Innovative Ecological Engineering BMP's

and Their Application Towards the Chesapeake Bay Cleanup Effort

Kevin Nunnery
Biohabitats Inc.

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Background

Case Studies

Floating Wetlands

Shoreline Management

Algal Flow-way Technologies

Original artwork for Biohabitats by Sofya Korash

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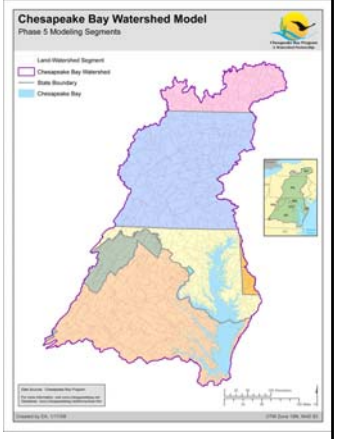

- 1967-Chesapeake Bay Program
- 1972-Clean Water Act
- 1987-Chesapeake Bay Agreement
- 1993- Ag. Nutrient Reductions
- 1994-CBP's Buffer Program
- 2003- EPA's Bay Water Quality Criteria
- 2010- EPA Establishes TMDL's
- 2011- DC MS4 Permit Requires Gr. Infr.
- 2014- C Bay Watershed Agreement- All Watershed States Sign-NY , PA, DE, WV, MD, DC, VA

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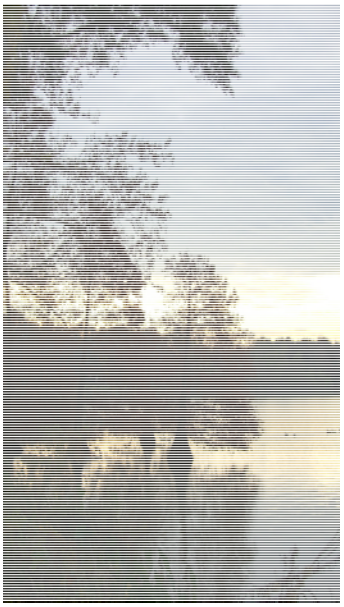
Background

The CBP is a regional partnership that directs Chesapeake Bay restoration and protection. Partners include federal and state agencies, local governments, non-profit orgs. and academic institutions. The CBP unites leaders and experts from a vast range of agencies and organizations. Each Bay Program partner uses its own resources to implement Bay restoration and protection activities. Partners work together through the Bay Program's goal teams, workgroups and committees to collaborate, share information and set goals.



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The Bay Program partnership includes:

- 19 federal agencies
- Nearly 40 state agencies and programs in Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia and the District of Columbia
- Approximately 1,800 local governments, represented through the Local Government Advisory Committee
- More than 20 academic institutions, represented through the Scientific and Technical Advisory Committee
- More than 60 non-governmental organizations, including businesses, non-profits and advocacy groups

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The CBP uses loading estimates to quantify expected amounts of nutrients (nitrogen and phosphorus) or sediment loads to water from specific land uses or point sources and makes adjustments based on an estimate of the effectiveness of a best management practice (BMP). BMP Expert Panels are convened to develop the BMP effectiveness estimates and the Water Quality Goal Implementation Team (WQGIT) is responsible for approving the loading rate reductions, and percentage adjustments to these rates, used in the Chesapeake Bay Watershed Model (CBWM). Since the definitions and values used for both loading and effectiveness estimates have important implications for the CBP and the various partners, it is critical that they be developed in a process that is consistent, transparent, and scientifically defensible.

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Expert Panel Evaluations ⇒ Assessments of New Technologies

- Floating Treatment Wetlands
- Shoreline Management
- Algal Flow-way Technologies
- Forested and Grassed Buffer Removal Rate Reassessment
- Urban Tree Canopy Expansion

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Floating Treatment Wetlands (FTWs) are rafts of wetland vegetation that are deployed in stormwater ponds with a permanent pool of water.

- Much of the improved performance was due to improved settling conditions in the pond after the retrofit, especially by the underwater root network. Some denitrification was also observed within the rafts.
- Nutrient uptake by the plants was found to be a significant pollutant removal mechanism. Pond removal rates also increased when more raft coverage was added.
- Frequent maintenance required to ensure FTW performance, consequently the panel recommended a three year credit duration (with an approved maintenance plan), which is renewable if a field inspection confirms that the retrofit is still meeting its FTW performance criteria.

