Clean Water Optimization Tool

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2015 North Country Stormwater Tradeshow

Queensbury, NY

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We Work Here.....

- National non-profit 501(c)3 organization
- 21 staff
- Offices in MD, VA, NY, PA

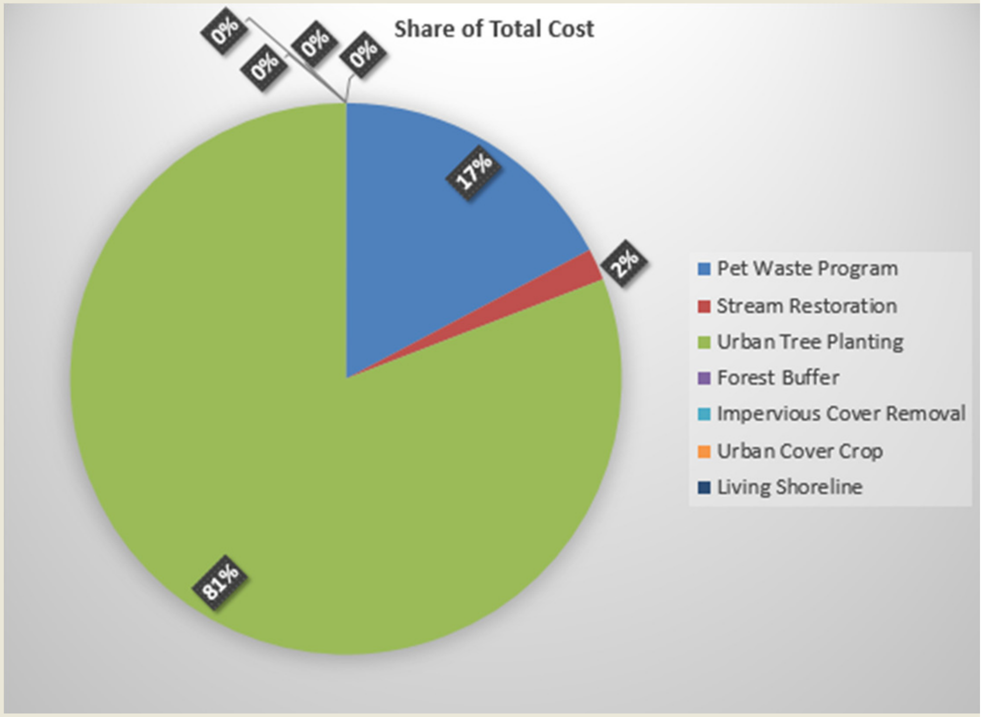
What we do

- Distill research into practical tools
- Provide local watershed services
- Train others to manage watersheds

Clean Water Optimization Tool

Overview

- Spreadsheet-based Tool
- Developed for the Eastern Shore of Maryland
- Pilot areas in 4 Counties in this region
- Planning tool designed to help communities achieve water quality and other goals at the lowest cost possible.



Center for Watershed Protection

Clean Water Optimization Tool

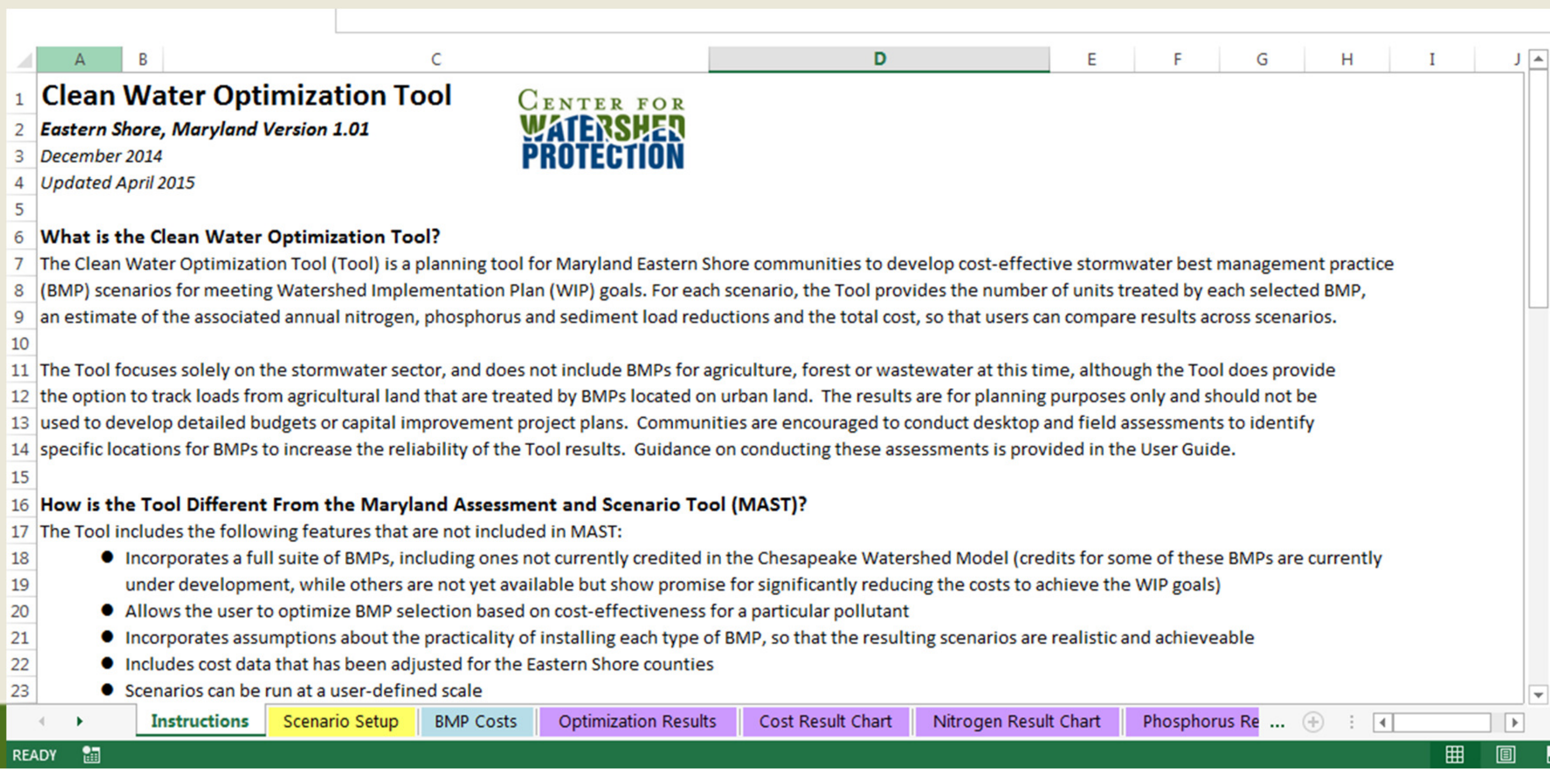
Overview

- Tool Can Be Used To:
  - Help the user find the least expensive way to meet a water quality goal.
  - Meet multiple goals for the lowest price (currently TN and TP)
  - Incorporate weighting to select "favorite" practices.

