

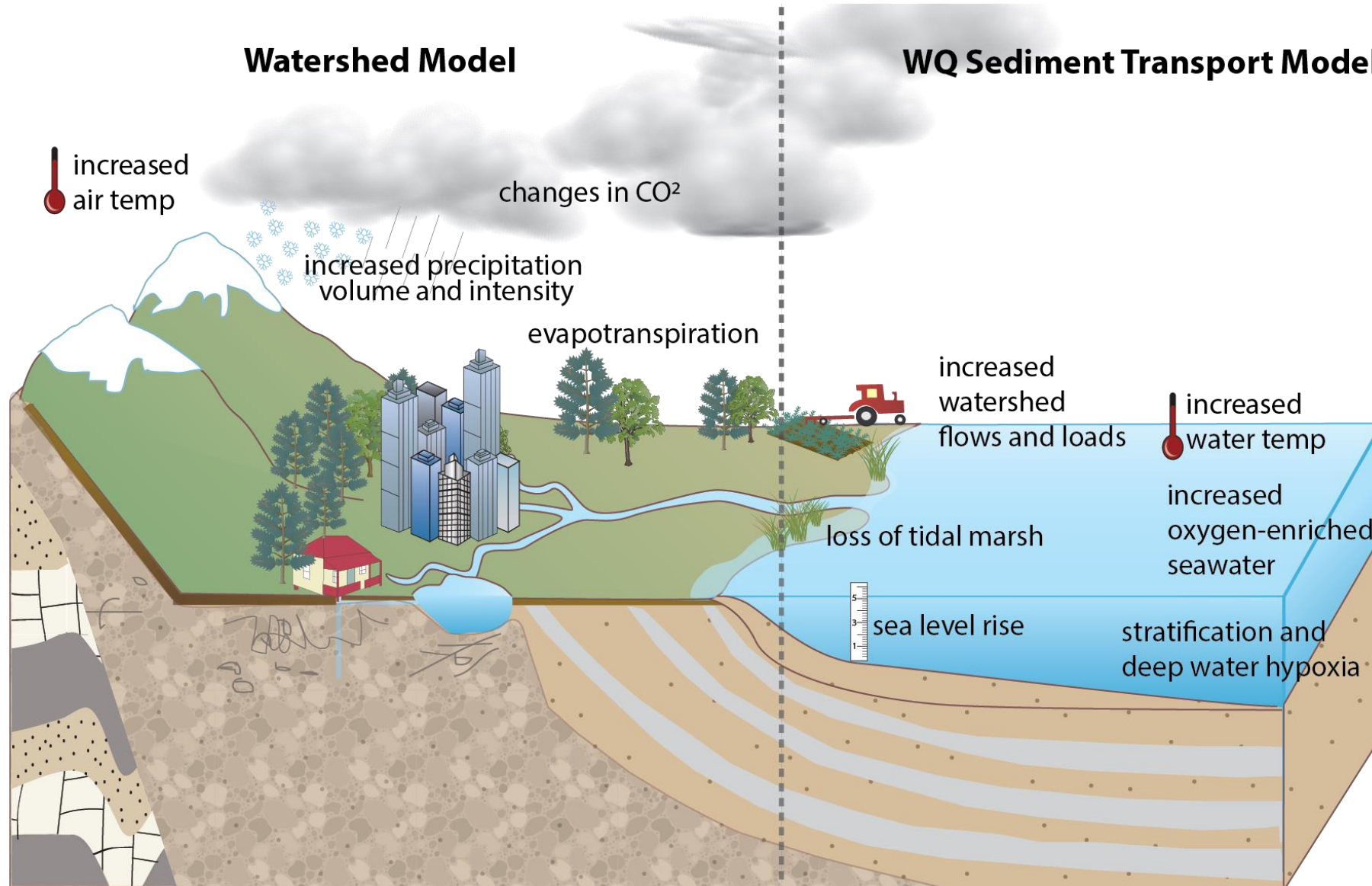


2025 Chesapeake Bay Climate Change Load Projections



**Mark Bennett, U.S. Geological Survey
CBP Climate Resiliency Workgroup Co-Chair
Chesapeake Bay Stakeholder Advisory Group
April 30, 2018**

