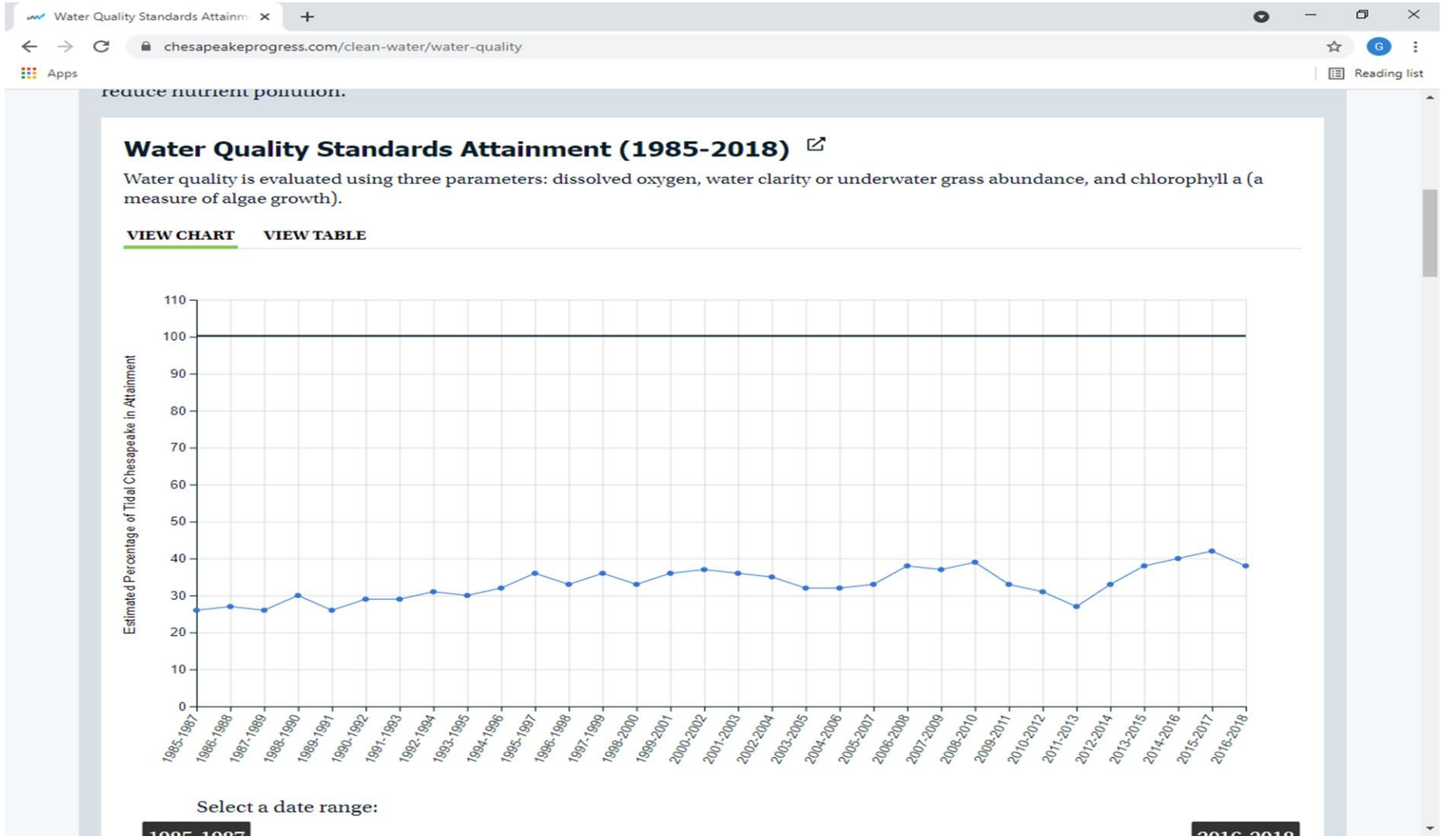
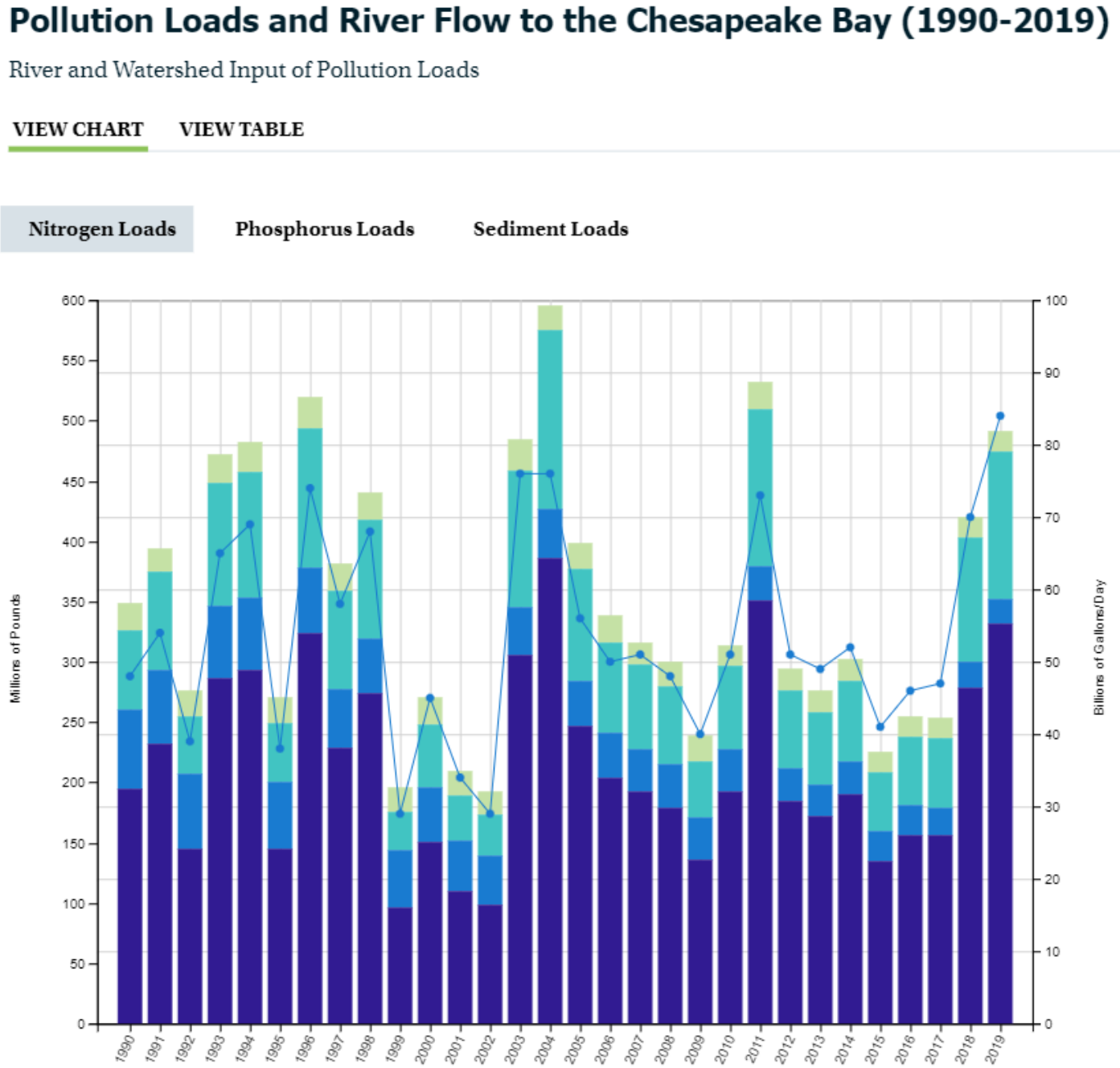
CBP Integrated Watershed TMDL indicator

Gary Shenk, Qian Zhang, Gopal Bhatt, Isabella Bertani, Chris Mason, Doug Moyer

Current Tidal Water TMDL Indicator



Current Nontidal Load Indicator



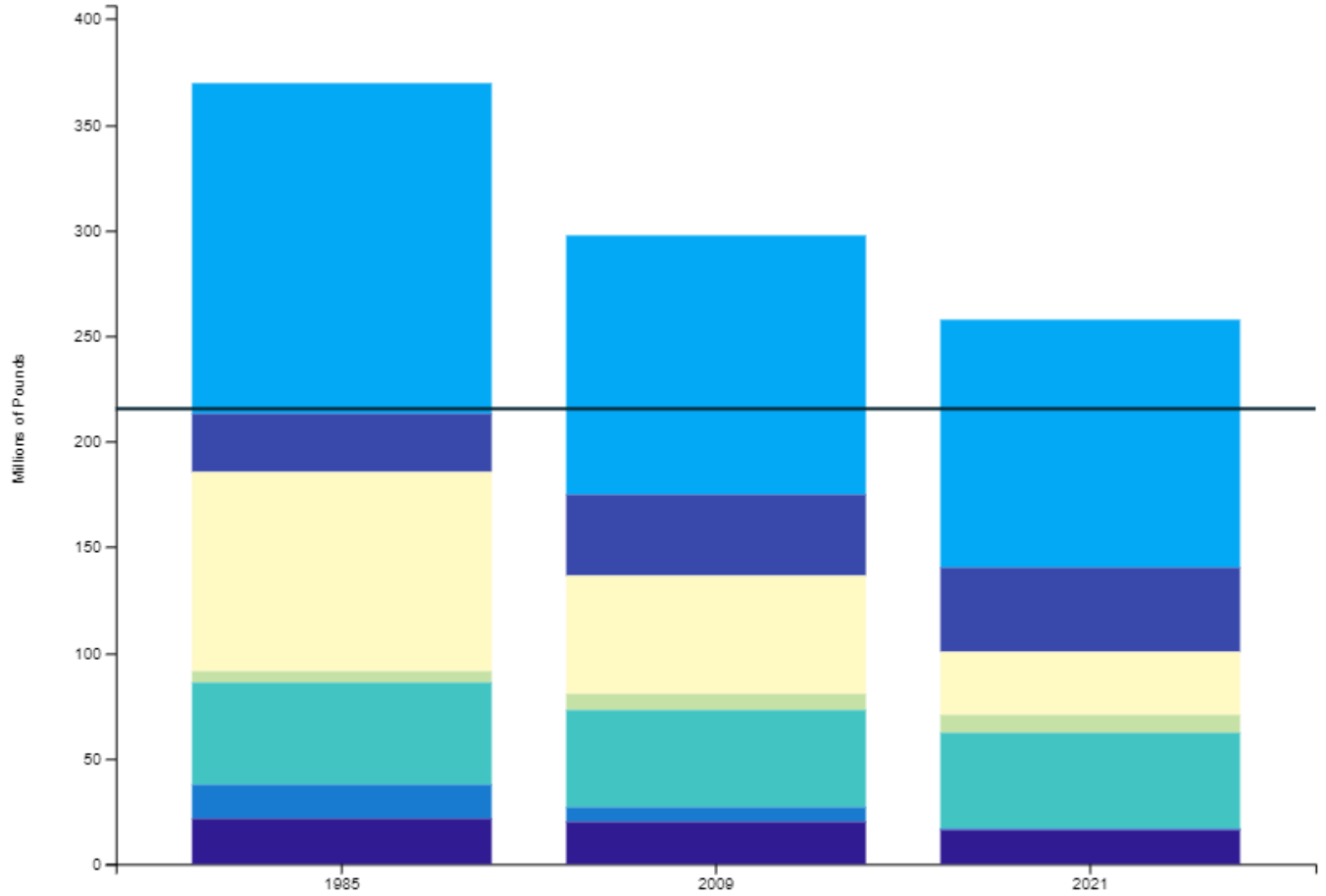
Current WIP Indicator

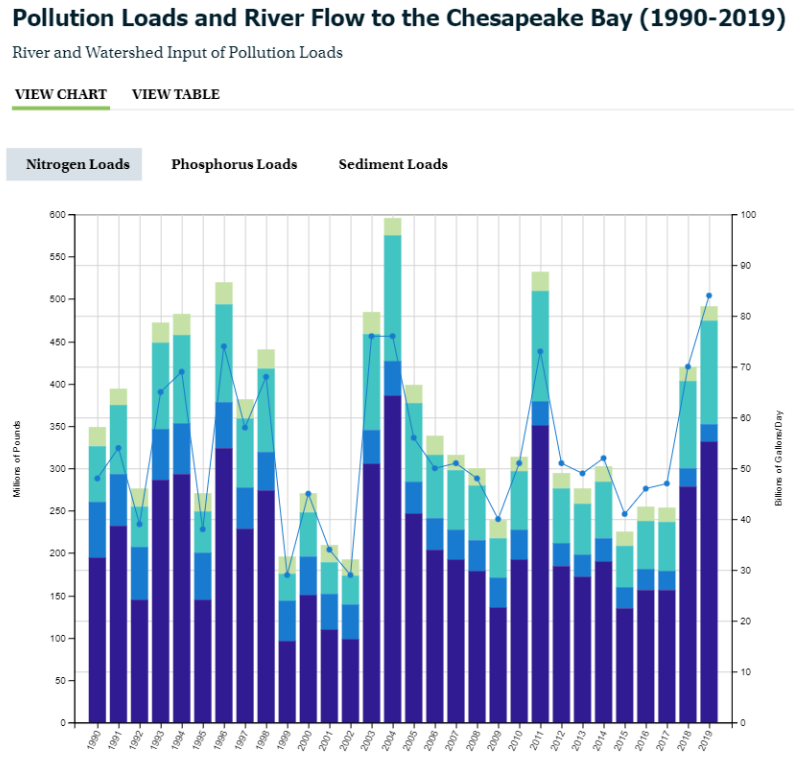
Modeled Nitrogen Loads to the Chesapeake Bay (1985-2021)

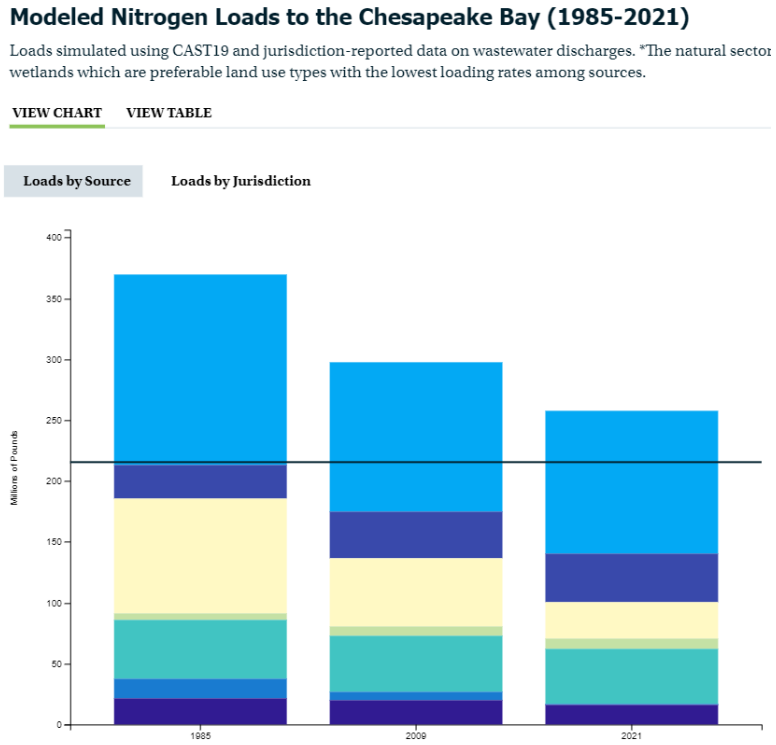
Loads simulated using CAST19 and jurisdiction-reported data on wastewater discharges. *The natural sector wetlands which are preferable land use types with the lowest loading rates among sources.

VIEW CHART VIEW TABLE

Loads by Source Loads by Jurisdiction







Differences due to:

Normalization for flow

Lag times

Non-management factors

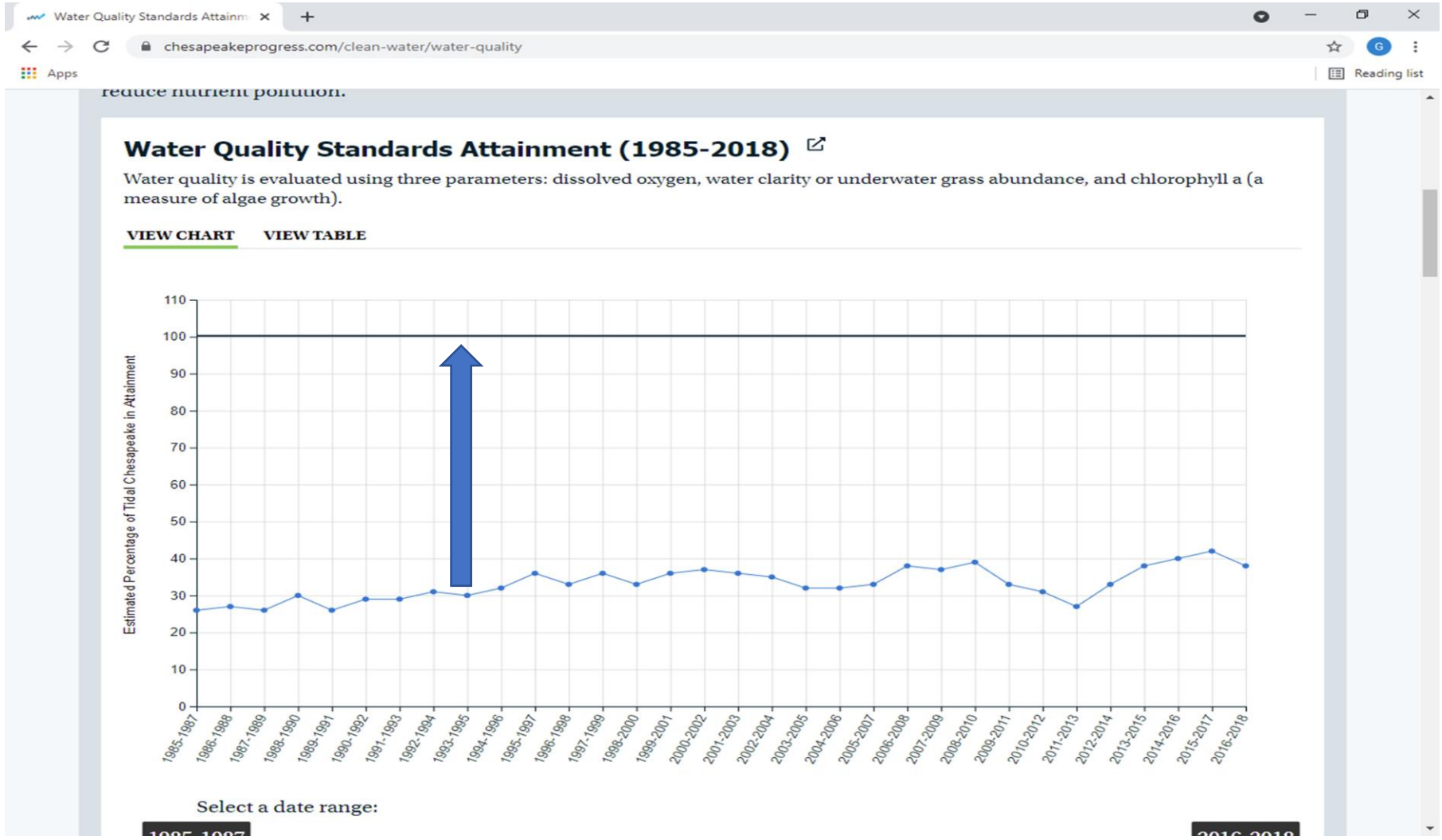
Errors in both estimates

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.

