Integrated Watershed TMDL Indicator and Dashboard Products

Qian Zhang, Gopal Bhatt, Isabella Bertani, and other CBPO staff

MWG

4/5/2023

Follow up from 11/14/2022 https://d18lev1ok5leia.cloudfront.net/chesapeakebay/documents/2022-11-14-Monitored-TMDL-Indicator-gshenk-WQGIT.pdf

WIP Indicator

We've almost hit the target level of implementation?

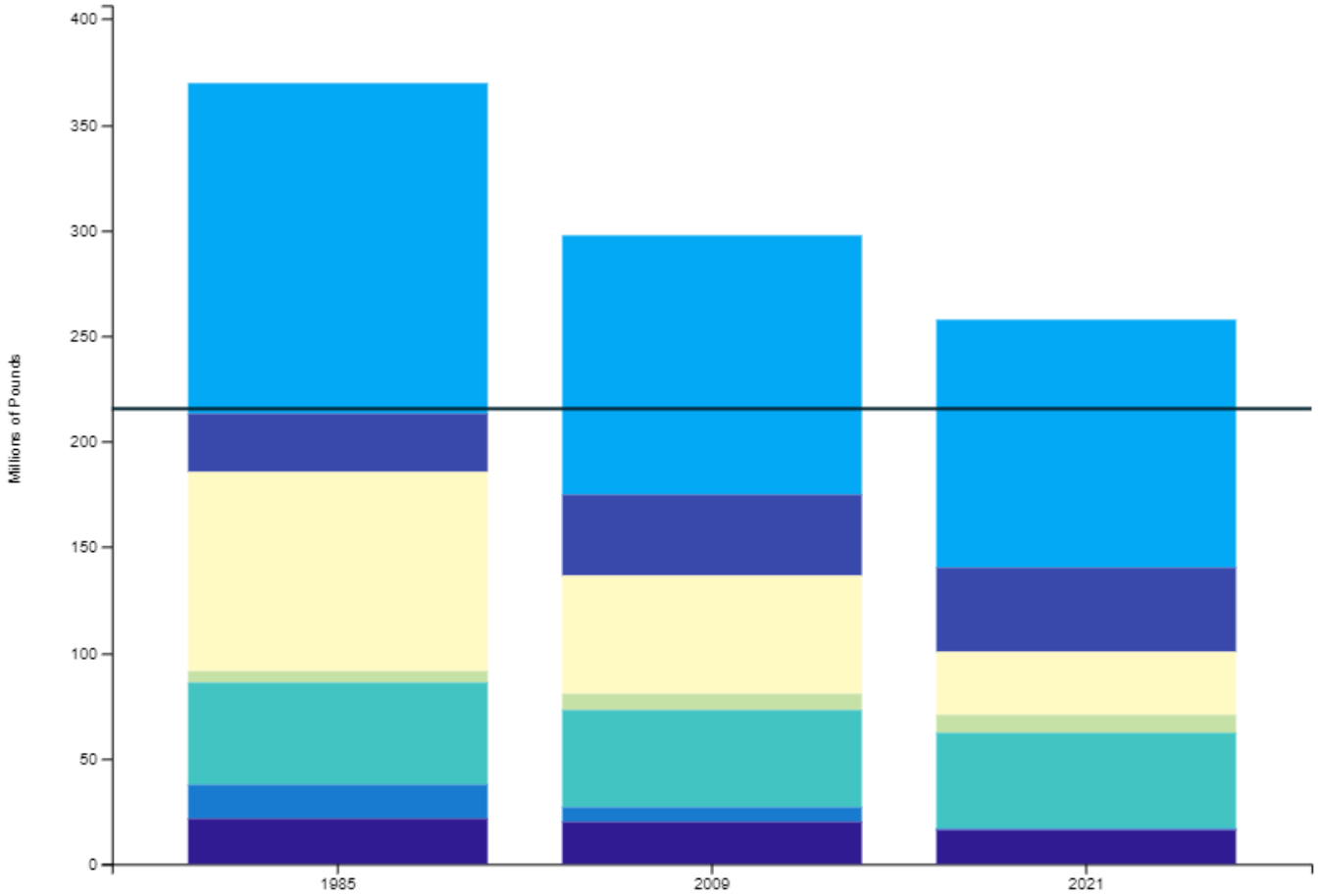
- Agriculture
- Developed
- Wastewater
- Septic
- Natural
- Atmospheric Deposition to Watershed
- Atmospheric Deposition to Tidal Water

Modeled Nitrogen Loads to the Chesapeake Bay (1985-2021)

Loads simulated using CAST19 and jurisdiction-reported data on wastewater discharges. *The natural sector wetlands which are preferable land use types with the lowest loading rates among sources.

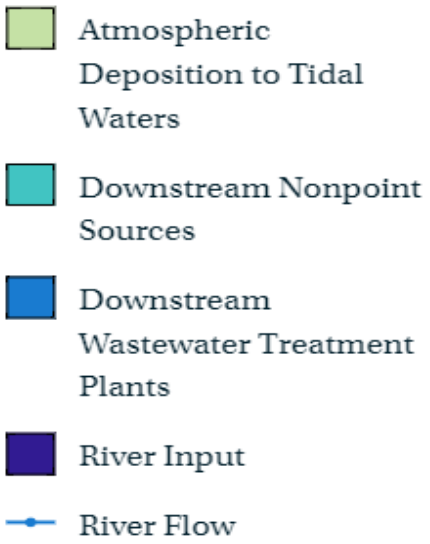
VIEW CHART VIEW TABLE

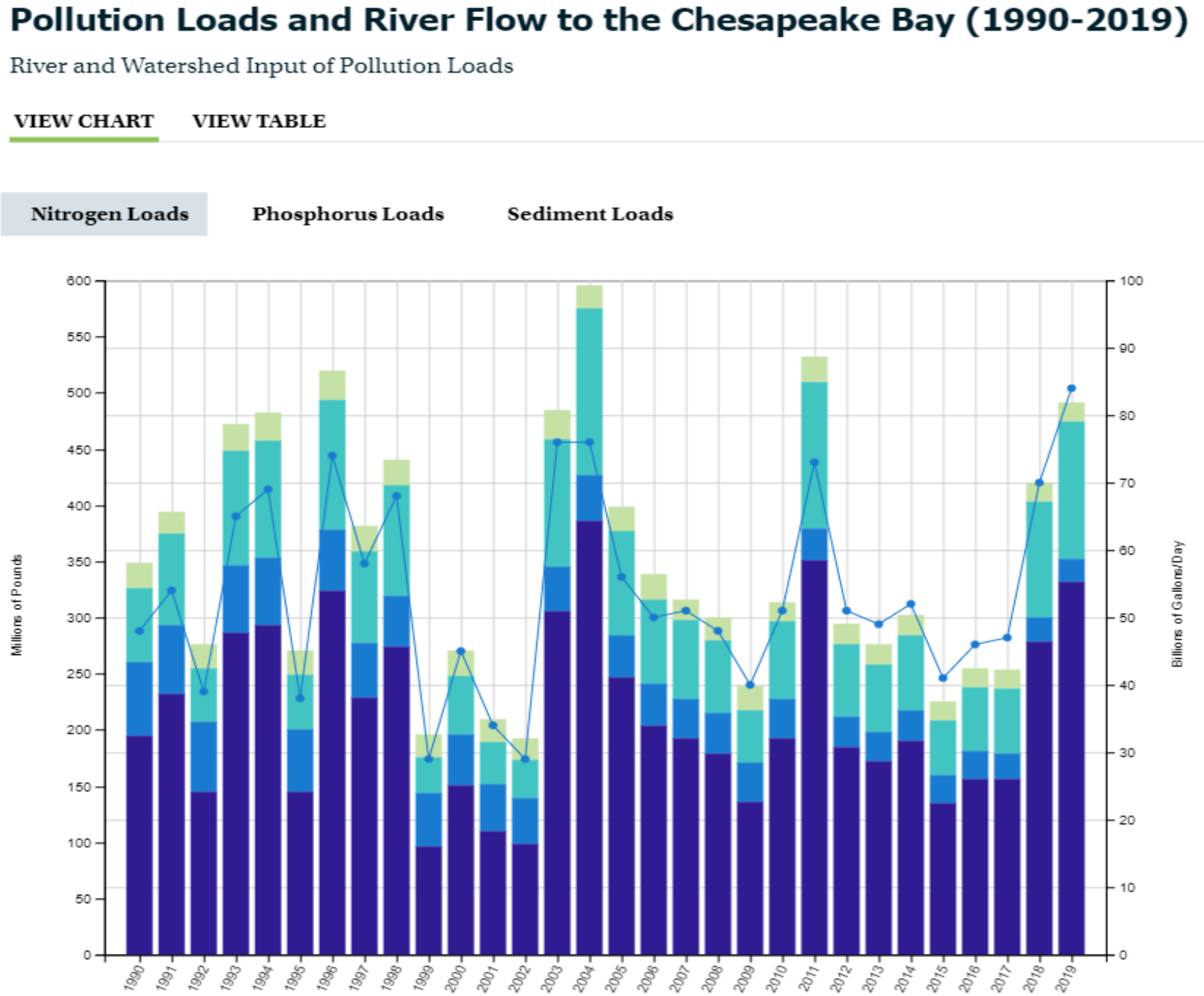
Loads by Source Loads by Jurisdiction



Nontidal Load Indicator

Extreme variability
No Clear Trend





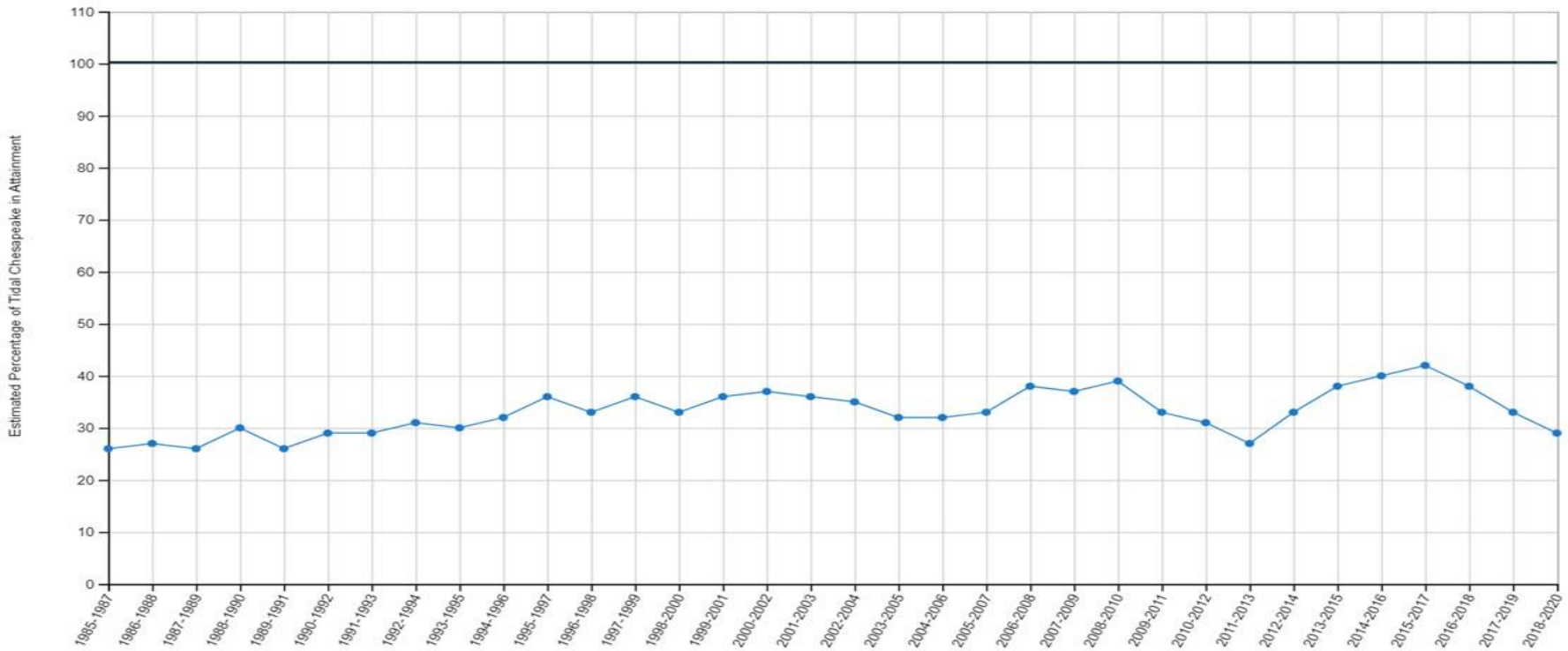
Tidal Water TMDL Indicator

Very slow positive change

Water Quality Standards Attainment (1985-2020)

Water quality is evaluated using three parameters: dissolved oxygen, water clarity or underwater grass abundance, and chlorophyll a (a measure of algae growth).

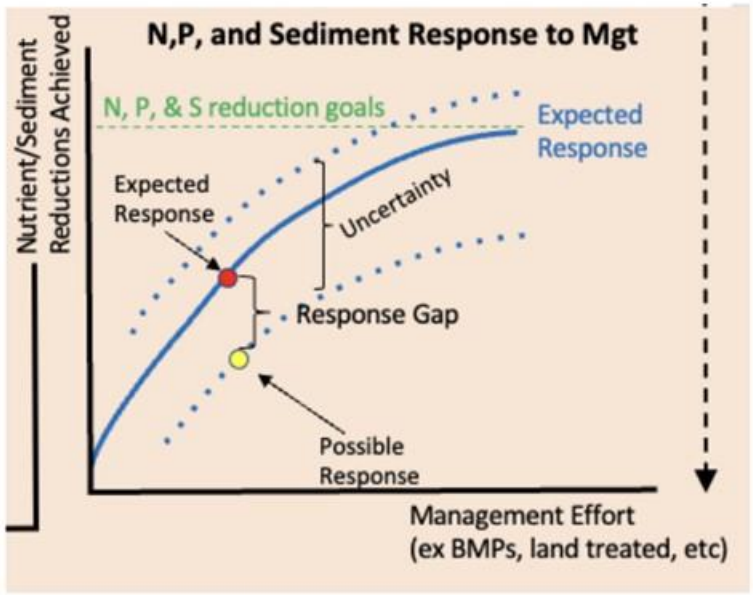
VIEW CHART VIEW TABLE



STAC Comprehensive Evaluation of System Response Report

Watershed Framing Questions

- Is the physical and social system responding to management efforts to meet TMDL N, P, and S goals in ways consistent with expectations?
- What are the major uncertainties in efforts to reduce N, P, and S stressors delivered to the Chesapeake Bay?
- What management actions/policy options could improve nutrient/sediment response or reduce response uncertainties? (see implications)



- Presented to WQGIT 10/26/2021
- https://d18lev1ok5leia.cloudfront.net/chesapeakebay/documents/cesrtowqgit10-26-2021_final.pdf

Purpose: Build an indicator that is:

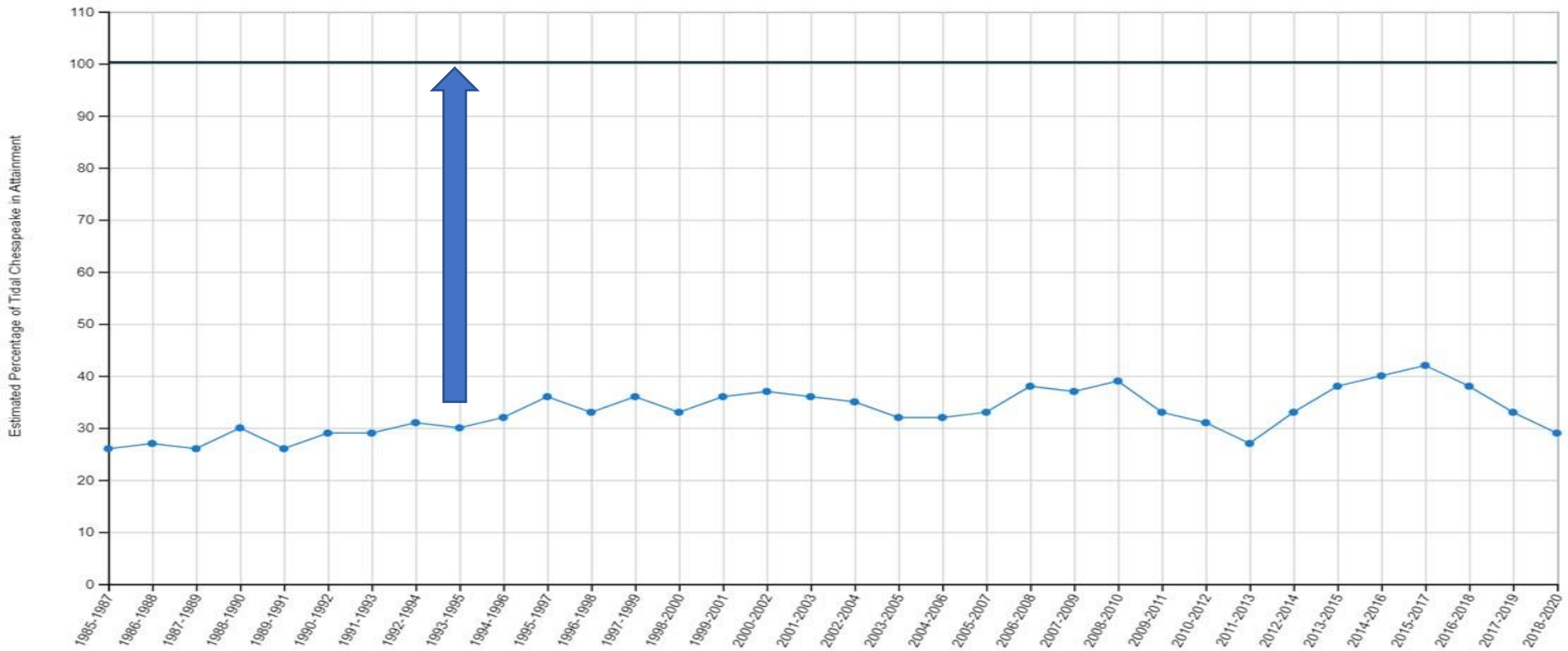
- Relevant to the TMDL
- Based on monitored changes in load to the extent possible
- Bridges monitoring and modeling by assessing lag time and other effects

TMDL question: What level of load reduction from 1995 will be necessary to meet water quality standards?