Clean Water Optimization Tool

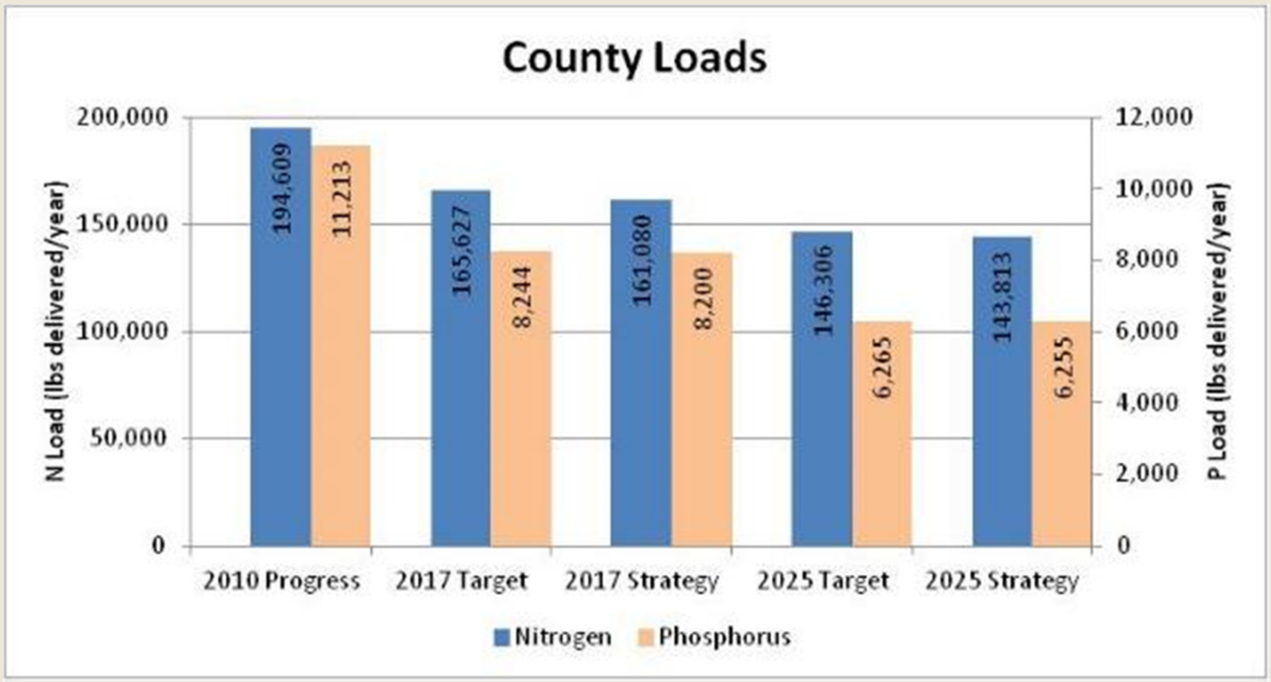
Overview

- Elements of the Tool
  - Set up the Scenario
  - Enter BMP Cost Data
  - Optimization Results



Cost for Water Quality Goals are all over the place

Urban Sector Bar Graphs Representing TN and TP Loads for 2010 Progress, 2017 Interim Strategy and Target, and 2025 Final Strategy and Target.



Source: MDE Nutrient Allocation Files (CBP Model 5.3.2.), MDE prepared 2010 Progress MAST loading decks, and the Core Planning Team Loading Decks

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Clean Water Optimization Tool

Background and Importance of This Work

Cost of Achieving Goals with Stormwater Practices is Staggering

BMP Name	Unit	Pre-Construction Costs	Construction Costs	Land Costs	Total Initial Costs	Total Post-Construction Costs	Total Costs over 12 Years	Average Annual Costs over 12 years
Bioretention/raingardens	Acres	$6,920,211	$27,680,843	$2,214,467	$36,815,521	$13,561,487	$48,865,698	$4,072,141
Bioswale	Acres	$3,780,000	$9,450,000	$630,000	$13,860,000	$3,519,218	$16,857,841	$1,404,820
Permeable Pavement – with sandveg with underdrain with AB soils	Acres	$8,095,549	$80,955,492	-	$89,051,041	$9,747,602	$95,834,684	$7,986,224
Stormwater Management by Era 1985 to 2002 MD	Acres	$8,208,196	$16,416,391	-	$26,624,587	$12,131,054	$35,652,972	$2,971,081
Street Sweeping 25 times a year – acres (formerly mechanical monthly)	Acres/Year	-	$3,599,155	-	$3,599,155	$3,223,639	$6,618,110	$551,509
Urban Forest Buffers	Acres	$86,734	$867,340	-	$954,074	$426,870	$1,339,516	$111,626
Urban Infiltration Practices – with sandveg no underdrain	Acres	$12,610,679	$31,526,697	$3,603,051	$47,740,427	$7,834,561	$53,907,738	$4,492,312
Urban Nutrient Management	Acres/Year	-	$27,723,893	-	$27,723,893	$1,876,601	$28,712,479	$2,392,707
Urban Stream Restoration (Interim)	Linear Feet	$5,676,000	$11,352,000	-	$17,028,000	$12,548,448	$28,689,155	$2,390,763
Urban Stream Restoration; Shoreline Erosion Control; Regenerative Stormwater Conveyance	Linear Feet	$34,056,000	$68,112,000	-	$102,168,000	$75,290,688	$172,134,927	$14,344,577
Urban Tree Planting; Urban Tree Canopy	Acres	$2,851,750	$28,517,500	$125,000,000	$156,369,250	$13,998,600	$165,256,815	$13,771,401
Vegetated Open Channel - Urban	Acres	$5,040,000	$25,200,000	$2,520,000	$32,760,000	$9,228,341	$40,728,691	$3,394,058
Total		$87,325,119	$331,401,311	$133,967,518	$554,693,948	$163,387,109	$694,598,624	$57,883,219

Wicomico County Cost to Implement Developed Lands BMPs (2010 – 2025)[1] derived from King and Hagan (2011)

Over $58 Million/year for One County (about $580/person)!!

