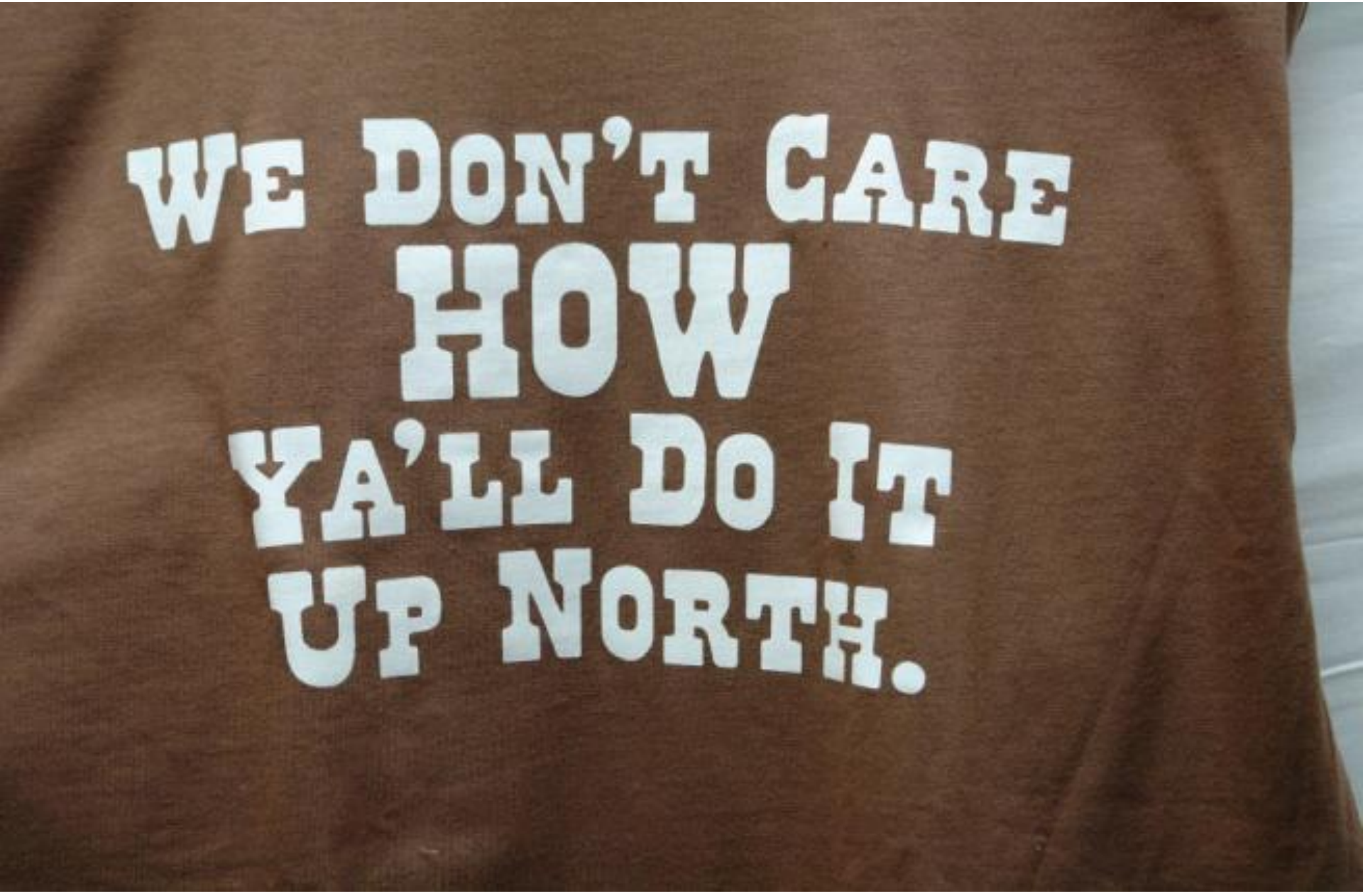
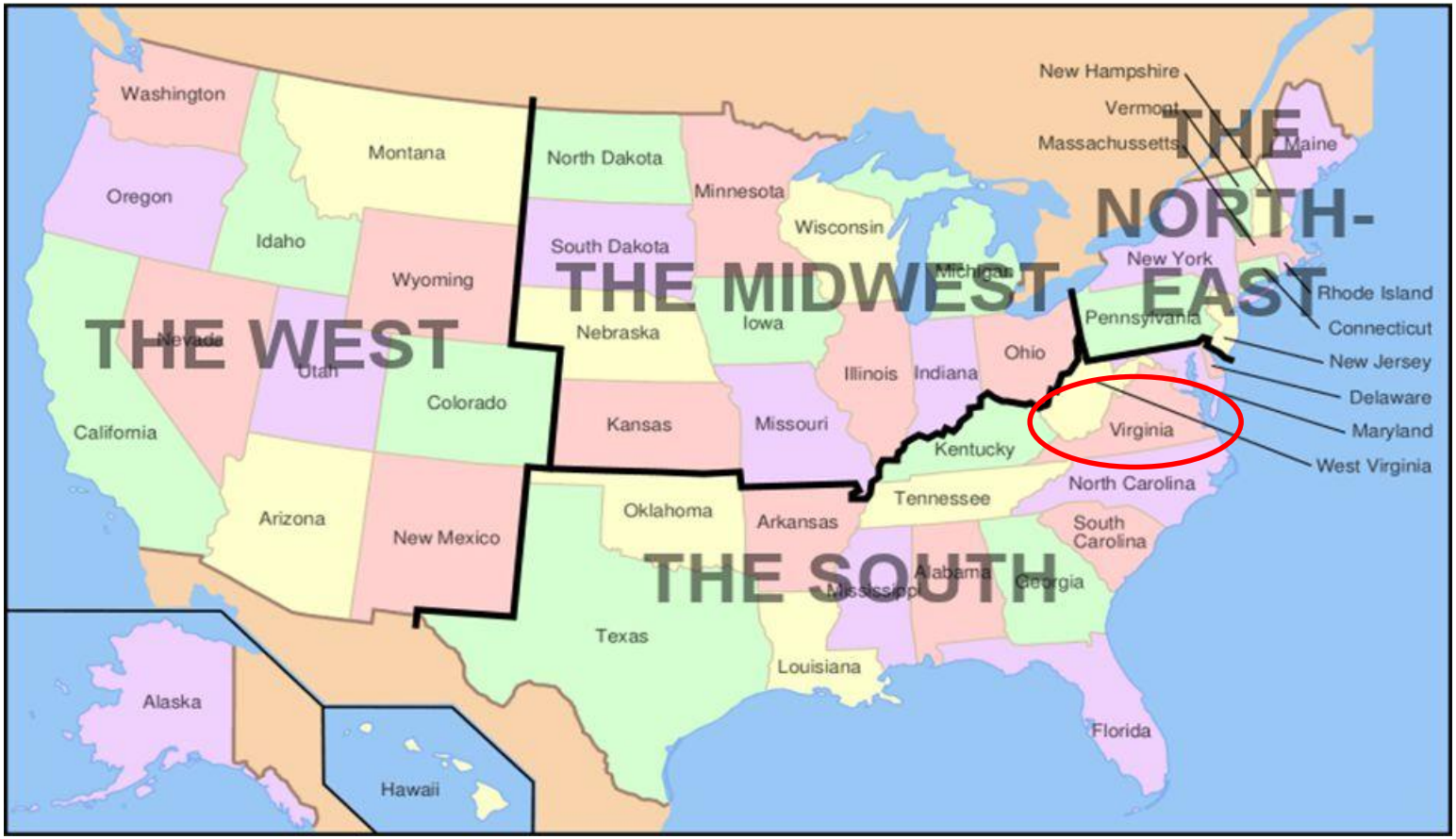
Brown AND Caldwell

North Georgia Water Resources Partnership

Nutrient Trading in Virginia:
Lessons from a Mature (and Maturing) Program

May 1 | 2019


WE DON'T CARE
HOW
YA'LL DO IT
UP NORTH.


THE WEST
THE MIDWEST
THE NORTH-EAST
THE SOUTH
Washington
Oregon
California
Idaho
Nevada
Montana
Wyoming
Utah
Arizona
Colorado
New Mexico
North Dakota
South Dakota
Nebraska
Kansas
Oklahoma
Texas
Minnesota
Iowa
Missouri
Arkansas
Louisiana
Wisconsin
Illinois
Michigan
Indiana
Ohio
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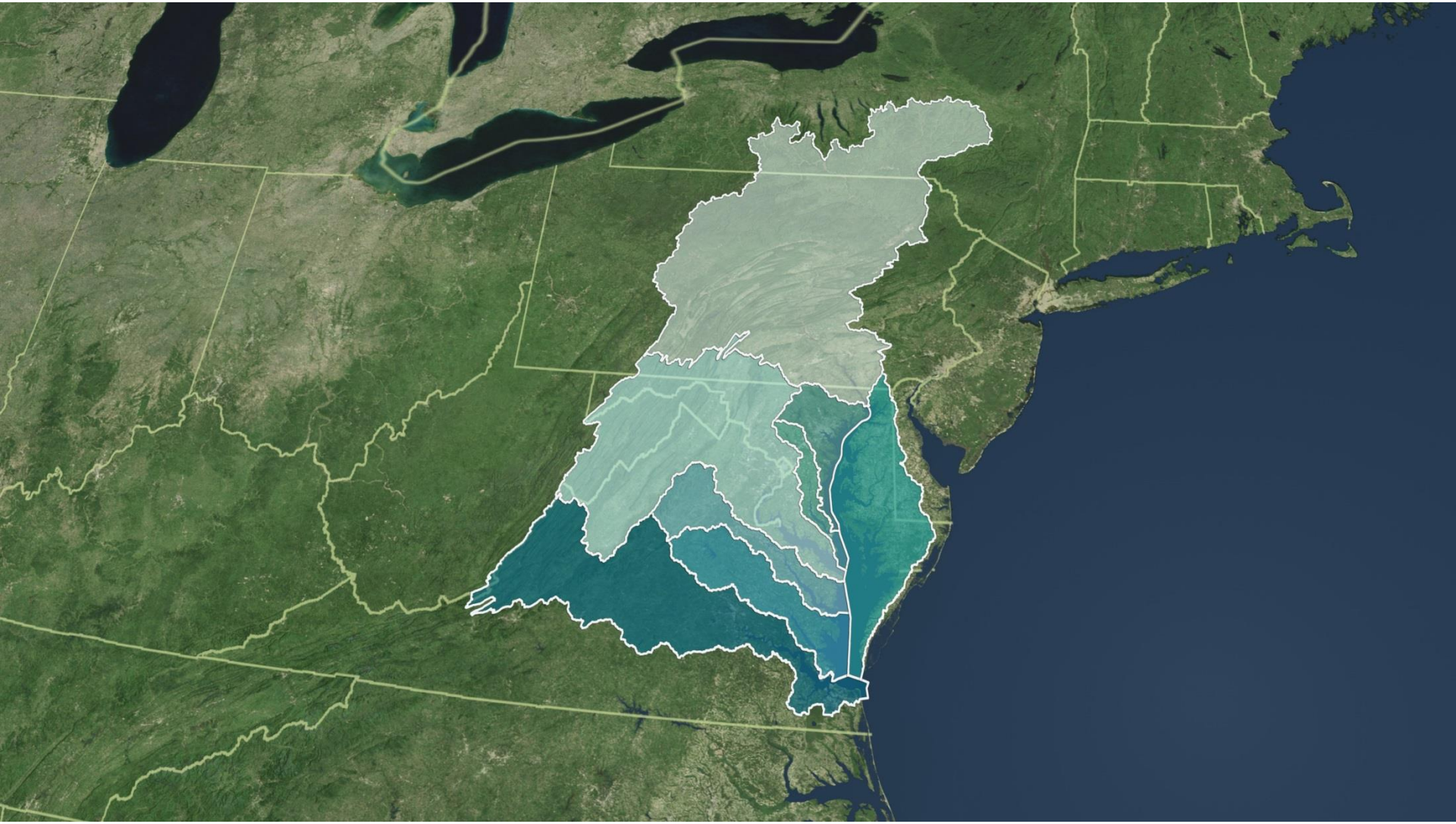
South Carolina
North Carolina
Virginia
West Virginia
Pennsylvania
New York
Maryland
Delaware
New Jersey
Connecticut
Rhode Island
Massachussetts
Vermont
New Hampshire
Maine
Alaska
Hawaii

Why Look at the Virginia Trading Program?

- Maturity: The Chesapeake Bay forced early adoption of trading.
- Success: The program has been a keystone of TMDL progress.
- Sophistication: A lot of science and accountability behind the trades.
- Flexibility: Trades can go a lot of directions.
- Lessons learned: Why are some types of trades not happening?.

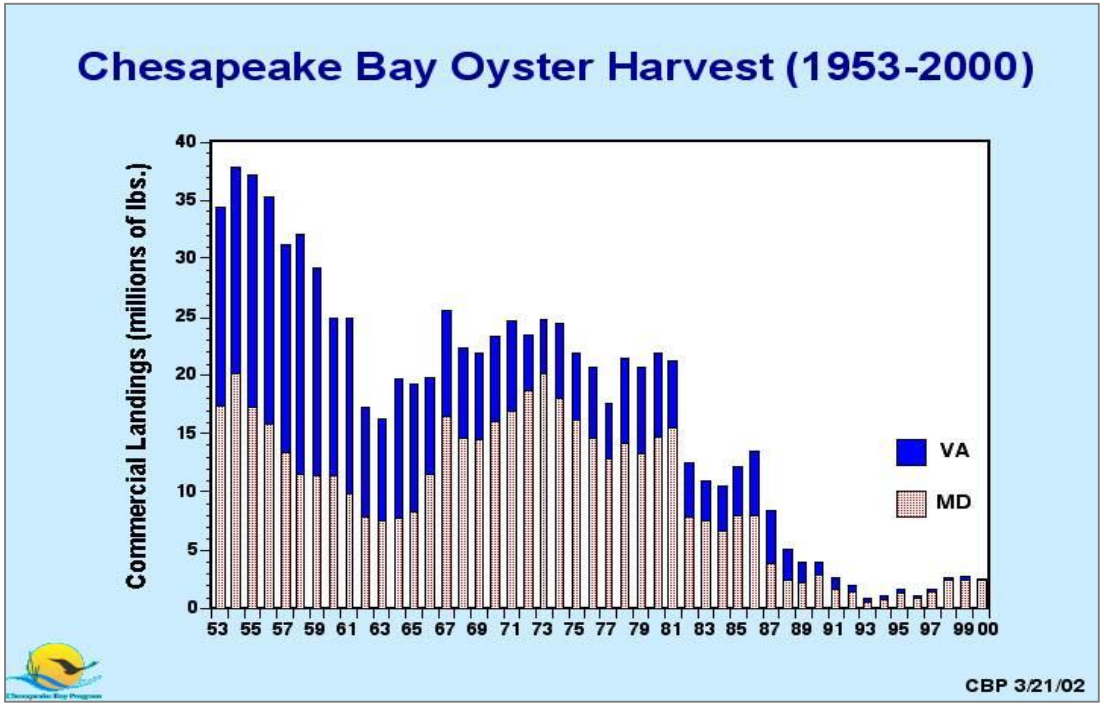
Chesapeake Bay Watershed



Chesapeake Bay Fast Facts

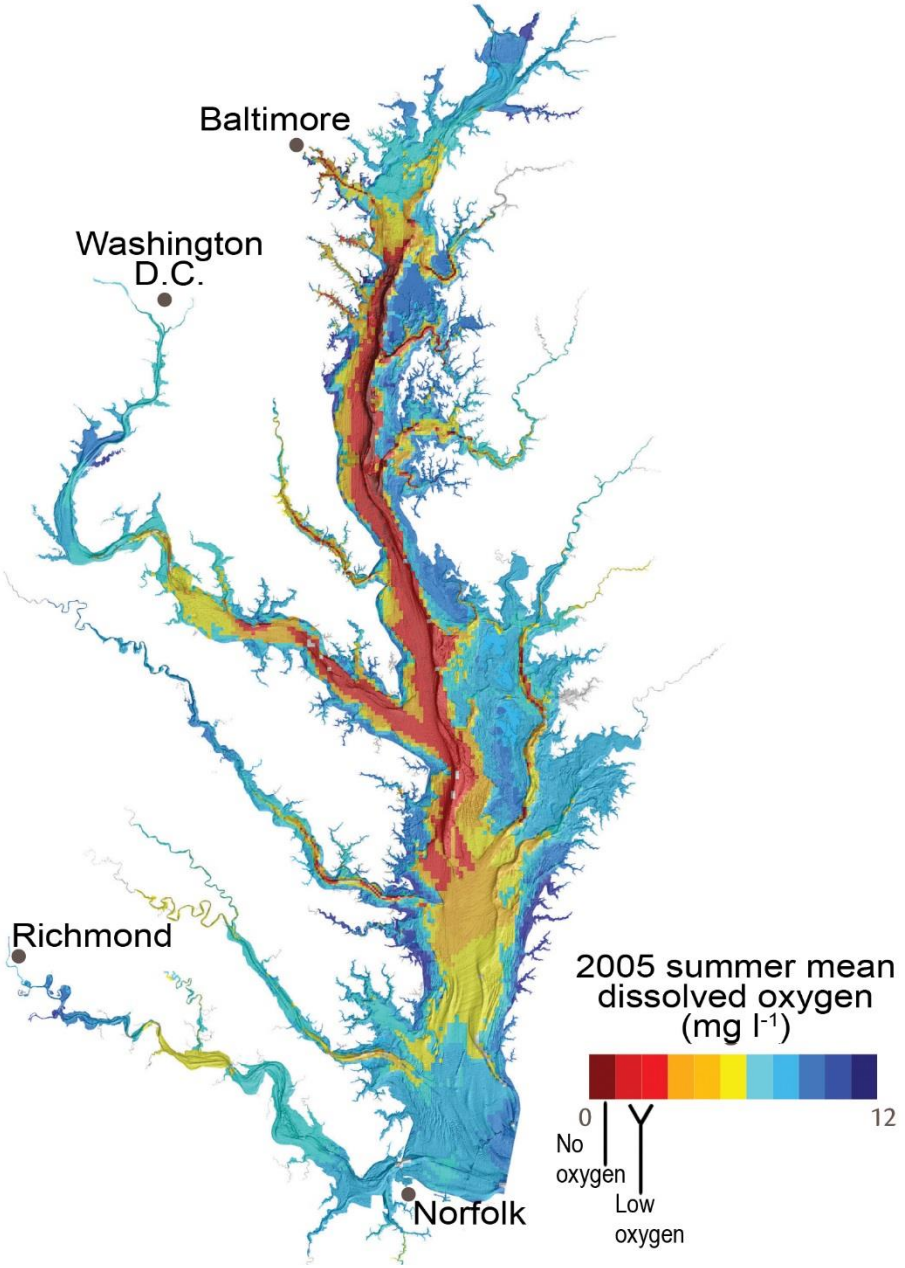
- Nation's largest estuary
- 200 miles long
- Drains parts of 6 states + DC
- Relatively shallow (average depth 21 feet)
- Depth of up to 174 feet in deep channel

