Chesapeake Bay 2017 Midpoint Assessment: Incorporating Climate Change into the Phase 3 WPA

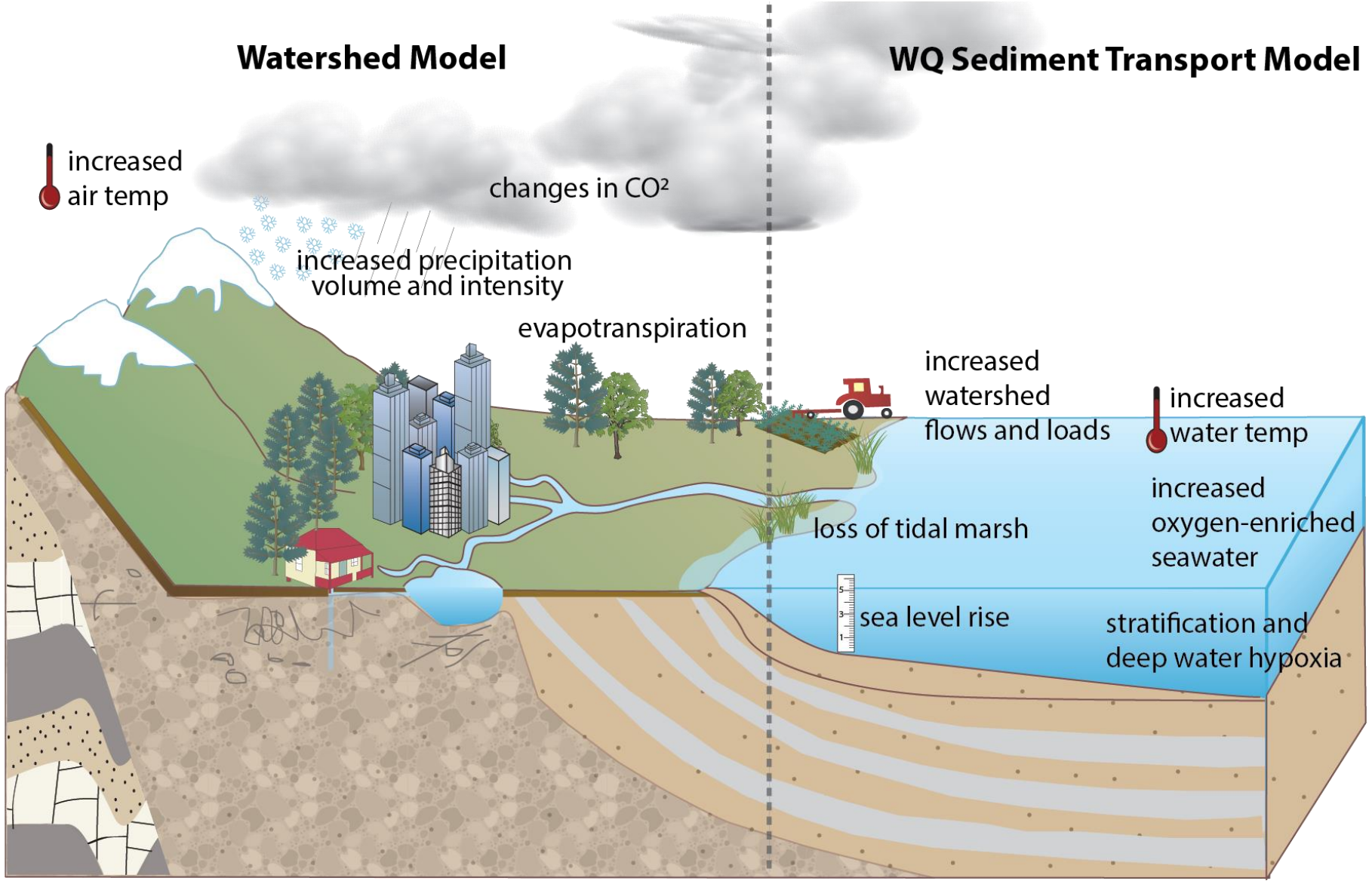
Water Quality Goal Implementation Team Meeting
December 4-5, 2017

Accounting for the Changing Conditions

- The Climate Resiliency Workgroup and the Modeling Workgroup have been working with the Partnership's Scientific and Technical Advisory Committee to account for changing conditions occurring in the watershed and the Bay's tidal waters in a scientifically defensible manner

- The Water Quality Goal Implementation Team recommends that the Partnership take into account the cumulative responses of climate change (watershed and estuary) and not view impacts separately or in isolation

Accounting for Changing Conditions



Impact of Changing Conditions on Bay and Watershed Increase Through Time

- Based on STAC guidance[1], the Partnership is using projections for 2025 that have a high level of confidence
  - Selection of projections for sea level rise and precipitation change were based on past records of observed climatic and resultant river flow conditions.
  - There is less uncertainty in downscaled temperature projections for 2025.
- According to the National Climate Assessment[2], impacts associated with precipitation, temperature and sea level are all expected to increase beyond 2025

1. CBP Scientific and Technical Advisory Committee. 2016. The Development of Climate Projections for Use in Chesapeake Bay Program Assessments. March 2016 Workshop.
2. 4th National Climate Assessment (November 2017)

