Assessment of Chesapeake Assimilation Capacity Application to Phase III Draft Targets

Water Quality Goal Implementation Team
January 22, 2018

Lew Linker, EPA-CBPO, Gary Shenk, USGS
and Richard Tian, UMCES

Chesapeake Bay Program
Science, Restoration, Partnership

Refining Assimilation Capacity Assessment

DECSION: The Principals' Staff Committee approved setting the Chesapeake Bay's assimilative capacity at a higher level, as needed, of nitrogen and phosphorus above 195 and 13.7 million pounds, respectively, which will still achieve Delaware, the District of Columbia, Maryland and Virginia's* applicable Chesapeake Bay water quality standards, including a 6 percent restoration variance for Maryland's CB4 deep channel segment.

ACTION: Based on the revised draft Phase III WIP planning targets that provide an additional one million pounds of nitrogen and 100,000 pounds of phosphorus to New York, and an additional two million pounds of nitrogen to West Virginia, EPA, in coordination with the Partnership's Water Quality Goal Implementation Team and Modeling Workgroup, will conduct further analyses to determine the source(s) of those additional nitrogen and phosphorus pounds, and any impacts to the Bay's assimilative capacity.

*Excludes Virginia's tidal James River mainstem chlorophyll-a water quality standards

Refining Assimilation Capacity Assessment *(continued)*

ACTION: By the end of January 2018, EPA will present to the Principals' Staff Committee the following results:

- Additional scenario runs to determine the Bay's assimilative capacity based on the revised draft Phase III WIP planning targets (201.25 million pounds of nitrogen and 14.173 million pounds of phosphorus) listed below to determine what additional pounds of nitrogen and phosphorus may be available while still achieving a 6 percent restoration variance in Maryland's CB4 deep channel segment; and
- Determination if any additional pounds of nitrogen from implementation of Clean Air Act regulations are available.

ACTION: The Principals' Staff Committee will convene in mid-February to determine the Bay's assimilative capacity that will reflect agreed-upon results from these additional analyses.

PSC Actions

Based on the revised draft Phase III Planning Targets that provide:

- an additional one million pounds of nitrogen and 100,000 pounds of phosphorus to New York and
- an additional two million pounds of nitrogen to West Virginia

EPA, in coordination with the WQGIT and Modeling Workgroup, will conduct further analyses to determine the source of those additional nitrogen and phosphorus pounds, and impacts to the Bay's assimilative capacity

Draft Phase III Planning Targets*: Nitrogen

Jurisdiction	1985 Baseline	2013 Progress	Phase III Planning Target
NY	18.71	15.44	11.59
PA	122.41	99.28	73.18
MD	83.56	55.89	45.30
WV	8.73	8.06	8.35
DC	6.48	1.75	2.43
DE	6.97	6.59	4.59
VA	84.29	61.53	55.82
Basinwide	331.15	248.54	201.25

Includes a 1 million lb nitrogen addition to the New York draft target load.

Includes a 2 million lb nitrogen addition to the West Virginia draft target load.

Units: millions of pounds

*Draft planning targets are subject to change as a result of the Partnership's review period to be completed in May 2018