Treatment Costs per acre of impervious cover are also extremely variable

Jurisdiction	Acres of Untreated Impervious Surface	Acres to be Treated in Next 5 Year MS4 Permit Cycle	Projected Costs Annualized	Average Annual Cost Per Acre to be Treated
Anne Arundel	14,887	2,714	$80,540,000	$29,676
Baltimore	23,373	4,953	$45,700,000	$9,227
Baltimore City	28,983	4,180	$33,400,000	$7,990
Carroll	6,449	1,644	$6,813,873	$4,145
Charles	2,607	512	$9,488,120	$18,531
Frederick	6,725	1,192	$22,400,000	$18,792
Harford	8,308	1,573	$18,000,000	$11,443
Howard	11,453	2,179	$42,000,000	$19,275
Montgomery	21,458	3,835	$66,580,942	$17,361
Prince George’s	22,020	4,243	$89,800,000	$21,164

Innovative BMPs can substantially reduce costs

Annual cost to remove equivalent annual TN load

The cost-effectiveness of stormwater controls for nitrogen removal.

Practice	Type of practice	Equivalent Annual cost ($/lb N/IC[1] ac)
Bag filter	Structural	**$69[1]**
Bioretention (new, suburban)	Structural	$335-$634[2,3]
Wet pond (new)	Structural	$733[4]
Street sweeping	Non-structural	$165[5]

[1] Based practice life expectancy of 10-years.

[2] Costs for other practices based on King and Hagen (2011) over a 20-year period and an urban loading rate of 14.1 lb TN/acre.

[3] Range represents a removal efficiency of 45% and 85% from Simpson and Weammert 2009.

[4] 20% removal efficiency for TN from Simpson and Weammert 2009

[5] Berretta et al. 2011 expressed as lb N/year

Illicit discharge elimination is a cost effective approach to nutrient management

Common sense housekeeping practices can be extremely cost effective also

Table 5. Urban BMPs Applicable in City of Richmond, Sorted by Cost-Effectiveness for TSS Removal

Urban BMP[10]	**TN Cost Effectiveness (dollars per pound removed)**	**TP Cost Effectiveness (dollars per pound removed)**	**TSS Cost Effectiveness (dollars per pound removed)**
Pet waste program	0.44	3.36	N/A
Nutrient Management (old efficiencies)	306.73	641.91	N/A
Nutrient Management (recommended efficiencies)	579.38	2,055.82	N/A

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Stormwater BMP Cost-Effectiveness Study

James River Basin, VA

- Evaluation of all urban practices
- Costs and pollutant removal
- Case study in the City of Richmond

Richmond Virginia

James River Association

Methods: Cost Estimates

- King and Hagan (2011): *Costs of Stormwater Management Practices in Maryland Counties*
- Additional studies, data and assumptions used for pet waste programs, illicit discharge elimination, stormwater retrofits, and urban growth reduction
- Considered 20-year life cycle costs, including:
  - Design and construction
  - Land values and financing
  - Operations and maintenance

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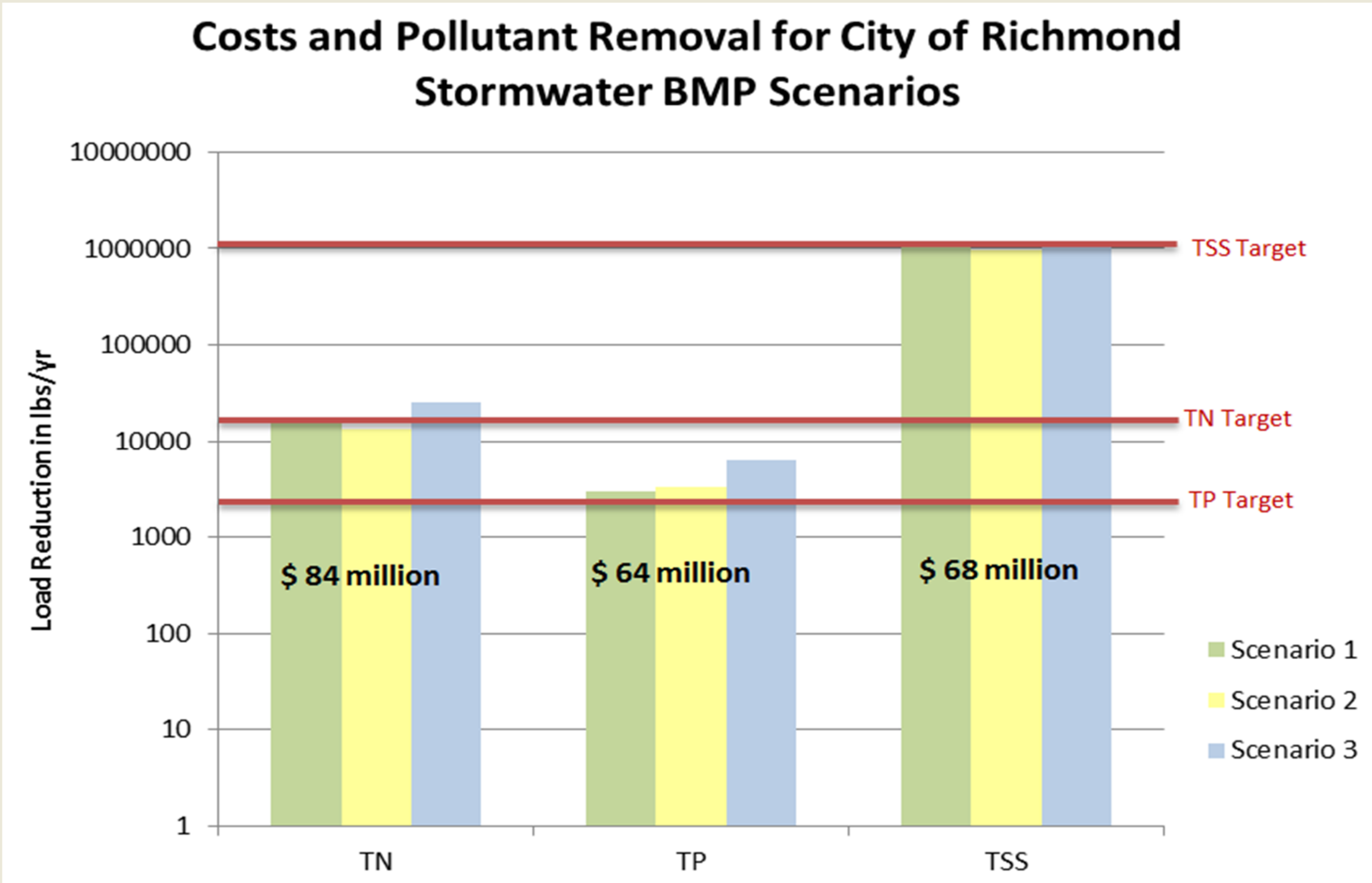
Cost: Case Study