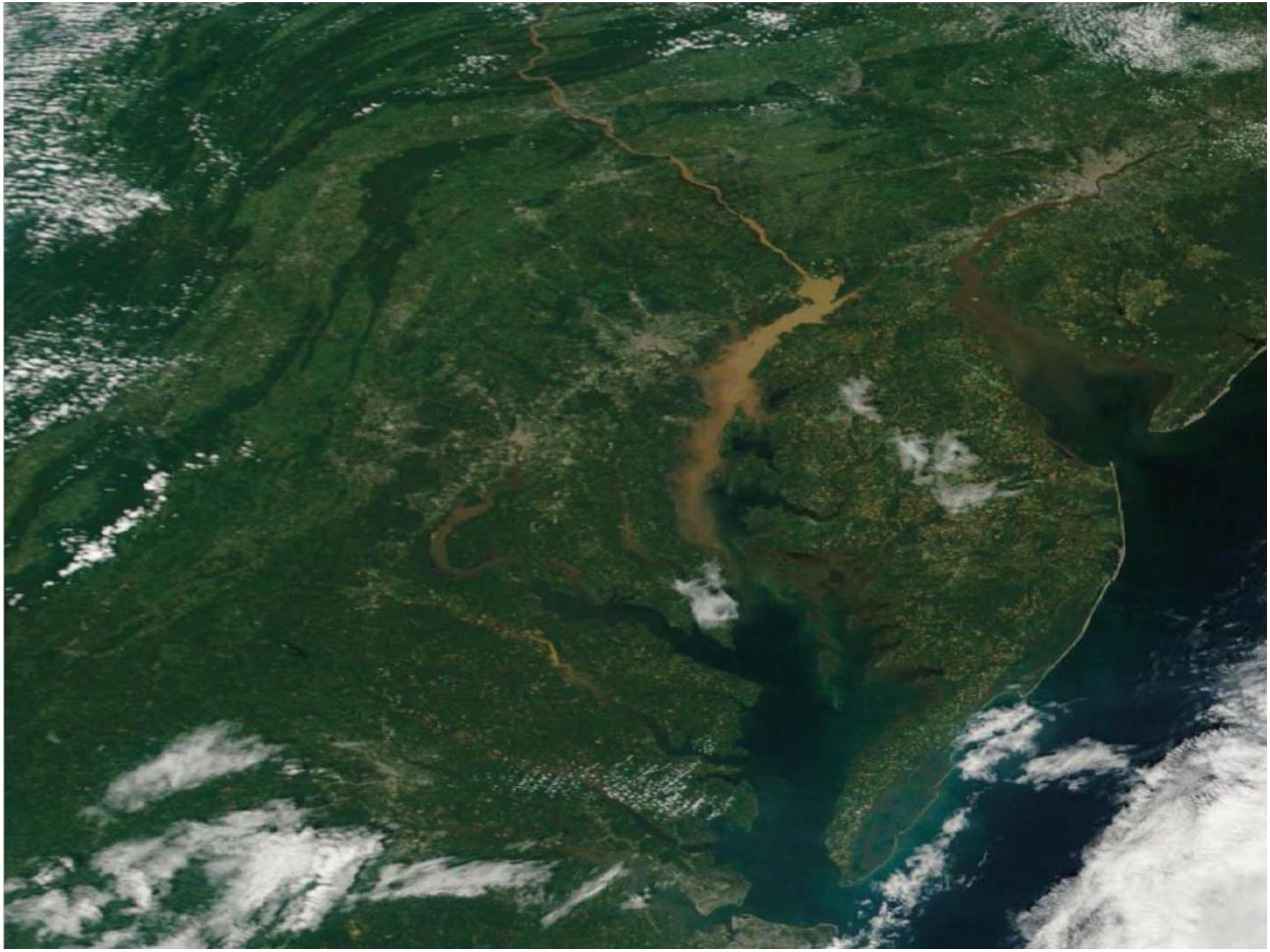
Chesapeake Bay – Historical Issues



- Water quality
  - Oxygen
  - Water clarity
  - Algal blooms
- Loss of SAV
- Overfishing
- Disease

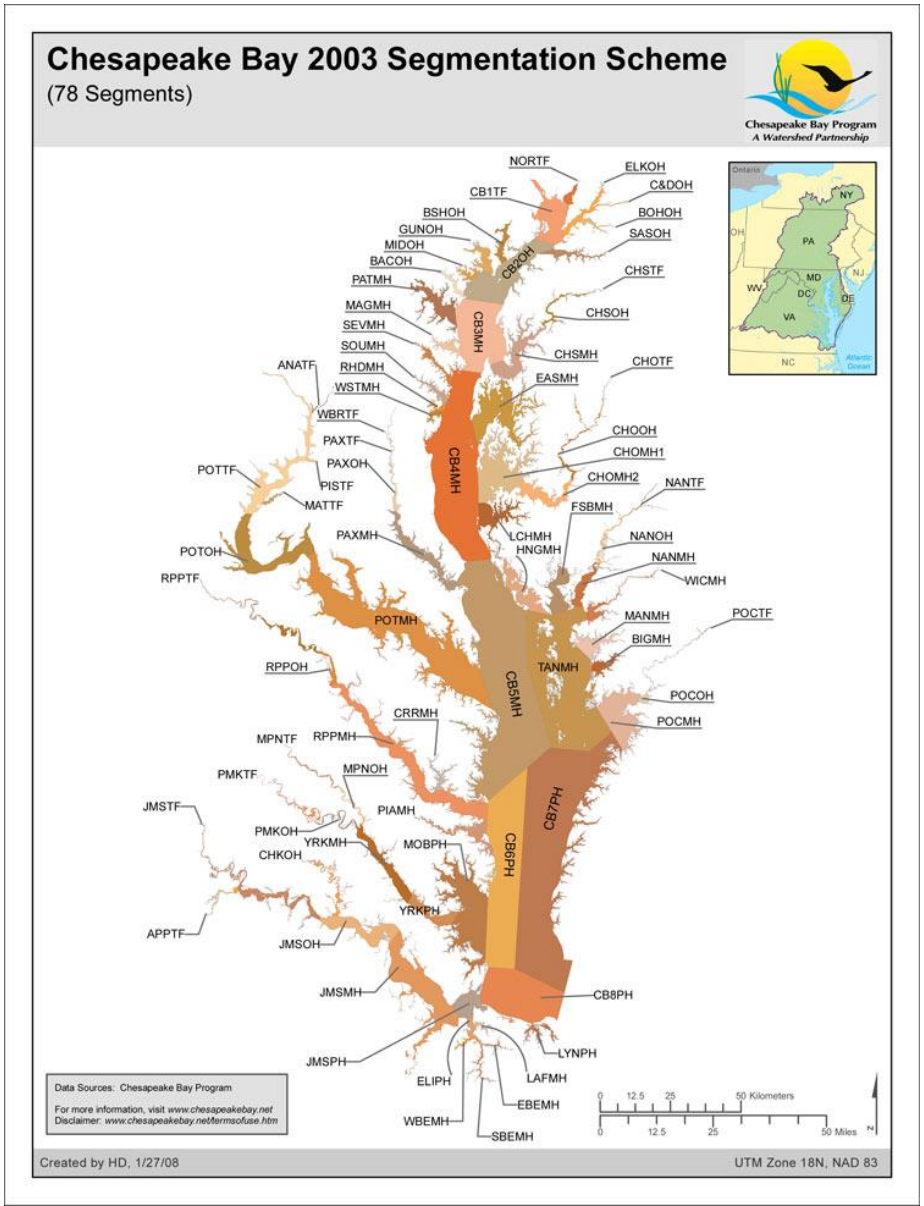
Dissolved Oxygen Impairment



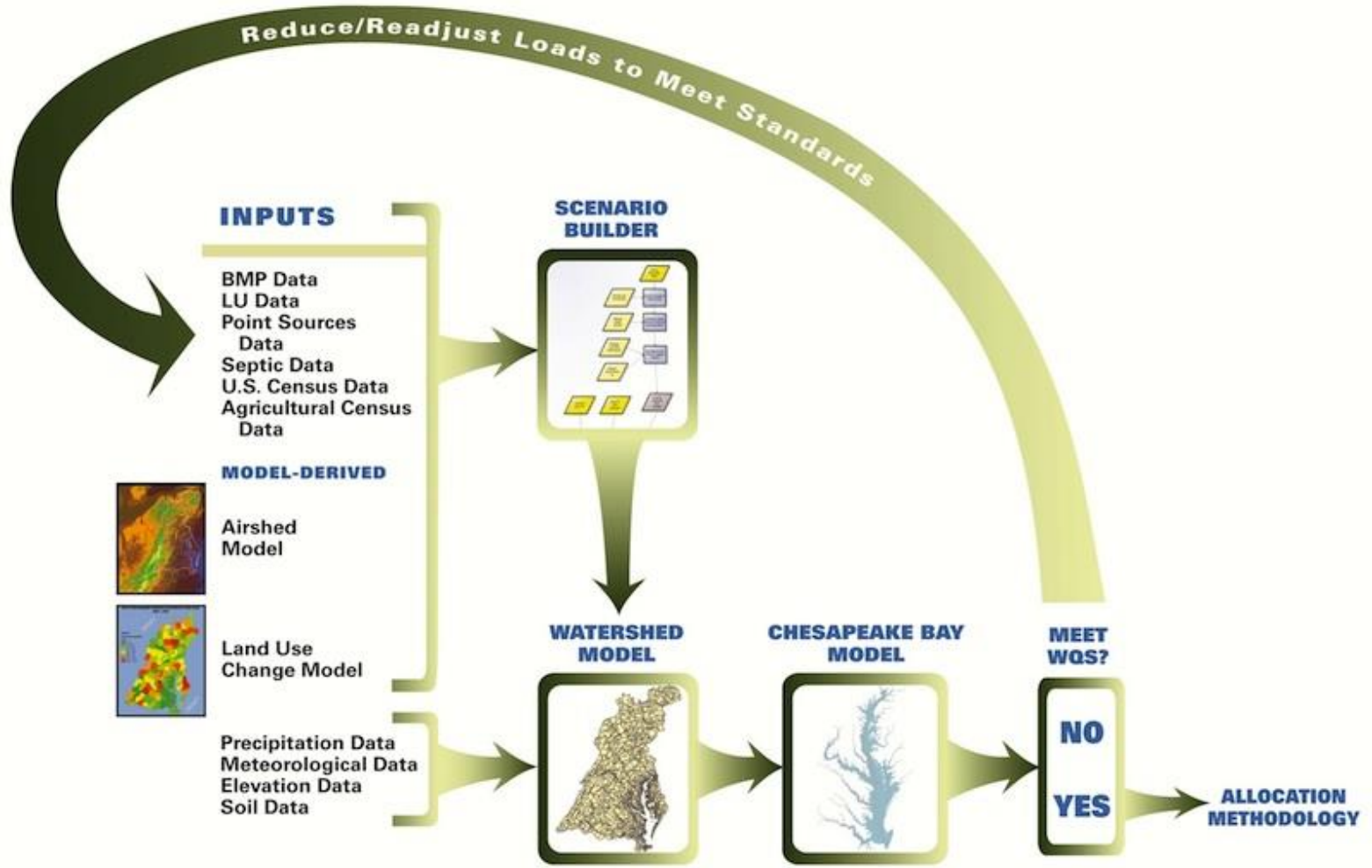


Chesapeake Bay TMDL

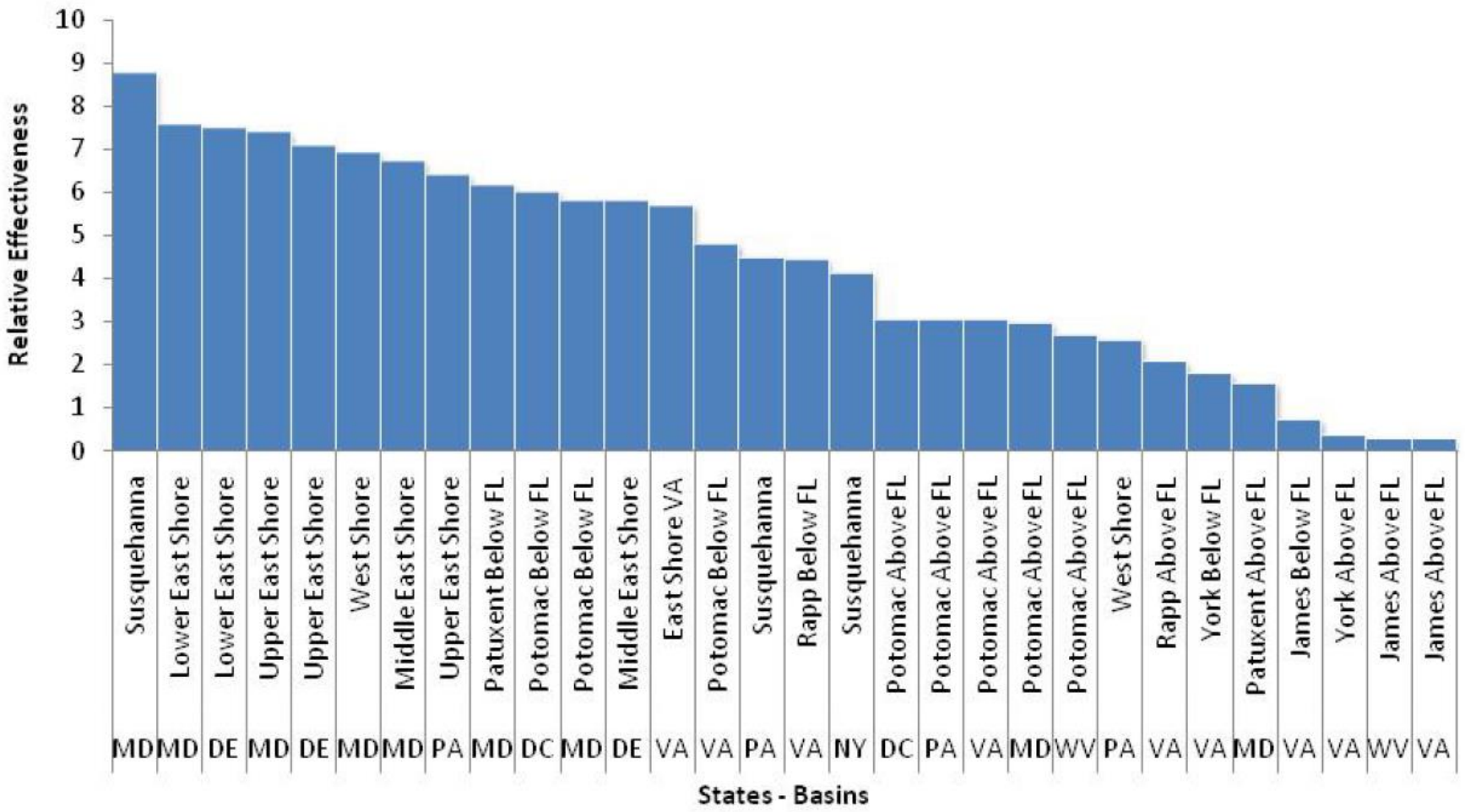
- Adopted in 2010
- Actually 92 TMDLs (!)
- Driven primarily by DO criteria
- Reductions
  - Nitrogen (25%)
  - Phosphorus (24%)
  - Sediment (20%)
- Goal of complete implementation by 2025



Modeling Framework Used to Model Management Scenarios



Required reductions high in more "effective" parts of watershed



Elements of Implementation


Clean Air rules (CAIR)


NPDES permits


MS4 Permits


State regs. on new development


CAFO permits


Agricultural cost share programs


Etc.

