain permitting data**
   b) **Determine aggregate quality**

3. **Begin identification of suitable sites**
   a) **>50 acres**
   b) **Access to roads, rail, barging, infrastructure etc.**

Summary of the Innovative Reuse Demonstration Program for the Maryland Port Administration

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Advantages to the MPA from Using LWA Manufacturing for Sediment Management

Fully Permitted, Renewable Capacity Disposal Site Inside the Harbor

1) Eliminates expense & risk securing other disposal sites
2) Reduces dredged material haul costs
3) Requires small footprint – nominally 15 acres

Operational Year Round with Scale Up Potential

1) 365 days per year operation, rain or shine
2) Initial System Capacity of 500,000 CY/yr or more
3) Rapid scale up to >1.0 million CY/yr. without increases in site acreage

Handles Clean or Contaminated Materials

1) Material segregation not required
2) Verifiable contaminate destruction > 99.99 % effective
3) No Mixing or Blending with other products
4) No waste products

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Advantages to the MPA from Using LWA Manufacturing for Sediment Management

Financial

1) Innovative Reuse cost is competitive & predictable
2) Enables long-term budgeting & forecasting
3) Pay for IR only as the dredged material is processed – no capital outlay

Job Creation

1) 200 man-years of construction employment
2) 65 ongoing family wage jobs in operations
3) 50 ongoing transportation related jobs
4) 345 indirect jobs @ 3:1 multiplier

Capital Investment & Taxes

1) Over $75 million manufacturing facility constructed

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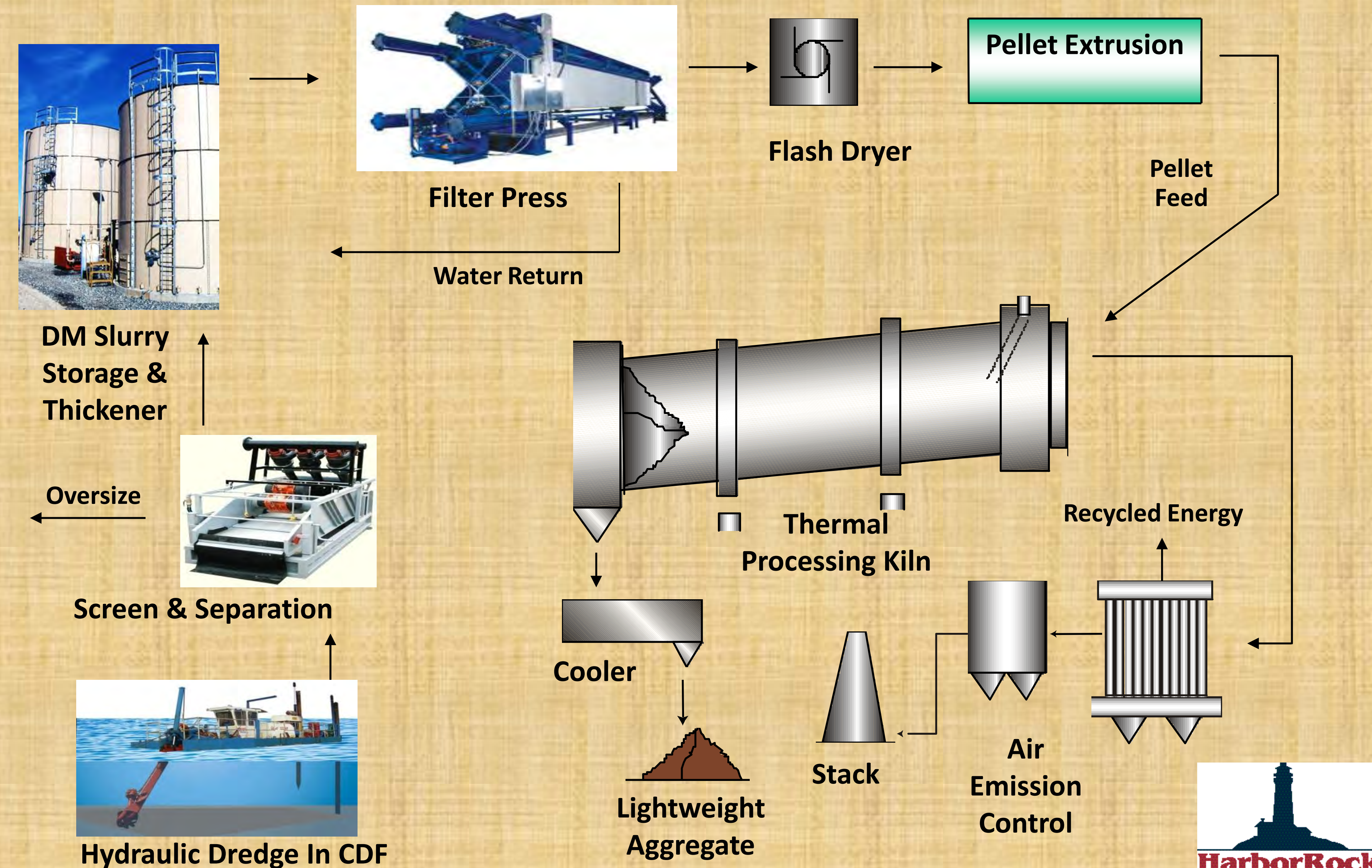
HarborRock - Simplified Process Flowsheet