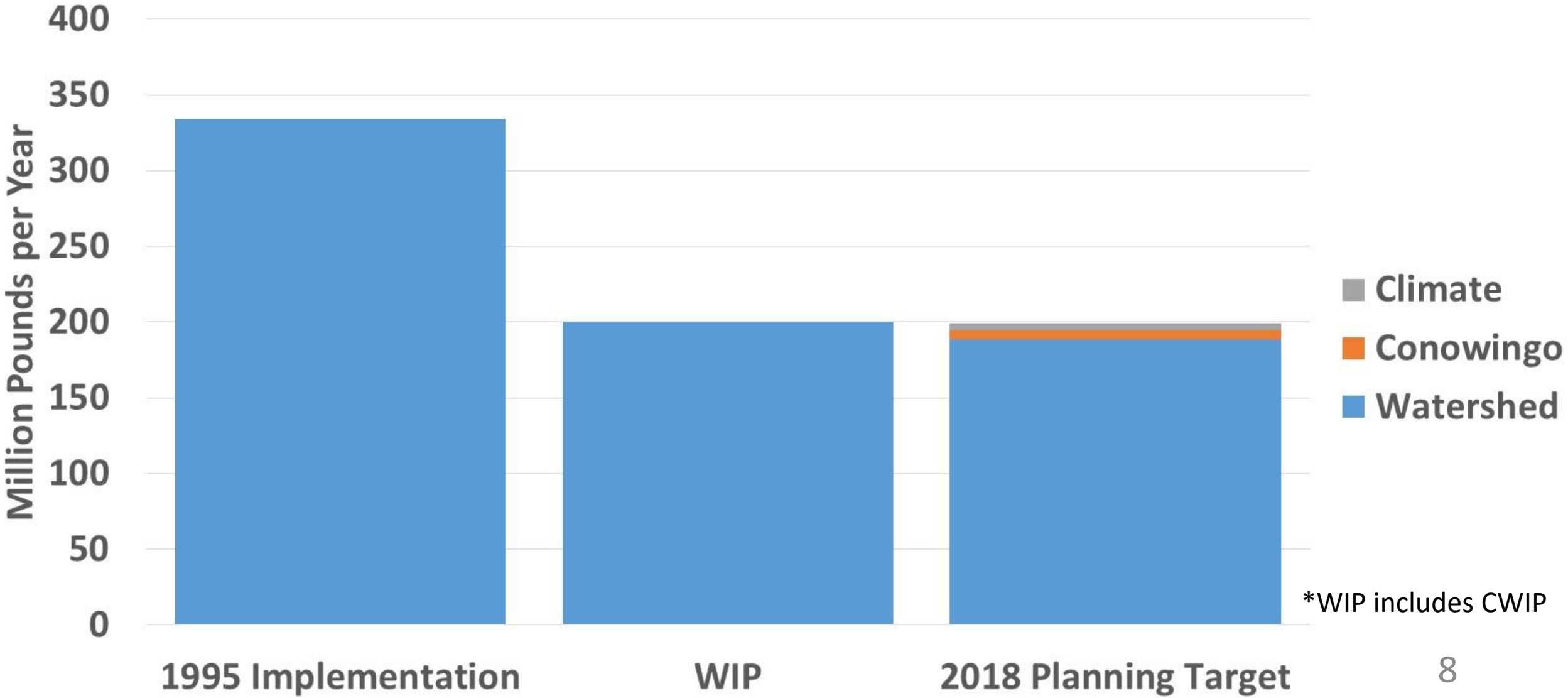
Purpose: Build an indicator that is:

- 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

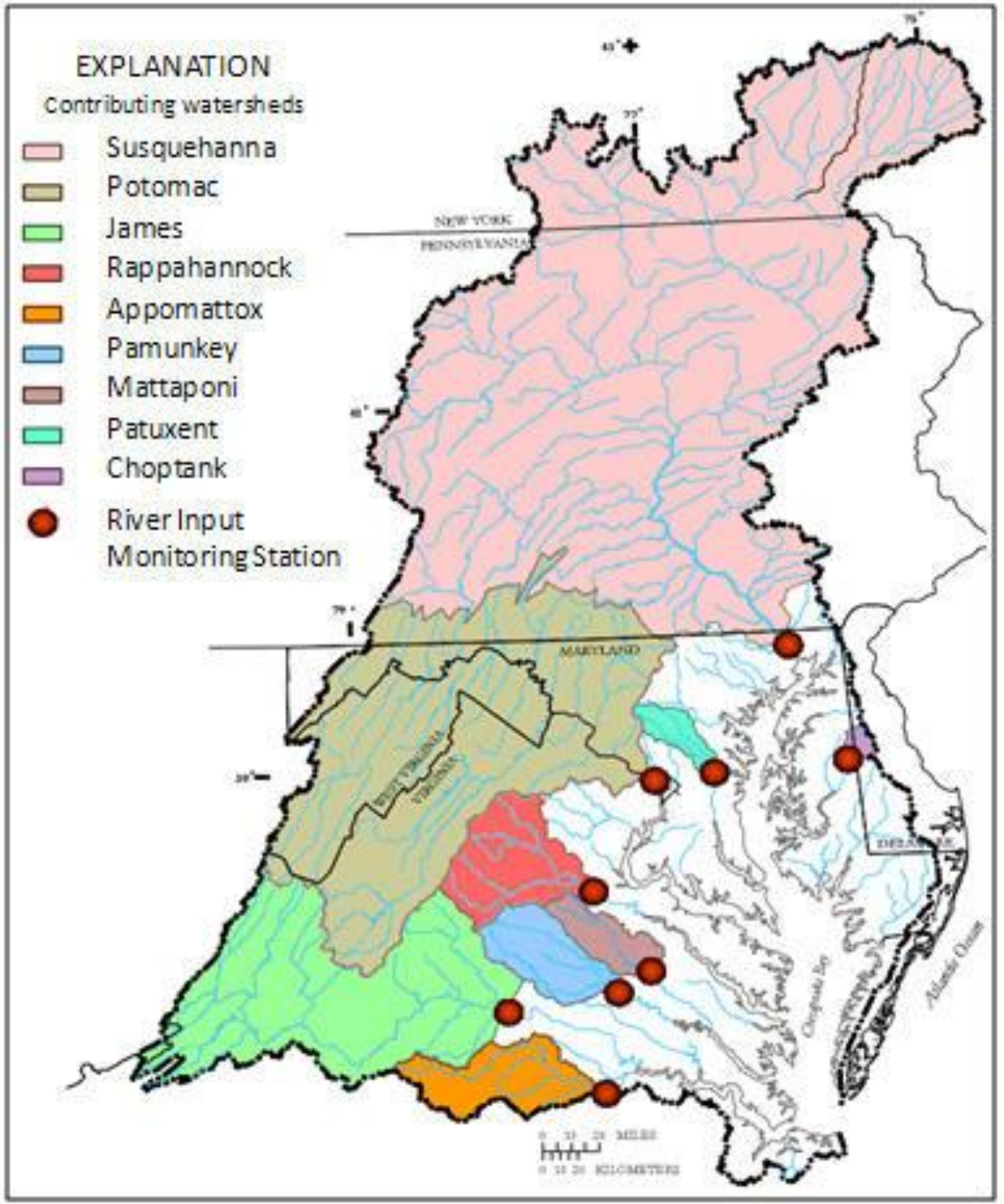
TMDL question: What level of load reduction from 1995 will be necessary to meet water quality standards?



Reductions required to meet TMDL Goals



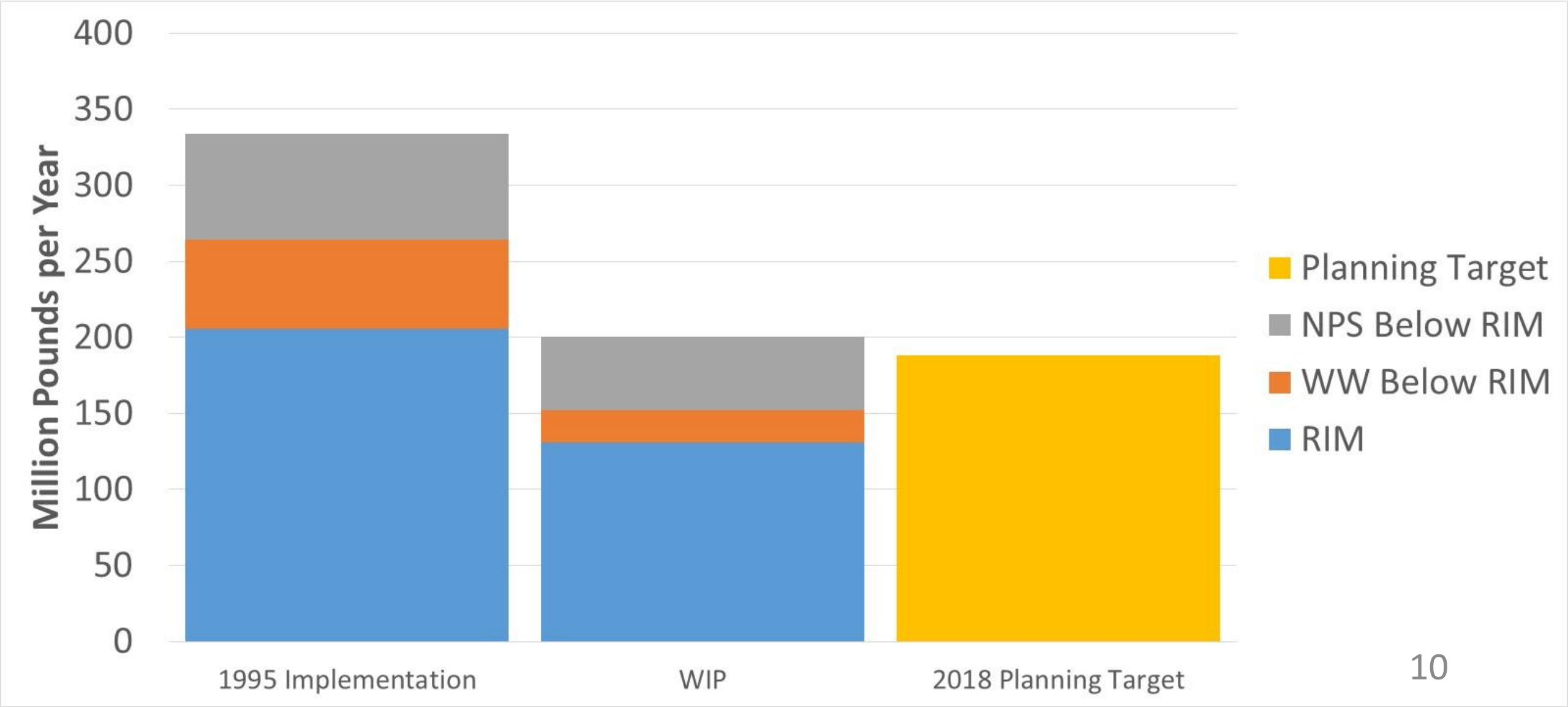
*WIP includes CWIP



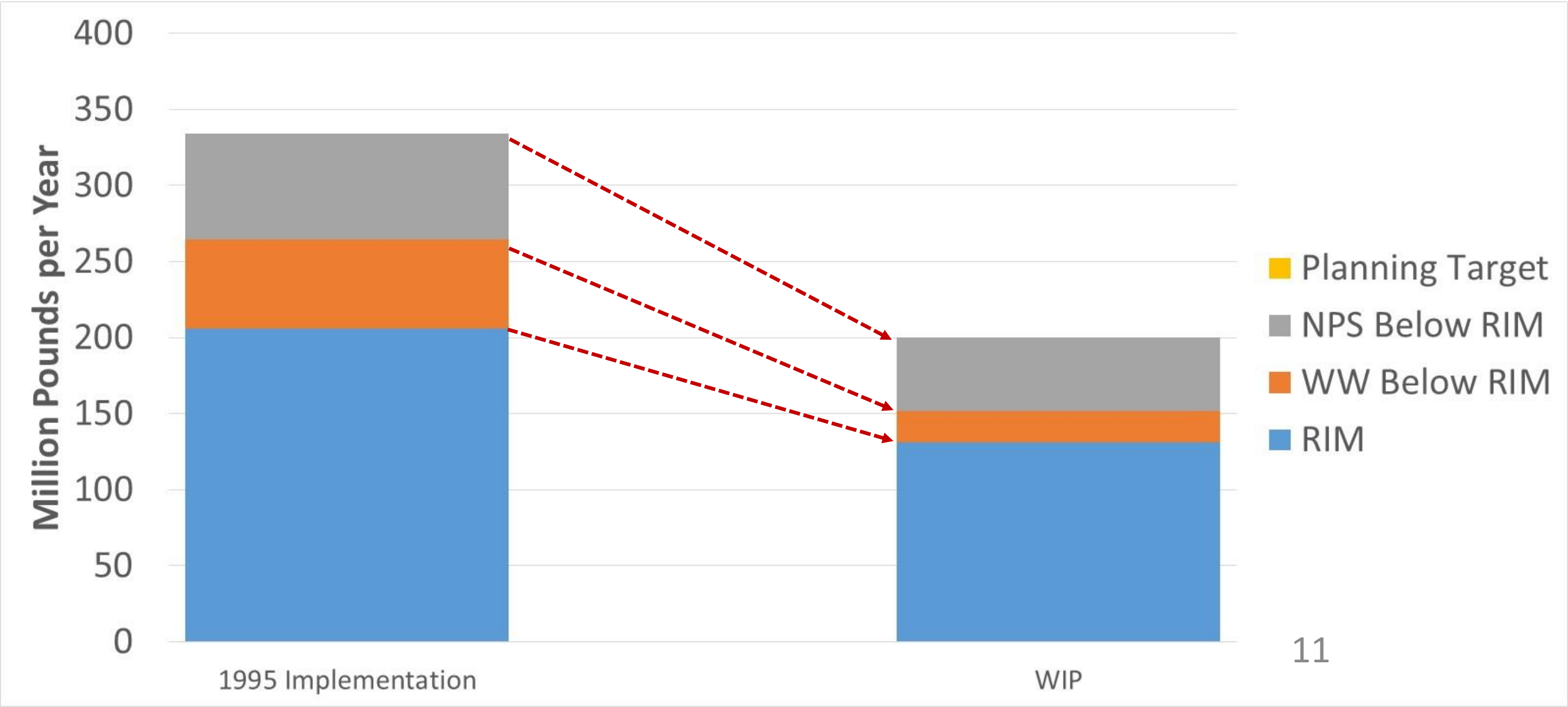
River Input Monitoring (RIM)

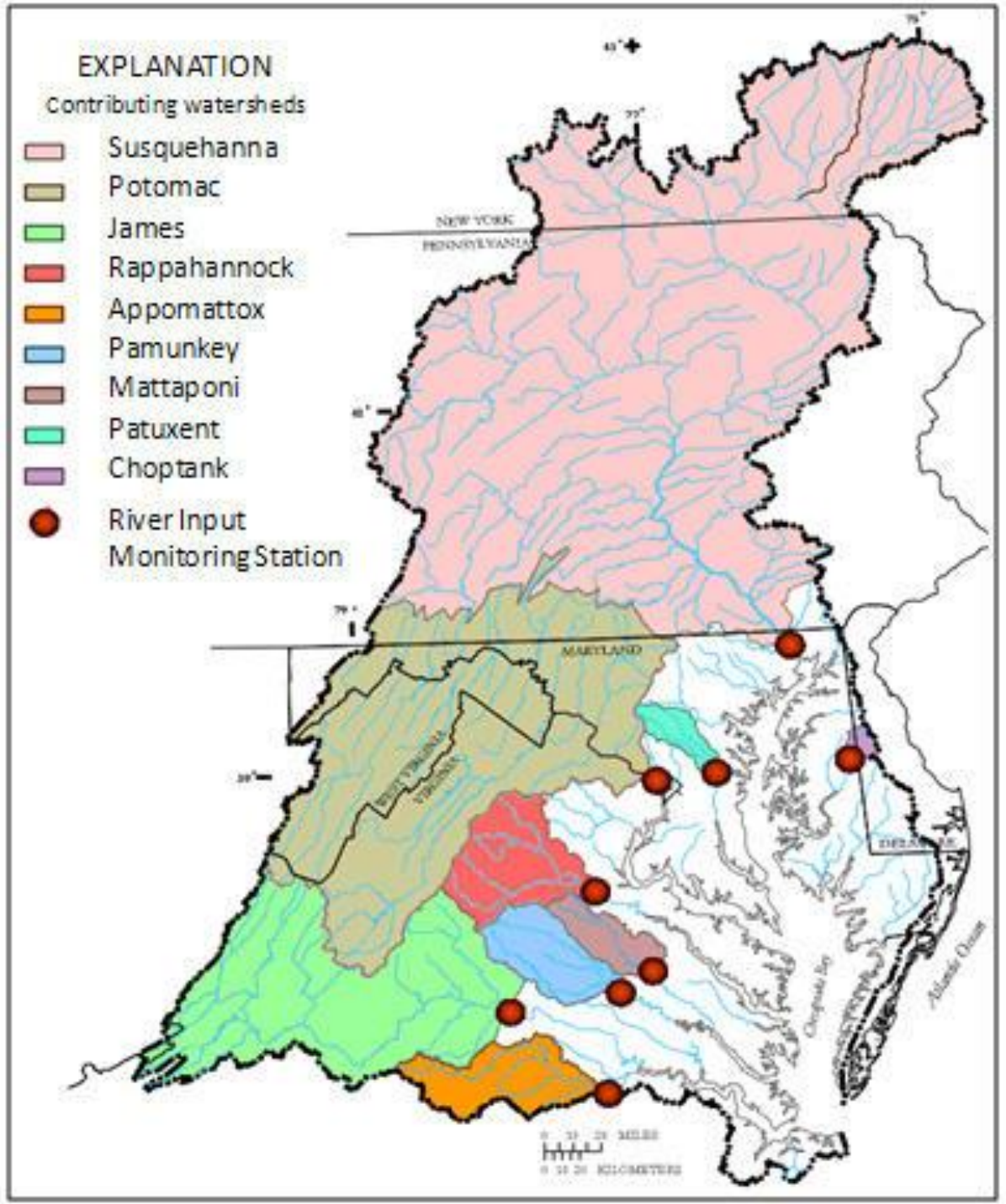
- Covers most of the CB watershed
  - 80% of land
  - 60% of load
- Many large WWTP are below RIM stations

