

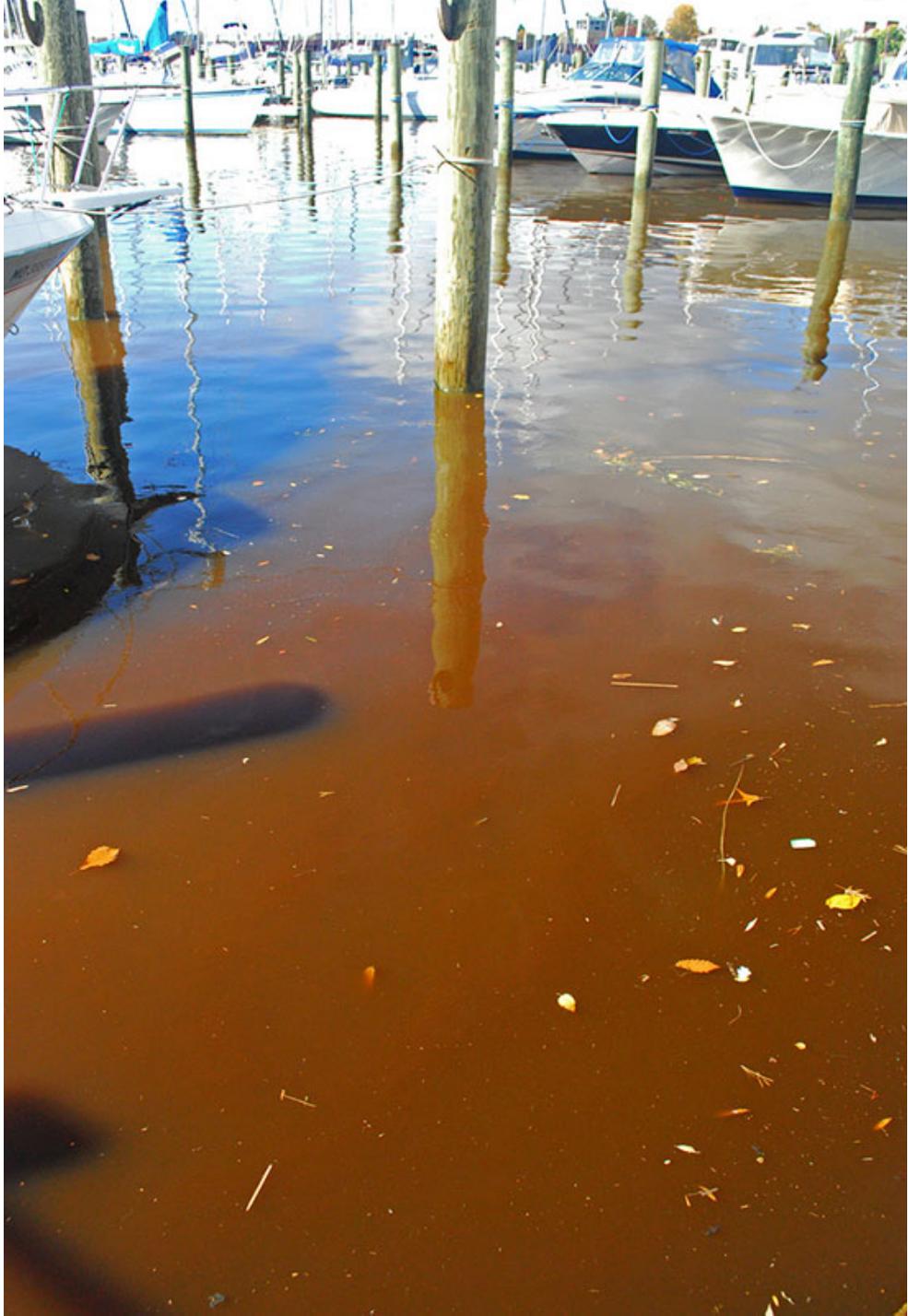
# Development of the Chesapeake Bay Program's Watershed Model for 2017

Gary Shenk – USGS - Chesapeake Bay Program

9/20/16

This information is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.

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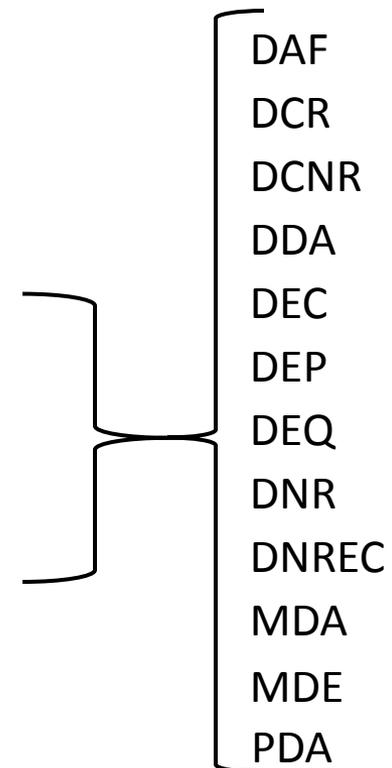






# Chesapeake Bay Program Partnership

- Federal agencies
  - Environmental Protection Agency (EPA)
  - US Department of Agriculture (USDA)
  - US Forest Service (USFS)
  - US Geological Survey (USGS)
  - US Fish and Wildlife Service (USFWS)
  - **And more**
- State agencies
  - Natural Resources/Environmental departments
  - Agricultural departments
  - Parks and Recreation groups
  - Fish and Wildlife agencies
- Local Governments





# Chesapeake Bay Program Partnership

- Non-profit organizations
  - Chesapeake Bay Foundation
  - Center for Watershed Protection
  - Ducks Unlimited
  - National Fish and Wildlife Foundation
  - And more
- Academic institutions
  - Land grant universities
  - Cooperative Extension programs
  - Sea Grant programs
  - Research centers and consortiums
  - And more



**CHESAPEAKE BAY  
FOUNDATION**

*Saving a National Treasure*



CHESAPEAKE  
WATERSHED  
AGREEMENT

**1983**



CHESAPEAKE  
WATERSHED  
AGREEMENT

**1987**



CHESAPEAKE  
WATERSHED  
AGREEMENT

**2000**



**TMDL  
2010**



CHESAPEAKE  
WATERSHED  
AGREEMENT

**2014**



40% goal

TMDL  
WQ goals

accountability

**1960s**

**1980s**

**2000s**

**1970s**

**1990s**

**2010s**

# TMDL Timeline

- 1999 – Lawsuit by American Canoe Association and American Littoral Society
- 2010 – TMDL put in place
- 2017 MidPoint Assessment
  - 60% of the management practices implemented
  - Mid-Course Correction?
- 2025 TMDL Goal Date
  - 100% of the management practices implemented