Scope of Innovative Reuse Demonstration

All key aspects of the HarborRock LWA process were tested and demonstrated

1) **Chemical & Physical Analysis of DM, Cox Creek Water, Effluent & LWA**

2) **Effectiveness of Dredged Material Dewatering with Filter Presses**

3) **Dredged Material Drying Operation (natural gas)**
   a) Mass & Energy Balance, b) Emissions Testing

4) **Pilot Scale LWA Production (approx. 5 tons)**
   a) Mass & Energy Balance, b) Emissions Testing

5) **LWA and Concrete Masonry Block Testing per ASTM standards**

6) **Engineering**
   a) Equipment Configuration, b) Air Pollution Control Design,
   c) Mass & Energy Balance, d) Capital & Operating Costs

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Overview of Demonstration Study Results

Hydraulic Dredge Performance Verified **(Ellicott Dredges, LLC)**

- ✓ Enabled sizing of tanks, plant flow rates, solids content

Screen & Separation Efficiency Determined **(DEL Tank/Krebs Engineers)**

- ✓ Enabled equipment sizing, reject rates, CAPEX and OPEX

Filter Presses & Thickener **(FLSmidth – Dorr Oliver Emico)**

- ✓ Enabled sizing, flocculant dose, sizing, CAPEX, OPEX and return water testing

Extrusion Testing **(J.C. Steele & Sons, Inc. and FLSmidth)**

- ✓ Verified small extrusions produce quality LWA - less final crushing needed

Air Emissions Data Obtained **(Peregrine Technical Services, LLC)**

- ✓ Enabled air pollution control system design for permitting

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Overview of Demonstration Study Results

Chemical & Physical Data Obtained **(Fredericktowne Labs Inc.)**

- ✓ Below detection limits for all organics and metals in solids
- ✓ Minor variations in metals concentrations from basin water input and return water from thickener – data currently under analysis by FLSmidth

Aggregate Quality Confirmed **(Construction Technology Laboratories, Inc.)**

- ✓ Meets and exceeds all ASTM C330 and C331 requirements

Block Testing **(National Concrete and Masonry Association & Ernest Maier, Co)**

- ✓ NCMA, in conjunction with Ernest Maier, Co., confirms masonry blocks made using only 25% HarborRock LWA meet and exceed ASTM C90 requirements

Engineering and Cost Evaluations Completed **(FLSmidth & Scully Capital)**

- ✓ Pollution control system design for permitting
- ✓ Full Scale plant Capital & Operating Expenses developed

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Overview of Lightweight Aggregate

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What is Lightweight Aggregate?