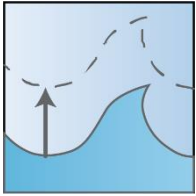


Accounting for Changing Conditions



To Limit Uncertainty

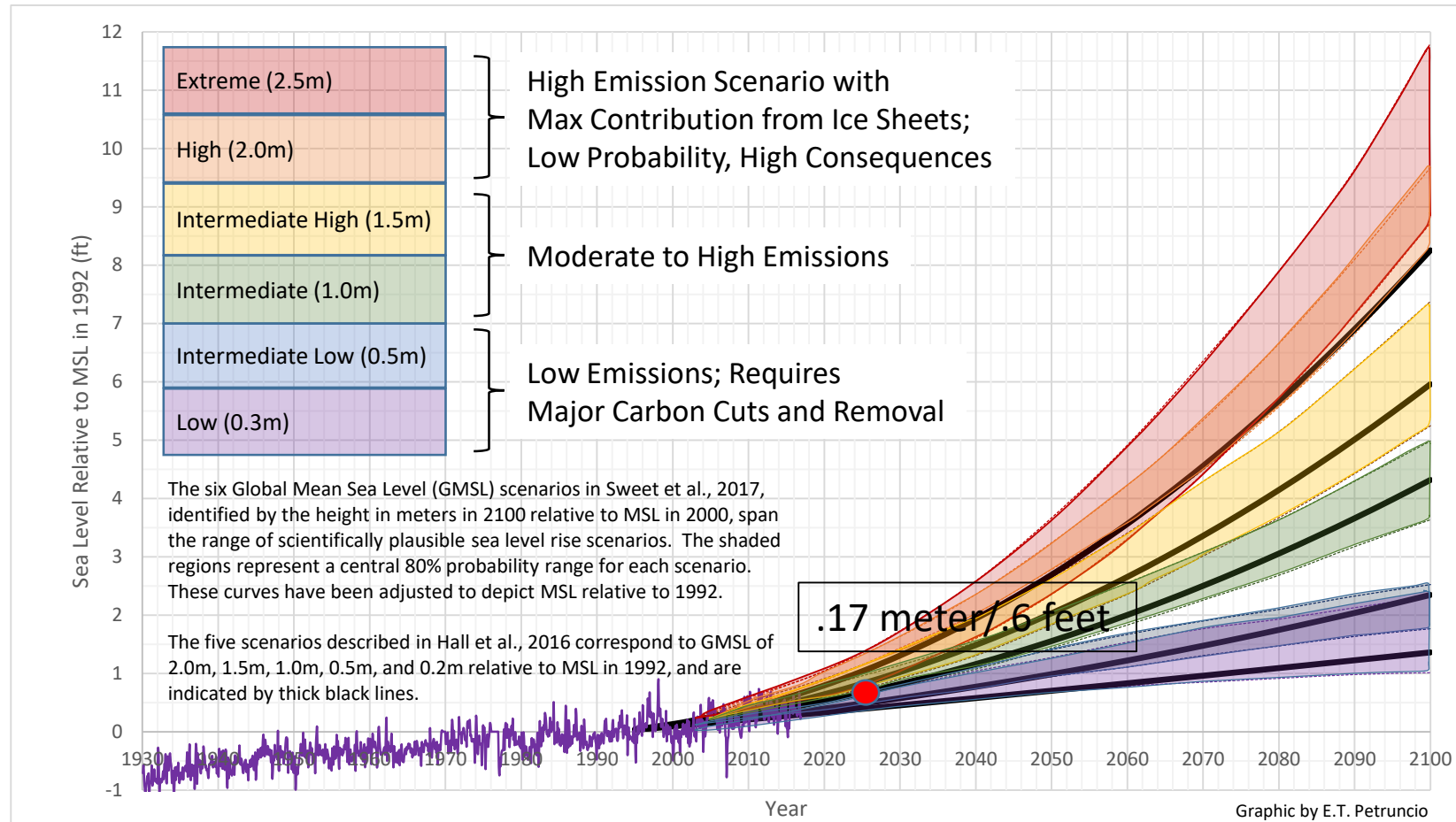
- The Partnership used STAC recommended projections for 2025 that have a high level of confidence¹
- Selection of projections for sea level rise and precipitation change were based on past records of observed climatic and resultant river flow conditions
- Downscaled temperature projections for 2025 are closely aligned with observed trends

Major Climate Variables: 2025 Projections

| | | |
|--|---------------------------|--|
|  <p>Relative Sea Level Rise</p> | 17 centimeters | Extrapolation of NOAA observed sea level trends (Swells Point, VA) |
|  <p>Temperature Increase</p> | 1.98° F / 1.1° C Increase | Downscaled climate projections (RCP 4.5) |
|  <p>Precipitation Change</p> | 3.1% Increase | Observed trends in 88-years of annual PRISM ^[1] data |

Relative Sea Level Rise

(2025 CRWG Recommended Projection: .17 meter/.6 feet)