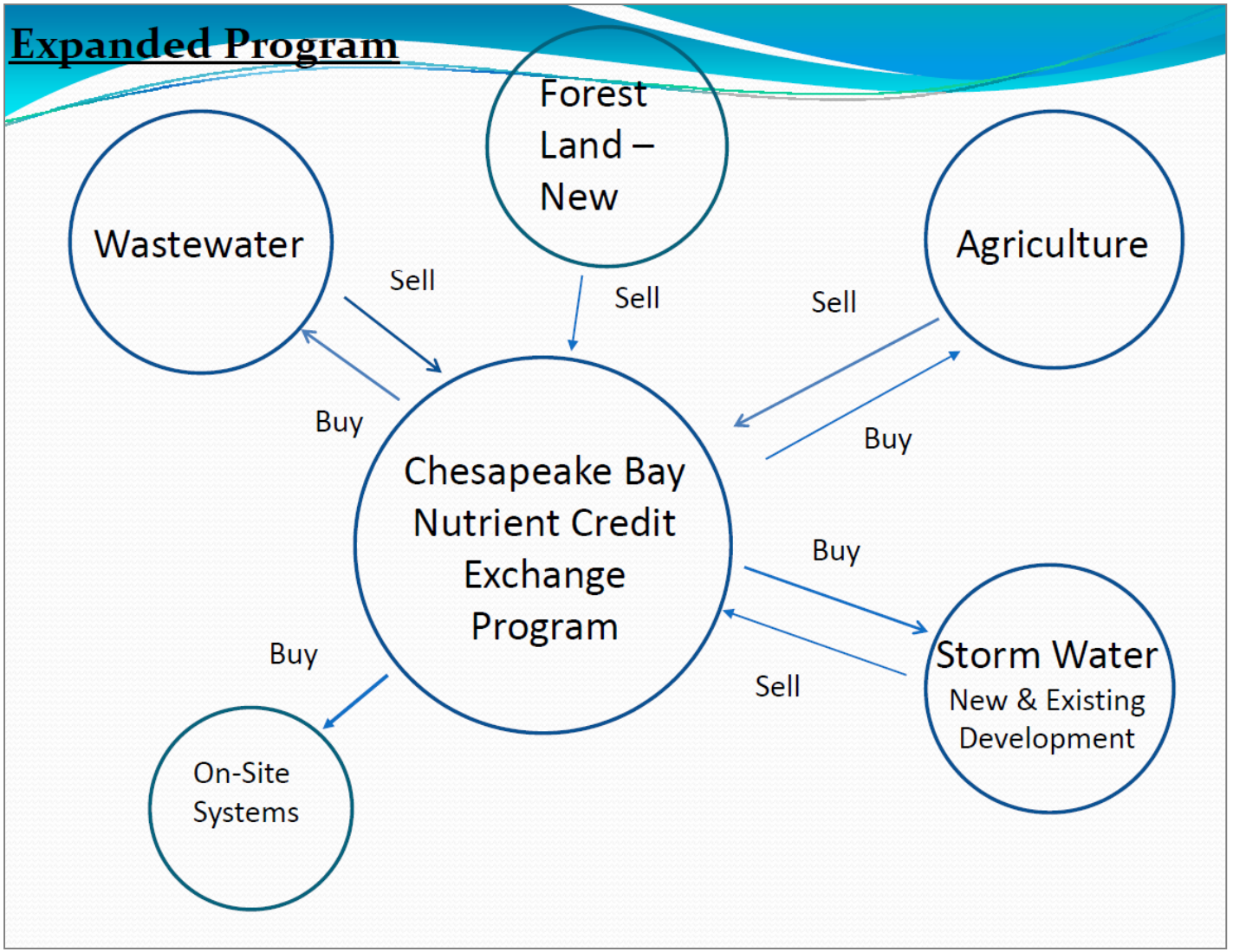
Point Source Nutrient Controls in Virginia

1997	• Water Quality Improvement Fund Established to fund nutrient reduction strategies in the Chesapeake Bay watershed
2005	• Tributary Strategies establish loading goals • Legislation requiring watershed general permit • Authorized the Nutrient Credit Exchange
2007	• VPDES Watershed General Permit becomes effective on January 1, 2007
2010	• Bay TMDL issued by EPA on December 29, 2010
2011	• Effluent limits in 2007 VPDES Watershed General Permit become effective

Perceived Benefits of Trading in ~2005

- Timing
  - Let the big guys go first…or those already planning an upgrade
  - Don’t all compete for the same consultants and contractors at one time
- Operational flexibility in living under a cap
- Cost savings ($0.8 billion on a $2.2 billion program)
- Accommodate economic & population growth
- Market-based incentives
  - Go beyond compliance (regulated sources)
  - Achieve reductions from non-regulated sources

Virginia's Trading Program at a Glance



Source: Baxter, 2015

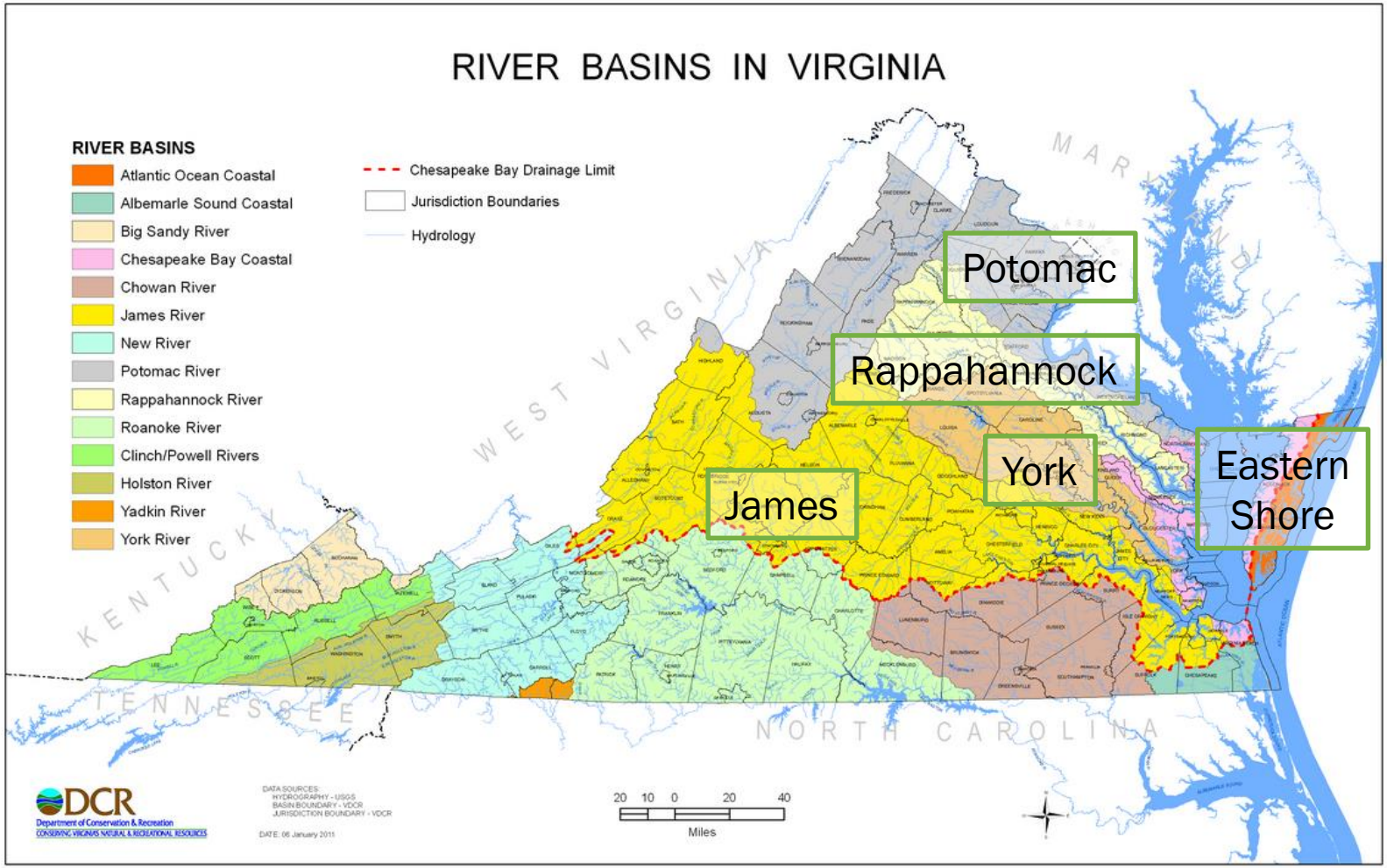
Watershed Nutrient General Permit Highlights

- Cap & trade program
- General permit overlays individual NPDES permits and addresses nutrient loads only
- >150 facilities covered
- Calendar year annual TN and TP load limits
- “Bubbling” or aggregate permits allowed
- Sets conditions for nutrient credit transactions
- Other permit components
  - Compliance schedules and plans
  - Monitoring and reporting

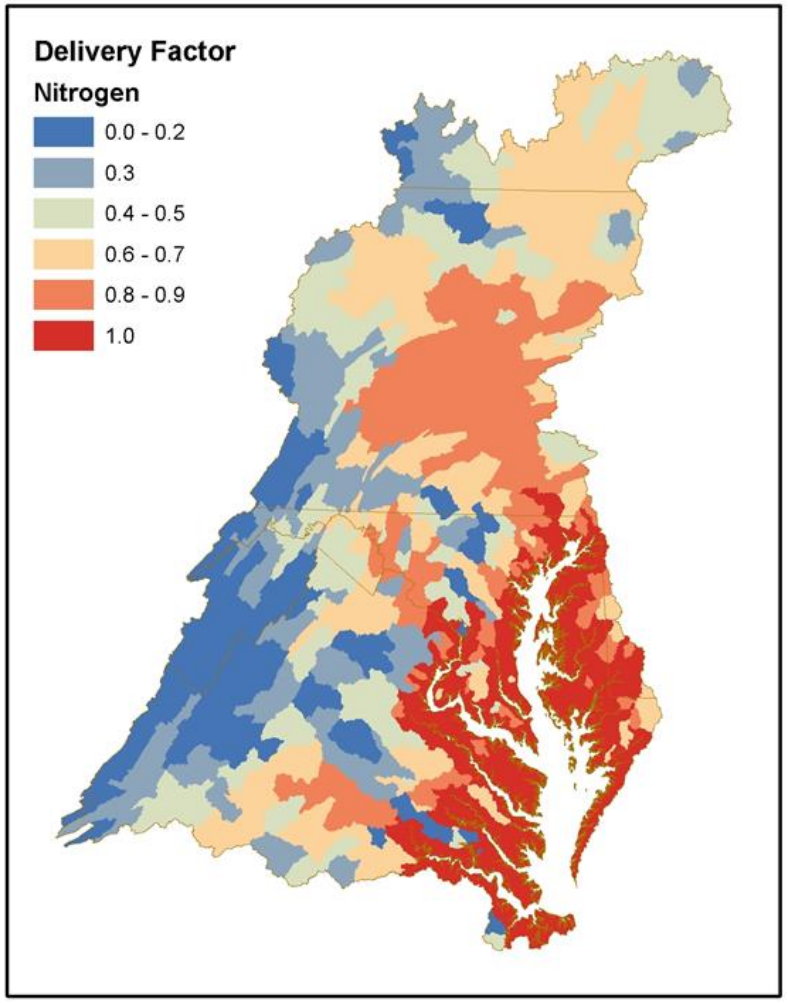
WLAs based on stringent treatment at design capacity (3-8 mg/L TN, 0.3 – 0.5 mg/L TP)

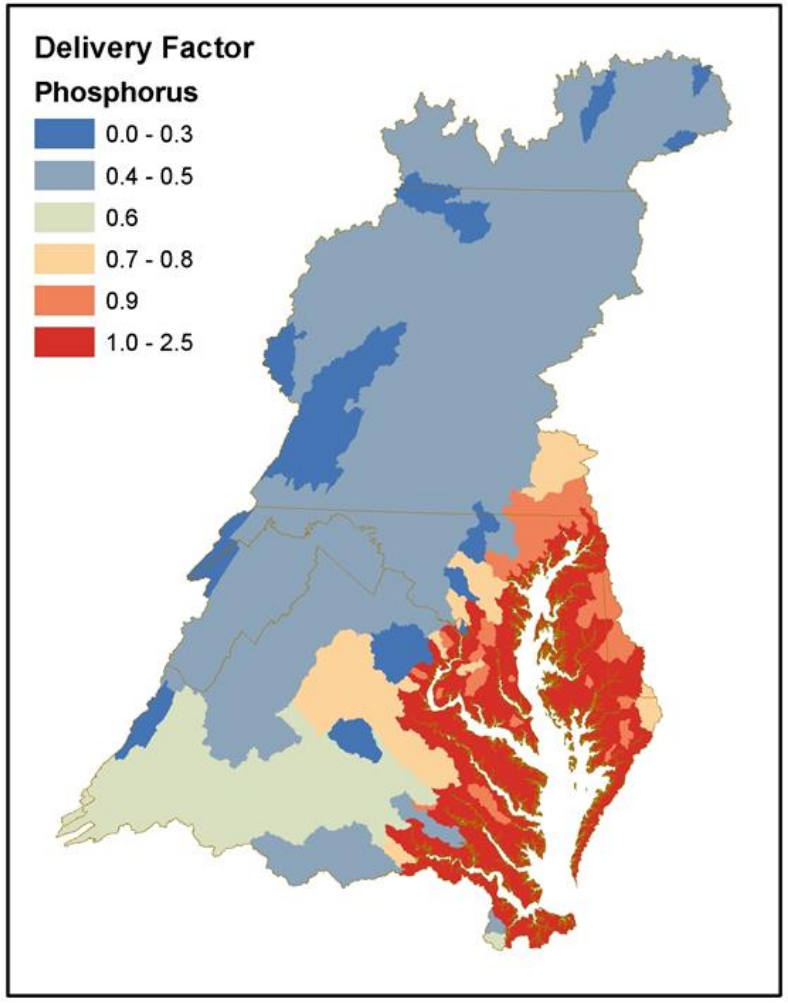
Virginia Waterbody ID	Discharger Name	VPDES Permit No.	Total Nitrogen (TN) Wasteload Allocation (lbs/yr)	Total Phosphorus (TP) Wasteload Allocation (lbs/yr)
B37R	Coors Brewing Company	VA0073245	54,820	4,112
B14R	Fishersville Regional STP	VA0025291	48,729	3,655
B32R	INVISTA - Waynesboro (Outfall 101)	VA0002160	78,941	1,009
B39R	Luray STP	VA0062642	19,492	1,462
B35R	Massanutten PSA STP	VA0024732	18,273	1,371
B37R	Merck - Stonewall WWTP (Outfall 101)[1]	VA0002178	43,835	4,384
B12R	Middle River Regional STP	VA0064793	82,839	6,213
B23R	North River WWTF	VA0060640	253,391	19,004
B22R	VA Poultry Growers -Hinton	VA0002313	27,410	1,371
B38R	Pilgrims Pride - Alma	VA0001961	18,273	914
B31R	Stuarts Draft WWTP	VA0066877	48,729	3,655

Trading Only Allowed within Major Basins



Trades based on loads delivered to tidal waters





Three Pathways of Point Source Compliance

1. Meet your individual WLA
2. Acquire point source credits through the Exchange or independently
3. Acquire credits through the Nutrient Offset Fund if no other option is available

Virginia Nutrient Credit Exchange

- Voluntary association
- 73 owners of 105 treatment facilities, municipal and industrial
- Consultant members (to pay for the beer)
- What they do:
  - Facilitate trades
  - Sets credit prices among its members
  - Acts as clearinghouse – buys all generated credits and offers cost-sharing from sales
  - Annual accounting and compliance planning
- Virginia DEQ certifies annual compliance plans