1. Volcanic stone - pumice, lava rock;

2. Shale, slate or clay (dredged material) expanded in rotary kilns that operate at temperatures over 2,000°F.

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LWA provides more than twice the volume for the same weight as conventional aggregates

1 lb. Soil

1 lb. Gravel

1 lb. Lightweight Aggregate

1 lb. Limestone

1 lb. Sand

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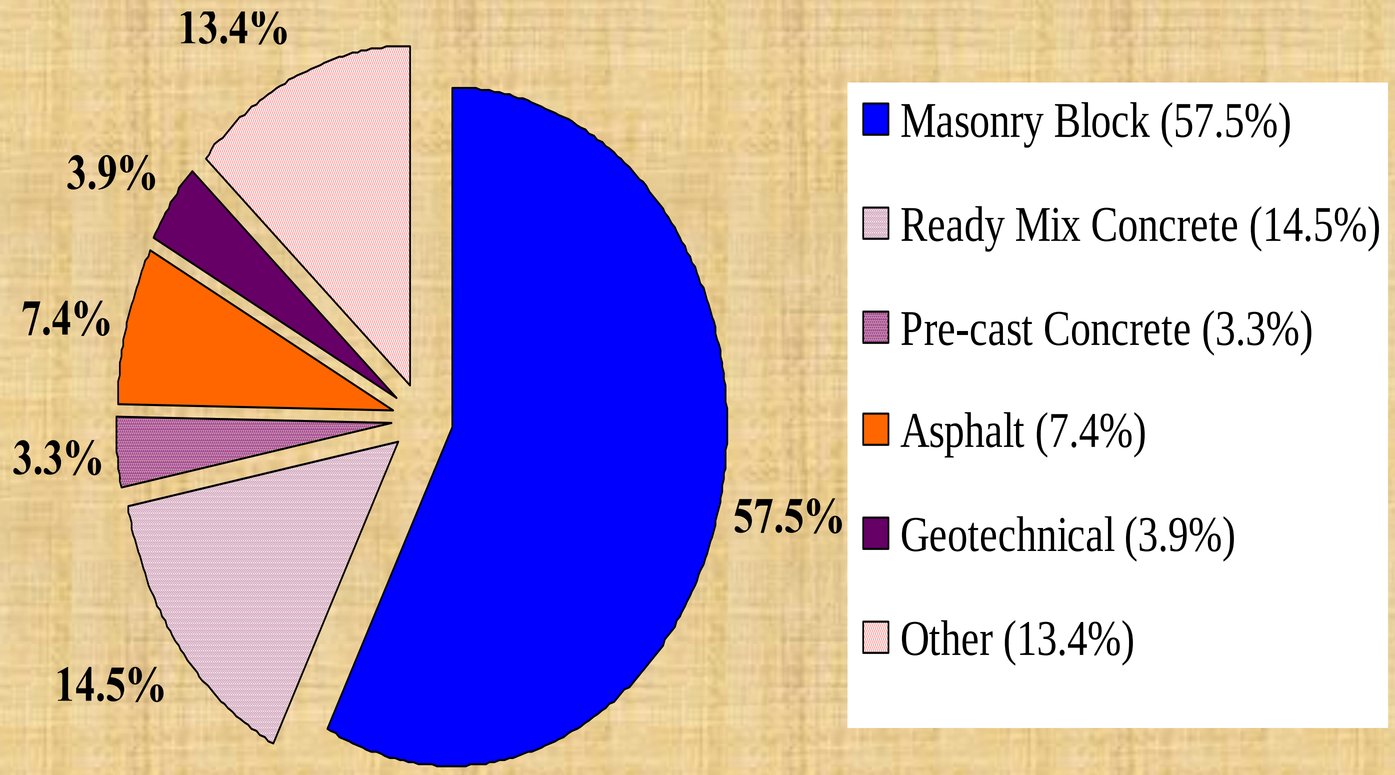
LWA Market Segments



Advantages of HarborRock's LWA

1. **Is Extruded & Highly Engineered:**
   - Uniform and consistent properties

2. **Meets ASTM standards**
   - C330 LWA for Structural Concrete
   - C331 LWA for Concrete Masonry Units
   - C90 for Concrete Masonry Units

3. **Is Inert & Highly Marketable:**
   - Complete destruction of organic contaminants
   - Metals immobilized magnitudes below RCRA TCLP limits
   - Not blended or mixed with other products
   - Eligible for LEED Certification

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Photographs

The following are photographs taken of various aspects of the HarborRock process including:

- kiln test equipment;
- LWA samples;
- the Maryland Port Administration's Cox Creek Dredged Material
- Containment facility
- hydraulic dredging.