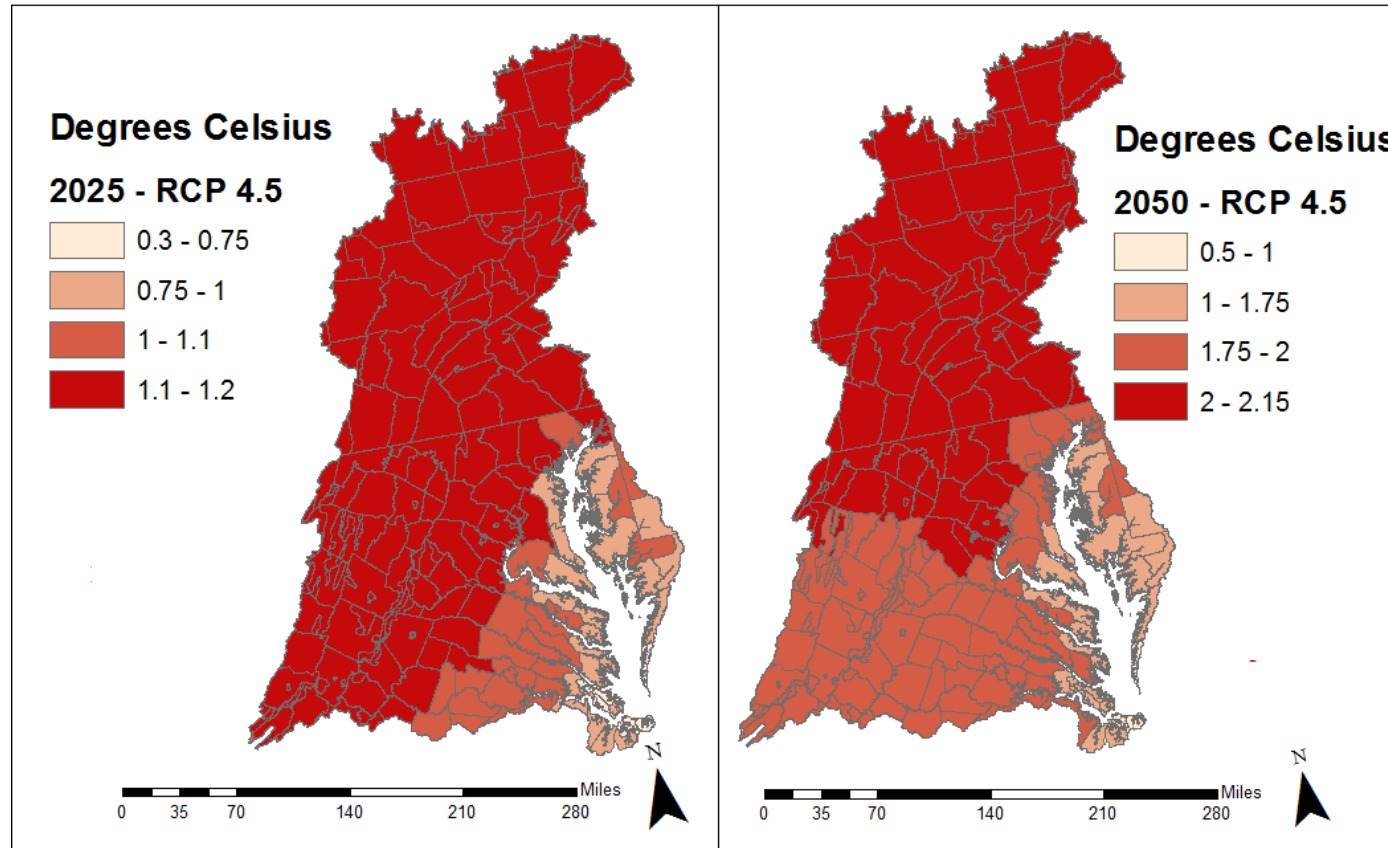
Relative Sea Level Rise Scenarios for Annapolis from Hall et al. (2016) and Sweet et al. (2017)
with Annapolis Monthly Mean Sea Level Data for 1930-2016