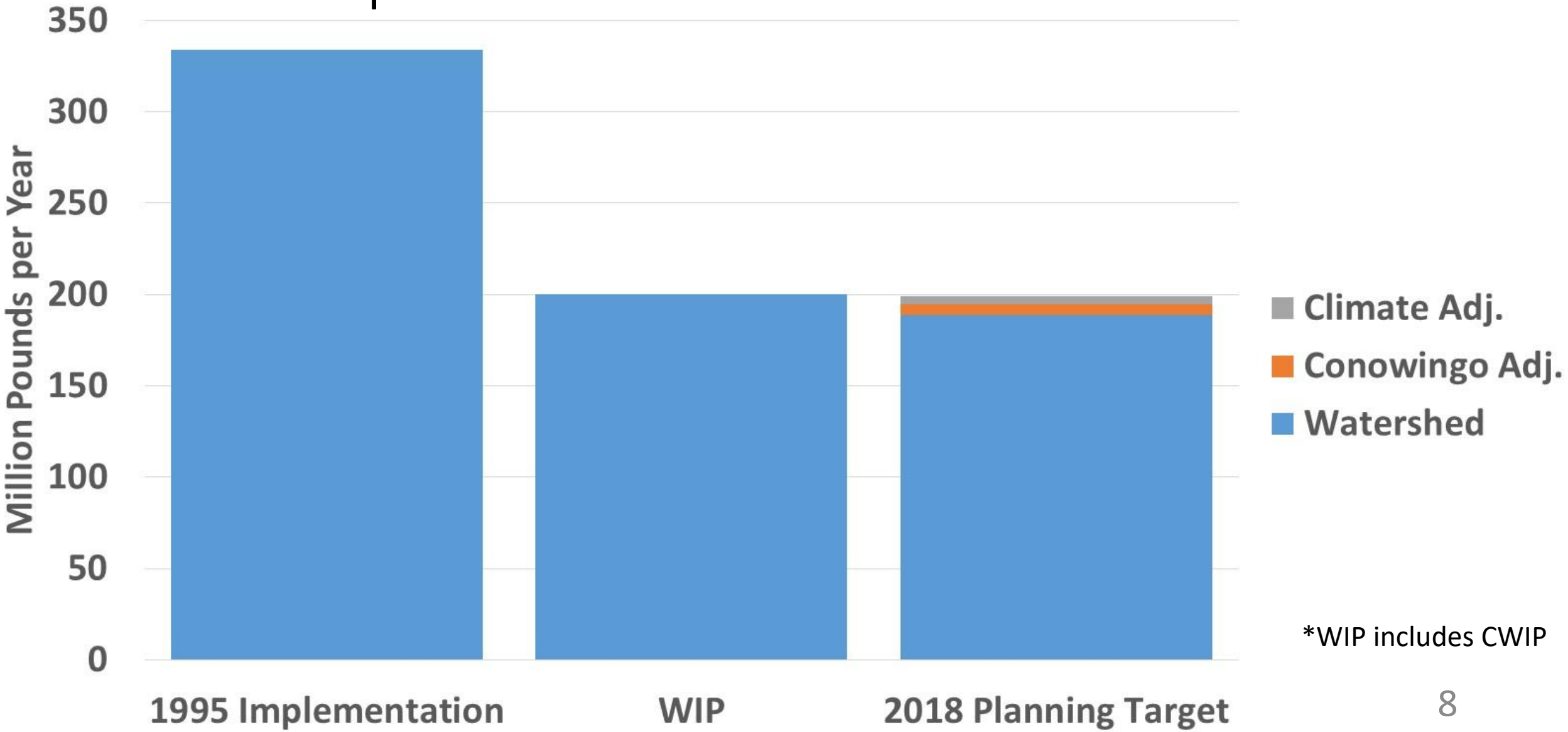
Water Quality Standards Attainment (1985-2020)

Water quality is evaluated using three parameters: dissolved oxygen, water clarity or underwater grass abundance, and chlorophyll a (a measure of algae growth).

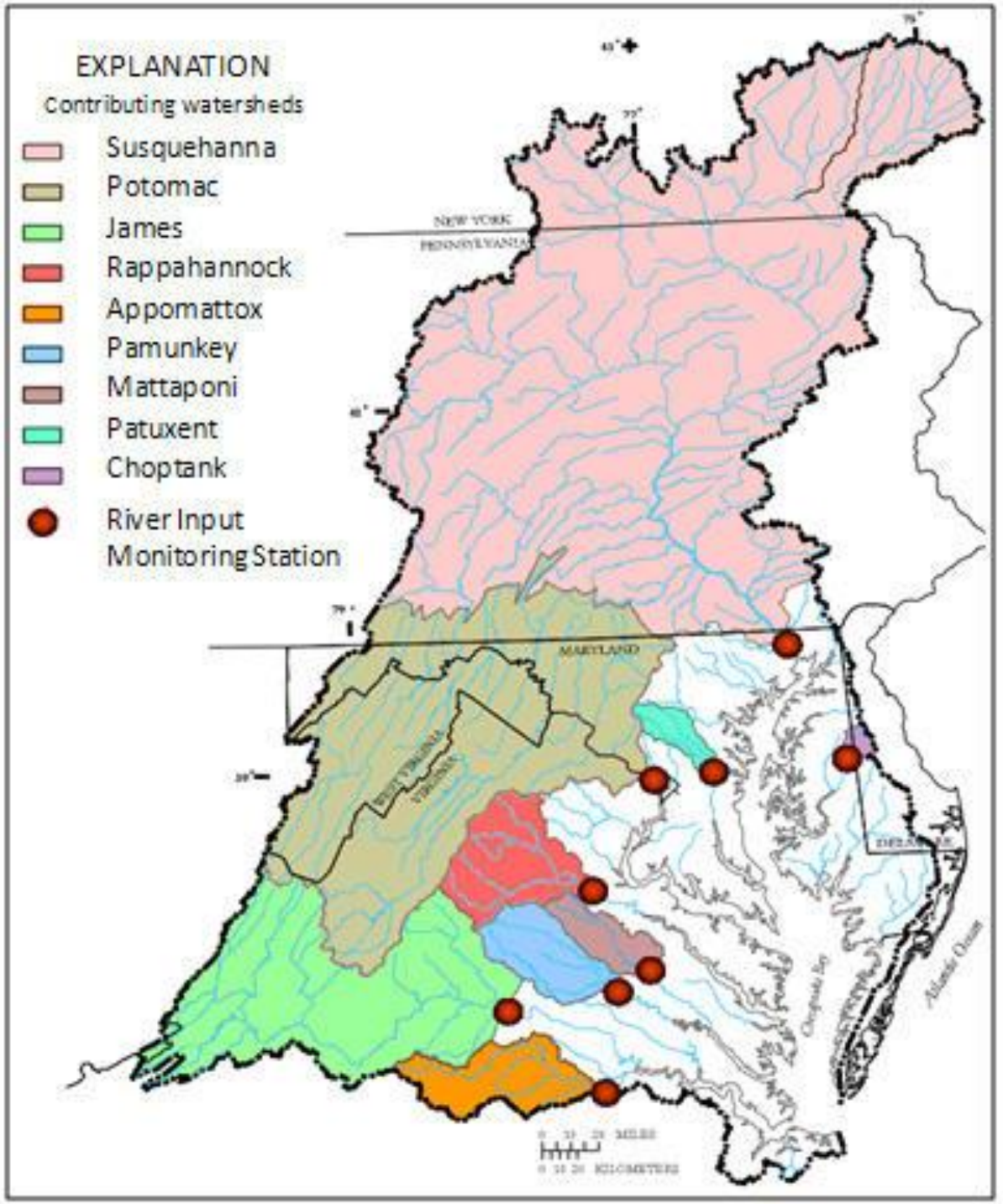
VIEW CHART VIEW TABLE



Loads required to meet TMDL Goals



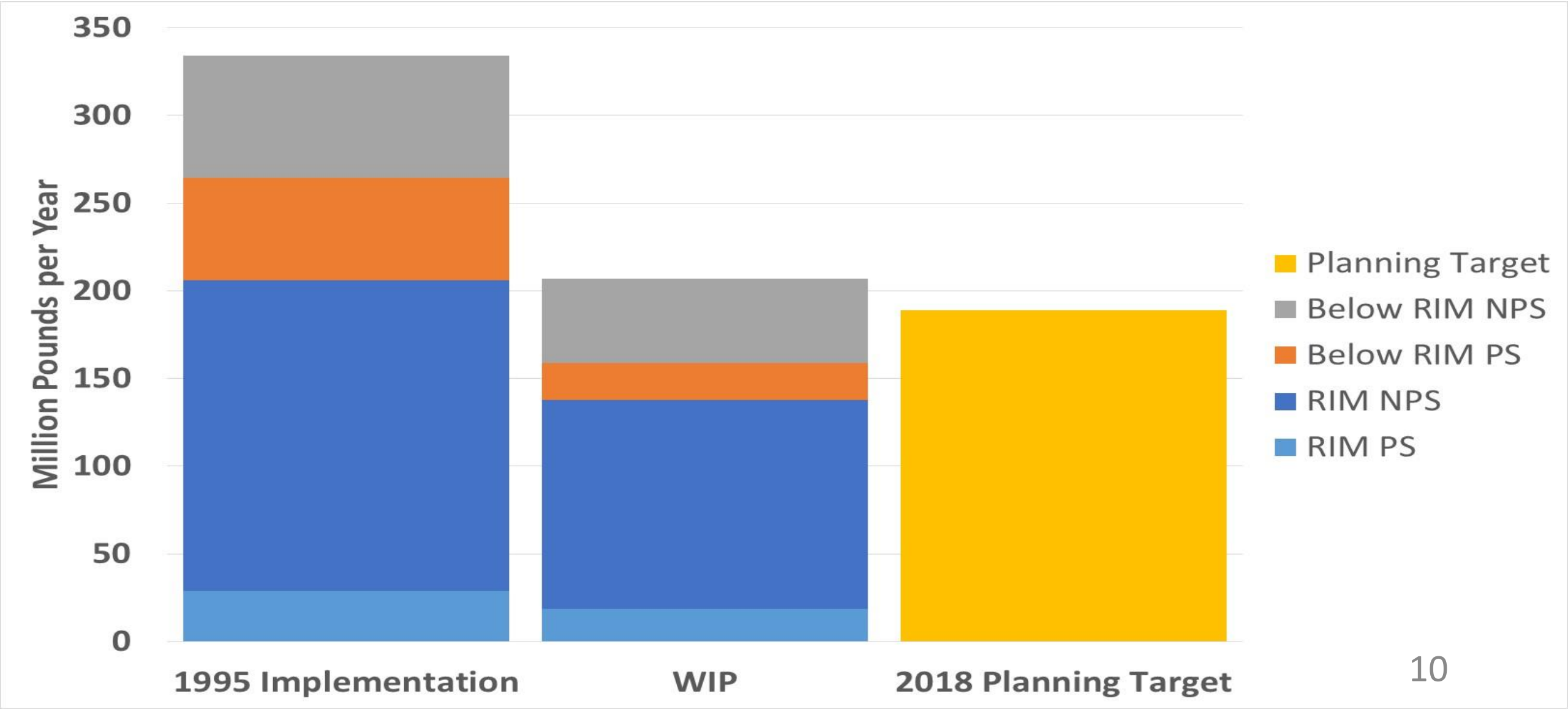
*WIP includes CWIP



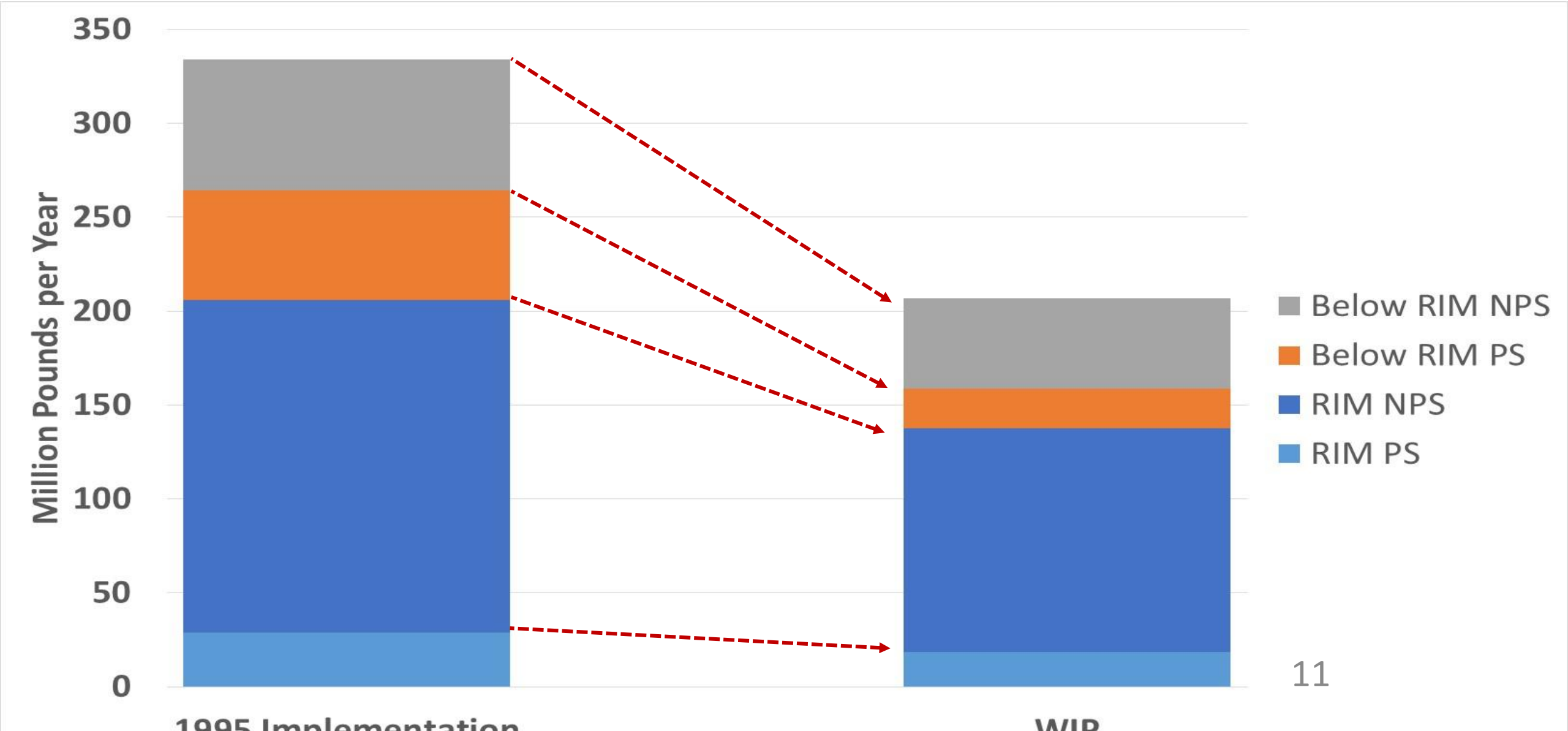
River Input Monitoring (RIM)

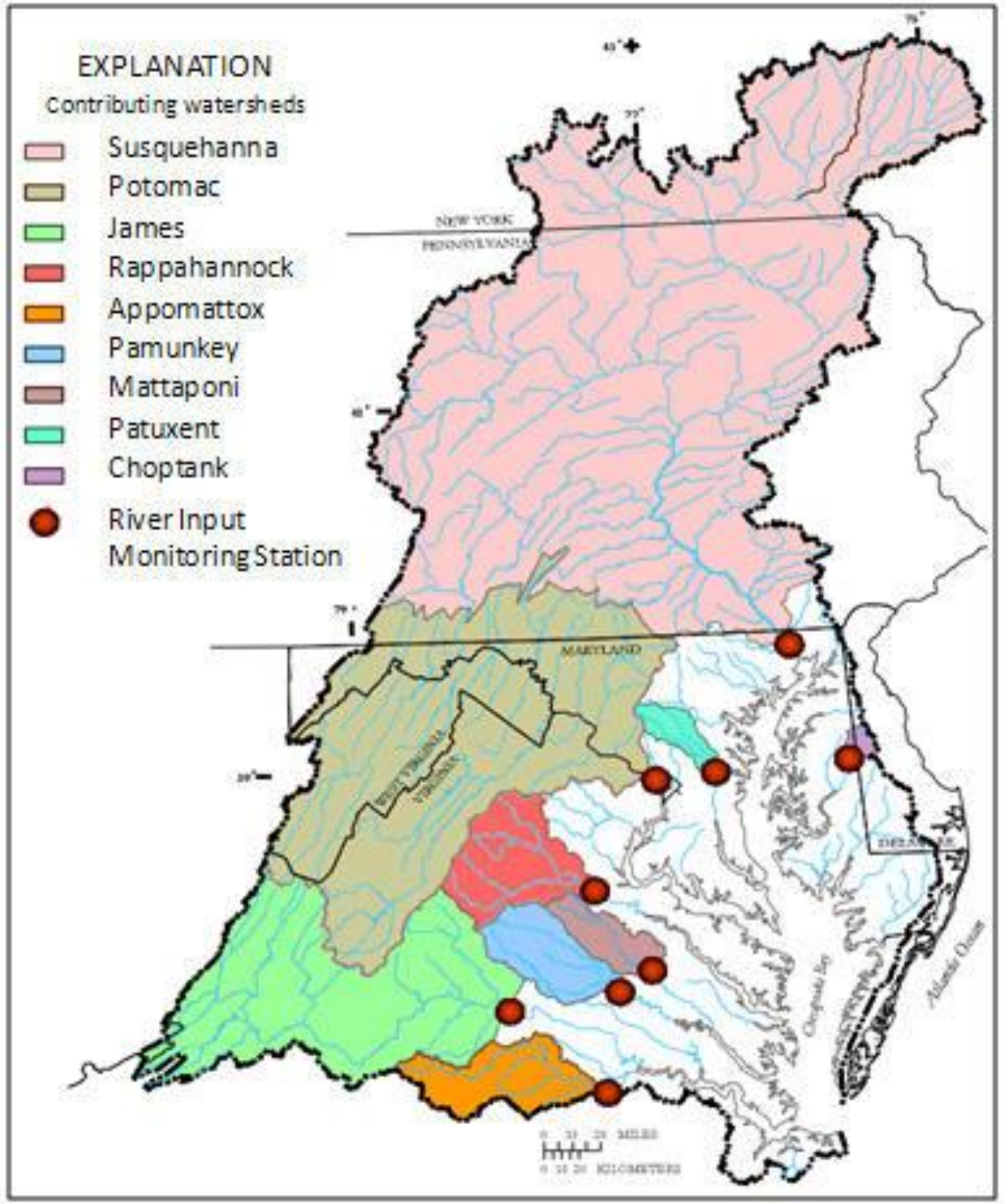
- Covers most of the CB watershed
  - 80% of land
  - 60% of load
- Many large WWTP are below RIM stations

