Agricultural Modeling vs Monitoring—What's Really Happening in the Chesapeake Bay?

Dana York, President, Green Earth Connection

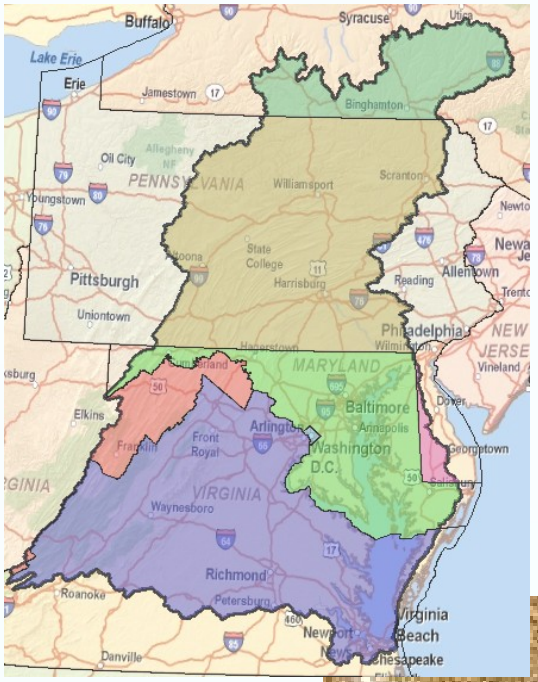
Green Earth CONNECTION

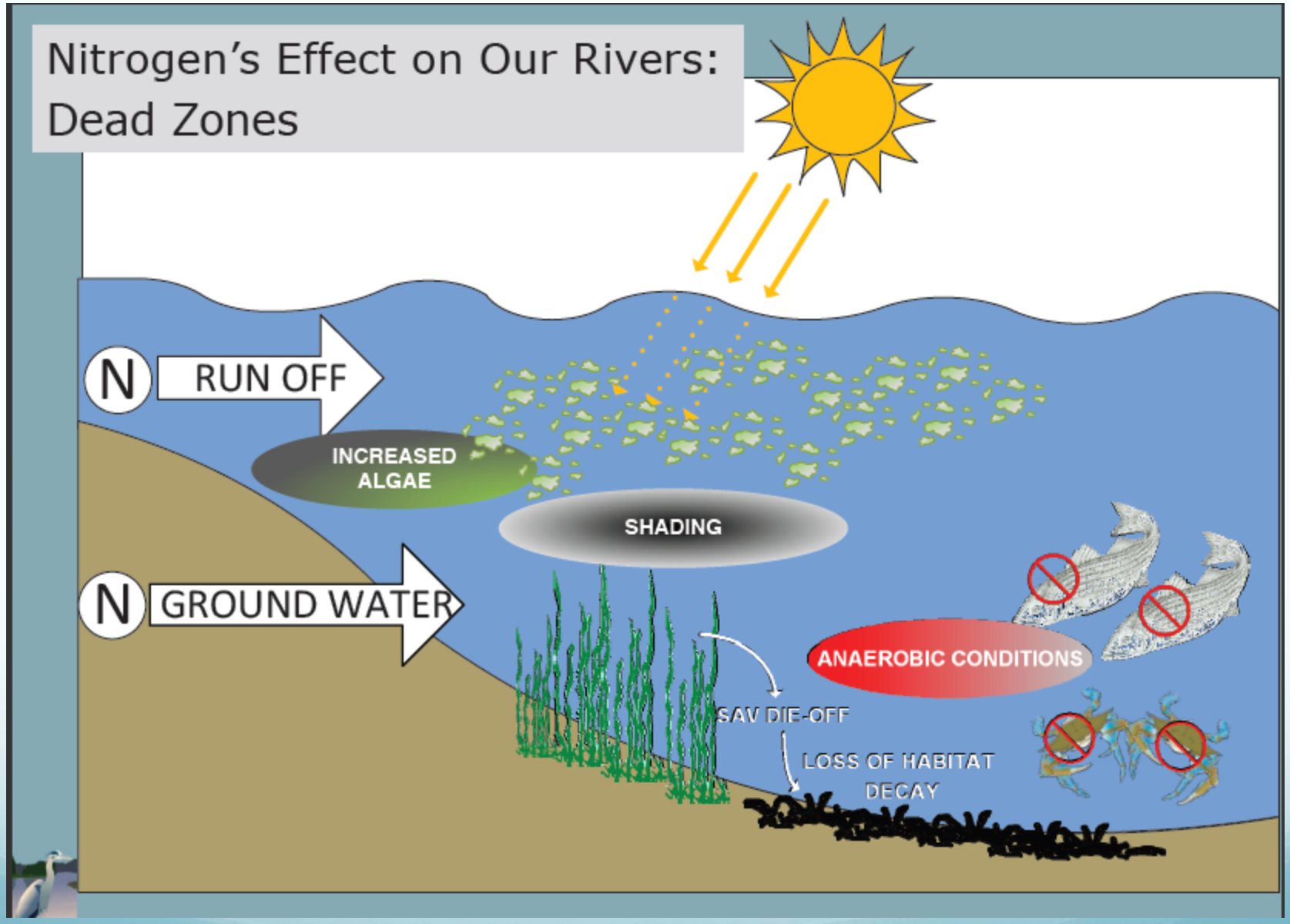
Monitoring

- **Monitoring is important in determining the success or failure of actions taken to resolve water quality problems.**
- **"Agricultural Monitoring" can take several forms.**
- **The Water Quality issues surrounding the Chesapeake Bay TMDL have intensified the need for data.**
- **In this presentation we will discuss:**
  - **How the TMDL and WQ Monitoring has affected Agriculture implementation.**
  - **How the Chesapeake Bay Partnership Model uses information.**
  - **How CBP Model assumptions and lack of data are important in comparing "model" results to "monitoring" results.**
  - **How "Water Quality Monitoring" results can be presented to prevent confusion.**
  - **"New" tools to help inform farmers about nutrient and sediment losses on their land.**
  - **The need for research on potential new WQ BMP's and the "benefits" to farmers using them.**

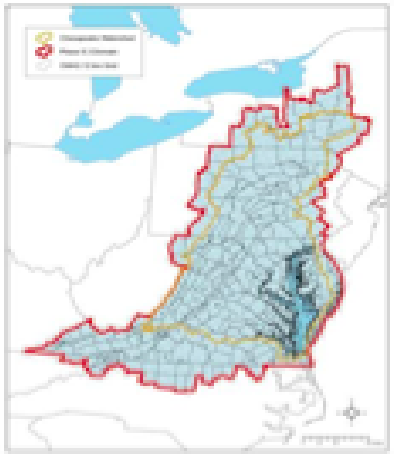
The Chesapeake Bay

- For more than **300 years**, the Bay and its tributaries have **sustained the region's economy** and defined its traditions and culture.
- It is 64,000 Square Miles and the largest **most biologically diverse estuary** in North America and the third largest in the world.
- **Land-to-water ratio is 14:1**; largest of any coastal water body in the world. **Average depth of 21 feet.**
- Supports more than **3,600 species of plants, fish and animals**
- The Bay watershed is home to almost **17 million people. About 150,000 new people** move into the watershed each year.
- **Tens of thousands of streams, creeks, and rivers** are resources for communities throughout the watershed.
- **77,000 principally family farms**.



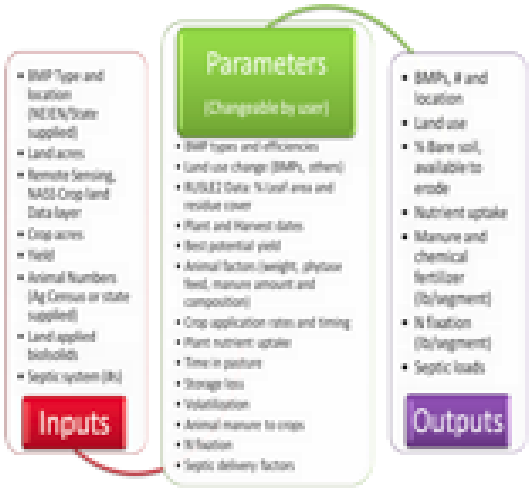

Nitrogen's Effect on Our Rivers:
Dead Zones
N
RUN OFF
INCREASED ALGAE
SHADING
N
GROUND WATER
ANAEROBIC CONDITIONS
SAV DIE-OFF
LOSS OF HABITAT
DECAY

Chesapeake Bay Partnership Model

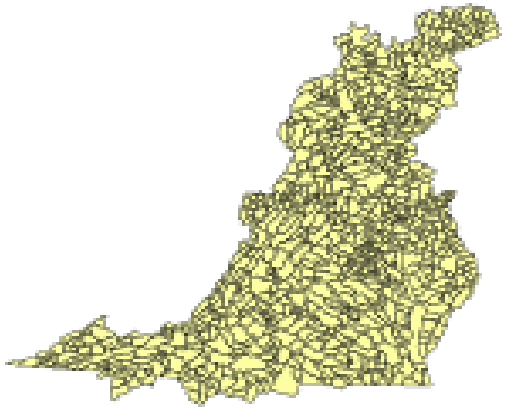


Chesapeake Bay Airshed Model

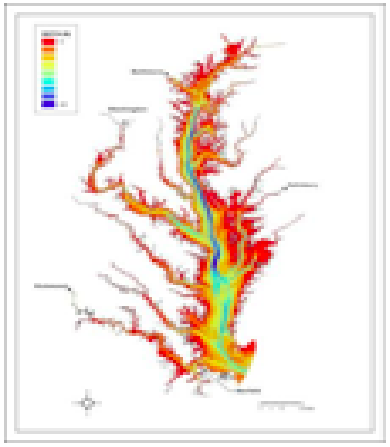
Chesapeake Bay Land Change Model



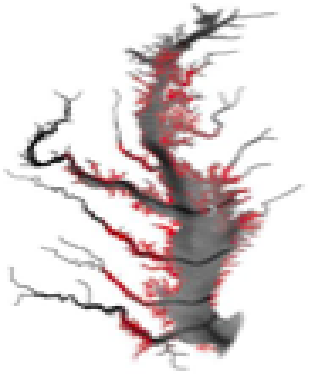
Chesapeake Bay Scenario Builder



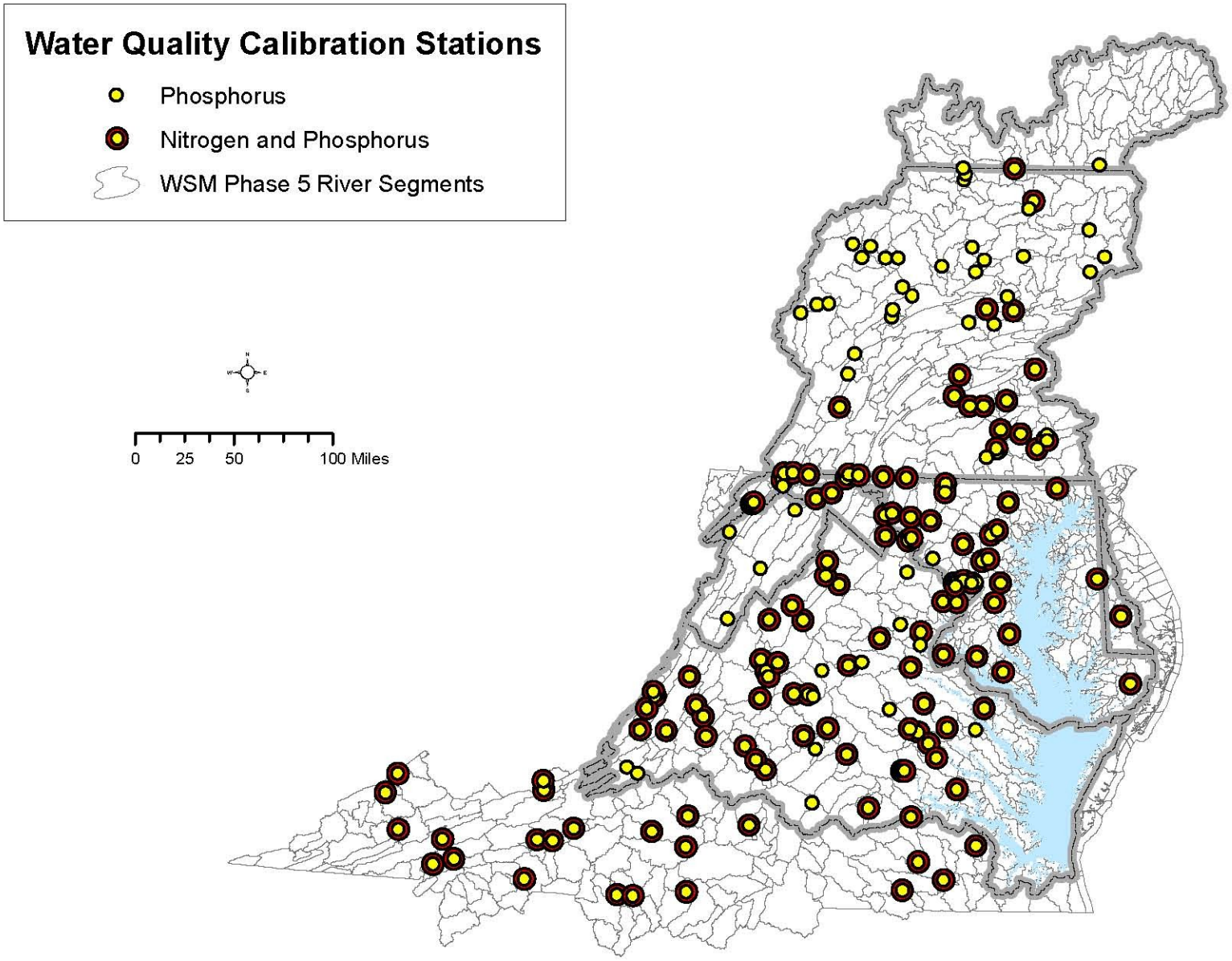
Chesapeake Bay Watershed Model



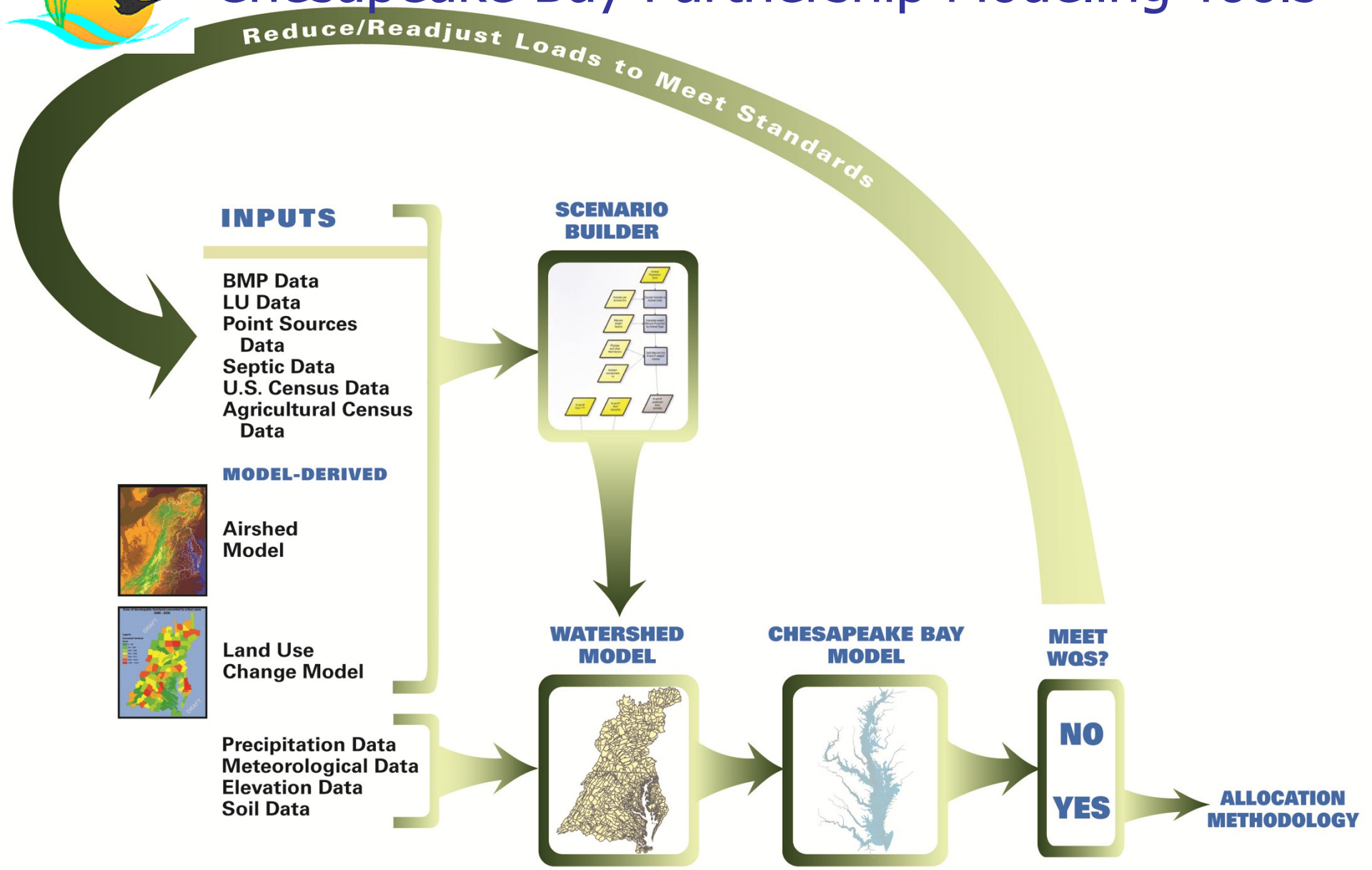
Chesapeake Bay Water Quality and Sediment Transport Model



Chesapeake Bay Filter Feeder Model

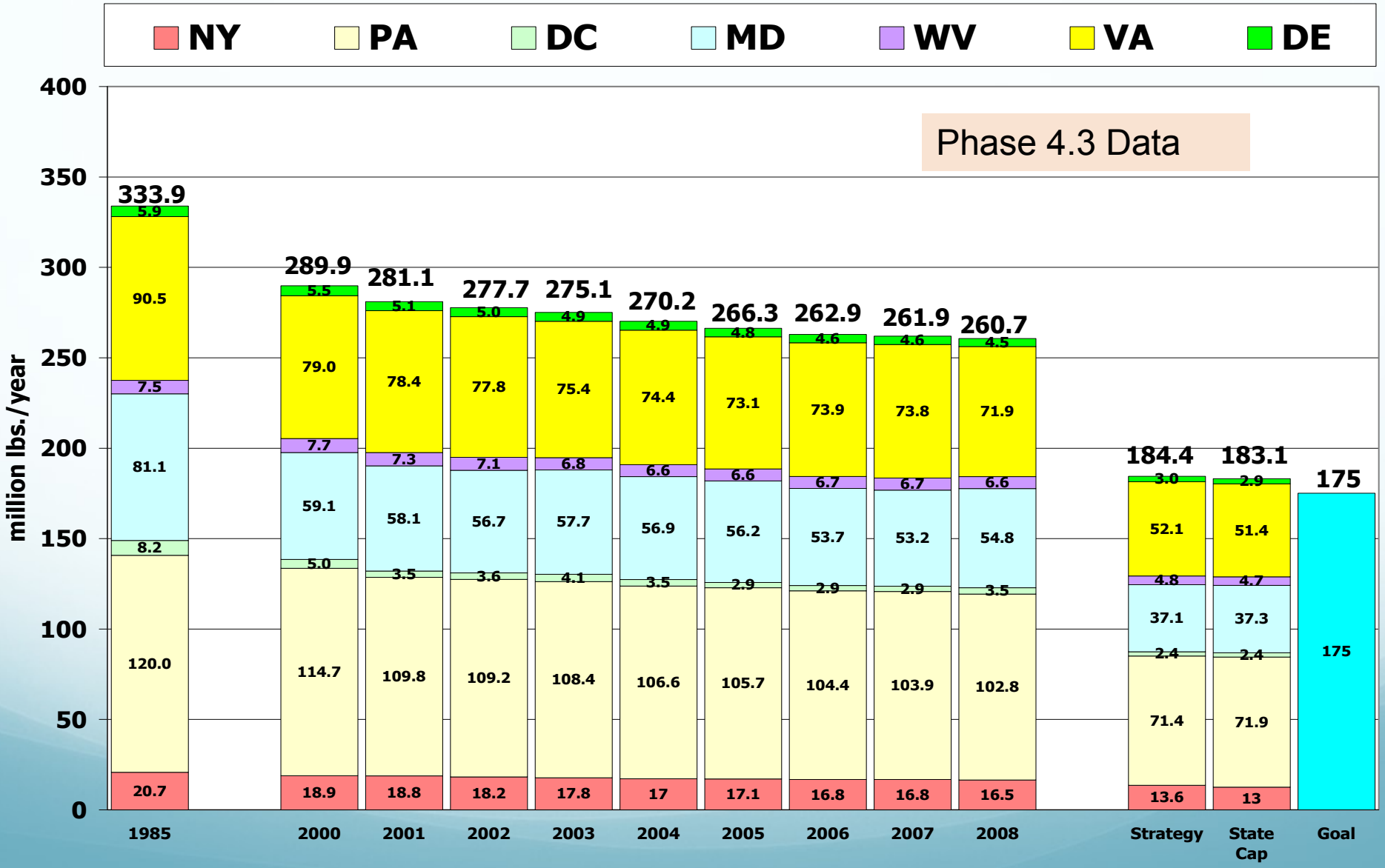

Water Quality Calibration Stations
Phosphorus
Nitrogen and Phosphorus
WSM Phase 5 River Segments
0
25
50
100 Miles