EXHIBIT 2-3

2018 Nitrogen Trading Ledger: Potomac-Shenandoah River Basin

POTOMAC Basin: Nitrogen Credit Ledger

Compliance Year:	2018	Credit Forecasts		Preliminary Use of Credits				Credit Exchange (Pounds)		
Facility Name	Delivered WLA	Expected Load	Expected Credits	In-Bubble Exchange	Private Exchange	WQIF-Held Credits	Expected Net Credits	Class A Sales	Class A* Purchases	Class B** (expected)
							PRICE:	$ 0.07	$ 3.78	$ 0.02
The Exchange (group)	**2,612,604**	**1,906,103**	**706,501**	**-**	**(274)**	**(24,365)**	**681,862**	**535,306**	**(11,587)**	**158,143**
ACSA-Fishersville	4,873	1,845	3,028	(3,028)	-	-	-	-	-	-
ACSA-Greenville	1,424	497	927	(675)	-	-	252	118	-	134
ACSA-Harriston	1,025	203	822	(822)	-	-	-	-	-	-
ACSA-Middle River	8,284	3,764	4,520	-	-	-	4,520	2,123	-	2,397
ACSA-Mt. Sidney	854	1,307	(453)	453	-	-	-	-	-	-
ACSA-Stuarts Draft	2,436	588	1,848	-	-	-	1,848	869	-	979
ACSA-Vesper View	1,025	546	479	-	-	-	479	225	-	254
ACSA-Weyers Cave	1,462	5,534	(4,072)	4,072	-	-	-	-	-	-
Alexandria Renew Ent.	493,381	367,386	125,995	-	-	-	125,995	94,496	-	31,499
Arlington Co.	365,284	232,985	132,299	-	-	-	132,299	132,299	-	-
Berryville	5,373	3,070	2,303	-	-	-	2,303	2,000	-	303
Broadway Regional	5,601	4,924	677	-	-	-	677	-	-	677
Fairfax Co-Noman Cole	612,158	455,738	156,420	-	-	-	156,420	156,420	-	-
FCWSA-Vint Hill	579	219	360	-	-	-	360	-	-	360
Front Royal	29,725	25,303	4,422	-	-	-	4,422	1,056	-	3,366
FWSA-Opequon	31,681	18,402	13,279	-	-	-	13,279	-	-	13,279
FWSA-Parkins Mill	15,837	11,086	4,751	-	-	-	4,751	-	-	4,751
HRRSA-North River	55,746	36,664	19,082	-	-	-	19,082	19,082	-	-
KGCSA-Dahlgren S.D.	9,137	6,700	2,437	-	-	-	2,437	-	-	2,437
KGCSA-Fairview Beach	1,827	731	1,096	(427)	-	-	669	-	-	669
KGCSA-Purkins Corner	1,096	1,523	(427)	427	-	-	-	-	-	-
Leesburg	97,458	31,261	66,197	-	(274)	(24,365)	41,558	-	-	41,558
Loudoun Water- Broad Run	119,264	54,929	64,335	-	-	-	64,335	56,632	-	7,703
Luray	8,187	1,688	6,499	-	-	-	6,499	6,499	-	-
Massanutten PSC	6,030	2,975	3,055	-	-	-	3,055	-	-	3,055
Merck	4,824	14,473	(9,649)	-	-	-	(9,649)	-	(9,649)	-
MillerCoors LLC	18,091	18,091	-	-	-	-	-	-	-	-
Mt. Jackson	2,900	2,237	663	-	-	-	663	-	-	663
Purcellville	13,157	9,648	3,509	-	-	-	3,509	2,023	-	1,486
PWCSA-HL Mooney	219,280	175,881	43,399	-	-	-	43,399	30,379	-	13,020
Stafford Co-Aquia	73,093	64,596	8,497	-	-	-	8,497	7,647	-	850
Stoney Creek	2,891	2,814	77	-	-	-	77	-	-	77
Strasburg	5,134	7,072	(1,938)	-	-	-	(1,938)	-	(1,938)	-
UOSA	302,607	292,754	9,853	-	-	-	9,853	-	-	9,853
VA Am. Water PW Sec. 1	42,029	22,842	19,187	-	-	-	19,187	11,512	-	7,675
VA Am. Water PW Sec. 8	42,029	22,842	19,187	-	-	-	19,187	11,512	-	7,675
Waynesboro	6,822	2,985	3,837	-	-	-	3,837	414	-	3,423
Purchase by Eastern Shore	-	-	-	-	-	-	-	-	-	-

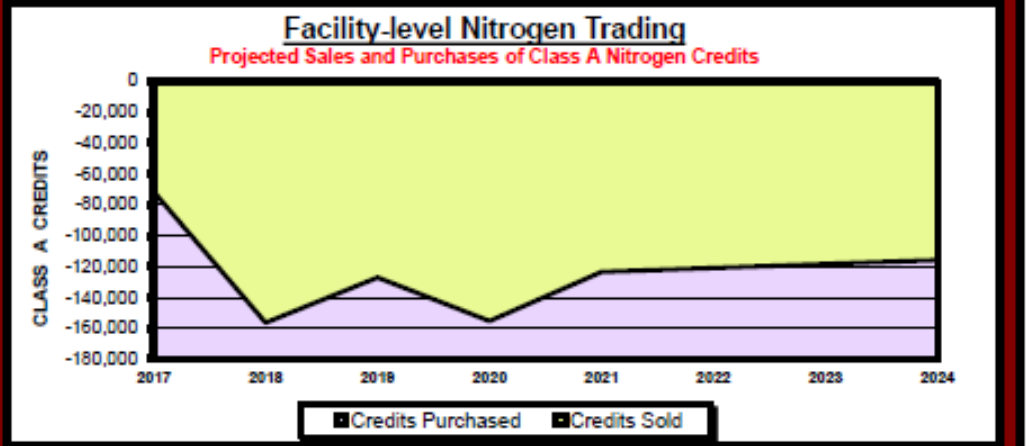
** For this Compliance Year, 0% of all Class A Credit Purchases are expected to be satisfied using Class B Credits.*

*** Expected Class B Credits are estimates only. Actual Class B Credits—and the resulting Class B sales price—will vary from estimates based on actual Delivered Loads in the Compliance Year.*

NITROGEN FACILITY SUMMARY

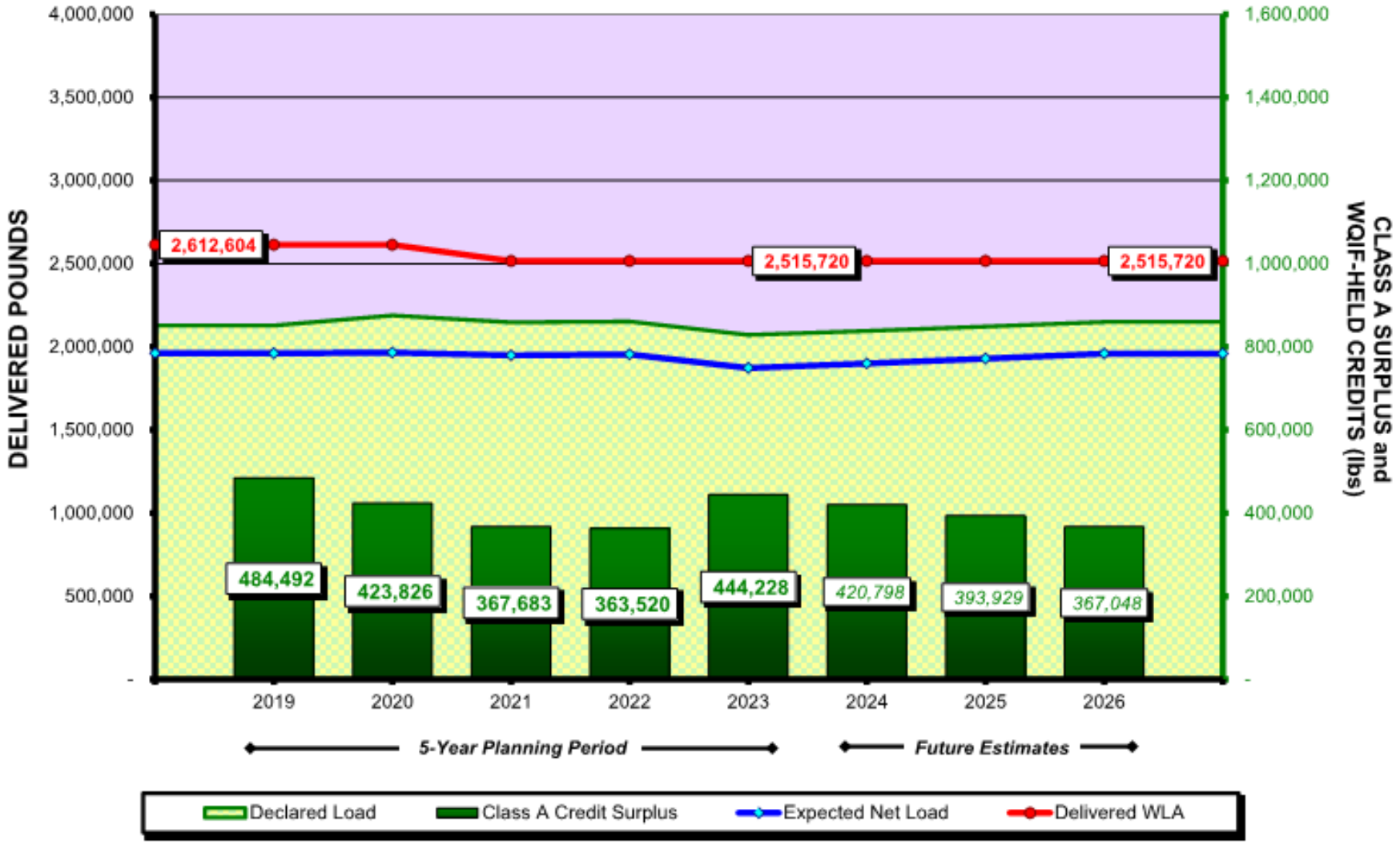
Fairfax Co-Noman Cole

POTOMAC Trading Basin



Loading & Credit Summary	2017	2018	2019	2020	2021	2022	2023	2024
	Planning Period					*Future Estimates (non-binding)*		
Design Flow (mgd)	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00
Projected Flow (mgd)	47.40	49.88	51.54	50.00	53.48	53.76	54.04	54.32
Projected Avg. Annual Concentration (mg/L)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Discharged Load (end of pipe)	433,079	455,738	470,904	456,834	488,630	491,188	493,746	496,304
Delivery Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Expected Load	433,079	455,738	470,904	456,834	488,630	491,188	493,746	496,304
Delivered WLA	612,158	612,158	612,158	612,158	612,158	612,158	612,158	612,158
Expected Credits (delivered)	179,079	156,420	141,254	155,324	123,528	120,970	118,412	115,854
Transfers In (Out) within Owner Bubble	0	0	0	0	0	0	0	0
Transfers In (Out) from Private Exchange	0	0	0	0	0	0	0	0
WQIF-Held Credits	0	0	0	0	0	0	0	0
Expected Net Credits	**179,079**	**156,420**	**141,254**	**155,324**	**123,528**	**120,970**	**118,412**	**115,854**
Class A Credit Sales (Purchases)	**71,632**	**156,420**	**127,128**	**155,324**	**123,528**	**120,970**	**118,412**	**115,854**
Expected Class B Credits	**107,447**	**0**	**14,126**	**0**	**0**	**0**	**0**	**0**

Nitrogen Compliance: Potomac Basin



Different Prices for Class A and Class B Credits Provide Incentive for Up-Front Commitments

Class A Buyer
$4 P / $2 N

Exchange Buyer
$6 P / $3 N

Outside Buyer
$8 P / $4 N

Disbursement of Funds

90%

10%

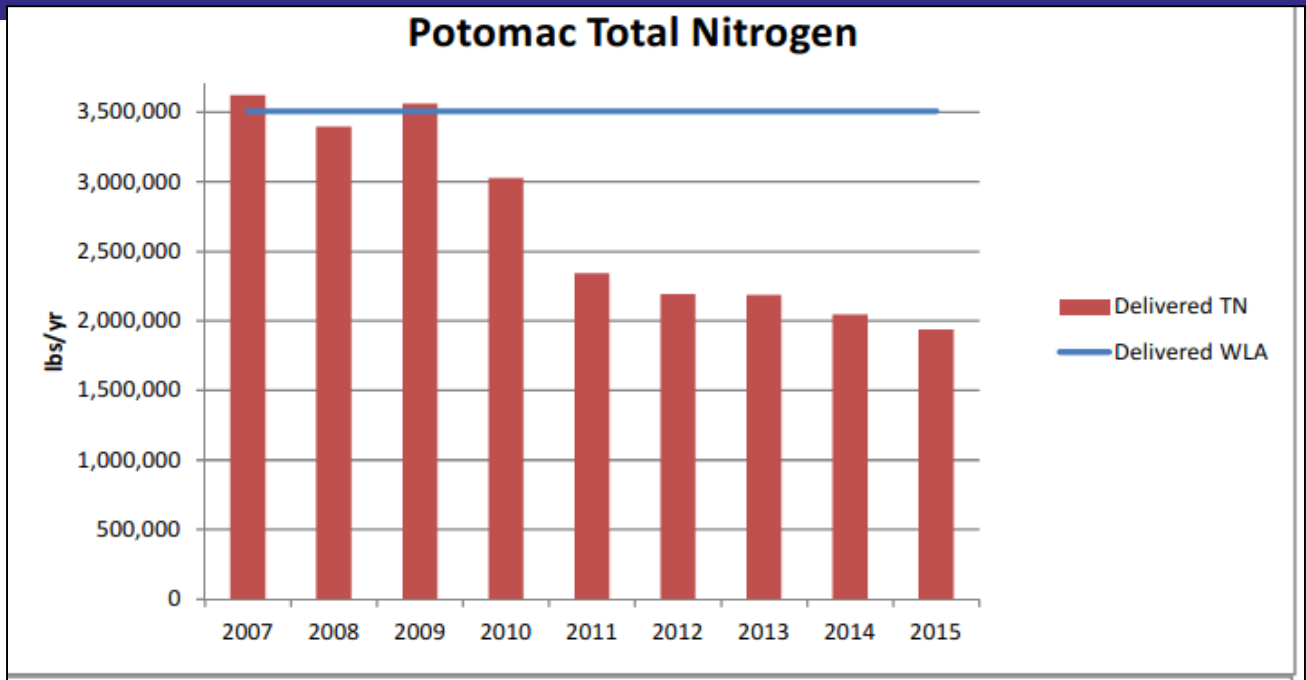
Class A Supply Pool
A Pool / Total A Credits

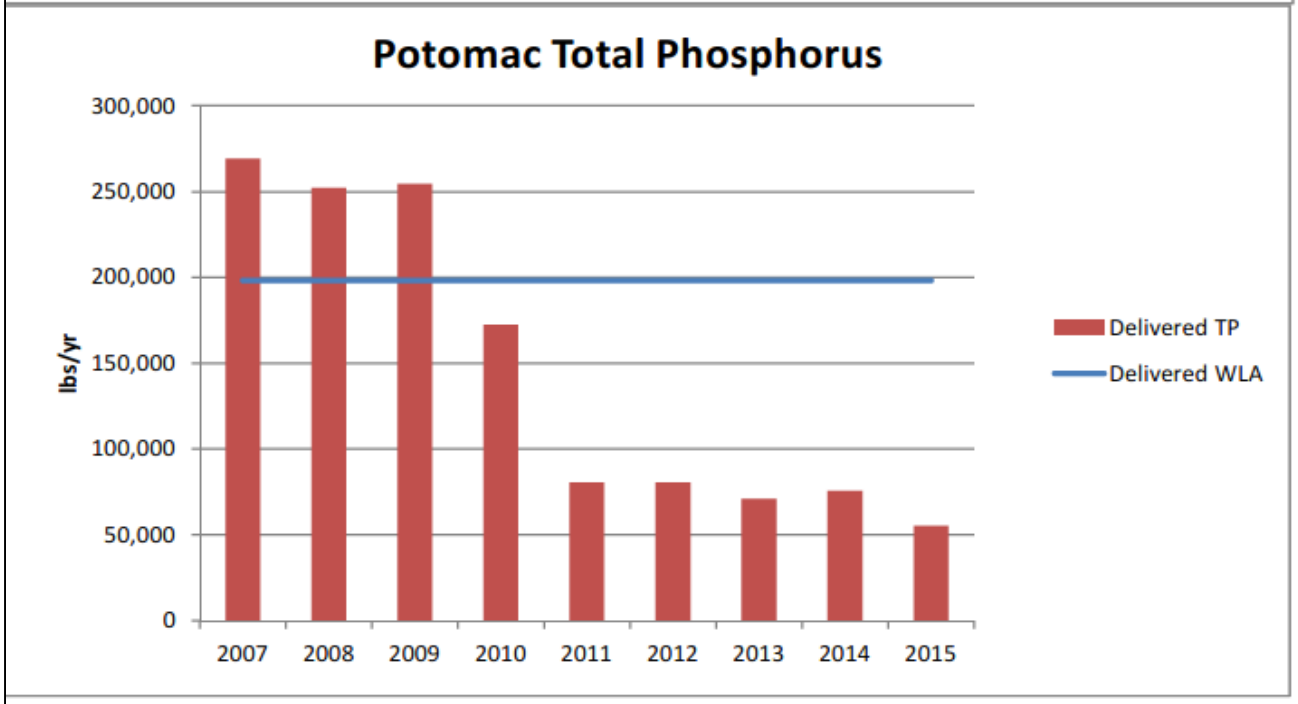
Class B Supply Pool
B Pool / Total B Credits