Reductions required to meet TMDL Goals

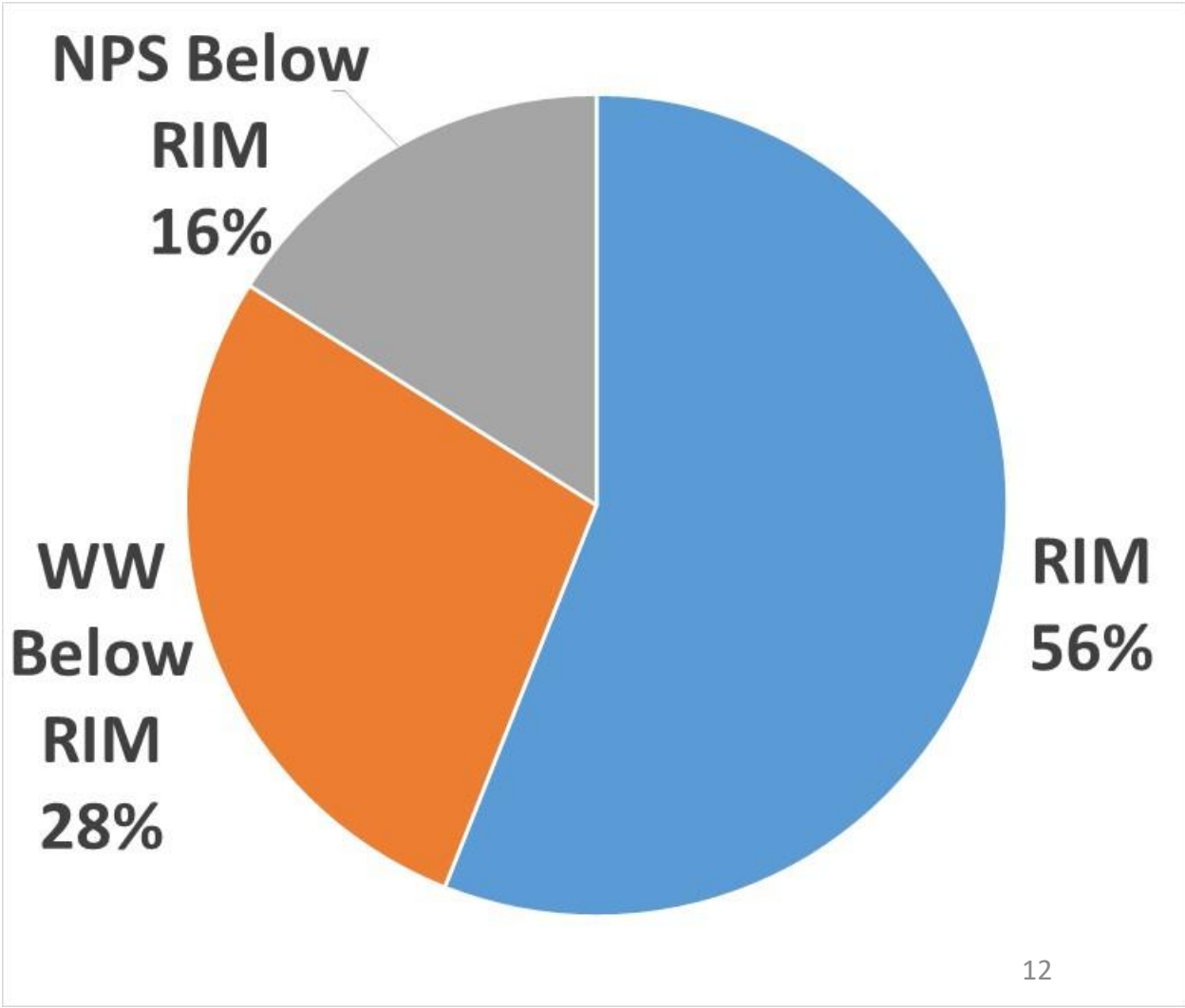


Reductions required to meet TMDL Goals

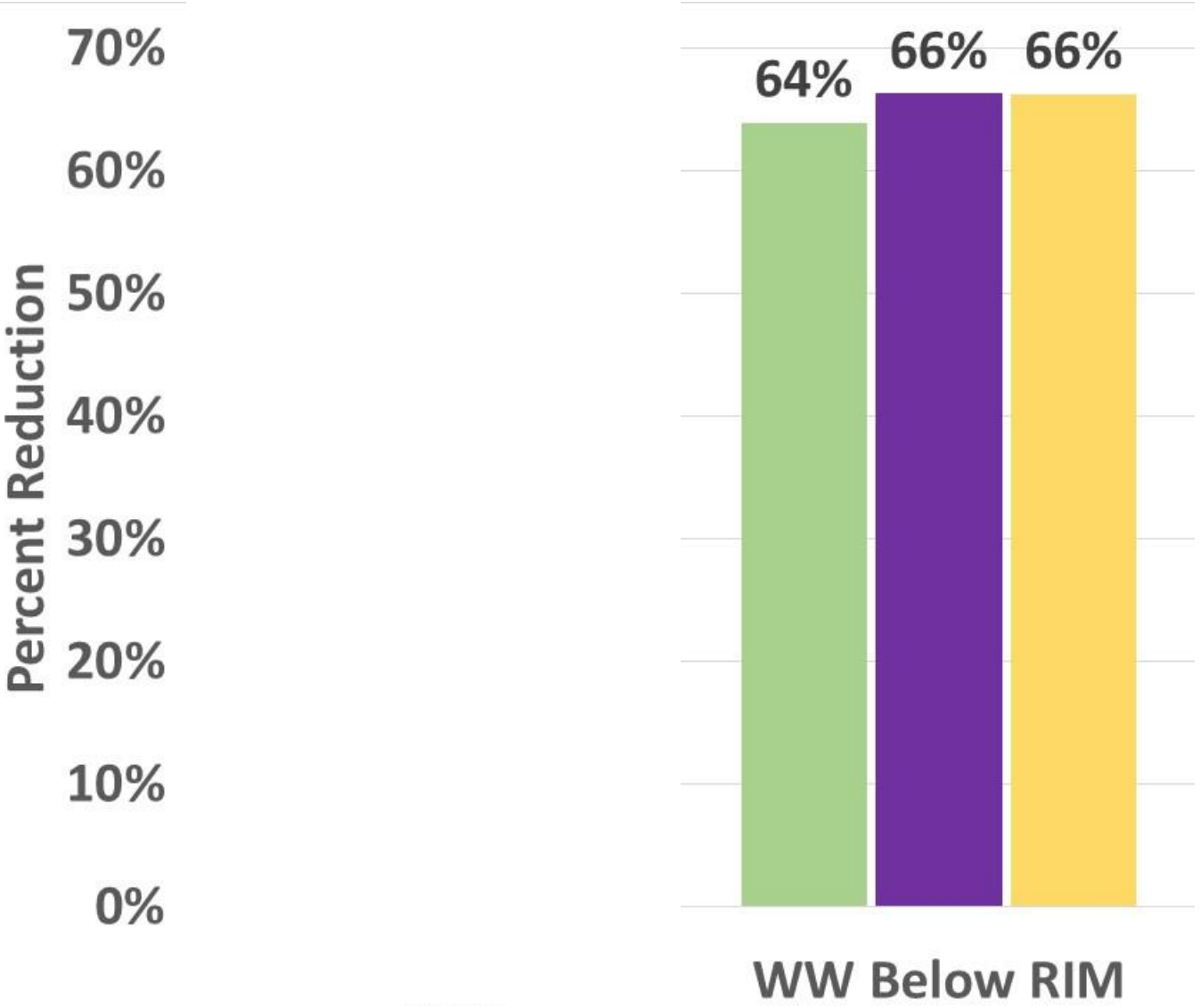


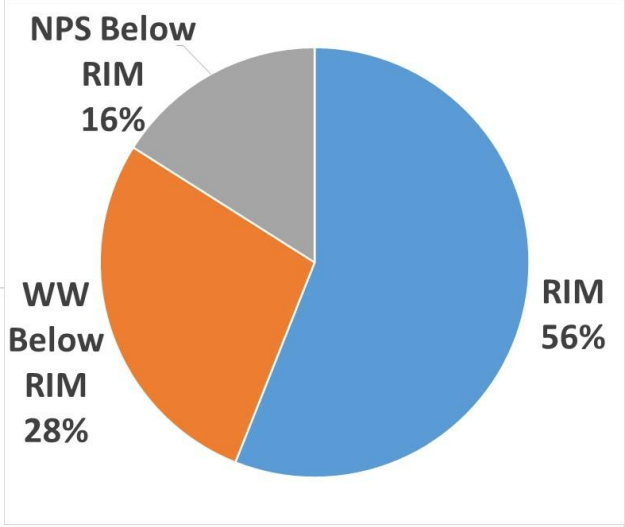


84% of Expected Reduction is Monitored



Wastewater is easy to measure and successful



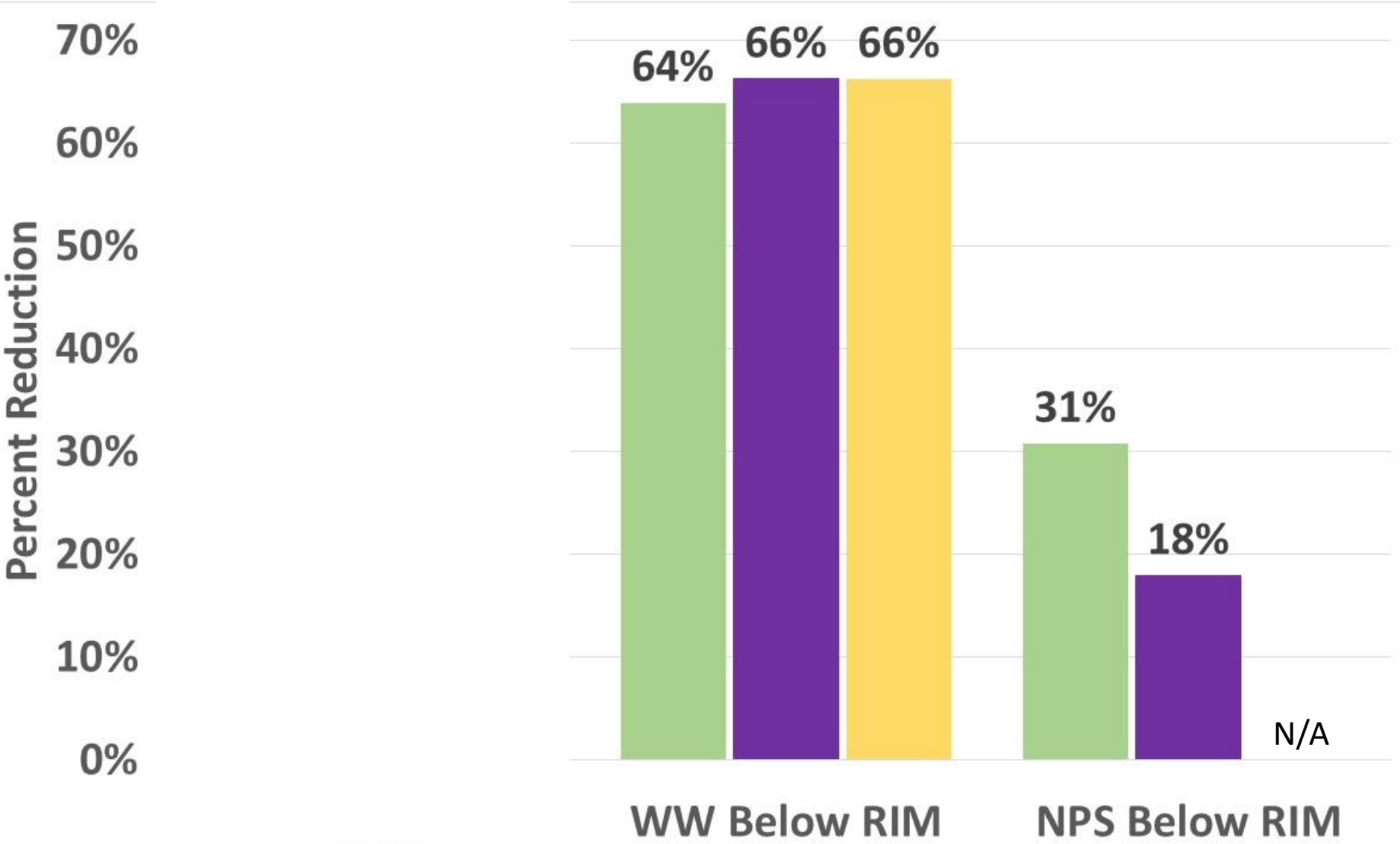


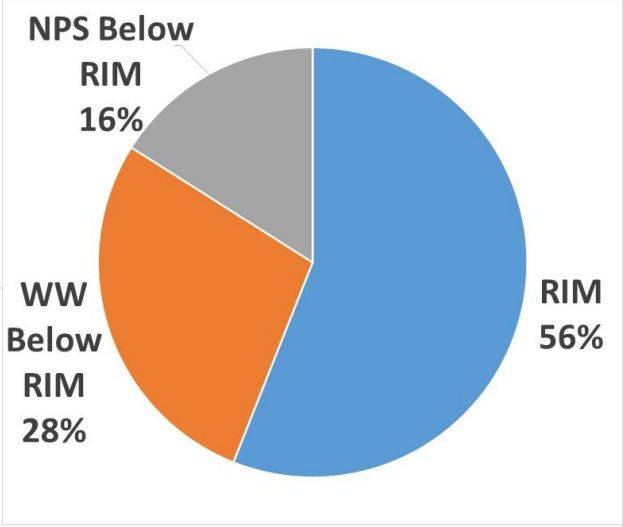
Percent reduction to WIP

Expected percent reduction to 2020

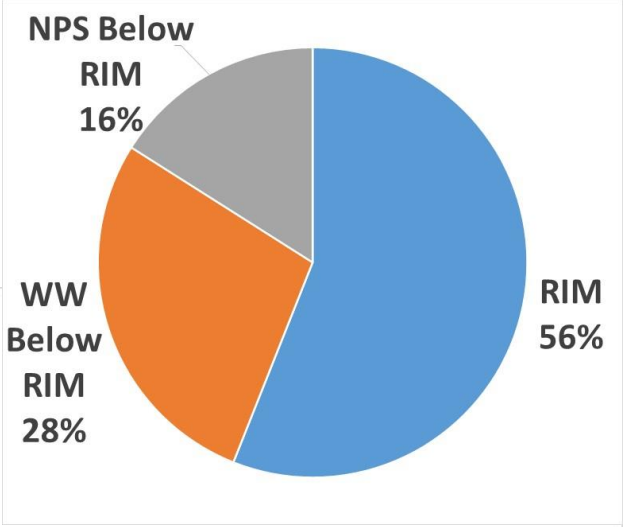
Monitored percent reduction to 2020

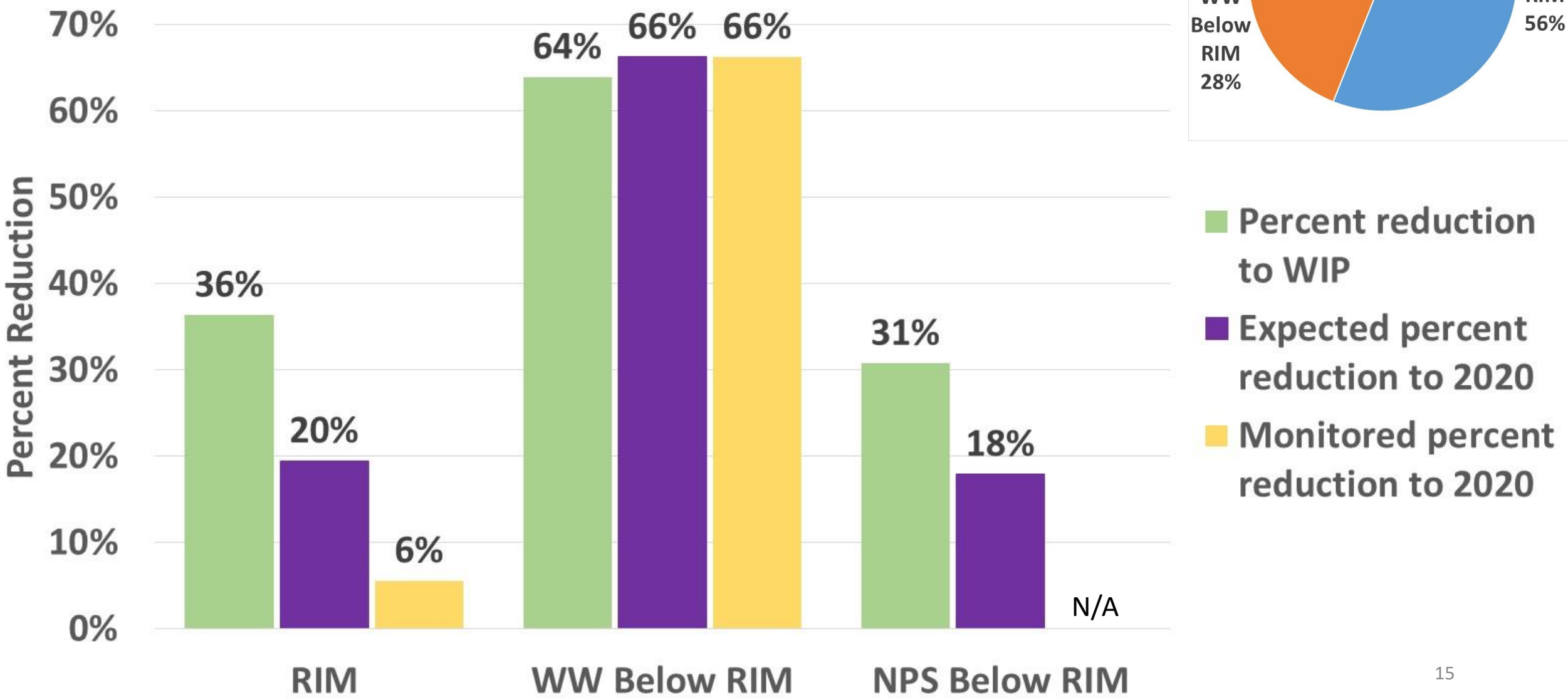
Below RIM NPS is about half implemented and is not fully monitored



