Patuxent River Case Study: Robust Decision Making Applied to Urban Stormwater Management

STAC Workshop: The Development of Climate Projections for Use in Chesapeake Bay Program Assessments

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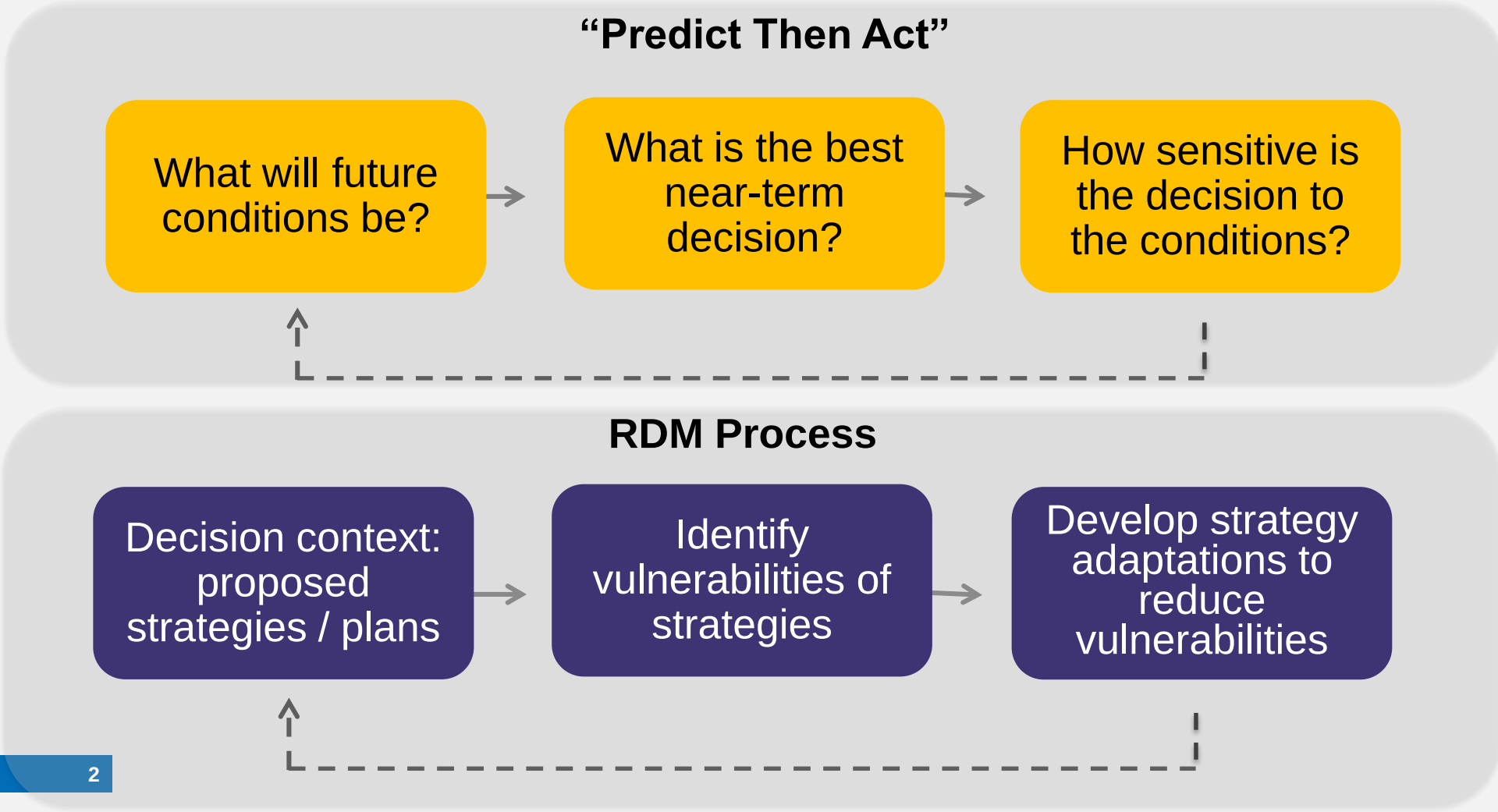
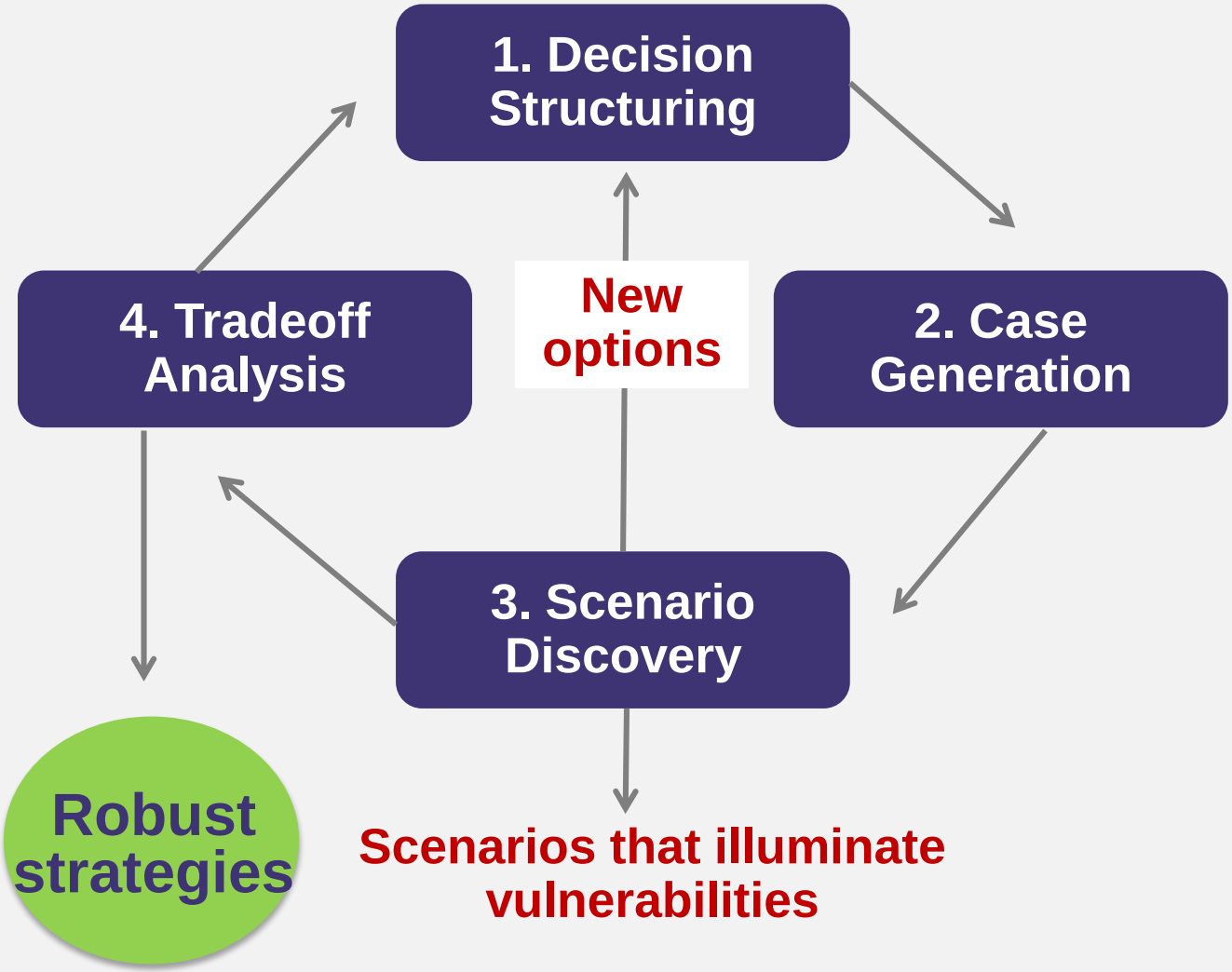
Robust Decision Making (RDM) works under deep uncertainty by running the analysis backwards