Point Source Compliance Trades

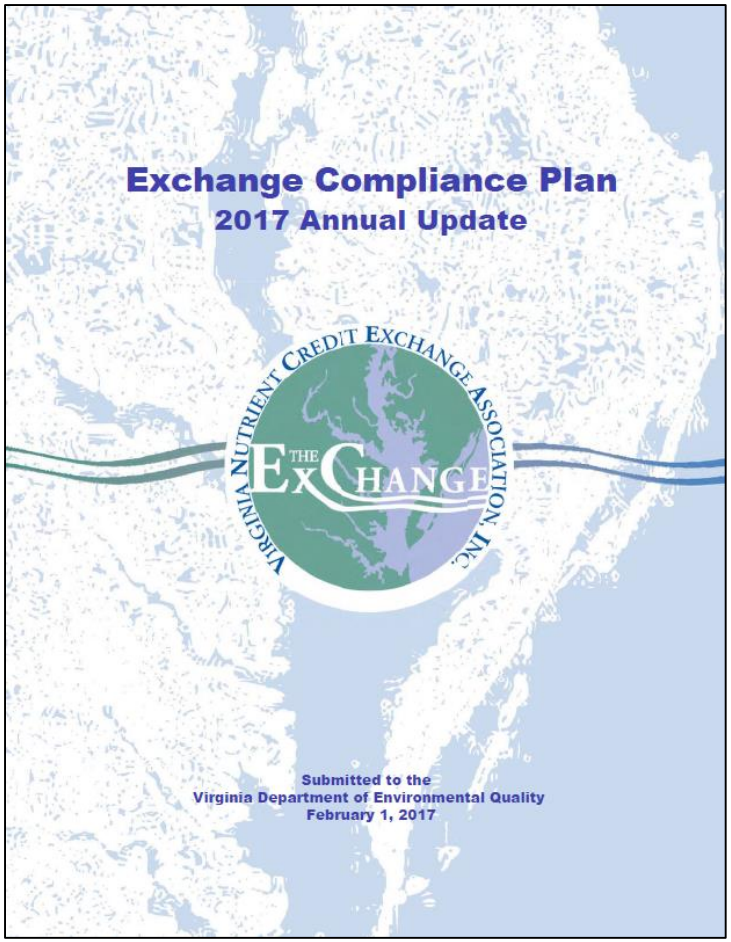
	2017	
21 buyers	306,174 lbs of TN	1.9 % of WLA
	28,073 lbs of TP	2.4 % of WLA

Point Source Nutrient Reductions





Primary Factors in Success of the Point Source Trading Program



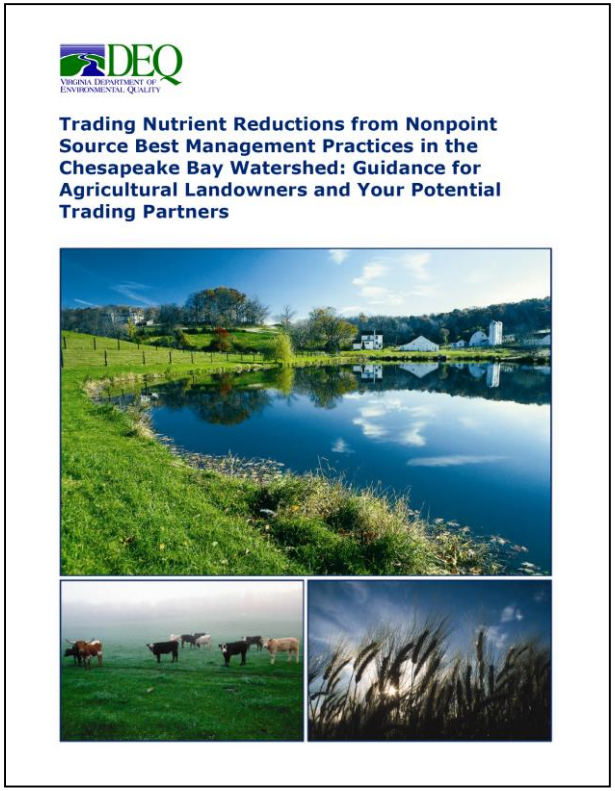
- Watershed general permit
  - Expedient – one negotiation
  - Common schedule of compliance
  - Consistent requirements
- Formation of the Virginia Nutrient Credit Exchange Association with voluntary membership
- Permittees given ownership of the market and have embraced the program

Nonpoint Source Trading in VA

Reserved for accommodating <u>new and expanding point sources only</u>

Guidance adopted in January 2008

First bank approved in July 2008



To generate NPS credits, farms must first meet baseline requirements

Soil conservation plan

Nutrient management plan

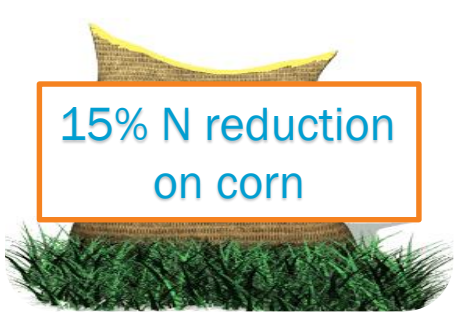
Cover crops

Livestock exclusion w/ 35’ buffer

35’ riparian buffer

Credits are generated from enhanced versions of the baseline practice

Soil conservation plan



Nutrient management plan

Cover crops

Livestock exclusion w/ 35’ buffer

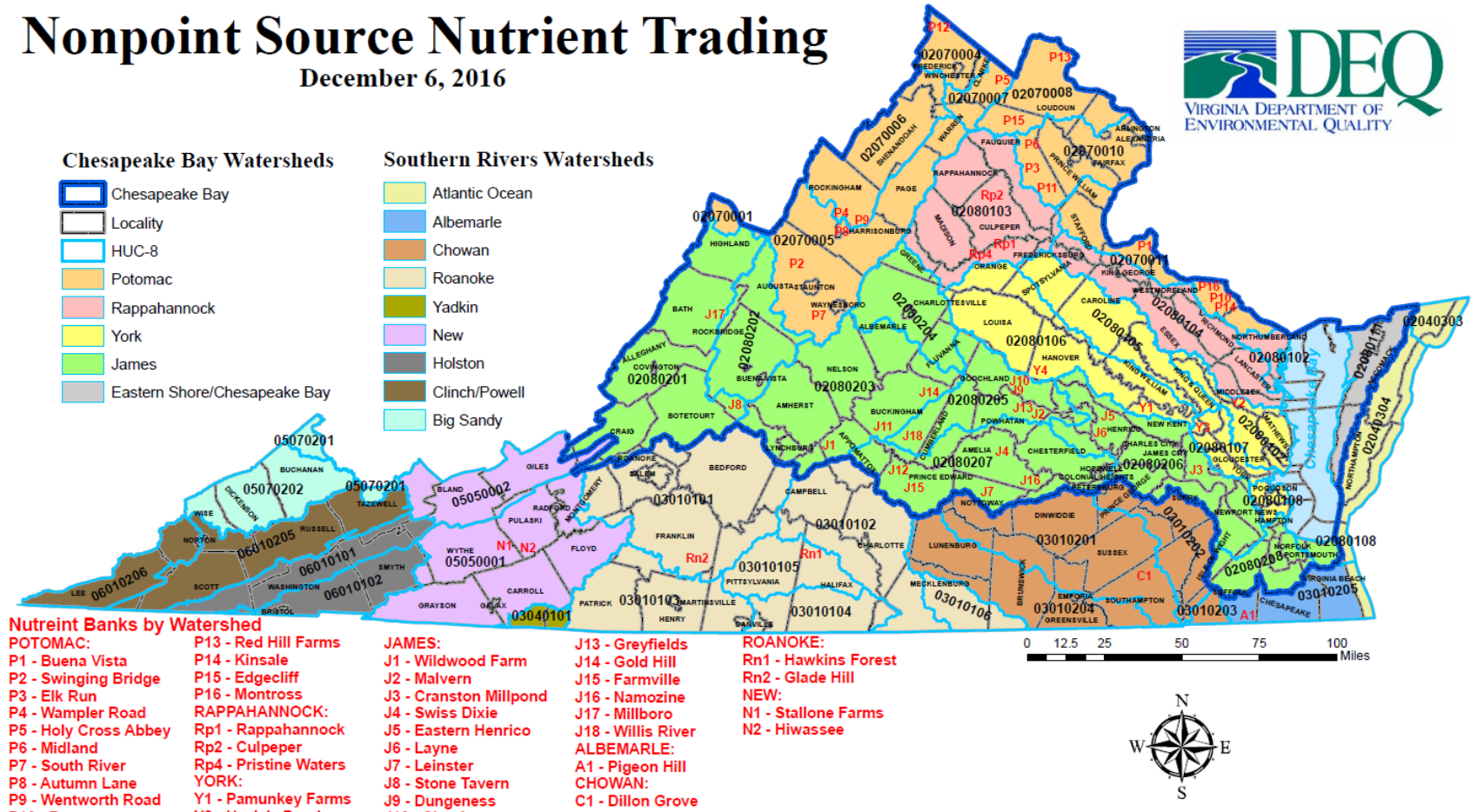
35’ riparian buffer

Credits can also be generated by stormwater retrofits (enhancements)

Other aspects of nonpoint source credits

- 2:1 trading ratio for NPS:PS trades
- 5% of credits are permanently retired
- Requires public or private broker; e.g.
  - Nutrient bank
  - Land conservation trust
  - Agricultural cooperative
- Credits certified/authenticated on an annual basis

~125 banks in operation across state



Nutreint Banks by Watershed

POTOMAC:
P1 - Buena Vista
P2 - Swinging Bridge
P3 - Elk Run
P4 - Wampler Road
P5 - Holy Cross Abbey
P6 - Midland
P7 - South River
P8 - Autumn Lane
P9 - Wentworth Road
P10 - Bowen
P11 - Owl Run
P12 - Cross Junction
P13 - Red Hill Farms
P14 - Kinsale
P15 - Edgecliff
P16 - Montross

RAPPAHANNOCK:
Rp1 - Rappahannock
Rp2 - Culpeper
Rp4 - Pristine Waters

YORK:
Y1 - Pamunkey Farms
Y2 - Healy's Pond
Y3 - York
Y4 - Clover Creek

JAMES:
J1 - Wildwood Farm
J2 - Malvern
J3 - Cranston Millpond
J4 - Swiss Dixie
J5 - Eastern Henrico
J6 - Layne
J7 - Leinster
J8 - Stone Tavern
J9 - Dungeness
J10 - Shaefer
J11 - Buckingham
J12 - Prince Edward
J13 - Greyfields
J14 - Gold Hill
J15 - Farmville
J16 - Namozine
J17 - Millboro
J18 - Willis River

ALBEMARLE:
A1 - Pigeon Hill

CHOWAN:
C1 - Dillon Grove

ROANOKE:
Rn1 - Hawkins Forest
Rn2 - Glade Hill

NEW:
N1 - Stallone Farms
N2 - Hiwassee

2:1 nonpoint : point trading ratio has been controversial

- Intended to address greater uncertainty in NPS practices.
- Reduces incentive for trading
- Nationally, trading ratios range from 1.1 to >3
- “The use of appropriate models and verification practices may reduce or eliminate the need for trading ratios…” EPA Memo on Trading Policy (2019)

How has NPS:PS trading actually worked?

Type of Trade	Trades Occurring or Planned?
WWTP ➔ WWTP	Yes
WWTP ➔ MS4	Yes
Agriculture ➔ new development	Yes
Agriculture ➔ WWTP	No

Why no NPS-to-PS trades?

- Lack of demand
  - Not a lot of new WWTPs
  - Adequate capacity in existing WWTPs
  - Credits available from other point sources
- Lack of (cheap) supply
  - It takes a lot of land – a problem of scale
  - 2:1 trading ratio
  - NPS credit pricing driven by new development market (e.g., $20,000/lb P)

2017 Nutrient Trades

Point Source to Point Source under Watershed General Permit

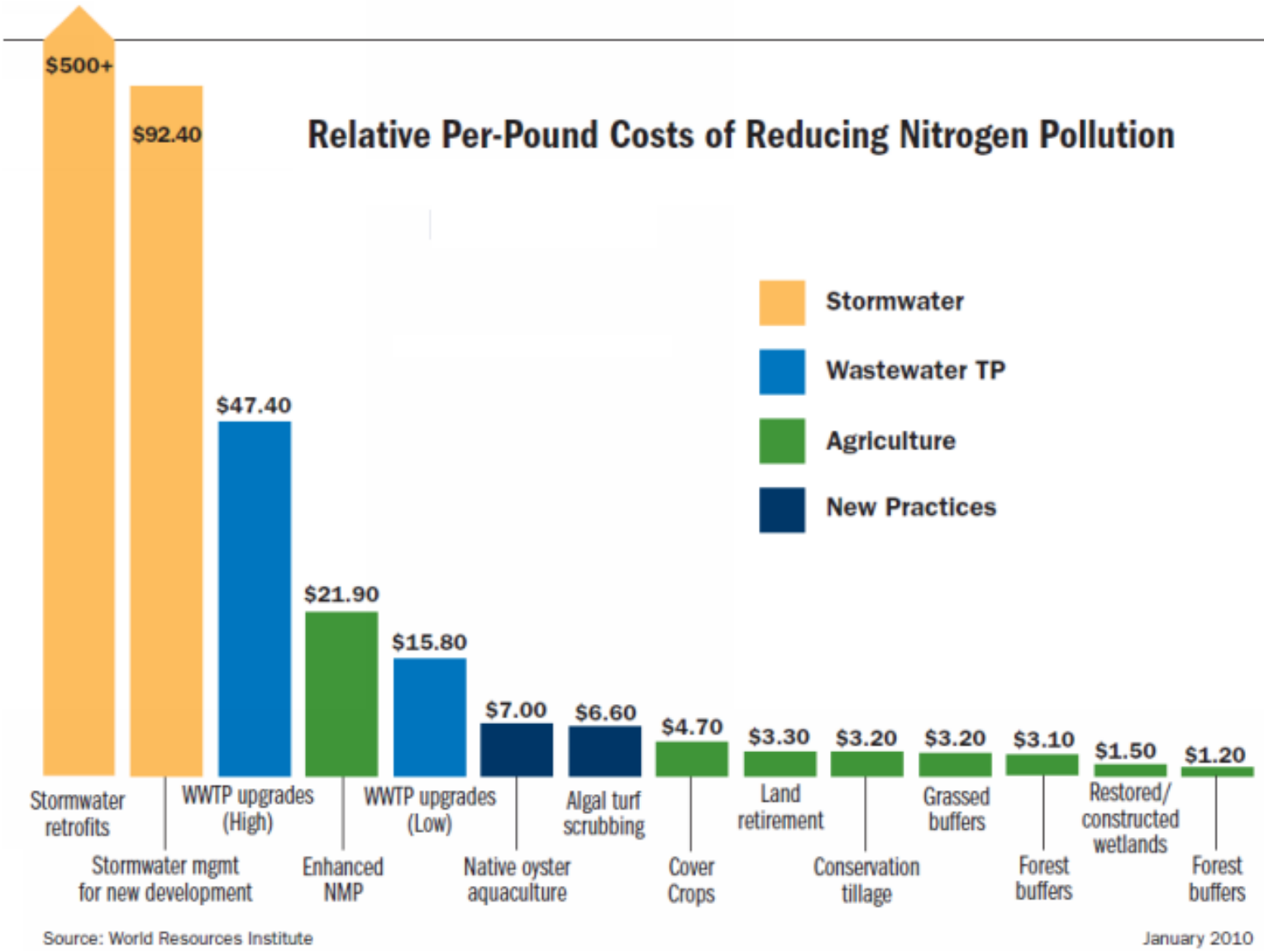
- 25 facilities acquired approximately 28,000 lbs of TP and 306,000 lbs of TN credits
- Several minor WLA trades
- Approximately $1,800,000 market value