# Model Timeline

- 1999 – Lawsuit by American Littoral Society

**1980s – Phase 0, Phase 1**

- 2010 – TMDL put in place

**1990s – Phase 2, Phase 4**

- 2017 MidPoint Assessment

- 60% of the management practices implemented
- Mid-Course Correction

**2000s – Phase 4 versions**

**2010 – Phase 5**

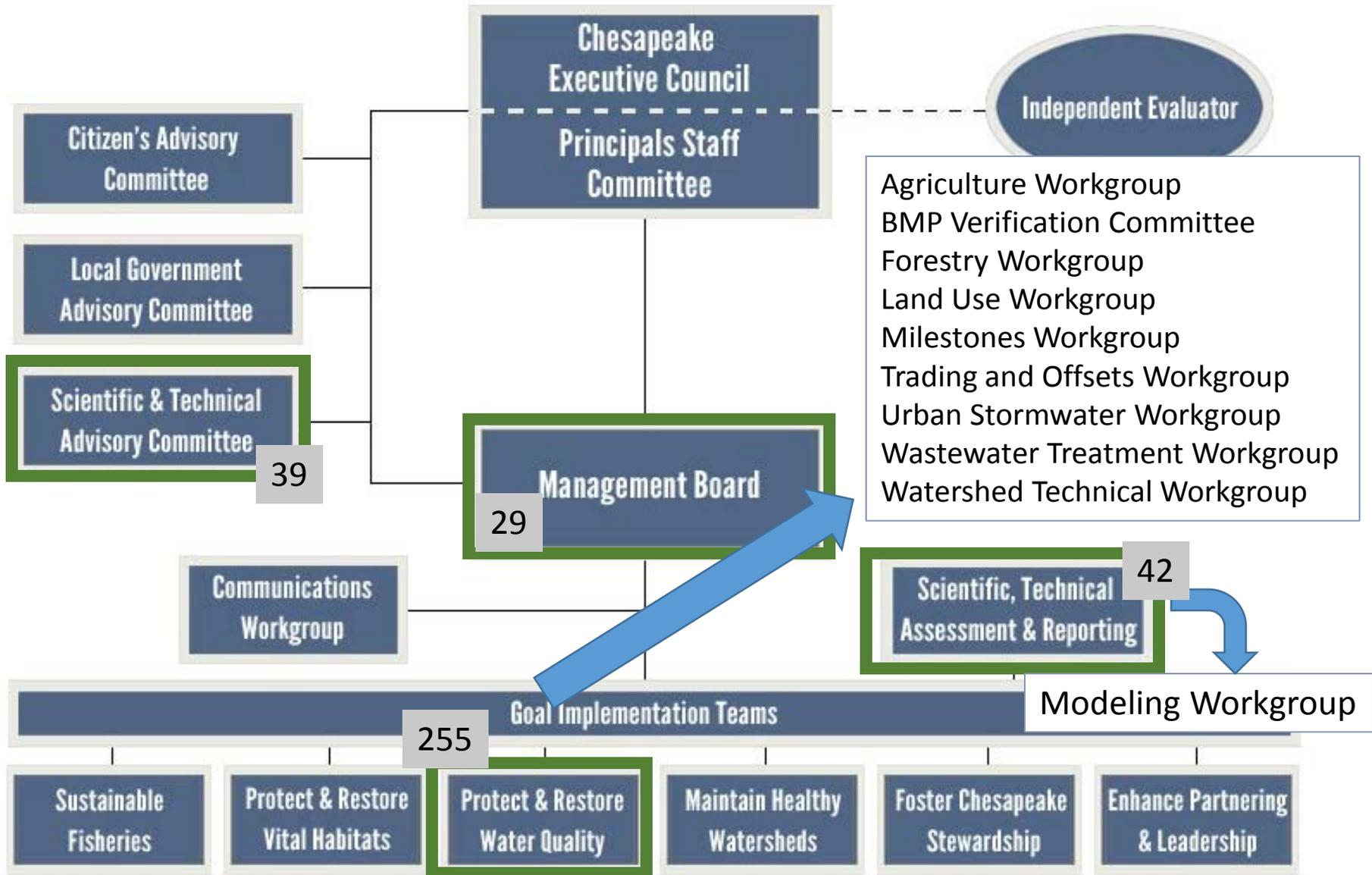
- 2025 TMDL Goal Date

- 100% of the management practices implemented

**2017 – Phase 6**

Model related Membership as of 7/2013 – 365 individuals

# Chesapeake Bay Program



# Partnership Feedback on Modeling

- **Water Quality Managers**

- Need more **transparent and easier** to understand decision-support tools to enable successful engagement of local partners

- **Scientific and Technical Advisory Committee**

- Multiple Models
- Phosphorus
- Complex Reservoir Dynamics
- Fine-scale processes

# Partnership Feedback on Modeling

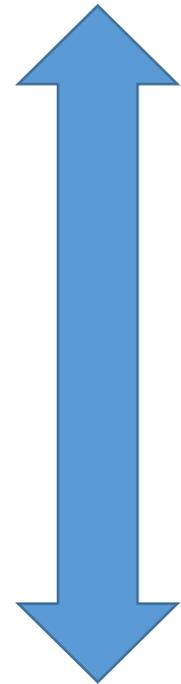
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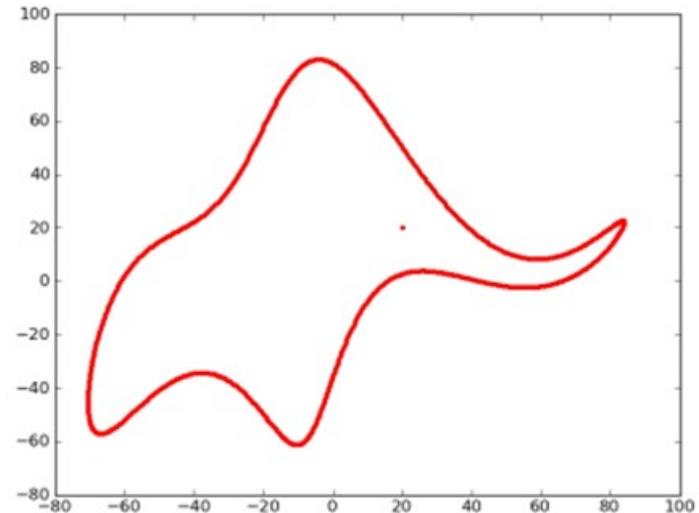
Keep it Simple!!



Include Everything!!!

# Model Complexity

- Von Neumann: With four parameters I can fit an elephant, and with five I can make him wiggle his trunk.