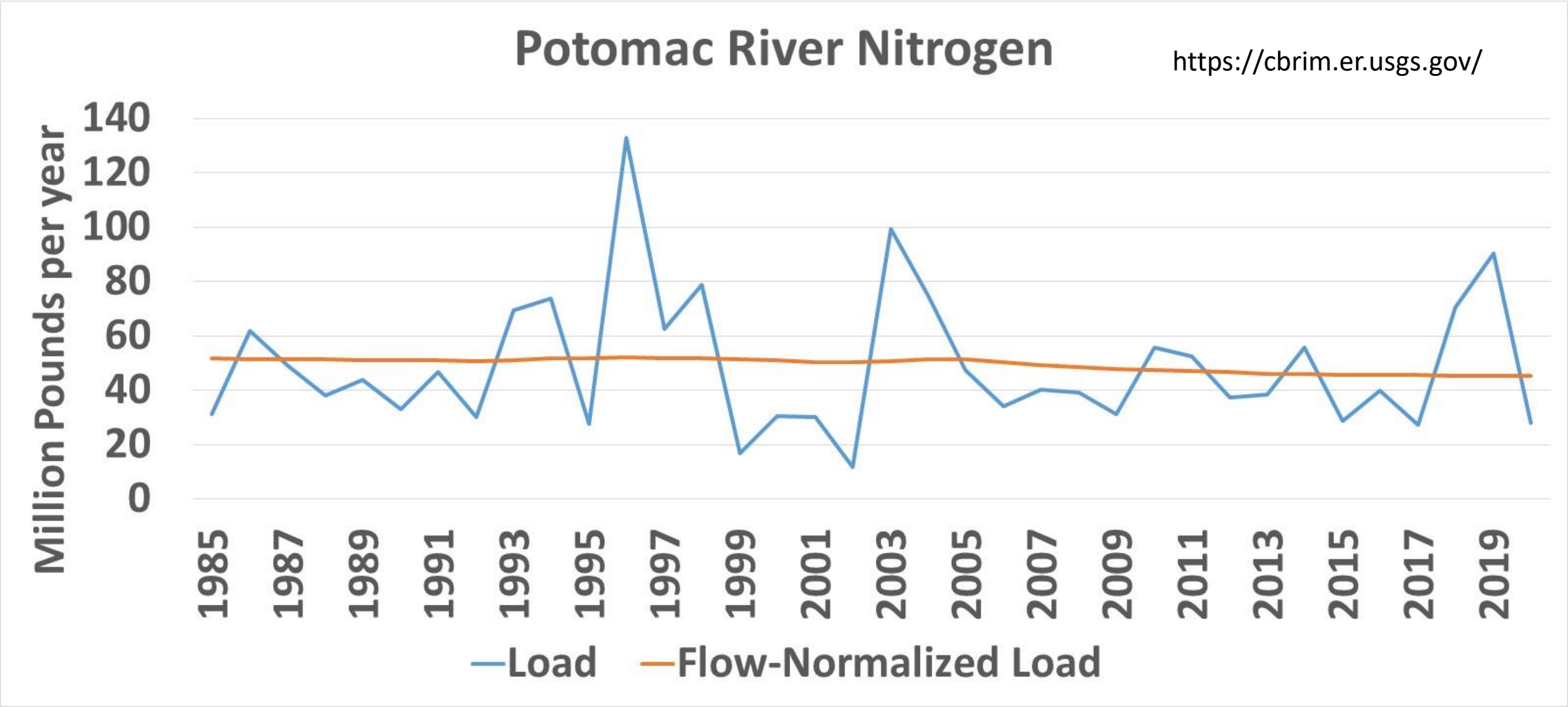


Above RIM is about half implemented, but monitoring shows only a small reduction

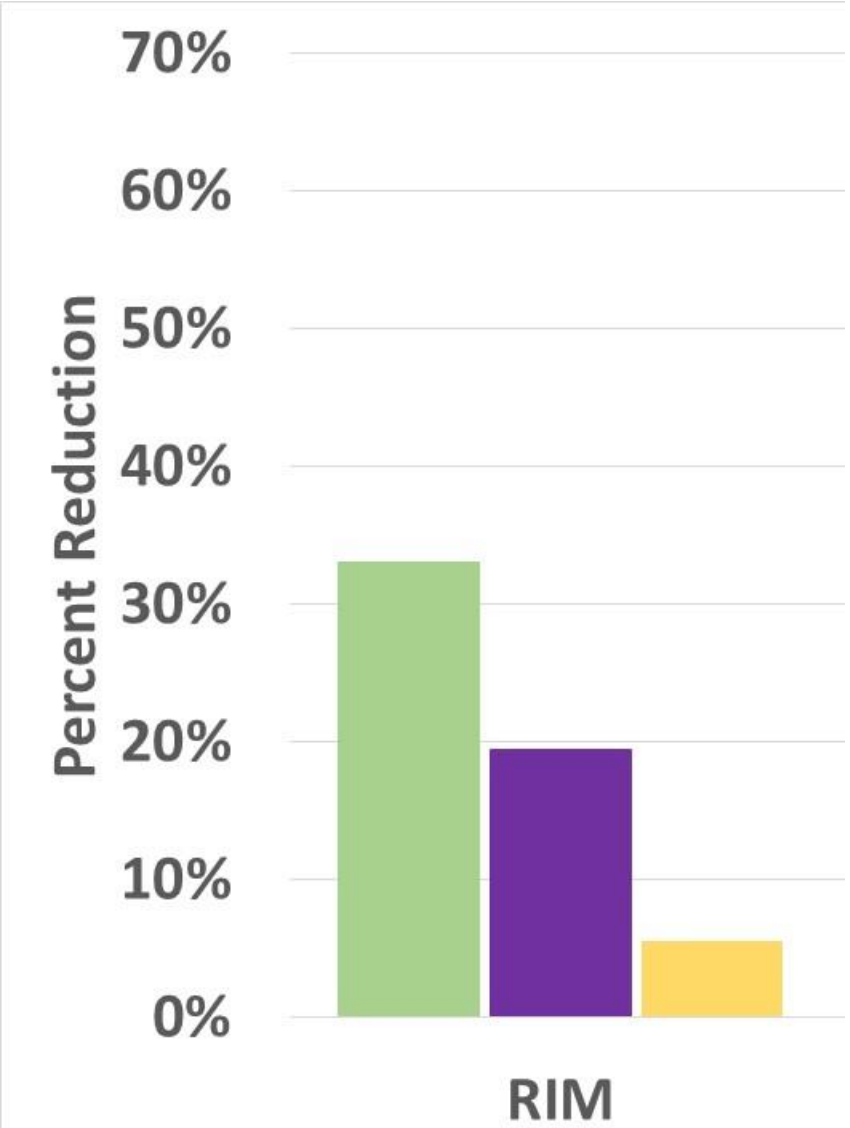




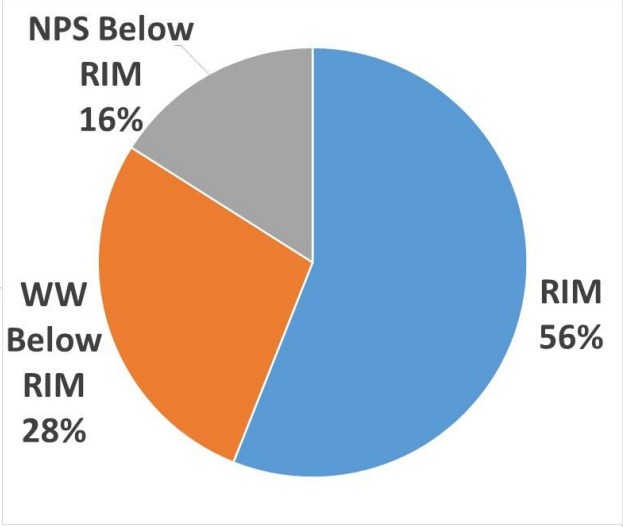
Loads and Flow-Normalized Loads

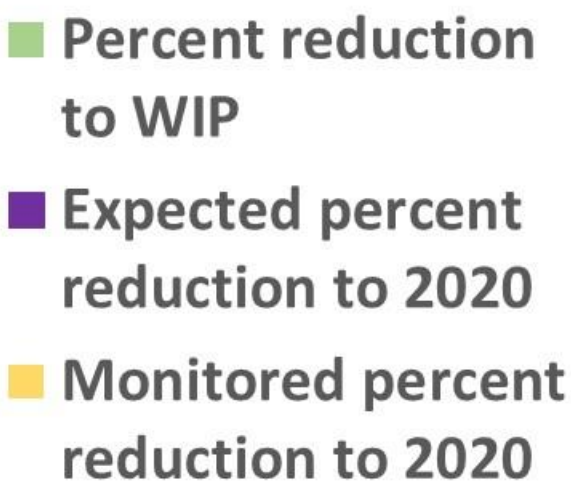


Why are monitoring and modeling not showing the same thing?



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

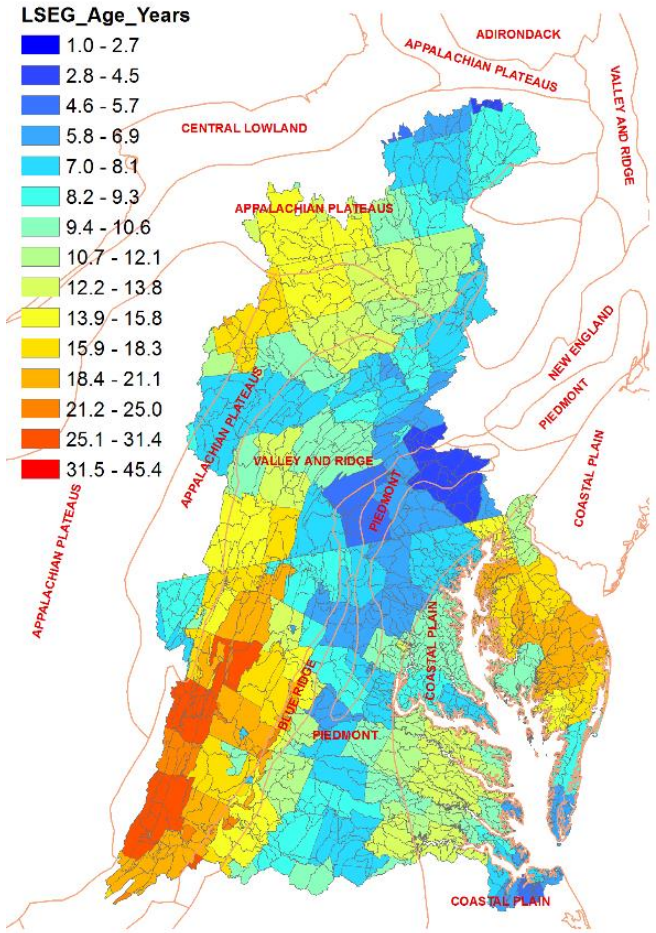




Ator, S.W., Blomquist, J.D., Webber, J.S. and Chanat, J.G., 2020. Factors driving nutrient trends in streams of the Chesapeake Bay watershed. *Journal of Environmental Quality*, *49*(4), pp.812-834.

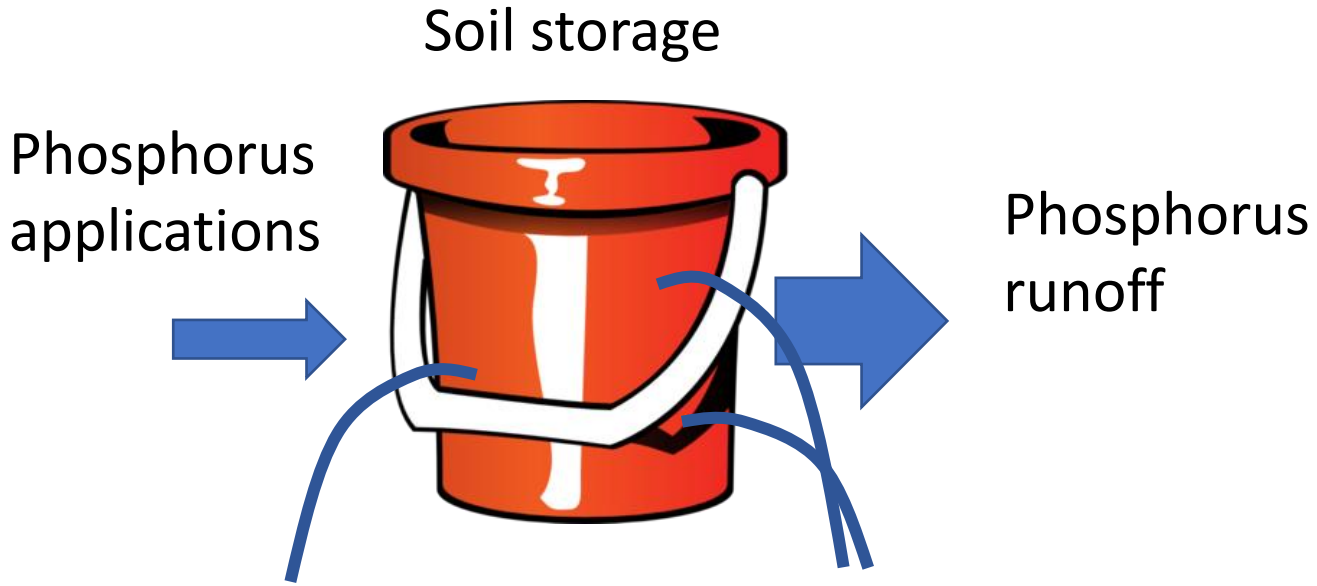
Lag times

Nitrate in groundwater



Phase 6 CAST documentation

Phosphorus in soils

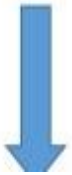


Conowingo effect

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

2017/2018 Presentations to WQGIT, MB, and PSC

Conowingo effect

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↓

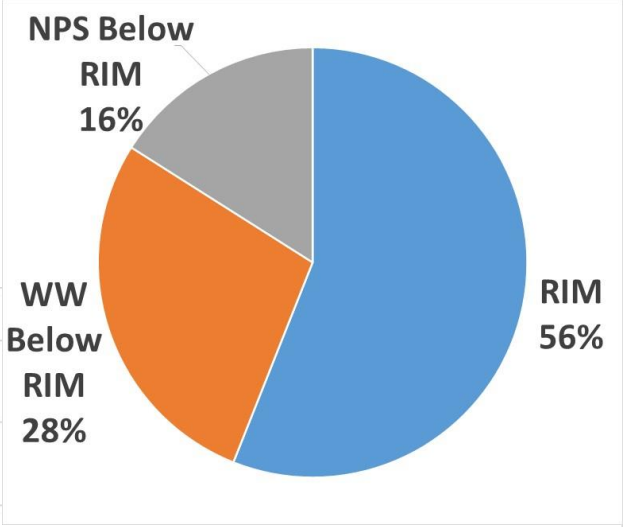
HOWEVER: These are less bioavailable nutrients and its delivery to Bay is dependent on large storm events. Reduction equivalent to 6 million pounds of Nitrogen and 0.26 million pounds of Phosphorus

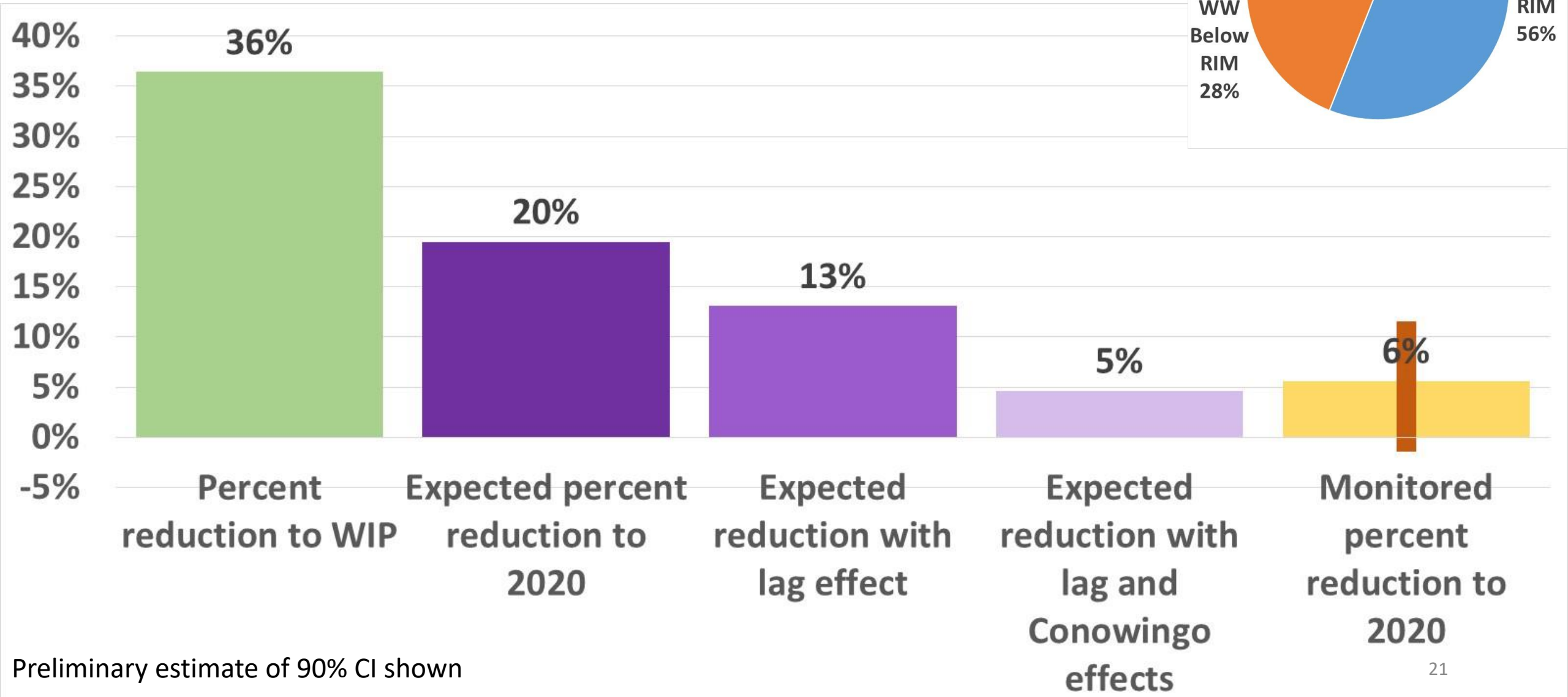
2017/2018 Presentations to WQGIT, MB, and PSC

Even when the jurisdiction and Conowingo WIPs are implemented, the monitored load will still be 7 million lbs N and 1.5 million lbs P higher because of this availability conversion effect

Put another way, the Conowingo infill has raised the loads by 13 million pounds N, but has also raised the assimilative capacity by 7 million lbs N

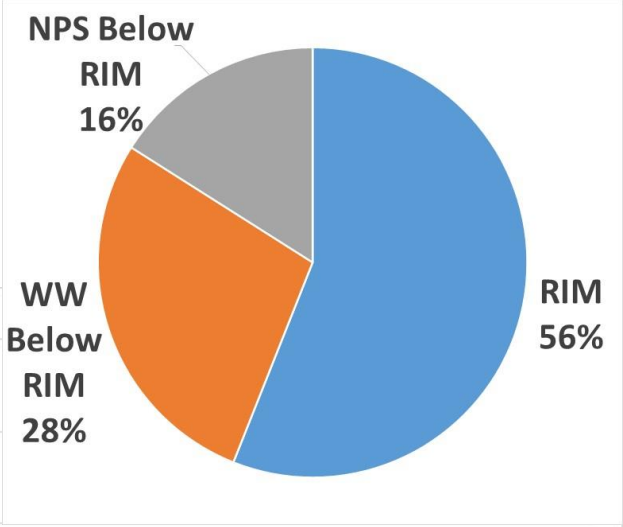
Lags and Conowingo account for major differences between Modeling and Monitoring