Chesapeake Bay Partnership Modeling Tools



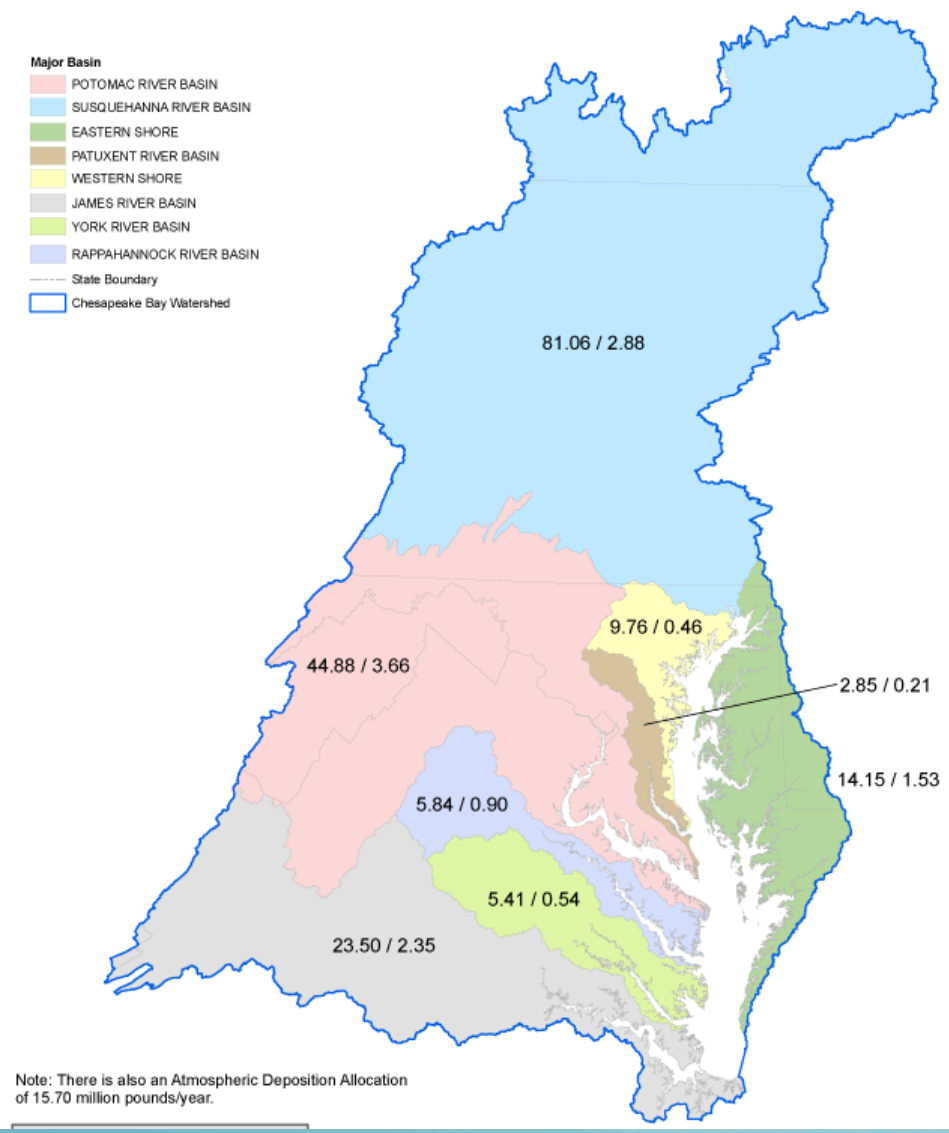
Nitrogen Loads Delivered to the Chesapeake Bay By Jurisdiction

Point source loads reflect measured discharges while
nonpoint source loads are based on an average-hydrology year

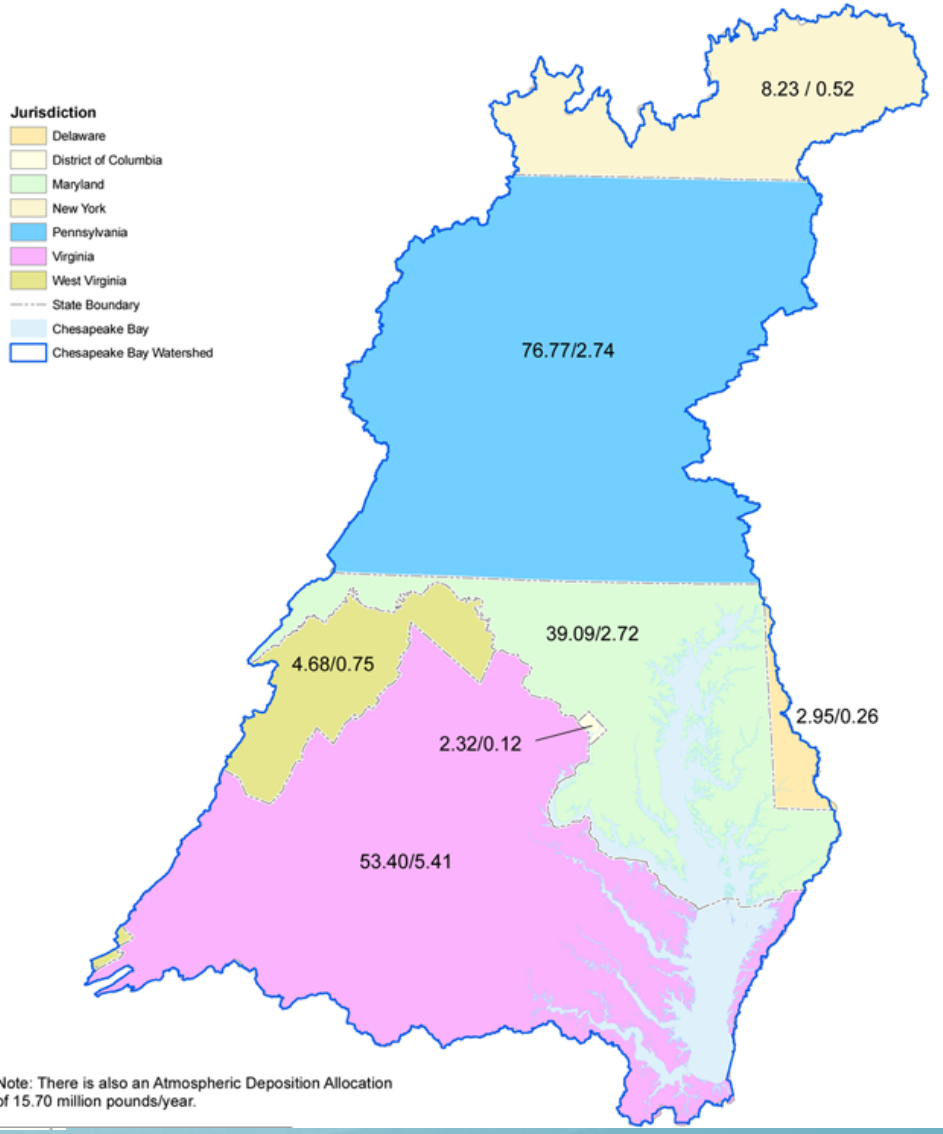


Pollution Diet by River

N/P in Millions of Pounds per Year
Phase 1 WIP's--- Model 5.3.0



Pollution Diet by State



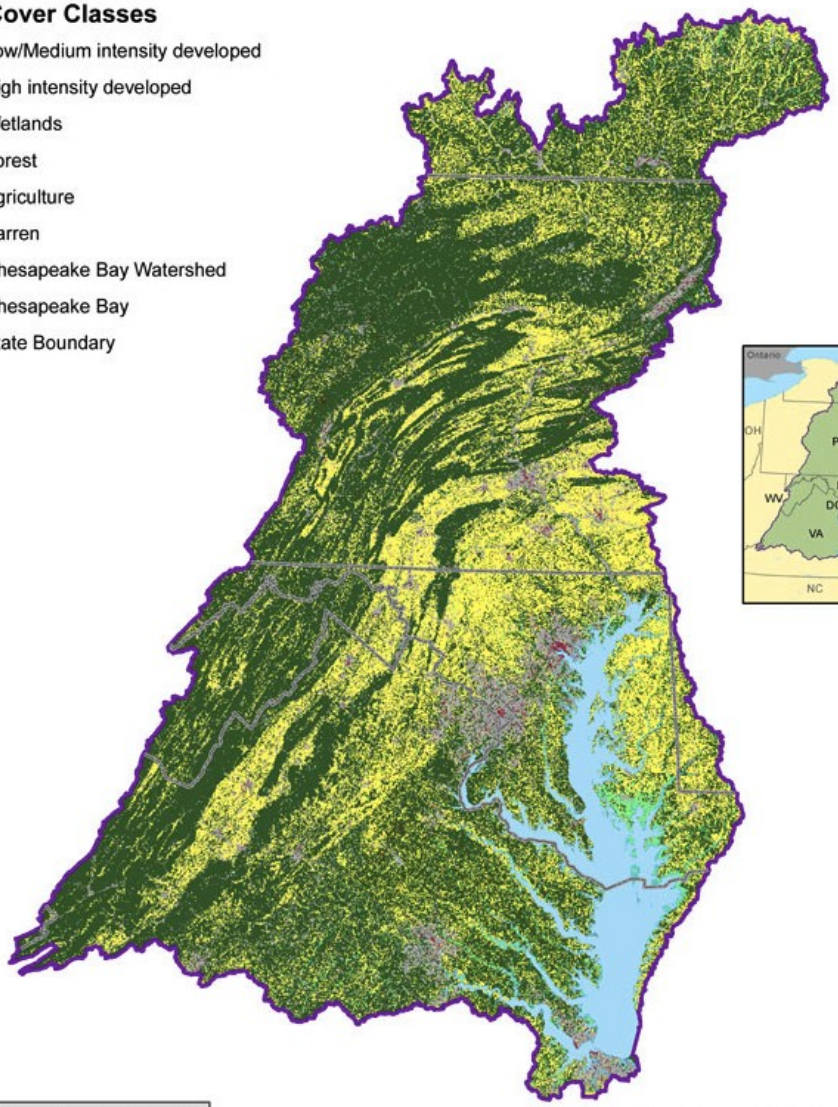
Land Cover

Chesapeake Bay Watershed

Chesapeake Bay Program
A Watershed Partnership

Land Cover Classes

- Low/Medium intensity developed
- High intensity developed
- Wetlands
- Forest
- Agriculture
- Barren
- Chesapeake Bay Watershed
- Chesapeake Bay
- State Boundary



Data Sources: Chesapeake Bay Program, National Land Cover Data 2001

For more information, visit *www.chesapeakebay.net*

0 25 50 100 Kilometers

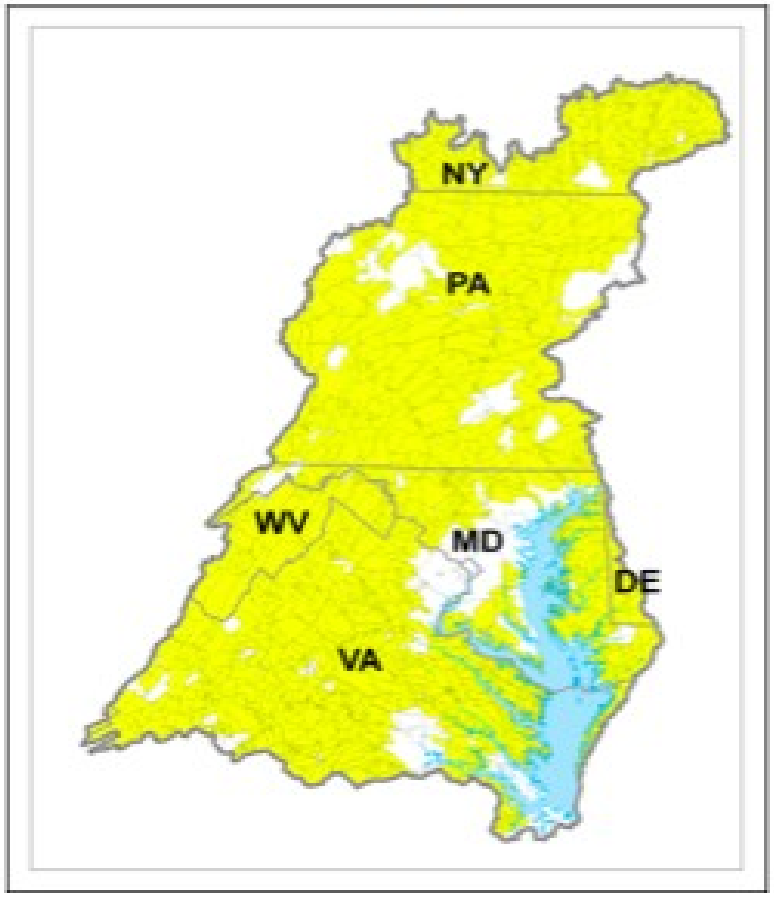
0 25 50 100 Miles

N

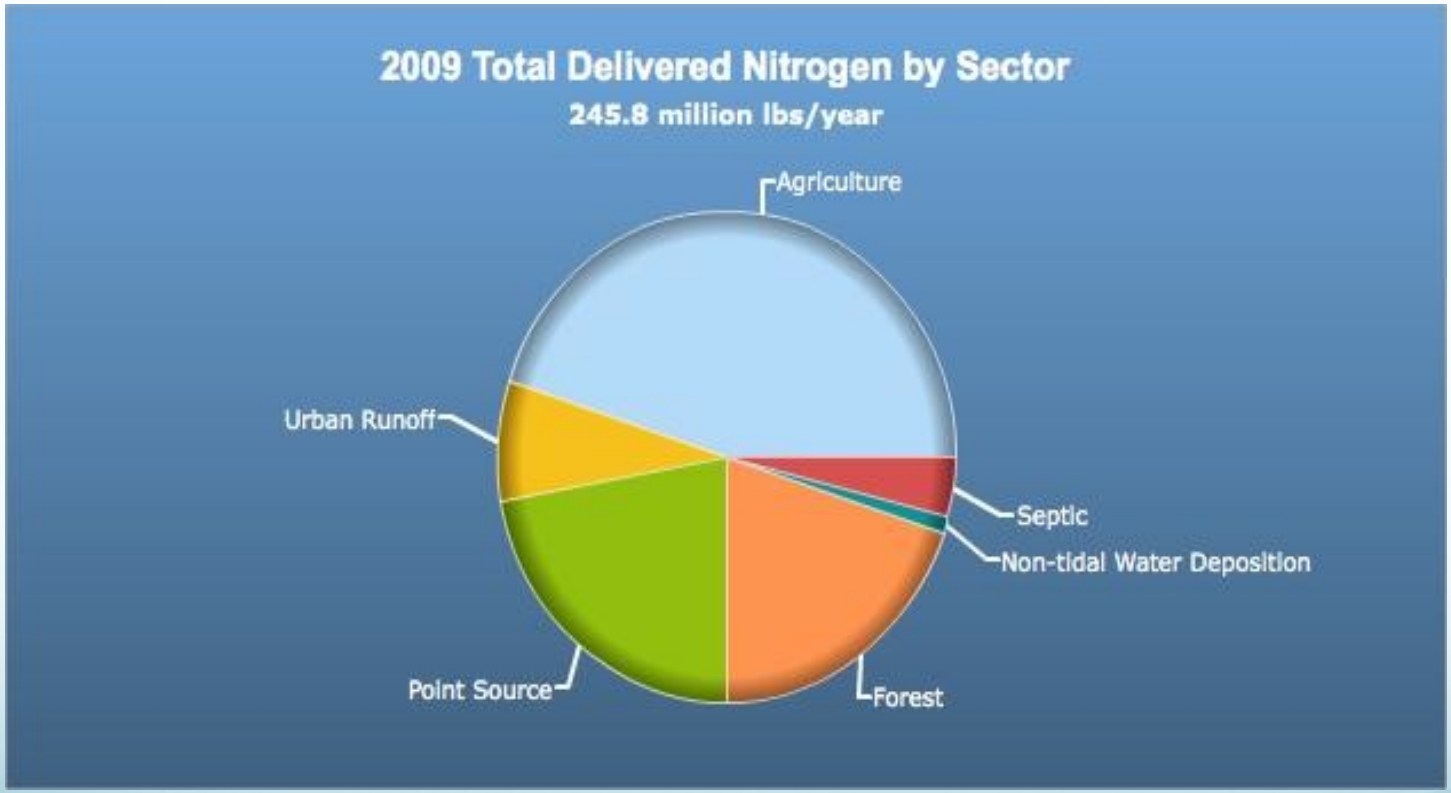
Created by EA, 1/23/08

UTM Zone 18N, NAD 83

>50% of Managed Lands in Ag

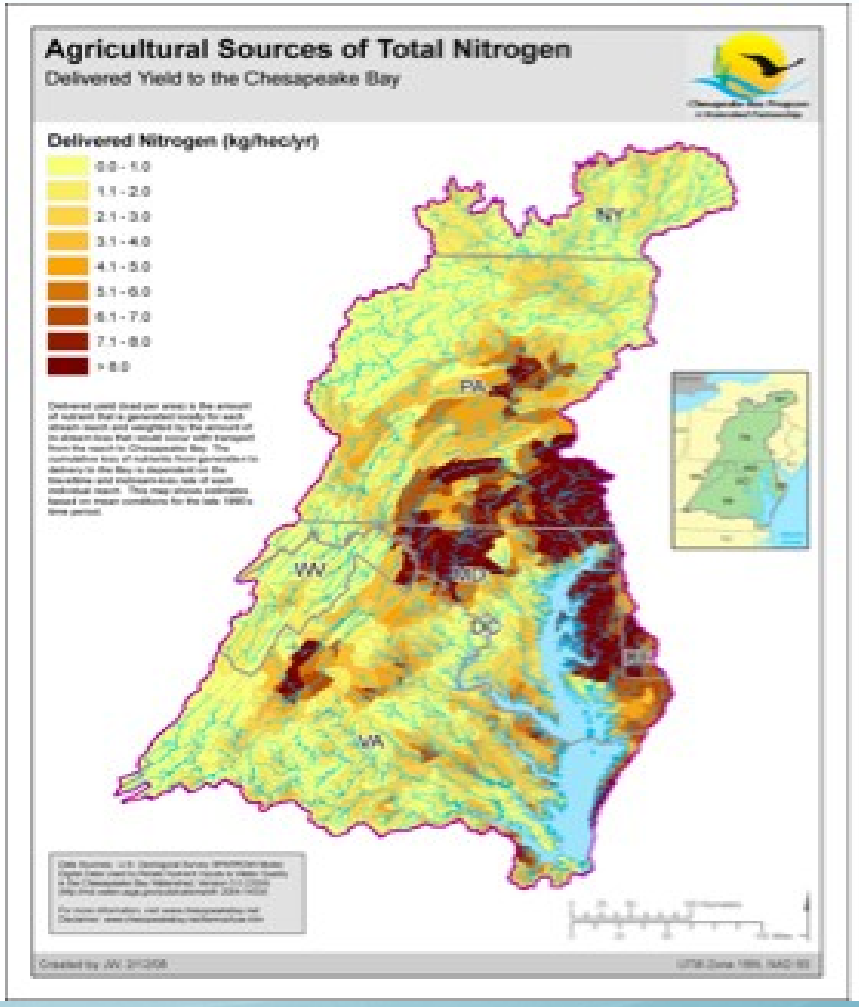


Nitrogen Delivery By Sector

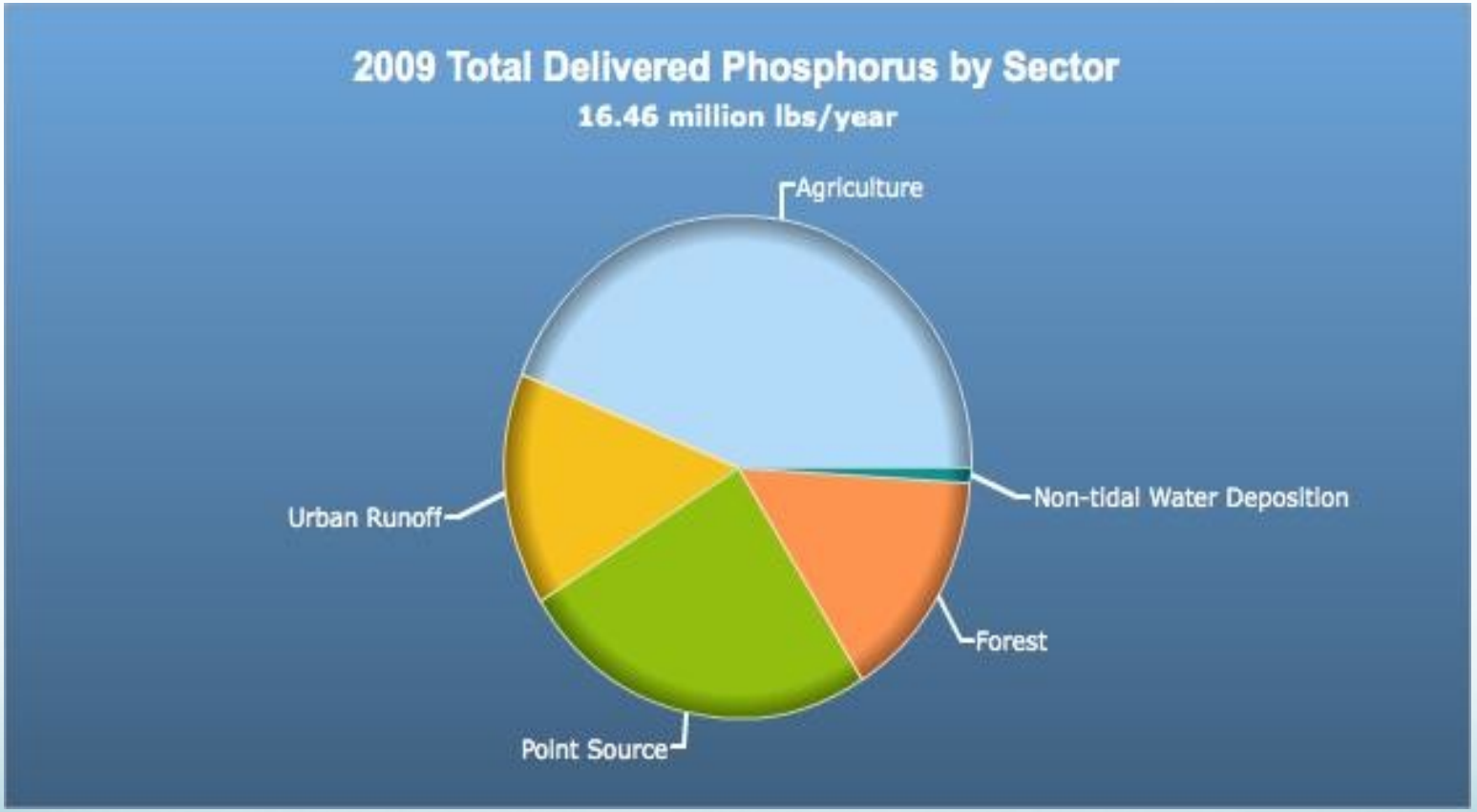


Regional Delivered Nitrogen

SPARROW
Total Delivered
Yield of Nitrogen
from Agricultural
Sources

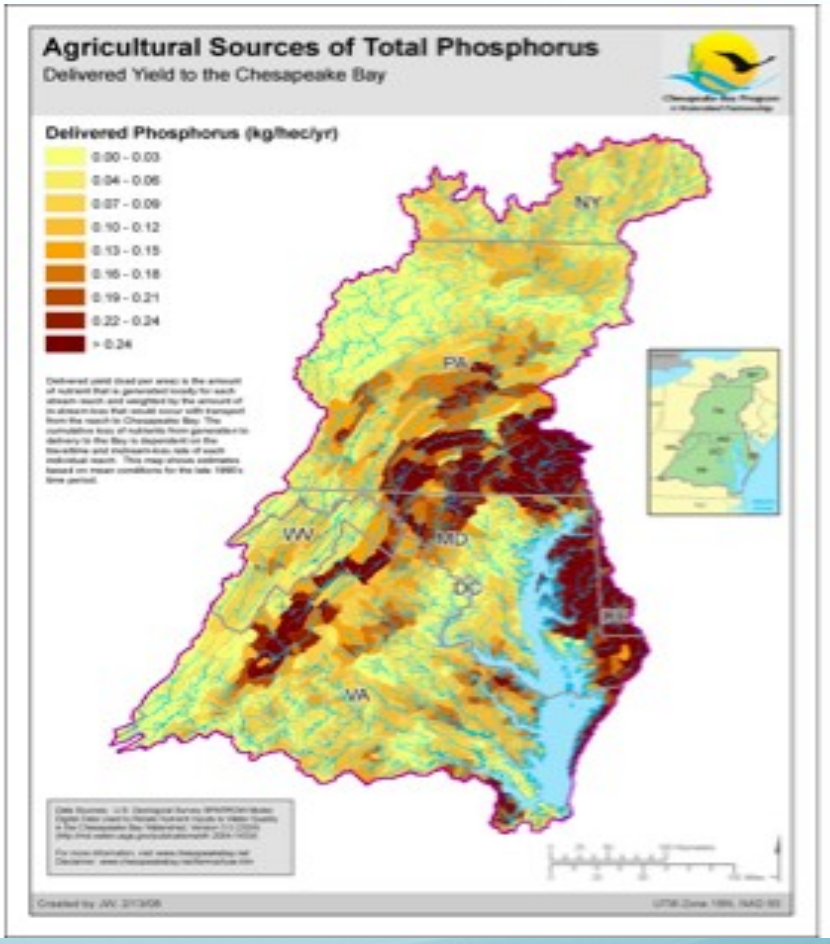


Phosphorous Delivery By Sector



Regional Delivered Phosphorous

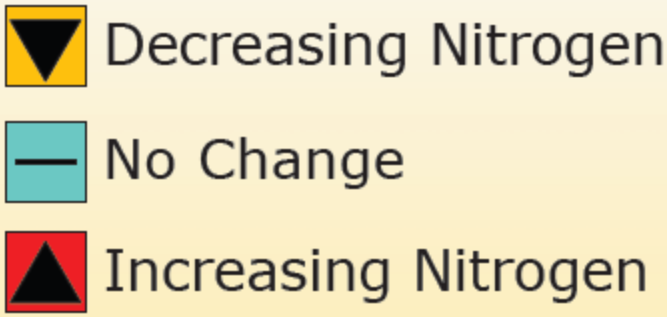
SPARROW Total Delivered Yield of Phosphorous from Agricultural Sources