“Drawing an elephant with four complex parameters”  
by Jurgen Mayer, Khaled Khairy, and Jonathon  
Howard, *Am. J. Phys.* 78, 648 (2010),  
DOI:10.1119/1.3254017

# Phase 6 Model Structure

Average Load +  $\Delta$  Inputs \* Sensitivity

\*

Land Use Acres

\*

BMPs

\*

Land to Water

\*

Stream Delivery

\*

River Delivery

Direct Loads

## Phase 6

Preliminary Information-Subject to Revision.  
Not for Citation or Distribution



# Keep It Simple

# Include Everything

Average Load +  $\Delta$ Inputs \* Sensitivity

\*  
Land Use Acres

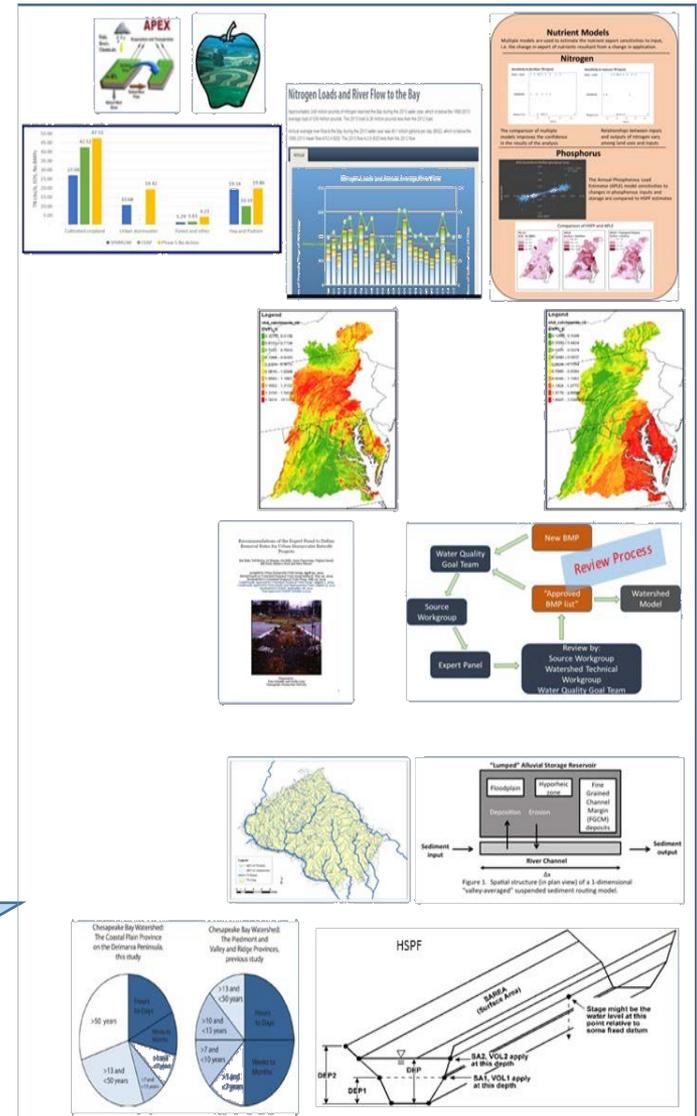
\*  
BMPs

\*  
Land to Water

\*  
Stream Delivery

\*  
River Delivery

Direct Loads

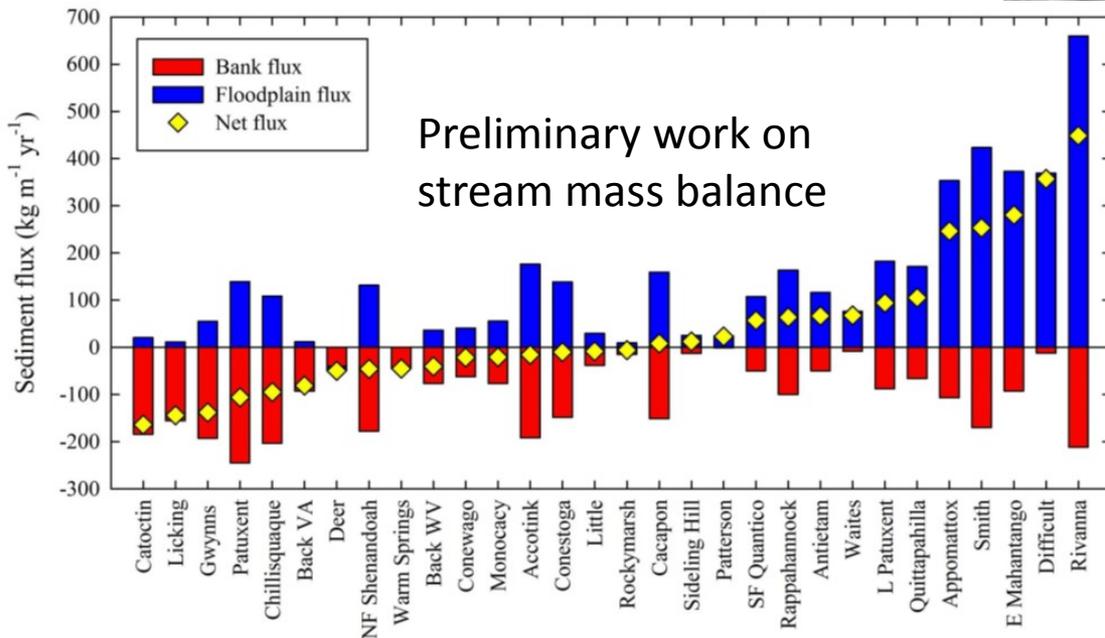
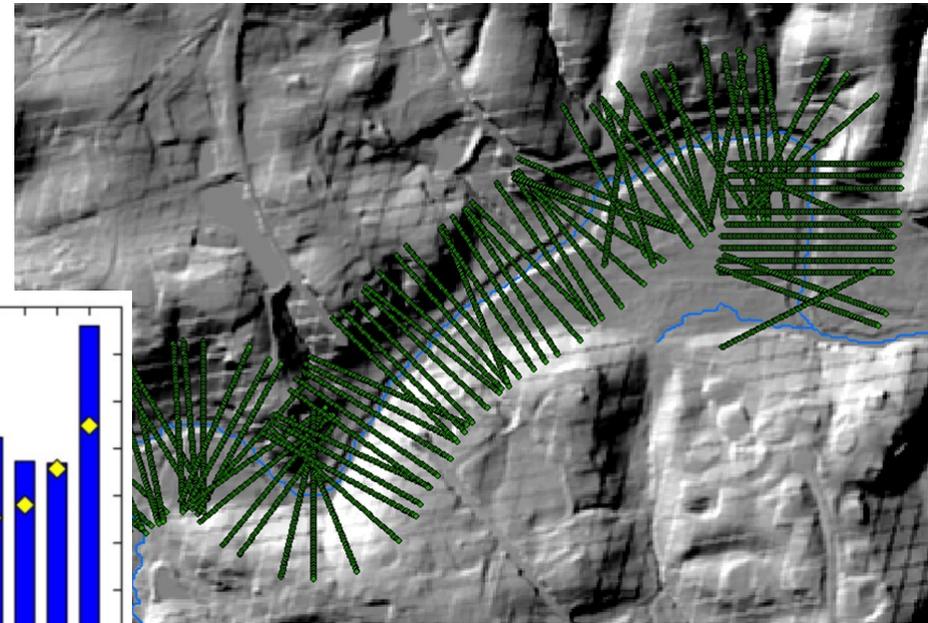