~$6+/lb P

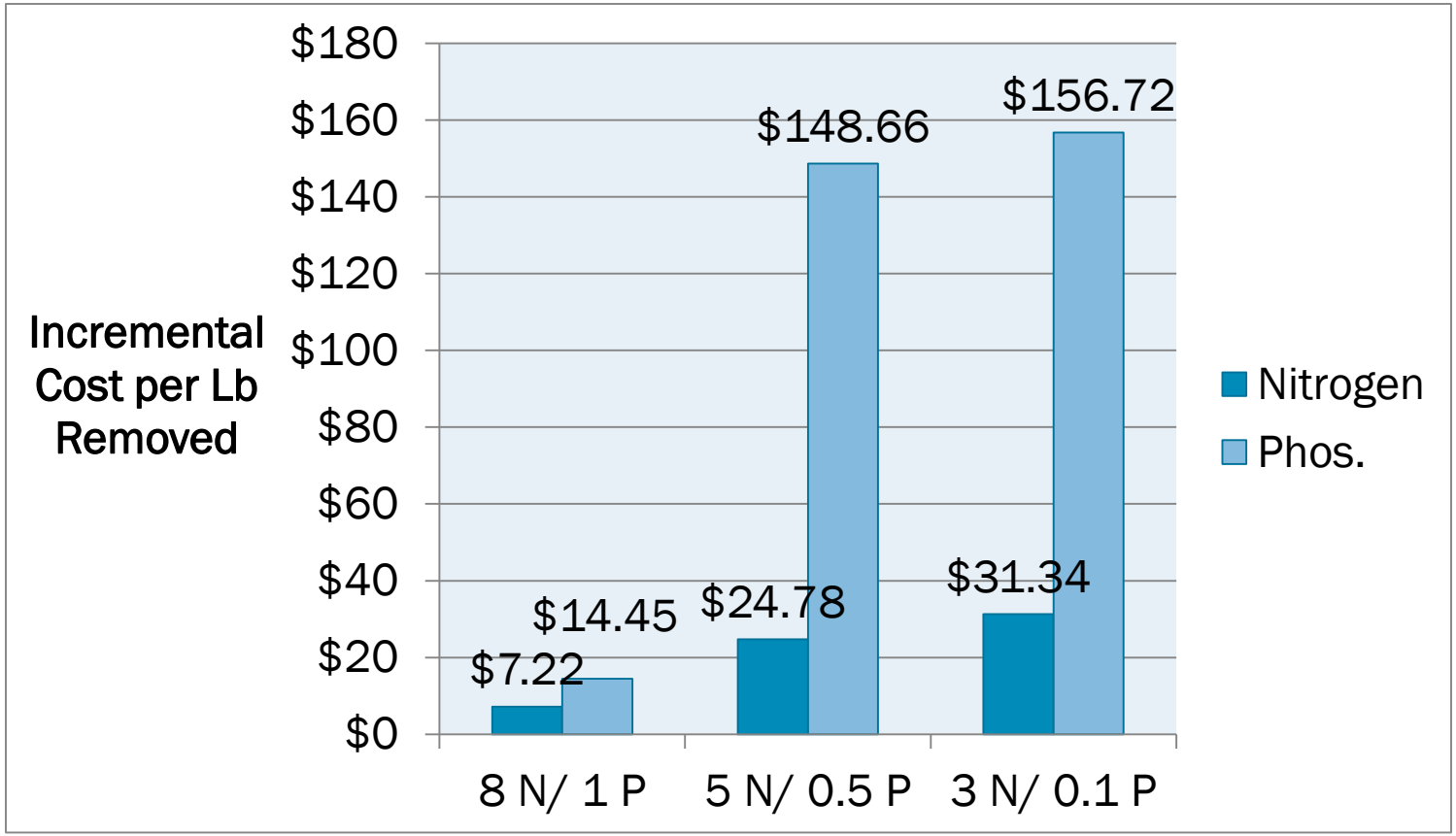
Non-Point Source Credits Sold (Permanent Offsets)

- Approximately 900 lbs of TP with 5,400 lbs of TN retired
- Approximately $18,000,000 market value

~$10,000 – 24,000/lb P


Relative Per-Pound Costs of Reducing Nitrogen Pollution
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

Cost per pound escalates as treatment level increases



Data Source: RTI International, 2012, *Nutrient Credit Trading for the Chesapeake Bay: An Economic Study*. Report prepared for the Chesapeake Bay Commission

If you want agriculture→WWTP trades…

- Look for highly economical ag practices
- Lots of land opportunity
- Avoid high trading ratios
- Streamlined trading mechanism
- Consider other market forces
- Buyers might have to make it happen

Underwater Grass Comeback Helps Chesapeake Bay

Stories of Progress in Achieving Healthy Waters

U.S. EPA Region 3 Water Protection Division

Susquehanna Flats• January 21, 2016

The fortified Susquehanna Flats, the largest bed of underwater grasses in the Chesapeake Bay and a popular fishing spot, seems able to withstand a major weather punch. Its resilience is contributing to an overall increase in the Bay's submerged aquatic vegetation (SAV), a key indicator of ecosystem health.

Susquehanna Flats in the Chesapeake Bay with underwater grasses returning.

Chesapeake Bay water quality at near-record high

Bay Barometer shows Chesapeake resilient, improving

Steep Cuts in Wastewater Pollution Leading Way in Chesapeake Bay Restoration; Sector Meeting 2025 Pollution Limits 10 Years Early (June 14, 2016) - Upgrades and operational efficiencies at wastewater treatment plants throughout the Chesapeake Bay watershed have achieved steep reductions in nitrogen and phosphorus pollution, putting this sector at the forefront of Bay restoration. The wastewater sector has reduced nitrogen going to the Bay by 57 percent and phosphorus by 75 percent since 1985 and, for the first time, is effectively meeting its 2025 nutrient pollution limits in the landmark Chesapeake Bay TMDL, according to Chesapeake Bay Program analysis.

Chesapeake regaining "resilience," EPA reports

Extra Slides

Brown AND Caldwell

Grateful Dead-Zone: Thank You for Not Growing

Follow

30 NOV 2017

Blog Post CBF in Maryland, CBF in Virginia

What does this mean?

The overall message is best stated by Beth McGee: "**There is scientific consensus that the dead zone is getting smaller over time, and ending earlier in the summer.** This is an indication that the Clean Water Blueprint is working. But we also know that much more needs to be done to achieve a Bay that is healthy for all living creatures."

We will always have year to year variations in the dead zone due to the weather, but the long-term trend is very encouraging. **The Chesapeake Clean Water Blueprint's ongoing programs to reduce nutrient pollution are working and we hope to keep on truckin' for smaller dead zones in years ahead.**

Commonwealth of Virginia's Chesapeake Bay Watershed General Permit

Puget Sound Nutrient Source Reduction Project
March 6, 2019 Forum Meeting
Lacey, WA

Allan Brockenbrough, VA DEQ

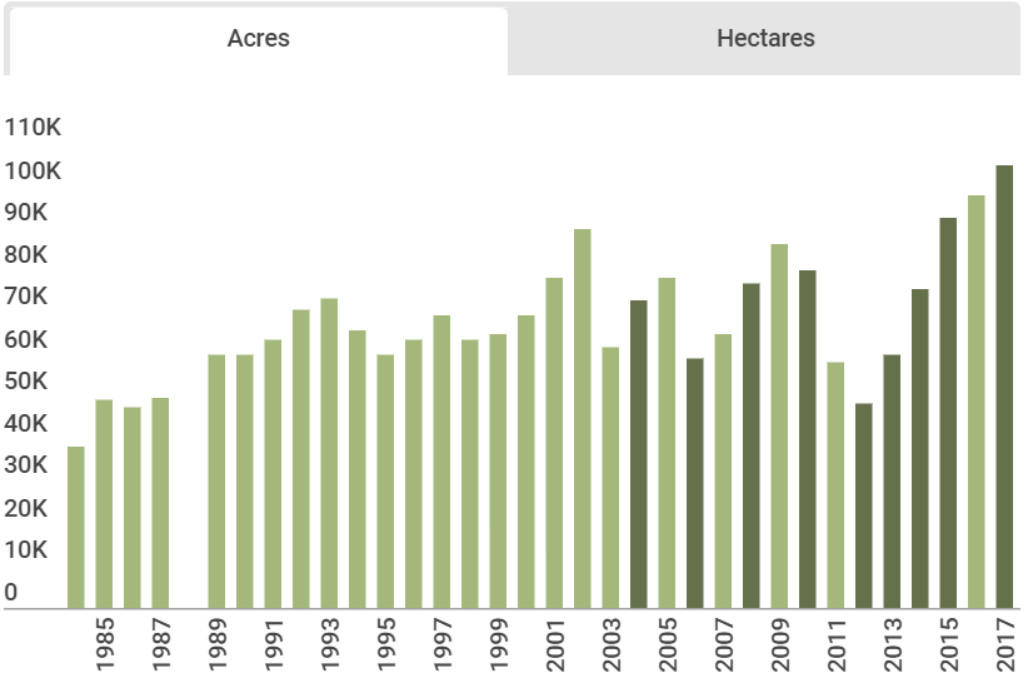
Lessons Learned in Virginia

- Nutrient and sediment reductions necessary in all sectors
  - Wastewater, Agriculture, Regulated and Unregulated Urban, Septic, Forest
- State and local funding is critical
  - VA's Water Quality Improvement Fund (WQIF)
  - Local stormwater fee programs
- Wastewater reductions have been the most dependable reductions and have "carried the load" under the Chesapeake Bay TMDL
- Watershed General Permit/Technology Regulation combined with WQIF funding was instrumental in achieving timely and lasting nutrient reductions
- Point Source – to – Nonpoint Source trading is very difficult
- Large scale environmental restoration is possible!

Background on Chesapeake Bay Watershed

- Portions of 5 states and the District of Columbia in 2 EPA regions lie within the Basin:
  - 64,000 square miles watershed
  - 11,684 miles of shoreline
  - 200 miles long and 21 ft. deep on average
- Significant portions of Chesapeake Bay and its tidal tributaries are listed as impaired because of nitrogen, phosphorus, and sediment
- Home to over 18 million people
- Agricultural land use grew by >100,000 acres between 2004 and 2014
- Largest land area per unit volume of water of any estuary in the world

Submerged Aquatic Vegetation (SAV)



Light green bars denote years with partial data. Dark green = years with complete data. No bar

Source: Virginia Institute of Marine Science

Virginia's Efforts To Restore Seaside Grasses May Be A Worldwide Model

By PAMELA D'ANGELO • JUL 13, 2018

Harvested eel grass with seed pods

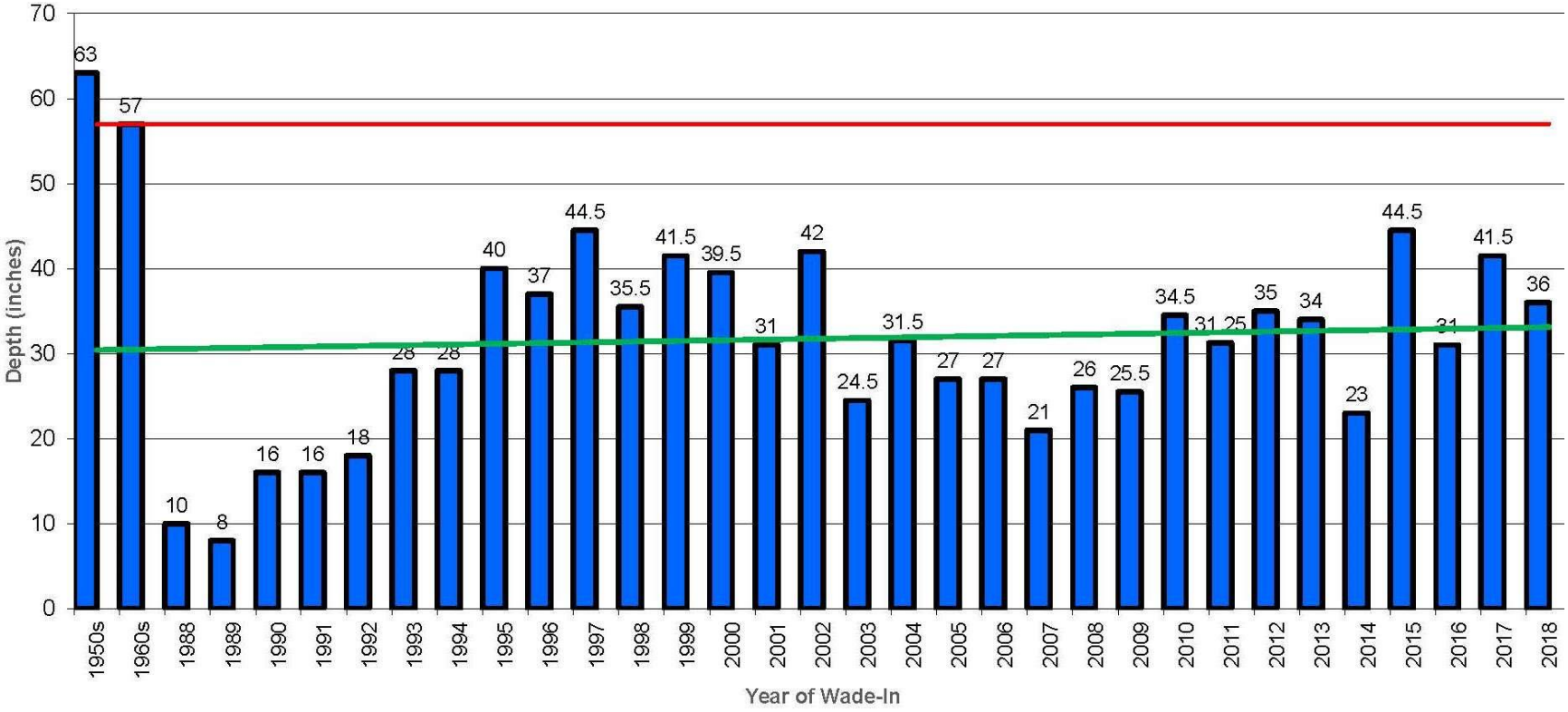
CREDIT PAMELA D'ANGELO

Water Quality Impairments

- Dissolved Oxygen
- Water Clarity
- Submerged Aquatic Vegetation

Bernie Fowler Sneaker Index

Bernie Fowler Sneaker Index



Chesapeake Bay Program History

1983	• Original Chesapeake Bay Agreement (1 page) • MD, PA, VA, DC, EPA and chair of CB Commission • Signatories became Chesapeake Bay Executive Council
1987	• First numeric goals to reduce N and P by 40% by 2000
1999	• EPA is sued for failing to require VA to develop a TMDL for Chesapeake Bay • Consent decree mandated EPA develop TMDL by 2011 if VA did not do so by 2010
2000	• Comprehensive agreement set a clear vision and strategy for restoration efforts thru 2010 • 102 goals addressing pollution reduction, habitat restoration, living resources protection, land use policies, public engagement, ecosystem-based fisheries management, etc. • NY and WV subsequently joined CB Partnership

Chesapeake Bay Program History cont.