Temperature Change

2025/2050 STAC Recommended Projections

1995-2025

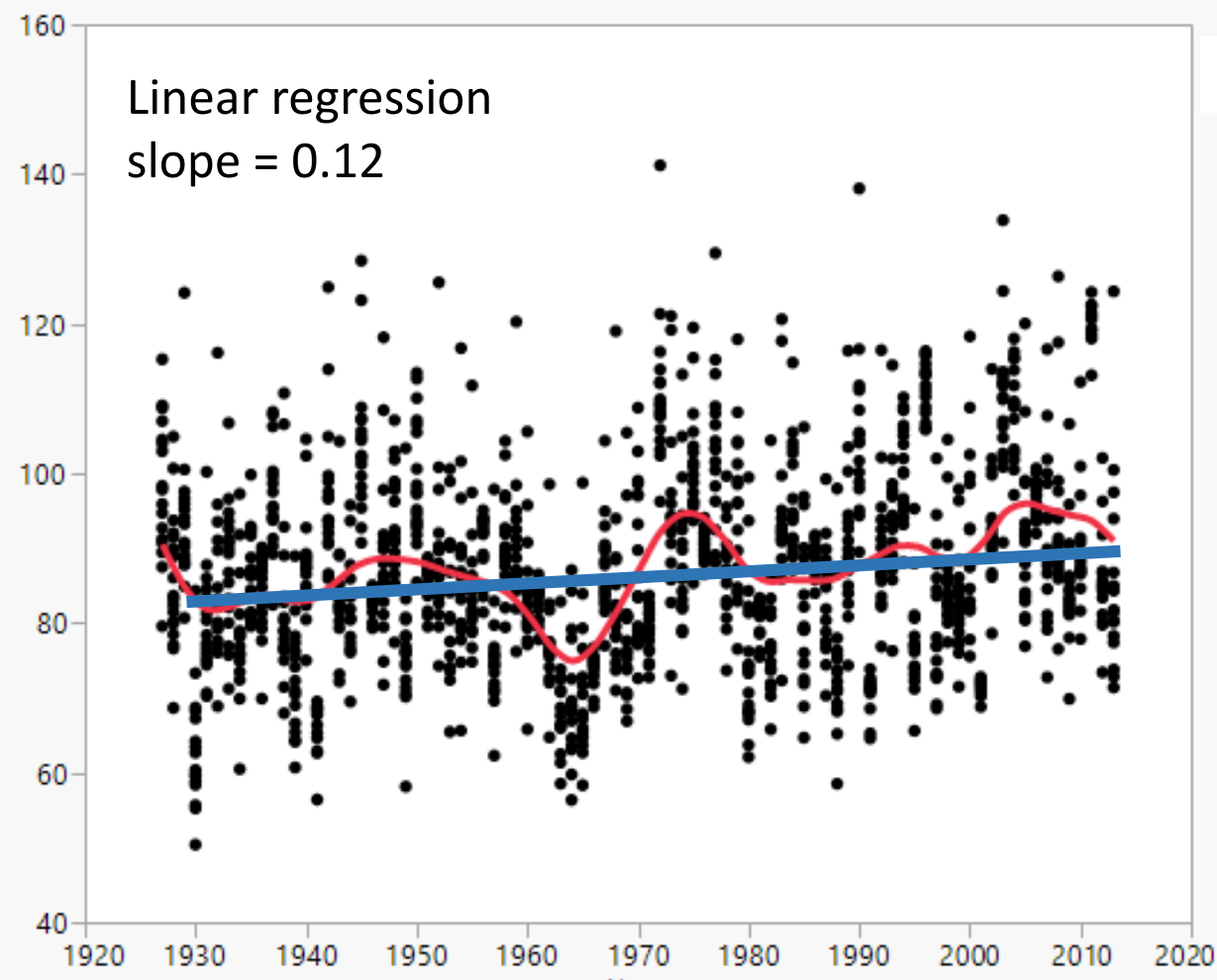
1995-2050



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

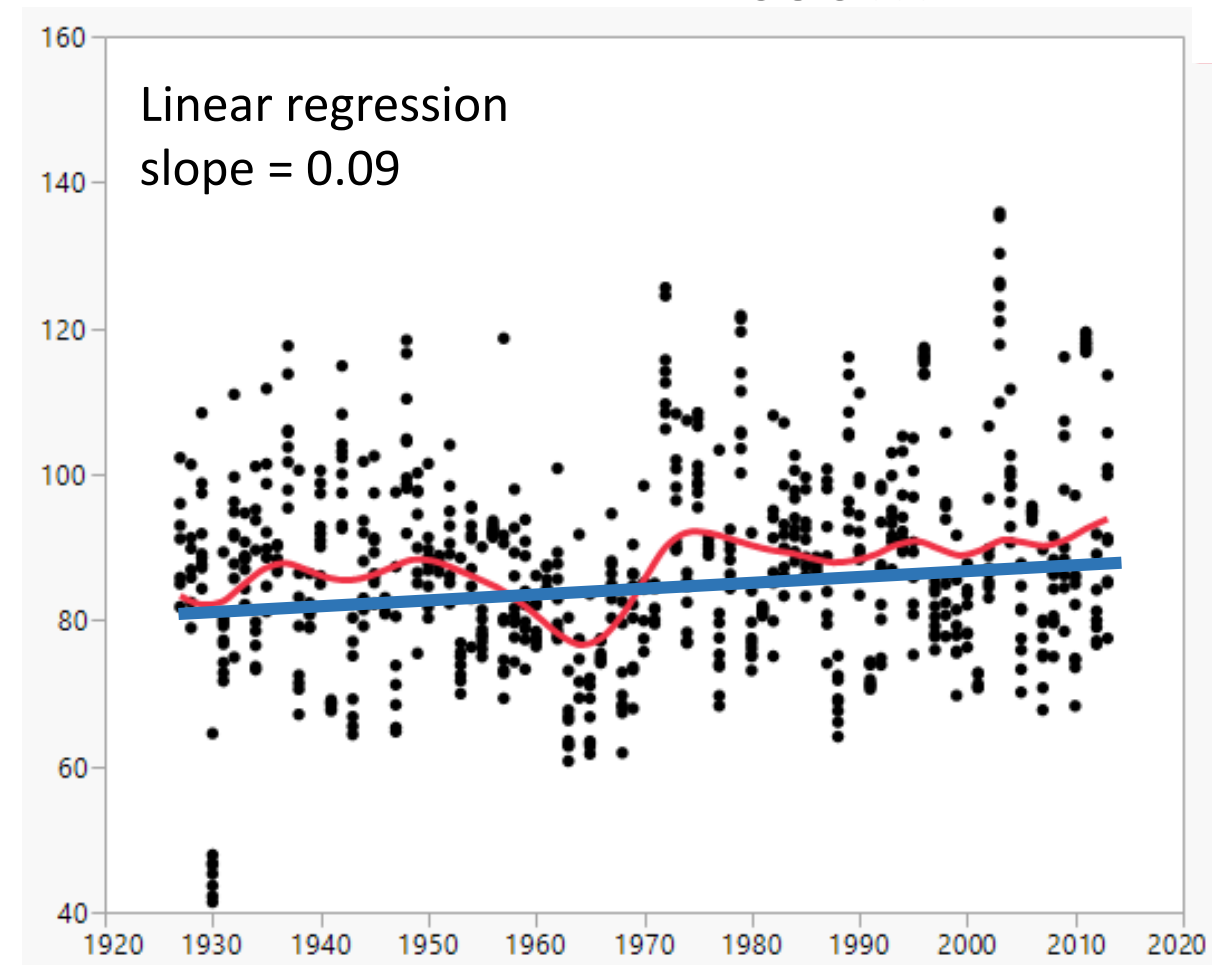
3.5° F / 1.94° C Increase in Average Annual Temp