# Use of Multiple Models for Nitrogen Export Rate

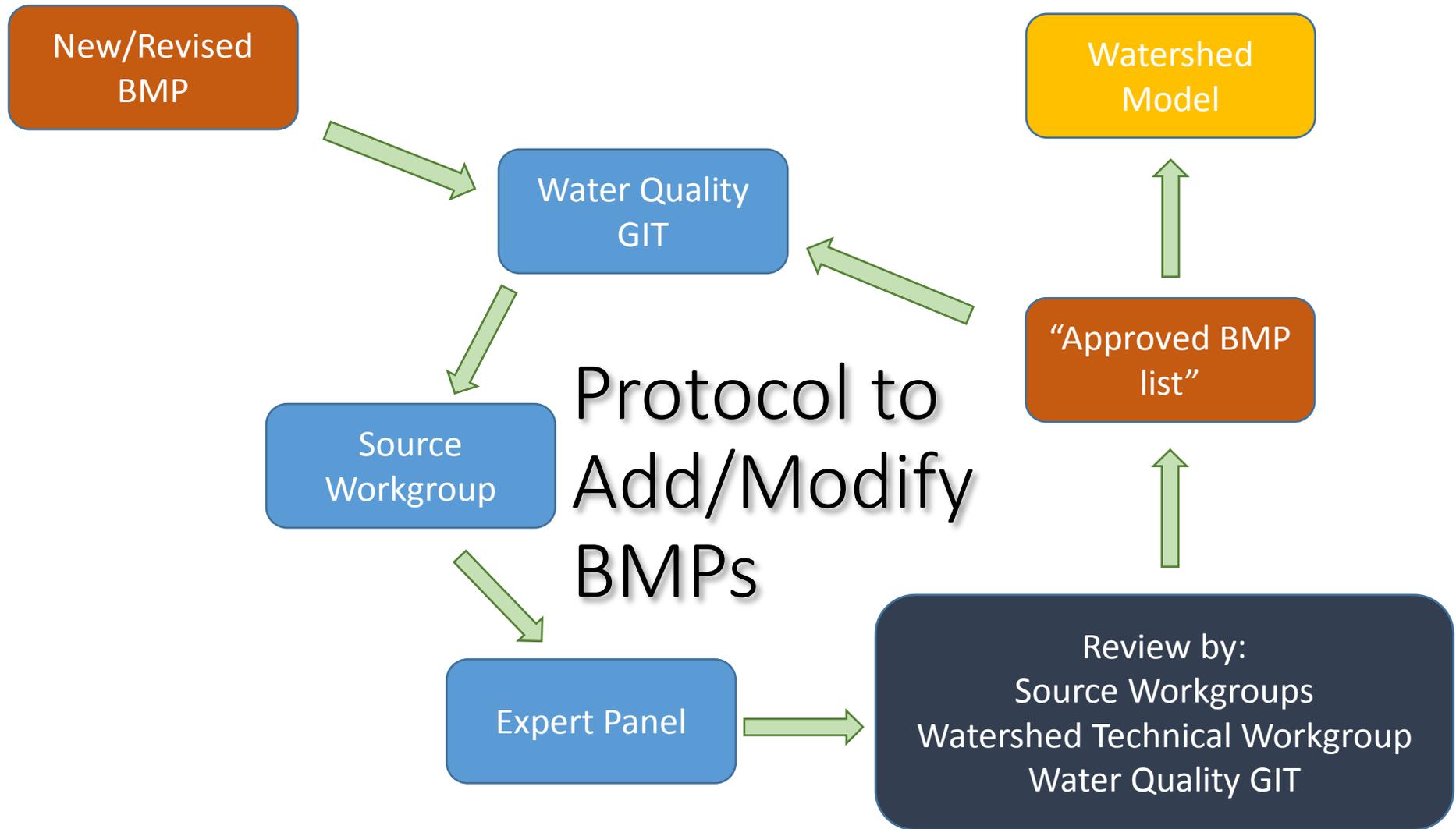
Sector	Crop	Pasture/ Hay	Developed	Natural
CBP Phase 5 model	47.5	19.9	19.4	4.2
USDA-CEAP Model	42.5	10.2	Not used	1.6
USGS- SPARROW Model	22.9	10.2	8.9	0.4
Average Ratio to Crop Rate	1.00	0.37	0.40	0.05

# Contributions from new research

- Lidar over 166,000 km<sup>2</sup>
- Regression of Stream mass balance against morphology