Draft Phase III Planning Targets*: Phosphorus

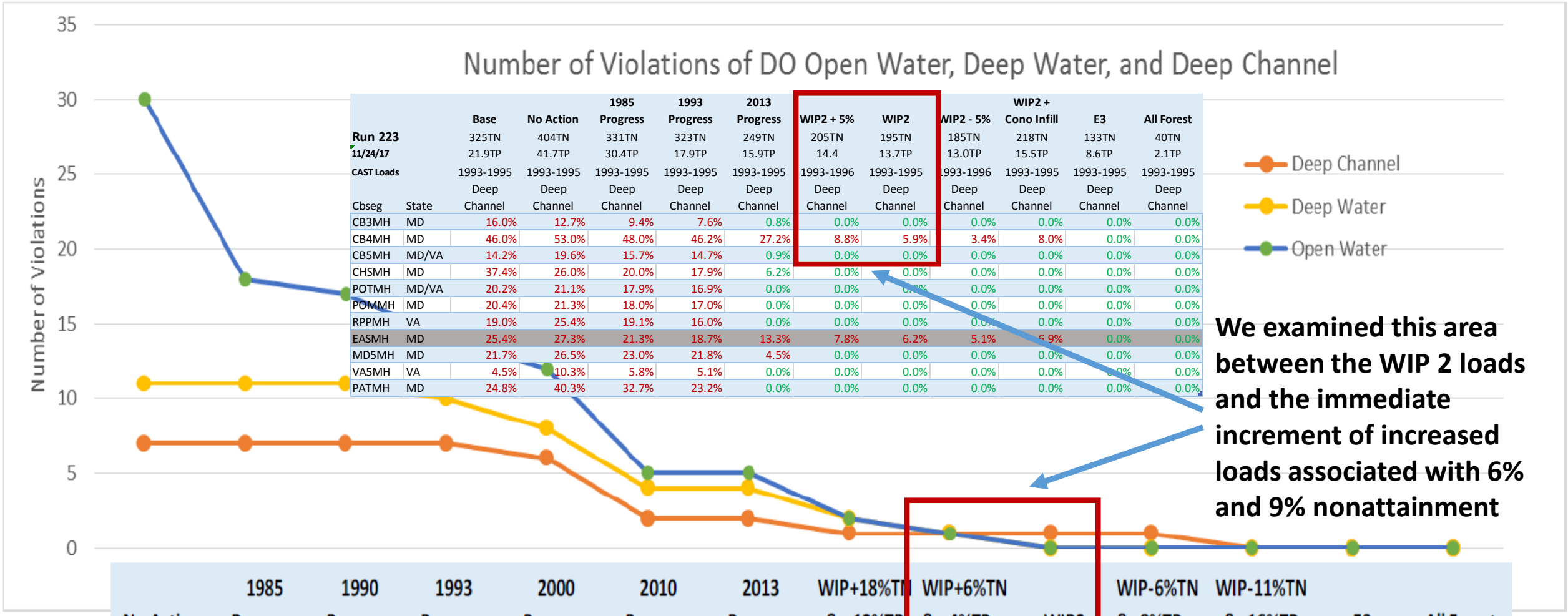
Jurisdiction	1985 Baseline	2013 Progress	Phase III Planning Target
NY	1.198	0.710	0.606
PA	6.115	3.696	3.073
MD	7.419	3.919	3.604
WV	0.793	0.560	0.456
DC	0.090	0.062	0.130
DE	0.225	0.115	0.120
VA	13.545	6.345	6.186
Basinwide	29.384	15.408	14.173

Includes a 0.1 million lb phosphorus addition to the New York draft target load.

Units: millions of pounds

*Draft planning targets are subject to change as a result of the Partnership's review period to be completed in May 2018

Determining the Bay's Ability to Absorb Pollutants



		Base	No Action	1985 Progress	1993 Progress	2013 Progress	WIP2 + 5%	WIP2	WIP2 - 5%	WIP2 + Cono Infill	E3	All Forest
Run 223		325TN	404TN	331TN	323TN	249TN	205TN	195TN	185TN	218TN	133TN	40TN
11/24/17		21.9TP	41.7TP	30.4TP	17.9TP	15.9TP	14.4	13.7TP	13.0TP	15.5TP	8.6TP	2.1TP
CAST Loads		1993-1995	1993-1995	1993-1995	1993-1995	1993-1995	1993-1996	1993-1995	1993-1996	1993-1995	1993-1995	1993-1995
Cbseg	State	Deep Channel	Deep Channel	Deep Channel	Deep Channel	Deep Channel	Deep Channel	Deep Channel	Deep Channel	Deep Channel	Deep Channel	Deep Channel
CB3MH	MD	16.0%	12.7%	9.4%	7.6%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CB4MH	MD	46.0%	53.0%	48.0%	46.2%	27.2%	8.8%	5.9%	3.4%	8.0%	0.0%	0.0%
CB5MH	MD/VA	14.2%	19.6%	15.7%	14.7%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CHSMH	MD	37.4%	26.0%	20.0%	17.9%	6.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
POTMH	MD/VA	20.2%	21.1%	17.9%	16.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
POMMH	MD	20.4%	21.3%	18.0%	17.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RPPMH	VA	19.0%	25.4%	19.1%	16.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
EASMH	MD	25.4%	27.3%	21.3%	18.7%	13.3%	7.8%	6.2%	5.1%	6.9%	0.0%	0.0%
MD5MH	MD	21.7%	26.5%	23.0%	21.8%	4.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
VA5MH	VA	4.5%	10.3%	5.8%	5.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
PATMH	MD	24.8%	40.3%	32.7%	23.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