Annual Precipitation Data



NORTH

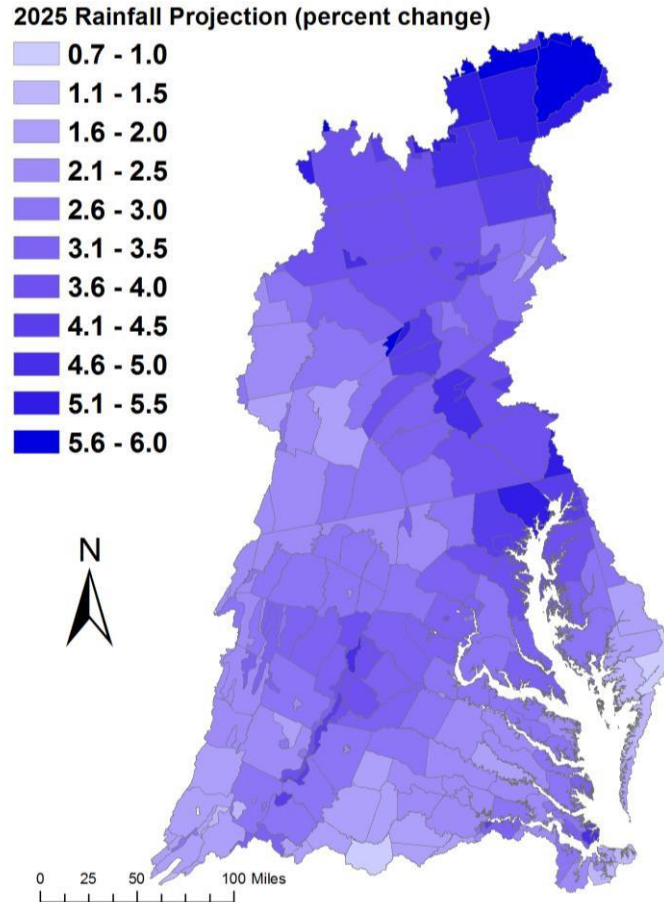
SOUTH



Precipitation Change

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

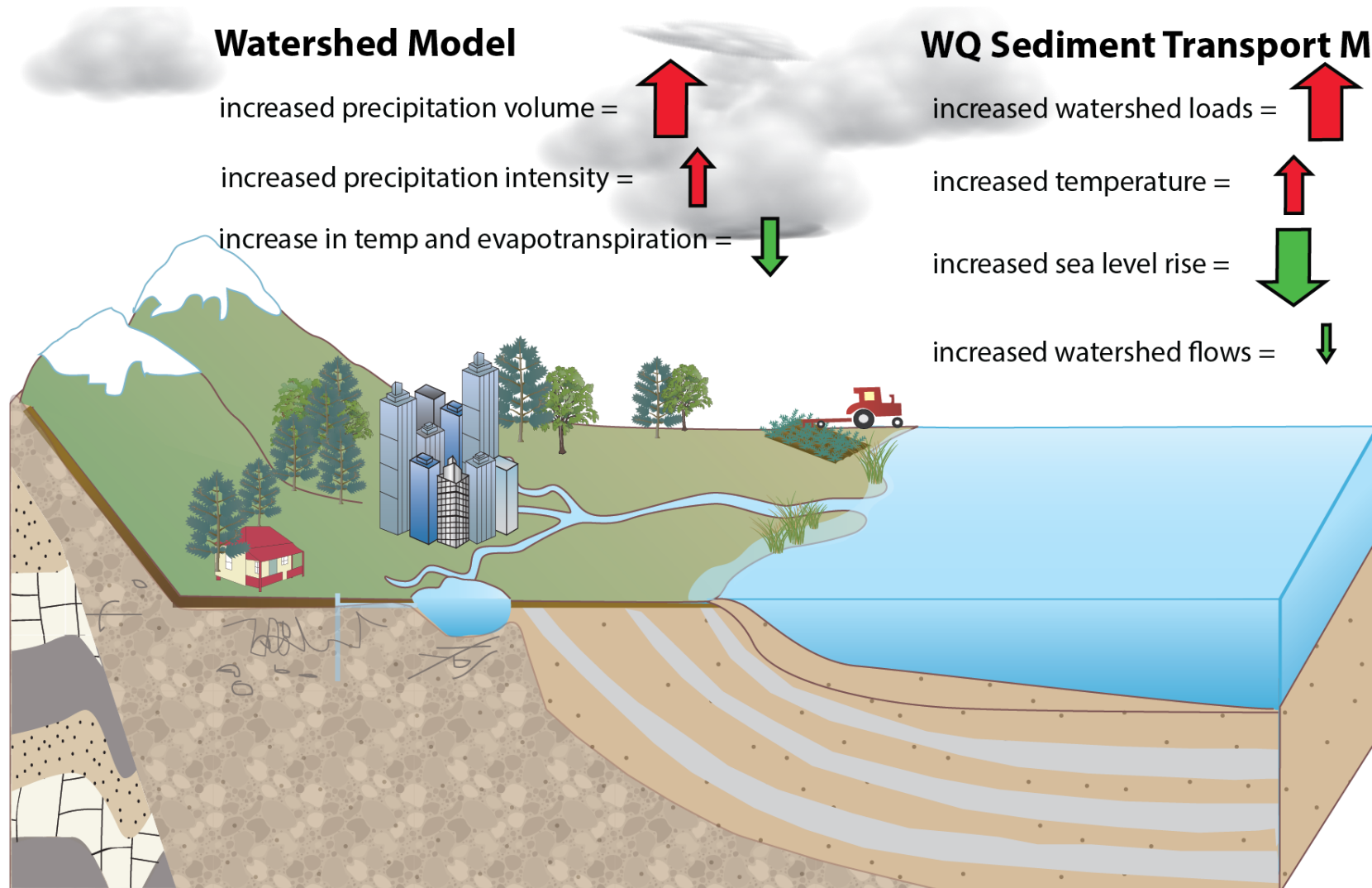
Change in Rainfall Volume 2021-2030 vs. 1991-2000