Initial estimates for stormwater pollution reduction in the City of Richmond = $305 million

Key Findings

- Focus on CBP BMP approval is vital but cannot ignore alternatives
- Implementation constraints can impact ability to meet load reductions
- On the ground assessments needed to further refine strategies
- Costs may be lower if focus is placed on private land
- Cost will vary depending on goals (TN vs. TP)

BMPs

36 Urban Practices:

- Pavement/Impervious Cover
- Rooftop
- Bioretention
- Filtering/Infiltration
- Channels
- Ponds/Wetlands
- Conservation/Enhancement
- Land Use Change
- Social/Programmatic

- Also Includes cross-sector trading and user-defined options

Cost Estimate Resources

- King and Hagan study: *Costs of Stormwater Management Practices in Maryland Counties*
  - *Life cycle costs per impervious acre for 24 BMPs in 2011 dollars. Developed to be used for estimating the cost of MAST scenarios.*
- CWP James River Report: *Cost-Effectiveness Study of Urban Stormwater BMPs in the James River Basin*
  - Additional studies used for pet waste, retrofits, IDDE
- CWP Retrofit Manual: *Urban Stormwater Retrofit Practices (Urban Subwatershed Restoration Manual Series)*
  - Used to fill in the cost estimate gaps for stormwater planters, green roofs, vegetated filter strips, soil augmentation, rainwater harvesting, and stormwater tree pits/structural soils.

Cost Components

- Initial Costs - design, construction, land costs
- Operation and Maintenance – annual routine maintenance, intermittent maintenance, county implementation cost (inspection and enforcement)
- Annualized life cycle costs are estimated as the annual bond payment required to finance the initial cost of the BMP (20-year bond at 3%) plus average annual routine and intermittent maintenance costs.

Process for Estimating Cost

1. Used the King and Hagan study as the initial framework.
2. Converted unit costs for tree planting, forest buffers, and urban nutrient management from impervious to pervious acres based on the approach in the James River Report. Also converted the unit cost for stream restoration to linear feet.
3. Added pet waste, retrofits, and IDDE cost estimates from the James River Report.
4. Filled in the gaps in cost data using the Retrofit Manual.
5. Applied a 4% cost adjustment for inflation to convert $2011 to $2014.