Reductions required to meet TMDL Goals

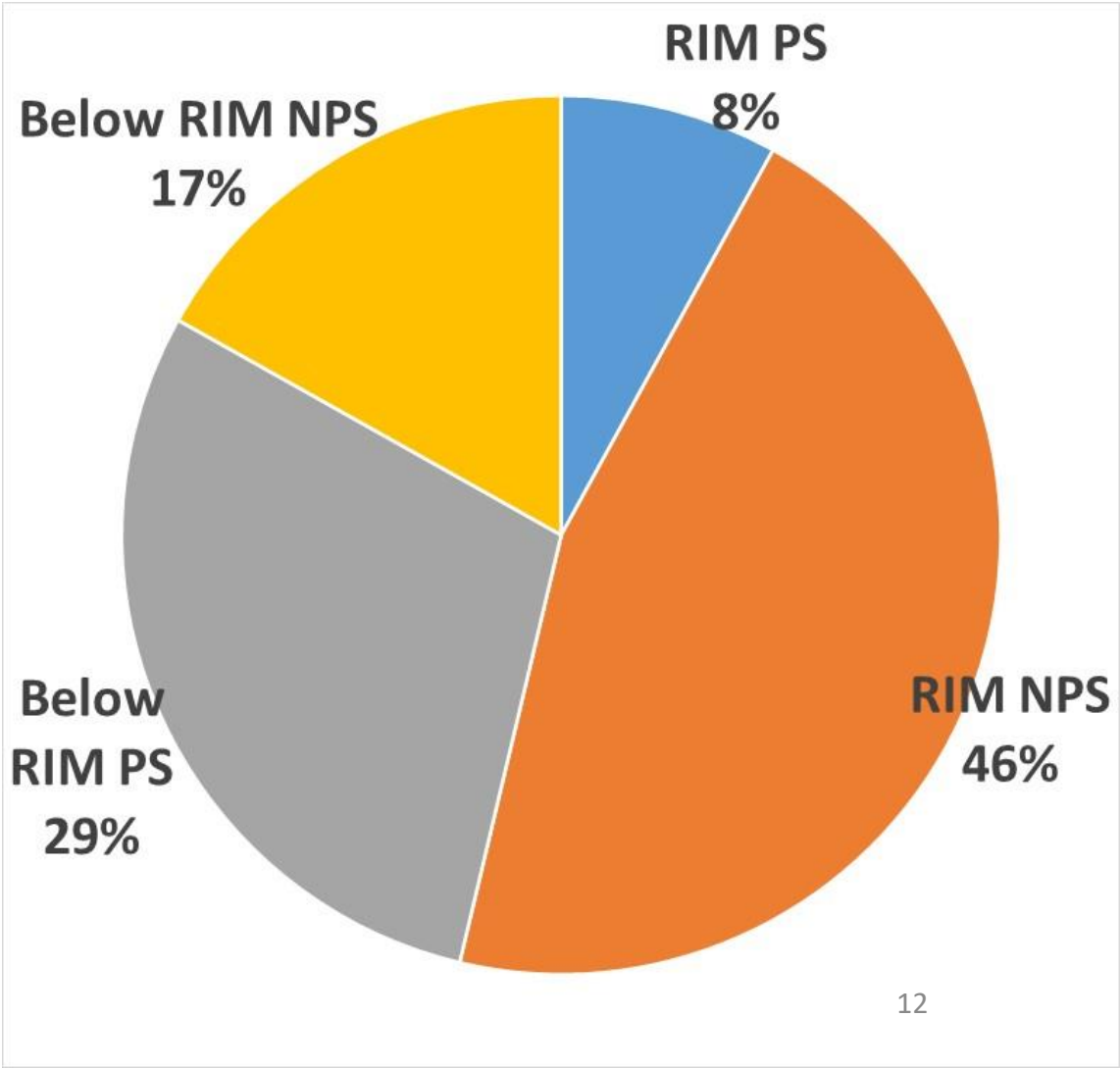


Reductions required to meet TMDL Goals

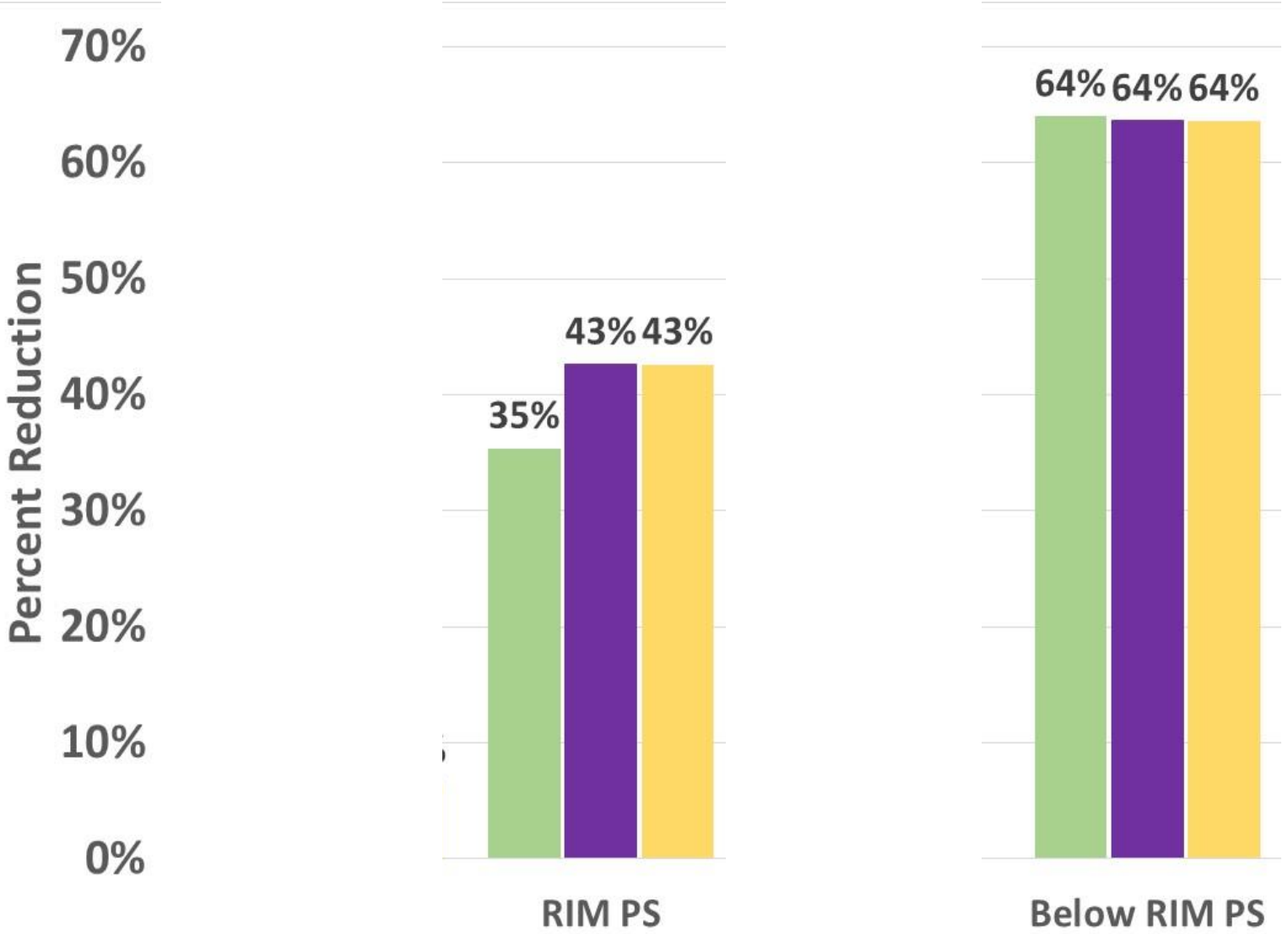


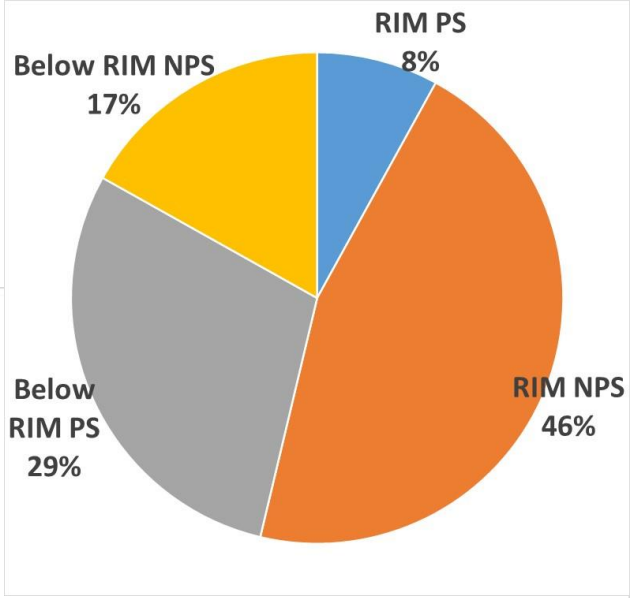


83% of Expected Reduction is Monitored



Wastewater is easy to measure and successful



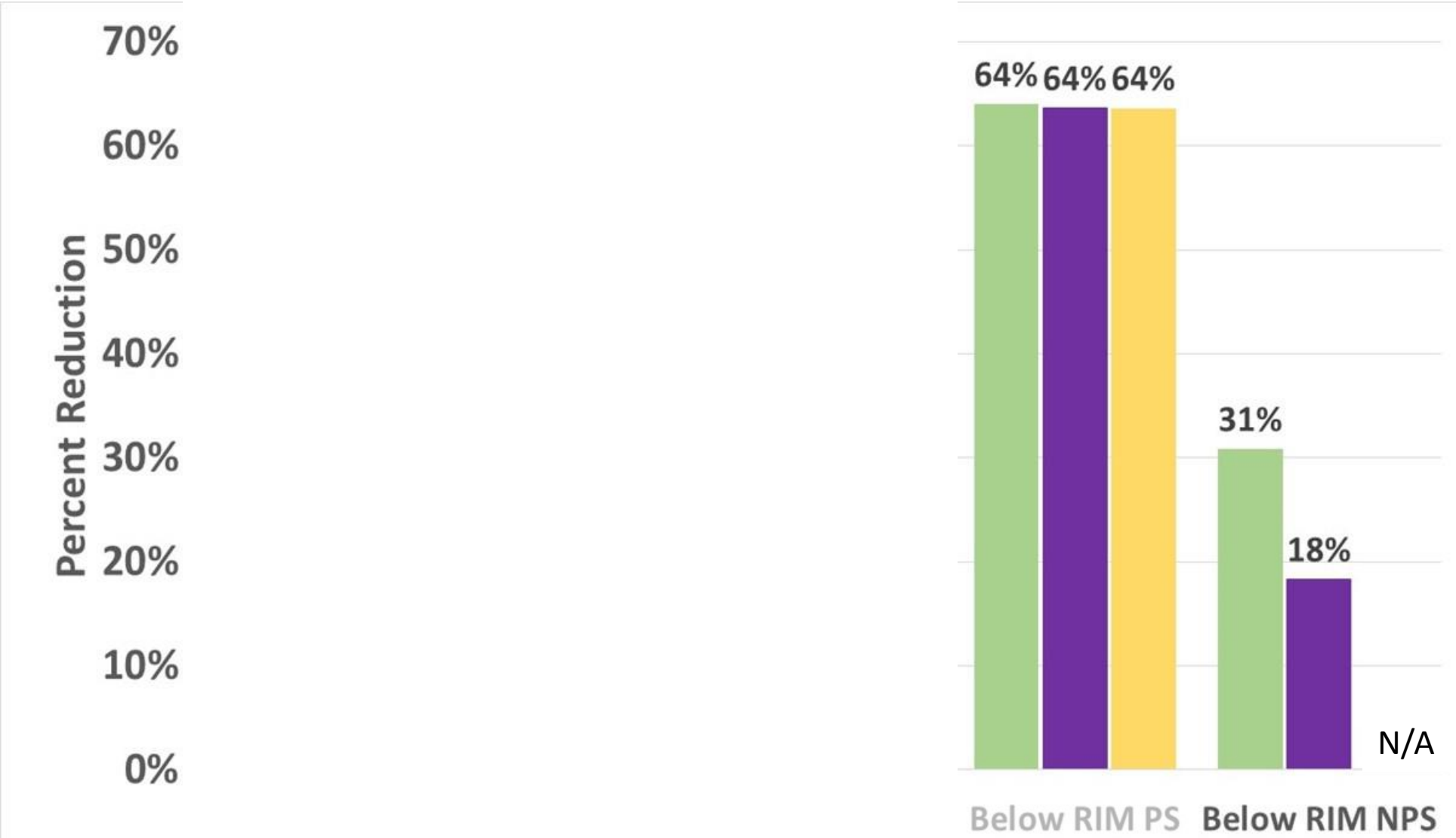


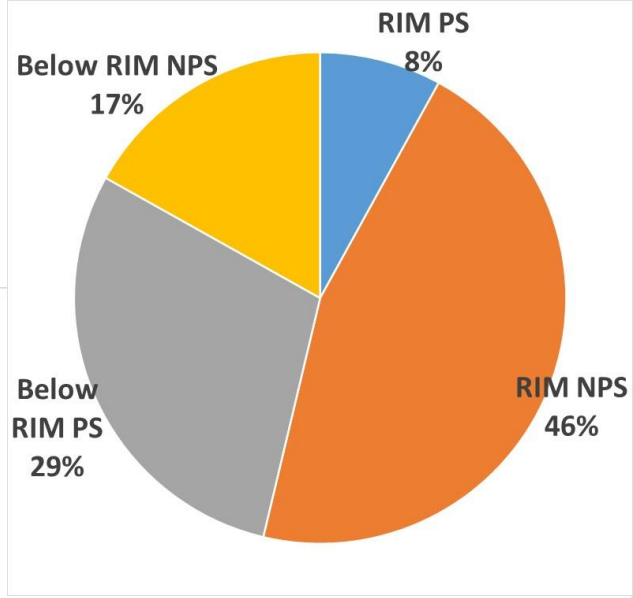
Percent reduction to WIP (with Conowingo WIP)

Expected reduction to 2021

Monitored reduction to 2021

Below RIM NPS is more than half implemented and is not fully monitored





Percent reduction to WIP (with Conowingo WIP)

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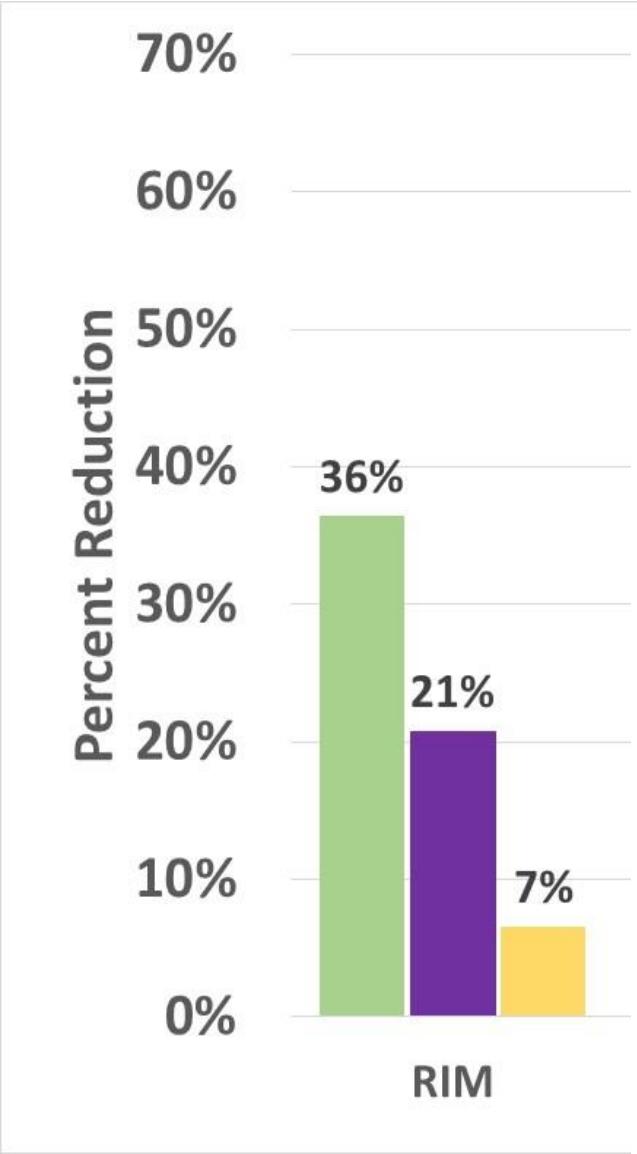
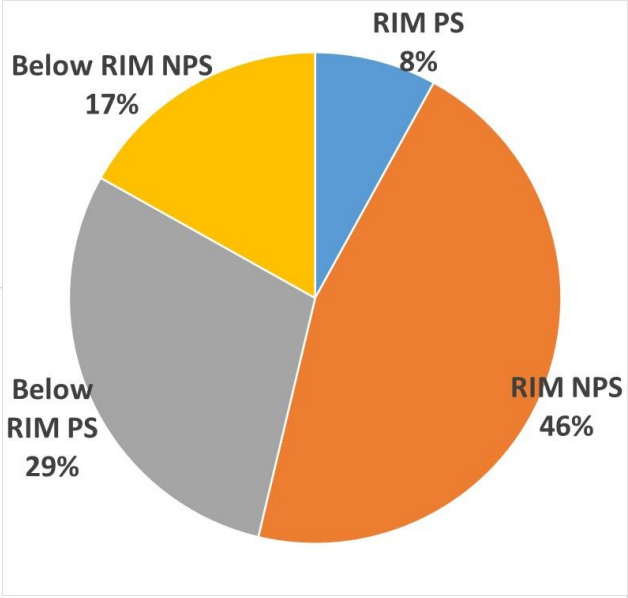
Monitored reduction to 2021