2007

- Recognizing that the 2010 deadline established in the Chesapeake 2000 Agreement would not be met, the Bay partnership begins work on a Bay-wide TMDL

2009

- EPA again sued with plaintiffs asserting that EPA was legally required to establish a TMDL
- President Obama issues Executive Order requiring development of a federal strategy to restore Chesapeake Bay.
- Chesapeake Executive Council requires 2-year milestones

2010

- 2009 lawsuit settled requiring TDML and accountability framework
- TMDL issued

Elements of Trading Success

- Equitable WLAs
- Water quality improvement fund
- Watershed general permit
  - Expedient – one negotiation
  - Common schedule of compliance
  - Consistent requirements
- Permittees given ownership of the market through the Exchange
- WWTP➔MS4 trades may be a huge cost savings

Point Source Nutrient Controls in Virginia

1997	• Water Quality Improvement Fund Established to fund nutrient reduction strategies in the Chesapeake Bay watershed
2005	• Tributary Strategies establish loading goals • Legislation requiring watershed general permit
2007	• VPDES Watershed General Permit becomes effective on January 1, 2007
2010	• Bay TMDL issued by EPA on December 29, 2010
2011	• Effluent limits in 2007 VPDES Watershed General Permit become effective
2012 & 2017	• Virginia reissues the VPDES Watershed General Permit on January 1, 2012

Dual Approach to PS Nutrient Control

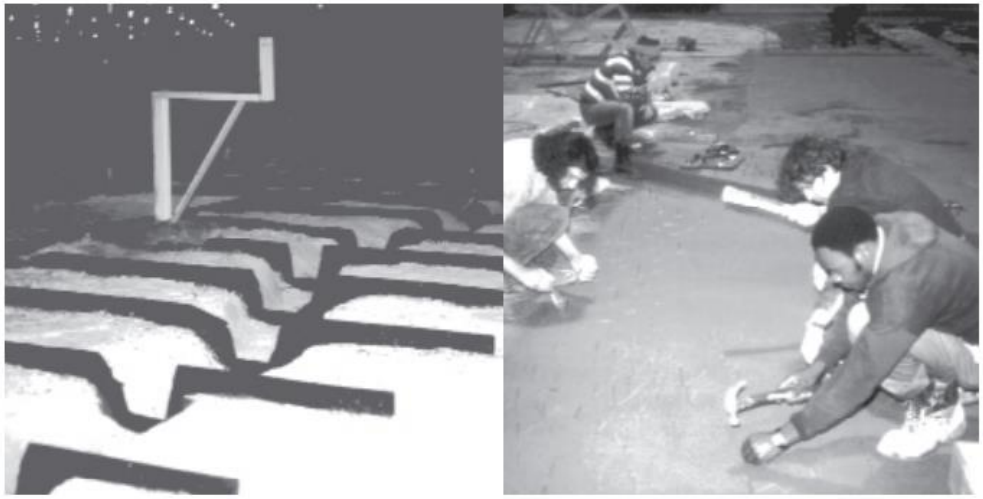
- Watershed General Permit for the control of annual TN and TP loads under the Chesapeake Bay TMDL (9VAC25-820)
  - Annual load limits
  - Trading allowed
- Technology based regulation for nutrient enriched waters and dischargers within the Chesapeake Bay watershed (9VAC25-40-70)
  - Minimum technology requirements for new or expanding facilities
  - Annual concentration limits based on nutrient removal technology installed at any plant in CB watershed
  - No trading

Chesapeake Bay Hydraulic Model

Chesapeake Bay Model, as it looked in August 1977. U.S. Army Corps of Engineers Waterways Experiment Station photo

Chesapeake Bay Model technician at a tide gauge located on the Elizabeth River, at Portsmouth, Virginia, August 1977. U.S. Army Corps of Engineers Waterways Experiment Station photo

The Chesapeake Bay Model is contained in this warehouse, on Kent Island, Maryland. The Chesapeake Bay Bridge is in the background. *U.S. Army Corps of Engineers Waterways Experiment Station photo*

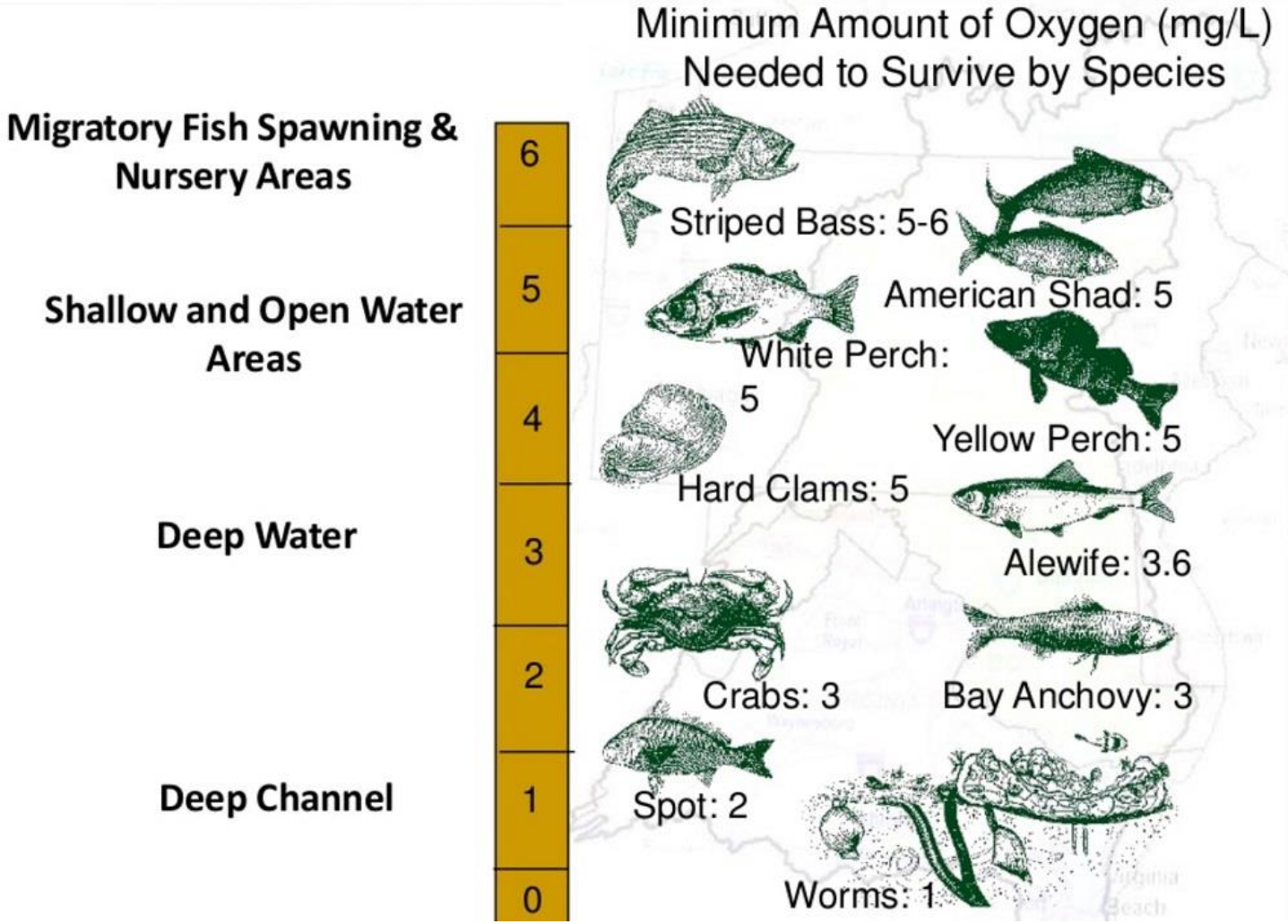


(Left) Templates installed every two and a half feet for the construction of the model, between which the concrete was poured and contoured. (Right) Model aides installing some of the 700,000 resistance strips.
U.S. Army Corps of Engineers Baltimore District photos, c. 1976

Chesapeake Bay Modeling Today

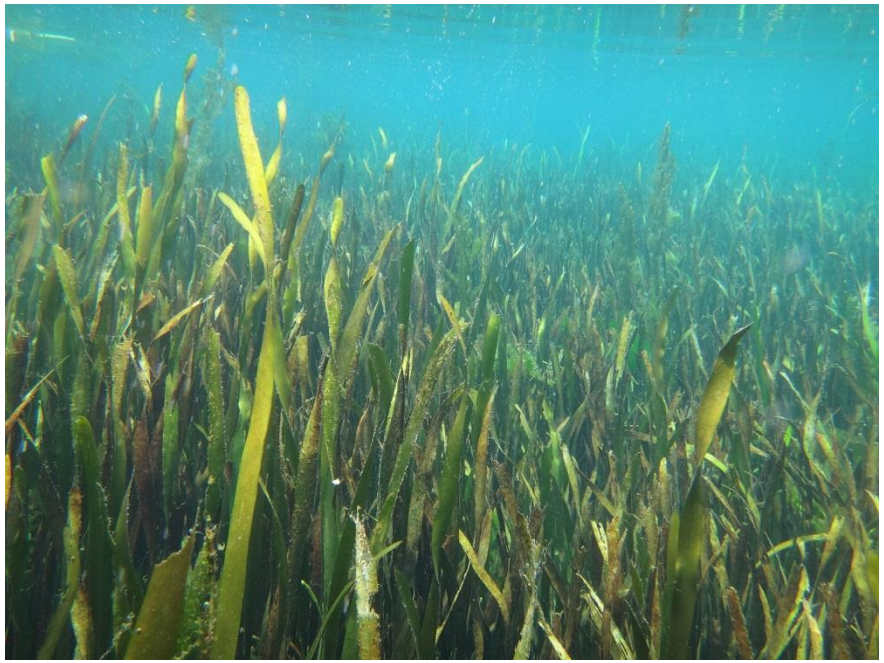
- Watershed Model
- Estuary Model
- Airshed Model
- Land Change Model
- Chesapeake Assessment Scenario Tool (CAST)

DO Criteria Tailored to Aquatic Life Use

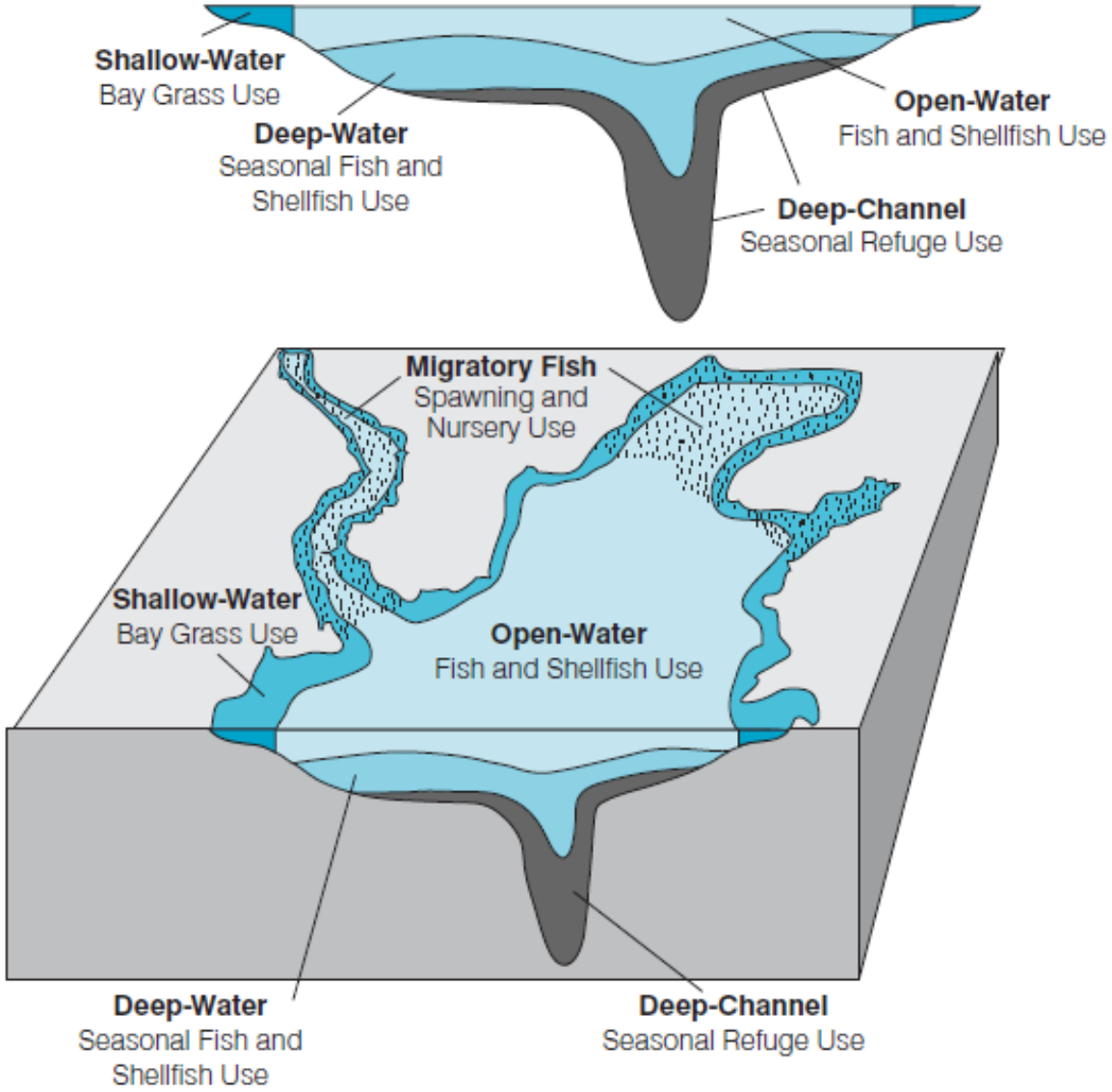


Water clarity criteria set to protect submerged aquatic vegetation

- 13% of surface light (freshwater-olighaline)
- 22% of surface light (mesohaline-polyhaline)
- …or attain grass coverage (biocriteria)



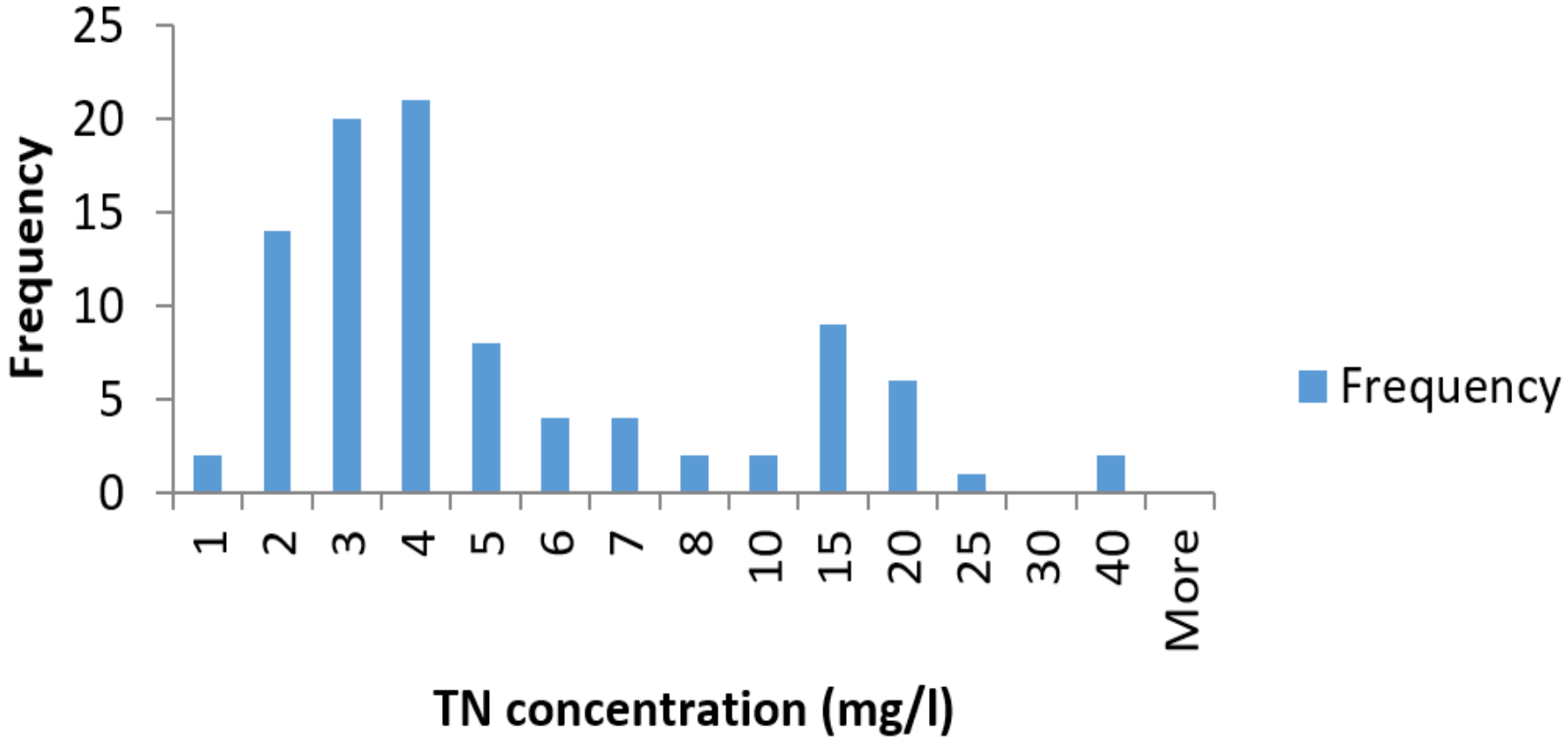
Bay Designated Uses Refined in early 2000s