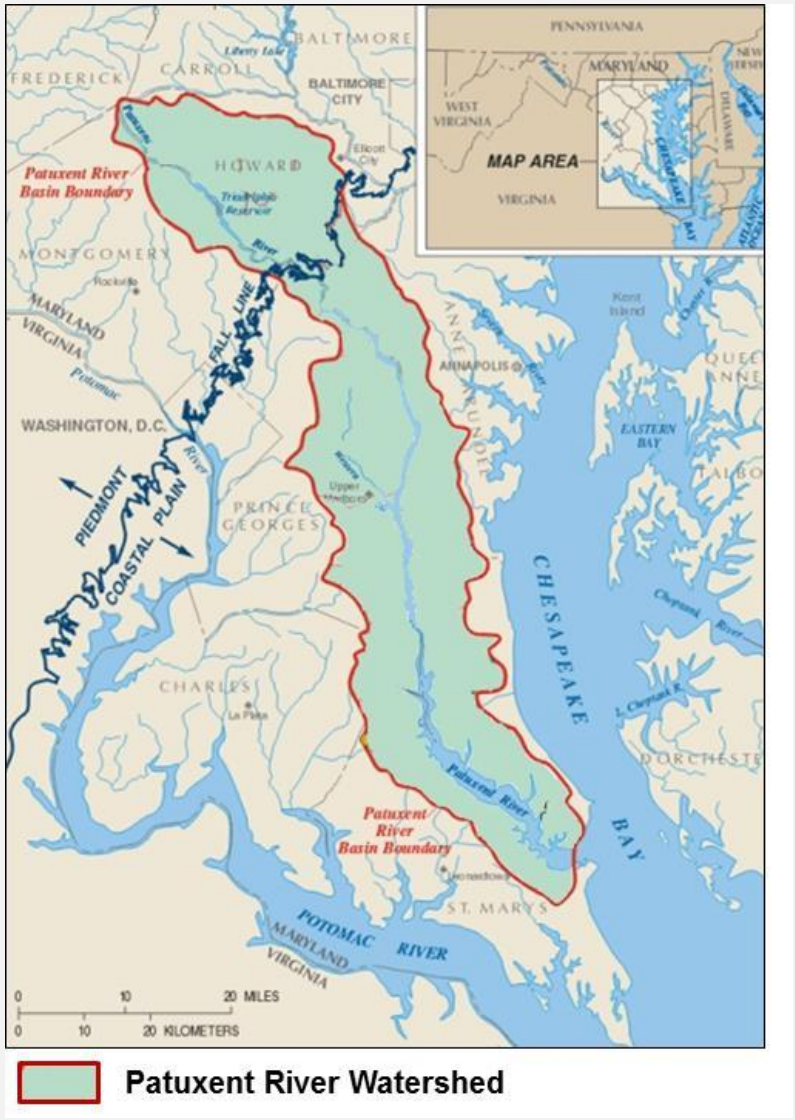
RDM Uses Analytics to Facilitate New Conversations Among Decisionmakers