Above RIM is more than half implemented, but monitoring shows a small reduction





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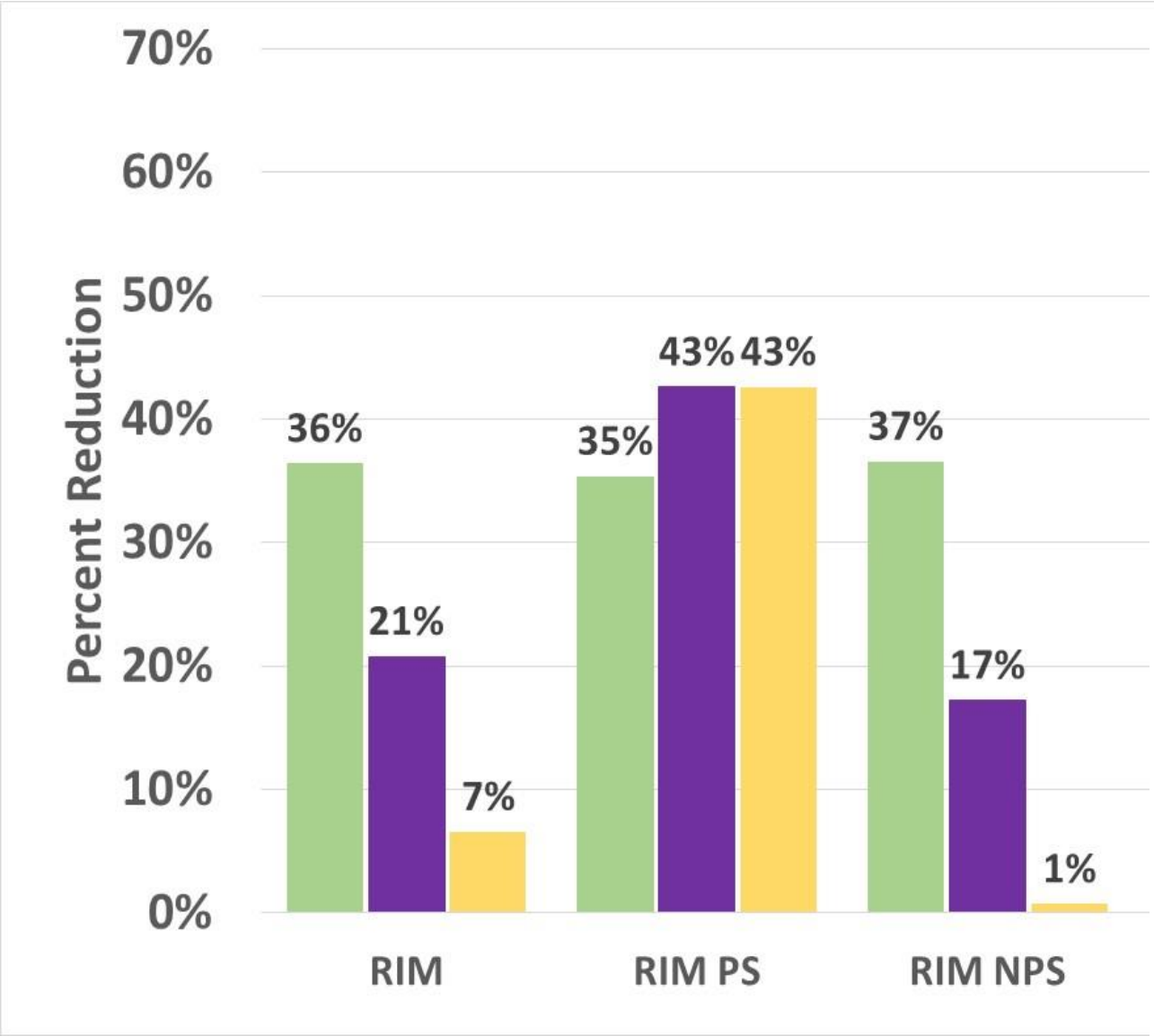
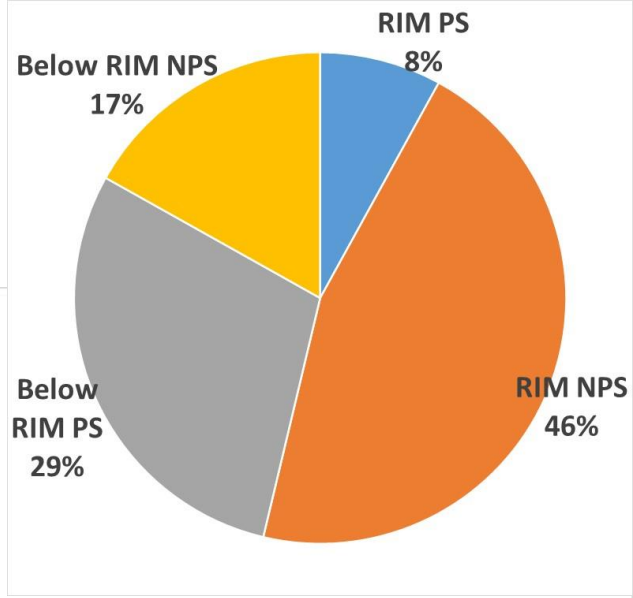


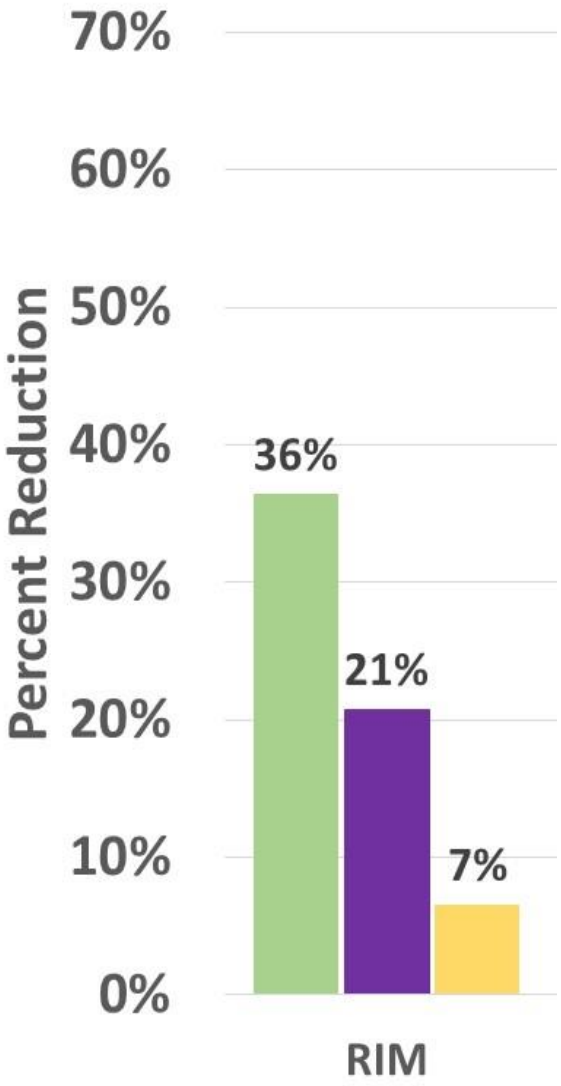


Percent reduction to WIP (with Conowingo WIP)

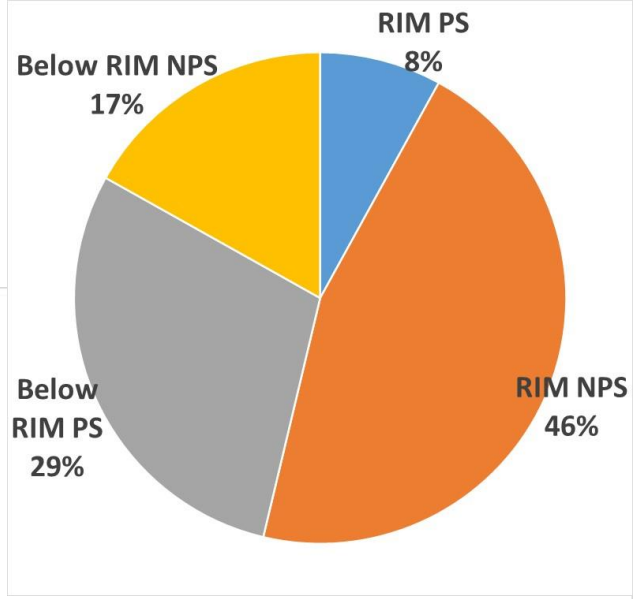
Expected reduction to 2021

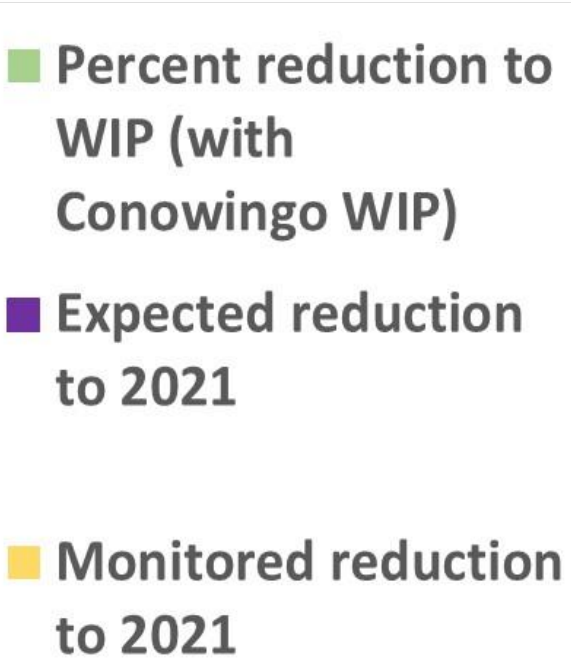
Monitored reduction to 2021

Why are monitoring and modeling not showing the same thing?



- Uncertainty in CAST
  - BMPs implemented
  - BMP effectiveness
  - Nutrient applications
  - Watershed response
- Uncertainty in “monitored” loads
- Lag time
- Competing factors such as
  - Climate change
  - Conowingo

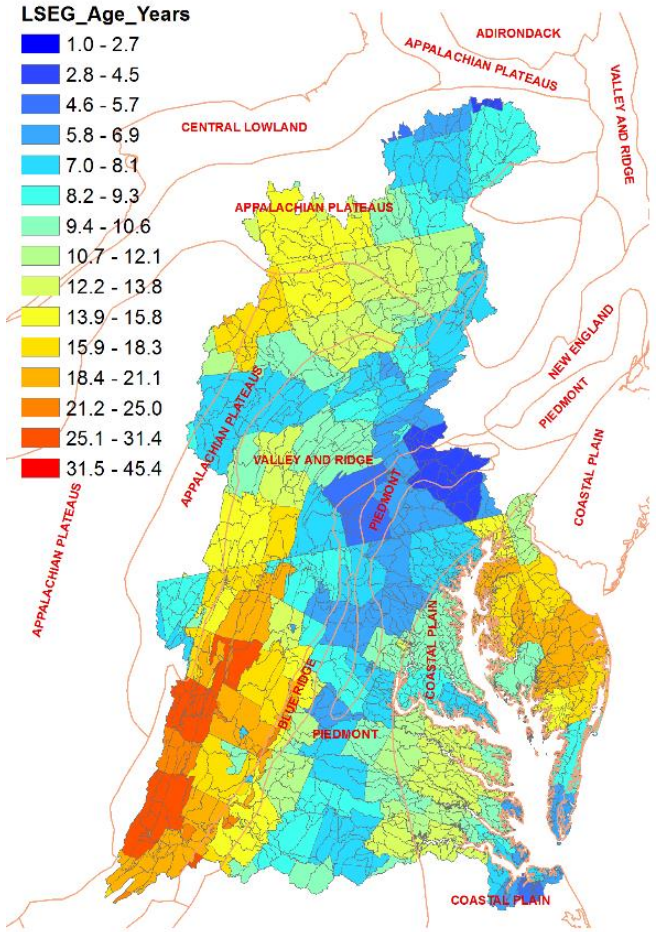




Ator, S.W., Blomquist, J.D., Webber, J.S. and Chanat, J.G., 2020. Factors driving nutrient trends in streams of the Chesapeake Bay watershed. *Journal of Environmental Quality*, *49*(4), pp.812-834.

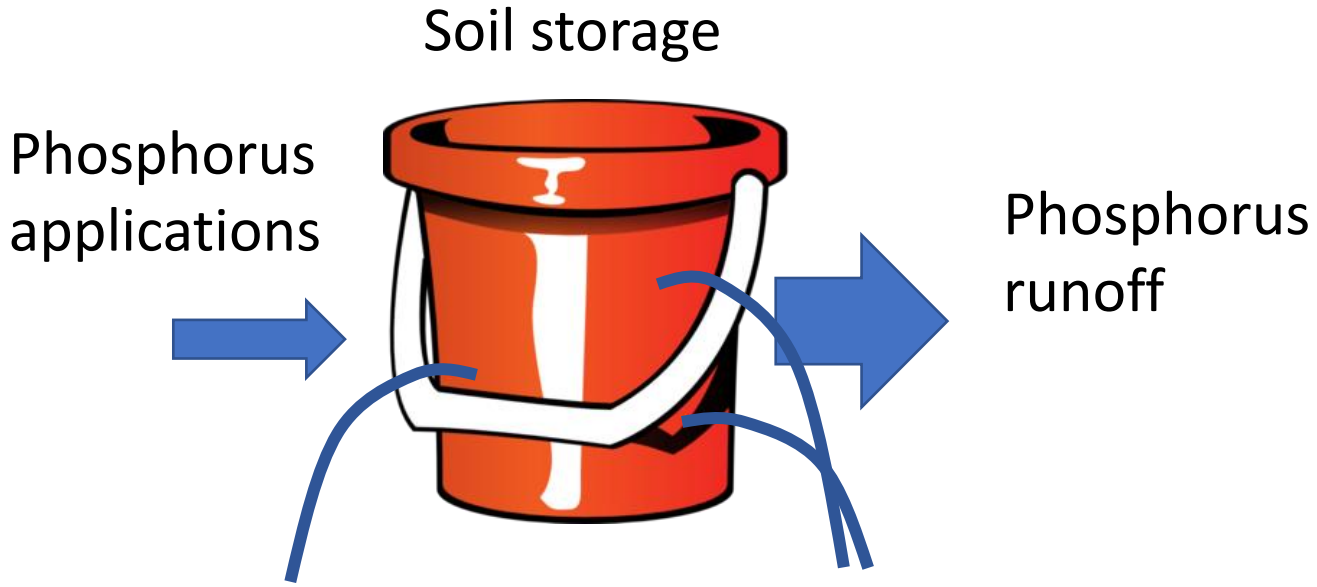
Lag times

Nitrate in groundwater



Phase 6 CAST documentation

Phosphorus in soils



Conowingo effect

2017/2018 Presentations to WQGIT, MB, and PSC

Estimated Loads to the Bay with Conowingo Dam and Reservoir at Infill Conditions

Additional Nitrogen Load: 13 million pounds

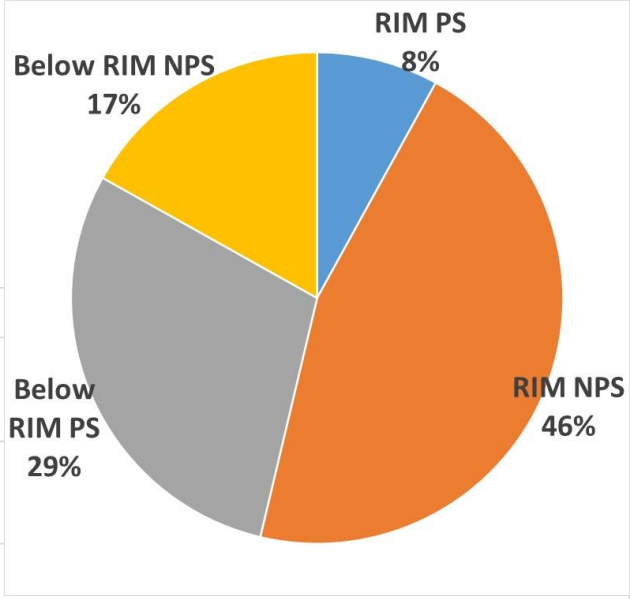
+

Additional Phosphorus Load: 1.8 million pounds

↓

6 million lbs of N and 0.26 million lbs of P reduction

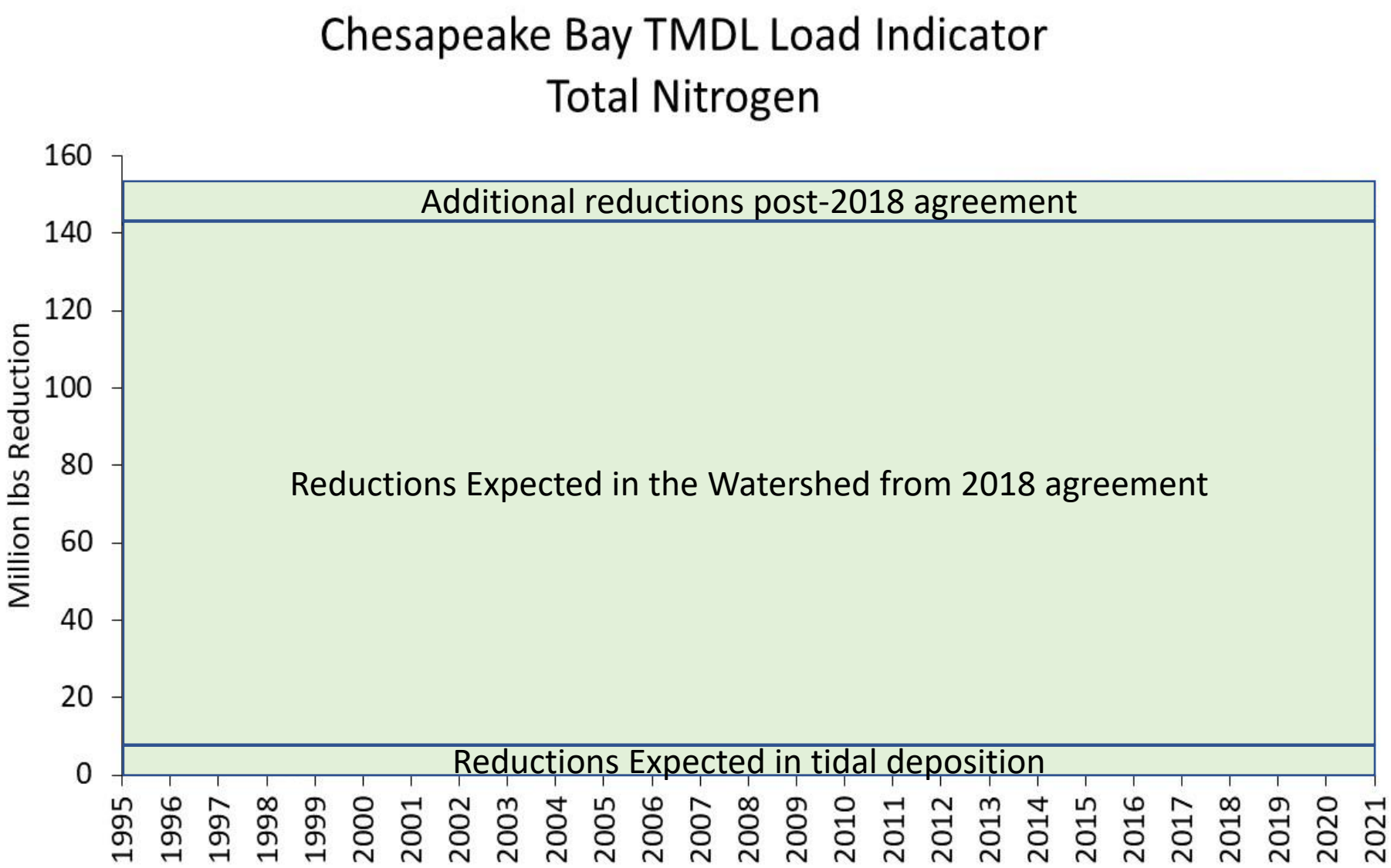
Lags and Conowingo account for major differences between Modeling and Monitoring