We examined this area between the WIP 2 loads and the immediate increment of increased loads associated with 6% and 9% nonattainment

No Action	1985 Progress	1990 Progress	1993 Progress	2000 Progress	2010 Progress	2013 Progress	WIP+18%TN & +12%TP	WIP+6%TN & +4%TP	WIP2	WIP-6%TN & -8%TP	WIP-11%TN & -16%TP	E3	All Forest
404TN	347TN	338TN	337TN	317TN	266TN	253TN	224TN	205TN	195TN	185TN	174TN	133TN	40TN
41.7TP	30.4TP	27.7TP	23.7	21.9TP	16.9TP	15.9TP	14.8TP	14.4	13.7TP	13.0TP	11.9TP	8.6TP	3.9TP

Method of Assimilation Capacity Assessment

A series of model scenarios were run to estimated the assimilative capacity of Chesapeake Bay.

- The first scenario applied the full 1 million pound nitrogen and 0.1 million pound phosphorus special case load of New York to the Susquehanna fall line and the 2 million pound nitrogen special case load of West Virginia to the Potomac fall line
- Another scenario applied exactly half of the loads of the first scenario to the Susquehanna and Potomac fall lines.
- The last two scenarios applied exactly one quarter and three quarters of the loads of first scenario to the Susquehanna and Potomac fall lines.

Note: Loads between all basins and between nitrogen and phosphorus nutrients are entirely fungible among basins and nutrients.

Deep Channel Sensitivity to Loads at the Susquehanna and Potomac Fall Lines

WIP2 Sensitivity: CAST Loads as modified at Sus and Pot Fall Lines		WIP2	WIP2 + Sus 1M TN & 0.1M TP Pot 2 M TN	WIP2 + Sus 0.75M TN & 0.075M TP Pot 1.5 M TN	WIP2 + Sus 0.5M TN & 0.05M TP Pot 1 M TN	WIP2 + Sus 0.25M TN & 0.025M TP Pot 0.5 M TN
		195TN	198TP	197TN	197TN	196TN
1/8/18		13.7TP	13.8TP	13.8TP	13.8TP	13.7TP
Cbseg	State	1993-1995 Deep Channel	1993-1995 Deep Channel	1993-1996 Deep Channel	1993-1997 Deep Channel	1993-1998 Deep Channel
CB3MH	MD	0.00%	0.00%	0.00%	0.00%	0.00%
CB4MH	MD	5.87%	6.95%	6.69%	6.47%	6.17%
CB5MH	MD	0.00%	0.00%	0.00%	0.00%	0.00%
CB5MH	VA	0.00%	0.00%	0.00%	0.00%	0.00%
POTMH	MD	0.00%	0.00%	0.00%	0.00%	0.00%
RPPMH	VA	0.00%	0.00%	0.00%	0.00%	0.00%
ELIPH	VA	0.00%	0.00%	0.00%	0.00%	0.00%
CHSMH	MD	0.00%	0.00%	0.00%	0.00%	0.00%
EASMH	MD	6.24%	6.63%	6.45%	6.39%	6.35%

Deep Water Sensitivity to Loads at the Susquehanna and Potomac Fall Lines

WIP2 Sensitivity: CAST Loads as modified at Sus and Pot Fall Lines 1/8/18		WIP2 195TN 13.7TP	WIP2 + Sus 1M TN & 0.1M TP Pot 2 M TN 198TP 13.8TP	WIP2 + Sus 0.75M TN & 0.075M TP Pot 1.5 M TN 197TN 13.8TP	WIP2 + Sus 0.5M TN & 0.05M TP Pot 1 M TN 197TN 13.8TP	WIP2 + Sus 0.25M TN & 0.025M TP Pot 0.5 M TN 196TN 13.7TP
		1993-1995	1993-1995	1993-1996	1993-1997	1993-1998
Cbseg	State	Deep Water	Deep Water	Deep Water	Deep Water	Deep Water
CB3MH	MD	0.05%	0.05%	0.05%	0.05%	0.05%
CB4MH	MD	5.00%	5.23%	5.18%	5.13%	5.06%
CB5MH_MD	MD	0.94%	1.08%	1.05%	1.01%	0.98%
CB5MH_VA	VA	0.00%	0.00%	0.00%	0.00%	0.00%
CB6PH	VA	0.00%	0.00%	0.00%	0.00%	0.00%
CB7PH	VA	0.00%	0.00%	0.00%	0.00%	0.00%
PATMH	MD	0.67%	0.67%	0.67%	0.67%	0.67%
MAGMH	MD	1.21%	5.40%	5.40%	5.40%	1.21%
SOUMH	MD	2.96%	7.64%	7.64%	7.64%	7.64%
SEVMH	MD	0.00%	0.00%	0.00%	0.00%	0.00%
PAXMH	MD	0.00%	0.00%	0.00%	0.00%	0.00%
POTMH_MD	MD	0.00%	0.00%	0.00%	0.00%	0.00%
RPPMH	VA	0.00%	0.00%	0.00%	0.00%	0.00%
YRKPH	VA	0.00%	0.00%	0.00%	0.00%	0.00%
ELIPH	VA	0.00%	0.00%	0.00%	0.00%	0.00%
CHSMH	MD	0.00%	0.00%	0.00%	0.00%	0.00%
EASMH	MD	0.45%	0.45%	0.45%	0.45%	0.45%