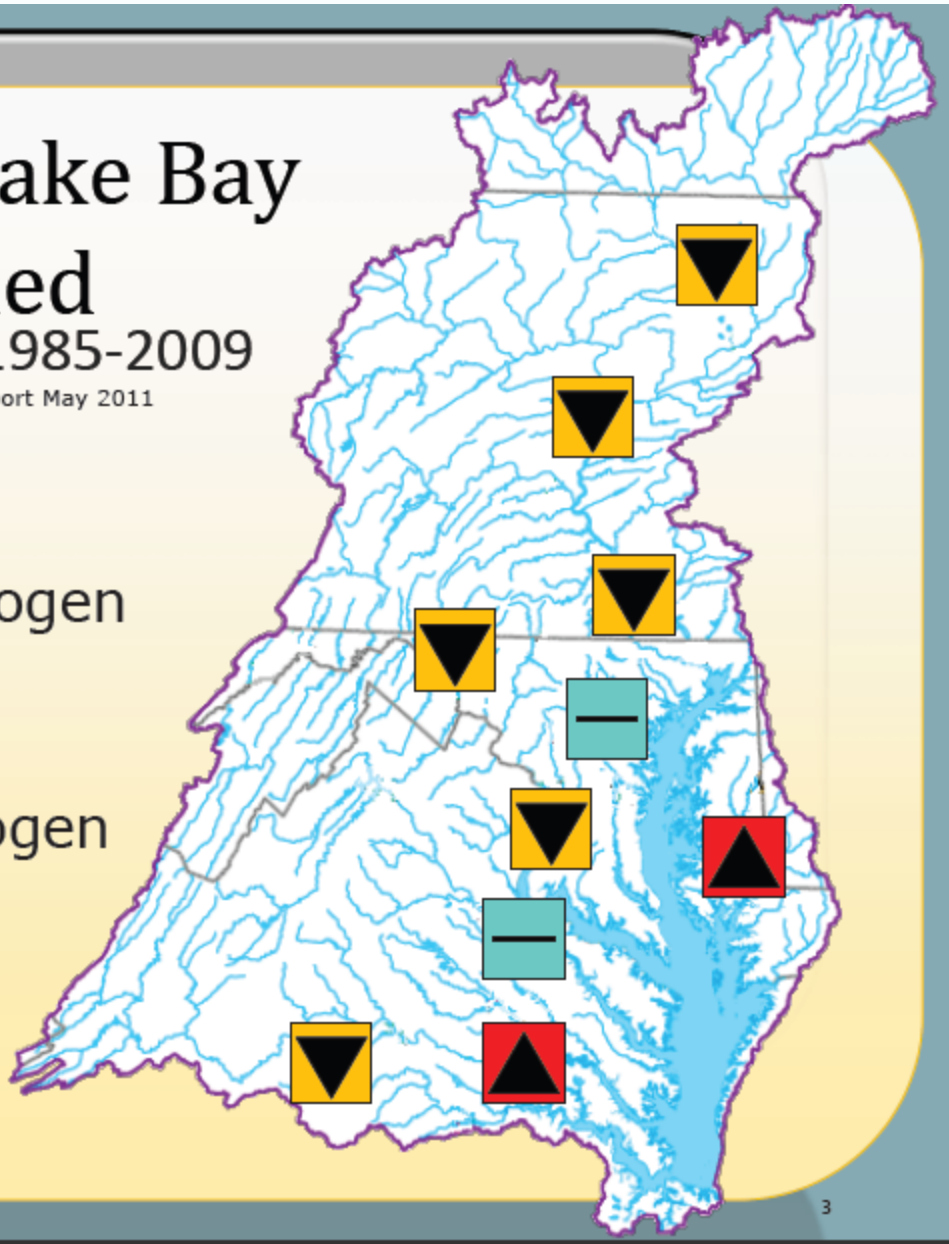


Chesapeake Bay Watershed

Nitrogen Trend 1985-2009

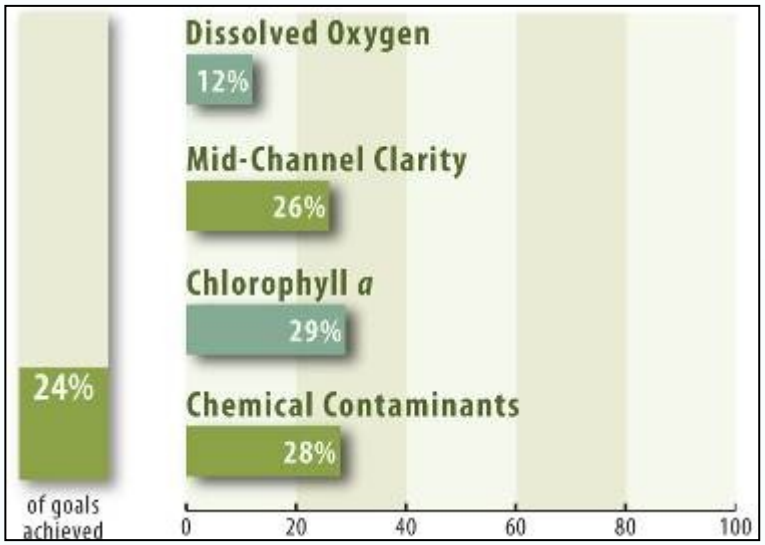
Source: US Geological Survey Report May 2011



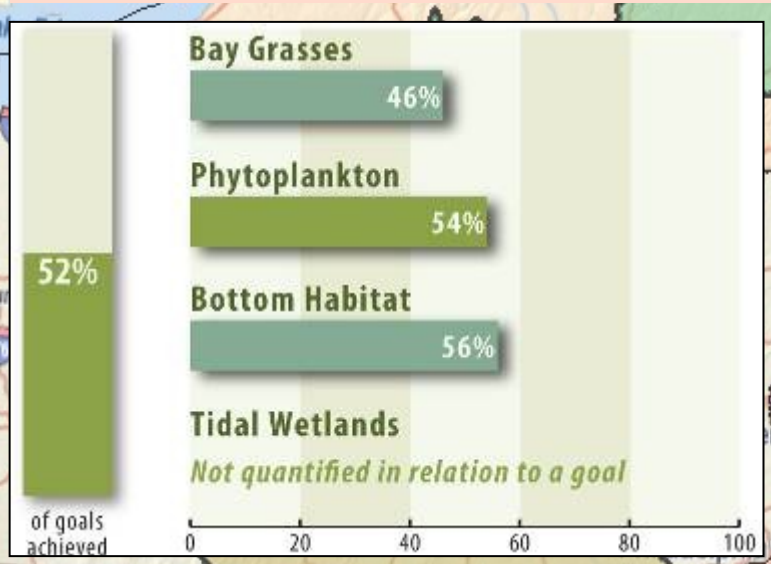


Bay Measures- 2009

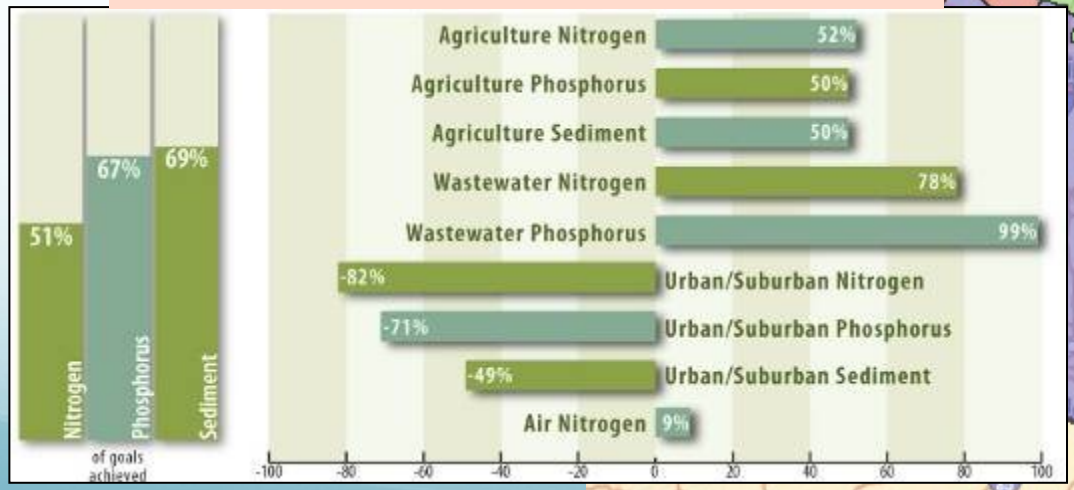
Water Quality



Habitats/Lower Food Web



Reducing Pollution

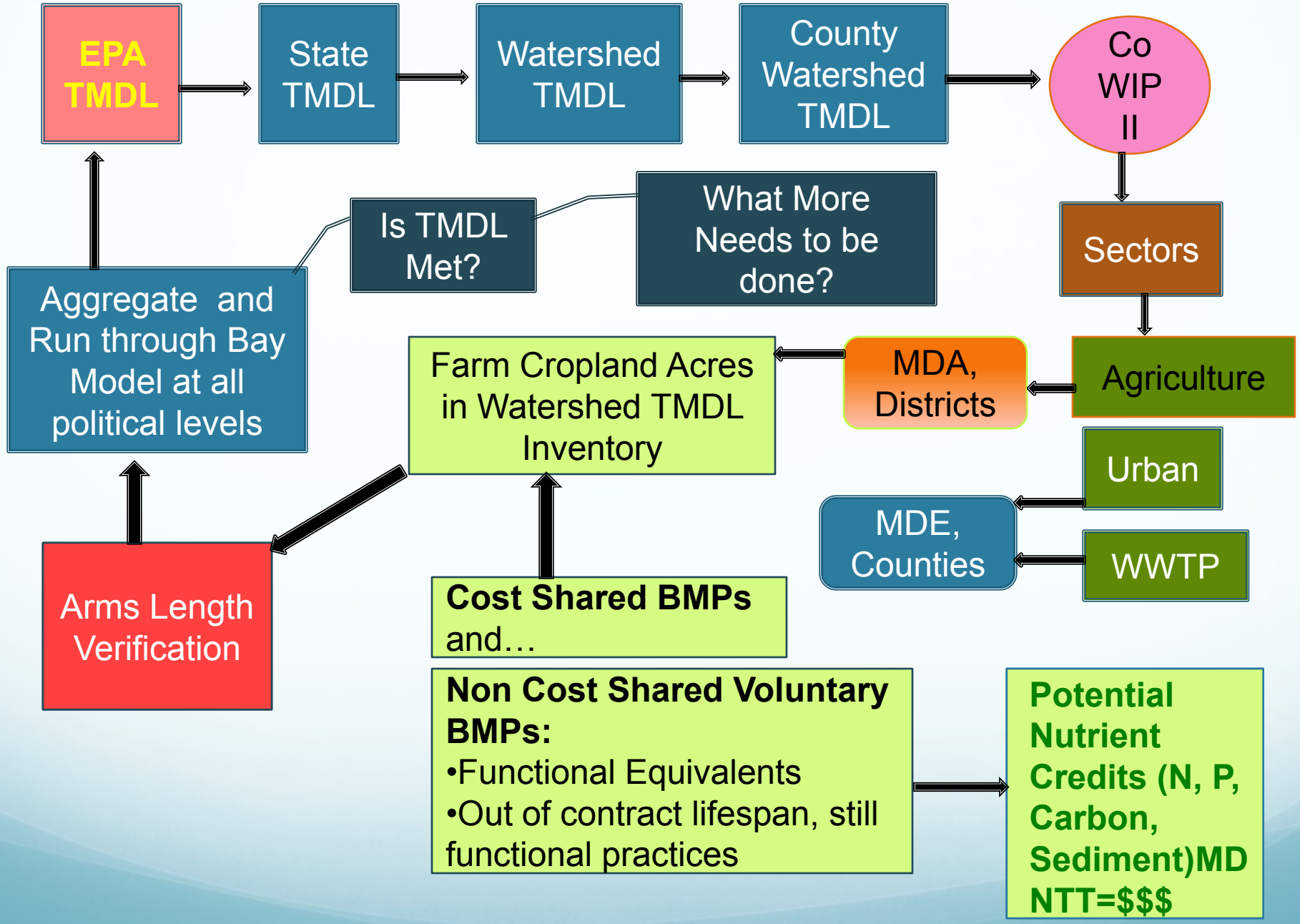


What is the Chesapeake Bay TMDL?

- **Referred to as a "pollution diet" for the Chesapeake Bay, TMDL is the Total Maximum Daily Load of nutrients and sediment that can enter the Bay while still achieving water quality standards.**
  - **Established by the EPA under authority of the federal Clean Water Act of 1972.**
  - **Responds to consent decrees in federal court cases due to insufficient progress and poor water quality in the Bay, despite extensive restoration efforts over the past 25 years.**
  - **The Chesapeake Bay TMDL identifies pollution reductions for the entire Bay watershed, including part of six states (Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia) and the District of Columbia. Adopted in 2010, it is the largest TMDL ever developed by the EPA.**
  - **The plan requires full implementation by 2025, with at least 60 percent of actions completed by 2017.**
  - **Two year milestones to measure incremental progress.**
  - **The EPA established specific watershed-wide pollution reduction goals for the Bay:**
    - **25 percent reduction in nitrogen.**
    - **24 percent reduction in phosphorus.**
    - **20 percent reduction in sediment.**
  - **The Bay TMDL is comprised of 92 smaller TMDLs for individual segments,**

Watershed Implementation Plans

- **The Bay TMDL requires all states in the Chesapeake Bay region to develop Watershed Implementation Plans (WIP) to meet specific pollution reduction goals.**
  - **The WIP details how and when the states will meet pollution allocations for each sector in each waterway segment.**
  - **The Watershed Implementation Plan includes specific strategies for each of the major sources of pollution in the Chesapeake Bay Watershed. The four major sectors are:**
    - **Wastewater treatment plants.**
    - **Agricultural runoff.**
    - **Urban/suburban storm water runoff.**
    - **Onsite wastewater/septic systems.**

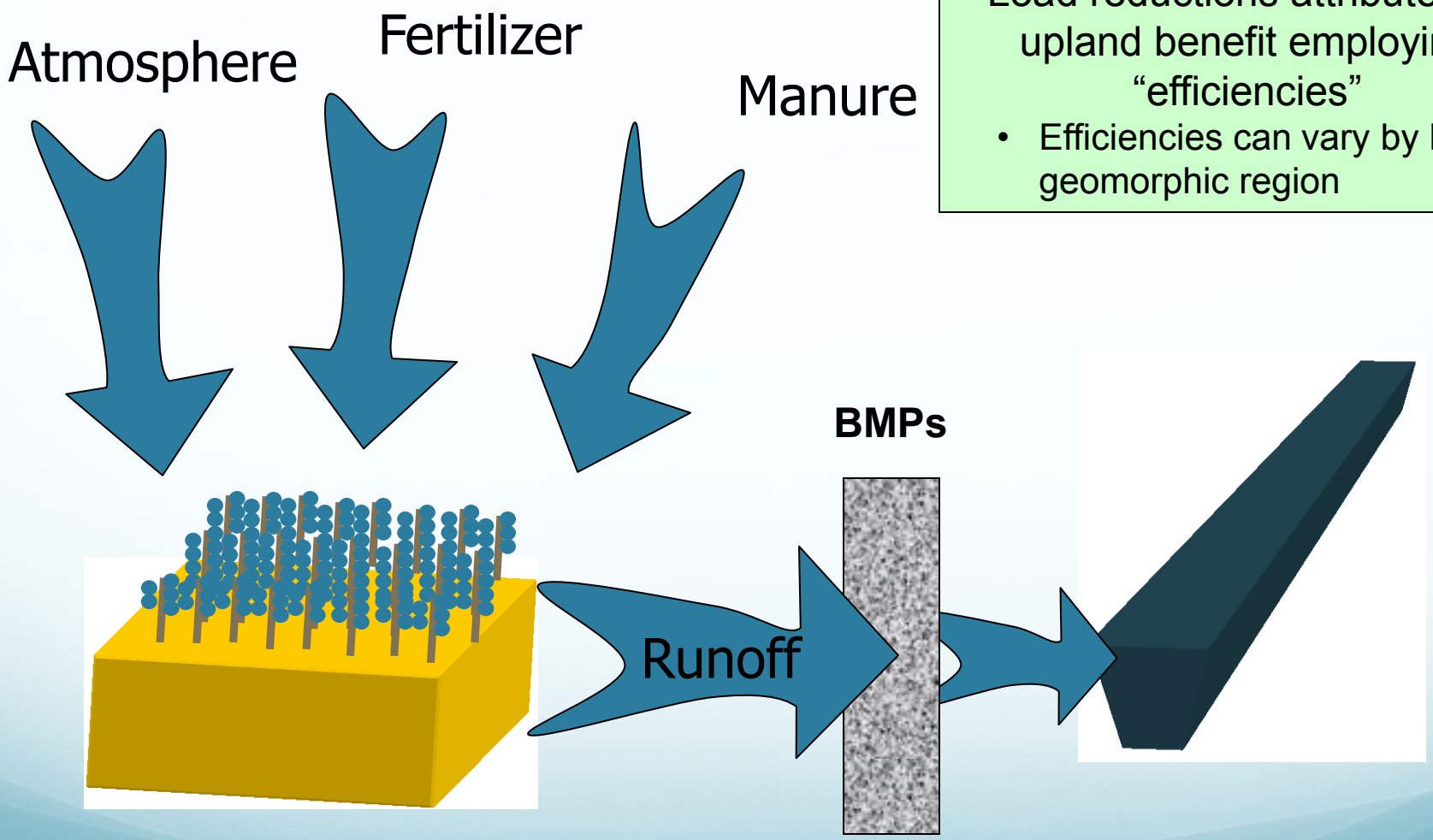

EPA TMDL
State TMDL
Watershed TMDL
County Watershed TMDL
Co WIP II
Sectors
Agriculture
MDA, Districts
Farm Cropland Acres in Watershed TMDL Inventory
Aggregate and Run through Bay Model at all political levels
Is TMDL Met?
What More Needs to be done?
Urban
MDE, Counties
WWTP
Arms Length Verification
Cost Shared BMPs and…
Non Cost Shared Voluntary BMPs:
•Functional Equivalents
•Out of contract lifespan, still functional practices
Potential Nutrient Credits (N, P, Carbon, Sediment)MD NTT=$$$

Non-Point Source Practices and Programs

Practices With Nutrient and Sediment Reduction Efficiencies

Load reductions attributed to upland benefit employing "efficiencies"

- Efficiencies can vary by hydro-geomorphic region



Current Agricultural BMP List in Model

Nutrient Management

- Nutrient Management
- Precision Agriculture
- Enhanced Nutrient Management

Conservation Tillage

- Continuous No-Till
- Conservation Tillage

Cover Crops

- Cover Crops – Late Planting
- Cover Crops – Early Planting
- Small Grain Enhancement – Late Planting
- Small Grain Enhancement – Early Planting

Pasture Grazing BMPs

- Alternative Watering Facilities
- Stream Access Control with Fencing
- Prescribed Grazing
- Precision Intensive Rotational Grazing
- Horse Pasture Management

Other Agricultural BMPS

- Forest Buffers
- Wetland Restoration
- Land Retirement
- Grass Buffers
- Forest Buffers
- Tree Planting
- Carbon Sequestration/Alternative Crops
- Conservation Plans/SCWQP
- Animal Waste Management Systems
- Mortality Composters
- Water Control Structures
- Non-Urban Stream Restoration
- Poultry Phytase
- Poultry Litter Management
- Dairy Precision Feeding and Forage Management
- Swine Phytase
- Ammonia Emissions Reductions

Chesapeake Bay Program Watershed Model Urban/Suburban BMPs – Current List

Other Urban/Suburban BMP

- Forest Conservation
- Impervious Surface and Urban Growth Reduction
- Forest Buffers (Urban)
- Tree Planting (Urban)
- Grass Buffers (Urban)
- Stream Restoration (Urban)
- Erosion and Sediment Control
- Nutrient Management (Urban)
- Street Sweeping
- Forest Buffers (Mixed Open)
- Wetland Restoration (Mixed Open)
- Tree Planting (Mixed Open)
- Nutrient Management (Mixed Open)
- Abandoned Mine Reclamation
- Non-Urban Stream Restoration (Mixed Open)
- Dirt and Gravel Road Erosion and Sediment Control (Mixed Open)

Stormwater Management

- Wet Ponds and Wetlands
- Dry Detention Ponds and Hydrodynamic Structures
- Dry Extended Detention Ponds
- Urban Infiltration Practices
- Urban Filtering Practices
- Recent/Retrofit Stormwater Managemer