No approved method of aggregating uncertainty across RIM stations
Initial estimate for monitored reduction by Zhang and Bertani at +/- 6%

Public Indicator

Updated Annually



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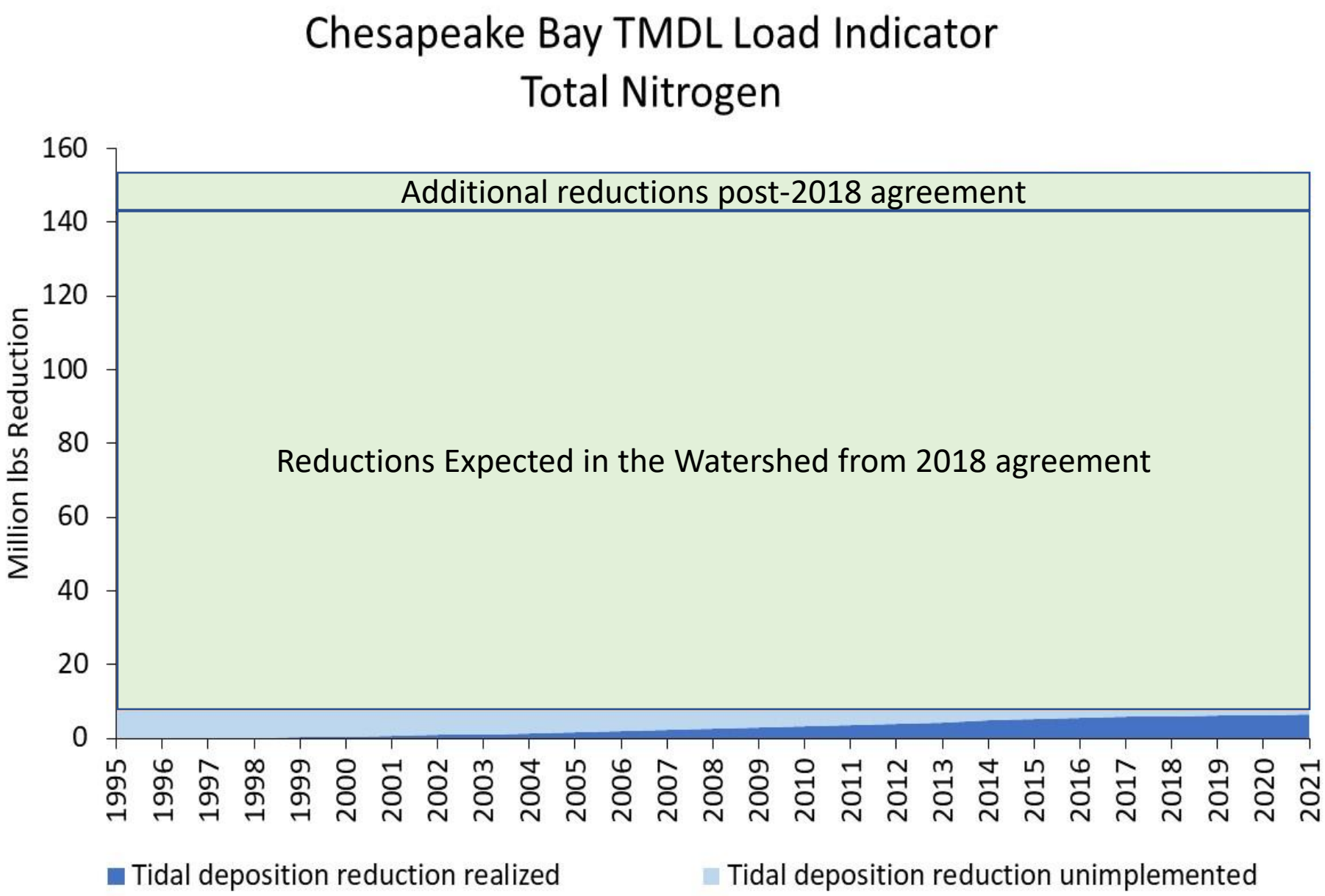

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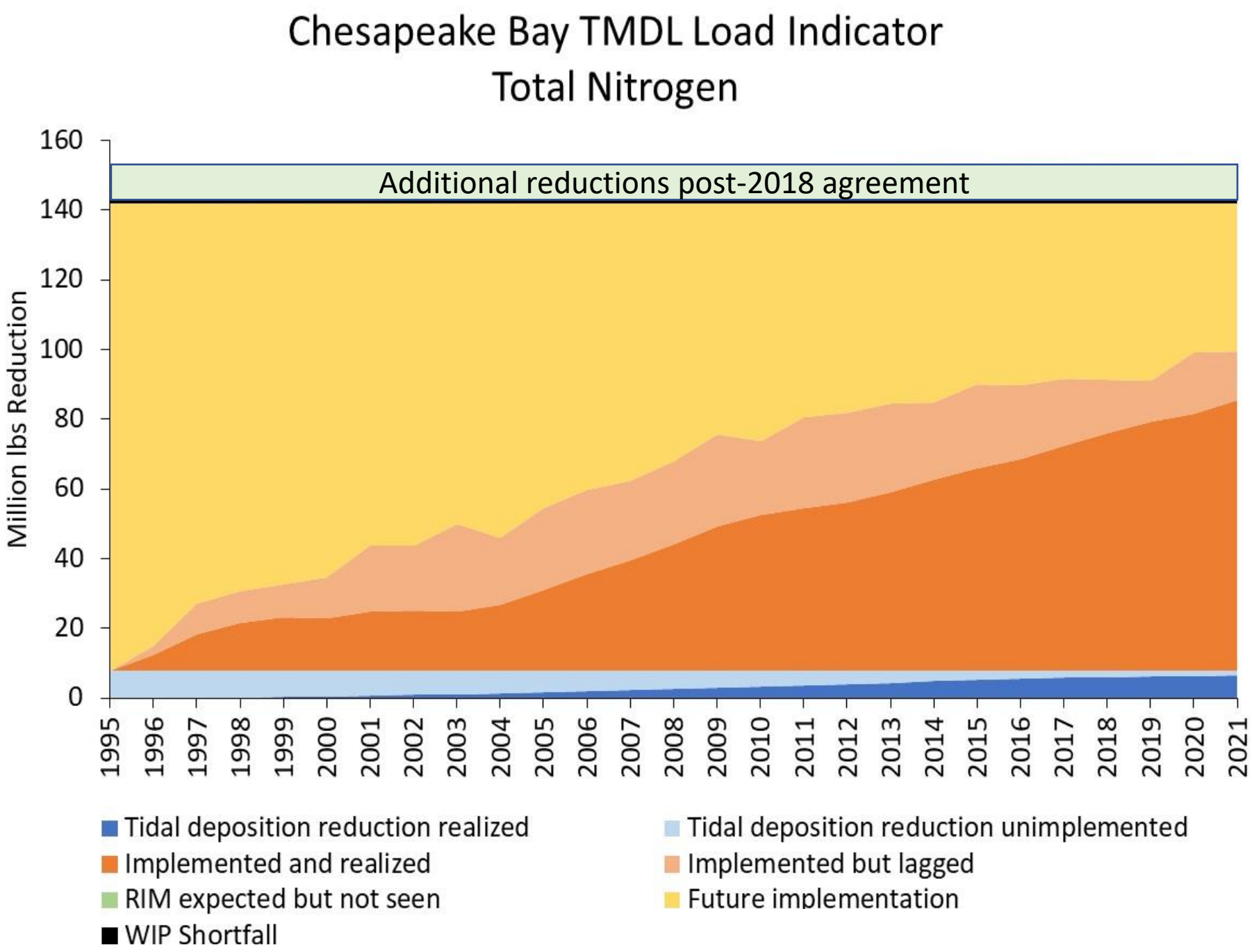

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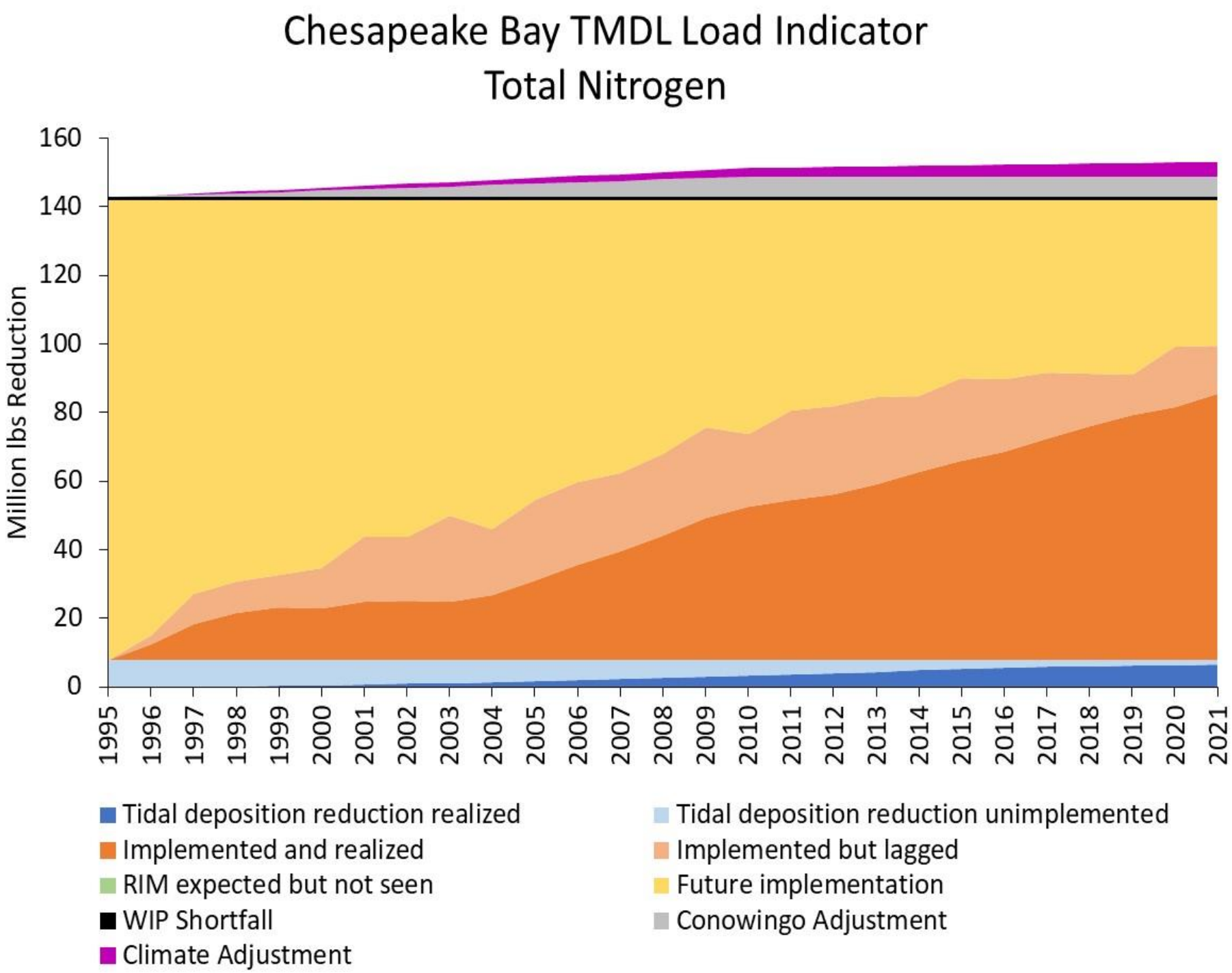

Web team will reformat
Including addressing accessibility

Public Indicator

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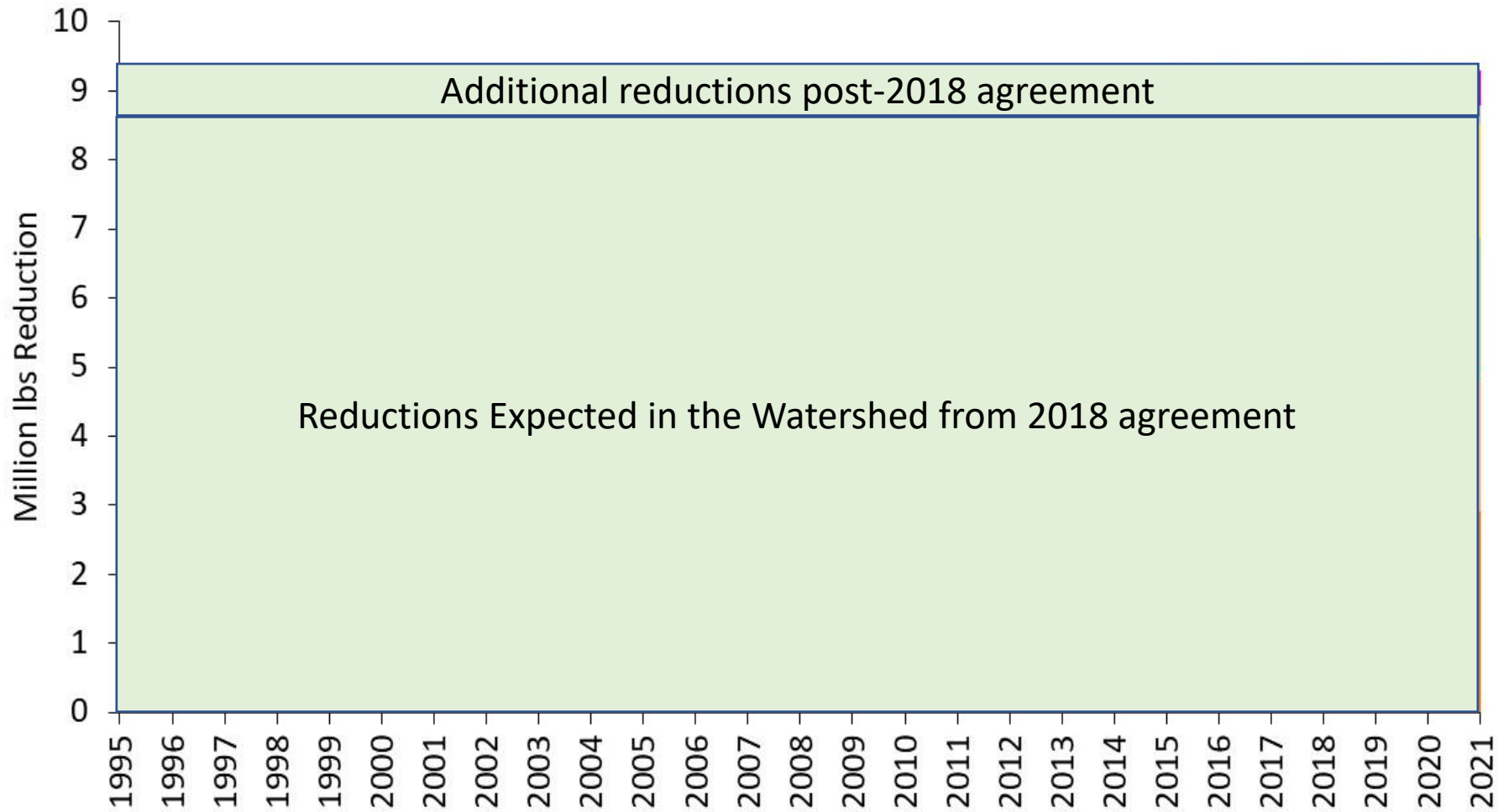