LWA TEST SAMPLES

SMALL DIAMETER EXTRUSION WORK

EXTRUDER OPERATION

FURNACE TEST SAMPLES

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BATCH KILN TEST UNIT

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PILOT ROTARY KILN (3’ x 50’)

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Greater Port of Baltimore

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The MPA's Cox Creek Dredged Material Containment Facility (DMCF)

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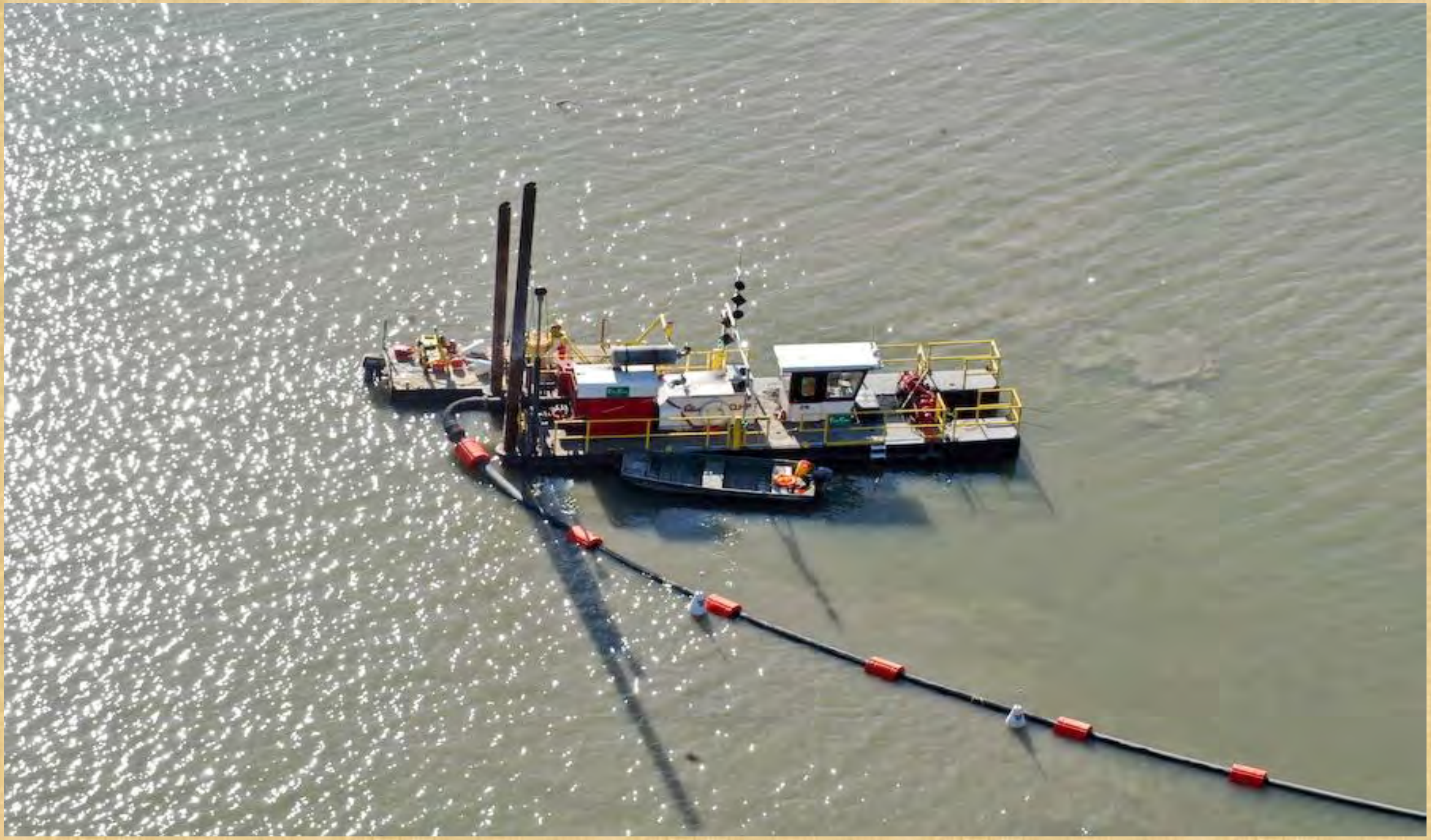
Hydraulic Dredging