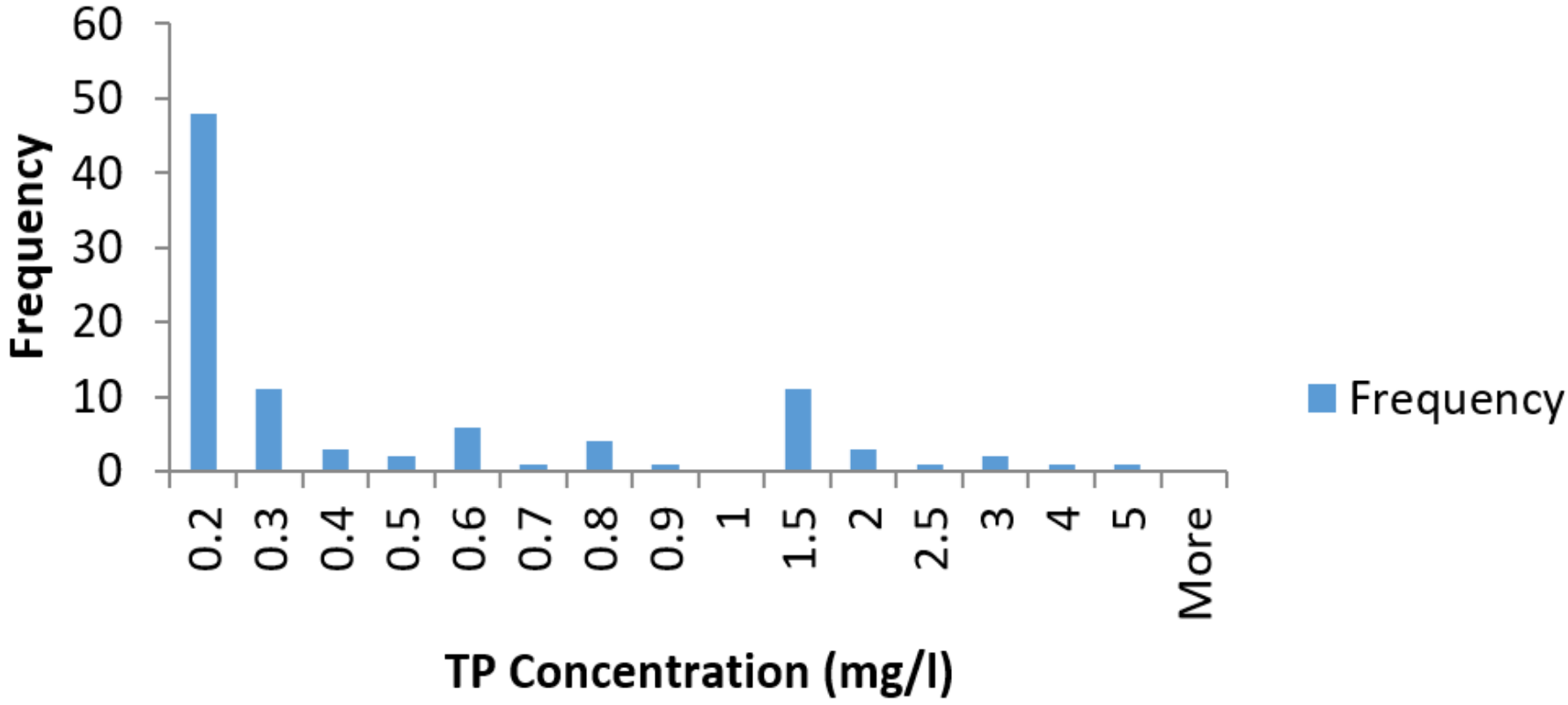
Virginia Watershed-based Permit Benefits

- Environmental Benefits
  - Quicker nutrient reductions from point sources
  - Manages additional loadings from growth through offsets of loads from new or expanding facilities
  - Creates incentives for NPSs to meet load allocations
  - BMP secondary benefits (e.g., habitat restoration, carbon sink)
- Benefits to Permittees
  - Provides several different tools for achieving compliance
  - More cost-effective approach than treatment upgrades only
  - Allows for future growth as it eases costs and resource demands
- Benefits to Virginia DEQ
  - More streamlined and efficient permitting process
  - Increased stakeholder support

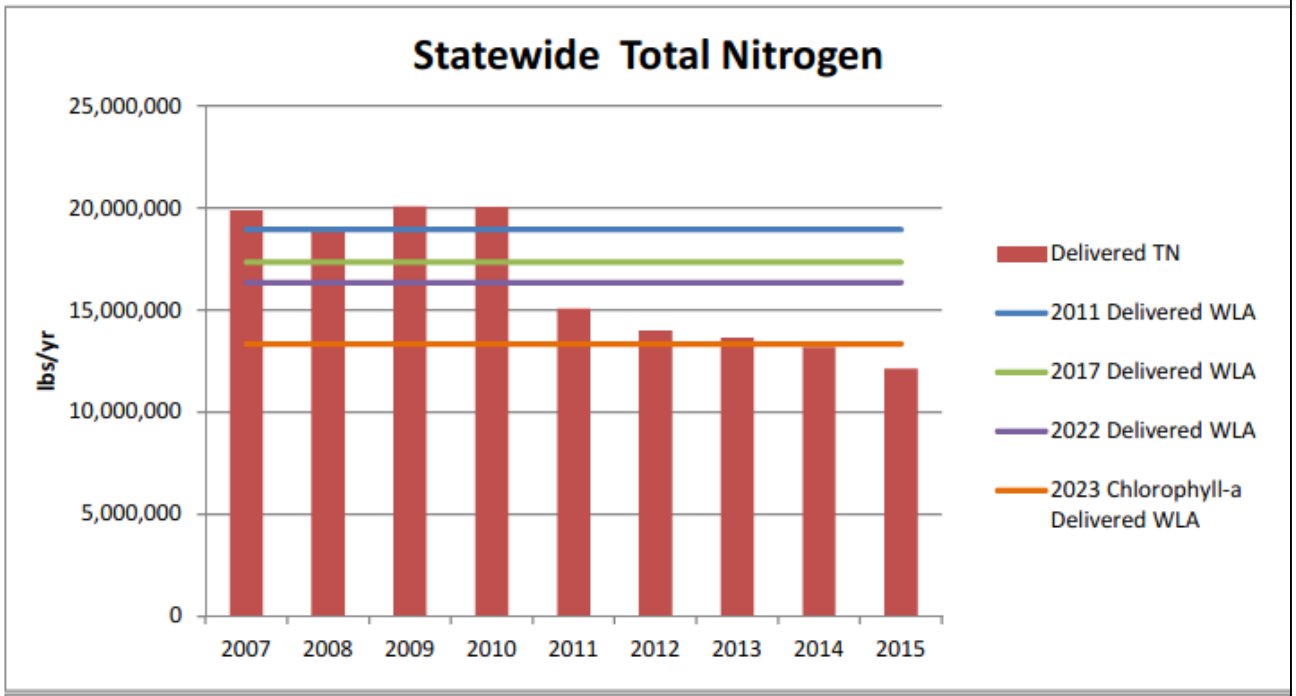
2018 Municipal TN

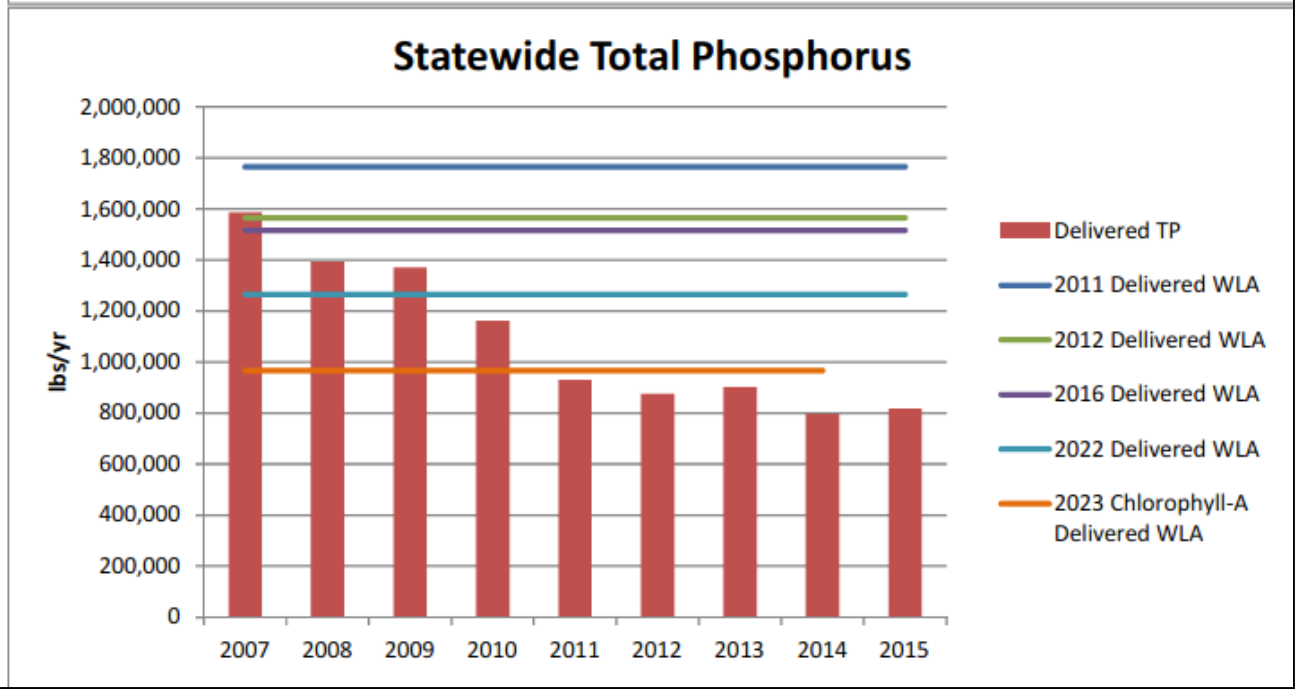


2018 Municipal TP

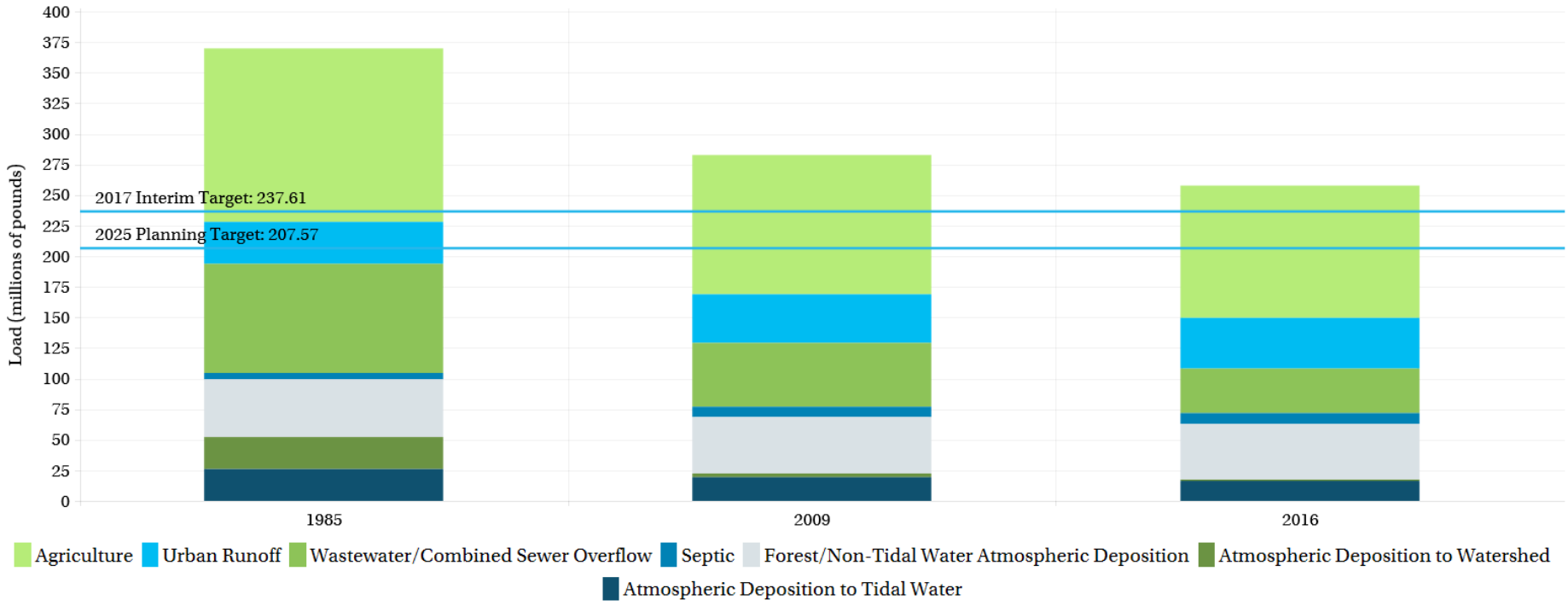


Point Source Nutrient Reductions

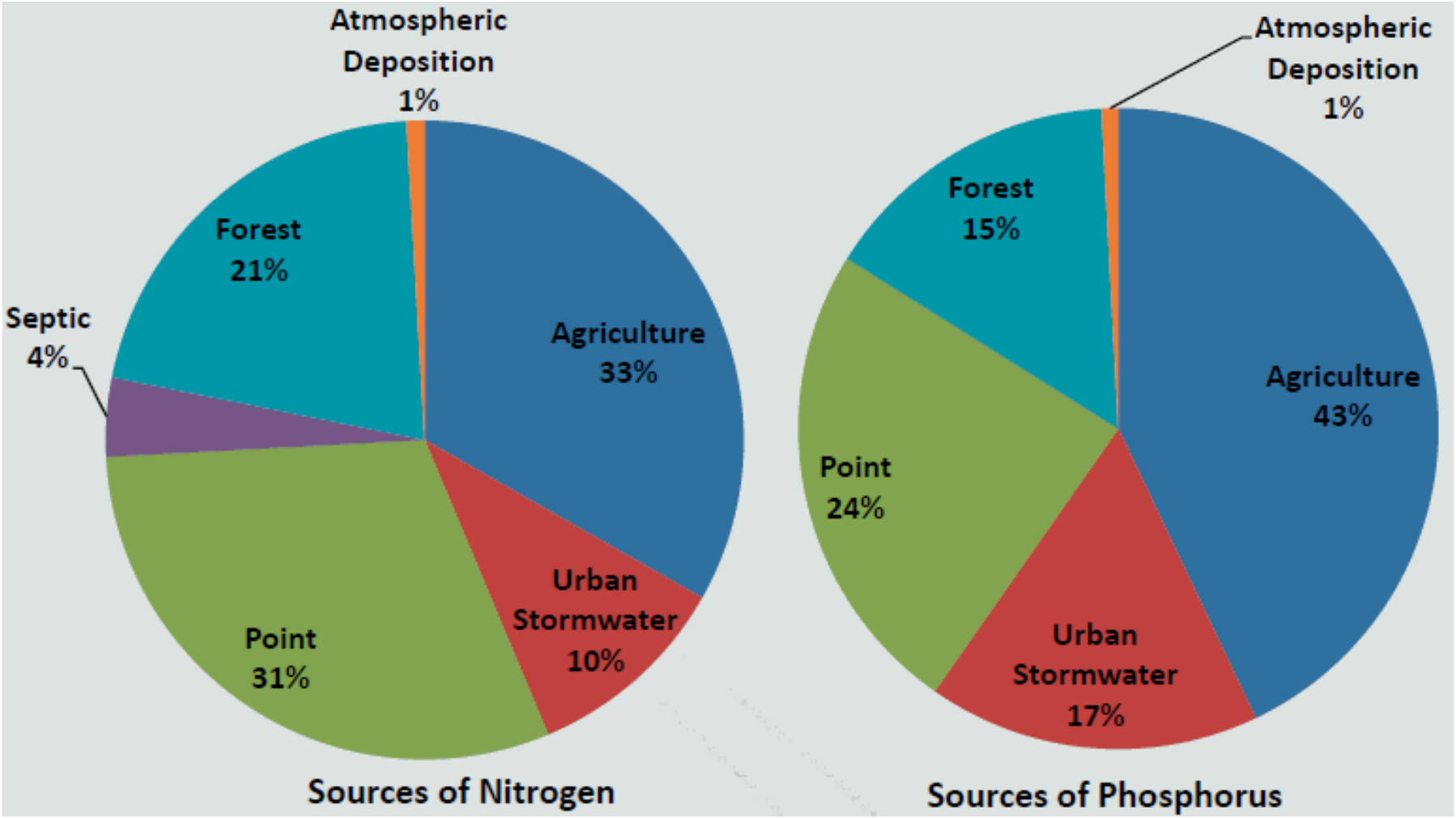




Wastewater sector leads progress in Chesapeake Bay Restoration



All Major Source Sectors Included



Most NPS trades are permanent stormwater offsets

- Many small P trades to provide permanent stormwater offsets to meet Virginia's post construction P loading requirements under the Virginia Stormwater Management Program (VSMP)
- ~125 NPS banks with 7,100 lbs of permanent TP offsets and 47,800 lbs of permanent TN offsets on state registry
- Many small P trades – approximately 4,000 lbs of P sold with retirement of an associated 27,600 lbs of N reductions retired (P serves as a proxy for N reductions under VSMP

Options for New or Expanded Sources

- Compliance credits from one or more permitted facilities
- Purchase of WLAs from other sources (either short term or permanent)
- Credits from nonpoint source best management practices
- Credits through payments to Nutrient Offset Fund if no other option available
- Allocations through other means approved by Virginia DEQ on a case-by-case basis
- Acquire 5 years of offsets prior to permitting