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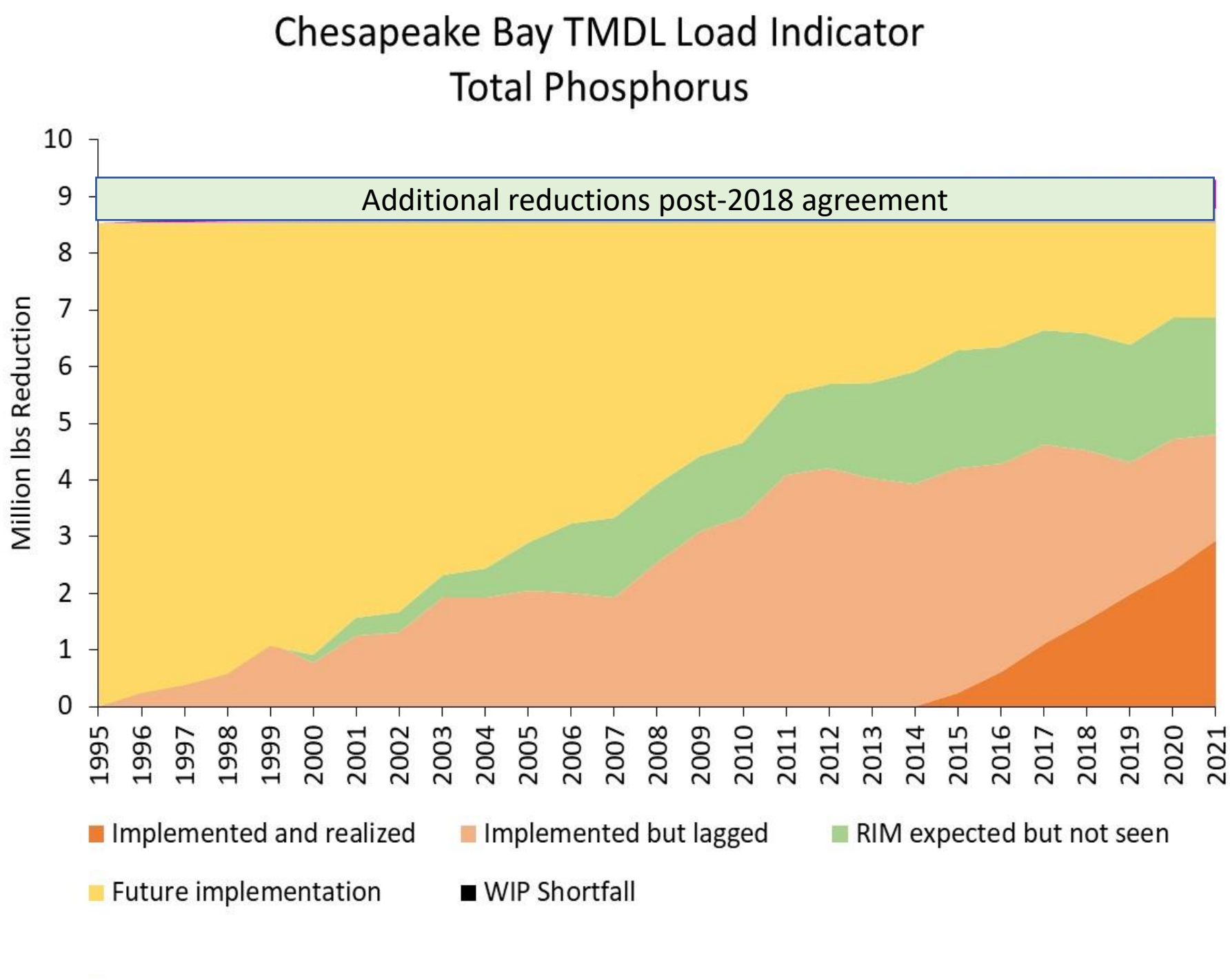

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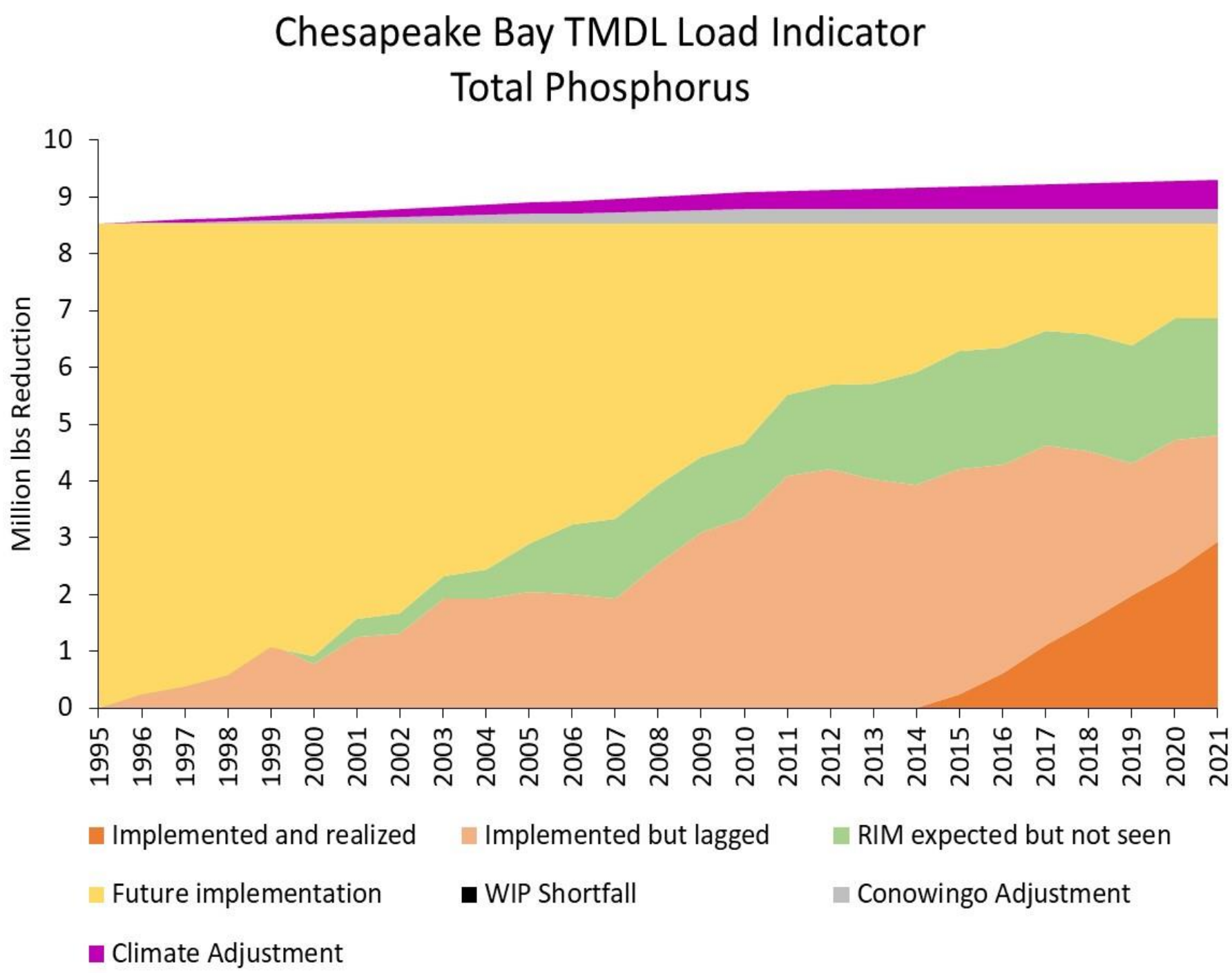

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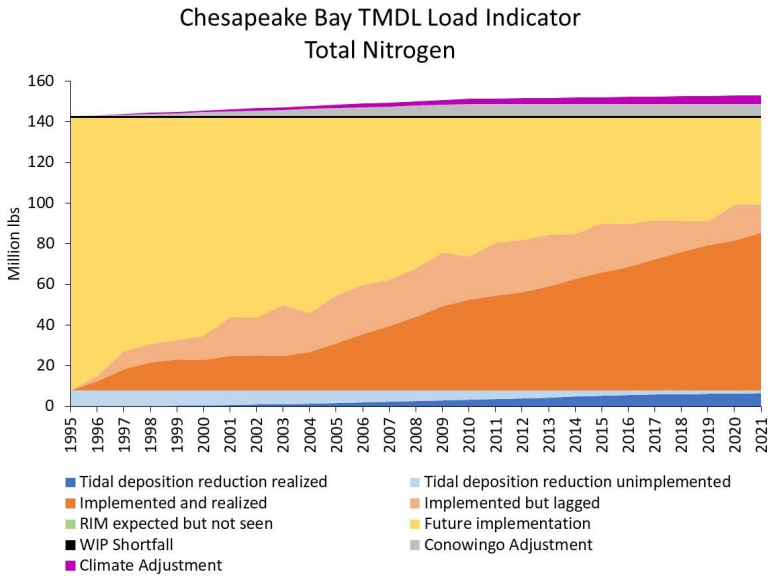
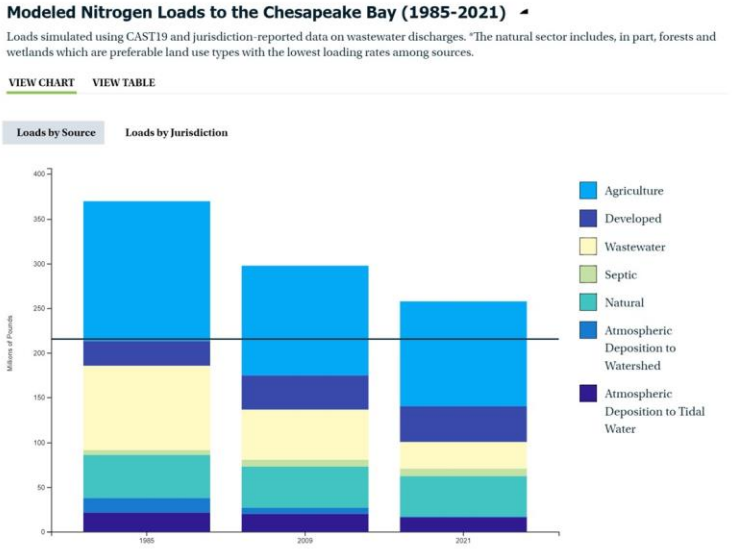
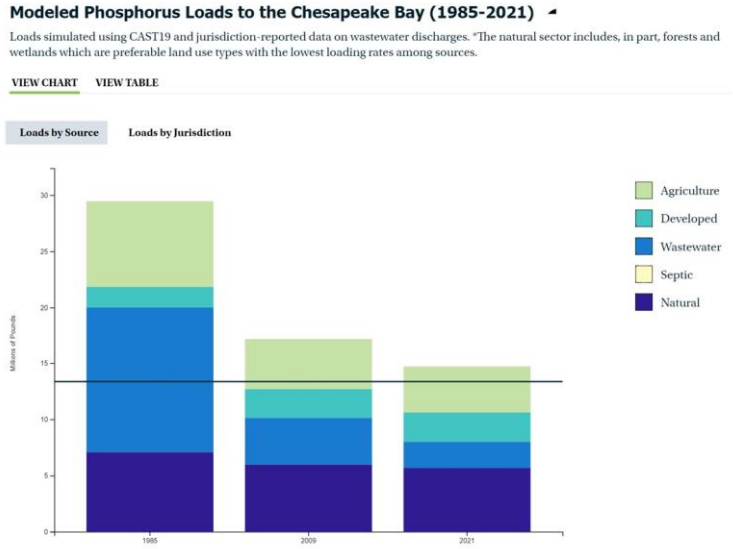
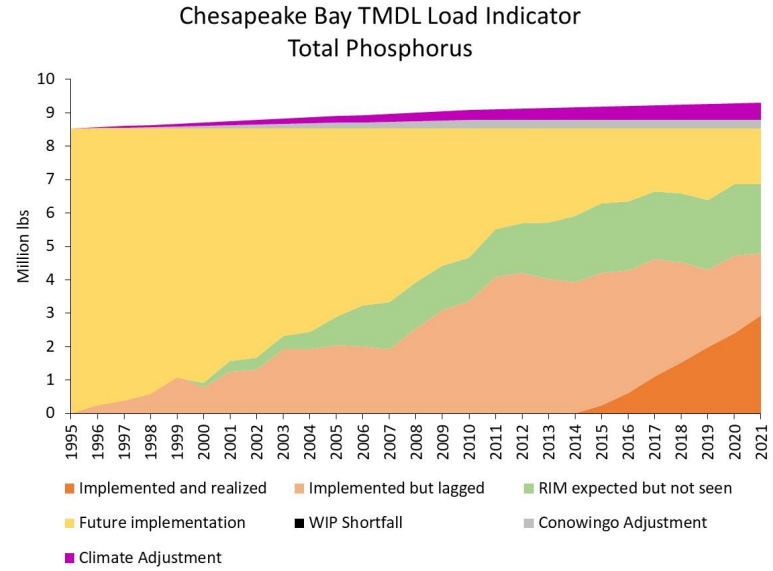
Location: WIP 2025 outcome









Partnership Product for Data Dashboard

Plus all years in between. Updated Annually

	Nitrogen				Phosphorus			
Category	1995	2005	2015	2021	1995	2005	2015	2021
WIP Shortfall	0.92	6.58	10.25	11.25	-0.87	-0.50	-0.21	-0.09
WIP Shortfall	0.92	0.92	0.92	0.92	-0.87	-0.87	-0.87	-0.87
Conowingo Adjustment	0.00	4.00	6.01	6.01	0.00	0.17	0.26	0.26
Climate Adjustment	0.00	1.66	3.32	4.32	0.00	0.20	0.40	0.52
RIM Unimplemented	68.30	43.75	26.73	26.65	6.33	4.28	2.18	1.77
RIM Unimplemented Conowingo	6.67	6.67	6.67	6.67	0.14	0.14	0.14	0.14
RIM expected but not seen	0.00	0.00	0.00	0.00	0.00	1.77	2.09	2.07
RIM Lagged	0.00	17.94	21.39	16.87	0.00	2.29	3.58	2.40
RIM Conowingo Conversion	0.00	8.81	11.81	11.26	0.00	1.86	2.95	2.30
RIM Monitored	0.00	-2.20	8.38	13.53	0.00	-3.88	-4.48	-2.21
Below-RIM PS Implemented	0.00	17.56	30.04	37.19	0.00	0.32	1.25	1.38
Below-RIM PS Unimplemented	37.41	19.85	7.38	0.22	1.57	1.25	0.32	0.19
Below-RIM Estimated	0.00	-1.11	7.85	15.67	0.00	0.79	0.52	1.48
Below-RIM Lagged	0.00	5.60	2.71	-2.95	0.00	-0.25	0.38	-0.55
Below-RIM Unimplemented	21.44	16.96	10.88	8.72	1.36	0.82	0.46	0.43
Tidal Deposition Reduction Realized	0.00	1.68	5.18	6.50				
Tidal Deposition Reduction Unimplemented	7.92	6.24	2.74	1.42				

Station-level dashboard Product

Qian Zhang

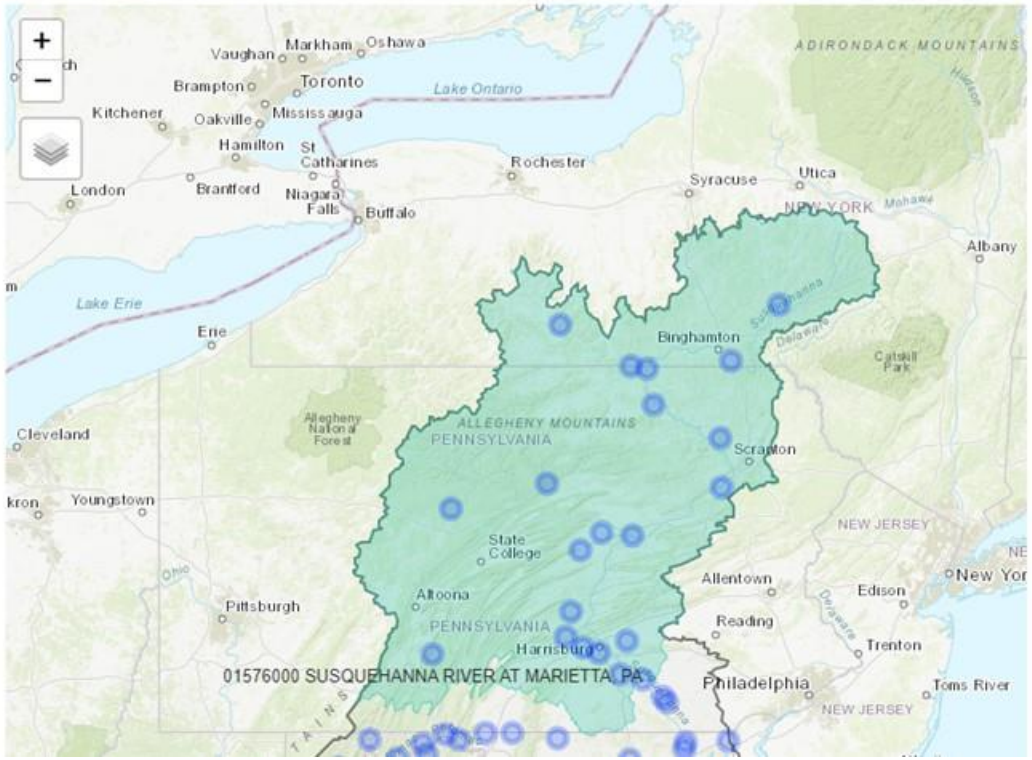
Step 1: Select the water-quality parameter:

Total Nitrogen

Step 2: Select the monitoring station by clicking either Map or Table:

Map | Data Table

Tip: Move mouse cursor to any circle marker to show the station name.



About | Timeseries | WIP Goal | Progress | Download

Station

The selected station is SUSQUEHANNA RIVER AT MARIETTA, PA:
* USGS ID: 01576000
* Area (km^2): 67349.2
* Major Basin: Susquehanna
* Latitude: 40.054541
* Longitude: -76.530799

Data Availability

Total Nitrogen: 1987-2020.
Total Phosphorus: 1987-2020.
Suspended Sediment: 1987-2020.

Data Type

WRTDS: Monitored load - computed using the USGS WRTDS flow-normalization method (source).

CAST: Expected load in the long term - computed using the Chesapeake Bay Program Watershed Model (source).

CAST_DM: Expected load with lags - computed using the Chesapeake Bay Program Watershed Model (source).

Contact

Qian Zhang (UMCES @ CBPO).

Contributors

Qian Zhang (UMCES @ CBPO), Gopal Bhatt (PSU @ CBPO), Isabella Bertani (UMCES @ CBPO).