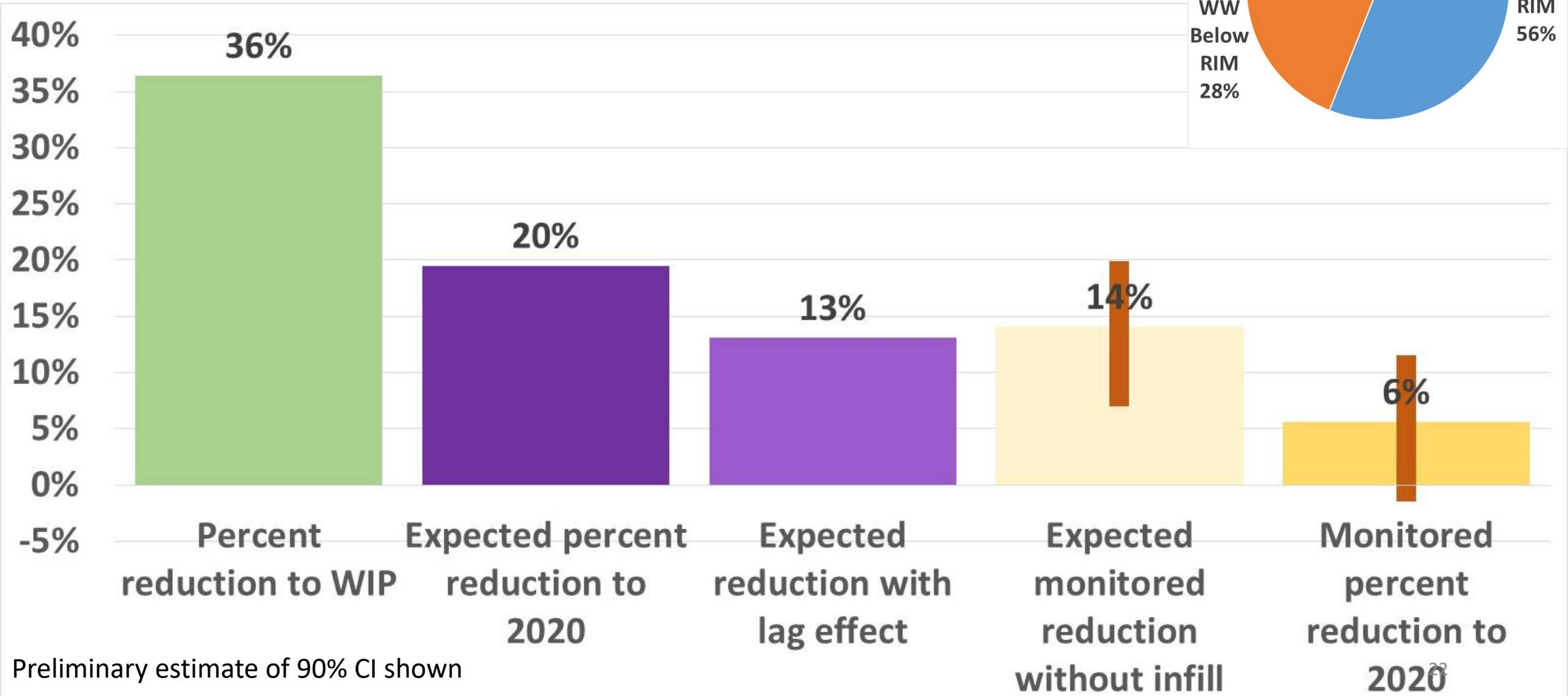




Preliminary estimate of 90% CI shown

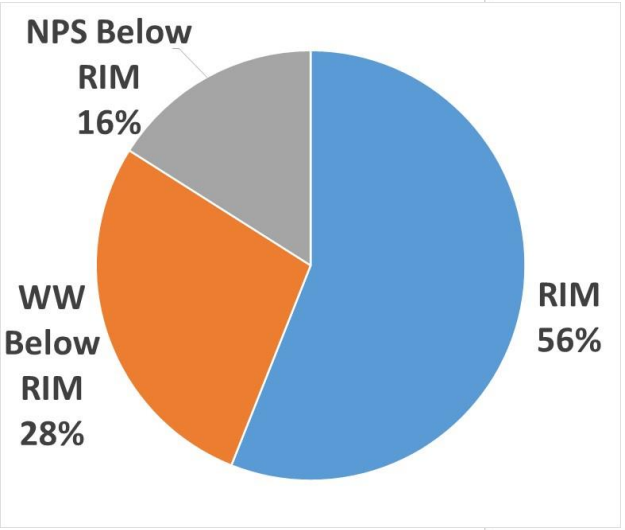
Lags and Conowingo account for major differences between Modeling and Monitoring

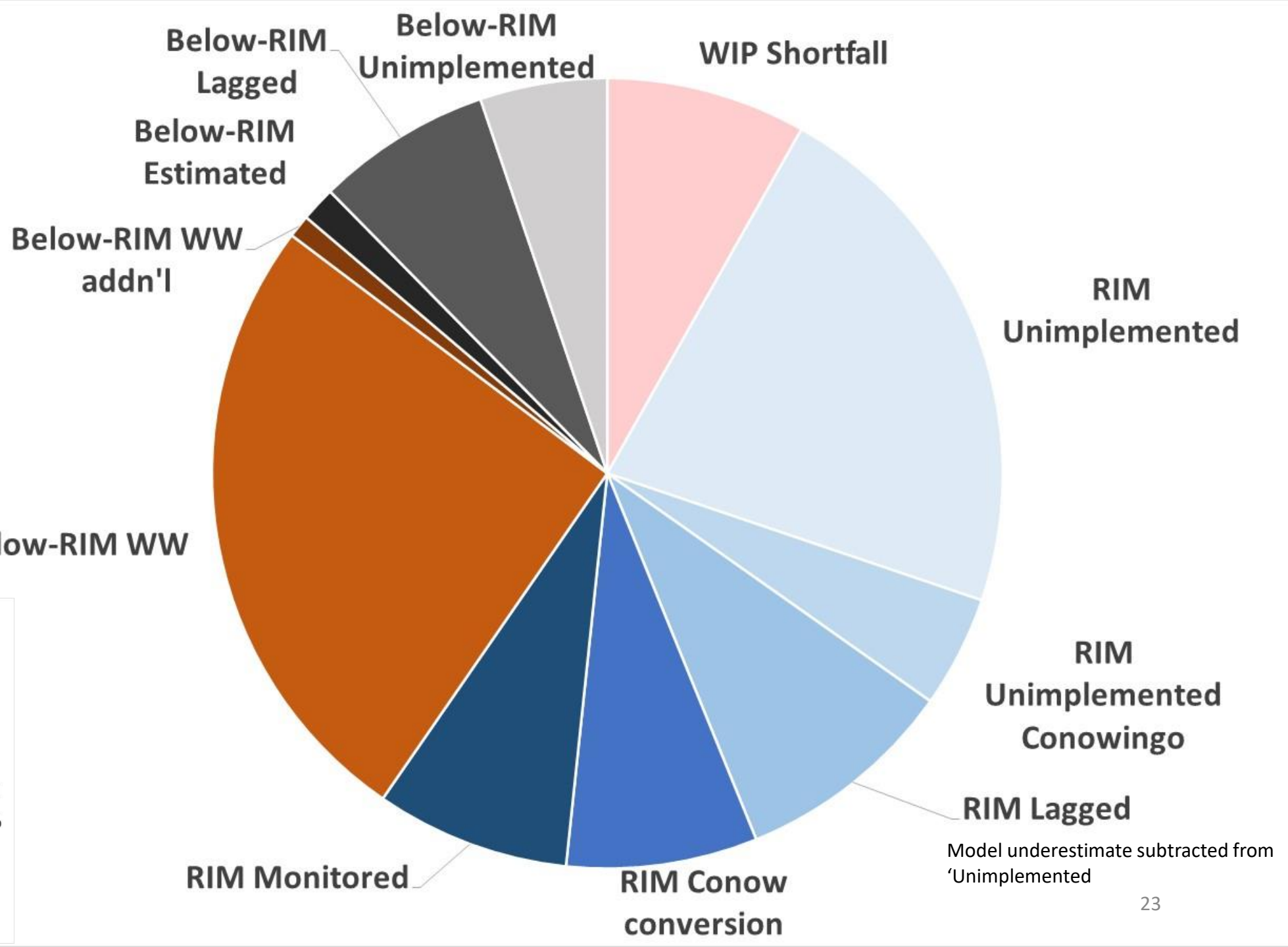




Preliminary estimate of 90% CI shown

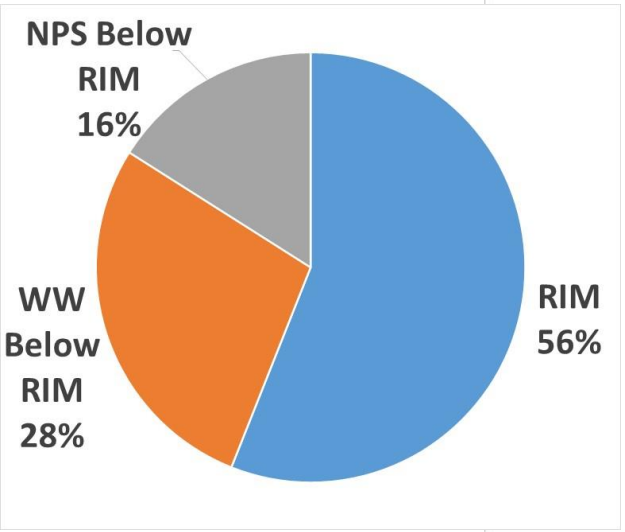
Overall indicator of TMDL N reductions

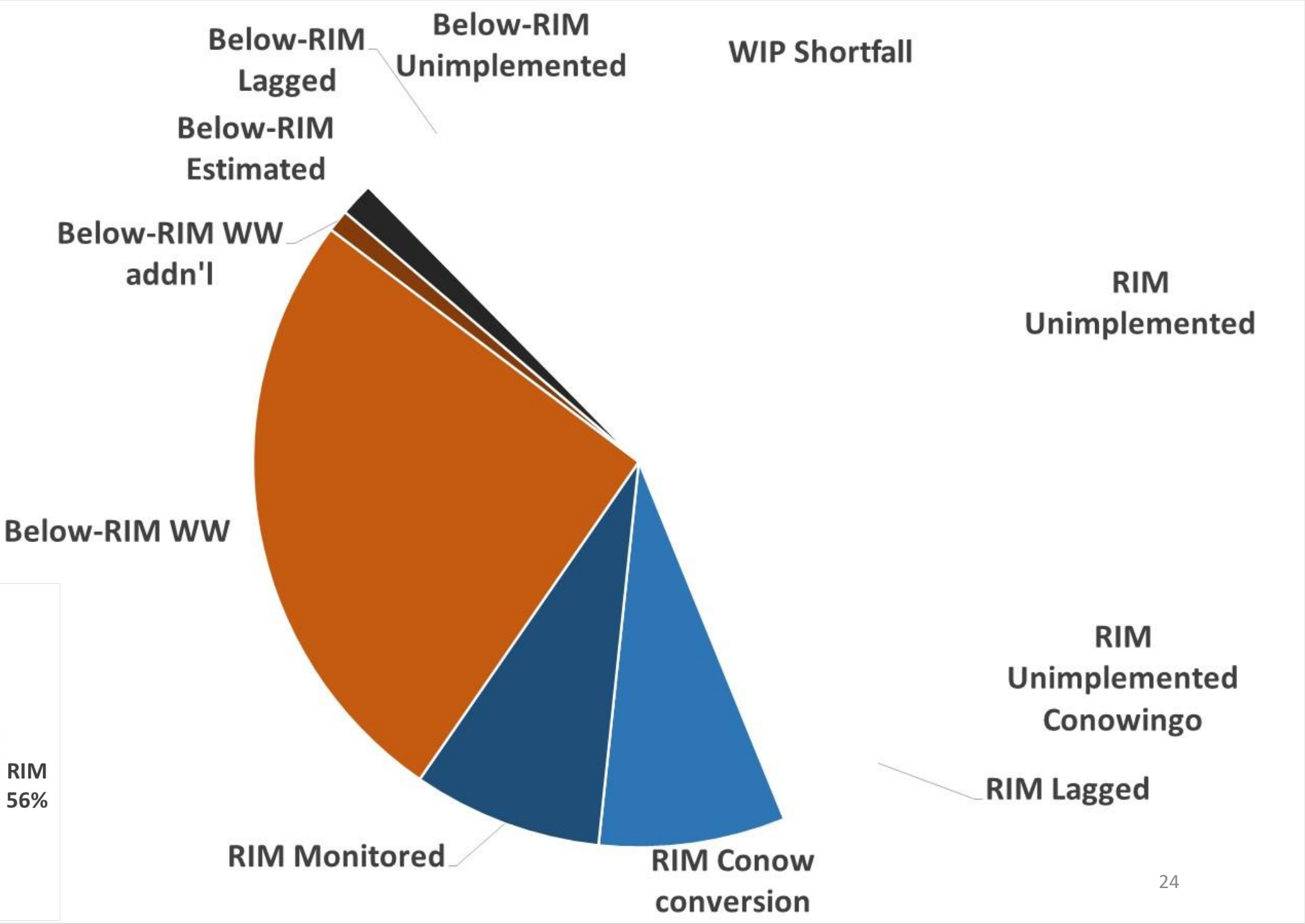




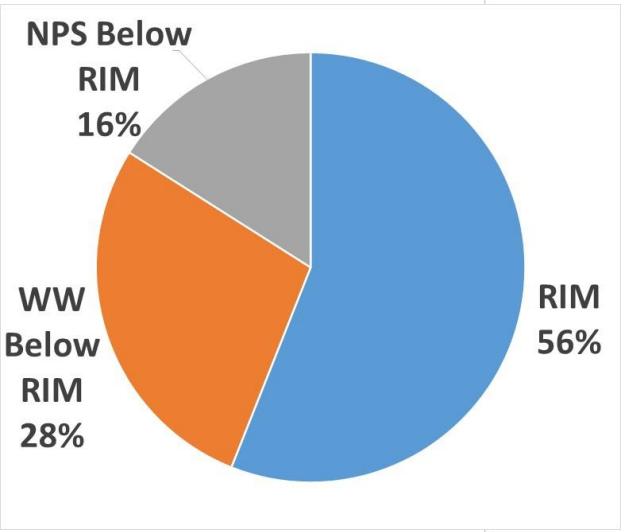
Model underestimate subtracted from 'Unimplemented