Results of Assimilation Capacity Assessment

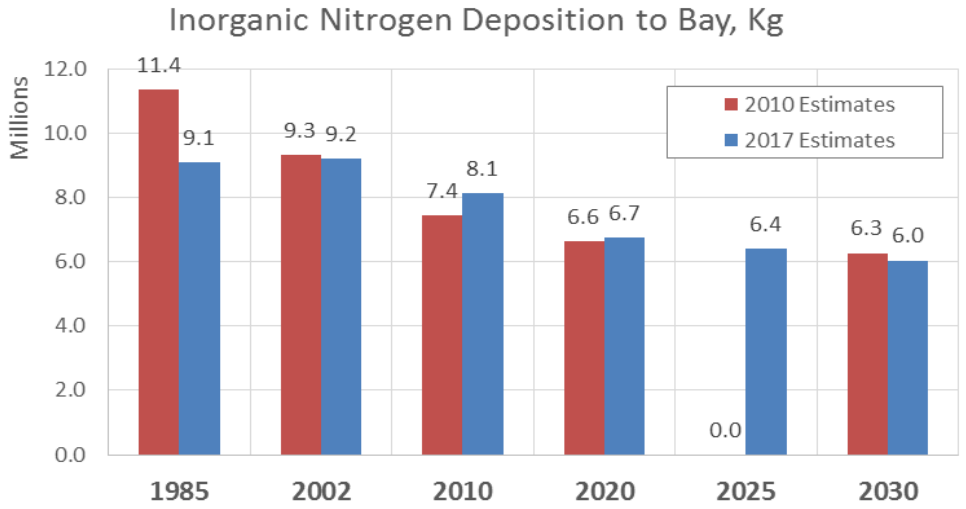
Based on running the full series of model scenarios, the estimated assimilative capacity of Chesapeake Bay factoring in the PSC's required condition of maintaining no more than a 6 percent nonattainment in CB4MH Deep Channel allows an increase of 500,000 pounds of total nitrogen and 50,000 pounds of total phosphorus from the Susquehanna River watershed, and 1 million pounds of total nitrogen from the Potomac River watershed. The total additional loads available from this assimilative capacity scenario analysis is 1.5 million pounds of nitrogen and 50,000 pounds of phosphorus. Again, note that all loads estimated in the analysis are completely freely exchangeable among all basins and between nitrogen and phosphorus.

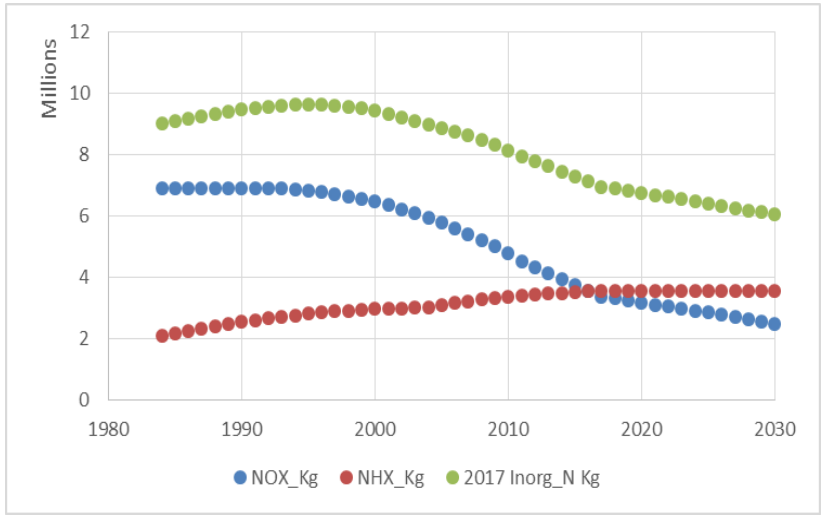
So we are ½ way there with assimilation capacity, but need more.