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Incremental Pollutant Removal Rates for FTW Pond Retrofits					
Pollutant	Raft Coverage in Pond				
	10%	20%	30%	40%	50%
TN	0.8%	1.7%	2.5%	3.3%	4.1%
TP	1.6%	3.3%	4.9%	6.5%	8.0%
TSS	2.3%	4.7%	7.0%	9.2%	11.5%

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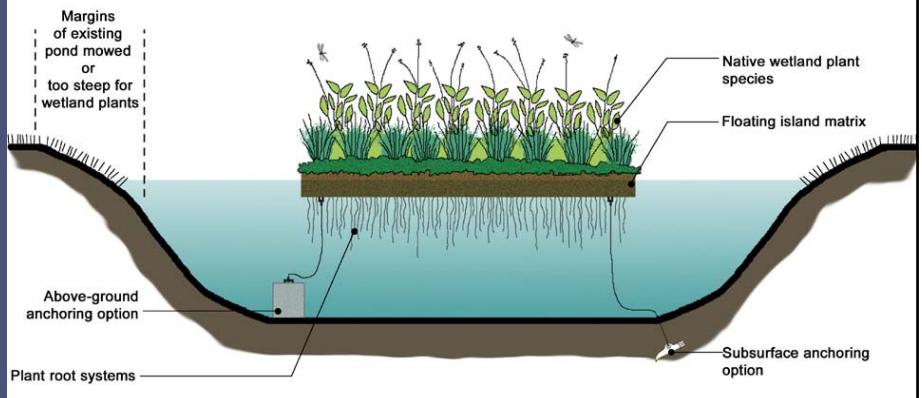

TAMU-TX Coastal Watershed Program

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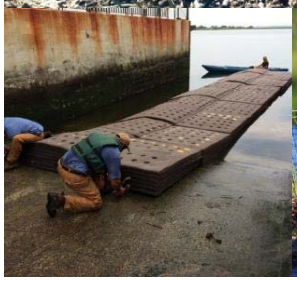

Floating Islands | NYCDEP wave attenuator pilot project

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Shoreline Management

Expert Panel developed four general protocols to define the pollutant load reductions associated with individual shoreline management projects plus a default rate for non-conforming projects (optional).

Protocol 1: Sediment Prevention

Protocol 2: Credit for Denitrification

Protocol 3: Credit for Sedimentation-sediment accretion

Protocol 4: Marsh Redfield - represents the nitrogen and phosphorus that is biologically and chemically unavailable to nearshore waters and Chesapeake Bay due to vegetative processes.

Default Rate: generally for hardening projects that strictly reduce erosion, without a vegetation component

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Protocol	*Name*	*Units*	*Pollutants*	*Reduction Rate **
1	Prevented Sediment*	Pounds per year	Sediment	• Measured TSS in sediment prevented. • Calculated based on shoreline erosion with reductions for sand content and bank instability
2	Denitrification	Pounds per year	TN	• Measured TN removal for denitrification rate associated with vegetated area. • 85 lbs TN/acre/yr
3	Sedimentation	Pounds per year	Sediment and TP	• Measured TSS and TP removal rates associated with vegetated area. • 6,959 lbs TSS/acre/yr • 5.289 lbs TP/acre/yr
4	Marsh Redfield Ratio	Pounds per year	TN, TP	• Measured TN and TP removal rates associated with vegetated area. • 6.83 lbs TN/acre/yr • 0.3 lbs TP/acre/yr
	Default Rate	Pounds per year	Sediment	• 164 lbs TSS/lf/yr MD, DE, DC • 42 lb TSS/lf/yr VA

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Shoreline Management Practice	**The Practice Must Meet these Criteria for TMDL Pollutant Load Reduction[1]**
Living Shoreline – a) nonstructural; b) hybrid system including a sill; and c) hybrid system including a breakwater	1. The site is currently experiencing shoreline erosion or is replacing existing armor. The site was graded, vegetated, and excess sediment was removed or used.[2] AND 2. When a marsh fringe habitat (a or b) or beach/dune habitat (c) is created, enhanced, or maintained.
Revetment AND/OR Breakwater system without a living shoreline	1. The site is currently experiencing shoreline erosion, AND 2. A living shoreline is not technically feasible or practicable as determined by substrate, depth, or other site constraints. AND 3. When the breakwater footprint would not cover SAV, shellfish beds, and/or wetlands.
Bulkhead/Seawalls	1. The site is currently experiencing shoreline erosion. AND 2. The site consists of port facilities, marine industrial facilities, or other marine commercial areas where immediate offshore depth (e.g., depths deeper than 10 feet 35 feet from shore) precludes living shoreline stabilization or the use of a breakwater or revetment.