Clean Water Optimization Tool

Cost

Cost Data

Stormwater BMP	Unit	Initial Project Costs[1]					Routine and Intermittent Maintenance Costs			Average Annual County Implementation Costs[10]	Maintenance, Intermittent Repair, and Implementation Costs[11]		Total Stormwater BMP Costs per Unit Treated	
		Pre-Construction Costs[2]	Construction Costs (in 2014 dollars)[3]	Land Costs[4]	Total Initial Costs	Annualized Initial Costs[5]	Annual Routine Maintenance[8]	Annual Intermittent Maintenance[9]	Total Annual Maintenance Costs		Total (Over Selected Timeframe)	Average Annual	Costs (Over Selected Timeframe)	Average Annual Cost
Impervious Urban Surface Reduction	per impervious acre	$ 9,100	$ 91,000	$ 50,000	$ 150,100	$ 10,089	$ 910	$ -	$ 910	$ 10.34	$ 18,407	$ 920	$ 220,188	$ 11,009
Tree Planting/Forest Buffers	per pervious acre	$ 1,061	$ 10,612	$ -	$ 11,673	$ 785	$ 212	$ 212	$ 424	$ 3.52	$ 8,560	$ 428	$ 24,253	$ 1,213
Urban Tree Planting (street trees)	per pervious acre	$ 1,186	$ 11,863	$ 150,000	$ 163,050	$ 10,959	$ 237	$ 237	$ 475	$ 3.93	$ 9,569	$ 478	$ 228,759	$ 11,438
Wet Ponds and Wetlands (Suburban)	per impervious acre	$ 5,788	$ 19,292	$ 2,000	$ 27,080	$ 1,820	$ 386	$ 386	$ 772	$ 20.67	$ 15,847	$ 792	$ 52,250	$ 2,613
Wet Ponds and Wetlands (Urban)	per impervious acre	$ 23,073	$ 46,146	$ 2,000	$ 71,220	$ 4,787	$ 386	$ 386	$ 772	$ 20.67	$ 15,847	$ 792	$ 111,589	$ 5,579
Proprietary Devices	per impervious acre	$ 7,280	$ 36,400	$ -	$ 43,680	$ 2,936	$ 1,820	$ 1,820	$ 3,640	$ 31.01	$ 73,420	$ 3,671	$ 132,140	$ 6,607
Dry Extended Detention Ponds (Suburban)	per impervious acre	$ 9,360	$ 31,200	$ 5,000	$ 45,560	$ 3,062	$ 624	$ 624	$ 1,248	$ 31.01	$ 25,580	$ 1,279	$ 86,827	$ 4,341
Dry Extended Detention Ponds (Urban)	per impervious acre	$ 24,336	$ 48,672	$ 5,000	$ 78,008	$ 5,243	$ 624	$ 624	$ 1,248	$ 31.01	$ 25,580	$ 1,279	$ 130,447	$ 6,522
Infiltration Practices	per impervious acre	$ 17,784	$ 44,460	$ 5,000	$ 67,244	$ 4,520	$ 445	$ 445	$ 889	$ 31.01	$ 18,404	$ 920	$ 108,801	$ 5,440
Sand Filters	per impervious acre	$ 15,600	$ 39,000	$ 5,000	$ 59,600	$ 4,006	$ 780	$ 780	$ 1,560	$ 31.01	$ 31,820	$ 1,591	$ 111,941	$ 5,597
Urban Nutrient Management[6]	per pervious acre	$ -	$ 5,718	$ -	$ 5,718	$ 384	$ -	$ -	$ -	$ 2.79	$ 56	$ 3	$ 7,742	$ 387
Street Sweeping[7]	per impervious acre	$ -	$ 6,291	$ -	$ 6,291	$ 423	$ 431	$ -	$ 431	$ 20.67	$ 9,030	$ 451	$ 17,487	$ 874
Stream Restoration	per linear foot	$ 224	$ 447	$ -	$ 671	$ 45	$ -	$ 9	$ 9	$ 0.31	$ 185	$ 9	$ 1,087	$ 54
Bioretention (Suburban - aka Rain Garden)	per impervious acre	$ 9,750	$ 39,000	$ 3,000	$ 51,750	$ 3,478	$ 780	$ 780	$ 1,560	$ 31.01	$ 31,820	$ 1,591	$ 101,388	$ 5,069
Bioretention/Green Streets (Urban)	per impervious acre	$ 56,784	$ 141,960	$ 3,000	$ 201,744	$ 13,560	$ 780	$ 780	$ 1,560	$ 31.01	$ 31,820	$ 1,591	$ 303,027	$ 15,151
Vegetated Open Channels	per impervious acre	$ 4,160	$ 20,800	$ 2,000	$ 26,960	$ 1,812	$ 416	$ 208	$ 624	$ 10.34	$ 12,687	$ 634	$ 48,929	$ 2,446
Regenerative Stormwater Conveyance/Bioswale	per impervious acre	$ 12,480	$ 31,200	$ 2,000	$ 45,680	$ 3,070	$ 624	$ 312	$ 936	$ 31.01	$ 19,340	$ 967	$ 80,748	$ 4,037
Permeable Pavement w/o Sand, Veg. (New)	per impervious acre	$ 27,181	$ 271,814	$ -	$ 298,996	$ 20,097	$ 1,359	$ 1,359	$ 2,718	$ 10.34	$ 54,570	$ 2,728	$ 456,514	$ 22,826
Dry Pond Conversion to Wet Pond or Wetland	per impervious acre	$ 6,440	$ 12,880	$ -	$ 19,321	$ 1,299	$ 258	$ 258	$ 515	$ 20.67	$ 10,718	$ 536	$ 36,691	$ 1,835
Pet Waste Program	per program	$ 5,000	$ 172,707	$ -	$ 177,707	$ 11,945	$ 31,147	$ 23,849	$ 54,996	$ 1,610.24	$ 1,132,121	$ 56,606	$ 1,371,015	$ 68,551
Advanced IDDE: Correction of Cross-Connections	per connection	$ 1,400	$ 3,382	$ -	$ 4,782	$ 321	$ 55	$ -	$ 55	$ 43.84	$ 1,977	$ 99	$ 8,405	$ 420
Advanced IDDE: Sewer Repair	per discharge	$ 9,610	$ 96,096	$ -	$ 105,706	$ 7,105	$ 55	$ -	$ 55	$ 43.84	$ 1,977	$ 99	$ 144,078	$ 7,204
Stormwater Planter	per impervious acre	$ 21,904	$ 109,518	$ -	$ 131,422	$ 8,834	$ 1,095	$ 1,095	$ 2,190	$ 10.34	$ 44,014	$ 2,201	$ 220,686	$ 11,034
Dry Swales	per impervious acre	$ 59,055	$ 147,638	$ 2,000	$ 208,694	$ 14,027	$ 780	$ 780	$ 1,560	$ 31.01	$ 31,820	$ 1,591	$ 312,370	$ 15,619
Wet Swales	per impervious acre	$ 4,160	$ 20,800	$ 2,000	$ 26,960	$ 1,812	$ 416	$ 208	$ 624	$ 10.34	$ 12,687	$ 634	$ 48,929	$ 2,446
Green Roof	per impervious acre	$ 379,103	$ 947,757	$ -	$ 1,326,860	$ 89,186	$ 18,955	$ 18,955	$ 37,910	$ 31.01	$ 758,826	$ 37,941	$ 2,542,543	$ 127,127
Vegetated Filter Strip	per impervious acre	$ 2,527	$ 25,272	$ 2,000	$ 29,799	$ 2,003	$ 253	$ 253	$ 505	$ 10.34	$ 10,316	$ 516	$ 50,375	$ 2,519
Soil Augmentation	per impervious acre	$ 3,159	$ 31,590	$ -	$ 34,749	$ 2,336	$ -	$ -	$ -	$ 10.34	$ 207	$ 10	$ 46,920	$ 2,346
Rainwater Harvesting	per impervious acre	$ 21,061	$ 105,305	$ -	$ 126,366	$ 8,494	$ 1,053	$ 1,053	$ 2,106	$ 20.67	$ 42,535	$ 2,127	$ 212,411	$ 10,621
Tree Pits/Structural Soils	per impervious acre	$ 58,971	$ 294,856	$ -	$ 353,827	$ 23,783	$ 2,949	$ 2,949	$ 5,897	$ 31.01	$ 118,562	$ 5,928	$ 594,217	$ 29,711
Gross Solids Removal	per impervious acre	$ 302	$ 1,512	$ -	$ 1,814	$ 122	$ 151	$ 151	$ 302	$ 31.01	$ 6,668	$ 333	$ 9,107	$ 455

Clean Water Optimization Tool
Cost

User-Adjusted Values: Land/ Financing Costs

1. Variables Used to Develop Annualized Costs:

Annualized life cycle costs for each BMP were estimated as the annual bond payment required to finance the i
of the BMP plus average annual routine and intermittent maintenance costs.
Review the major assumptions used below and replace the defaults provided if necessary to better reflect the l

Variable	Value
Opportunity cost of developable land ($/acre)	$100,000
Typical proportion of land that is developable (%)	50%
Interest rate associated with bond payment to finance construction (%)	3%
Number of years over which to project costs	20

User-Adjusted Values: Unit Costs

2. BMP Cost Data:

For each BMP, an average annual cost per unit treated is provided below, based on the County selected in the Scenario Setup sheet.

Review the County-Specific costs, and if desired, enter annual per-unit cost data that better reflects local conditions in the User Defined column.

BMP	Units	Default Annual Cost per Unit	User-Defined Annual Cost per Unit
Permeable Pavement	Acres	$22,095.27	
Permeable Pavers	Acres	$22,095.27	
Rainwater Harvesting	Acres	$9,252.96	
Stormwater Planter	Acres	$10,681.22	
Green Roof	Acres	$123,059.06	
Downspout Disconnection	Acres	$29.20	
Bioretention	Acres	$4,907.20	
Rain Garden	Acres	$4,907.20	
Green Streets	Acres	$13,973.98	
Vegetated Filter Strips	Acres	$2,438.15	
Hydrodynamic and Filtering Practices	Acres	$6,395.56	
Infiltration	Acres	$5,265.98	
Stormwater Tree Pits/Structural Soils	Acres	$28,760.08	
Sand Filter	Acres	$5,417.96	

Example

A 500 foot stream restoration project will be installed in Wicomico County. Assume a 20 year life-cycle cost and 0.97 county adjustment factor.