# Collaborative Stakeholder Processes



# Phase 6 Model Structure

Average Load +  $\Delta$  Inputs \* Sensitivity

\*

Land Use Acres

\*

BMPs

\*

Land to Water

\*

Stream Delivery

\*

River Delivery

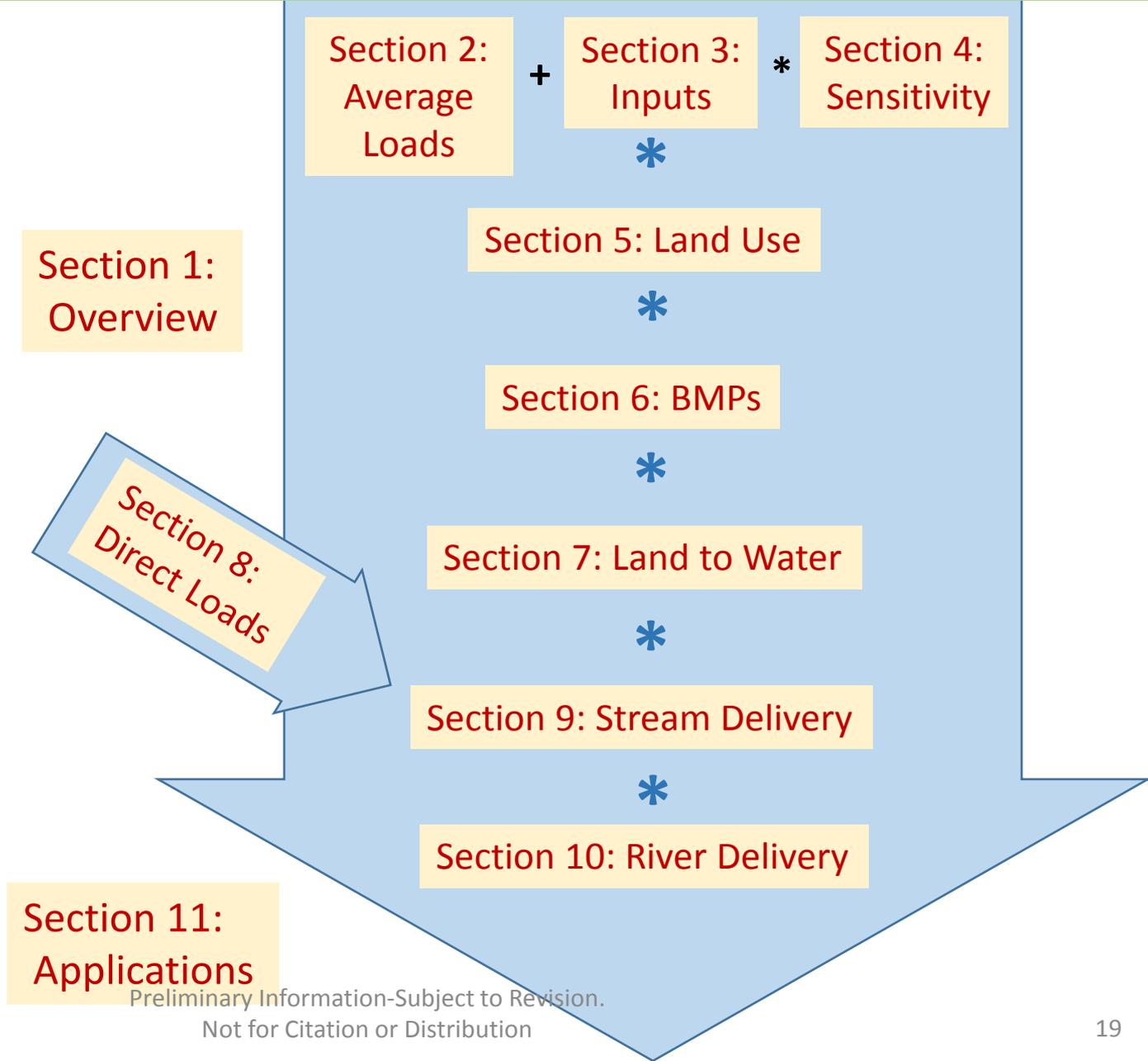
Direct Loads

## Phase 6

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# Phase 6 Model Documentation



Preliminary Information-Subject to Revision.  
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# Stakeholder Science

- Transparent science is more palatable to stakeholders
- Multiple lines of evidence has scientific support

... but does it work?