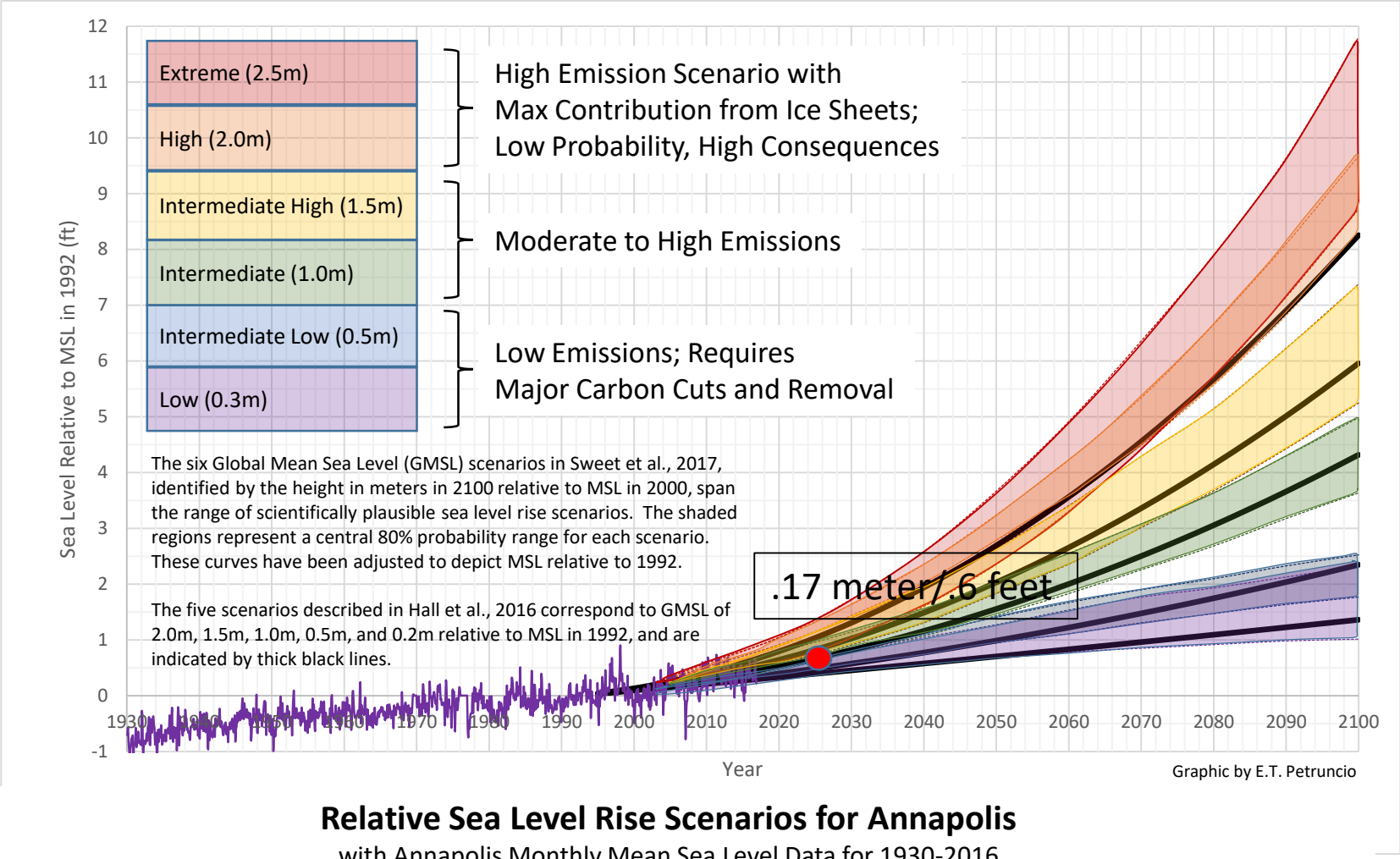
Impact of Changing Conditions on Bay and Watershed Increase Through Time

- "The Chesapeake Bay Watershed is already experiencing impacts associated with sea level rise (e.g., coastal storm impacts and nuisance flooding) as well as heavy precipitation events[1]"

- "Heavy precipitation events in most parts of the United States have increased in both intensity and frequency since 1901 (high confidence). There are important regional differences in trends, with the largest increases occurring in the northeastern United States (high confidence).[2]"

1. CBP Scientific and Technical Advisory Committee. 2016. The Development of Climate Projections for Use in Chesapeake Bay Program Assessments. March 2016 Workshop.
2. 4th National Climate Assessment (November 2017)

Relative Sea Level Rise



Relative Sea Level Rise Scenarios for Annapolis
with Annapolis Monthly Mean Sea Level Data for 1930-2016

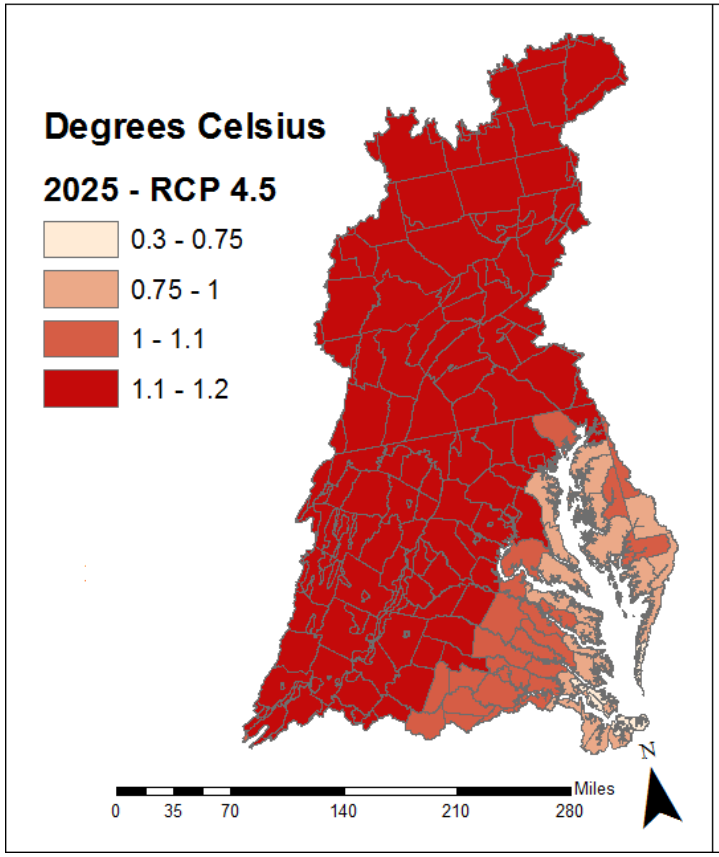
CBP Climate Resiliency Workgroup recommended 2025 projection: .17 meter/.6 feet