| 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% |

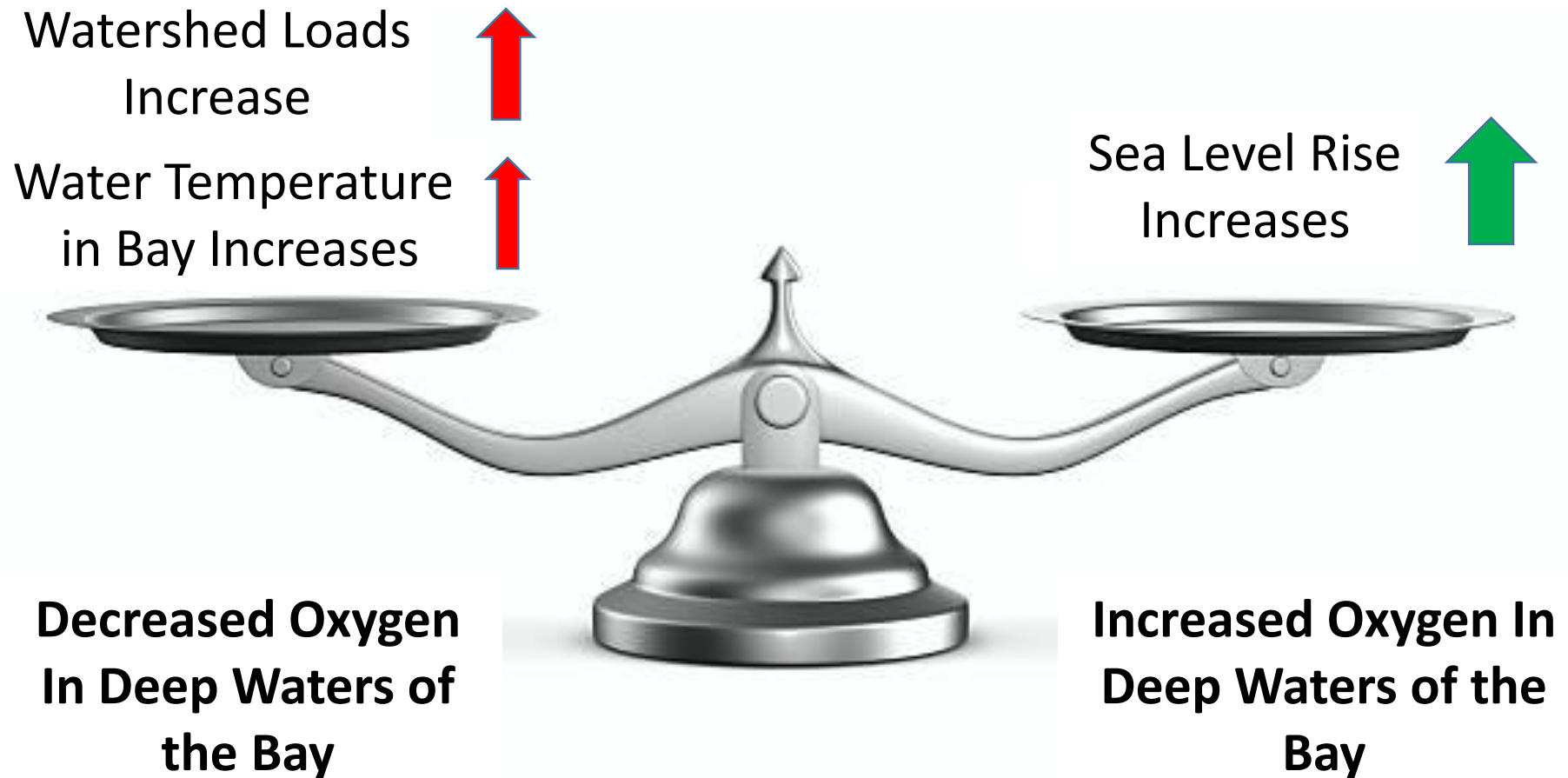
Accounting for Changing Conditions

Cumulative Assessment of Bay Low Dissolved Oxygen Impacts



**In the Summer of 2017 Our Message
was Climate Change Effects by 2025
were Projected to be Minimal as the
Different Effects were Largely
Counteracting Each Other**

Summer 2017 Assessment: Deep Water Dissolved Oxygen in Balance



**So What Changed Between the
Summer 2017 Assessment of
Projected Climate Change Impacts
and what was Presented to the PSC
at the December 19-20 Meeting?**