Version

Last updated on March 24, 2023.

https://zhangqian0324.shinyapps.io/CBNTN_TMDL_Indicator/

Station-level dashboard Product

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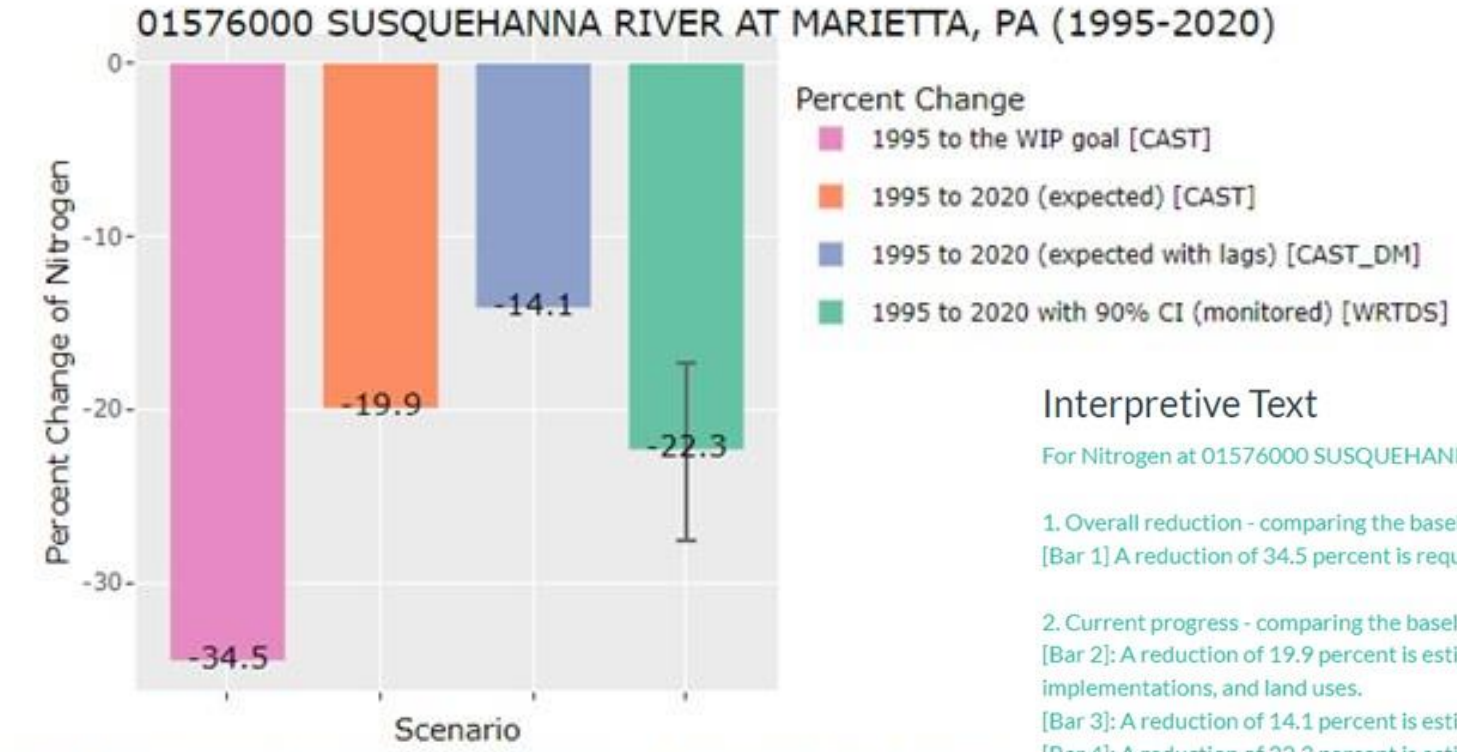
Interactive Plot



(Note: Negative values indicate reductions; positive values indicate increases)

Interpretive Text

For Nitrogen at 01576000 SUSQUEHANNA RIVER AT MARIETTA, PA, the period of analysis is 1995-2020.

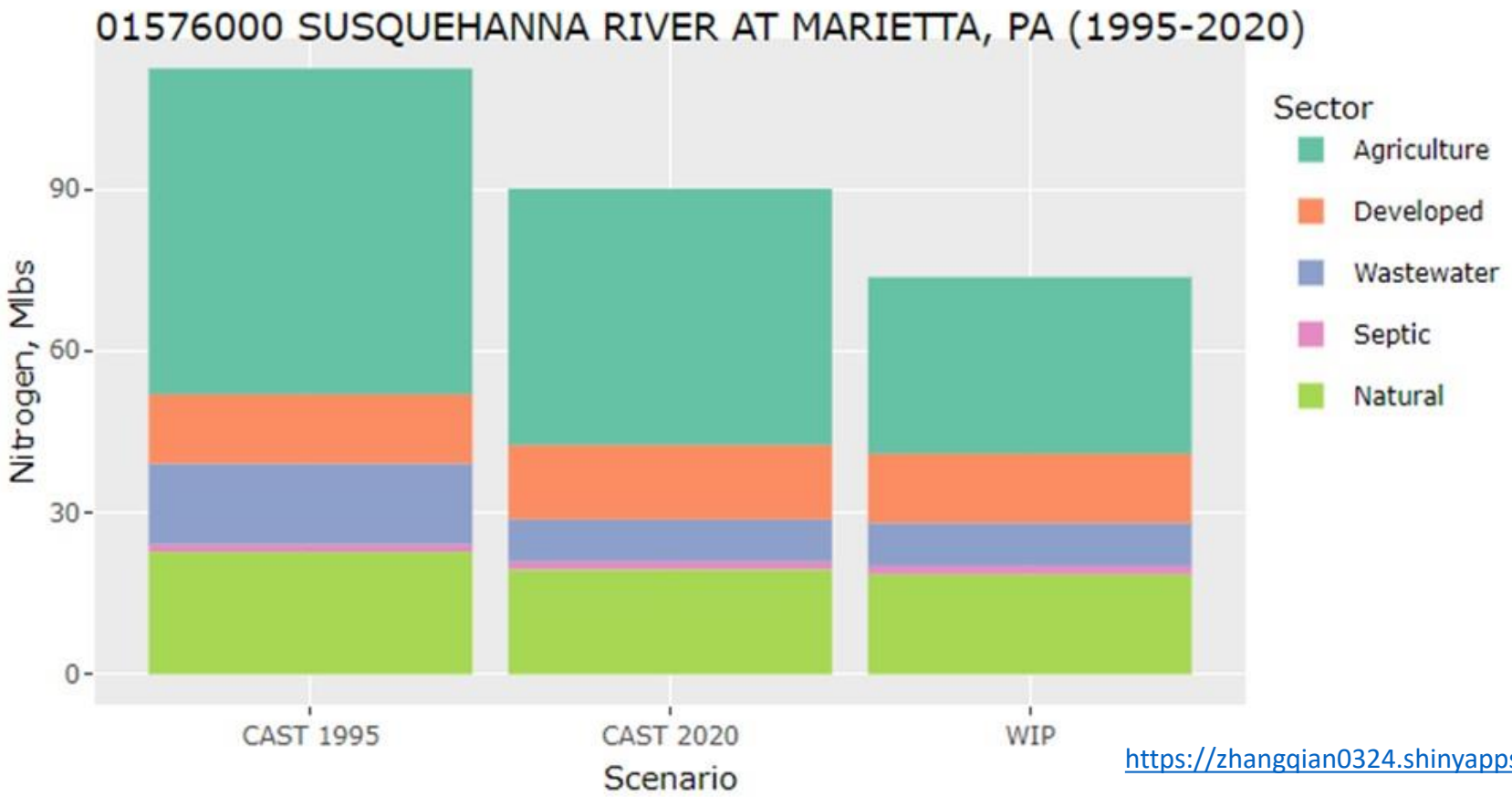
1. Overall reduction - comparing the baseline year of 1995 with the WIP goal:
[Bar 1] A reduction of 34.5 percent is required to meet the WIP goal, as estimated by CAST.

2. Current progress - comparing the baseline year of 1995 with the current year of 2020:
[Bar 2]: A reduction of 19.9 percent is estimated by CAST; this is the eventual (long-term) trend under the 2020 conditions of sources, implementations, and land uses.
[Bar 3]: A reduction of 14.1 percent is estimated by CAST_DM; this is the expected trend with lags and other factors.
[Bar 4]: A reduction of 22.3 percent is estimated by WRTDS; this is the observed trend based on the monitoring data. The estimated 90% confidence interval for this trend is (-27.6%, -17.3%).

Station-level dashboard Product

About | Timeseries | WIP Goal | Progress | Download

Interactive Plot



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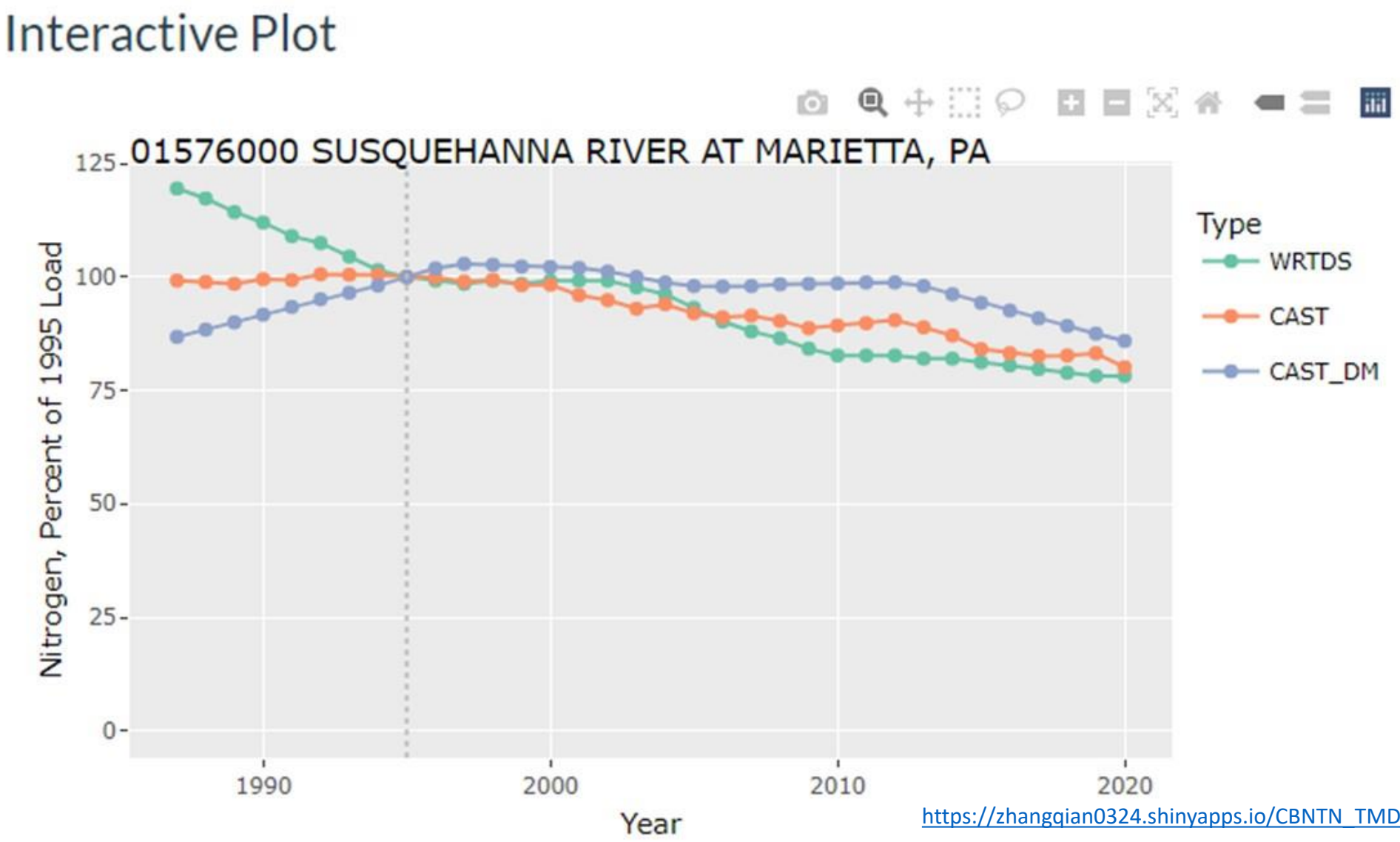
Station-level dashboard Product



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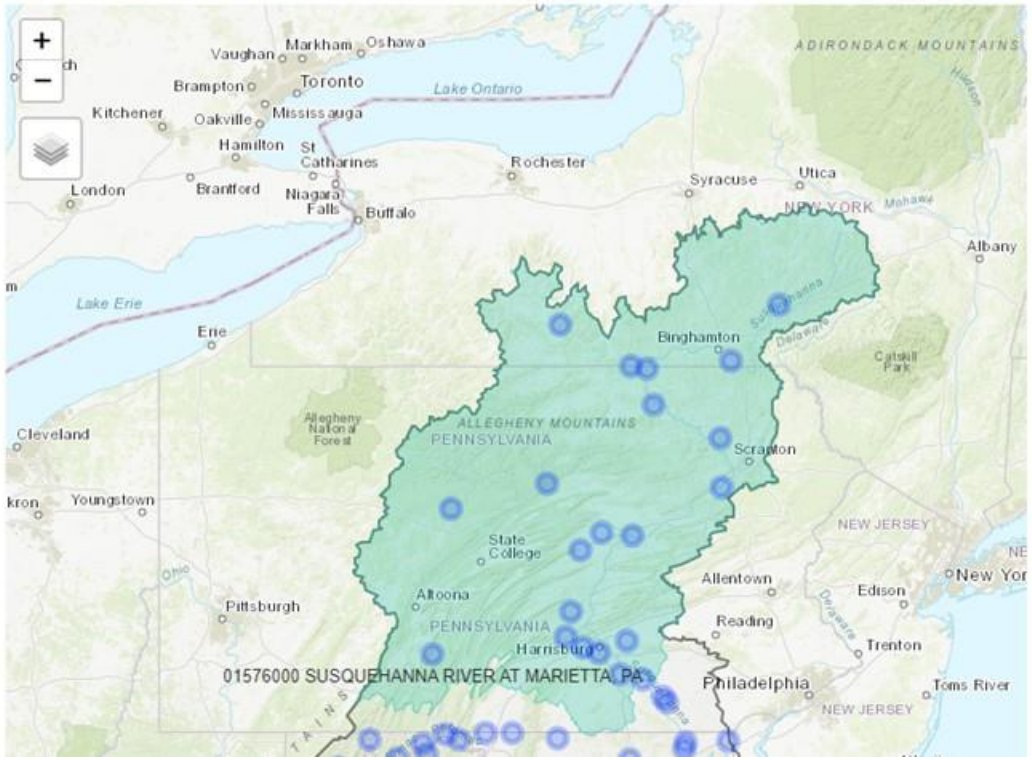
Map | Data Table

Tip: Move mouse cursor to any circle marker to show the station name.



About | Timeseries | WIP Goal | Progress | Download

Station

The selected station is SUSQUEHANNA RIVER AT MARIETTA, PA:
* USGS ID: 01576000
* Area (km^2): 67349.2
* Major Basin: Susquehanna
* Latitude: 40.054541
* Longitude: -76.530799

Data Availability

Total Nitrogen: 1987-2020.
Total Phosphorus: 1987-2020.
Suspended Sediment: 1987-2020.

Data Type

WRTDS: Monitored load - computed using the USGS WRTDS flow-normalization method (source).

CAST: Expected load in the long term - computed using the Chesapeake Bay Program Watershed Model (source).

CAST_DM: Expected load with lags - computed using the Chesapeake Bay Program Watershed Model (source).

Contact

Qian Zhang (UMCES @ CBPO).

Contributors

Qian Zhang (UMCES @ CBPO), Gopal Bhatt (PSU @ CBPO), Isabella Bertani (UMCES @ CBPO).

Version

Last updated on March 24, 2023.

https://zhangqian0324.shinyapps.io/CBNTN_TMDL_Indicator/

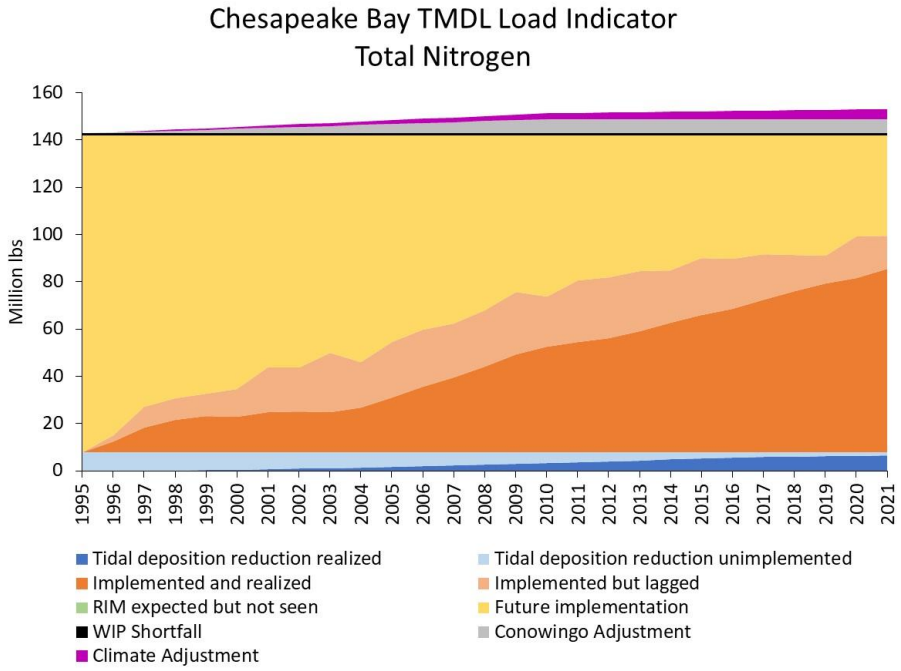
Partnership Vetting

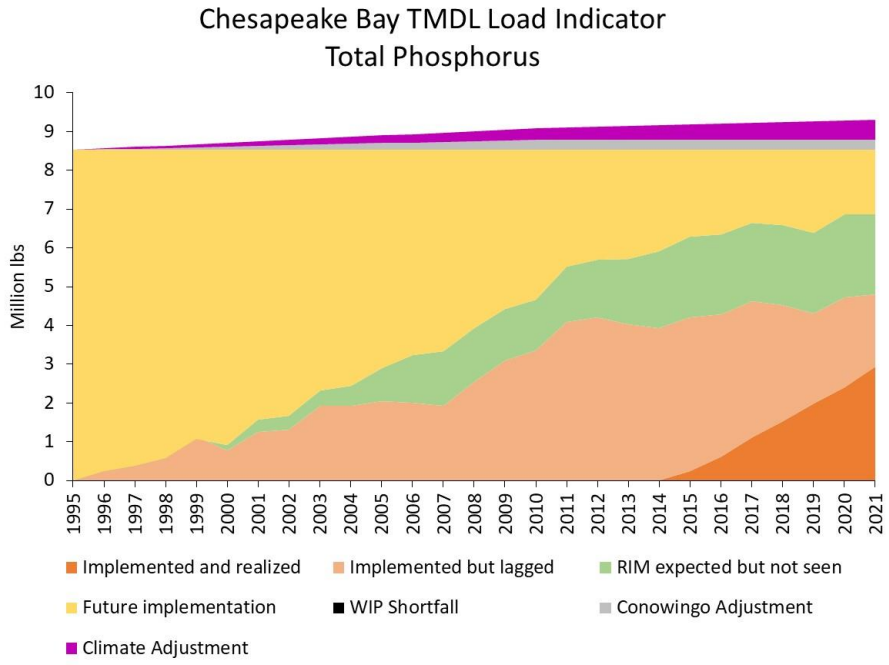
- 9/2021 CBPO discussions
- 7/2022 USGS-led Factors Affecting Trends Group
- 8/2022 Status and Trends Workgroup
- 10/2022 Watershed Technical Workgroup
- 11/2022 WQGIT
- 3/2023 Status and Trends Workgroup
- 3/2023 WQGIT - Approved

- Each meeting produced recommendations that strengthened the product.