Septic BMPs

- Septic Connections
- Septic Denitrification
- Septic Pumping

Interim Chesapeake Bay Program Agricultural BMPs – To Add to Model

Nutrient Management

- Irrigation Management
- Passive Hay Management

Manure Management

- Liquid Manure Injection
- Poultry Litter Injection
- Manure Processing Technology
- Poultry Litter Amendments

Mortality Management

- Mortality Incineration

Soil Amendments

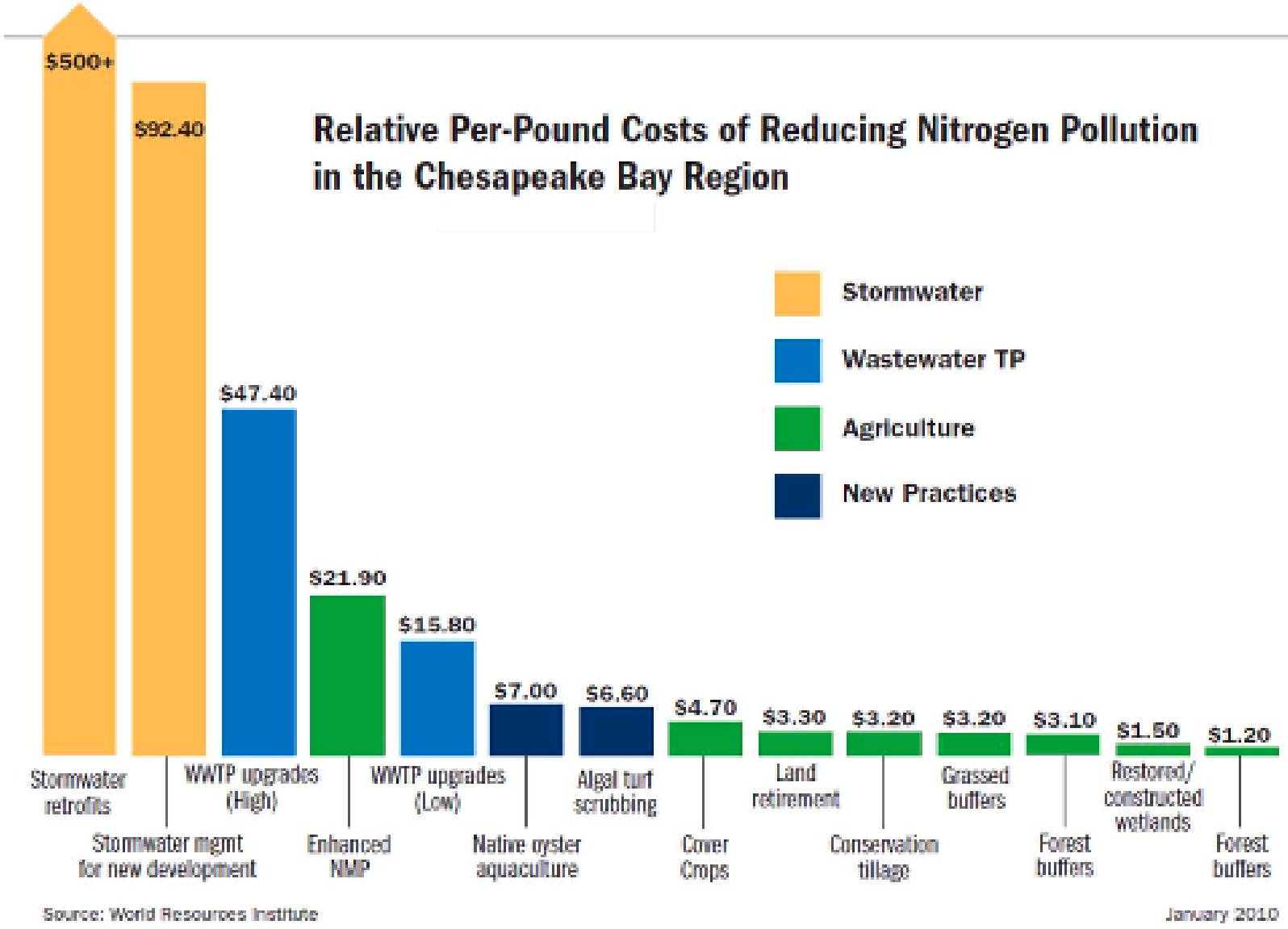
- Phosphorus Absorbing Materials

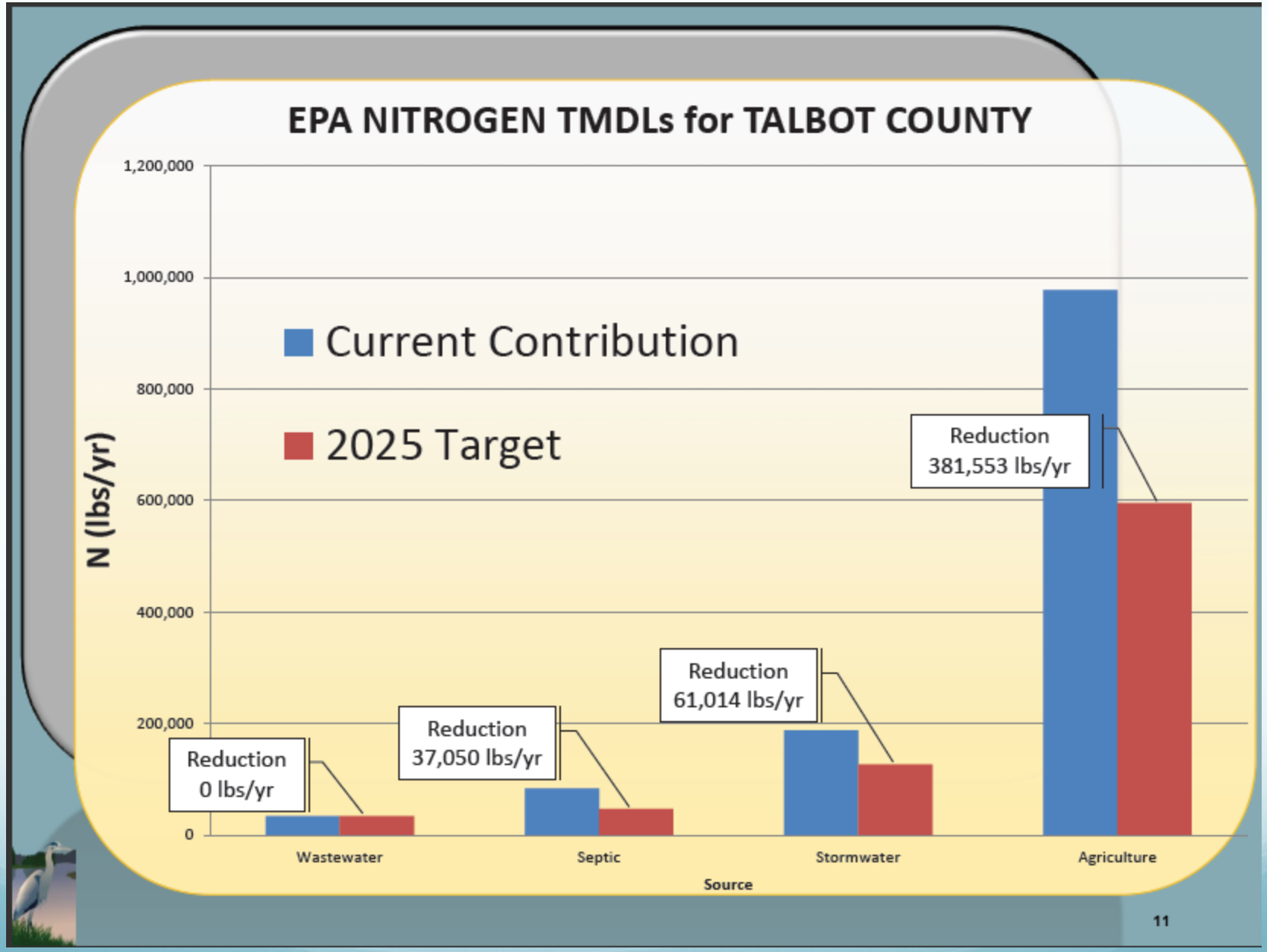
Nursery Management

- Nursery Runoff Management

Non-Cost Shared Practices

- Tracking and Reporting


Relative Per-Pound Costs of Reducing Nitrogen Pollution in the Chesapeake Bay Region
Stormwater
Wastewater TP
Agriculture
New Practices
$500+
$92.40
$47.40
$21.90
$15.80
$7.00
$6.60
$4.70
$3.30
$3.20
$3.20
$3.10
$1.50
$1.20
Stormwater retrofits
Stormwater mgmt for new development
WWTP upgrades (High)
Enhanced NMP
WWTP upgrades (Low)
Native oyster aquaculture
Algal turf scrubbing
Cover Crops
Land retirement
Conservation tillage
Grassed buffers
Forest buffers
Restored/ constructed wetlands
Forest buffers
Source: World Resources Institute
January 2010
For more information on nutrient trading and an updated version of this cost-curve, please visit the World Resources Institute Website at:
http://www.wri.org/publication/how-nutrient-trading-could-help-restore-the-chesapeake-bay


EPA NITROGEN TMDLs for TALBOT COUNTY
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
N (lbs/yr)
Current Contribution
2025 Target
Reduction
0 lbs/yr
Reduction
37,050 lbs/yr
Reduction
61,014 lbs/yr
Reduction
381,553 lbs/yr
Wastewater
Septic
Stormwater
Agriculture
Source

State Plan: Financial Consequences

Source: MD Phase II WIP Jan 25, 2012

Source Sector	Cost of 2017 Strategy 2010 - 2017 (Millions)	Cost of 2025 Strategy[a] 2010 - 2025 (Millions)
Agriculture	**$498**	**$928**
Municipal Wastewater	**$2,384**	**$2,384**
Major Municipal		$2,322
Minor Mun		$62
Stormwater		**$7,607**
MDOT[c]		$1,500
Local Government	$3,359	$6,107
Septic Systems	**$799**	**$3,746**
Septic System Upgrades	$336	$2,533
Septic System Connections	$439	$1,125
Septic System Pumping	$24	$88
TOTAL	**$7,507**	**$14,665**

$800M for 321,000 lbs

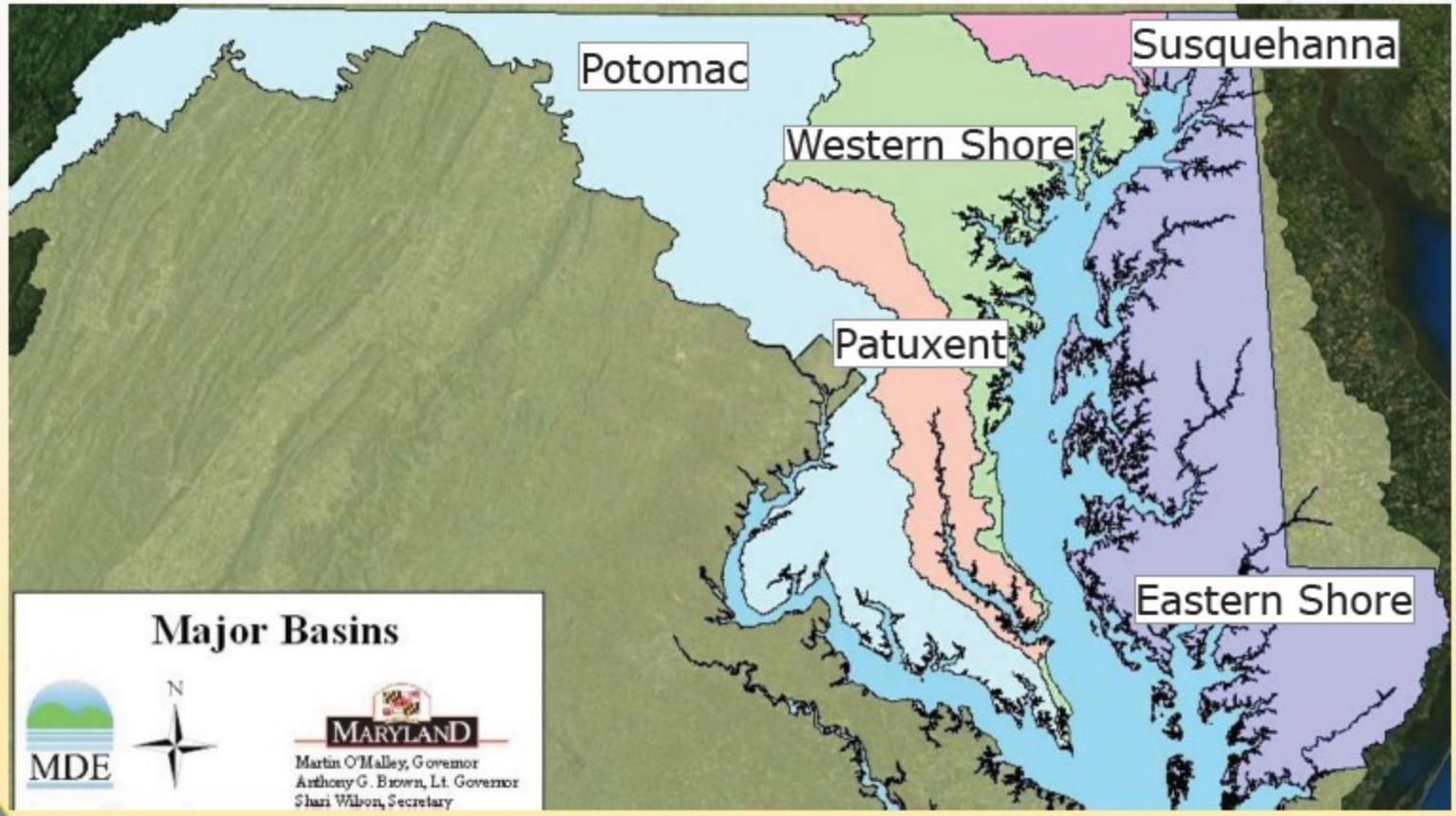
$3.7B for 1.1M lbs

Lets Take a Closer Look at Maryland Agriculture TMDL Issues

"Maryland ranked first among the states of the United States last year in the total pack of whole tomatoes."

"The 180 mile long Chesapeake tops the world in seafood production for any bay of like size."

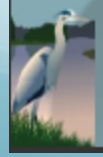
Maryland WIP Basin Approach



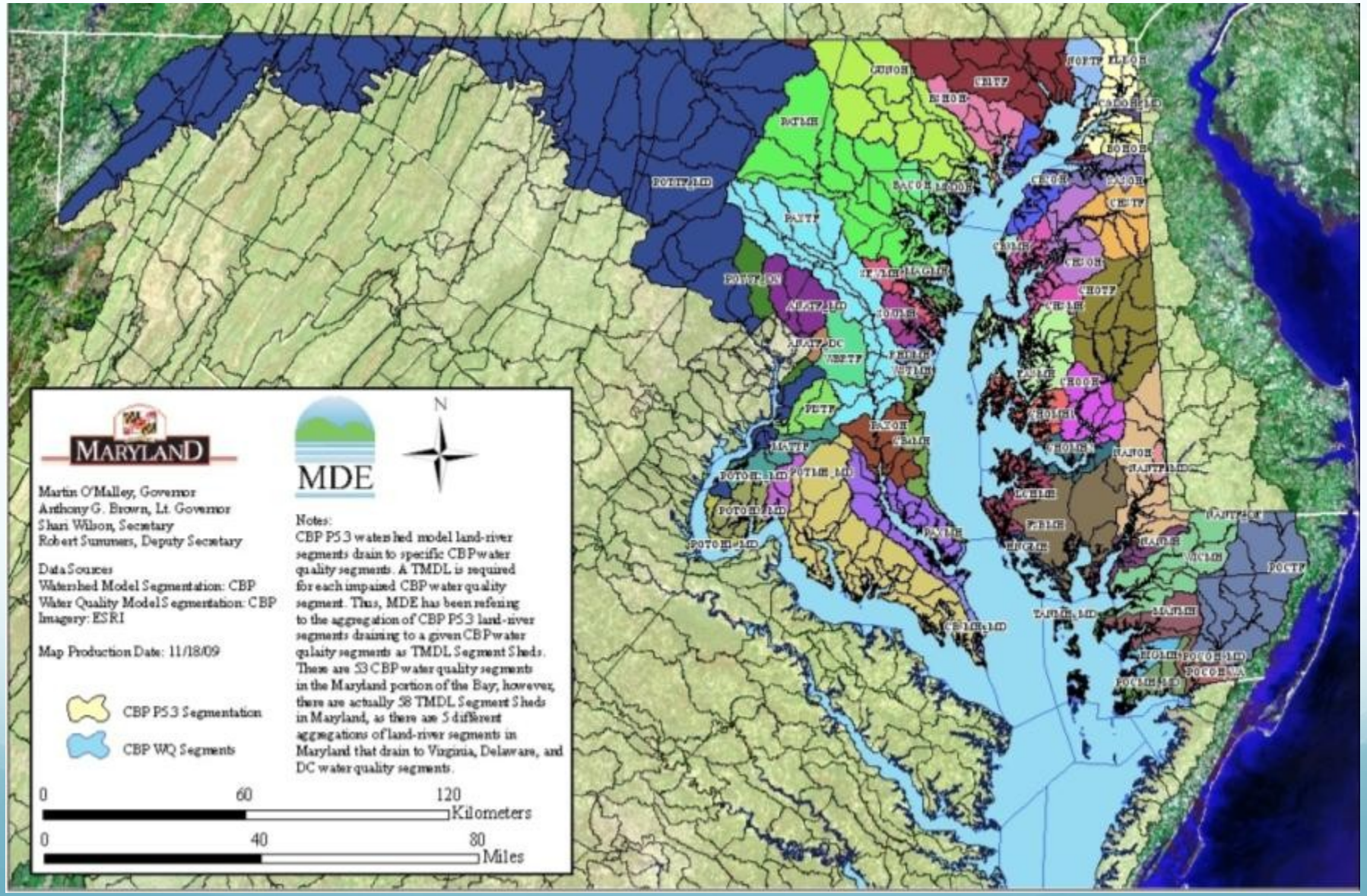
Final 2025 Target Loads for Basins

	Nitrogen	Phosphorus	Sediment
Susquehanna	1.19	0.06	64
Eastern Shore	11.82	1.02	189
Western Shore	9.77	0.55	243
Patuxent	3.10	0.24	123
Potomac	15.29	0.94	731
Total	41.17	2.81	1350

Millions of Lbs per Year

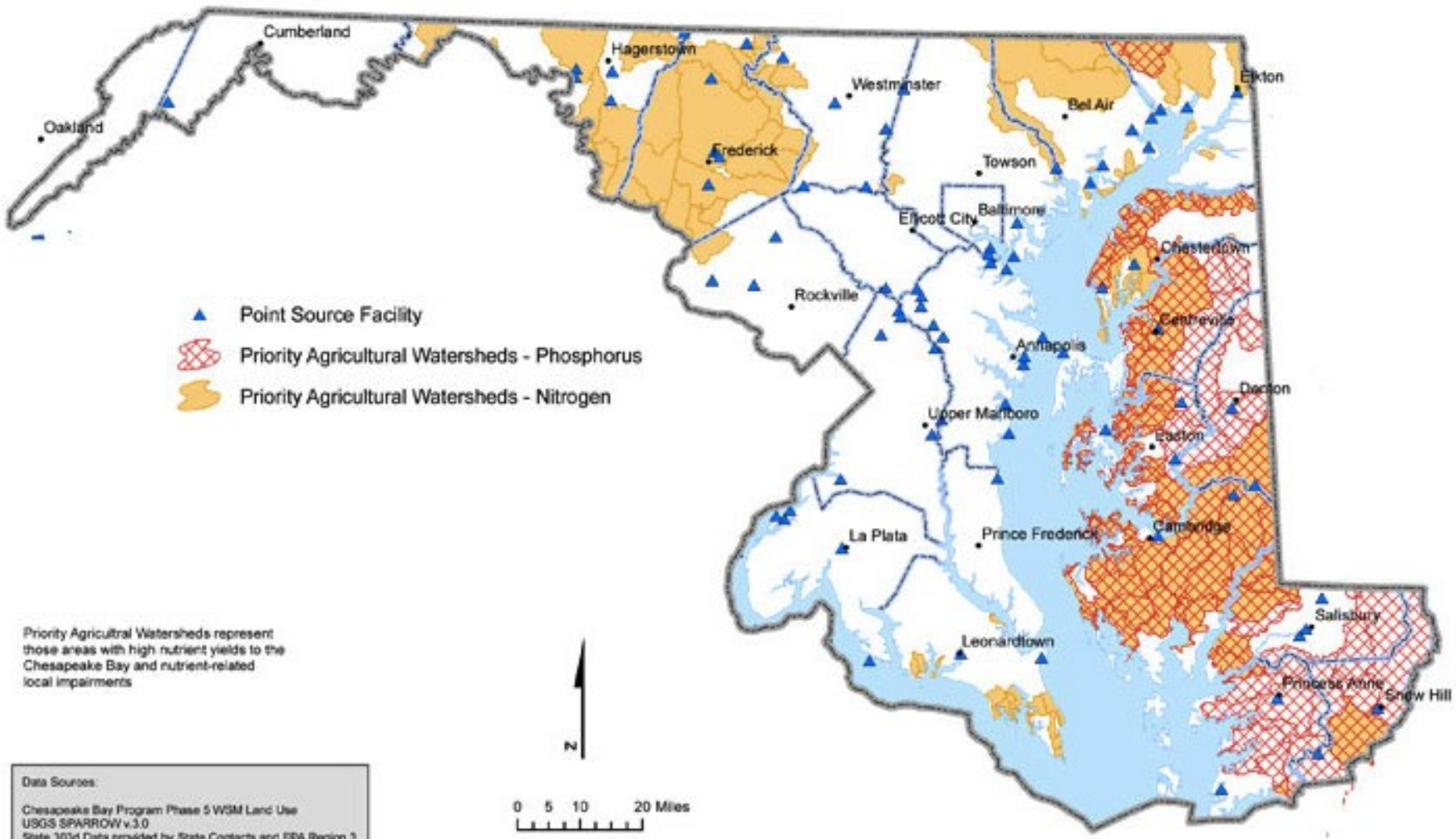


58 Sub-Allocation (TMDL) Segmentsheds



Point Sources and Priority Agricultural Watersheds

Chesapeake Bay Watershed within Maryland



Priority Agricultral Watersheds represent those areas with high nutrient yields to the Chesapeake Bay and nutrient-related local impairments