Initial Costs	Pre-Construction Costs	$223.60
	Construction Costs (in 2014 dollars)	$447.20
	Land Costs	$0.00
	Total Initial Costs	$670.80
	Annualized Initial Costs	$45.09
Operation and Maintenance	Annual Routine Maintenance	$0.00
	Average Annual Intermittent Maintenance	$8.94
	Total Annual Maintenance Costs	$8.94
	Average Annual County Implementation Costs	$0.31
	Total (Over Selected Timeframe)	$185.08
	Average Annual	$9.25
Total Cost per Unit Treated	Costs (Over Selected Timeframe)	$1086.85
	Average Annual Cost	$54.34

All costs are per linear foot.

500 ft x $1086.85/ft x 0.97 = $527,122 over 20 years

500 ft x $54.34/ft x 0.97 = $26,355 average annual cost

Clean Water Optimization Tool

Cost

- Additional BMP Benefits should be quantified:
  - Public Health/ Safety
  - Public Education
  - Recreation
  - Neighborhood Beautification
  - Urban Heat Island
  - Carbon Footprint
  - Wildlife Habitat
  - Stream Habitat
  - Flood Control

Clean Water Optimization Tool

Research – Pollutant Load and BMP effectiveness

- BMP Effectiveness
  - Structural practices and Land Use Changes based on Chesapeake Bay Program measures of performance.
  - Programmatic practices are based on various sources
    - IDDE Expert Panel (Chesapeake Bay Program)
    - Watershed Treatment Model (WTM)
    - Previous CWP publications, research, and experience

Clean Water Optimization Tool
Steps to Use the Tool

- Step 1: Desktop Assessment/Informative Exercise
  - Use local knowledge
  - Accepted data sources
    - National
    - State
    - County
    - Town

Field work in the South Prong, Wicomico County

- Step 2: Entering Practical Estimates
  - Apply information gathered to selected/accepted BMPs
    - This will allow practical maximums to be set
      - Practical maximum amount of permeable pavement to be installed, for example
  - Apply local knowledge and practical experience
    - For example, sand filters may not be readily accepted by the community
      - This would limit installation of this particular practice

- Step 3: Override Default Cost Values & Specify Programmatic Information
  - Enter information about local costs, if available
    - Important for realistic scenario development
  - Modify land cost, and length of time to project costs
  - Estimate parameters for programs
    - Quantity of Promotional and education materials for a pet waste program, for example

- Step 4a: Account for Practices that Have Already Been Implemented
  - These entries will count toward goals before optimization
    - These practices can be entered individually or estimated as groups of a given practice
      - For example, over an entire county there may be 20 acres treated by a bioretention, these can be aggregated and entered as one
  - Costs associated with the installation of these practices are ignored

Clean Water Optimization Tool
Steps to Use the Tool

- Step 4b: Enter High Priority Practices
  - Enter information about high priority practices
    - Practices that are publicly accepted
    - Practices proven to be effective
    - High comfort level with installation/maintenance
  - These practices will be weighted heavier during optimization
    - Estimated costs will not be changed

Outfall net in Talbot County

Clean Water Optimization Tool

Steps to Use the Tool

- Step 5: Optimize
  - Select optimization goals
    - Based on cost per pound of nitrogen reduction
    - Based on cost per pound of phosphorus reduction
    - Based on cost per pound of sediment reduction
    - Based on a nitrogen and phosphorus weighting
      - 50/50 would equally weight optimization based on cost per pound of N AND cost per pound of P
  - Results will show pertinent information
    - Pounds reduced, if less than goals
    - Estimated cost
    - Number of acres requiring treatment for each practice to achieve total reductions

Clean Water Optimization Tool

Demonstration – Community Information

Results Cells

1. Community Information:

Enter the required inputs in the yellow cells below. Required pollutant load reductions for urban areas will be calculated automatically based on the County selected. Optionally, specific pollutant reductions goals may be entered in the blue cells if the scenario is being run for a municipality or at the watershed scale.

County of Interest	Allegany County
Are you an NPDES regulated community?	Yes
Scenario Starting Year *(Use 2009 for WIP scenarios)*	2013
Scenario Endpoint	2025

Required Pollutant Load Reductions:

Pollutant	Total County Urban Load (lbs/yr)	County Reduction Goal (lbs reduced/yr)	Reduction Goal (lbs/yr) for scale other than county
TN	76,023	8,514	
TP	23,201	3,899	
TSS	48,025,081,112	#N/A	

Clean Water Optimization Tool

Demonstration - BMPs

2. Best Management Practices:

For each BMP below, enter the maximum practical number of units that can be treated in the jurisdiction or watershed of interest.
If you do not want to include a particular BMP in the scenario, enter a ZERO in the Maximum Practical Units Treated column.
For some BMPs, you must also estimate the average percent imperviousness in the drainage area.
You may also enter the % agricultural land in the drainage area for certain BMPs if applicable. There is currenlty no mechanism for counting these reductions to
the urban sector targets but the Tool will track these reductions separately so that opportunities to receive credit or trade with other sectors can be further expl
See the User Guide for instructions on deriving estimates of maximum practical number of units and impervious area treated.

****Not sure where to begin? Try this.****

Enter your budget for stormwater BMP implementation: $1,000,000.00 per year *Select Nutrient:* TN

The table below will populate with the number of units that can potentially be treated with the given budget, for the top 5 most cost-effective practices for N
Note that full implementation of the number of units suggested can only occur for ONE of the BMPs shown with the available budget

Top BMPs for Nitrogen

Suggested Practices	Units Treated*	Units**
Downspout Disconnection	34247	Acres
Stream Restoration	12148	Linear Feet
Living Shoreline	16089	Linear Feet
Pet Waste Program	1319	Number of pet waste stations
Conversion of Dry Pond to Wet Pond	563	Acres

** Units Treated is based only on the cost of the practice and does not account for physical and practical constraints on implementation*
***Number of units shown is for BMPs that treat a 100% impervious drainage area*

Clean Water Optimization Tool

Demonstration - BMPs

Stormwater Retrofits		Units	Maximum Practical Units Treated	Estimated Impervious Cover % in Drainage Area	Estimated Agricultural Land % in Drainage Area
Pavement/Impervious Cover BMPs					
	Permeable Pavement	Acres	1000	100%	0%
	Permeable Pavers	Acres	1000	100%	
Rooftop BMPs					
	Rainwater Harvesting	Acres	1000	100%	
	Stormwater Planter	Acres	1000	100%	
	Green Roof	Acres	1000	100%	
	Downspout Disconnection	Acres	1000	100%	
Bioretention					
	Bioretention	Acres	1000	100%	
	Rain Garden	Acres	1000	100%	
	Green Streets	Acres	100	100%	

Clean Water Optimization Tool

Demonstration - Costs

2. BMP Cost Data:

For each BMP, an average annual cost per unit treated is provided below, based on the County selected in the Scenario Setup sheet.