RDM is *iterative*; analytics facilitate stakeholder deliberation



The Patuxent is a Highly Urbanized Watershed with Stormwater Management Challenges

- Urban runoff carries pollutants into the Patuxent River
- Pollutants create harmful conditions for fish, shellfish, and other key species
- Climate change and urban growth can exacerbate these challenges



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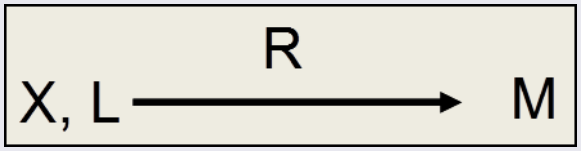
"XLRM" Framework Helps Organize Key Factors Considered in the Analysis

Uncertain Factors (X)	Policy Levers (L)
What uncertain factors outside decision makers' control affect their ability to pursue their goals?	What actions might they take to pursue their goals?
Relationships (R)	**Performance Metrics (M)**
How might policy levers (L) and uncertainties (X) be related to decision makers' goals (M)? 	What are decision makers trying to achieve?

Scoping Using the XLRM Framework

Uncertain Factors (X)

Hydrology and climate change

- Observed historical hydrology (1984-2005)
- Downscaled climate scenarios

Land use

- Population growth (2010-2050)
- Infill, sprawl, and forest conservation

Evapotranspiration model parameters

Policy Levers (L)

MDE Phase II Watershed Implementation Plan BMPs, including:

- Stormwater management-filtering practices
- Stormwater management-infiltration practices
- Urban stream restoration
- Urban forest buffers

System Model Relationships (R)

Phase 5.3.2 Chesapeake Bay Watershed Model

- Airshed model
- Land use change model
- Watershed model

Performance Metrics (M)

Metrics

Nitrogen delivered loads
Phosphorus delivered loads
Sediment delivered loads
Implementation costs (extended analysis only)
Targets: Phase II WIP TMDLs

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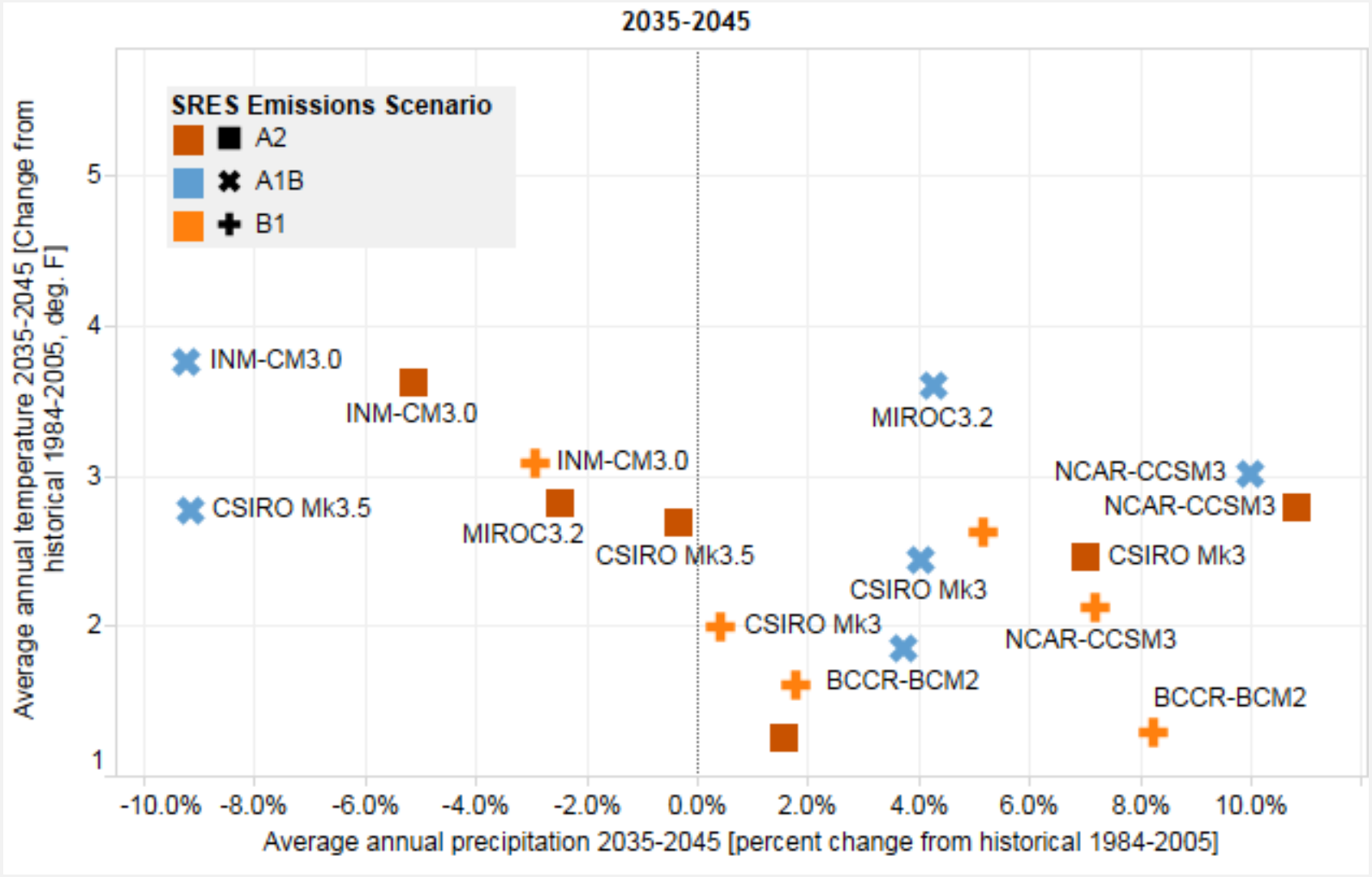
Climate Projections for Future Patuxent Basin Hydrology Vary Widely