2030 Atmospheric Deposition Loads:

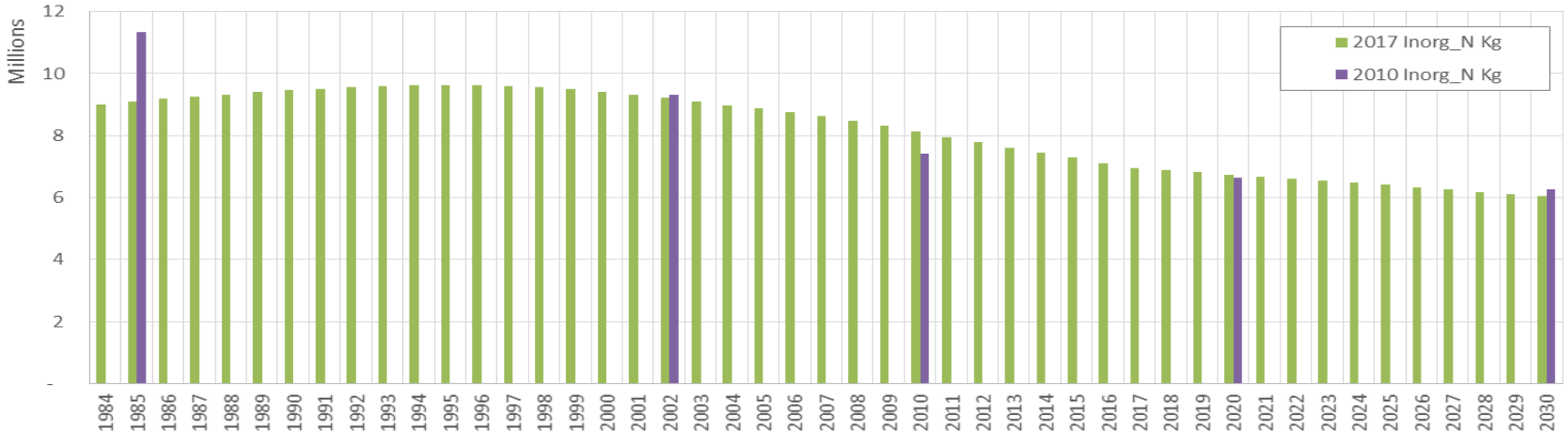
Available loads from 2030 atmospheric deposition to tidal waters Provided an estimated additional reduction 800,000 pounds of total nitrogen (almost entirely comprised of nitrogen oxides or NOx load reductions). The loads are available because load reductions beyond EPA's atmospheric deposition to tidal waters load allocation of 15.7 million pounds total nitrogen is projected to be available in 2030.

Tidal Bay Loads of Atmospheric Deposition of Nitrogen





The EPA Air Allocation is 15.7 million pounds (TN) to the tidal waters of the Chesapeake Bay. The Phase 6 estimate of TN deposition to tidal waters is 15.6 million pounds in 2025 and 14.9 million pounds in 2030.



A Question of Atmospheric Deposition Lag Times

Given the atmospheric deposition load reductions are estimated to occur after 2025 (at which point there is only an estimated additional reduction of 100,000 pounds of total nitrogen beyond EPA's allocation), can the Partnership take credit for and allocate these additional pounds based on reductions that have not yet taken place?

A Question of Atmospheric Deposition Lag Times *(continued)*

The Partnership has a long history of crediting practices, treatment, technologies, and programs which have been implemented on the ground, but due to the nature of the means for reducing the nutrient and sediment pollutant load, the Bay may fail to see the benefit of the pollutant load reduction actions for many years, perhaps decades, due to lag times. In the case of Clean Air Act implementation, there are lag times in emission/ deposition reductions due to fleet turnover of all mobile sources including on-road, off-road, and marine, as well as ongoing reductions from the CAFE fuel standard and other regulations. So there is a direct parallel between implementation of Clean Water Act land-based BMPs and implementation of Clean Air Act regulatory programs, both of which can be tracked, verified, reported, and credited under the Partnership's Bay TMDL accountability system.