Sources: Hall et al. (2016) and Sweet et al. (2017)

Temperature Change

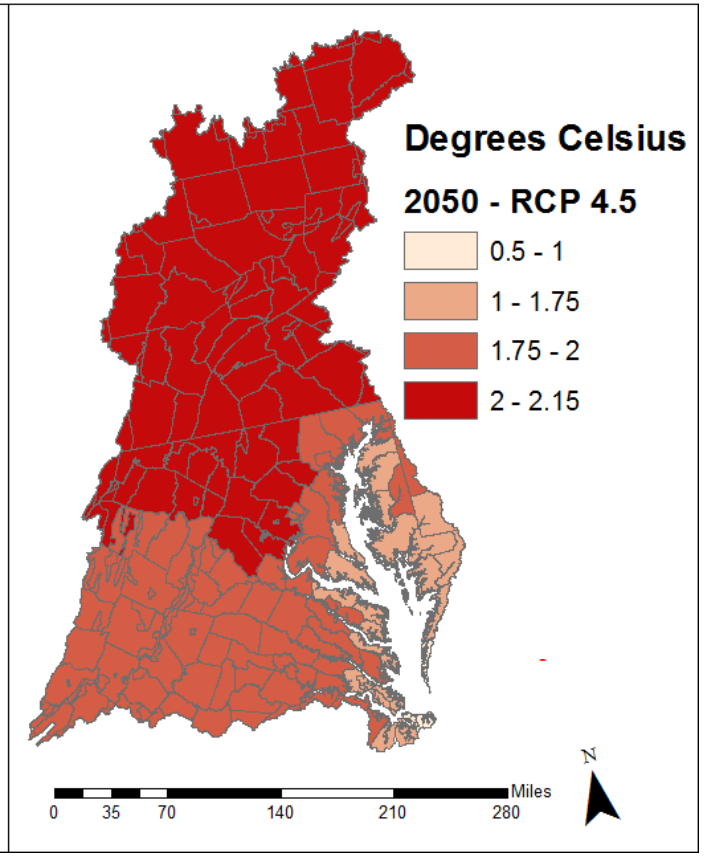
2025/2050 STAC Recommended Projections

1995-2025



1.98° F / 1.1° C Increase in Average Annual Temp

1995-2050

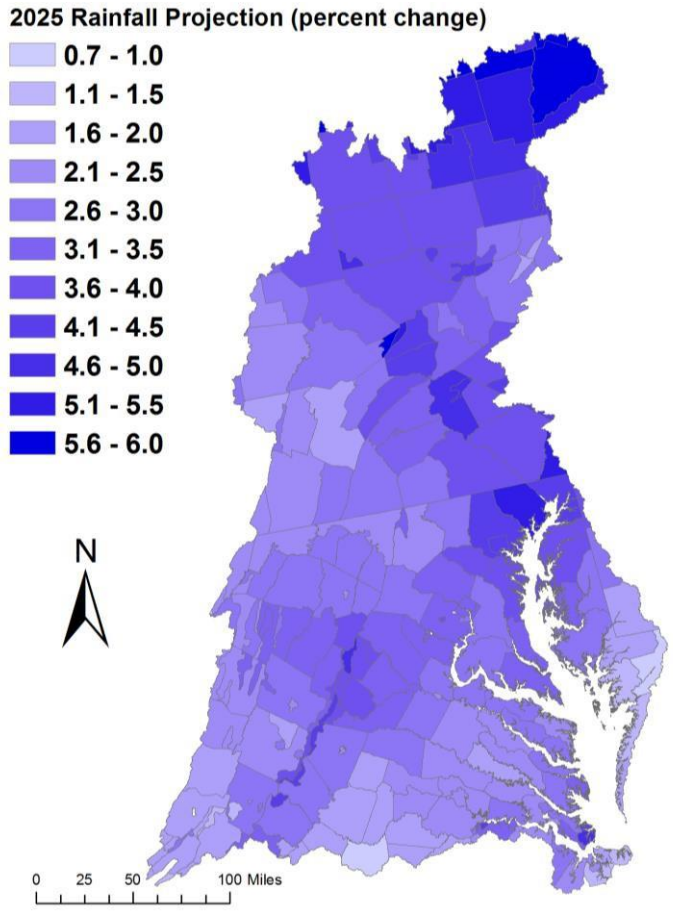


3.5° F / 1.94° C Increase in Average Annual Temp

Source: Kyle Hinson, CRC/CBPO

Precipitation Change

2025 STAC Recommended Projection: Trends in 88-years of annual PRISM[1] data



Change in Rainfall Volume
2021-2030 vs. 1991-2000

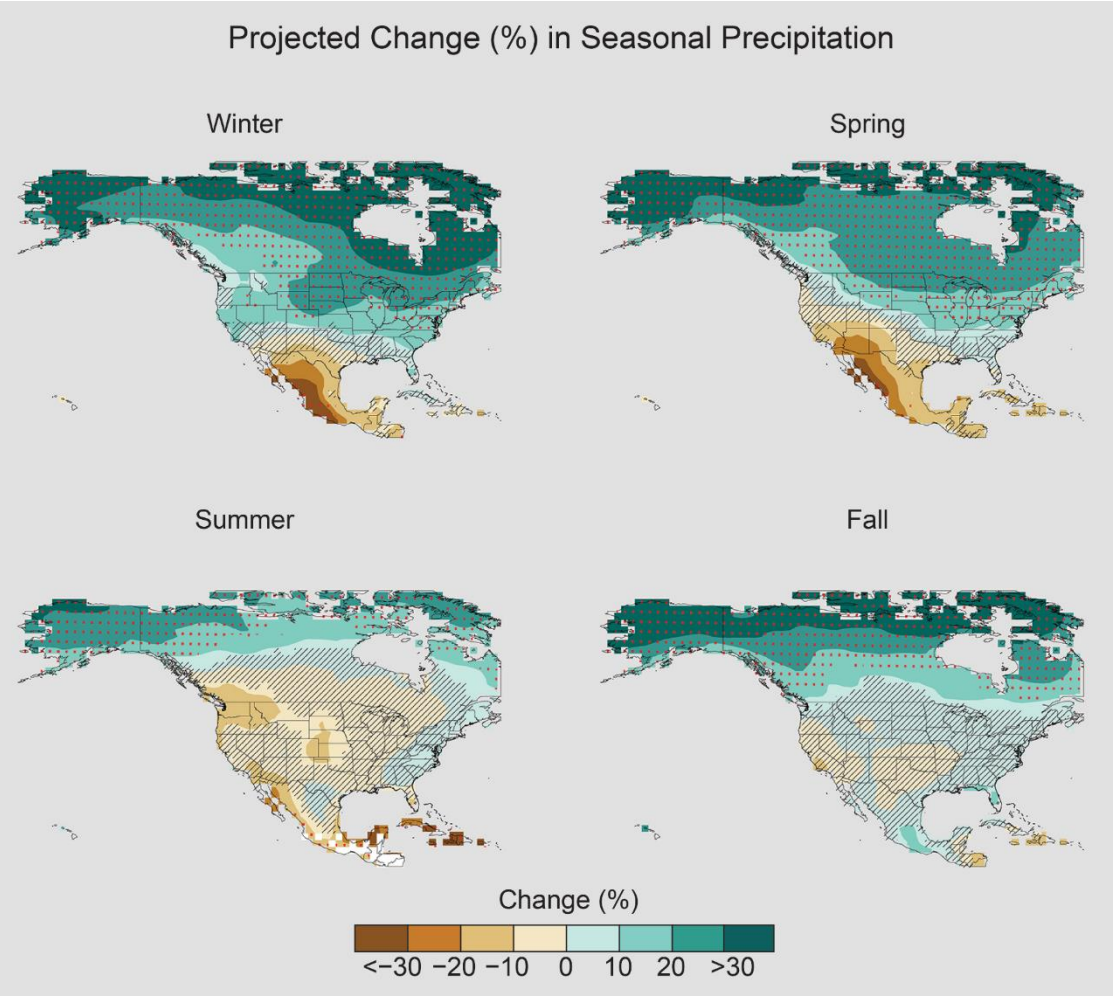
Major Basins	PRISM Trend
Youghiogheny River	2.1%
Patuxent River Basin	3.3%
Western Shore	4.1%
Rappahannock River Basin	3.2%
York River Basin	2.6%
Eastern Shore	2.5%
James River Basin	2.2%
Potomac River Basin	2.8%
Susquehanna River Basin	3.7%
Chesapeake Bay Watershed	**3.1%**

Source: Kyle Hinson, CRC/CBPO

[1] Parameter-elevation Relationships on Independent Slopes Model

Precipitation Change

4th NCA Future Seasonal Patterns (2070 – 2099)



Projected change (%) in total seasonal precipitation from CMIP5 simulations for 2070–2099. The values are weighted multimodel means and expressed as the percent change relative to the 1976–2005 average. These are results for the higher scenario (RCP8.5).

Source: NOAA NCEI (NCA 2017)