Next Steps

- Begin working with the CBP web and communications teams





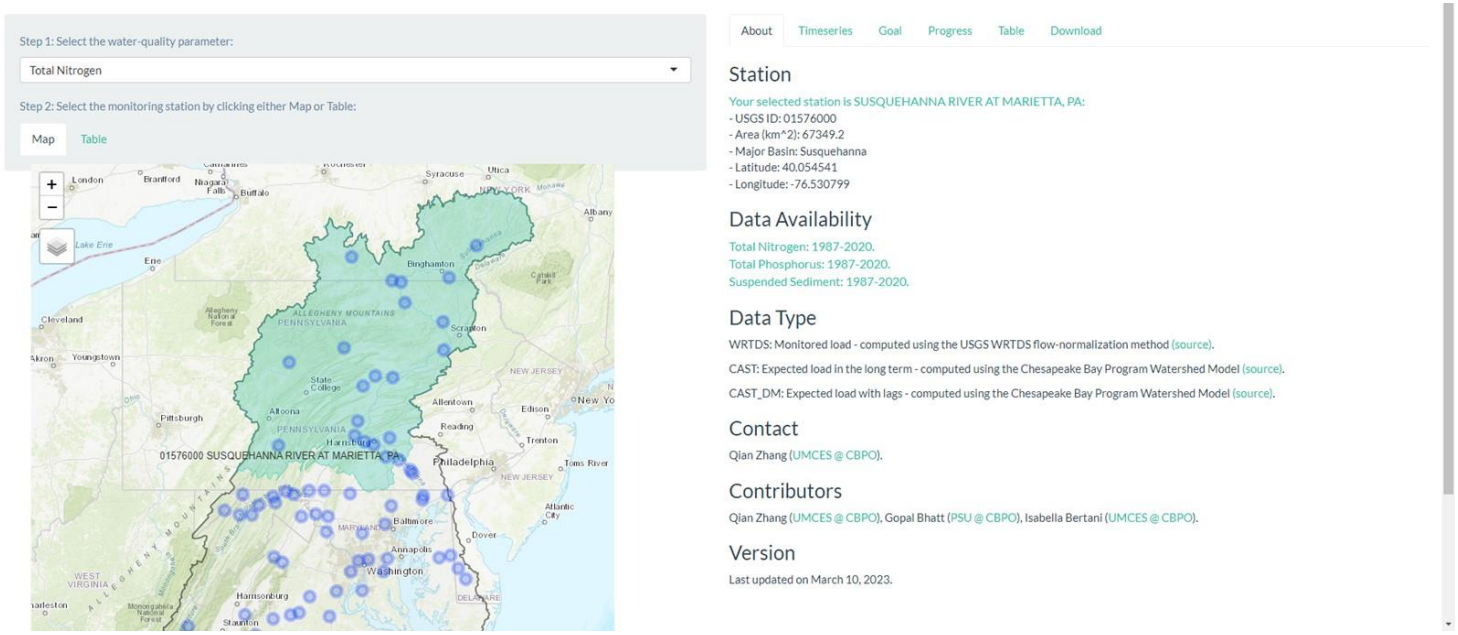
Next Steps

- Add the annual finer-category data to the nontidal data dashboard

	Nitrogen				Phosphorus			
Category	1995	2005	2015	2021	1995	2005	2015	2021
WIP Shortfall	0.92	6.58	10.25	11.25	-0.87	-0.50	-0.21	-0.09
WIP Shortfall	0.92	0.92	0.92	0.92	-0.87	-0.87	-0.87	-0.87
Conowingo Adjustment	0.00	4.00	6.01	6.01	0.00	0.17	0.26	0.26
Climate Adjustment	0.00	1.66	3.32	4.32	0.00	0.20	0.40	0.52
RIM Unimplemented	68.30	43.75	26.73	26.65	6.33	4.28	2.18	1.77
RIM Unimplemented Conowingo	6.67	6.67	6.67	6.67	0.14	0.14	0.14	0.14
RIM expected but not seen	0.00	0.00	0.00	0.00	0.00	1.77	2.09	2.07
RIM Lagged	0.00	17.94	21.39	16.87	0.00	2.29	3.58	2.40
RIM Conowingo Conversion	0.00	8.81	11.81	11.26	0.00	1.86	2.95	2.30
RIM Monitored	0.00	-2.20	8.38	13.53	0.00	-3.88	-4.48	-2.21
Below-RIM PS Implemented	0.00	17.56	30.04	37.19	0.00	0.32	1.25	1.38
Below-RIM PS Unimplemented	37.41	19.85	7.38	0.22	1.57	1.25	0.32	0.19
Below-RIM Estimated	0.00	-1.11	7.85	15.67	0.00	0.79	0.52	1.48
Below-RIM Lagged	0.00	5.60	2.71	-2.95	0.00	-0.25	0.38	-0.55
Below-RIM Unimplemented	21.44	16.96	10.88	8.72	1.36	0.82	0.46	0.43
Tidal Deposition Reduction Realized	0.00	1.68	5.18	6.50				
Tidal Deposition Reduction Unimplemented	7.92	6.24	2.74	1.42				

Next Steps

- Add the station-level app to the dashboard



Conowingo effect

2017/2018 Presentations to WQGIT, MB, and PSC

Estimated Loads to the Bay with Conowingo Dam and Reservoir at Infill Conditions

Additional Nitrogen Load: 13 million pounds

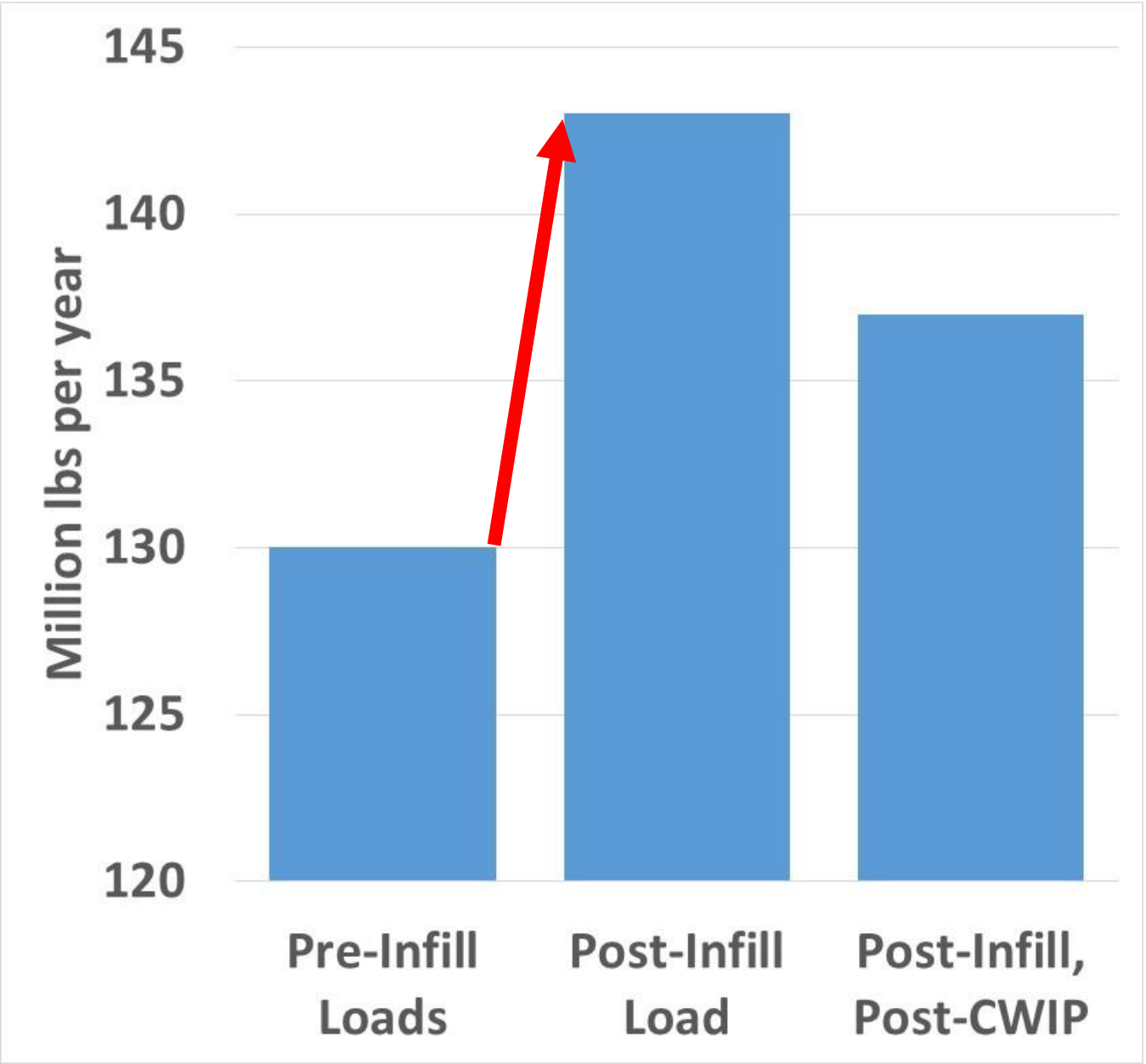
+

Additional Phosphorus Load: 1.8 million pounds

↓

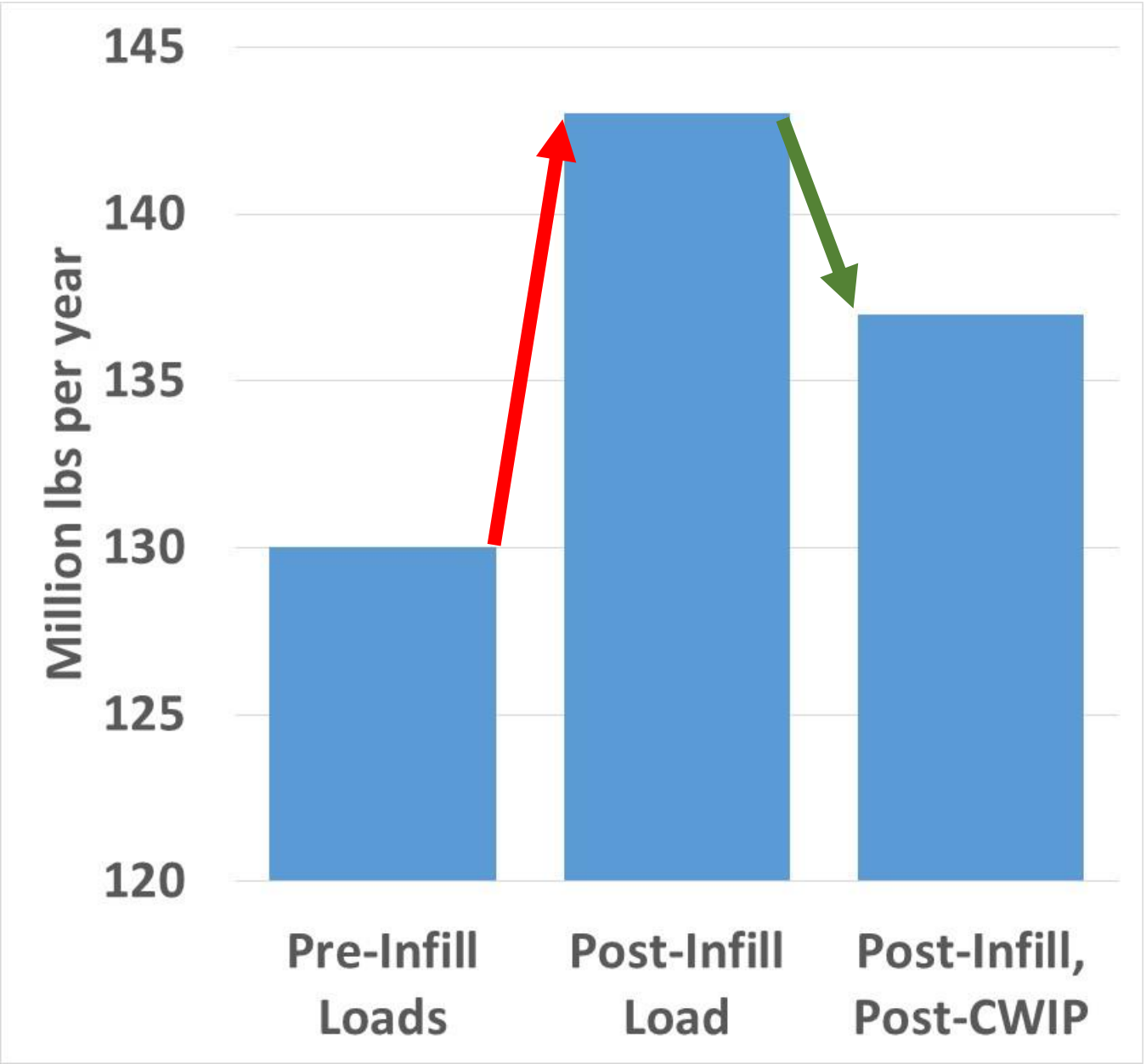
HOWEVER: These are less bioavailable nutrients and its delivery to Bay is dependent on large storm events. Reduction equivalent to 6 million pounds of Nitrogen and 0.26 million pounds of Phosphorus

Conowingo infill raises the assimilative capacity



All else being equal, Conowingo raised loads by 13 million (mostly organic and non-summer) lbs

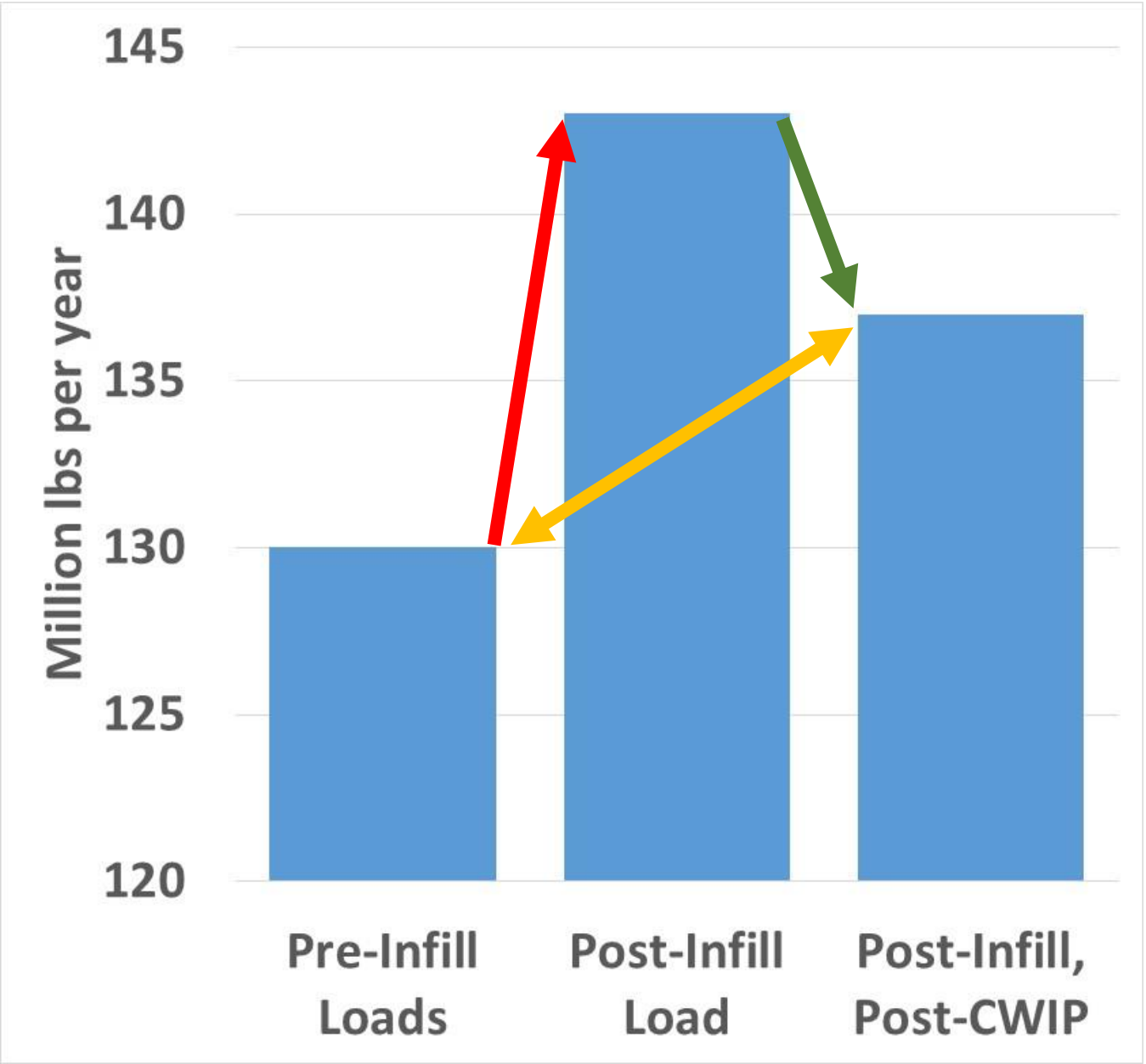
Conowingo infill raises the assimilative capacity



All else being equal, Conowingo raised loads by 13 million (mostly organic and non-summer) lbs

The infill effect can be removed by a watershed reduction of 6 million (more inorganic and summer) lbs

Conowingo infill raises the assimilative capacity



All else being equal, Conowingo raised loads by 13 million (mostly organic and non-summer) lbs

The infill effect can be removed by a watershed reduction of 6 million (more inorganic and summer) lbs

The TMDL water quality is equivalent at 130 pre-infill and 137 post-infill

The water quality change "Seen" by the Bay is greater than the monitoring results by 7 million pounds because of the infill effect