Over 125 years design/build experience in hydraulic dredges; two manufacturing plants in North America – one in Baltimore, MD

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Brinjac Engineering, Biological Dredging and Floating Islands- Biological Dredging to augment/optimize any sediment dredging management strategy that is implemented for the Conowingo Dam Pool or any other Dam reservoir on the Lower Susquehanna River. This technology would complement the HarborRock solution (which is a beneficial reuse option for the dredged solids) as this system (biological dredging) can be installed immediately and provide reduction impacts to the sediment in less than 9-15 months (permits would require 6 months to submit and approve) while at the same time this system can be then moved as the dredging would move from area to area of the Conowingo Dam Pool and other areas to proceed the dredging. The cost estimate includes a one-time capital investment of about $18 million and annual O&M of $1.011 million and annual return on investments (ROI) including nutrient credits (>$1 million / year) which could offset annual O&M costs and possibly even capital costs (See ROI list below). One important note is that the biological dredging option could possibly reduce the sediment layer by as much as 6-8 inches per year in a 1 square mile area which would total some 500,000 to 800,000 tons of sediment biologically dredged into living systems and microbe and fish life. While not close to the 3 million tons that comes down river annually, it still provides a positive potential impact. The concept involves a three-fold approach: floating wetland islands and submerged coral wetlands, laminar-flow diffusers and bacterial augmentation. The biological dredging system (islands-coral/diffusers/bacteria) would be anchored to the river bottom along with large floating islands placed on the surface near dredging operations and this system would biologically dredge the sediments to uptake nutrients and pollutants, increase water quality by adding oxygen and stimulating the proper bio-life while providing artificial reefs for the bacteria/aquatic life to thrive (coral/islands) and reduce and compact organic sediments to reduce the release of these constituents into the water column. The islands utilize an artificial wetland matrix made of inert recycled plastic fiber that supports/allows biofilm growth and along with the diffusers would support the establishment of biofilm and periphyton growth which leads to healthy eco-systems/fish and ultimately results in biologically dredging the sediment layer by using organics in the sediment layer as a food source for bacteria to consume and this leads to compaction/reduction of the sediment by removing the organic constituents and oxidizing anaerobic gasses. This biological dredging system can effectively reduce sediment overflows at the Conowingo Dam by compacting the sediment layer and potentially reducing the organic sediment layer so that it is no longer diffuse and it may even be potentially reduced in total volume and thereby less likely to move during storm events (not withstanding events like Hurricanes Lee and Sandy which would overwhelm any biological dredging system). The primary benefit of this technology is during non-storm flow periods in the river and the reduction (via bacterial degradation) of the organic sediment layer to reduce sediment movement to the Bay.

The size and amount of islands that would be required for the amount of sediments that could potentially dredged from this large river system would be in excess of 6000 acres of coral and more than 12,000 ft2 Leviathan large floating islands and more than 2 square miles of diffusers. The biggest concern is not the size of the river but the flow. High velocities could impact the anchors of the floating islands and thus hydraulic analysis for this risk component is included in costs. The benefits of biological dredging reach beyond the sediment dredging to include restoration of major fisheries in the River, enhancement of health of the river system (which may be a major cause of the reduced shad viability from Conowingo to Holtwood). The floating islands/diffusers systems also have direct impacts on reduced water treatment costs for major water utilities on the river by improving water quality, reducing pollutants in the river, reducing TSS/TDS and increasing DO in the water column. The islands would require regular harvesting and the diffusers would require annual maintenance along with annual bacteria dosing to stimulate periphyton growth all of which incurs an annual operations and maintenance cost.