Accounting for Changing Conditions

Cumulative Assessment of Bay Low Dissolved Oxygen Impacts

Watershed Model

increased precipitation volume =

increased precipitation intensity =

increase in temp and evapotranspiration =

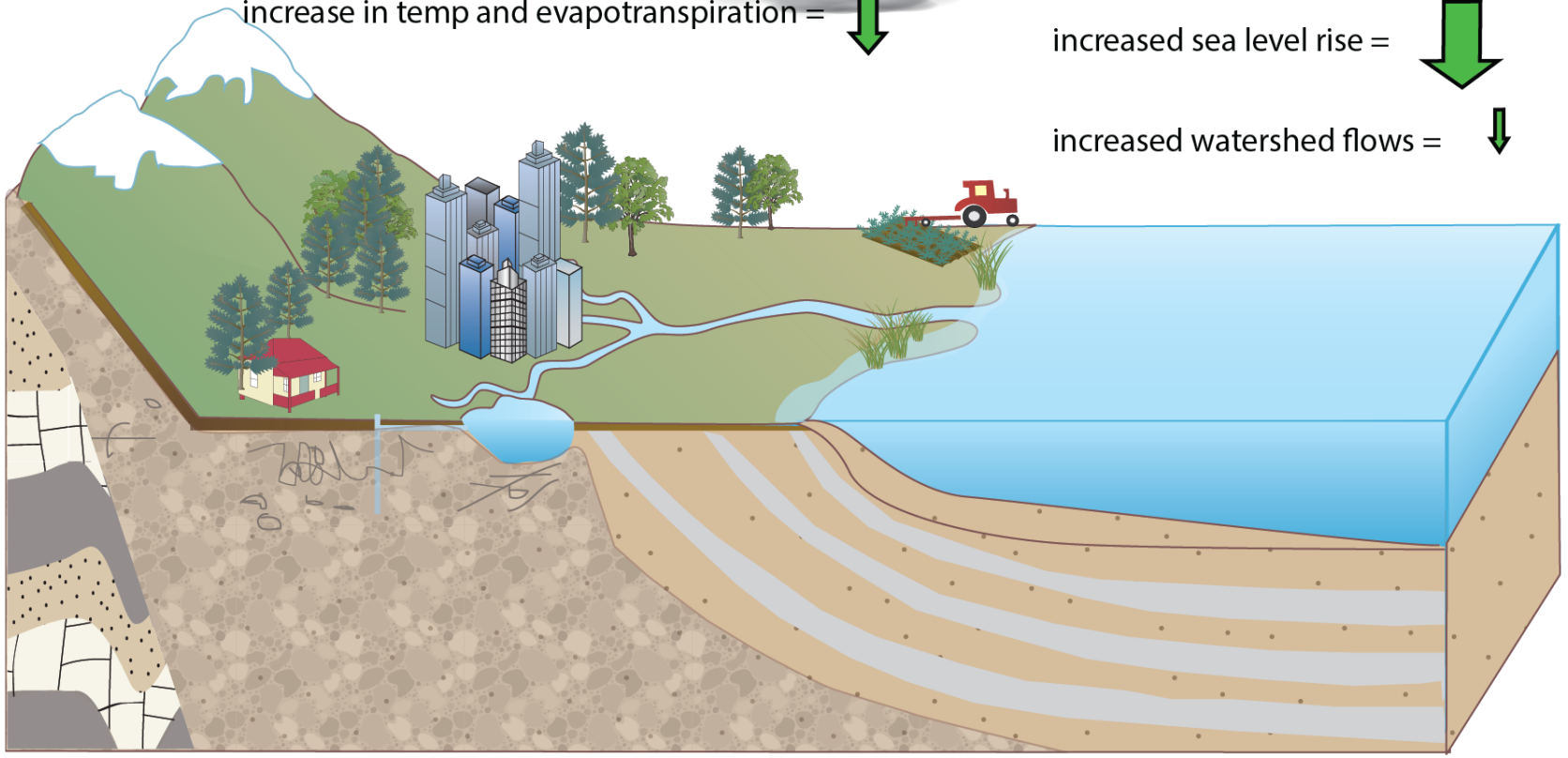
WQ Sediment Transport Model

increased watershed loads =

increased temperature =

increased sea level rise =

increased watershed flows =



Bay Water Quality Responses to 2025 Climate Change Conditions

Changes in estimated 2025 dissolved oxygen criteria attainment for Deep Channel, Deep Water, and Open Water due to observed temperature and precipitation changes since 1991-2000 (years of average Bay hydrology).

Run 223		WIP2	WIP2 + Cono Infill	WIP2 + Cono Infill + CC
11/30/17		195TN	208TN	210TN
		13.7TP	15.4TP	15.3TP
CAST Loads		1993-1995	1993-1995	1993-1995
		Deep	Deep	Deep
Cbseg	State	Channel	Channel	Channel
CB3MH	MD		0%	0%
CB4MH	MD	6%	8%	10%
CB5MH	MD	0%	0%	0%
CB5MH	VA	0%	0%	0%
POTMH	MD	0%	0%	0%
RPPMH	VA	0%	0%	0%
ELIPH	VA	0%	0%	0%
CHSMH	MD	0%	0%	4%
EASMH	MD	6%	7%	8%

Deep Channel nonattainment increases by 2% in CB4MH

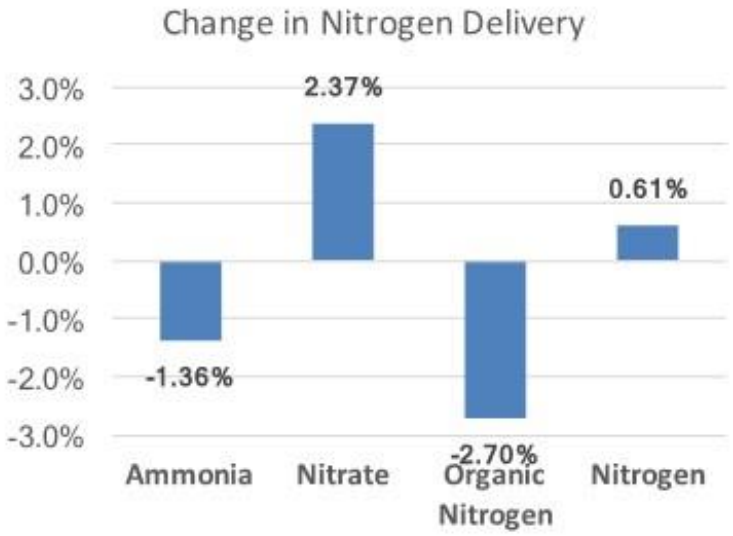
Run 223		WIP2	WIP2 + Cono Infill	WIP2 + Cono Infill + CC
11/30/17		195TN	208TN	210TN
		13.7TP	15.4TP	15.3TP
CAST Loads		1993-1995	1993-1995	1993-1995
Cbseg	State	Deep Water	Deep Water	Deep Water
CB4MH	MD	5%	6%	7%
CB5MH	MD	1%	1%	2%
CB5MH	VA	0%	0%	0%
CB6PH	VA	0%	0%	0%
CB7PH	VA	0%	0%	0%
PATMH	MD	1%	2%	3%
MAGMH	MD	1%	5%	5%
SOUMH	MD	3%	8%	7%
SEVMH	MD	0%	0%	0%
PAXMH	MD	0%	0%	0%
POTMH	MD	0%	0%	0%
RPPMH	VA	0%	0%	0%
YRKPH	VA	0%	0%	0%
ELIPH	VA	0%	0%	0%
CHSMH	MD	0%	0%	0%
EASMH	MD	0%	0%	0%