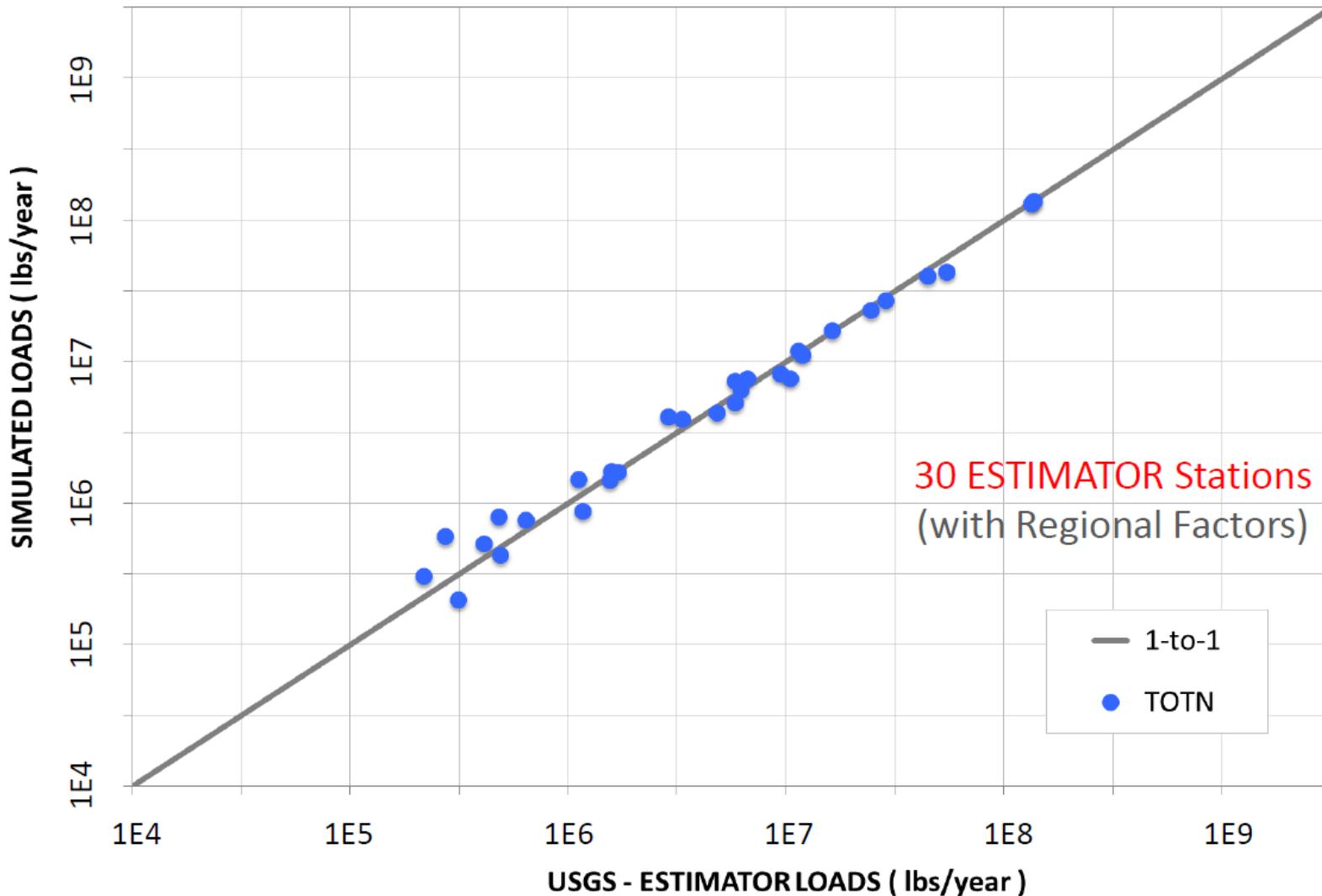
Compare

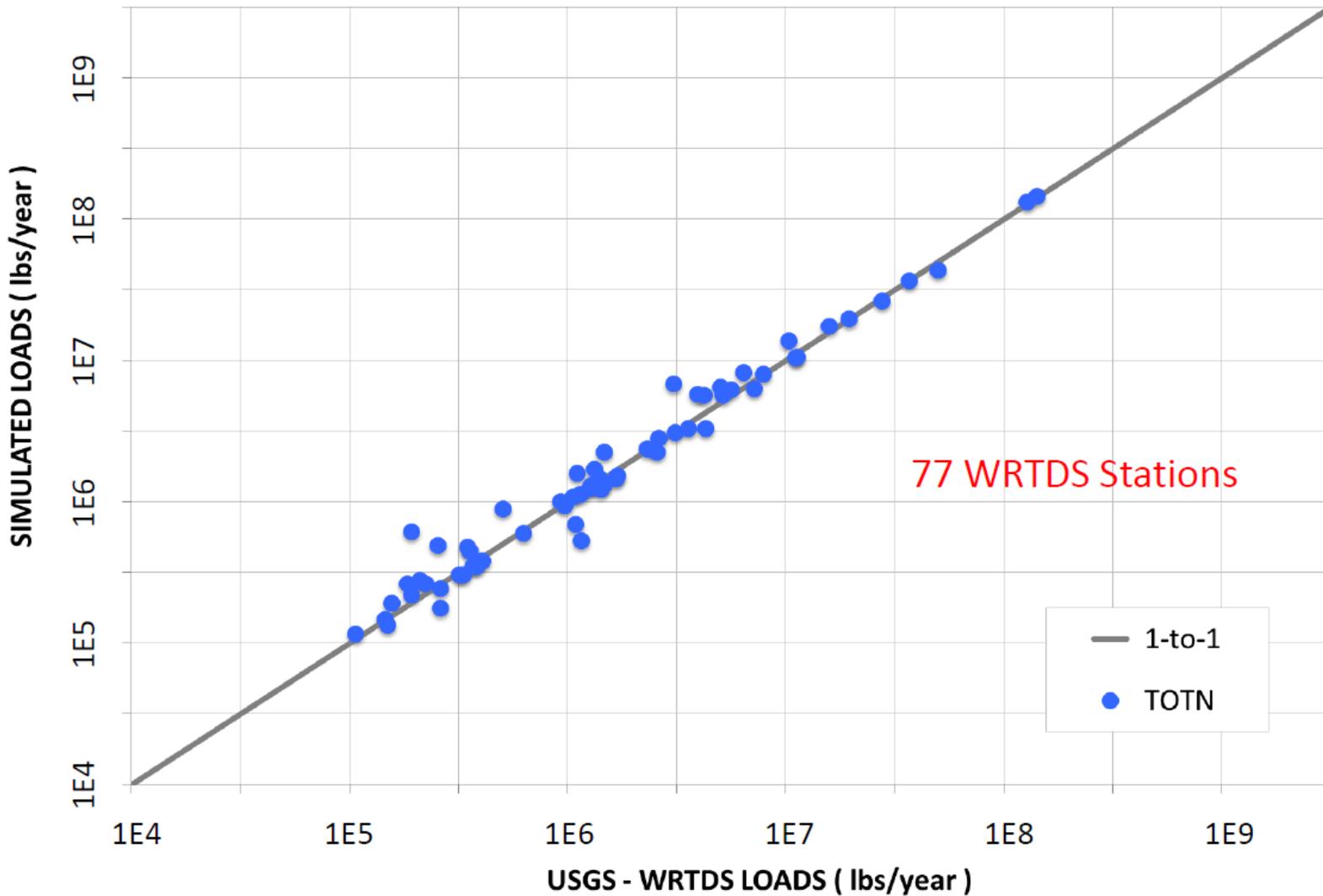
Heavily-Calibrated Process Model

Lightly-Calibrated Stakeholder Model

# Process Model

# NITROGEN





# On Line Version -- CAST



## Chesapeake Assessment Scenario Tool

[About CAST](#)
[Scenarios](#)
[Costs](#)
[Scenario Worksheets](#)
[Scenario Results](#)

[Log Out](#) | [Edit Profile](#)

### Dauphin County Summary Results

[Help](#)

**Description:** Irseg base loads  
**Initial Conditions:** 2017, revised: 4/2016  
**Date Created:** 5/4/2016 10:25:23 AM

[Download Results](#) | [Compare Scenarios](#)

#### Total Loads

Load Type	Lbs Nitrogen Edge of Stream	Lbs Nitrogen Delivered	Lbs Phosphorus Edge of Stream	Lbs Phosphorus Delivered	Lbs Sediment Edge of Stream	Lbs Sediment Delivered
Landuse	6,513,592.7	5,271,385.8	197,995.9	76,354.8	137,419,842.9	53,823,104.8
Septic	141,079.6	114,690.5	0.0	0.0	0.0	0.0
Waste Water and Combined Sewer Output	1,487,025.4	1,236,710.8	216,146.1	83,354.6	12,325,864.3	4,827,660.2
<b>Total:</b>	<b>8,141,697.7</b>	<b>6,622,787.1</b>	<b>414,142.0</b>	<b>159,709.4</b>	<b>149,745,707.2</b>	<b>58,650,765.0</b>

#### Total Annualized Costs

Sector	Total Annualized Cost
Urban Land	
Septic	



# Screenshots – Agriculture

## Agricultural Land BMP Worksheet

\* required fields Help

Select the BMP you would like to add\*

-- Please Select a BMP --

Select the land use or land use group you would like to apply the BMP to\*

-- Please Select a Land Use or Land Use Group --

Select the geographic scale you would like to use to determine the area for the BMP\*

-- Please Select a Geographic Scale --

Specify which geographic area you would like the BMP applied to\*

Enter an amount and select a unit for the BMP\*

Notes

Forest BMPs | Animal BMPs

## Agricultural Land Pre-BMP Acres

Land Use	Non-Federal	Federal
alfalfa	45,551.8	424.5
animal feeding operations	1,686.9	17.9
concentrated animal feeding operations	322.2	0.7
degraded riparian pasture	797.7	7.8
hay with nutrients	168,827.8	1,759.9
hay without nutrients	78,044.3	530.7
hightill with manure	963,715.6	5,170.8
hightill without manure	46,655.1	303.1
nursery	6,190.4	61.9
pasture	200,299.7	2,075.1
Total:	1,512,091.5	10,352.4

Download Land Use

Comment field to put consistent information that explains rationale behind numbers. Helps manage the large amount of information.

## BMP Data Submitted

BMP	Land Use Group	Geography	Unit	Total Amount	Notes	Annualized Cost Per Unit
Alternative Crops	Row crops-all	Caroline, MD	acres	34.18		\$18.24
Alternative Crops	Row crops-all	Cecil, MD	acres	13.01		\$18.24
Alternative Crops	Row crops-all	Dorchester, MD	acres	29.09		\$18.24
Alternative Crops	Row crops-all	Kent, MD	acres	30.22		\$18.24
Alternative Crops	Row crops-all	Queen Annes, MD	acres	34.39		\$18.24

# On Line Version -- BayFAST



*BAYFAST*

- About BayFAST
- Facilities
- Scenarios
- Costs
- Scenario Worksheets
- Scenario Results

Log Out | Edit Profile

## York City Location

When you are finished editing your parcel, please click off the parcel to deselect it and save the edits.