Review the County-Specific costs, and if desired, enter annual per-unit cost data that better reflects local conditions in the User Defined column.

BMP	Units	Default Annual Cost per Unit	User-Defined Annual Cost per Unit
Permeable Pavement	Acres	$22,095.27	
Permeable Pavers	Acres	$22,095.27	
Rainwater Harvesting	Acres	$9,252.96	
Stormwater Planter	Acres	$10,681.22	
Green Roof	Acres	$123,059.06	
Downspout Disconnection	Acres	$29.20	
Bioretention	Acres	$4,907.20	
Rain Garden	Acres	$4,907.20	
Green Streets	Acres	$13,973.98	
Vegetated Filter Strips	Acres	$2,438.15	
Hydrodynamic and Filtering Practices	Acres	$6,395.56	
Infiltration	Acres	$5,265.98	
Stormwater Tree Pits/Structural Soils	Acres	$28,760.08	
Sand Filter	Acres	$5,417.96	
Dry Swale/Bioswale	Acres	$3,908.22	
Wet Swale	Acres	$2,368.18	
Vegetated Open Channels	Acres	$2,368.18	
Regenerative Stormwater Conveyance	Acres	$20,815.42	

Clean Water Optimization Tool

Demonstration - Optimization

Optimize Based on:

TP

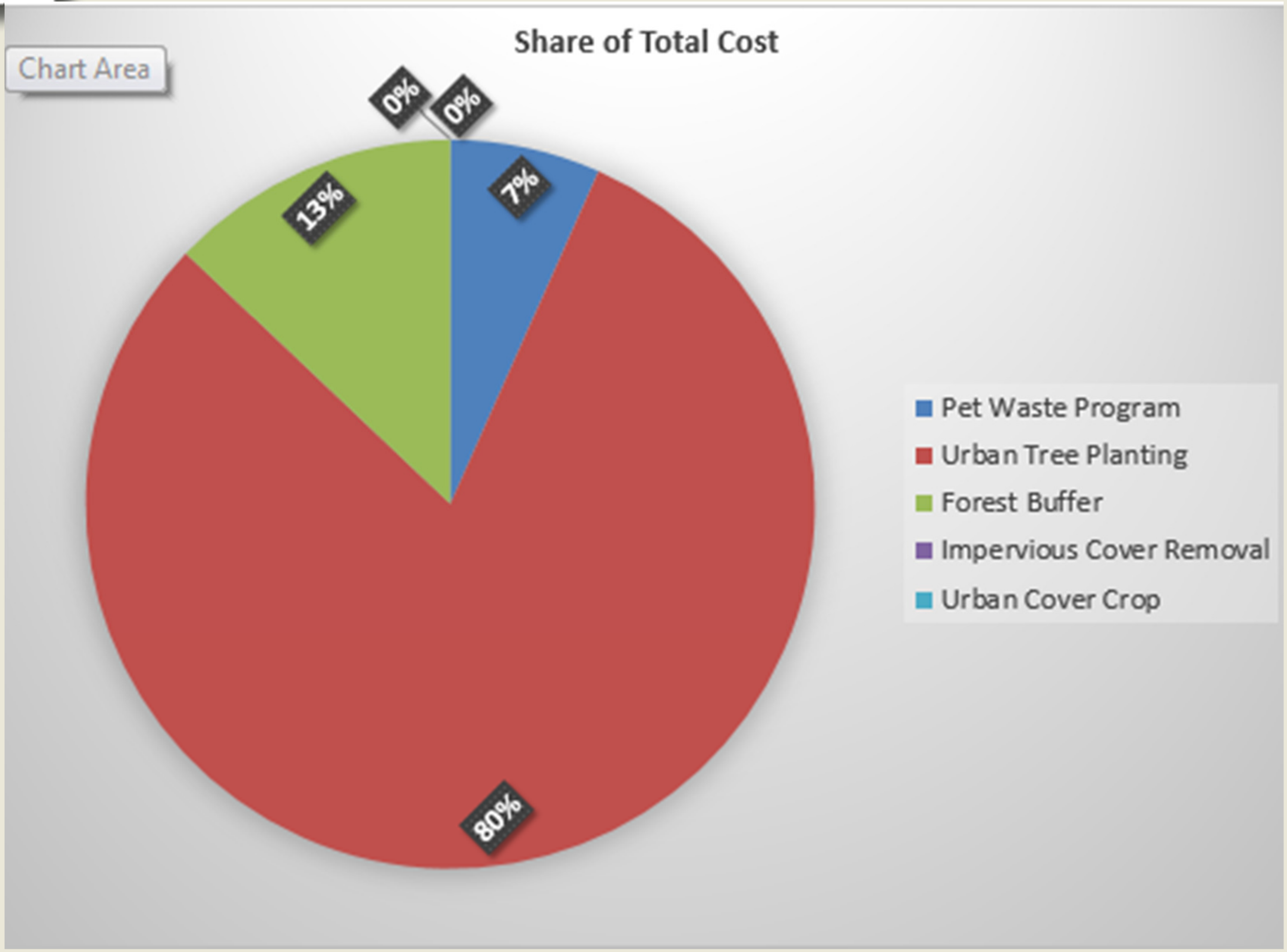
Update Results

4. Results:

Practice	Units Treated	TN Reductions (lbs/yr)	TP Reductions (lbs/yr)	TSS Reductions (lbs/yr)	Annual Cost	$/lb TN	$/lb TP	$/lb TSS
Pet Waste Program	500	3,148.1	410.6	0.0	$378,967	$120	$923	
Urban Tree Planting	1,000	3,066.6	1,299.3	1,505,335.4	$4,571,666	$1,491	$3,519	$3
Forest Buffer	622	1,292.3	188.7	94,467.9	$734,482	$568	$3,892	$8
Impervious Cover Removal	0	0.0	0.0	0.0	$0	$19,012	$11,798	$8
Urban Cover Crop	0	0.0	0.0	0.0	$0	$1,389	$22,030	
Total:	**2,122**	**7,507.0**	**1,898.6**	**1,599,803**	**$5,685,114 per year OR $113,702,284 over 20 years**			
Percent of Required Reductions Met:		**166.3%**	**100.0%**					
Remaining Reductions Needed to Meet Targets		**0.0**	**0.0**	**0**				