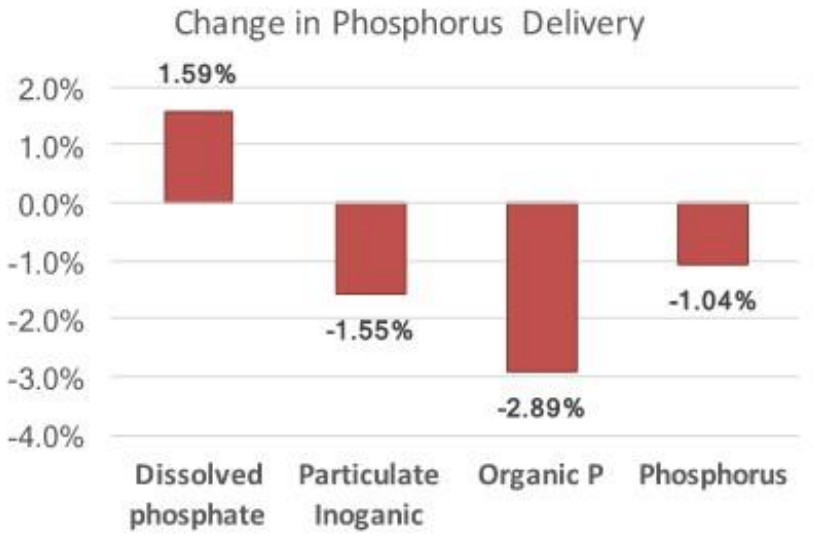
Deep Water nonattainment increases by 1% in CB5MH

Procedures for assessing Open Water attainment under climate change conditions are being developed.

Estimated Changes in Watershed and Bay Loads by 2025 Due to Climate Change

- Inorganic nutrients are increased with climate change
- Organic nutrients are decreased
- Inorganic nutrients have a higher effect on dissolved oxygen



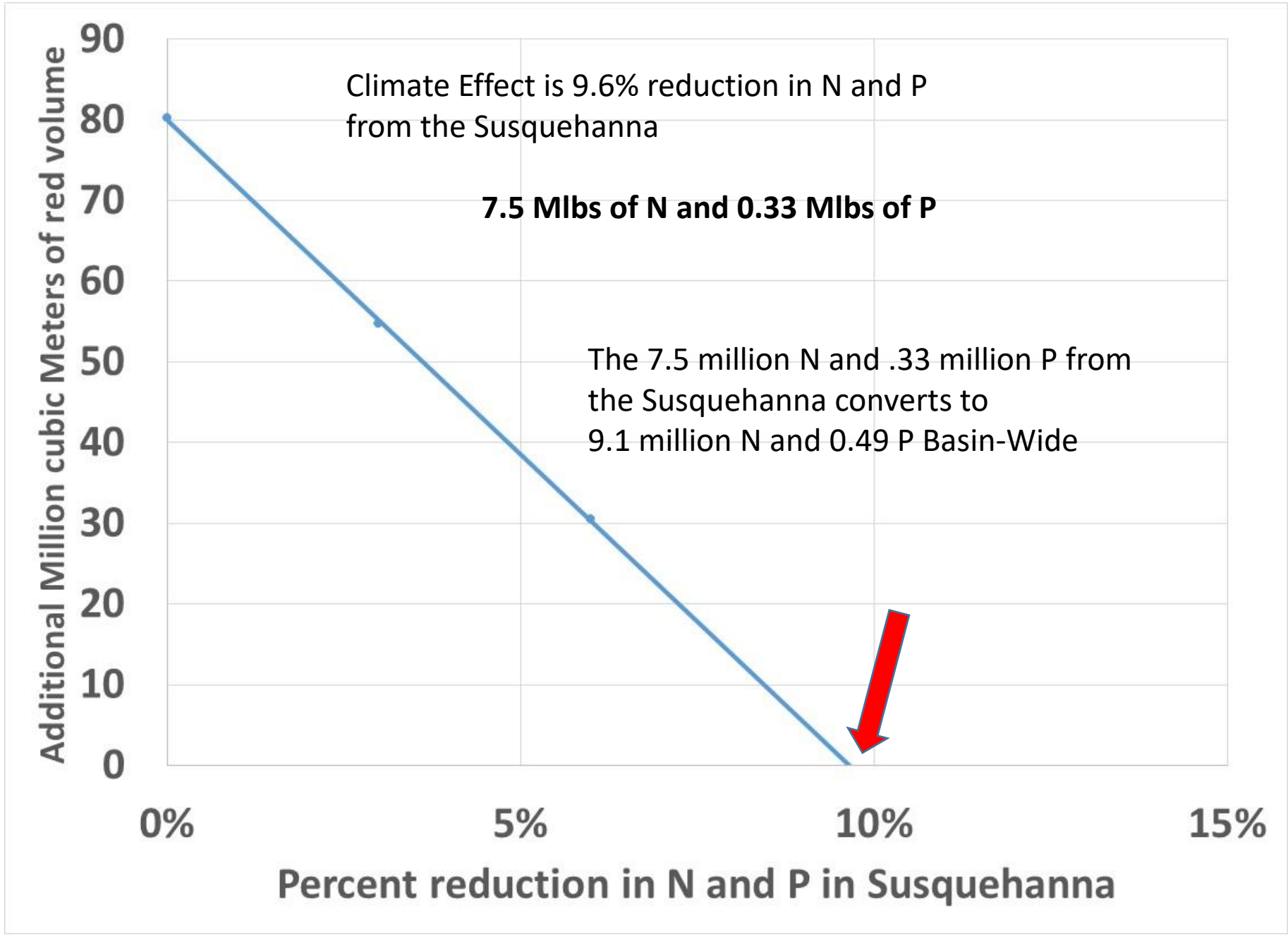


Calculate Climate Effect

CB Seg	Designated Use	Designated Use Total Volume	Red Percent WIP + Conow	Red Volume WIP + Conow	Red Percent WIP + Conow + CC	Red Volume WIP + Conow + CC
CB3MH	DW	864	0.05%	0	0.05%	0
CB4MH	DW	2854	5.52%	158	6.50%	186
MD5MH	DW	2097	1.09%	23	1.51%	32
VA5MH	DW	1605	0.00%	0	0.00%	0
POMMH	DW	1839	0.00%	0	0.00%	0
CB3MH	DC	390	0.00%	0	0.00%	0
CB4MH	DC	2126	8.04%	171	10.09%	215
MD5MH	DC	2875	0.00%	0	0.00%	0
VA5MH	DC	1848	0.00%	0	0.00%	0
				352		432
					CC Difference	**80**