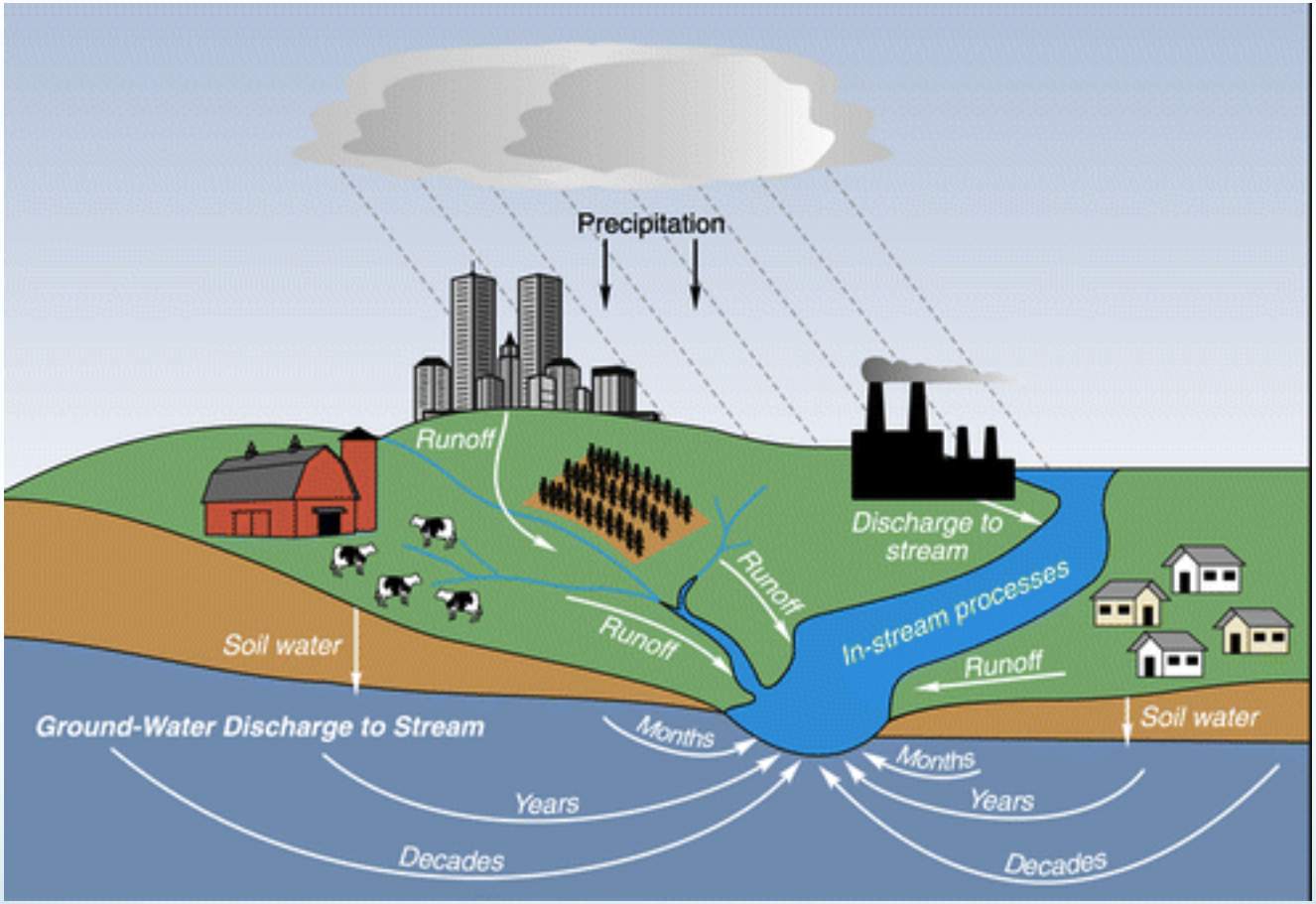
Data Sources:

Chesapeake Bay Program Phase 5 WSM Land Use
USGS SPARROW v.3.0
State 303d Data provided by State Contacts and EPA Region 3
Chesapeake Bay Program Point Source Data Base

For more information, visit www.chesapeakebay.net
Disclaimer: www.chesapeakebay.net/terms/ofuse.htm

Created by JW, 03/05/2009

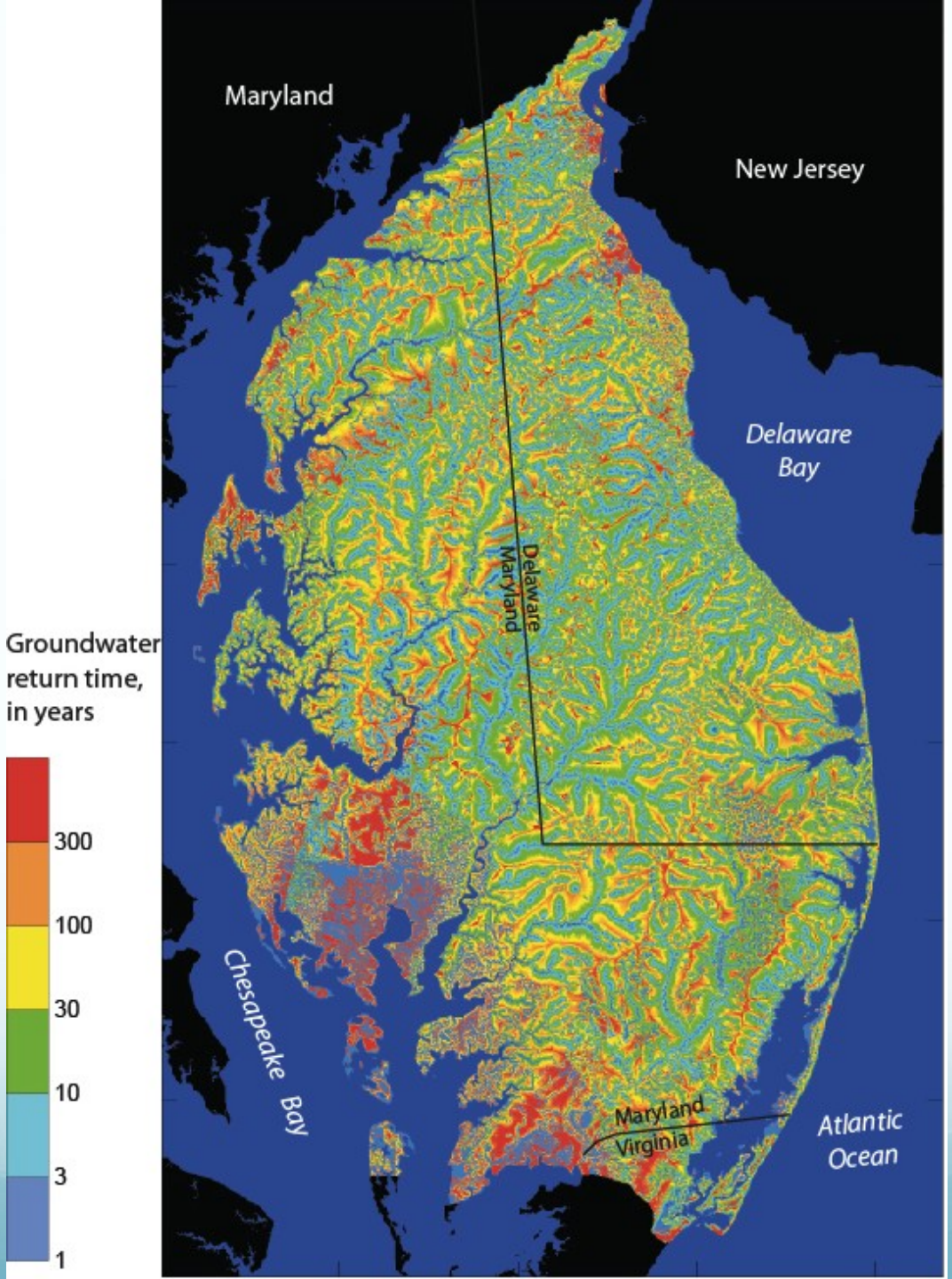
New Modeling and Monitoring Findings on the Eastern Shore!


Precipitation
Runoff
Discharge to stream
Runoff
Runoff
In-stream processes
Runoff
Soil water
Soil water
Ground-Water Discharge to Stream
Months
Years
Decades
Months
Years
Decades

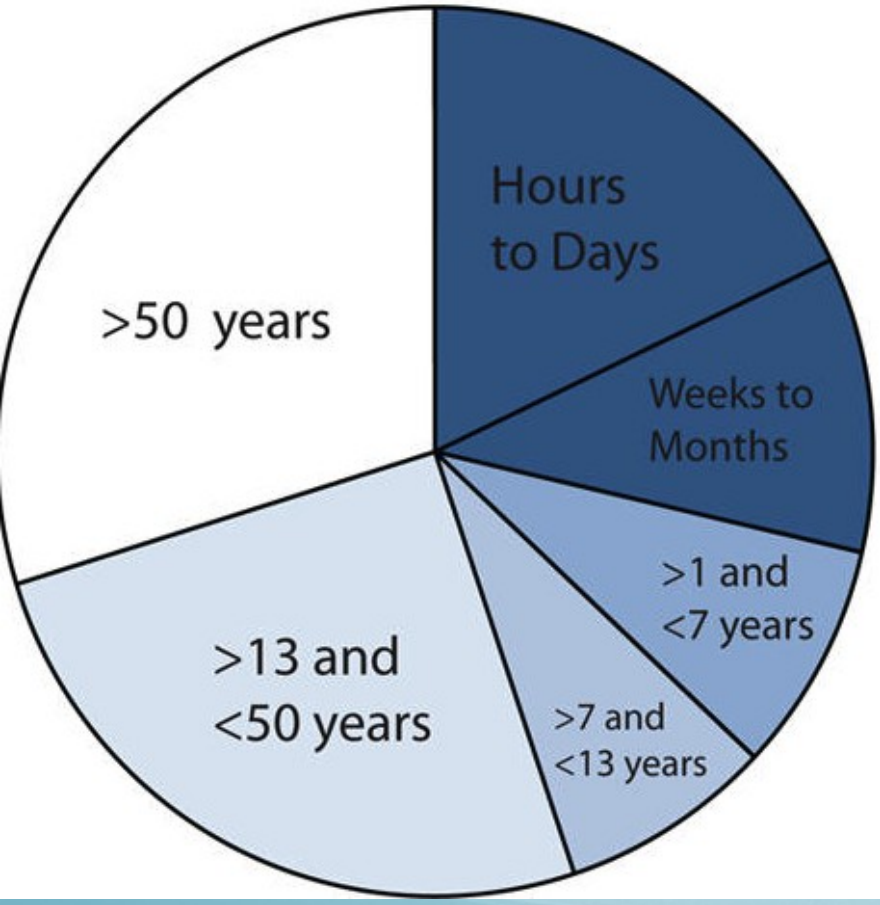
USGS Study: Journal of Environmental Science & Technology 10/23/2013

"Quantifying Groundwater's Role in Delaying Improvements to the Chesapeake Bay Water Quality"

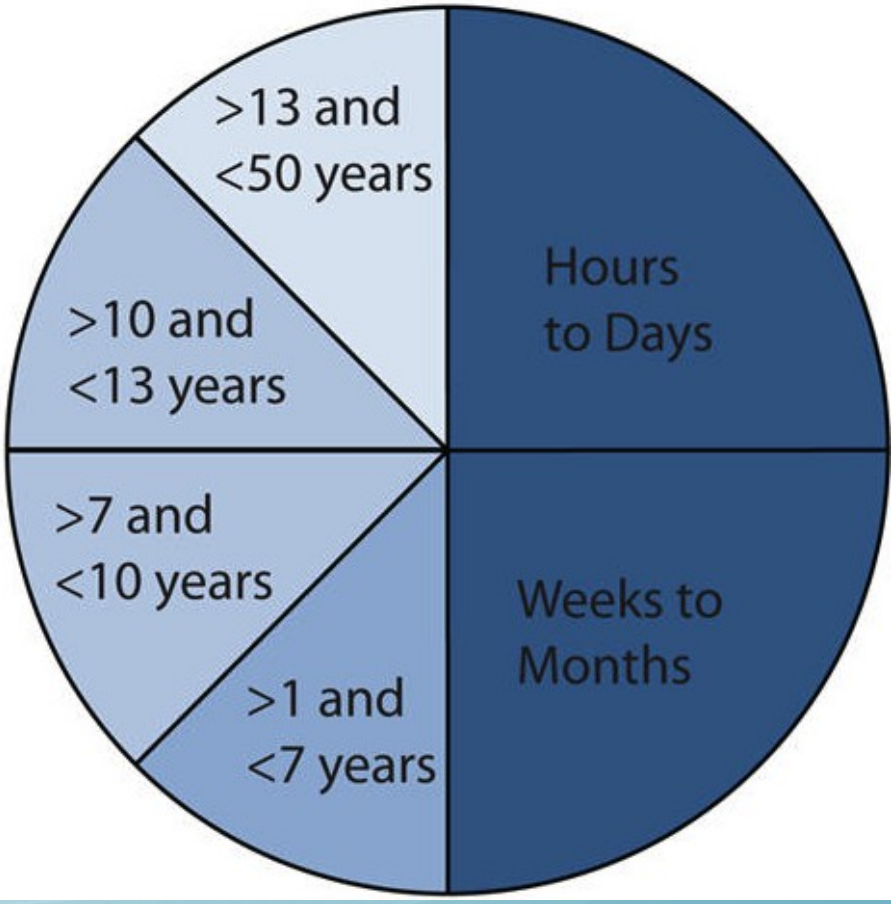
http://chesapeake.usgs.gov/studygroundwaterdelayingwaterquality.html

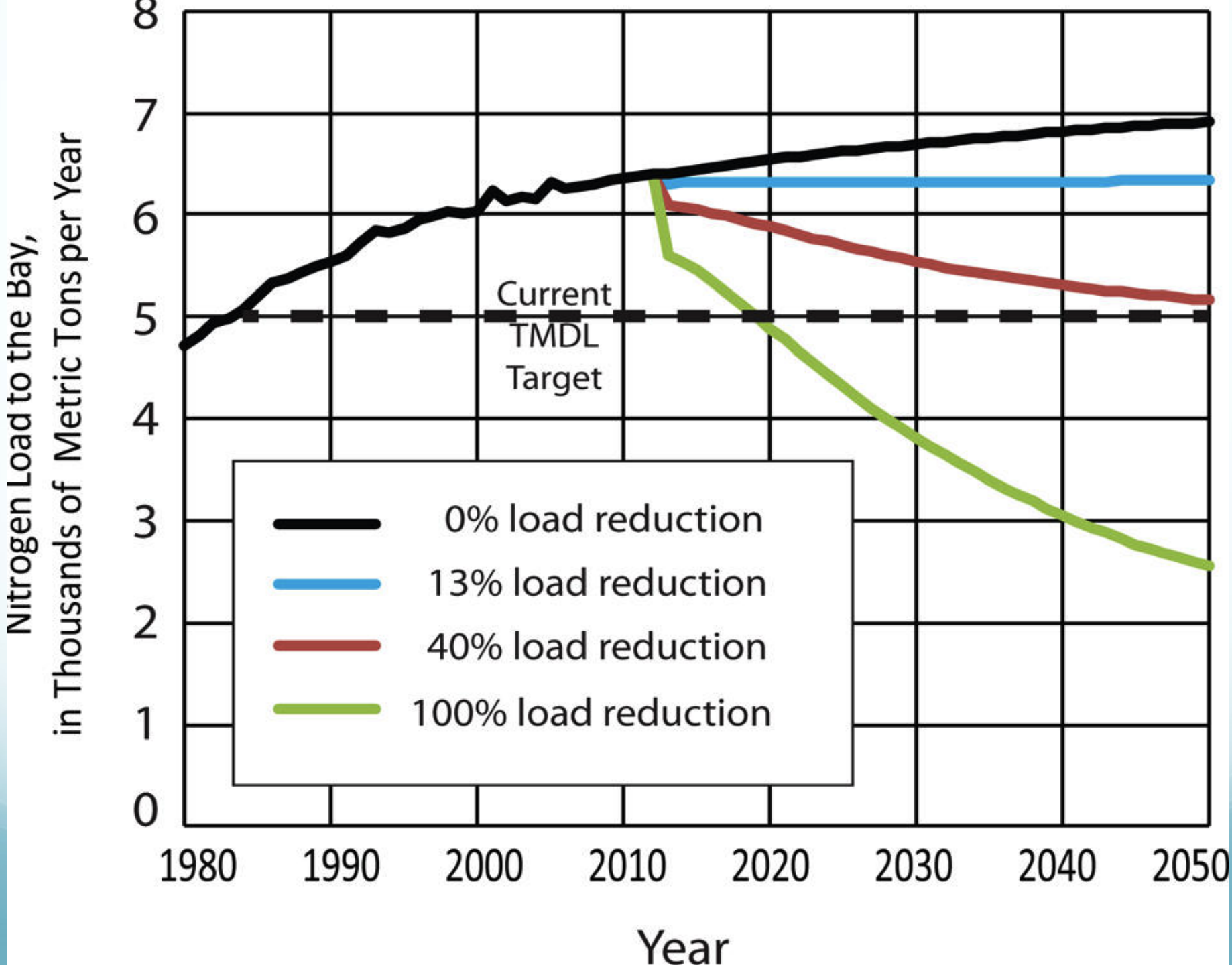


Chesapeake Bay Watershed:
The Coastal Plain Province
on the Delmarva Peninsula,
this study



Chesapeake Bay Watershed:
The Piedmont and
Valley and Ridge Provinces,
previous study

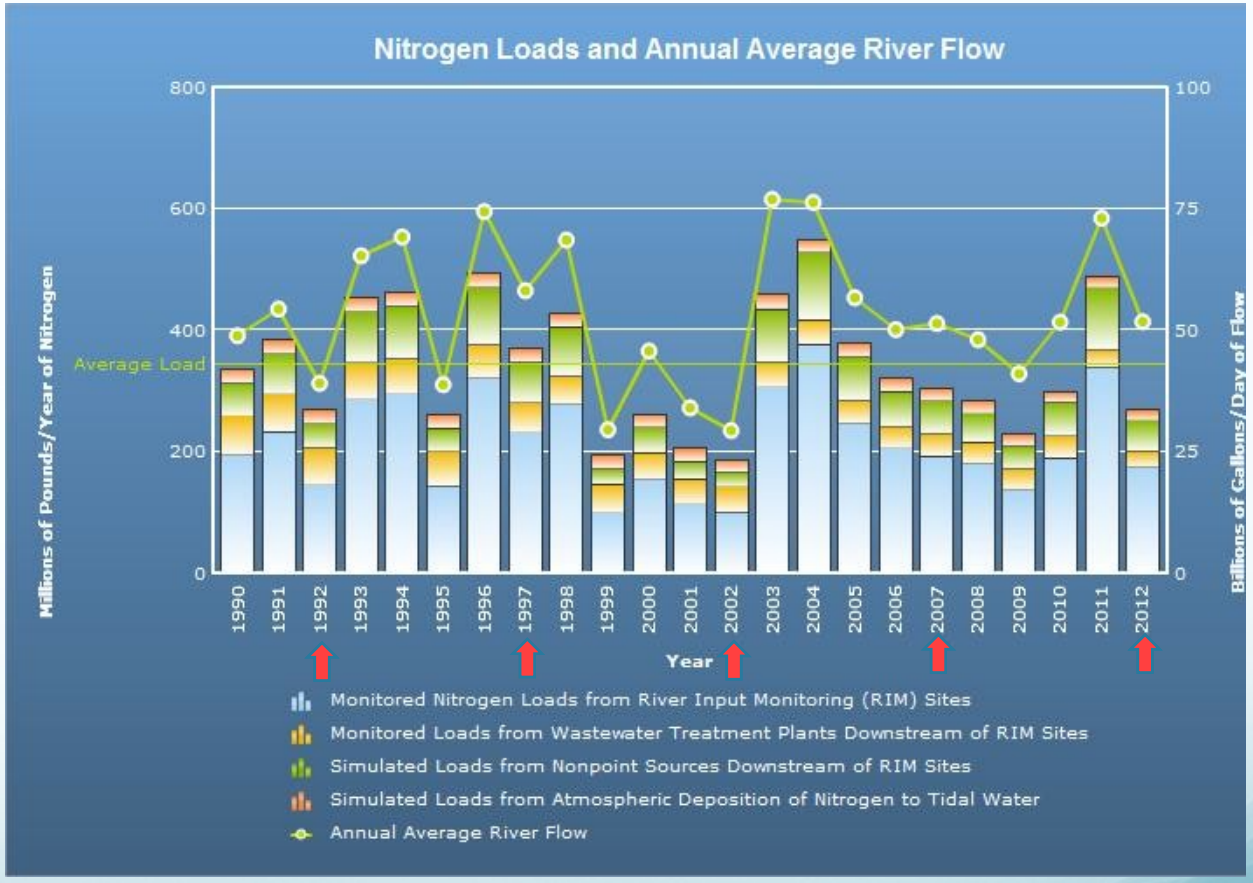



Nitrogen Load to the Bay,
in Thousands of Metric Tons per Year
8
7
6
5
4
3
2
1
0
Current
TMDL
Target
0% load reduction
13% load reduction
40% load reduction
100% load reduction
1980
1990
2000
2010
2020
2030
2040
2050
Year

Do Modeling Assumptions for Agriculture Need To Be Adjusted?