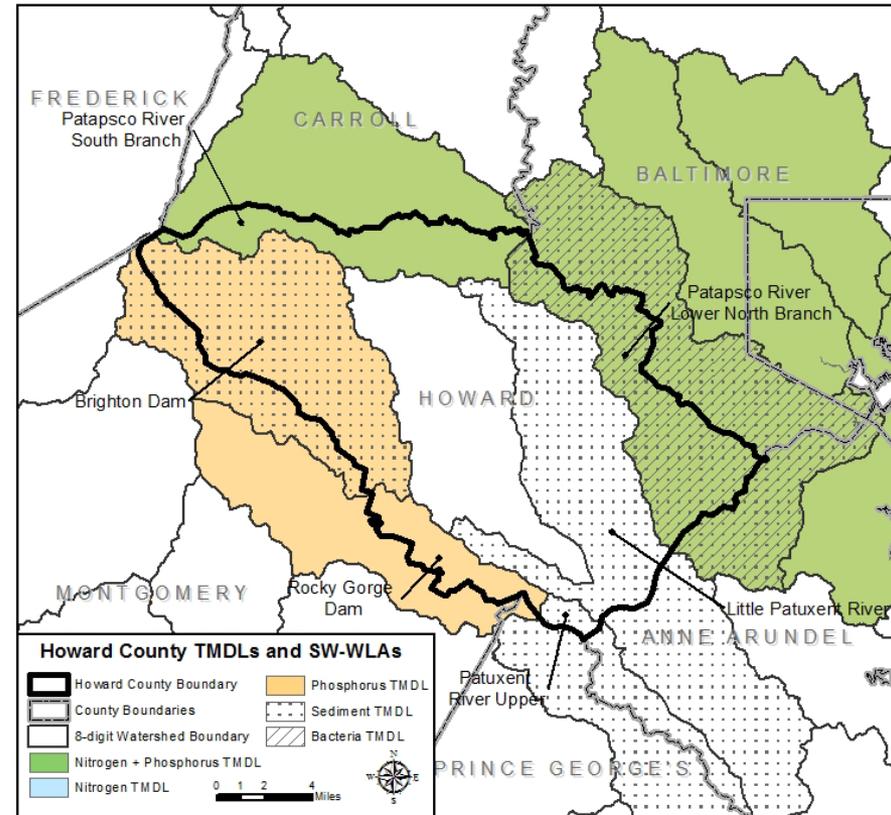
Help

- Save
- Reset
- Cancel

The map interface displays a satellite view of the York City area. A large parcel in the center is highlighted in light blue. A search bar is located in the top right corner. A menu titled 'Edit Parcels' is open on the left side, showing a blue triangle icon and the text 'Click to add a parcel'. Below the menu are three icons: a right-pointing arrow, a red 'X', and a green arrow pointing to the right. The map includes labels for various locations such as Newberrytown, Pinetown, York Haven, Conewago Heights, Manchester, Emigsville, North York, East York, York, West York, Valley View, Grantley, Spring Garden, and Thomasville. Major roads like Memorial Hwy, E Canal Rd, Lincoln Hwy, and I-83 are also labeled. The Susquehanna River is visible on the right side of the map.

# Howard County (BayFAST)

- Seven Local TMDLs:
  - Baltimore Harbor
  - Little Patuxent
  - Patapsco LNB
  - Upper Patuxent
  - Rocky Gorge
  - Triadelphia

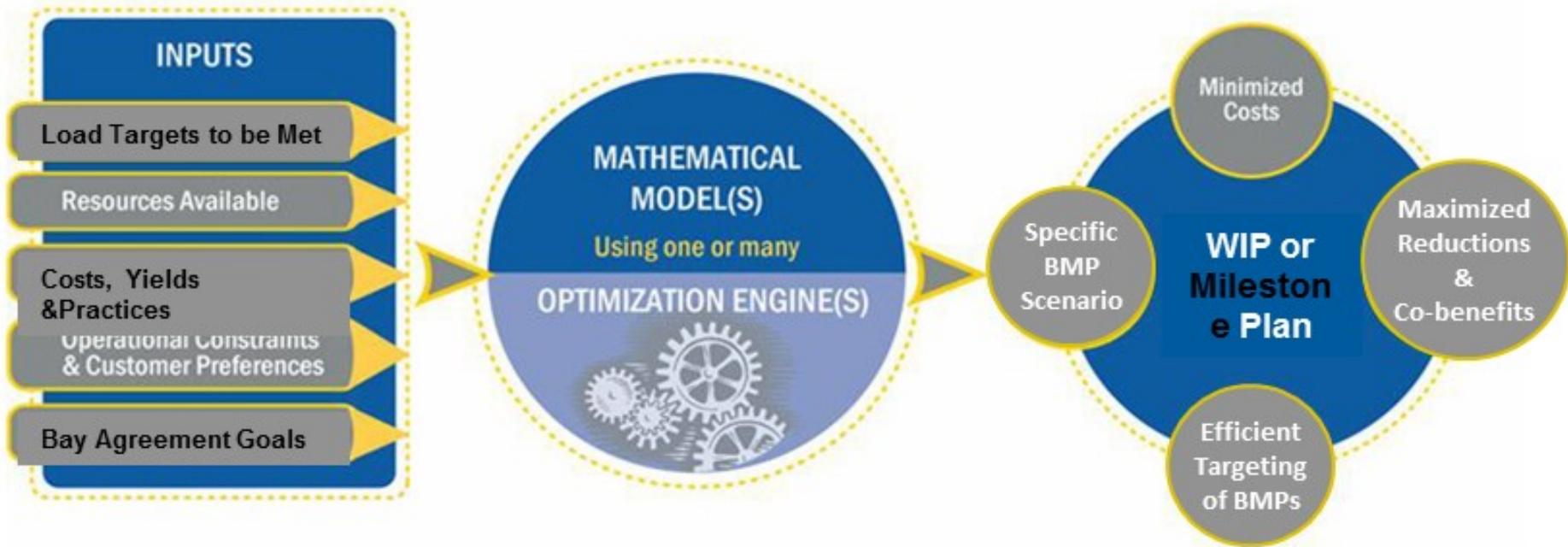


*William Frost, PE, D.WRE, Senior Water Resources Engineer, KCI Technologies, Inc.*

*Megan Crunkleton, CE, Project Scientist, KCI Technologies, Inc.*

# OPTIMIZATION Calculation Engine

Users input objectives, tool outputs BMPs in the plan that maximize effectiveness at minimum cost.