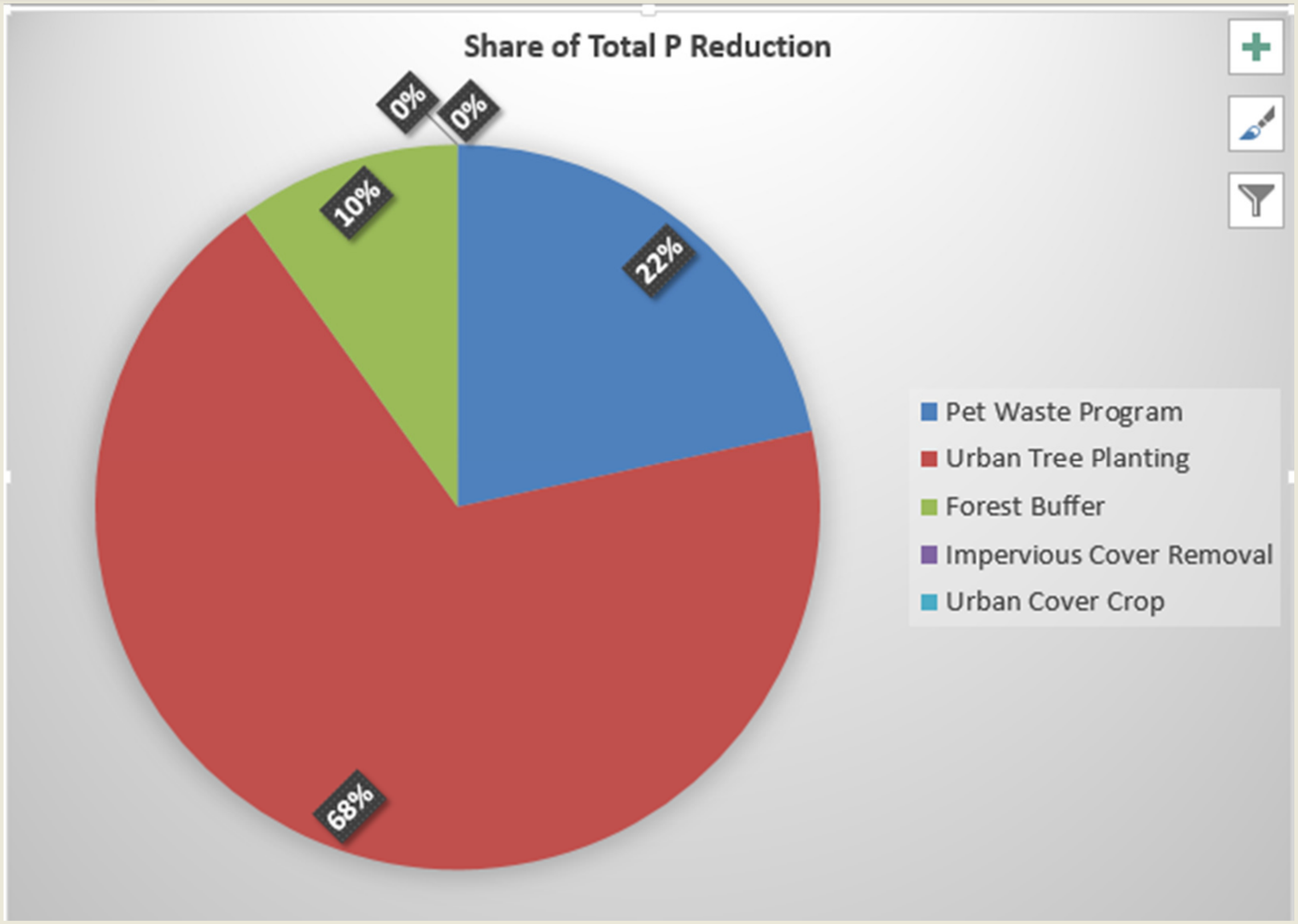
Clean Water Optimization Tool

Demonstration - Results



Clean Water Optimization Tool

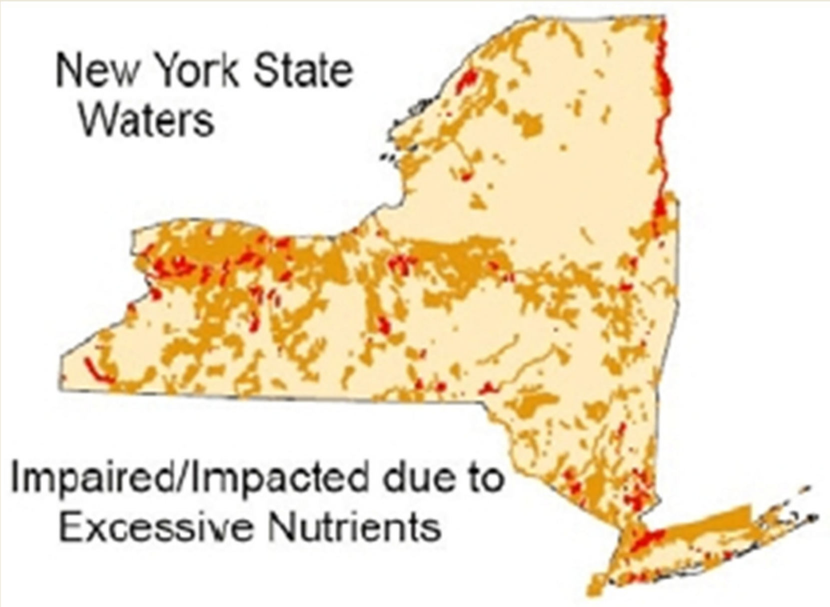
We Need Your Help



Clean Water Optimization Tool

Application in New York State

- Very Little of New York State is in the Chesapeake Bay Watershed.
- Other applications include:
  - Other TMDL Watersheds
  - Local pollution reduction goals
  - Capture targets in CSO watersheds
  - Others?



Changes Needed to Apply in New York

- Unit costs adjusted with NY Data
- Target loads tied to goals in New York State
- Possibly add new parameters (e.g., bacteria/ runoff reduction)
- Other changes?

Questions/Comments

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