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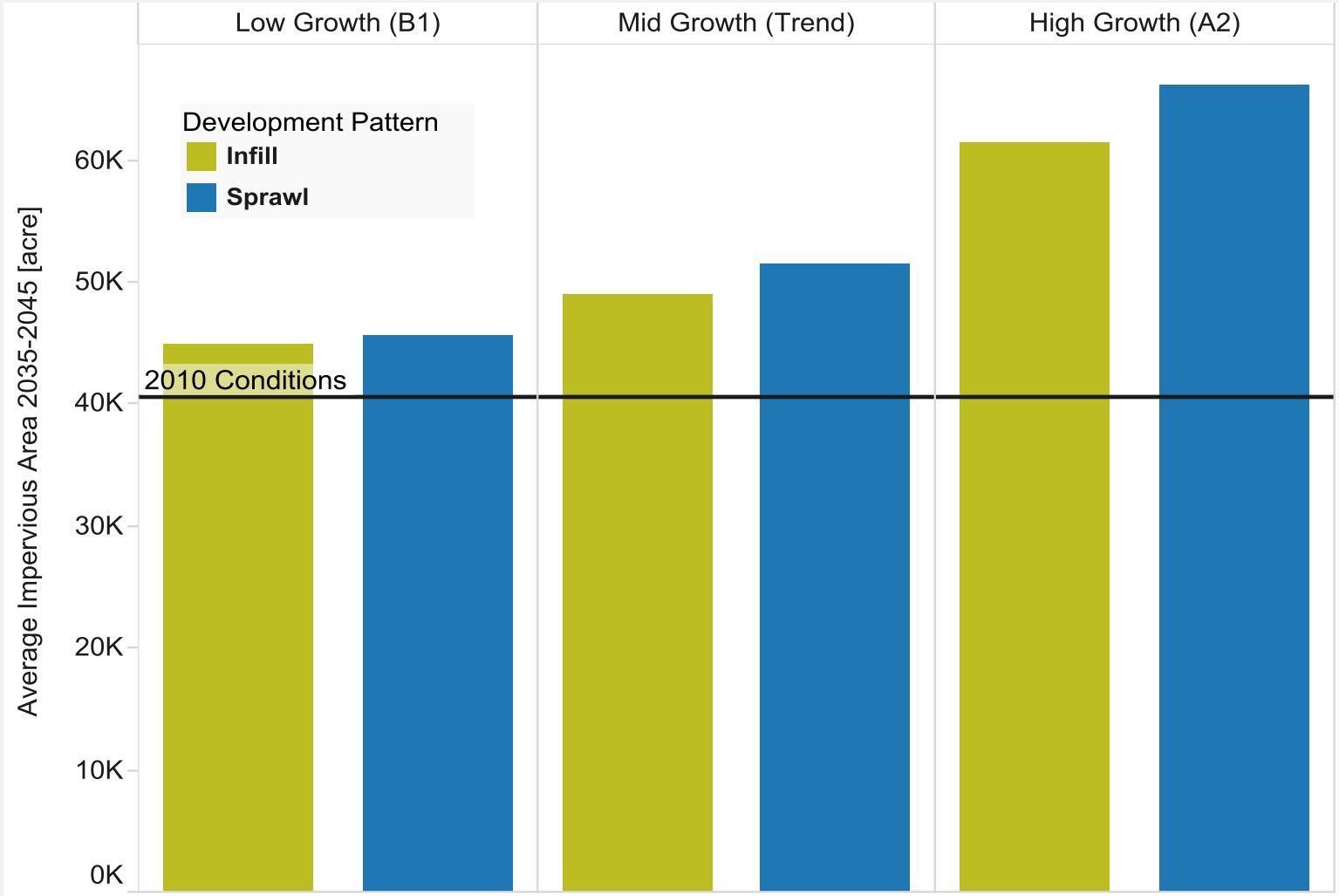
We Considered Six Land Use Change Scenarios with Varying Population and Sprawl Assumptions



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Maryland's WIP Identified Best Management Practices (BMPs) Designed to Meet Targets

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Maryland's Watershed Implementation Plan (WIP) Identified New Stormwater Targets for the Patuxent

Pollutant Type	Annual Target (million pounds/year)		
	Phase I	Phase II 2017 Interim	Phase II 2025 Final
Nitrogen	2.740	1.029	1.029
Phosphorous	0.210	0.078	0.078
Sediment	85	52	55.9

Source: Maryland Department of the Environment (2012). Note that these thresholds are adjusted to the calibration runs of the Phase 5.3.2 model, and differ somewhat from those listed in the Phase II WIP report.