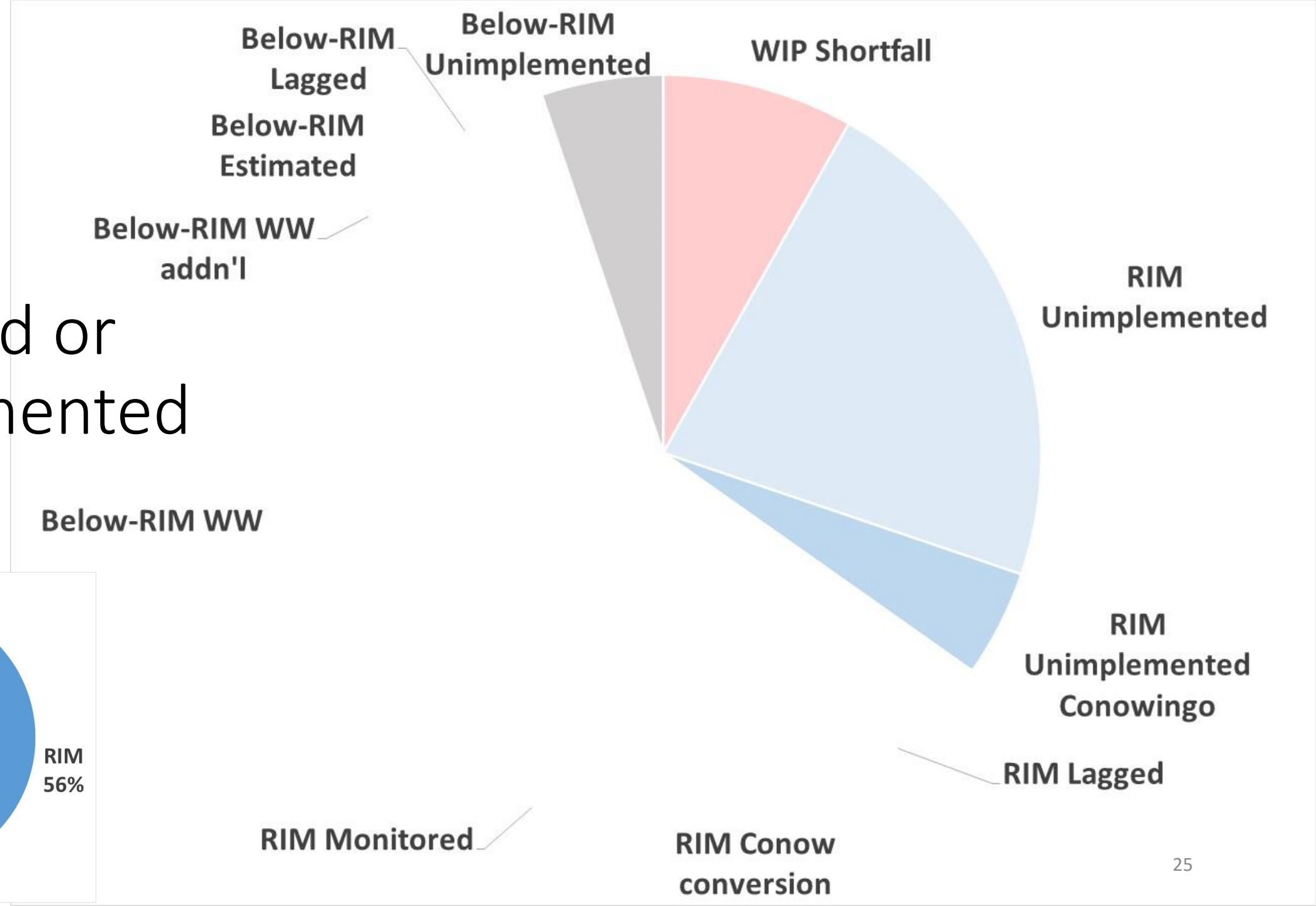
The bay has seen 44%



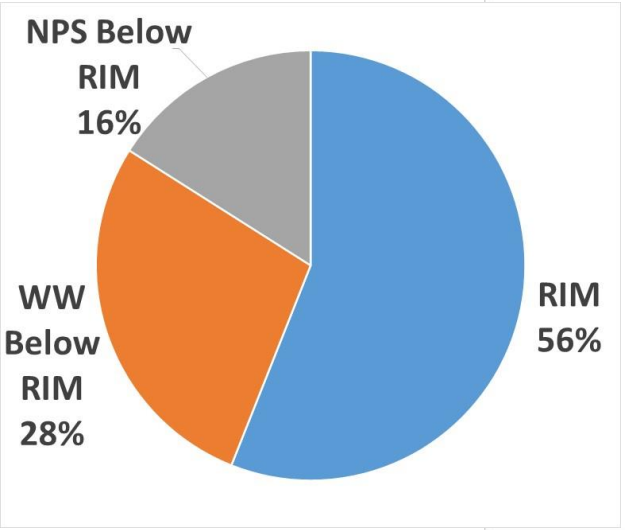


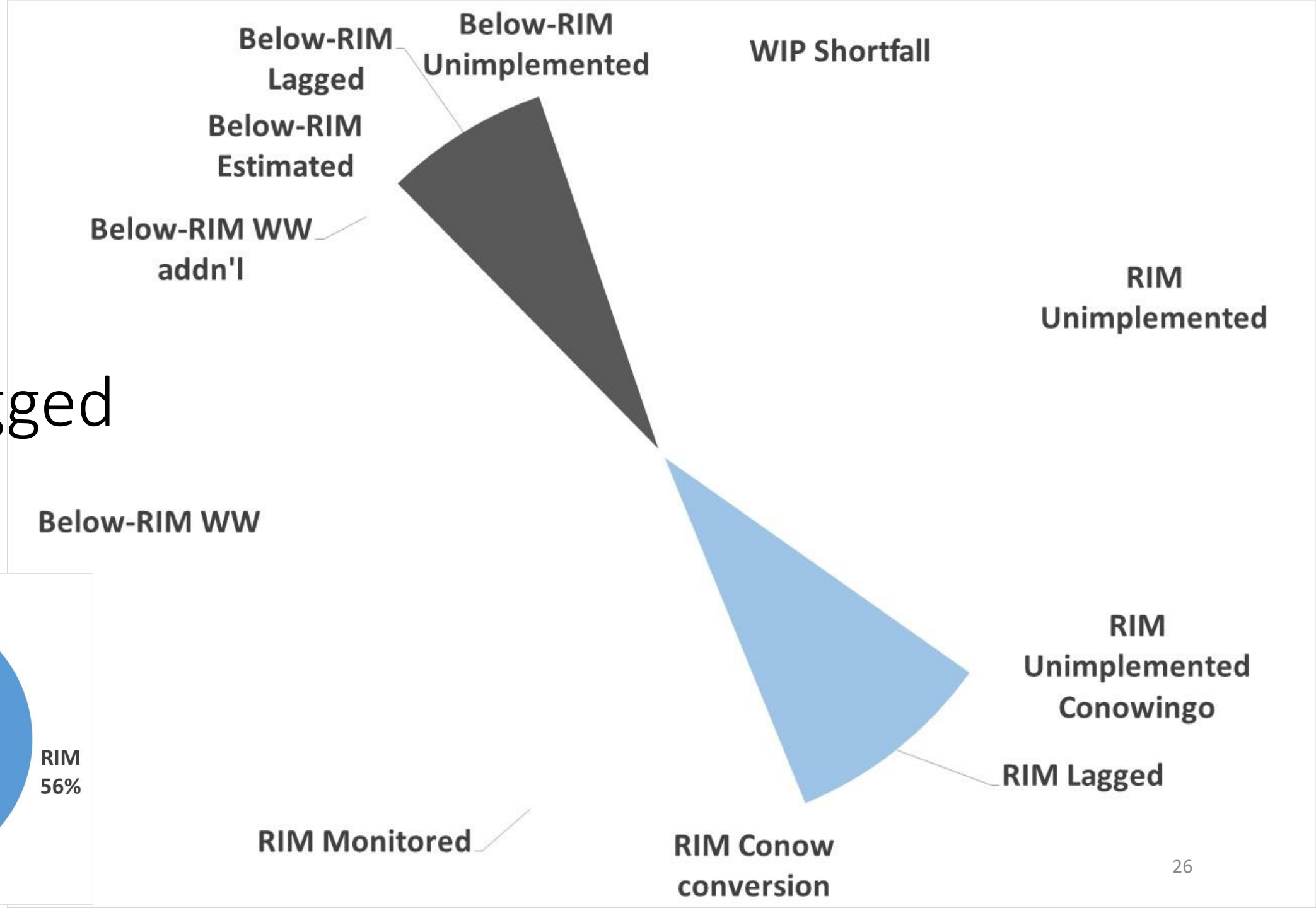
40% is unplanned or unimplemented



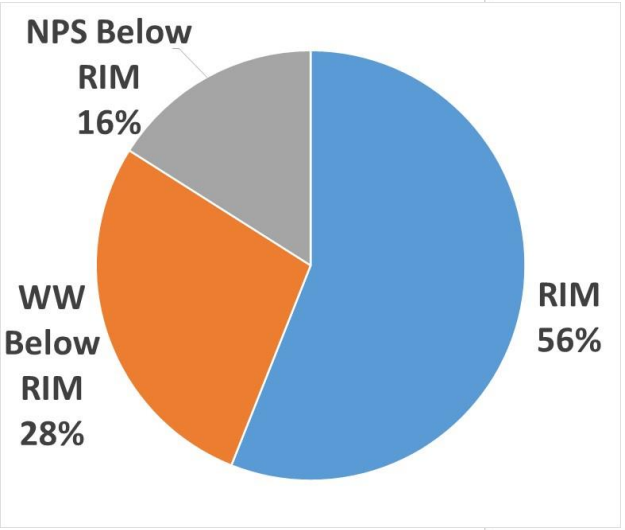


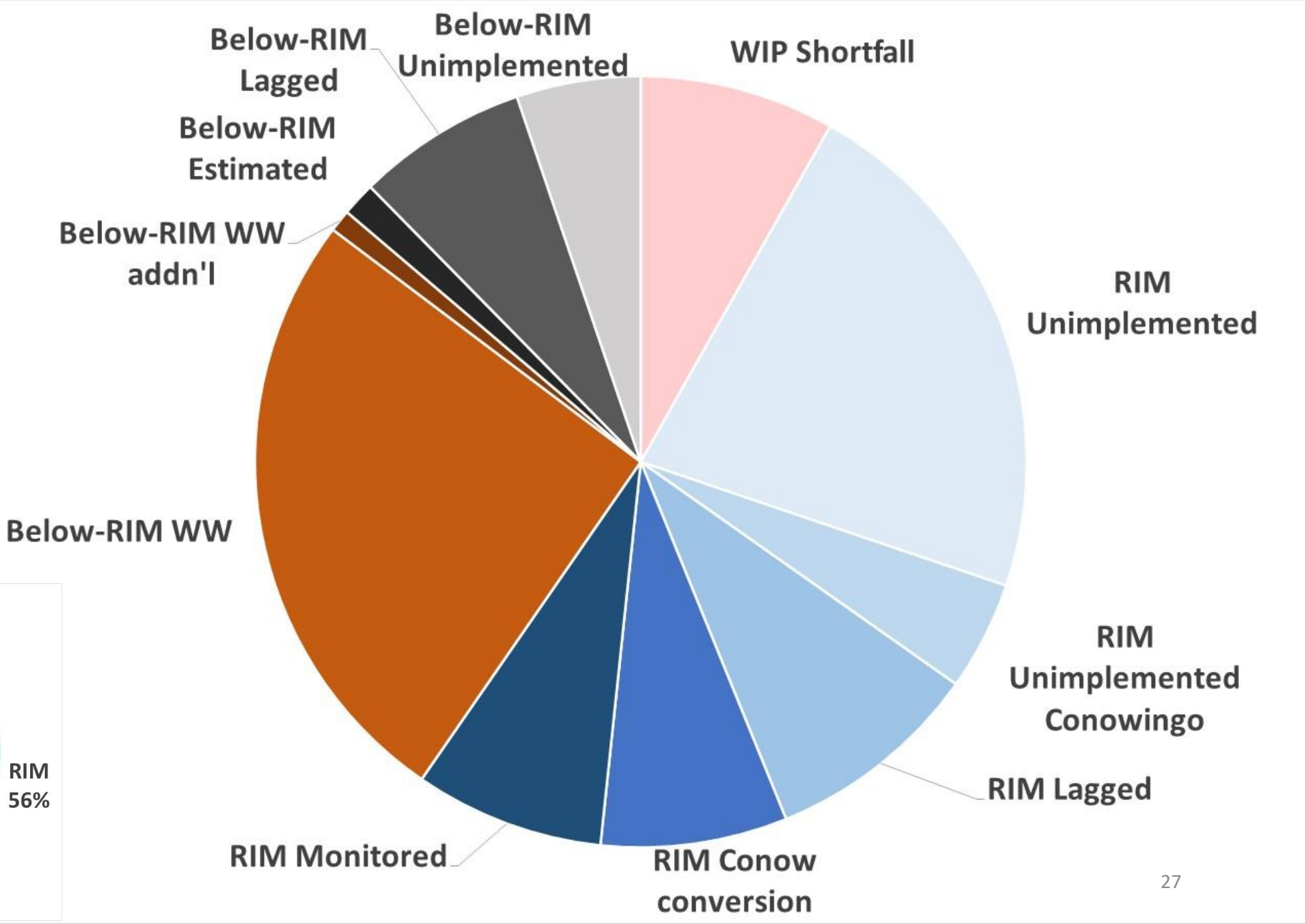
16% is lagged


NPS Below RIM 16%
WW Below RIM 28%
RIM 56%

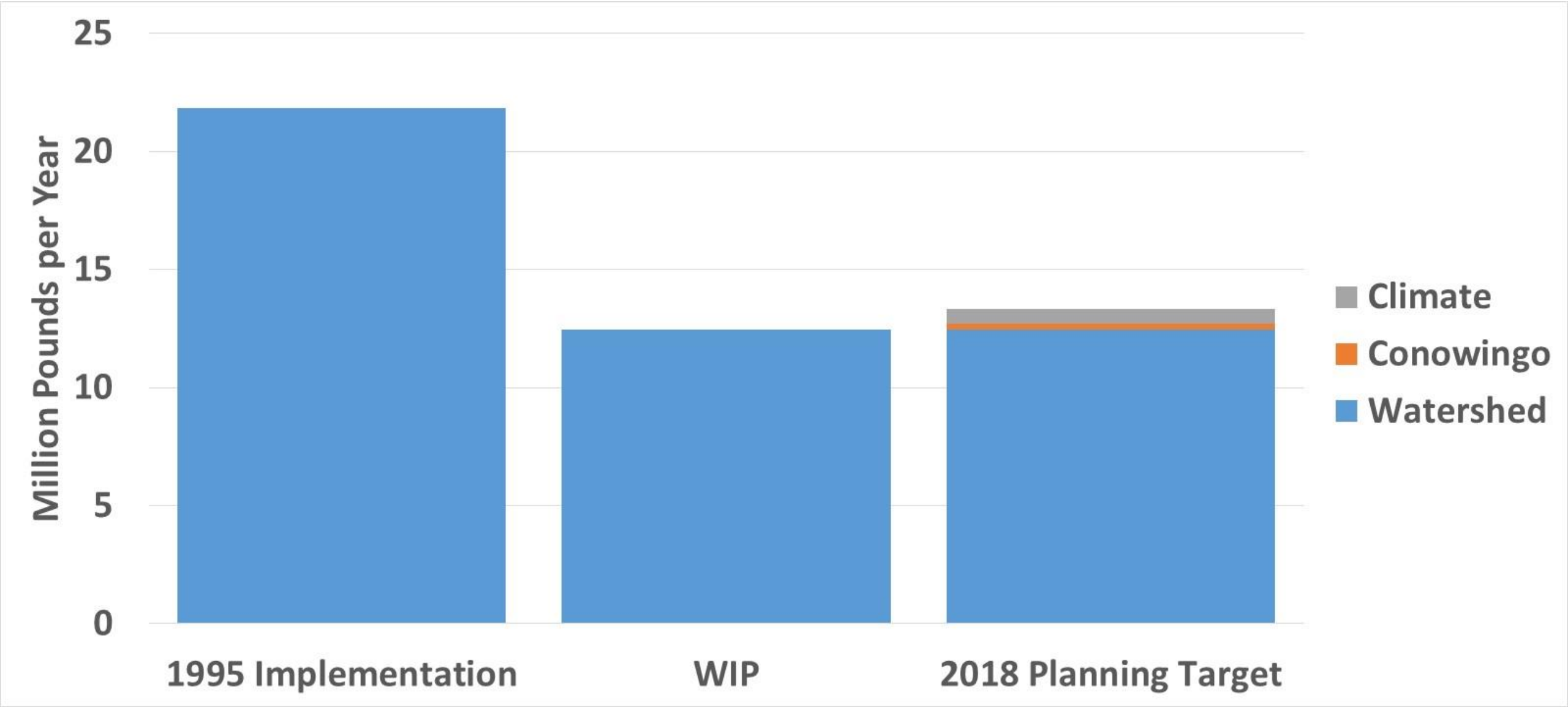

Below-RIM Lagged
Below-RIM Unimplemented
WIP Shortfall
Below-RIM Estimated
Below-RIM WW addn'l
RIM Unimplemented
Below-RIM WW
RIM Unimplemented Conowingo
RIM Lagged
RIM Monitored
RIM Conow conversion