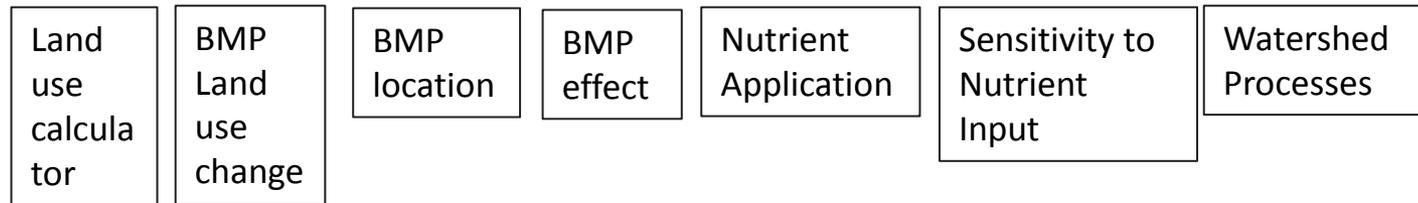
\* Still in vaporware stage

# CAST = WSM = Scenario Builder

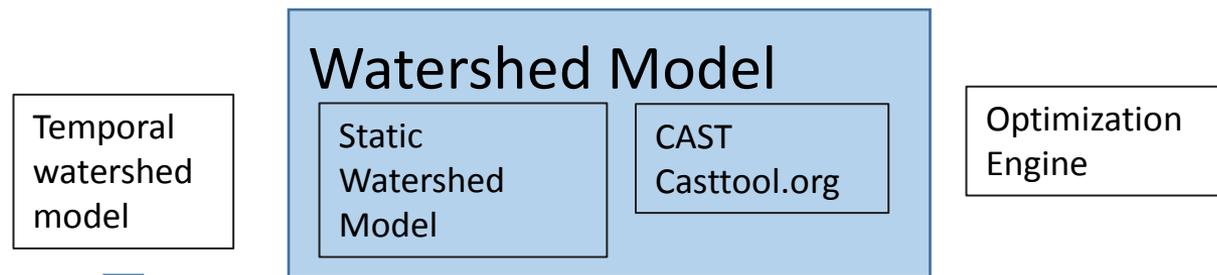
## Data



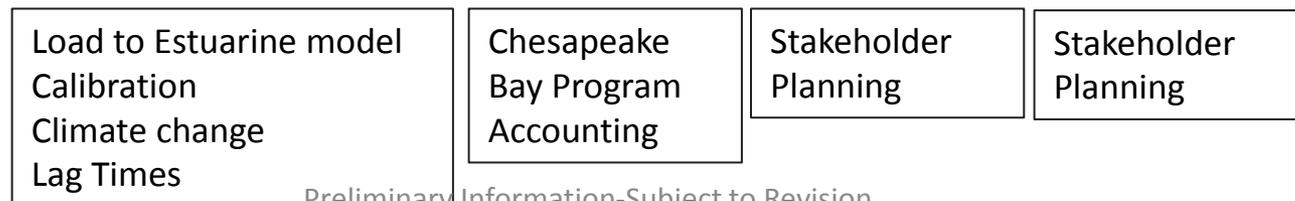
## Logic Engines



## Tools



## Products

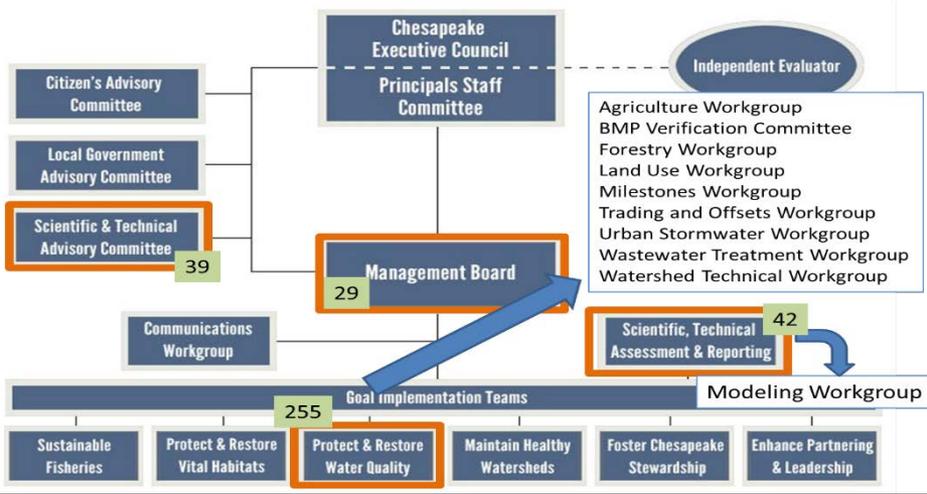


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# Extensive partnership involvement...

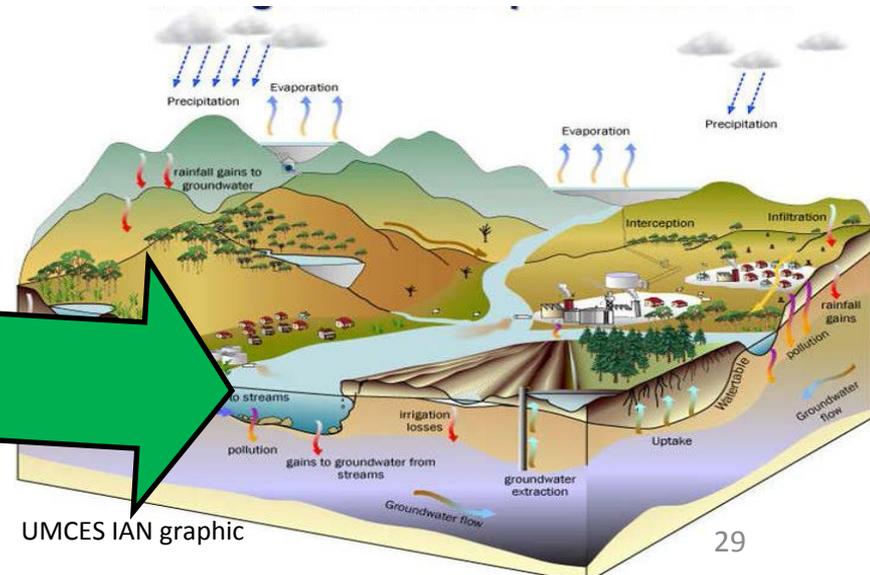
Model-Related Participants as of 7/2013 – 365 individuals

## Chesapeake Bay Program Partnership



...Which Leads to a robust model of the watershed

...Leads to collaborative thinking...



UMCES IAN graphic