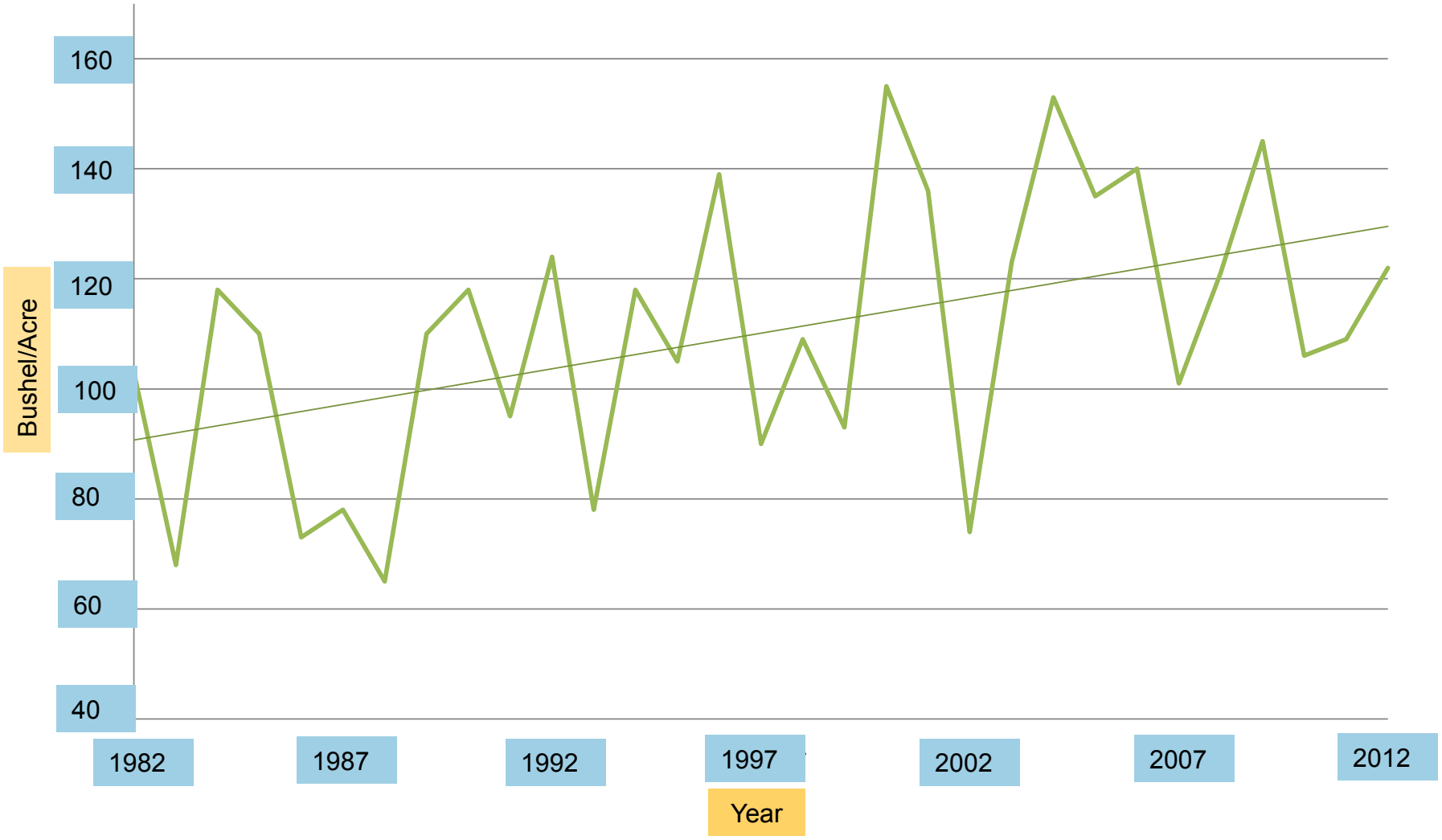
Total Load to the Bay

- Streamflow
- Nitrogen
- Phosphorus
- Sediment



USGS

MD Statewide Corn for Grain Yield

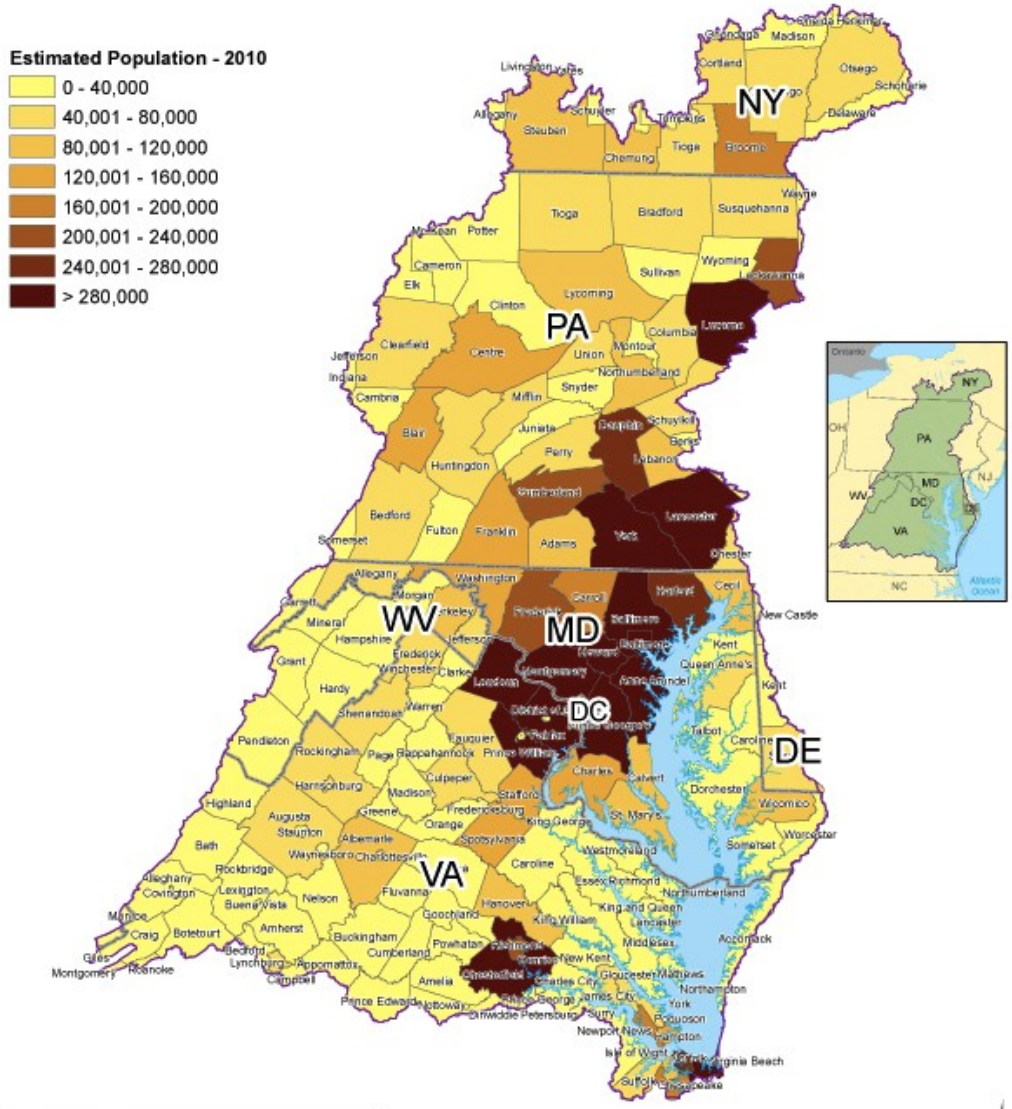


What about the 150,000 people who move to the Bay Region Each Year?

Population (2010)

Chesapeake Bay Watershed Counties

Chesapeake Bay Program
A Watershed Partnership

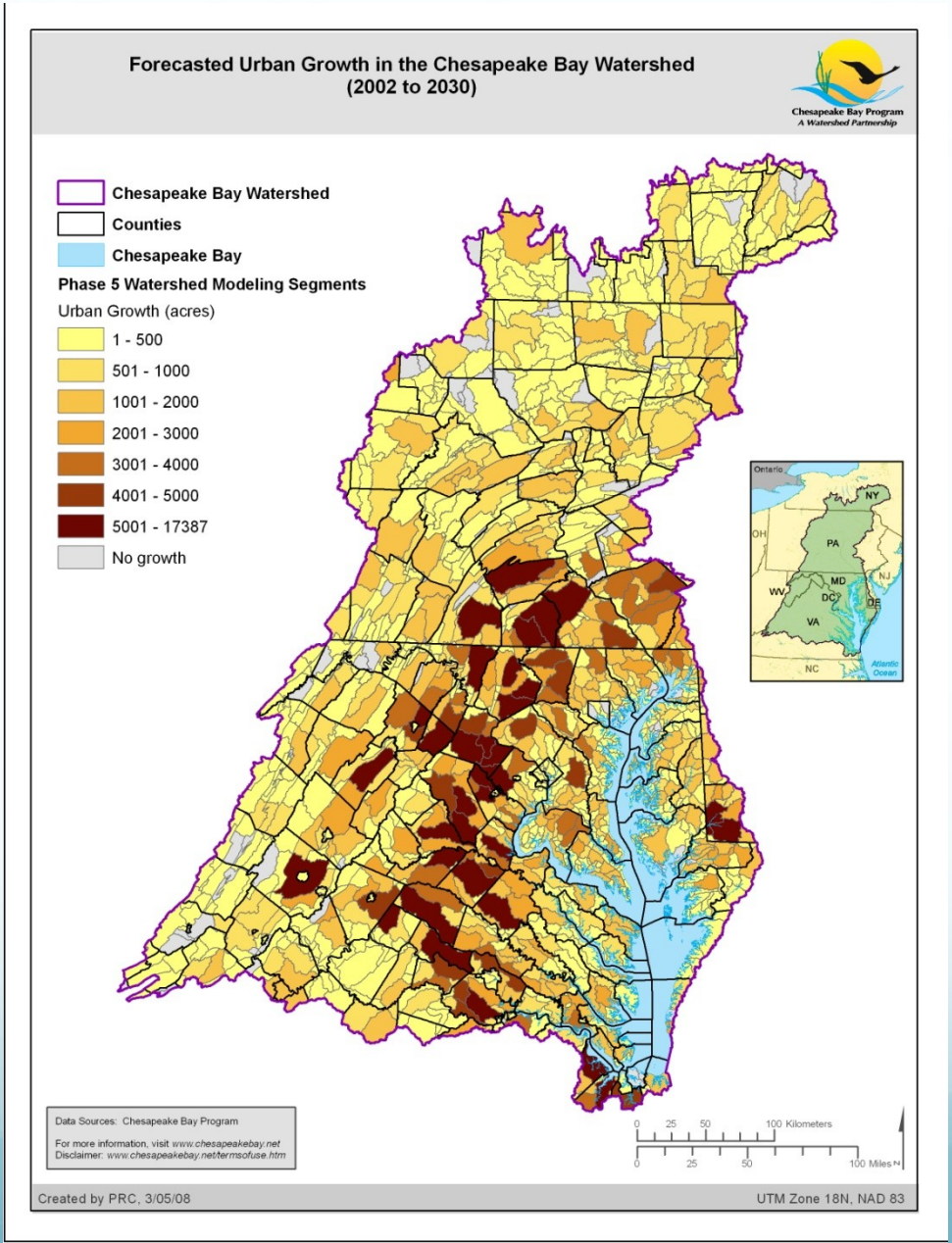


Created by HW, 08/05/11

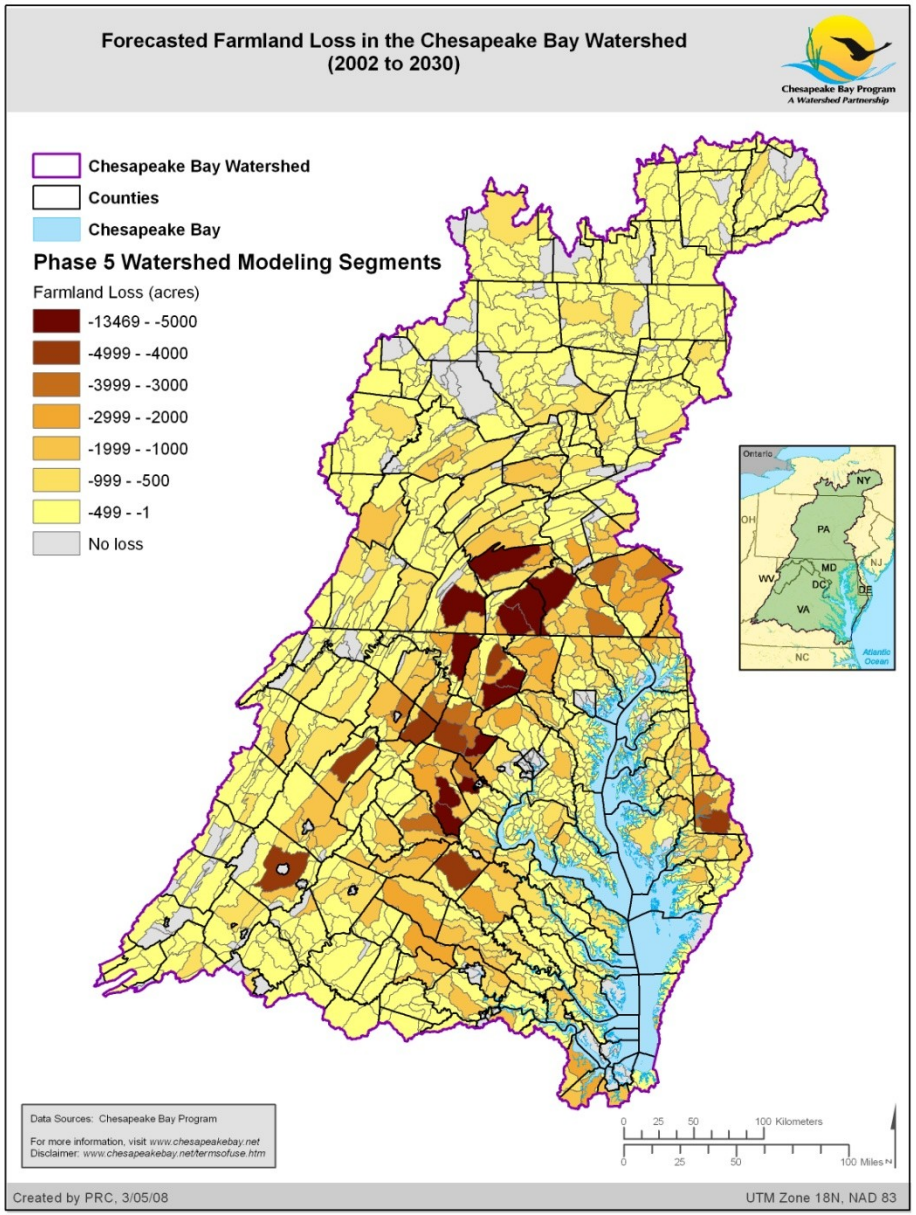
UTM Zone 18N, NAD 83

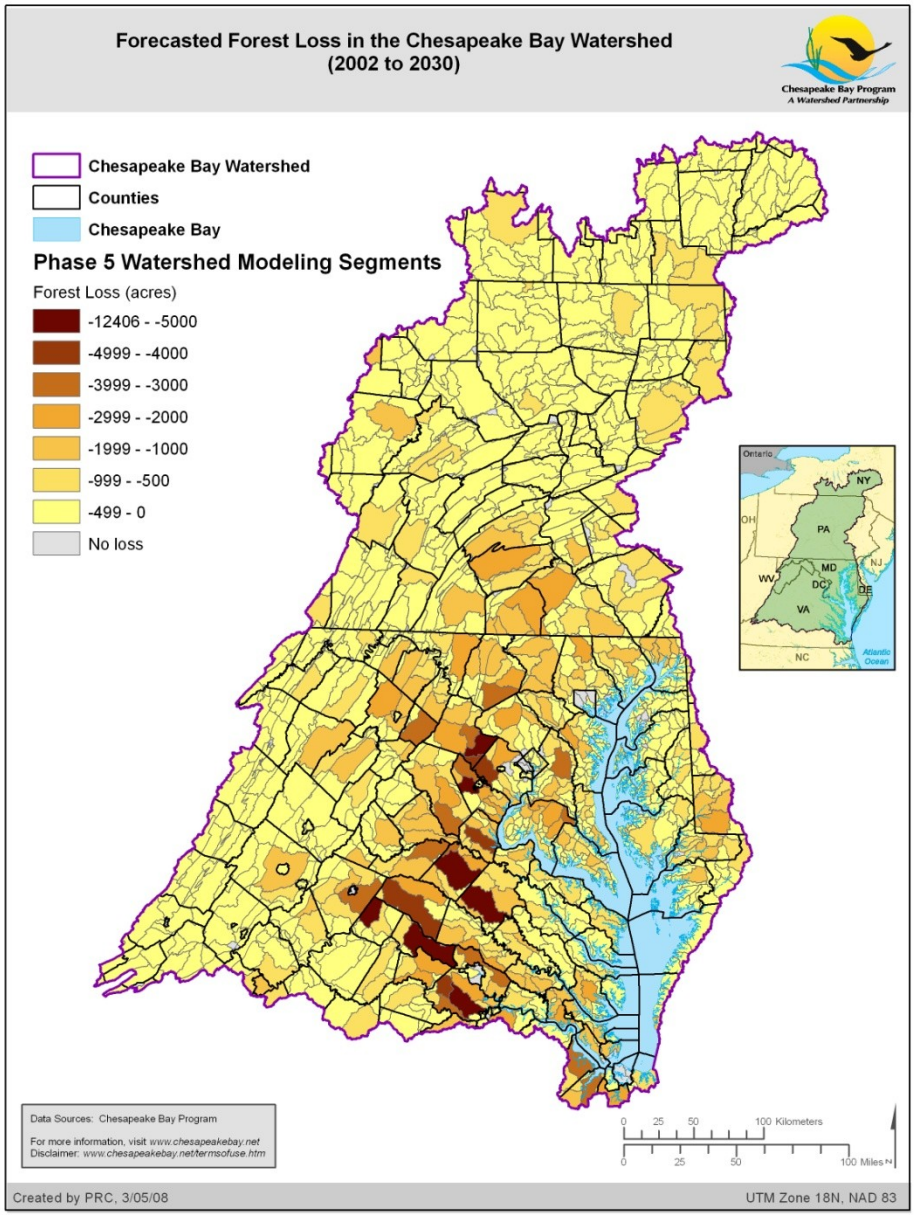

Chesapeake Bay Airshed
Chesapeake Bay Program
A Watershed Partnership
ME
VT
NH
MA
CT
RI
NY
MI
IN
OH
PA
NJ
MD
DE
WV
KY
VA
TN
NC
SC
AL
GA
FL
Atlantic Ocean
Airshed
State Boundary
Data Sources: Chesapeake Bay Program
For more information, visit www.chesapeakebay.net
Disclaimer: www.chesapeakebay.net/termsofuse.htm
0 70 140 280 Kilometers
0 60 120 240 Miles
N
Created by EA, 2/7/08
UTM Zone 18N, NAD 83

Forecasted Urban Growth (2000 to 2030)

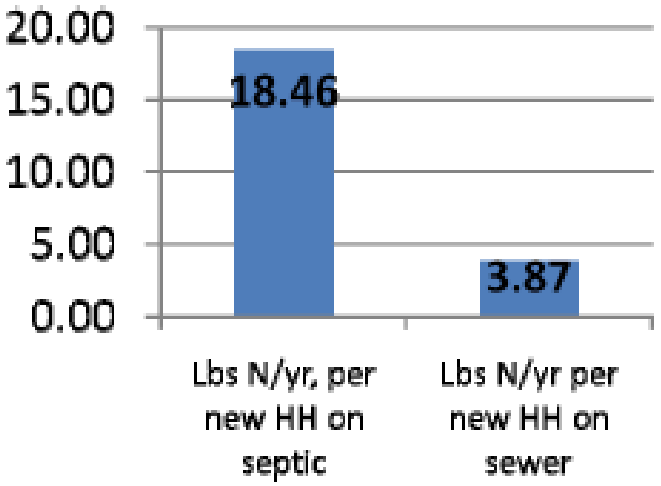


Farmland and Forest Land Loss (2000 to 2030)





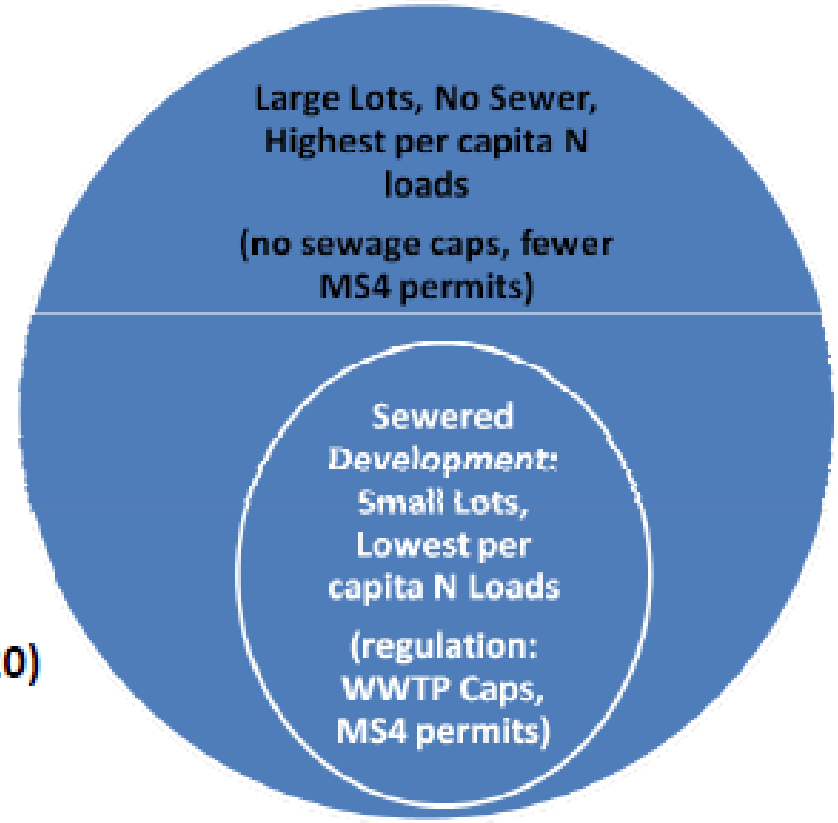
Housing Forecast in Maryland 2010-2020



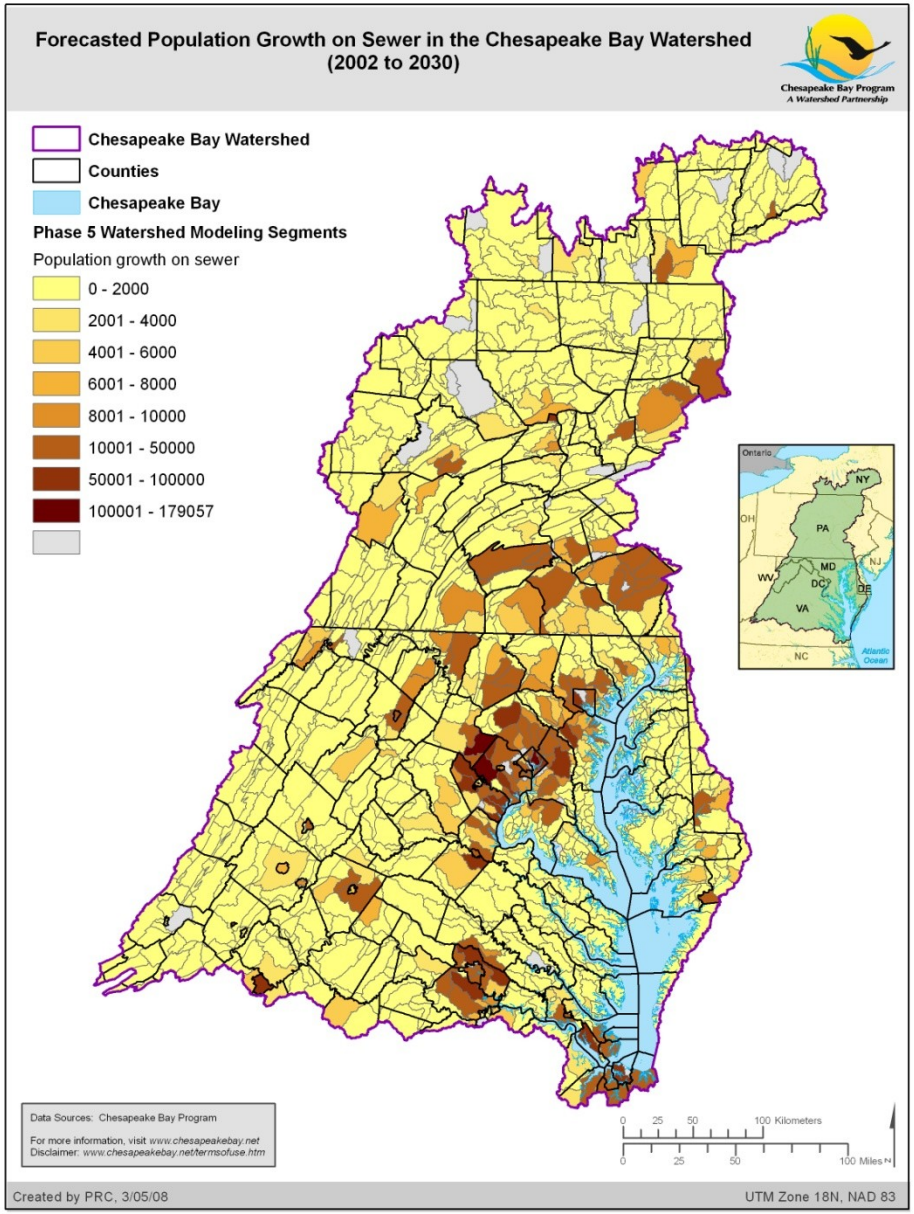
263,225 Additional Households Forecasted in Maryland (2010 -2020)