A Question of Atmospheric Deposition Lag Times *(continued)*

Chesapeake Bay Program Office staff followed up with EPA's Office of Air Quality Planning and Standards (OAQPS) and confirmed that the state and federal Clean Air Act regulatory programs resulting in the estimated additional total nitrogen reductions were in place and being implemented prior to 2025. Two exceptions were noted. The emissions used in the 2030 scenario included estimated reductions from the Clean Power Plan, currently under review by EPA. However, these same emissions did not include reductions that will take place to achieve the 2015 National Ambient Air Quality Standards as the states have not developed implementation plans to reach the new 70 ppb standard. Recognizing that the emission reductions necessary to achieve the 2015 National Ambient Air Quality Standards will likely be higher than those estimated for the Clean Power Plan, these two exceptions should not influence the current 2030 estimated additional nitrogen load reductions to tidal waters.

Analysis Results of 2030 Freeboard of Atmospheric Deposition

The CBPO's Modeling Team estimates that nitrogen atmospheric deposition loads to the tidal Bay have an influence on Bay hypoxia equivalent to a factor of 0.97 and 1.13 at the Susquehanna and Potomac fall lines, respectively. This means that for a reduction of each 100,000 pounds of nitrogen atmospheric deposition direct to the Bay's tidal waters below EPA's 15.7 million pounds of nitrogen atmospheric deposition to tidal waters allocation, the Partnership can decide to either increase loads at the Susquehanna River fall line by 97,000 pounds or at the Potomac River fall line by 113,000 pounds based on the nitrogen exchange rates between basins and tidal atmospheric deposition. Therefore, loads from the Susquehanna River could be increased by 776,000 pounds or loads from the Potomac River could be increased by 904,000 pounds.

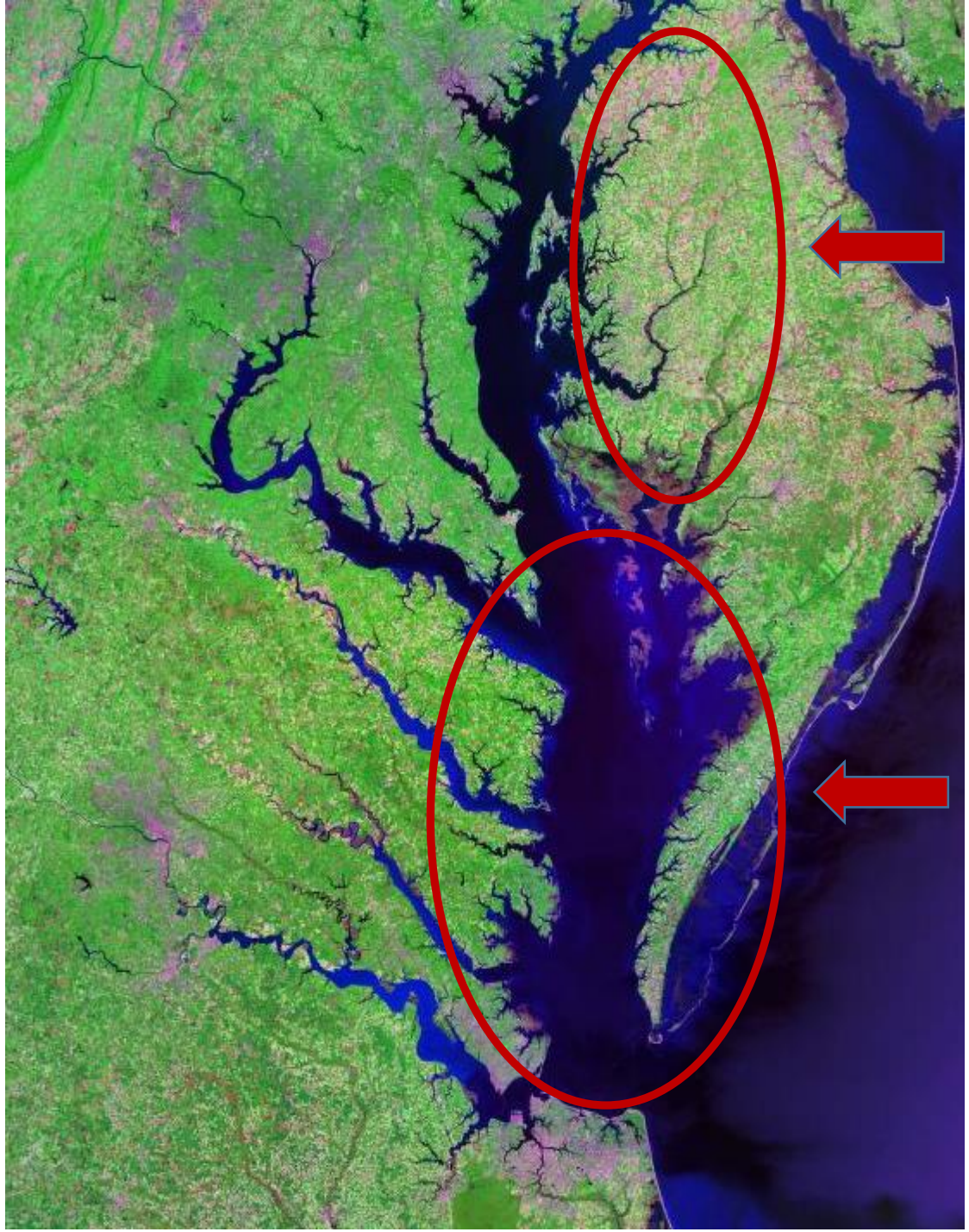
Basin to Basin and N to P Exchange Rates