Overall indicator of TMDL N reductions

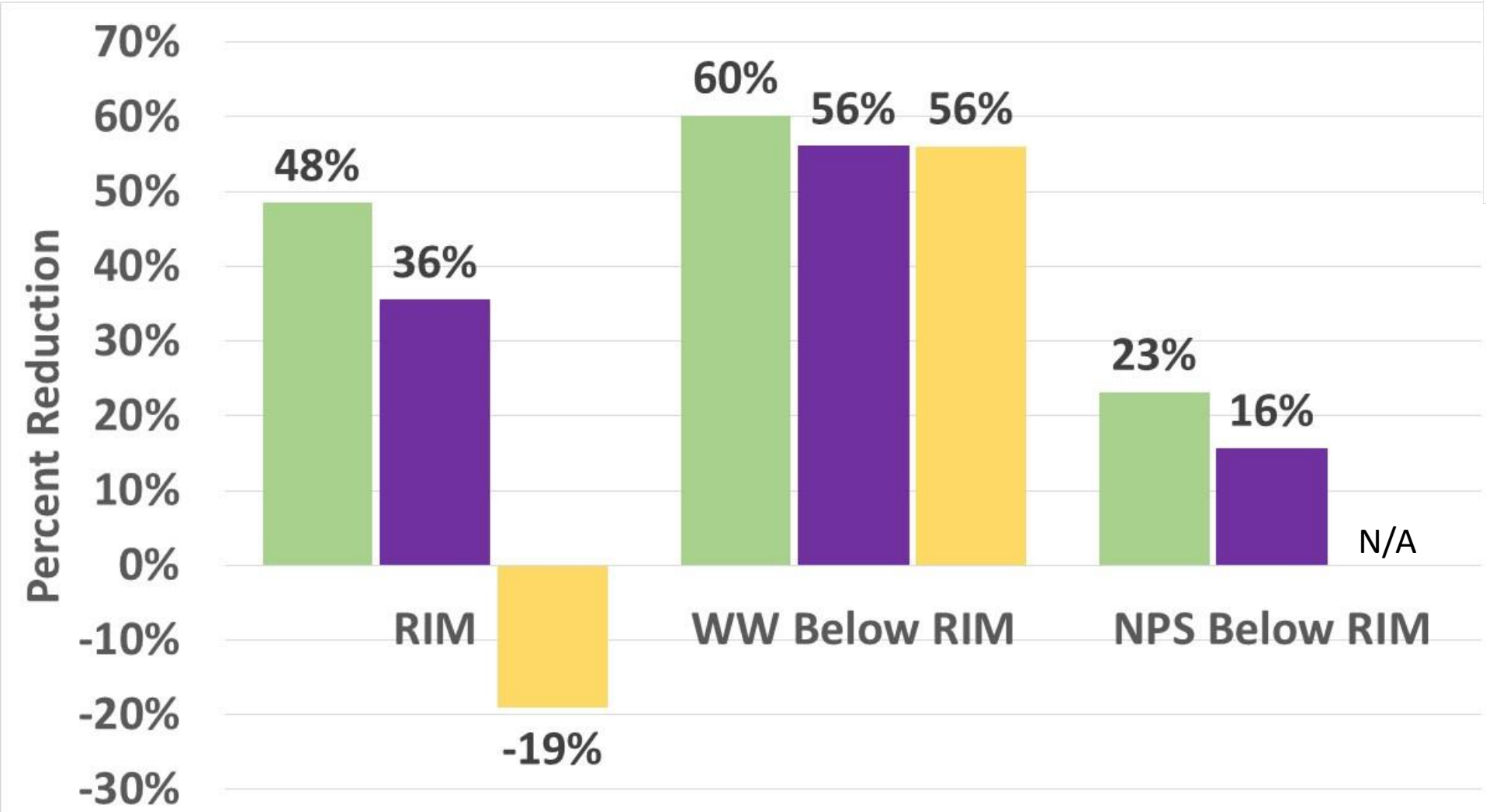


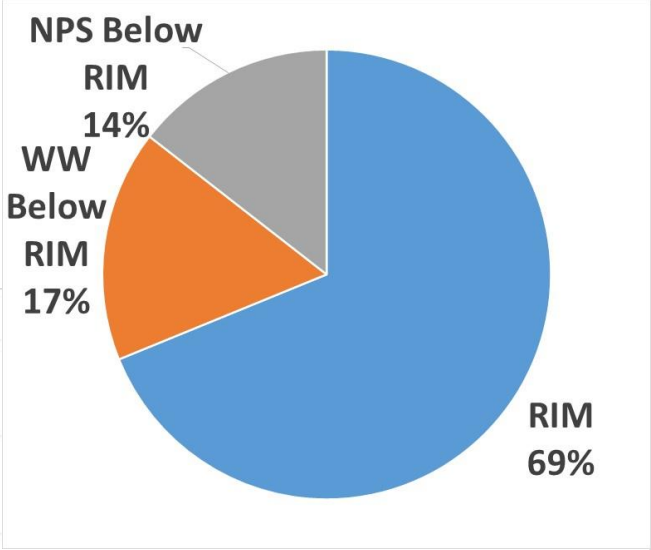


Phosphorus Reductions

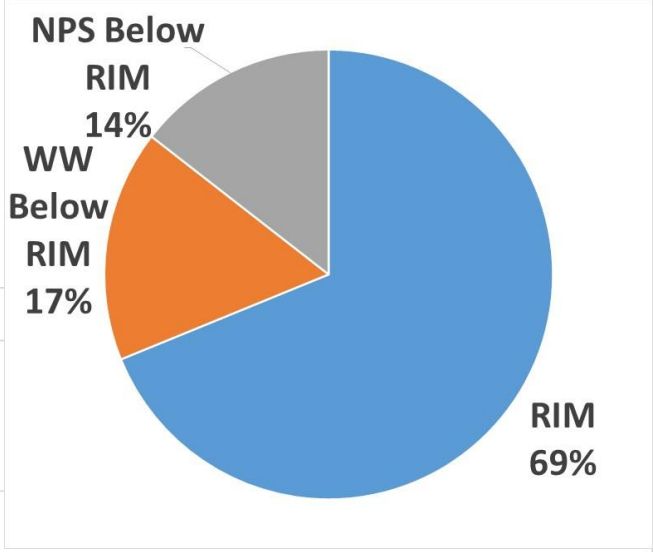


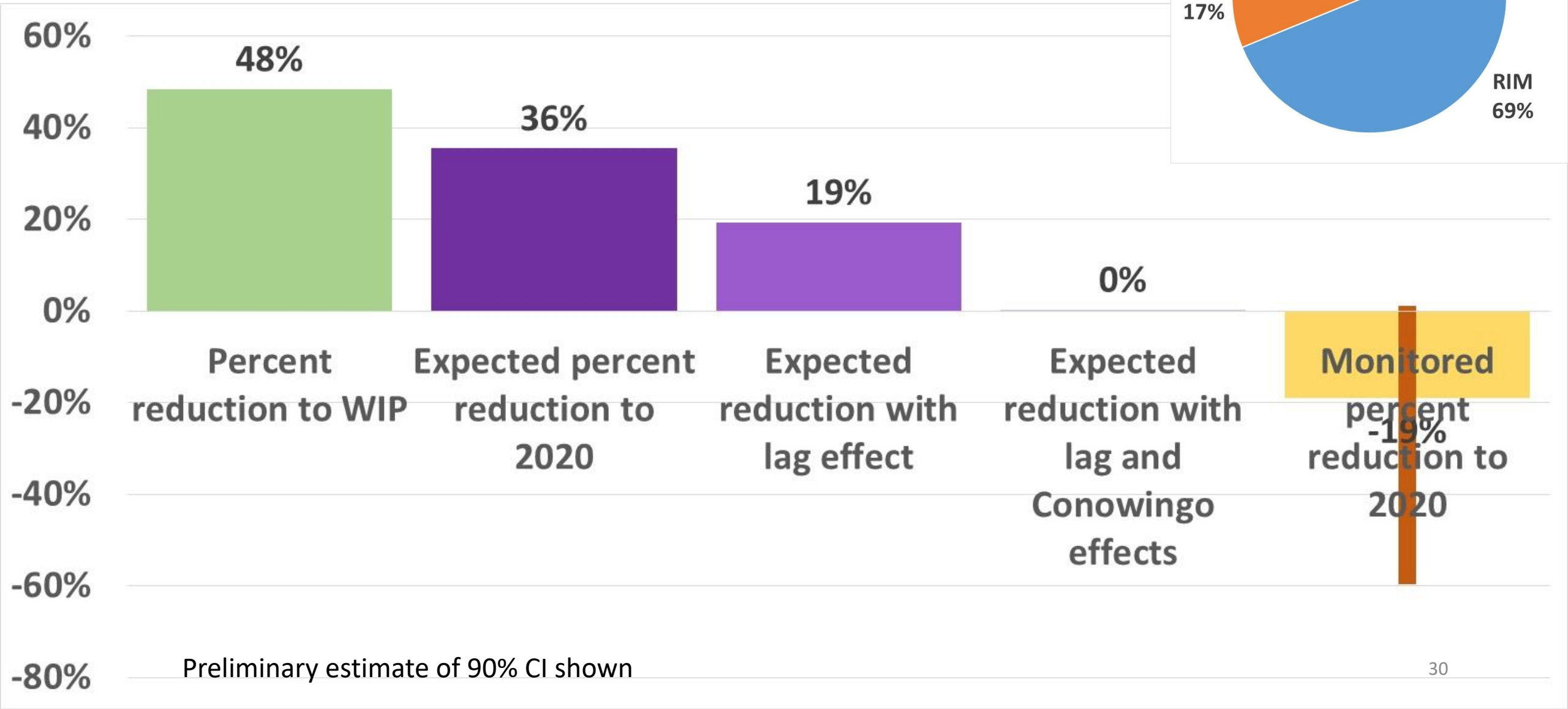
Phosphorus is mostly implemented, but monitoring results show increases





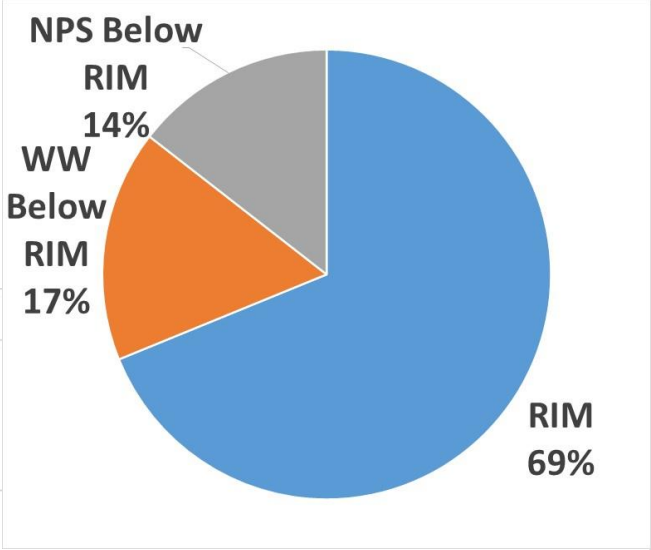
Lags and Conowingo account for more than half of the difference

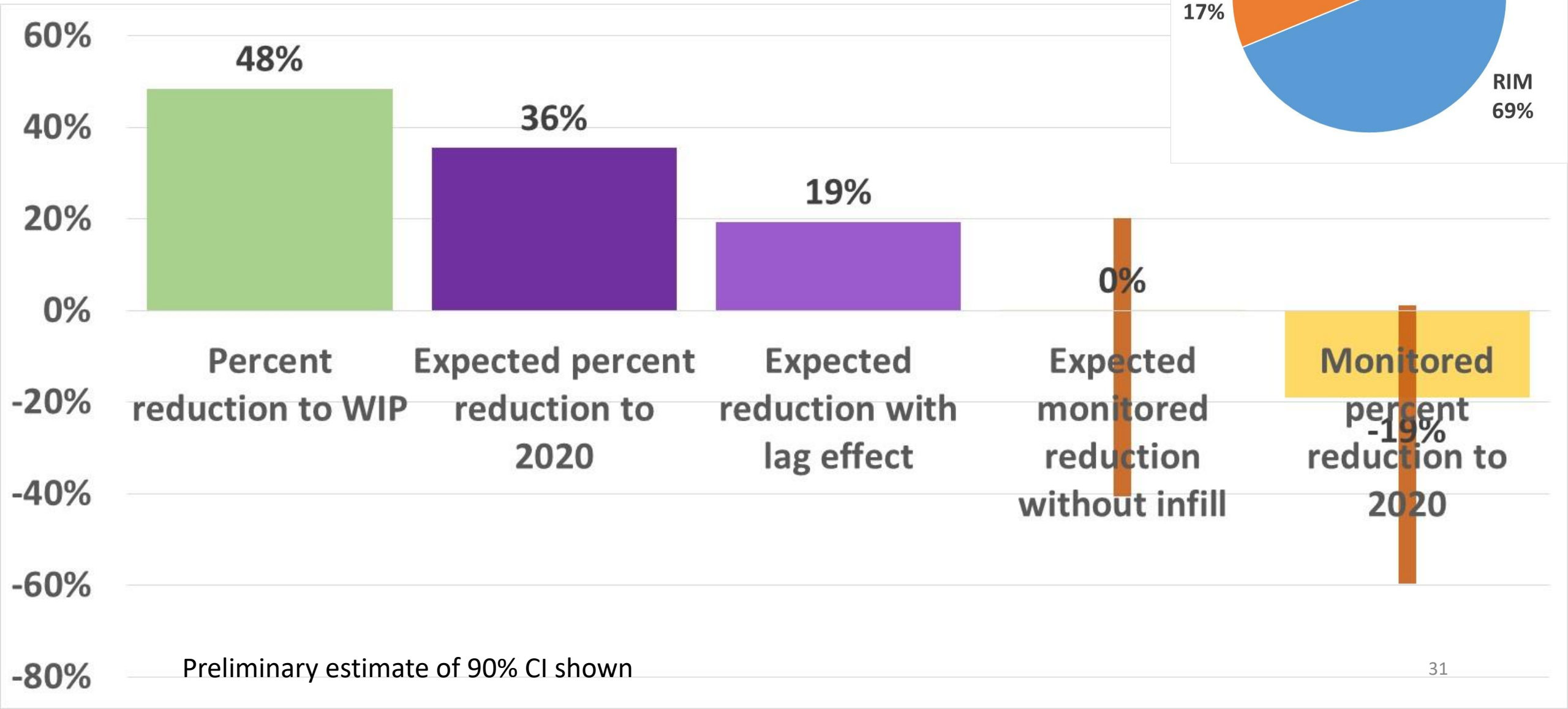




Preliminary estimate of 90% CI shown

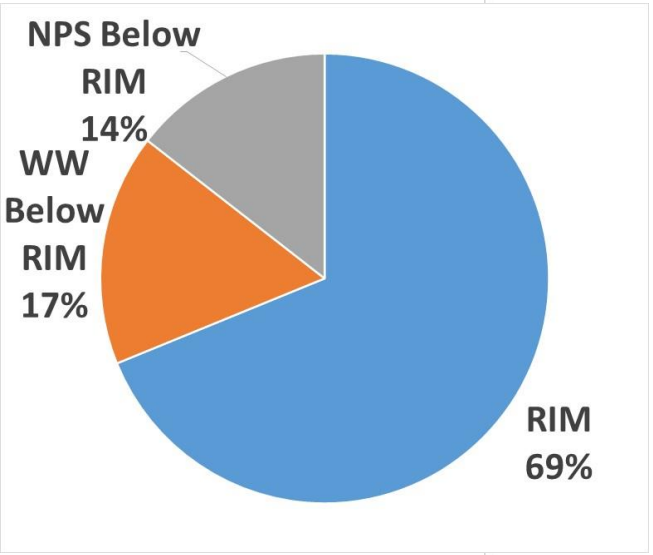
It is likely that unaccounted increases are occurring in the watershed

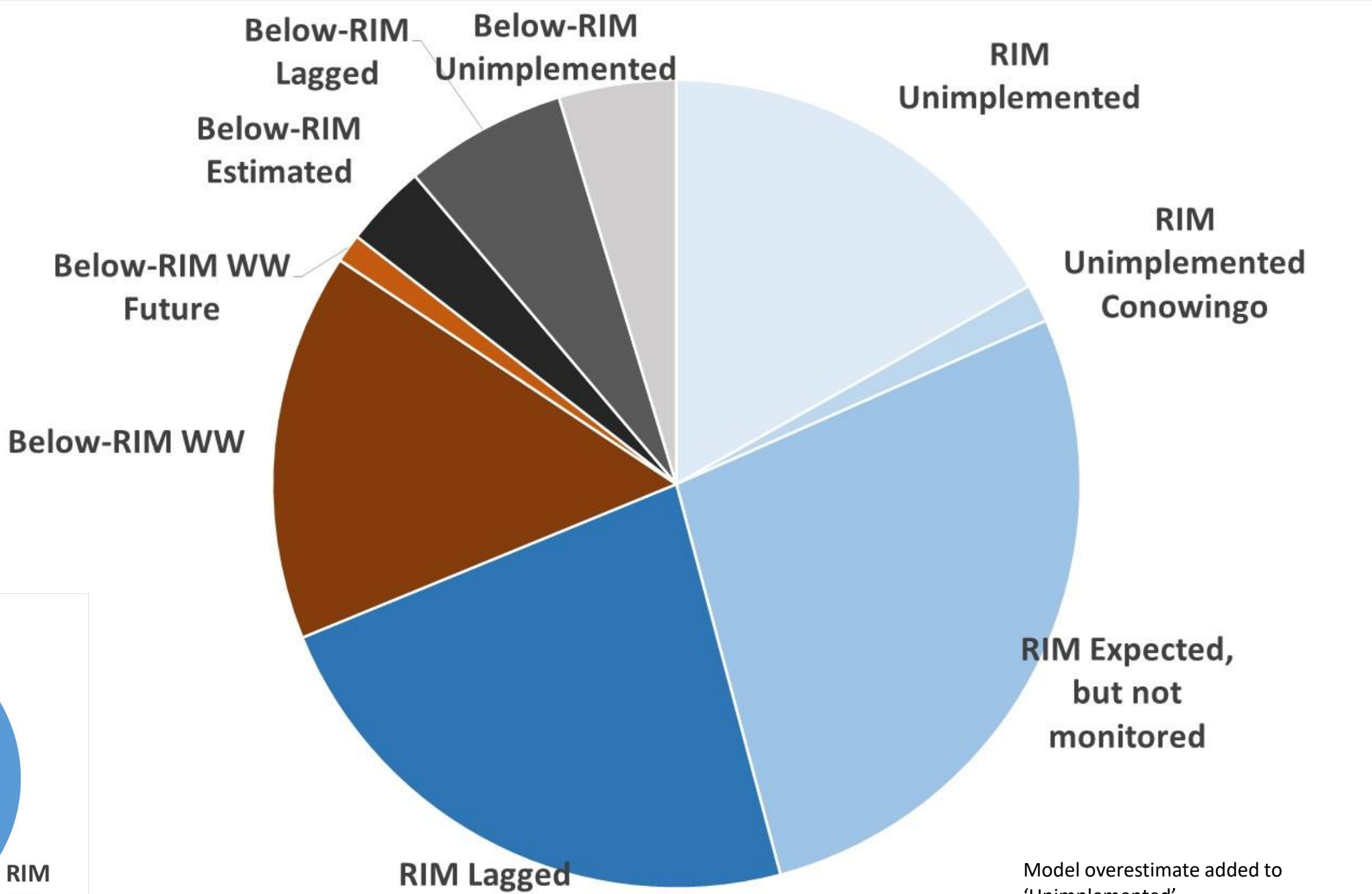




Preliminary estimate of 90% CI shown

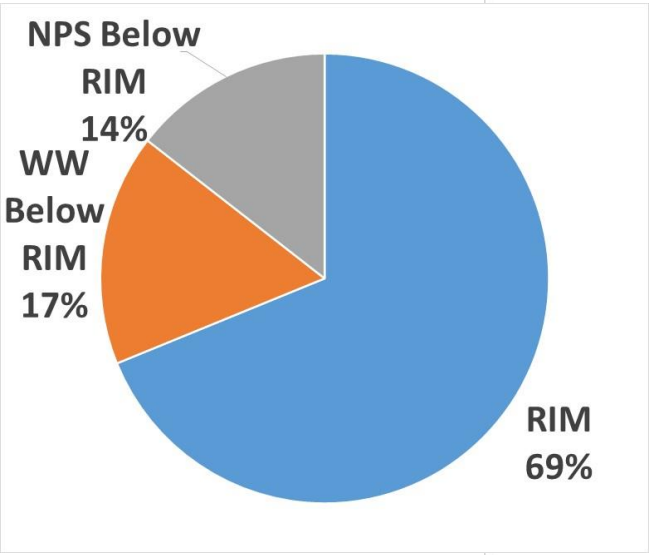
Overall indicator of TMDL P reductions

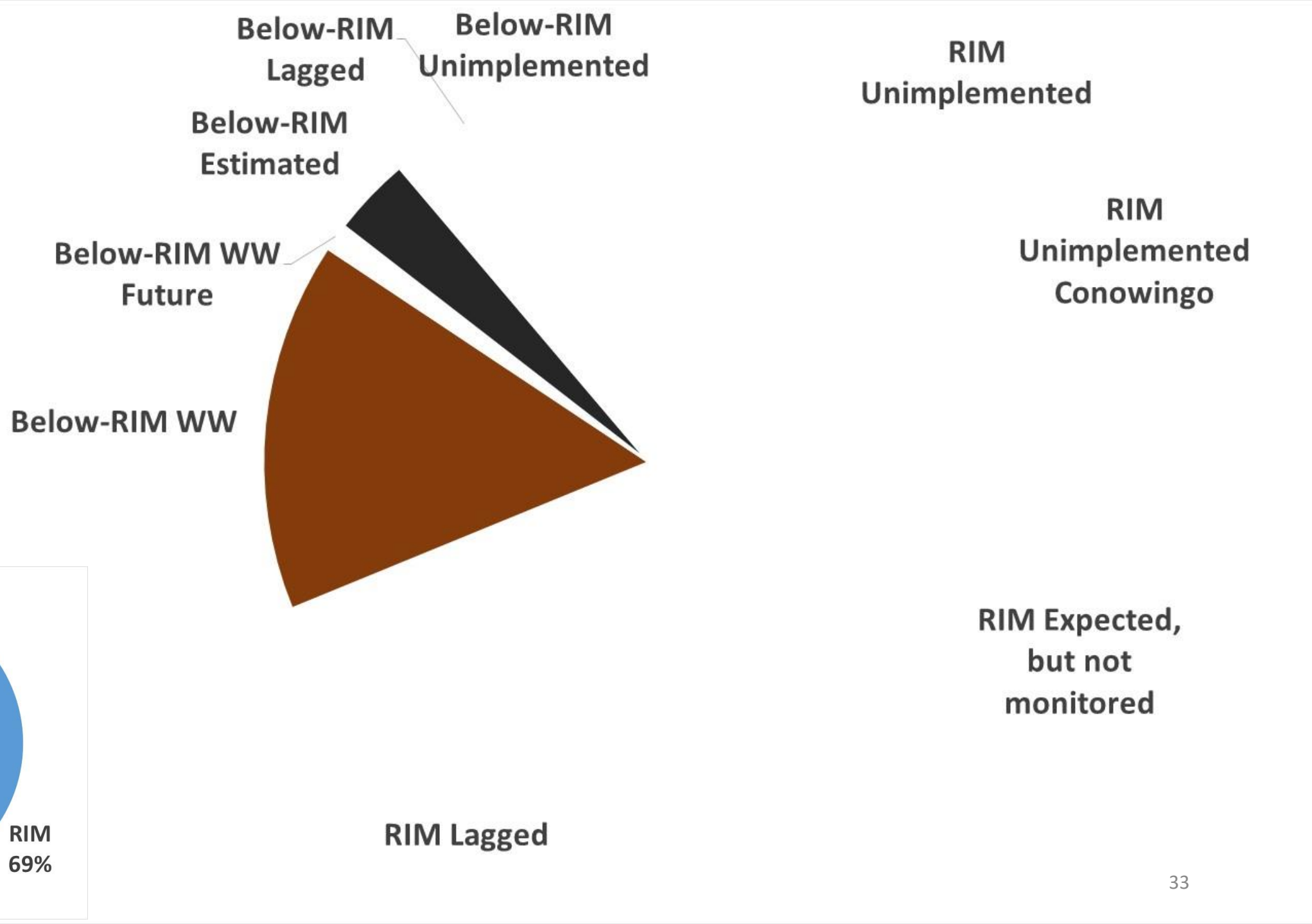


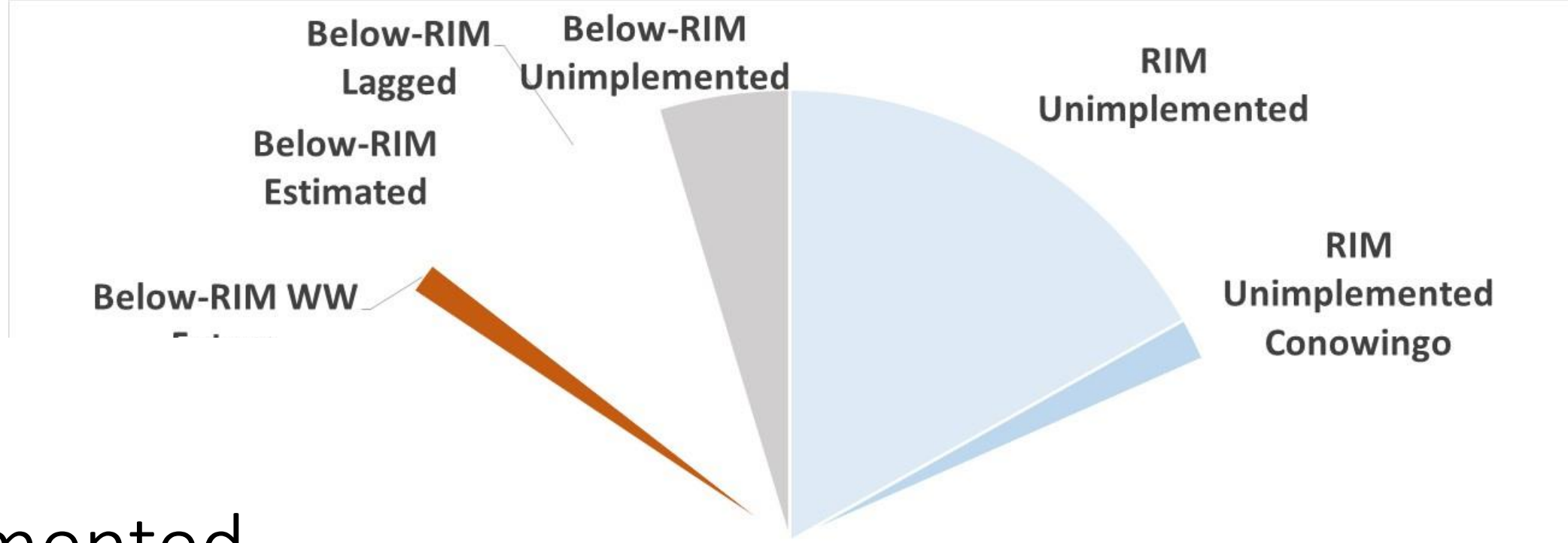


Model overestimate added to 'Unimplemented'