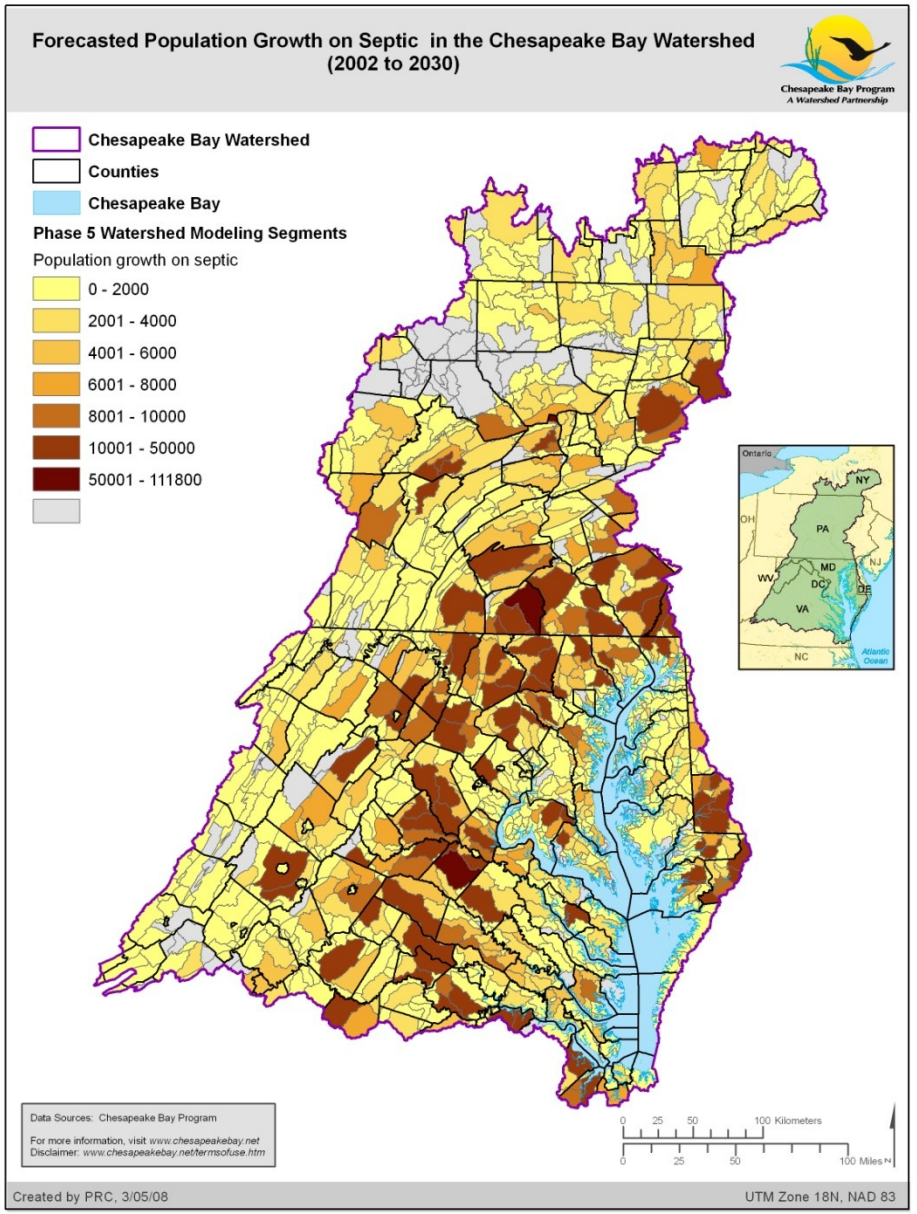
29% served by septic tanks

71% served by ENR WWTP



Forecasted Population Growth on Sewer vs. Septic (2000 to 2030)

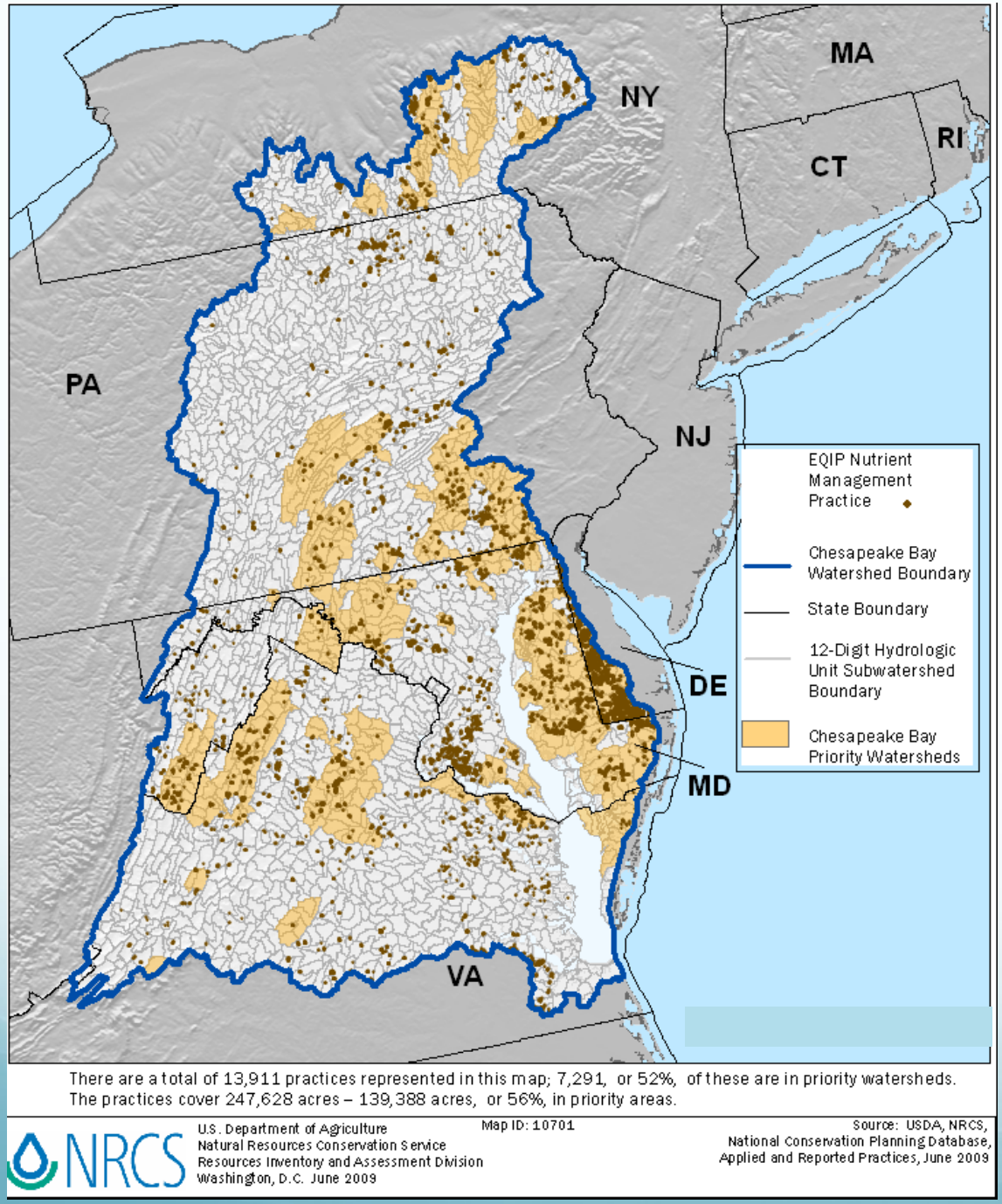




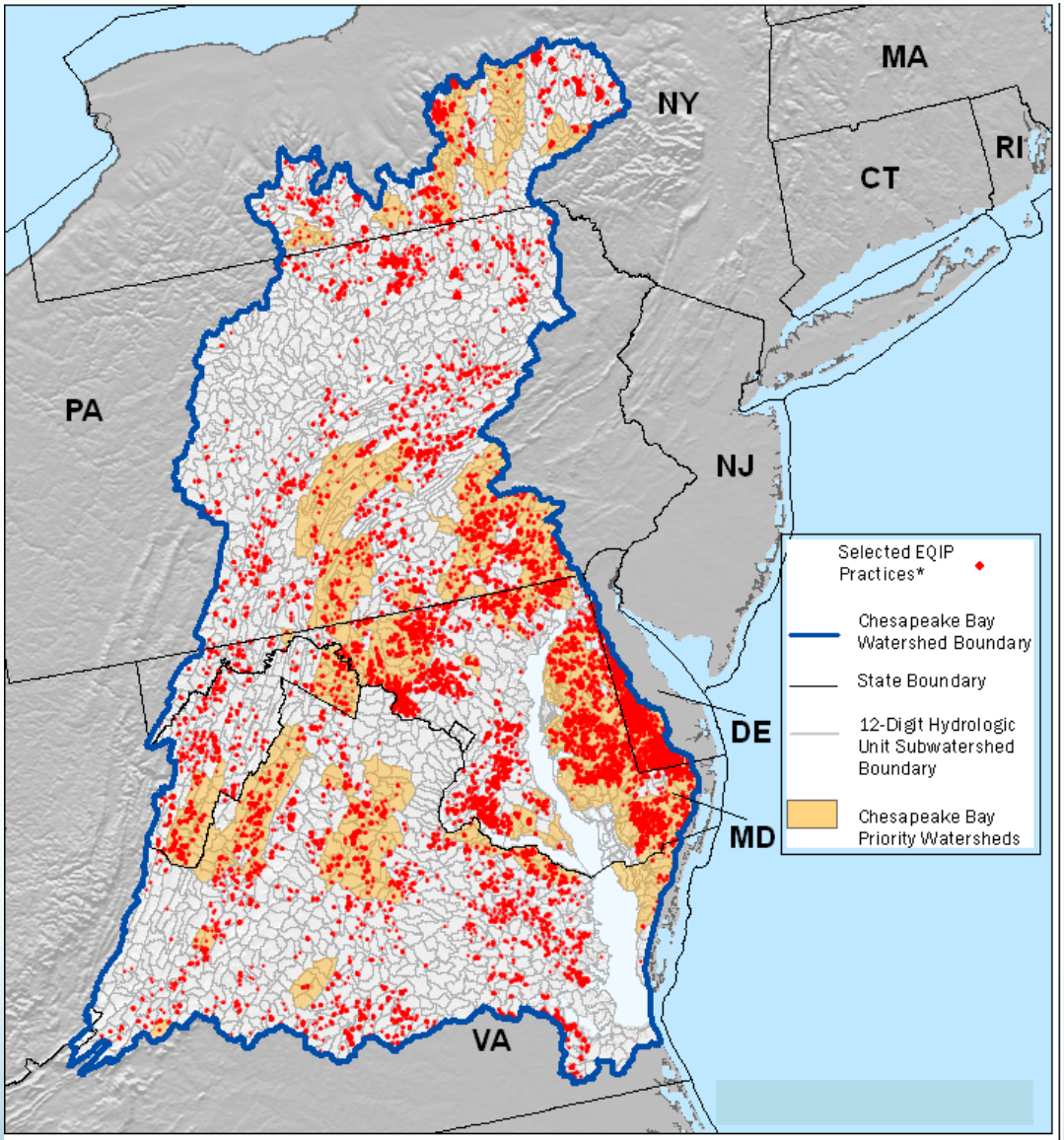
How Do We Assure Best Management Practices are on the land?----

BMP VERIFICATION

Environmental Quality Incentive Program- EQIP



- Nutrient Management (590) Practices in the Chesapeake Bay Watershed Applied and Reported FY 2004 to 2009
- Total of 13,911 practices installed.



There are a total of 45,602 practices represented in this map; 23,278 of these, or 51%, are in priority watersheds. The practices cover 651,164 acres -- 54% in priority areas; 4,409,461 feet -- 36% in priority areas; 799 facilities or structures - 53% in priority areas; and 302 animal units -- 99% in priority areas.

*This map includes the following practices: Conservation Cover, Conservation Crop Rotation, Cover Crop, Cover Crop Shoreline Protection, Diversions, Feed Mgmnt., Fencing, Filter Strips, Grassed Waterways, Heavy Use Area Protection, Irrigation Water Mgmnt., Lined Waterway or Outlet, Nutrient Mgmnt., Pasture and Hayland Planting, Pest Mgmnt., Prescribed Grazing, Residue & Tillage Mgmnt., Riparian Buffers, Riparian Herbaceous Cover, Structures for Water Control, Terraces, Tree Planting, and Waste Storage Facilities.

NRCS

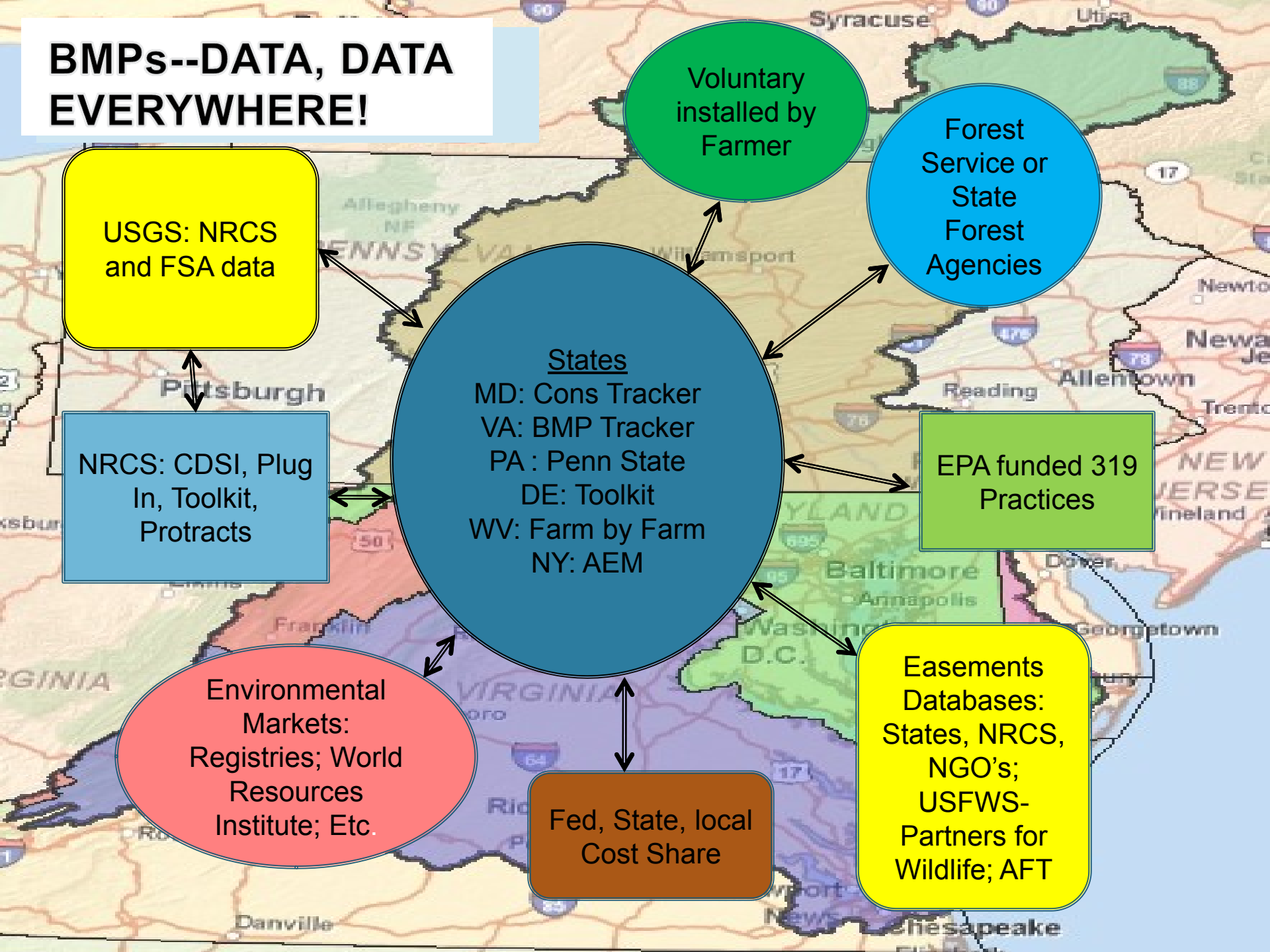
U.S. Department of Agriculture
Natural Resources Conservation Service
Resources Inventory and Assessment Division
Washington, D.C. June 2009

Map ID: 10677

Source: USDA, NRCS, National Conservation Planning Database, Applied and Reported Practices, June 2009

CHESAPEAKE BAY WATERSHED INITIATIVE

- EQIP practices applied and reported in the Chesapeake Bay Watershed FY2004 to May 2009.
- 24 priority practices as identified by each state for CBWI are represented.
- 45,602 Practices Installed. 40-51% are in the priority watersheds.


BMPs--DATA, DATA EVERYWHERE!
Voluntary installed by Farmer
Forest Service or State Forest Agencies
USGS: NRCS and FSA data
States
MD: Cons Tracker
VA: BMP Tracker
PA : Penn State
DE: Toolkit
WV: Farm by Farm
NY: AEM
NRCS: CDSI, Plug In, Toolkit, Protracts
EPA funded 319 Practices
Environmental Markets: Registries; World Resources Institute; Etc.
Fed, State, local Cost Share
Easements Databases: States, NRCS, NGO's; USFWS-Partners for Wildlife; AFT

CBP Verification Definition

The CBP Partnership has defined verification as:

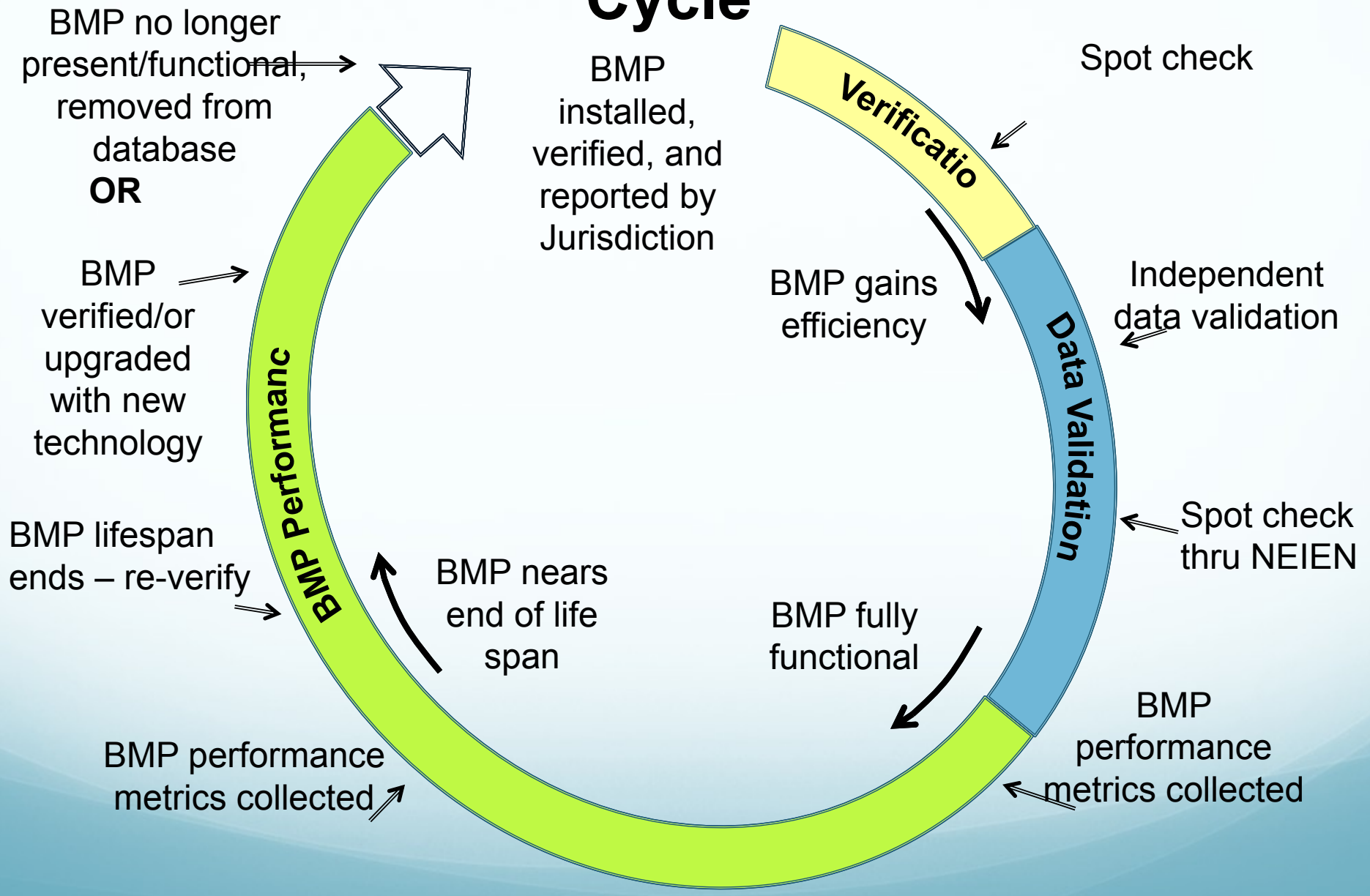
"the process through which agency partners ensure practices, treatments, and technologies resulting in reductions of nitrogen, phosphorus, and/or sediment pollutant loads are implemented and operating correctly."