Volume Weighted means a ‘red area’ increase of 80 million cubic meters

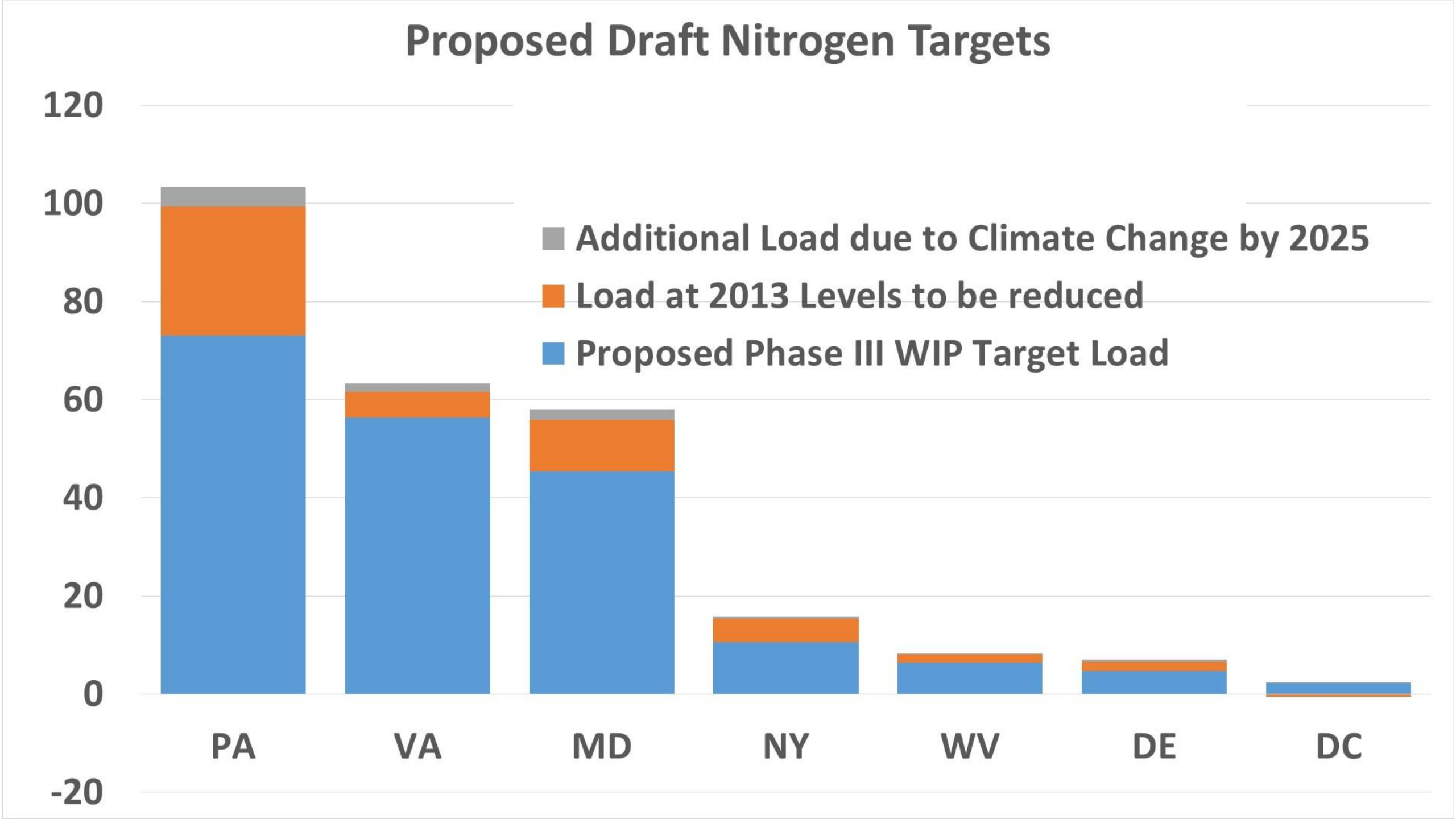
Ran Scenarios with 3% and 6% reduction in Susquehanna N and P



Climate Change Loads: Nitrogen

Jurisdiction	1985 Baseline	2013 Progress	Climate Change	Growth in Load to 2025	Conowingo Load Responsibility	2013 Progress +	Phase III Planning Target
NY	18.71	15.44	0.400			15.84	10.62
PA	122.41	99.28	4.135			103.41	72.99
MD	83.56	55.89	2.194			58.09	45.39
WV	8.73	8.06	0.236			8.30	6.36
DC	6.48	1.75	0.006			1.76	2.25
DE	6.97	6.59	0.397			6.98	4.66
VA	84.29	61.53	1.722			63.25	56.37
BasinWide	331.15	248.54	9.09			257.63	198.64

*Units: millions of pounds


Proposed Draft Nitrogen Targets
120
100
80
60
40
20
0
-20
Additional Load due to Climate Change by 2025
Load at 2013 Levels to be reduced
Proposed Phase III WIP Target Load
PA
VA
MD
NY
WV
DE
DC