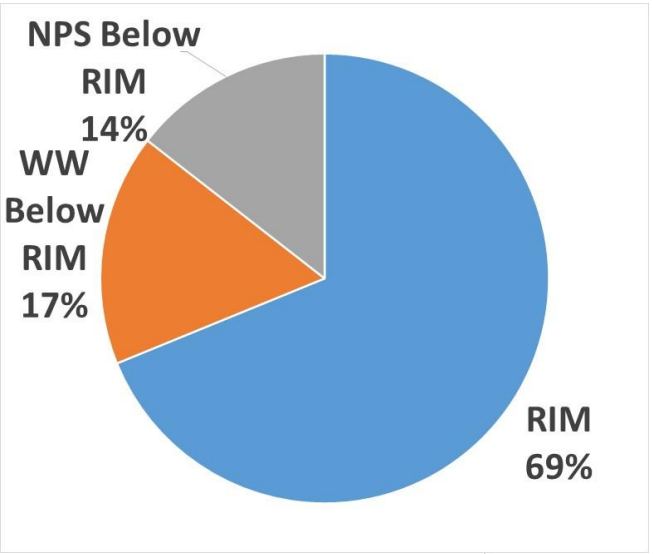
The bay has seen 19%







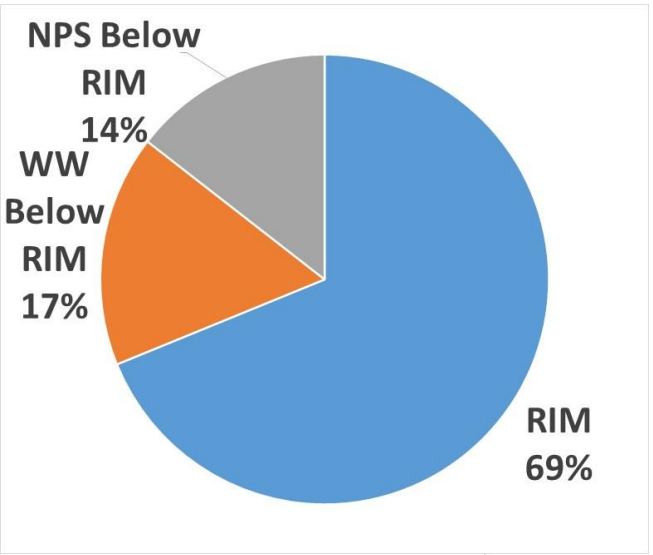
24% is unimplemented

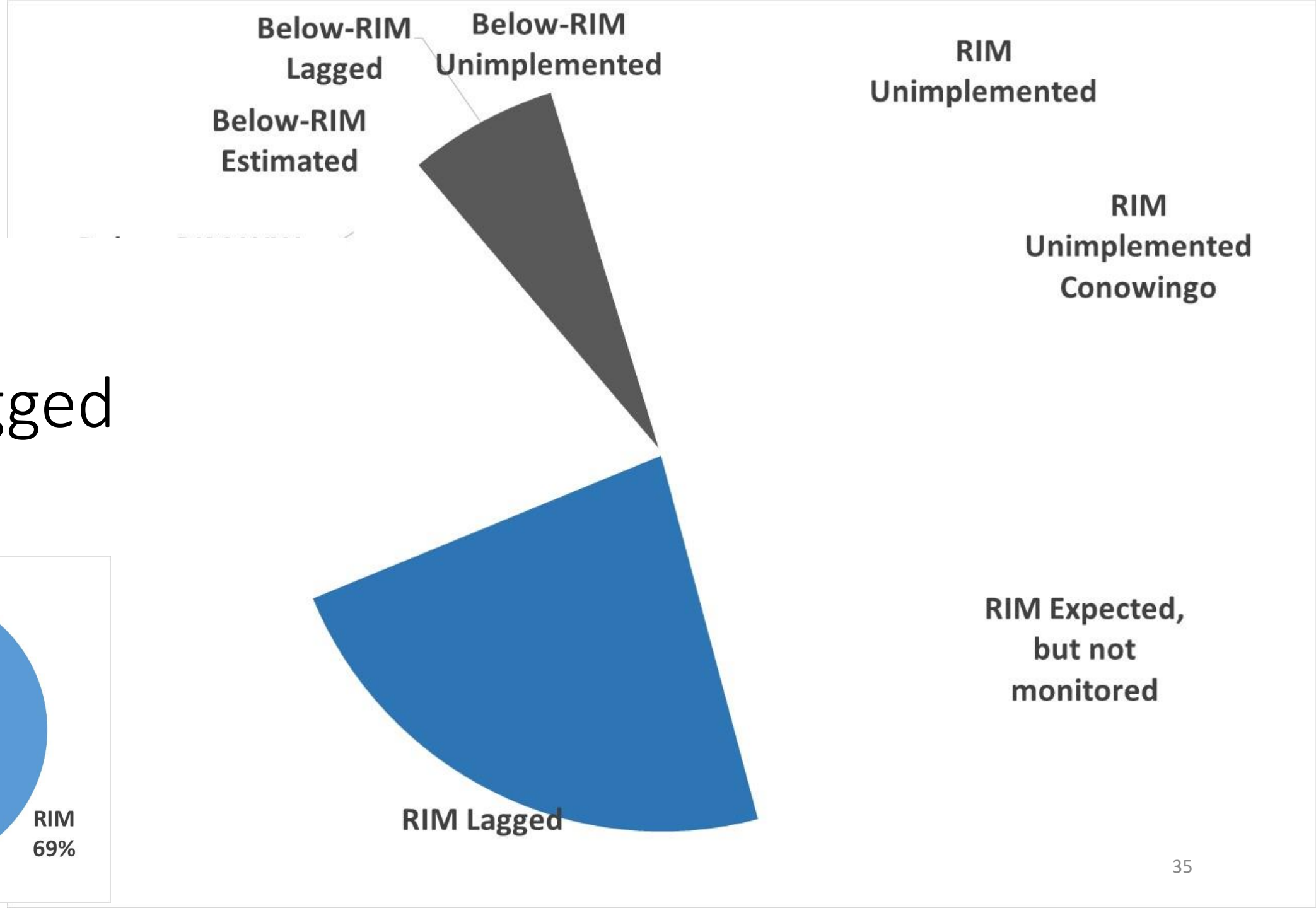


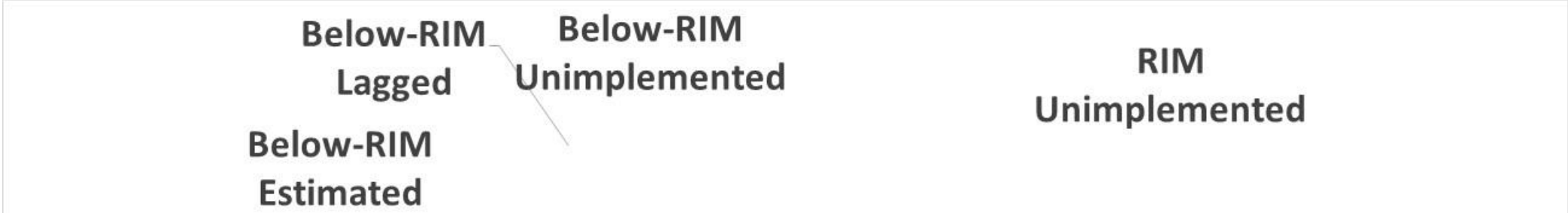
RIM Expected, but not monitored

RIM Lagged

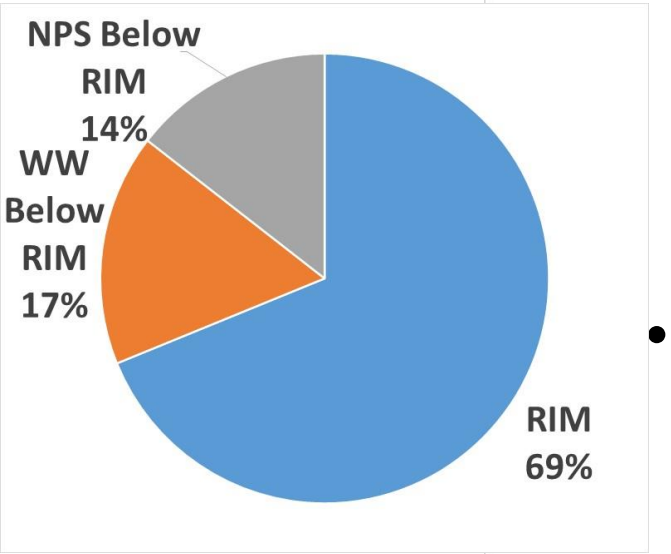
29% is lagged


NPS Below RIM 14%
WW Below RIM 17%
RIM 69%

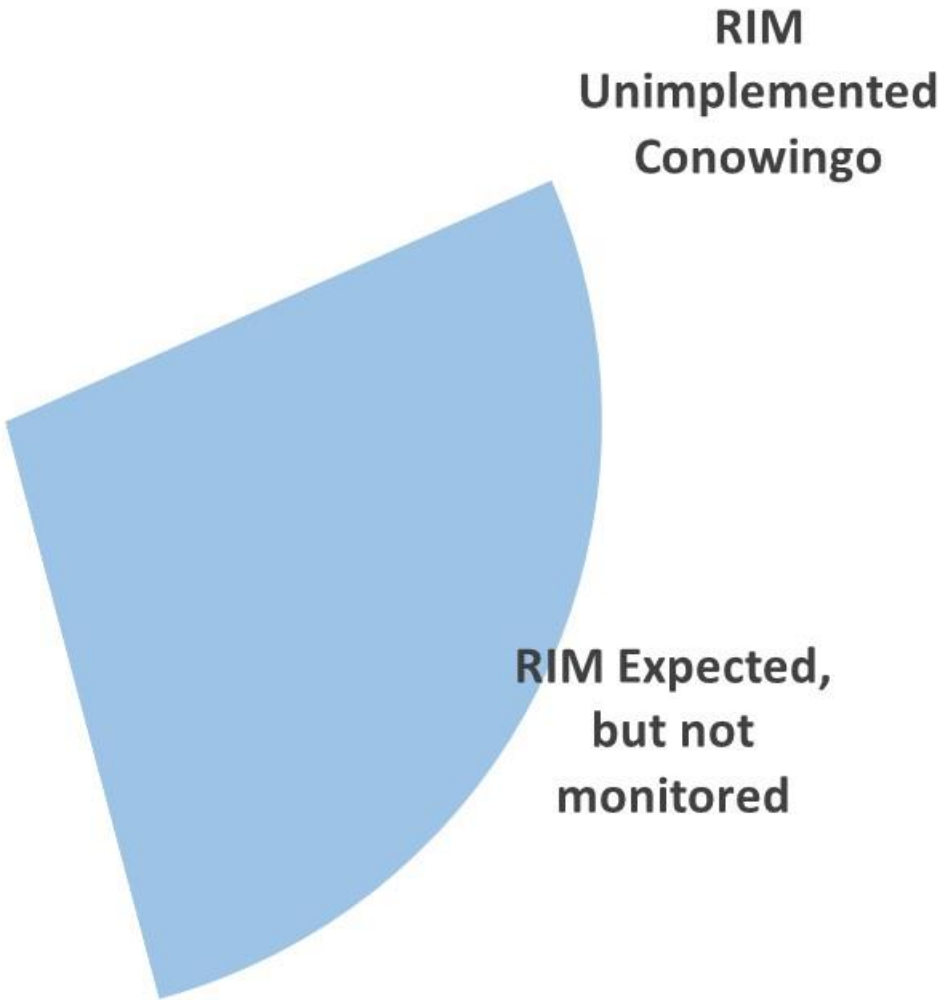

Below-RIM Lagged
Below-RIM Unimplemented
Below-RIM Estimated
RIM Unimplemented
RIM Unimplemented Conowingo
RIM Expected, but not monitored
RIM Lagged



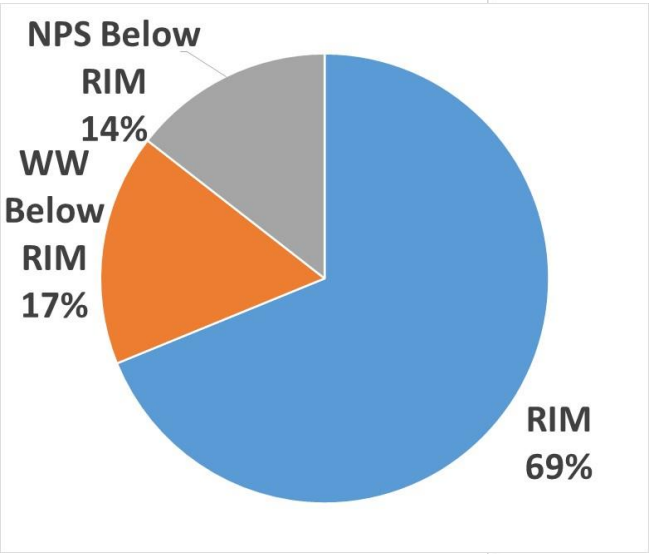
27% is the difference between modeled and monitored change

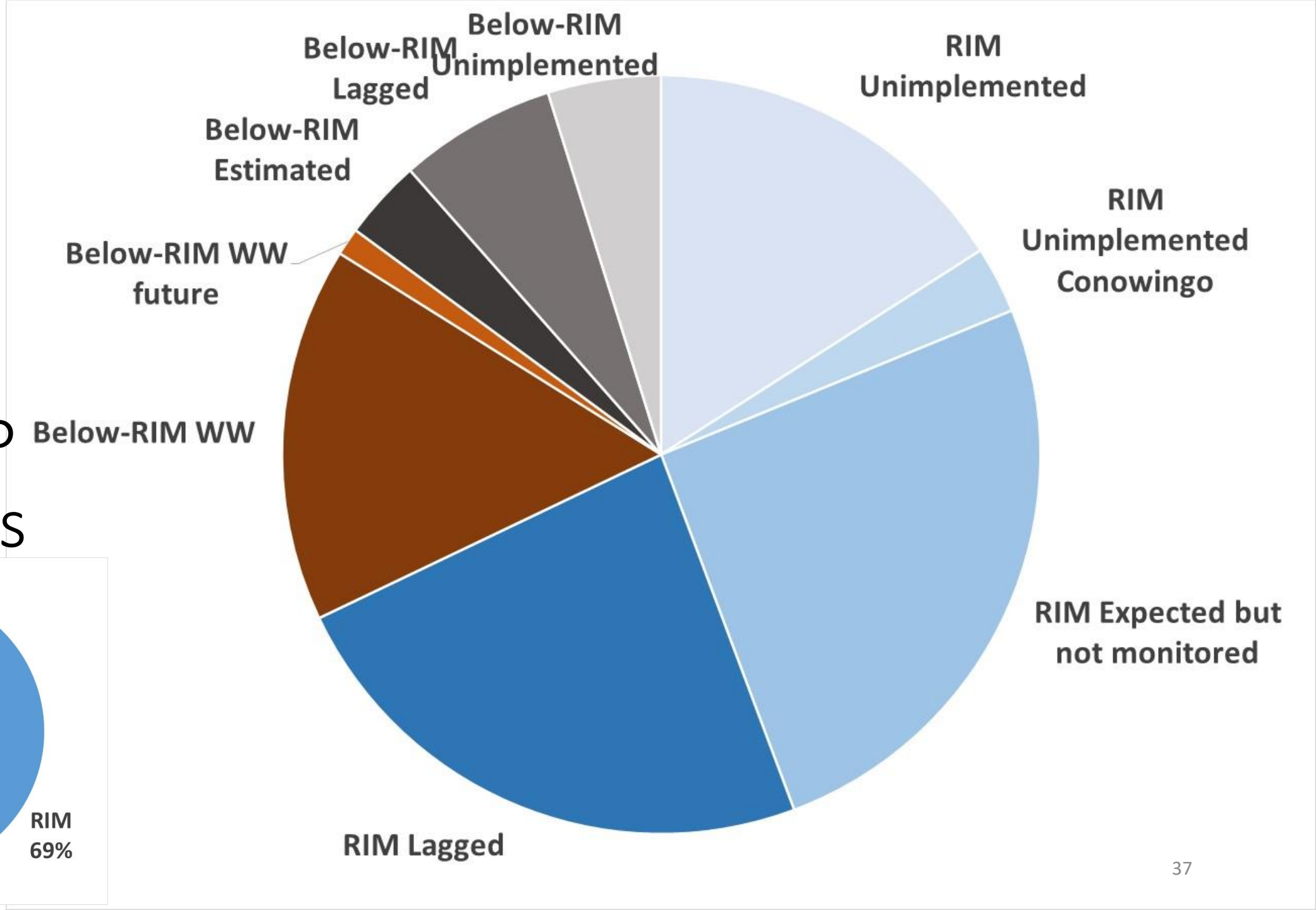


- Uncertainty in CAST
  - BMPs implemented
  - BMP effectiveness
  - Nutrient applications
  - Watershed response
- Uncertainty in “monitored” loads



Overall indicator of TMDL P reductions





Summary

- Indicator summarizes N and P progress toward the TMDL
- Divides load into
  - Implemented and realized
  - Implemented but unrealized due to lag
  - Implemented but unrealized due to uncertainty
  - Not implemented