Quartile change per 1,000,000 lbs N or P

GeoBasin	N	P
Susquehanna	**16.325**	**38.503**
Western Shore	14.109	35.264
Patuxent AFL	10.931	27.505
Patuxent BFL	13.514	35.667
Potomac AFL	**14.045**	**22.210**
Potomac BFL	13.201	22.165
Rappahannock AFL	8.065	11.765
Rappahannock BFL	9.278	15.453
York AFL	4.630	9.111
York BFL	5.165	8.681
James AFL	2.647	7.673
James BFL	2.351	7.434
Upper Eastern Shore	10.709	31.840
Middle Eastern Shore	11.244	43.196
Lower Eastern Shore	9.782	25.243
Virginia Eastern Shore	15.214	20.404
Atmospheric Deposition	**15.827**	

Why isn’t atmospheric deposition of DIN more effective than Susquehanna TN loads in influencing deep water hypoxia?

1. The nutrient addition of atmospheric deposition is relatively constant throughout spring, summer, fall and winter. In contrast, the Susquehanna nitrogen loads are pulsed during the spring freshet which is an effective time for hypoxia generation in the Chesapeake.



2. A portion of the atmospheric deposition falls on shallow tidal waters where it could be effectively processed in an aerobic region, having little influence on Chesapeake hypoxia.

3. Large surface area of the lower Bay is less likely to influence hypoxia because of the down estuary surface water flow.

Three Options for Applying the Estimated Additional Nutrient Loads

The Principals' Staff Committee committed to provide an additional 1 million pounds nitrogen and 100,000 pounds phosphorus for New York and 2 million pounds nitrogen for West Virginia at the Susquehanna and Potomac fall lines, respectively. While there are an infinite number of options for applying the estimated additional nutrient loads to New York and West Virginia special cases, three key options were examined.

- The first option applies all estimated additional nutrient loads to New York to entirely satisfy its special condition, with the remainder going to West Virginia.
- The second option applies all estimated additional nutrient loads to West Virginia to entirely satisfy its special condition with the remainder going to New York.
- The third option apportioned the additional nutrient loads equally among New York and West Virginia.

Option 1: All Estimated Additional Nutrient Loads to NY With the Remainder To WV

- Using the refined assimilation capacity estimates and the 2030 estimated freeboard below the allocation of atmospheric deposition to tidal waters, the New York special case of 1 million pounds TN and 100,000 pounds TP at the Susquehanna fall line can be fully satisfied.
- However, the West Virginia special case of 2 million pounds TN at the Potomac fall line be only partially fulfilled by a little more than half, or an estimated 1.18 million pounds.