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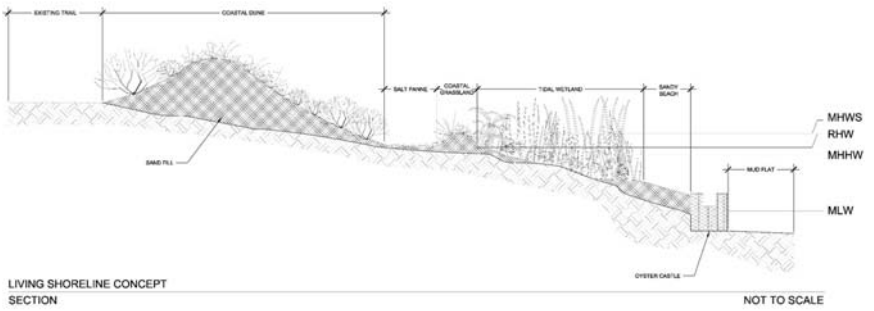

Living Shorelines-Soft

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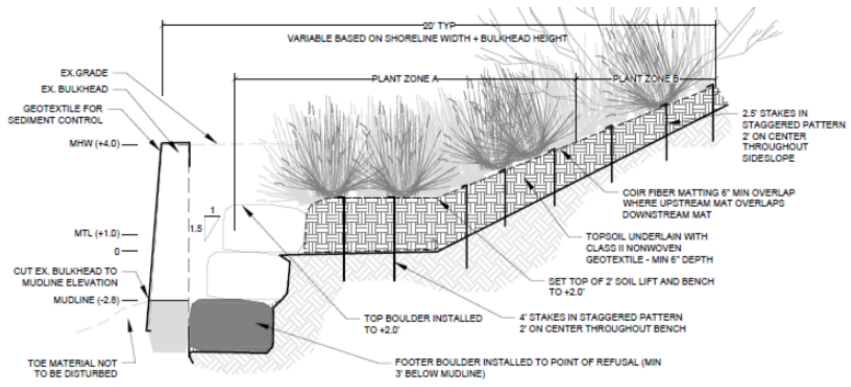

Living Shoreline-Hard

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Algal Floway Technology

AFTs are inclined (typically 1-2%) systems designed to improve water quality using natural algal assemblages that accumulate on screens or other substrate. In typical AFTs analyzed by the Expert Panel, nutrient-laden water is conveyed from a nearby ambient water source into the upslope end of the raceway and allowed to flow across the screens to a down-gradient outlet. Over time, algae from the ambient waters naturally colonize the screens and assimilate nutrients from the overlying water into algal biomass. This algal growth is strongly dependent upon temperature and light.

The algae are regularly harvested and the accumulated algal biomass can be used for biofuels, compost, omega-3 oils, fertilizer, soil amendments, or animal feed. The nitrogen, phosphorus, and sediment in the accumulated biomass is thus removed from the ambient source waters and prevented from entering adjacent waterways.

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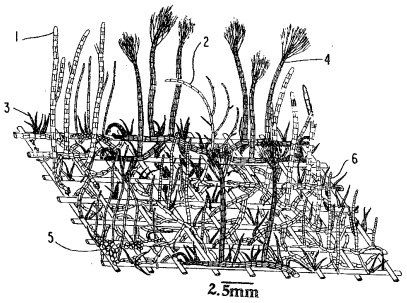

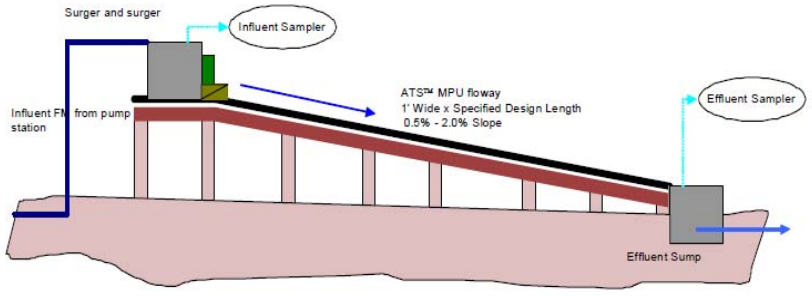

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- **Nutrient removal calculation:**
- Nutrient removal rate = biomass production rate x nutrient content of biomass
- *grams nutrient/m2/day= grams dry weight/m2/day x grams nutrient/grams dry weight*
- Typical biomass production rates for ATS ™ in the Chesapeake Bay region range from 10 – 35 grams dry weight/m2/day and typical nutrient contents are 3-5% nitrogen and 0.3-0.5% phosphorus.
- ***A unique quality of the ATS ™, relative to other BMPs, is that nutrient removal is quantifiable and easily verifiable.***

Table 1. Default Nutrient and Sediment Reductions Associated with Algal Flow Way Technology BMPs

Practice	TSS Removal (lbs)	TN Removal (lbs)	TP Removal (lbs)
AFT	3,219	545	45

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Conclusions

- To increase gains in water quality improvement, new techniques must be developed (innovative ideas)
- Openness to assessing and applying new techniques can equip State and local governments with more potential solutions to permit requirements

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Kevin Nunnery
Senior Ecologist
knunnery@biohabitats.com

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