Return on Investment for this technology would include:

A. Generation of phosphorous and nitrogen nutrient trading credits through in-situ reduction of nutrients in the river using floating islands matrix and diffusers to grow the proper bacteria which are effective at nutrient removal and then ultimately growing fish which through harvesting can lead to nutrient removal as well. Generation of nutrient credits is based on biological uptake of nitrogen and phosphorous as shown in both lab bench scale tests, empirical testing in real world applications (case studies) and in wastewater applications (Brinjac Engineering). With 6000 acres of coral and diffusers and 12,500 square feet of

Leviathans this amount to 40,300 lbs/year of total phosphorous (TP) and 310,000 lbs/year of total nitrogen (TN) removed biologically which at a cost of $3/lb TP and $4/lb TN equates to ROI $1.3 million/year.

B. Compaction and potential reduction of sediment layers supporting a more efficient conventional dredging program and reduced overflow of sediments during storm flows at the Dam. (As stated above this ROI is based on the potential to actual reduce sediment layers in the Conowingo Dam Pool: biologically dredge up to 6 inches per year of sediment through bacterial degradation (based on case studies – real world applications) which for a 1 square mile area of application would equate to about 500,000 to 800,000 tons of sediment removed and converted into aquatic life and bacteria). Based on current costs for excavation – as reported by Excelon of $48 million for dredging 3 million ton of material (not including disposal costs) – this would equate to about $7.68 million in ROI based on annual voided dredging costs. Payback alone if this reality bears fruit would be less than 2.5 years. This is similar to digesting sludge in a WWTP using bacteria and is generally well documented. We use bacteria to degrade the organics in the sediment.

C. Reduced water utility treatment costs by reducing algae, decreasing pollutants, increasing DO and decreasing TSS/TDS in the water column for nearby utility withdrawals. (Placement of the islands would be in proximity to these withdrawals as much as is possible). ROI – unknown but possibly quite large.

D. Reduced costs for utilities using river water for non-contact cooling water through elimination of algae and other contaminants that require costly treatment before use as a non-contact cooling water. (See comment in item C. – proximity is the key) ROI again unknown but potentially quite large as utilities may not need to treat with chemicals as heavily. Savings in chemical and maintenance costs. (Note – Excelon uses about 250 MGD so this impact could be quite significant).

E. Immediate restoration of water quality to the river to include sources of food and nurseries to sustain growth of fisheries along with the potential to increase the viability of the shad fisheries in the Conowingo Pool. (Increased fisheries because the Floating Islands and Coral act as a "artificial reef" so to speak and the diffusers add needed oxygen to the water column which together stimulates aquatic food web growth and fisheries enhancement). Could have dramatic positive impact on the shad fisheries in the Susquehanna River.

F. Reduction in pollutants in the sediment layers through biological dredging. (ROI here is that before dredging takes place the negative impacts of dredging are reduced through this biological dredging operation to reduce sediment pollutants. The ultimate benefit is the Bay ecosystem.)

G. Elimination of dead spots in the river by providing dissolved oxygen from the bottom of the pool to the top. (ROI here is most likely the water utilities and the fisheries impacts).

H. Increased periphyton growth and ultimately fish/aquatic organisms which would equate to removal of phosphorous nutrients. Increased fisheries due to increased food sources increased DO and reduced pollutants in the water. (ROI – the potential to turn the lower Susquehanna river back into a world class fishery is tremendous – Pa Fish and Boat Commission reports indicated that young small mouth bass mortality is very high and that shad are not moving through the Conowingo Pool – both of these issues would be positively impacted by the Biological Dredging as the health of the entire river ecosystem is impacted. Again – the application of this technology/solution to other lakes (behind dams) on the Lower Susquehanna would greatly impact this issue as well.

The technology is sustainable and has a very low carbon footprint related to produced results, beneficial to the river itself and presents no environmental impacts. Permitting would be straightforward with discussion already started with MDE and the PaDEP concerning joint permit applications and other permits needed for this system. The technology has the ability to meet the USACE system-wide approach for application up and down the river and provide ROI with the potential to offset O&M as well as capital costs.