TABLE OF OPTIONS FOR APPLYING THE ESTIMATED ADDITIONAL NUTRIENT LOADS

	New York	West Virginia
Additional Nutrient Loads Committed to by the PSC	1,000,000 N 100,000 P	2,000,000 N
Option 1: Fully address New York's needs first, with the remainder going to West Virginia	1,000,000 N 100,000 P	1,180,000 N
Option 2: Fully address West Virginia's needs first, with the remainder going to New York	420,000 N 50,000 P	2,000,000 N
Option 3: Apportioned equally between New York and West Virginia	890,000 N 25,000 P	1,520,000 N

Option 2: All Estimated Additional Nutrient Loads To WV With the Remainder To NY

- Using the refined assimilation capacity estimates and the 2030 estimated freeboard below the allocation of atmospheric deposition to tidal waters, the West Virginia special case of 2 million pounds nitrogen at the Potomac River fall line can be fully satisfied.
- The New York special case of 1 million pounds nitrogen and 100,000 pounds phosphorus at the Susquehanna River fall line be only partially fulfilled by less than half, or an estimated 420,000 pounds nitrogen and 50,000 pounds phosphorus.

TABLE OF OPTIONS FOR APPLYING THE ESTIMATED ADDITIONAL NUTRIENT LOADS

	New York	West Virginia
Additional Nutrient Loads Committed to by the PSC	1,000,000 N 100,000 P	2,000,000 N
Option 1: Fully address New York's needs first, with the remainder going to West Virginia	1,000,000 N 100,000 P	1,180,000 N
Option 2: Fully address West Virginia's needs first, with the remainder going to New York	420,000 N 50,000 P	2,000,000 N
Option 3: Apportioned equally between New York and West Virginia	890,000 N 25,000 P	1,520,000 N

Option 3: All Estimated Additional Nutrient Loads Split Evenly Between New York And West Virginia

- If the estimated additional nutrient loads are apportioned equally among New York and West Virginia, then the New York and West Virginia estimated shortfalls in the special case loads would both be a little more than half of the full special case condition.
- New York would receive 890,000 pounds of nitrogen and 25,000 pounds of phosphorus toward their special case and West Virginia would receive 1.52 million pounds of nitrogen toward their special case.

TABLE OF OPTIONS FOR APPLYING THE ESTIMATED ADDITIONAL NUTRIENT LOADS

	New York	West Virginia
Additional Nutrient Loads Committed to by the PSC	1,000,000 N 100,000 P	2,000,000 N
Option 1: Fully address New York's needs first, with the remainder going to West Virginia	1,000,000 N 100,000 P	1,180,000 N
Option 2: Fully address West Virginia's needs first, with the remainder going to New York	420,000 N 50,000 P	2,000,000 N
Option 3: Apportioned equally between New York and West Virginia	890,000 N 25,000 P	1,520,000 N

Results of the Three Options

TABLE OF OPTIONS FOR APPLYING THE ESTIMATED ADDITIONAL NUTRIENT LOADS

	New York	West Virginia
Additional Nutrient Loads Committed to by the PSC	1,000,000 N 100,000 P	2,000,000 N
Option 1: Fully address New York's needs first, with the remainder going to West Virginia	1,000,000 N 100,000 P	1,180,000 N
Option 2: Fully address West Virginia's needs first, with the remainder going to New York	420,000 N 50,000 P	2,000,000 N
Option 3: Apportioned equally between New York and West Virginia	890,000 N 25,000 P	1,520,000 N

Current Status and Next Steps: New York

CBPO staff reran the allocations methodology using the Phase 6 suite of models factoring in a 1985 No Action base year (versus the same approach using the 2010 Phase 5 suite of models) and generated very similar additional nitrogen and phosphorus loads—1.14 million pounds total nitrogen and 100,000 pounds total phosphorus with the Phase 6 model suite —as provided to New York under the 2010 Chesapeake Bay TMDL—1 million pounds total nitrogen and 100,000 pounds total phosphorus with the Phase 5 model suite.

Current Status and Next Steps: West Virginia

CBPO staff is in the process of working with West Virginia colleagues on correctly translating their Phase II WIP level of effort into the Phase 6 Watershed Model to more accurately determine how much additional pounds West Virginia needs to be fully consistent with what they received under the 2010 Chesapeake Bay TMDL.

Next Steps: Accounting For Remaining Shortfalls

Once the work with West Virginia is completed, CBPO staff will quantify how the remaining shortfalls illustrated in the three options above could be covered by spreading the remaining needed additional nutrient loads reductions across the remaining five jurisdictions following the Partnership's allocation methodology.