1. CBP BMP Verification Principles. December 5, 2012.

Agricultural BMP Verification System Options

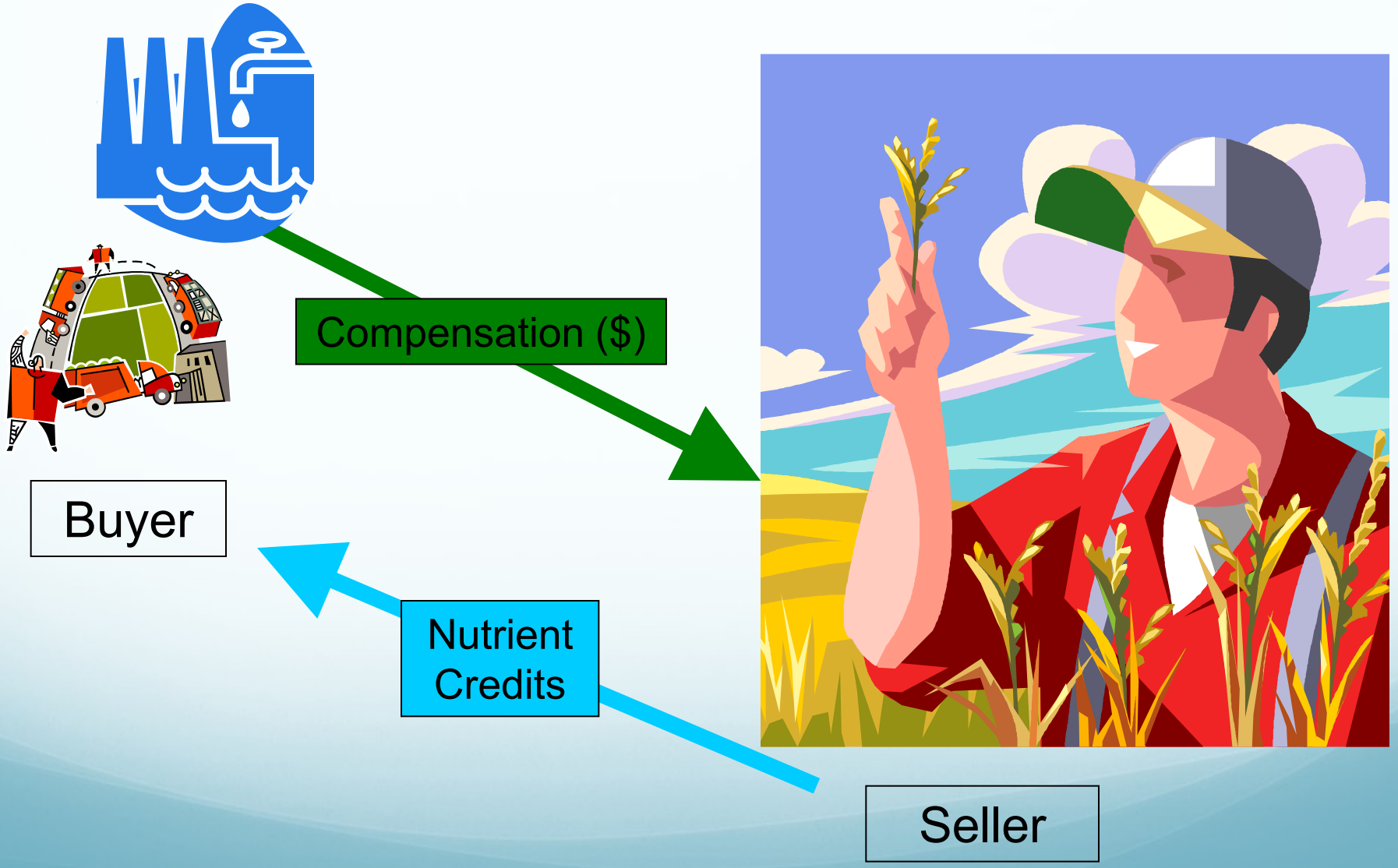
System	Method	Sample Size	Verification
1. Farm by Farm Inventory	Farm visit by trained personnel	100%	Through on-site visit by trained personnel while collecting data
2. Farmer Self Certification with Onsite visit	Farmer fills out survey and trained personnel visit site to confirm	100% (Return rate by the farmer affects %)	Through on-site visit by trained personnel
3. Farmer Self Certifications	Farmer fills out survey and mails back	100% (Return rate by the farmer affects % completed in sample)	By Farmer self certification when submitted
4. Use of Existing federal, state or District records	Trained personnel review existing farm data on practice implementation	<100%(Depends on the completeness of the records in the office)	Trained personnel verify through knowledge of the farm or through calls made to the farmer
5. Transect of County or Watersheds	Transect completed by trained personnel in selected areas of County or Watershed	Statistically Determined	Verified by the trained personnel completing the transect on the ground
6. Farmer Reported at USDA office	Farmers go to USDA office and reports practices (similar to FSA crop reporting)	100% (Rate will be affected by farmers who do not respond)	Farmer certified during the visit at USDA office
7. NASS Survey	NASS survey mailed to farm community.	NASS determined %. Return rate will affect outcome	NASS certification procedures
8. Aerial Photography Remote Sensing	Remote Sensing determination of practice implementation	100% or other statistically selected amount	Verification usually involves determining photographic signatures by field checks to determine accuracy of office determination
9. NRI Point or some other statistically selected sites	Remote Sensing or Field Visit to the points.	100% of Points selected completed	Verification can be same as Aerial Remote Sensing method or by visit to each site to collect and certify data

BMP Verification Life Cycle

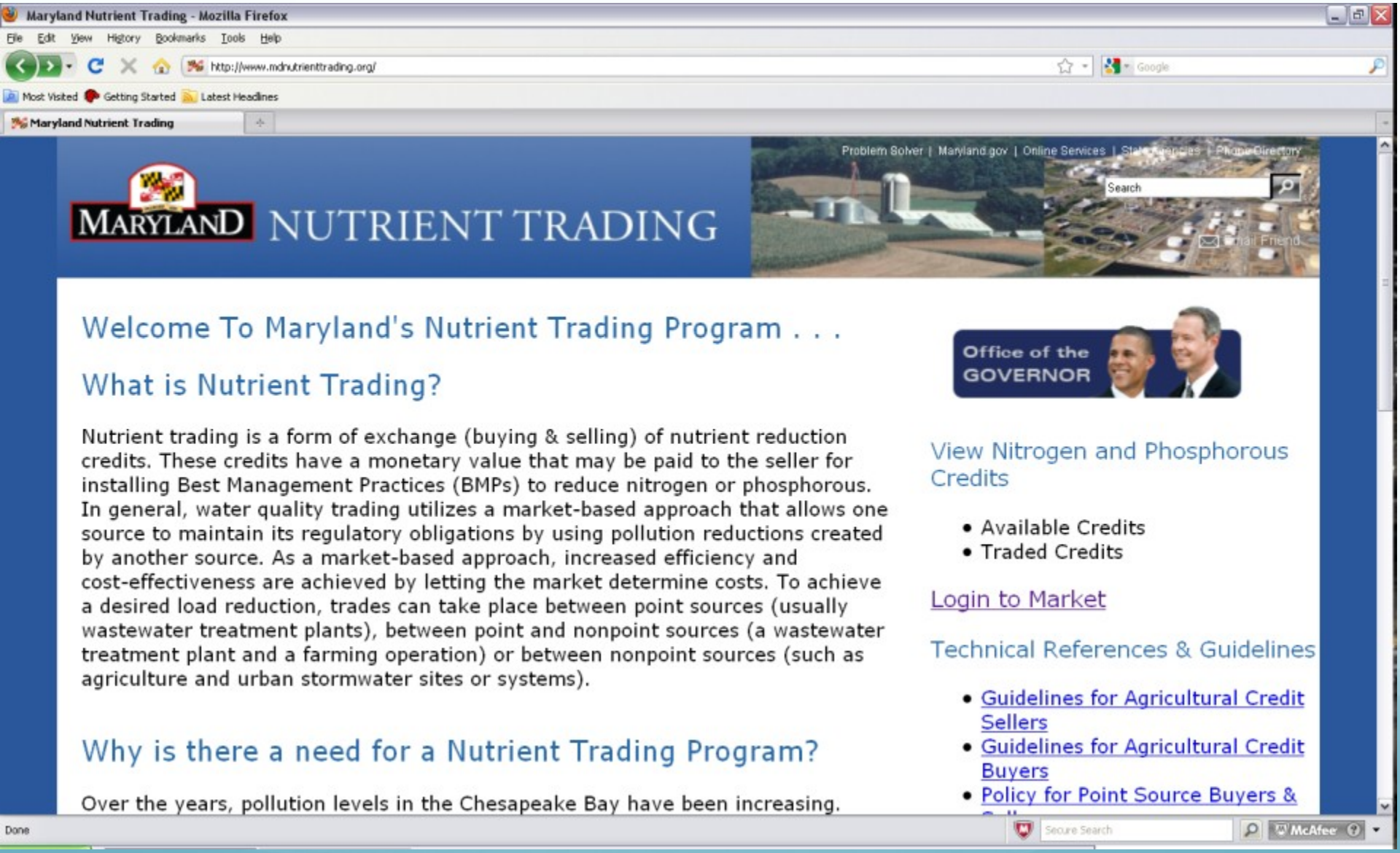



How do we clean up our rivers
without cleaning out our wallets?
There is a way!

New WQ Tool: Agricultural Nutrient Trading in Maryland



MDA Nutrient Trading Website: http://mdnutrienttrading.org/



Calculating Potential Credits

How to Generate Credits

Once a landowner or operator has determined the tract has **achieved the TMDL baseline requirements** for the watershed **additional implementation** of water quality improvements can be **considered as a tradable credit.**

Tradable credits can be generated from any planned agronomic, land conversion to less intensive agricultural production type (crop to hayland), or agricultural structural practice.

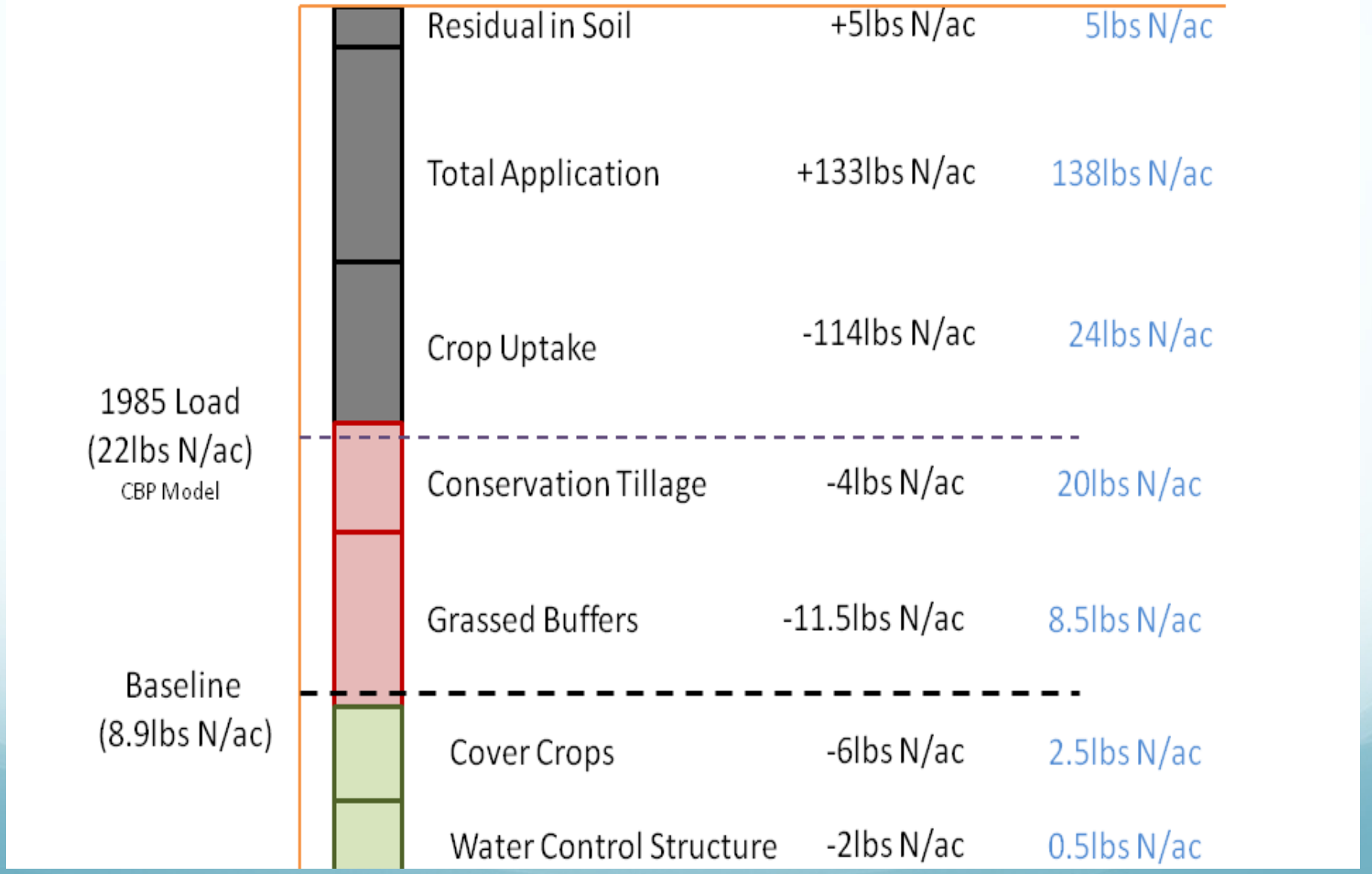
Nitrogen and Corn

Percent of Nitrogen left behind 38.5%

Percent of Nitrogen removed 61.5%

Source: Heckman et al Nutrient Removal by Corn Grain Harvest
The Facts Behind Nitrogen and Agricultural Practices in Talbot County 11/1/2011

Nutrient Trading Baseline and Credit Calculation Example



Agricultural Non Point Source Credit Potential

BMP's Approved Load Reductions	(N Lb/Ac/Yr)
Continuous No-Till	4.61
Riparian Forest Buffers	27.28
Riparian Grass Buffers	16.92
Wetland Restoration	27.28
Tree Planting	13.57
Cover Crops	9.48
Off – Stream Watering w/Fencing	6.79
Off – Stream Watering w/o Fencing	3.40
Animal Waste M.S.: Livestock	531.0
Animal Waste M.S.: Poultry	210.0
Barnyard Runoff Control/Loafing Lot Management	69.0

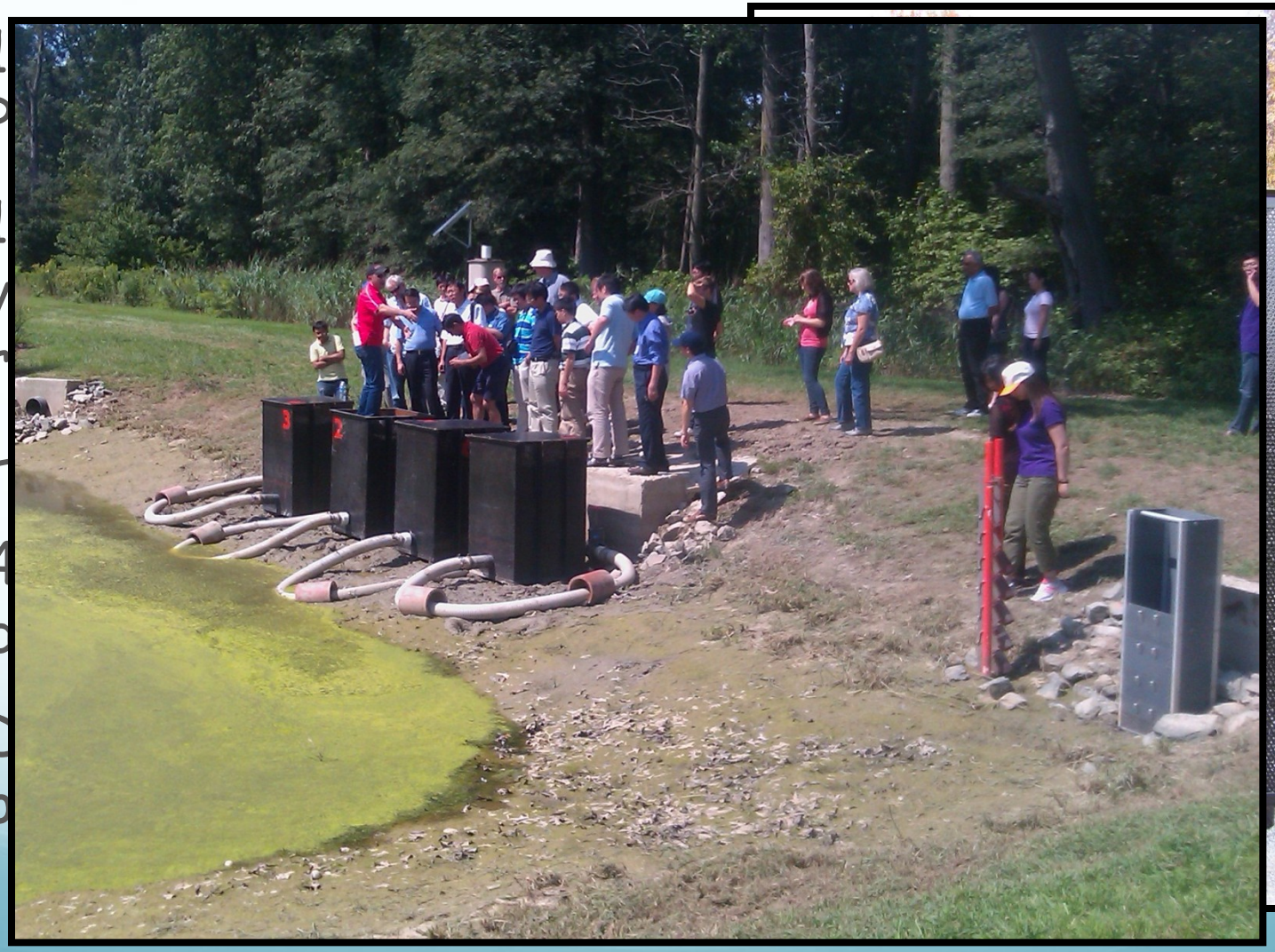
Is there a “Better Mouse Trap”?

What are the New Water Quality BMPs?

Algal Turf Scrubber

Stormwater Pond Filter

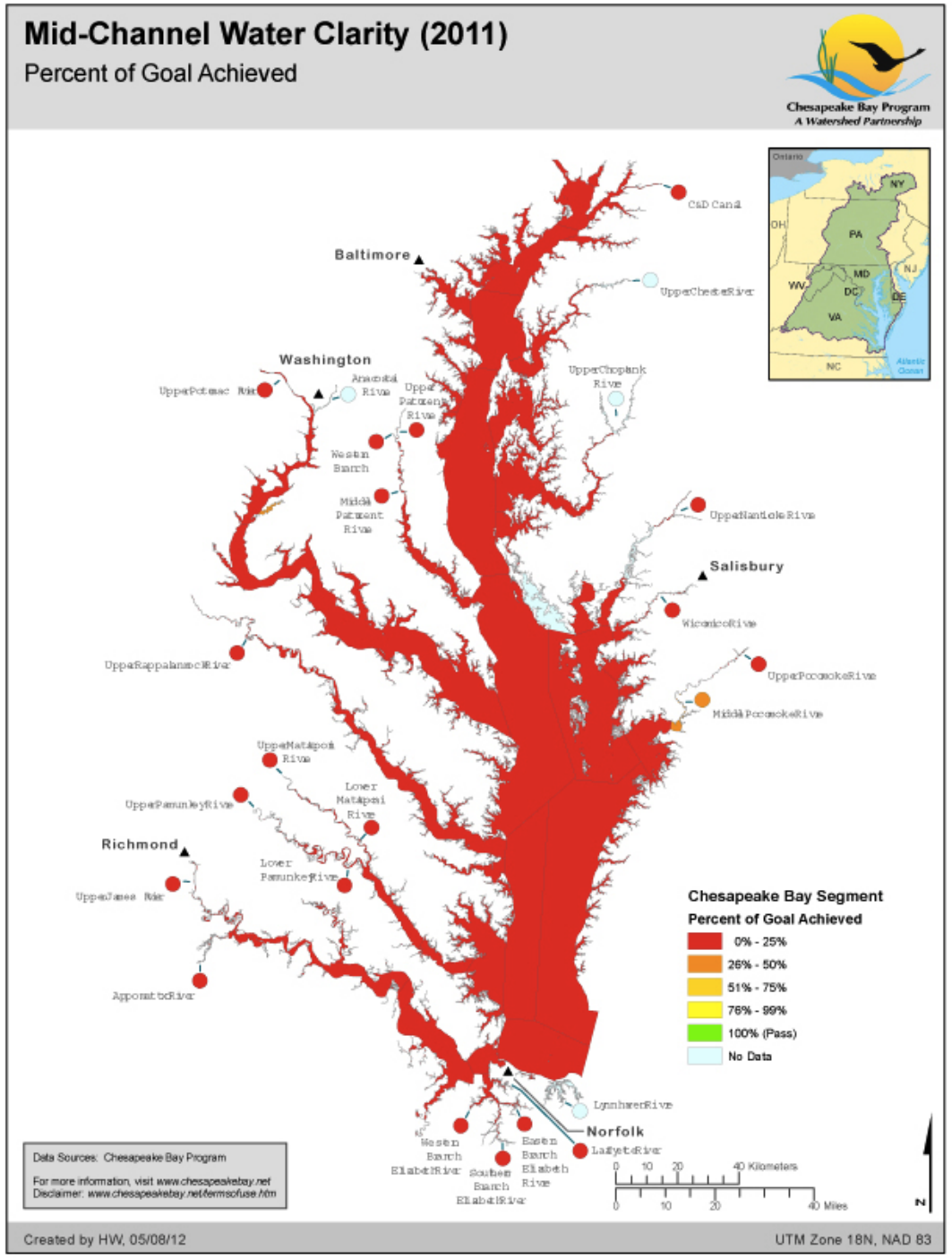
- 1
  P
- 1
  v
  r
- H
- 4
  c
- D
  p



In the end- Many types of monitoring can help explain if our actions will be successful…..

However we must:

- Continue monitoring--**<u>on the land</u> and <u>in the water</u>.**
- Determine if **WQ modeling assumptions** need updating?
- Verify **how many BMPs are on the ground** and **how many** are needed? Are their **nutrient "efficiencies" correct**?
- **Better explain small changes in WQ** even though **BMP implementation increases**.
- How **other tools such as NTT** can increase BMP implementation.
- **Determine/develop new WQ BMP's** and **monitor** how effective they are?
- **Money and Time are limited- Determine if the "juice" is worth the "squeeze".**



QUESTIONS ?

For Information Contact:

Dana York
Green Earth Connection
dyork818@yahoo.com

Green Earth CONNECTION