Estimated Sea Level Rise Decreased

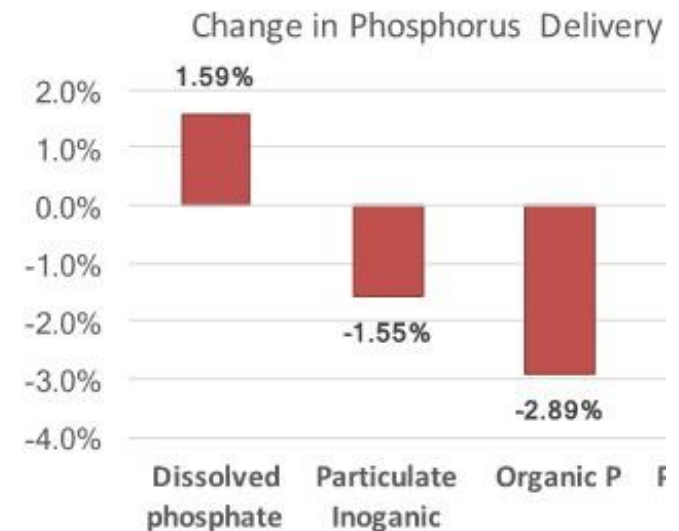
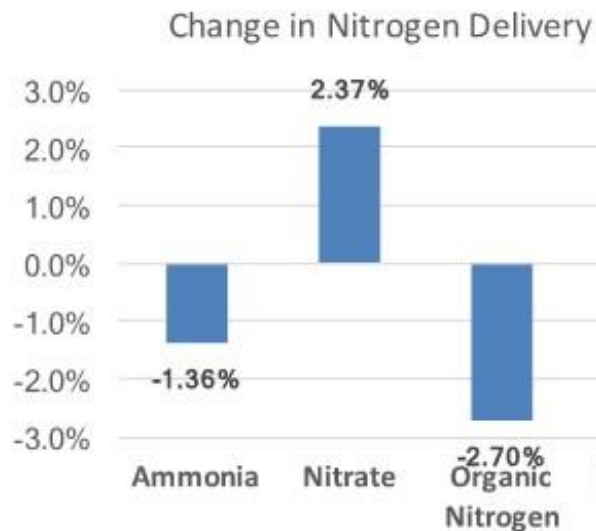
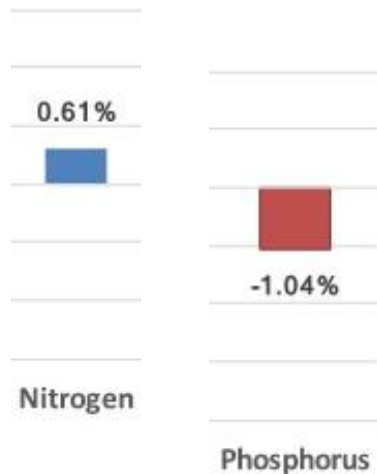
- Partnership originally used a predicted sea level rise of 30 centimeters (1 foot) between the 1990s and 2025
- Better scientific understanding brought forth by Partners
 - NOAA released new sea level rise projections for the Chesapeake Bay
 - VIMS also provided updated sea level rise projections
- Based on new science, the CBP Climate Resiliency Workgroup recommended using a projection of 17 centimeters
 - Consistent with long term trends at the Sewells Point, VA tide gauge at Bay mouth
- **Result:** less influx of colder, oxygen-rich ocean water causing less ventilation of low dissolved oxygen waters in the deepest portions of the Bay

Climate Change Effects on Loading of Different Types of Nutrients Better Understood