Policy Options for Accounting for Climate Change in the Jurisdictions' Phase III WIPs

Mark Bennett, USGS, CBP Climate Resiliency Workgroup Co-Chair

Two Policy Approaches

Numeric

and/or

Programmatic

Numerical Approach

- A quantitative, numerical approach will result in a very small changed level of effort necessary to meet water quality standards
- Account for the increased pollutant loads to each jurisdiction's portion of the Bay watershed
- Accounts for feedbacks to the Bay's assimilative capacity
- This approach would treat the estimated cumulative effect of changed conditions due to climate change similarly to the approach being taken to account for growth
- Jurisdictions would develop Phase III WIPs which account for the estimated increased pollutant loads

Numerical Approach: Pros & Cons

Pros	Cons
• Comprehensive, straight-forward approach • Demonstrates Partnership's commitment to Chesapeake Bay Agreement Climate Resiliency Goal • Small level of increased effort necessary • Near-term response • Implemented in sequence with development of Phase III WIPs	• Potential change in the level of effort required to meet water quality standards • If implemented in isolation (w/o the programmatic approach), would not address the anticipated impacts of climate change on BMPs

Programmatic Approach

- An “adaptive management approach” that would be implemented through the two-year milestone process
- Would not change a jurisdictions' planning targets
- Directs the Partnership to collect and consider new information on the performance of BMPs, including the contribution of seasonal, inter-annual climate variability, and weather extremes.
    - Jurisdictions would assess this information and adjust plans, over-time, to better mitigate anticipated changes in loads and impacts on the performance of BMPs.
- Would require the inclusion of a narrative strategy in Phase III WIPs, describing a jurisdictions’ programmatic commitments to address climate change.
    - A sample “*narrative strategy*” would be provided to jurisdictions to guide implementation.

Programmatic Approach: Pros & Cons

Pros	Cons
• Adaptively managing for long-term change • Allows for use of local expertise and knowledge • Provides for learning across jurisdictions about methods and results • Allows for flexibility in jurisdictions' approaches to addressing climate change • Provides standard elements to be addressed	• If implemented in isolation (w/o numeric approach), delays substantive action to address climate change in the near-term • Lack of specific technical understanding to guide implementation • Requires additional monitoring and assessment efforts • Inconsistency in implementation across jurisdictions

Requested WQGIT Policy Recommendation

- Recommend a numerical and/or programmatic approach to guide jurisdictions' development and implementation of Phase III Watershed Implementation Plans.

- Recommend the level of flexibility among jurisdictions, as well as commitments for CBP programmatic support (e.g., guidance, data, funding, etc.), for implementation of climate change policies that exceed the Partnership approved policy.

WQGIT Recommendations to the PSC

Accounting for Changed Conditions: Climate Change

PSC-Approved Guiding Principles
WIP Development

- **Capitalize on "Co-benefits"** – maximize BMP selection to increase climate resiliency
- **Account for and integrate planning and consideration of existing stressors** – consider existing stressors in establishing reduction targets or BMP selection
- **Align with existing climate resilient plans and strategies** – document jurisdictions' action plans and strategies to address climate change
- **Manage for risk and plan for uncertainty** – employ risk management and flexible implementation strategies to achieve and maintain water quality standards
- **Engage Local Agencies and Leaders** – work cooperatively with local partners to provide best available data on local impacts

PSC Approved Guiding Principles
WIP Implementation

- **Reduce vulnerability** – use “Climate Smart” principles to site and design BMPs

- **Build in flexibility and adaptability** – allow for adjustments in BMP implementation to consider potential uncertainties and response options

- **Adaptive manage** – allow for changes in BMP selection or WIP implementation over-time

WQGIT Recommendations to the PSC

Adopt a dual approach to factor climate change into the Phase III WIPs

1. **Adopt a programmatic approach to address climate change**
   - Include a narrative strategy in the Phase III WIPs that describes the jurisdictions' current action plans and strategies to address climate change, as well as the jurisdiction-specific nutrient pollutant loadings due to 2025 climate change conditions (derived using the planning targets methodology)
   - Incorporate local priorities (e.g., flooding) and actions to address climate change impacts
   - Document the current understanding of the science and identify the research gaps and needs, and what we hope to learn over time given the current state of uncertainty (e.g., a better understanding of the BMP responses, including new or other emerging BMPs, to climate change conditions)
   - Identify a date by which the Partnership will provide additional science and information to help inform implementation efforts to address climate change (early 2021 to inform 2022-2023 milestones?)

WQGIT Recommendations to the PSC

Adopt a dual approach to factor climate change into the Phase III WIPs

2. **Document and communicate additional nutrient pollutant loads of up to 9 million pounds of nitrogen and 0.5 million pounds of phosphorus due to 2025 climate change conditions**
   - Continue to understand the nature and effect of climate change impacts in the watershed and estuary to inform management strategies (e.g., WIP/2-year milestones)
   - By [insert date], develop recommendations for new and/or refined methods and modeling techniques to better assess projected impacts on watershed loads and estuarine impacts for a range of future scenarios, including the methodology used to develop jurisdiction-specific nutrient pollutant loads due to 2025 climate change impacts
   - By [insert date], consider results of updated methods, techniques, and studies and revisit whether to explicitly account for those additional nutrient pollutant loads due to 2025 climate change conditions in the Phase III WIPs and/or 2-year milestones
   - Identify a date (post-2025) by which the Partnership will fully address the additional nutrient pollutant loads in a Phase III WIP addendum and/or 2-year milestones

WQGIT Recommendations to the PSC

Provide the jurisdictions with the **flexibility** to explicitly account for additional nutrient pollutant loadings due to 2025 climate change impacts in their Phase III WIPs and/or 2-year milestones **prior to the Partnership agreed-upon date**