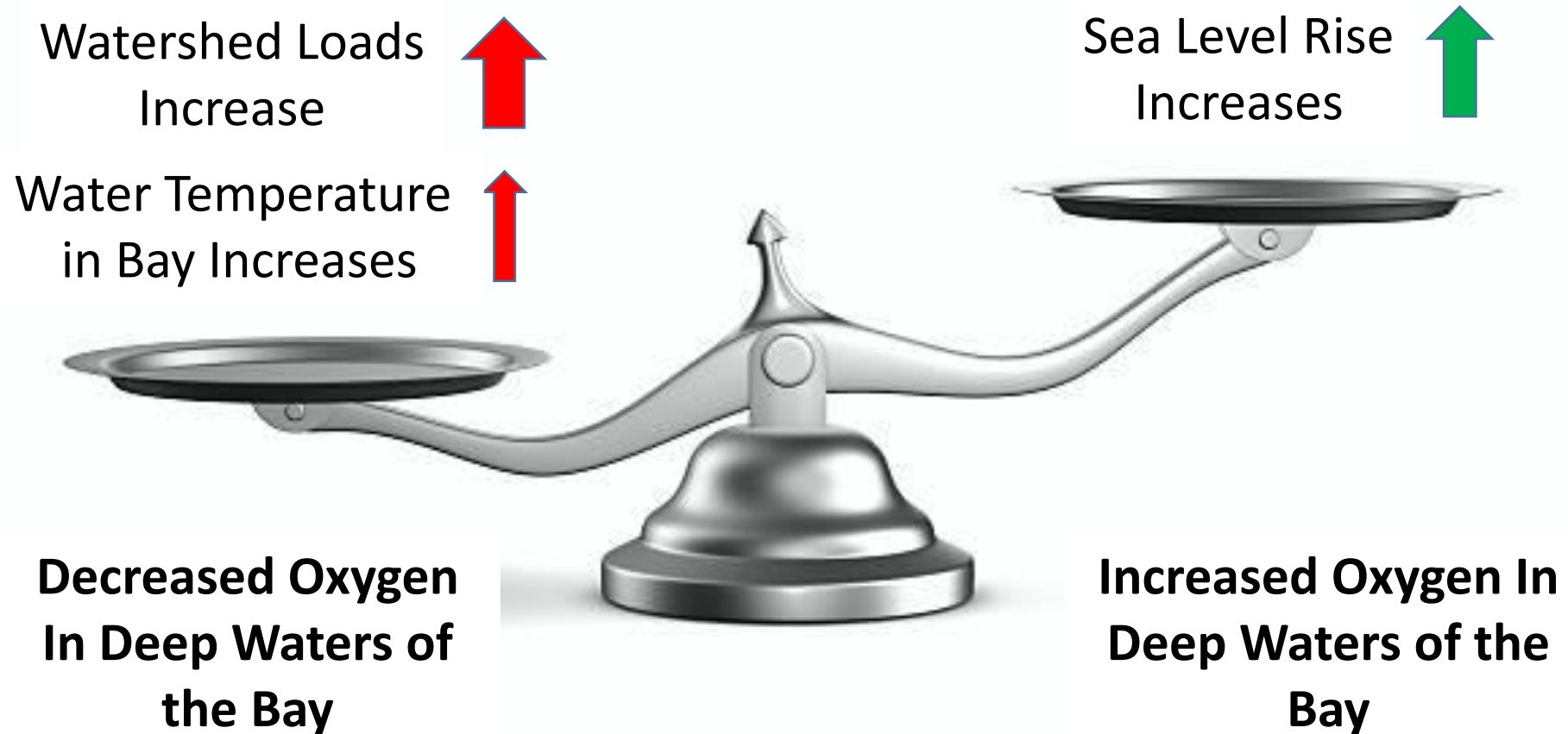
- Total nitrogen and phosphorus are expected to stay about the same
- Dissolved nitrate and phosphate have a strong effect on dissolved oxygen and increase with climate change
- Ammonia decreased as a percentage, but the absolute amount is small
- Organic nutrients decrease, but they have a weak effect on dissolved oxygen

Assessed changes in types of nutrients

- Total nitrogen and phosphorus are expected to stay about the same.
- Dissolved nitrate and phosphate have a strong effect on dissolved oxygen and increase with climate change.
- Ammonia decreased as a percentage, but the absolute amount is small.
- Particulate and organic nutrients decrease, but they have a weak effect on dissolved oxygen.



December 2017 Assessment: Deep Water Dissolved Oxygen Not in Balance



Nutrient Load Reductions Needed to Account for Reduced Oxygen Due to Climate Change

- We can choose to reduce nitrogen, phosphorus, or both
- Since most BMPs apply to both nutrients, a balanced approach is more efficient than just focusing on one or the other
- Analysis performed in December of 2017 indicated that raising the level of effort for all jurisdictions using the approved planning target method resulted in an estimate of 9.1 million pounds of nitrogen and 490,000 pounds of phosphorus basin-wide

Climate Change Loads: Nitrogen

| Jurisdiction | 1985 Baseline | 2013 Progress | Climate Change | Phase III Planning Target |
|------------------|---------------|---------------|--------------------|---------------------------|
| NY | 18.71 | 15.44 | 0.400 (3.8%) | 11.59 |
| PA | 122.41 | 99.28 | 4.135 (5.7%) | 73.18 |
| MD | 83.56 | 55.89 | 2.194 (4.8%) | 45.30 |
| WV | 8.73 | 8.06 | 0.236 (3.7%) | 8.35 |
| DC | 6.48 | 1.75 | 0.006 (0.3%) | 2.43 |
| DE | 6.97 | 6.59 | 0.397 (8.5%) | 4.59 |
| VA | 84.29 | 61.53 | 1.722 (3.1%) | 55.82 |
| Basinwide | 331.15 | 248.54 | 9.09 (4.6%) | 201.25 |

*Units: millions of pounds

Climate Change Loads: Phosphorus

| Jurisdiction | 1985 Baseline | 2013 Progress | Climate Change | Phase III Planning Target |
|------------------|---------------|---------------|---------------------|---------------------------|
| NY | 1.198 | 0.710 | 0.014 (2.9%) | 0.606 |
| PA | 6.282 | 3.749 | 0.141 (4.7%) | 3.073 |
| MD | 7.495 | 3.942 | 0.114 (3.2%) | 3.604 |
| WV | 0.902 | 0.617 | 0.019 (3.9%) | 0.456 |
| DC | 0.090 | 0.062 | 0.001 (0.8%) | 0.130 |
| DE | 0.225 | 0.116 | 0.006 (5.1%) | 0.120 |
| VA | 14.244 | 6.751 | 0.193 (3.0%) | 6.186 |
| Basinwide | 30.44 | 15.95 | 0.489 (3.4%) | 14.173 |

*Units: millions of pounds

Understanding the Science: Proposed Next Steps