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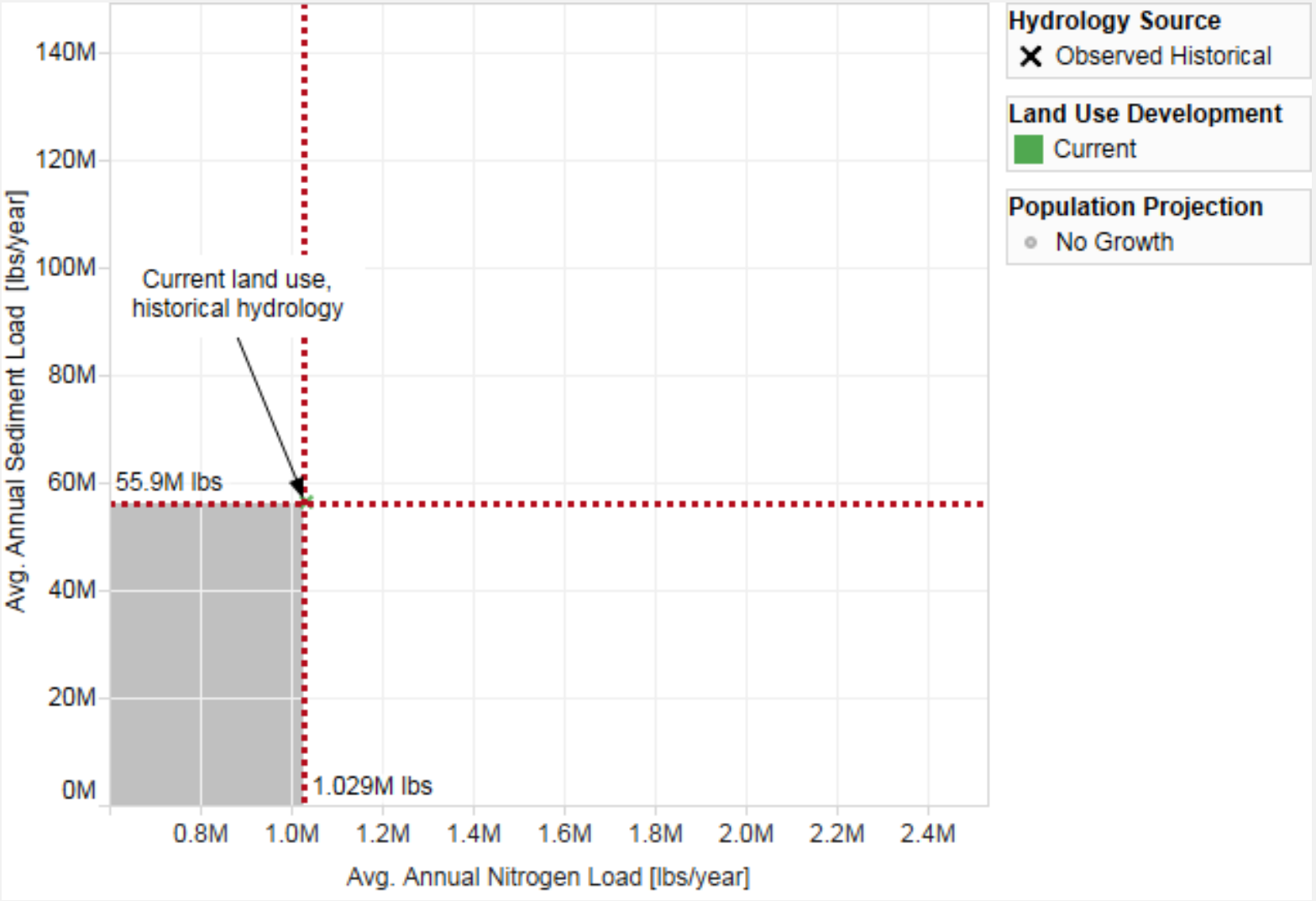
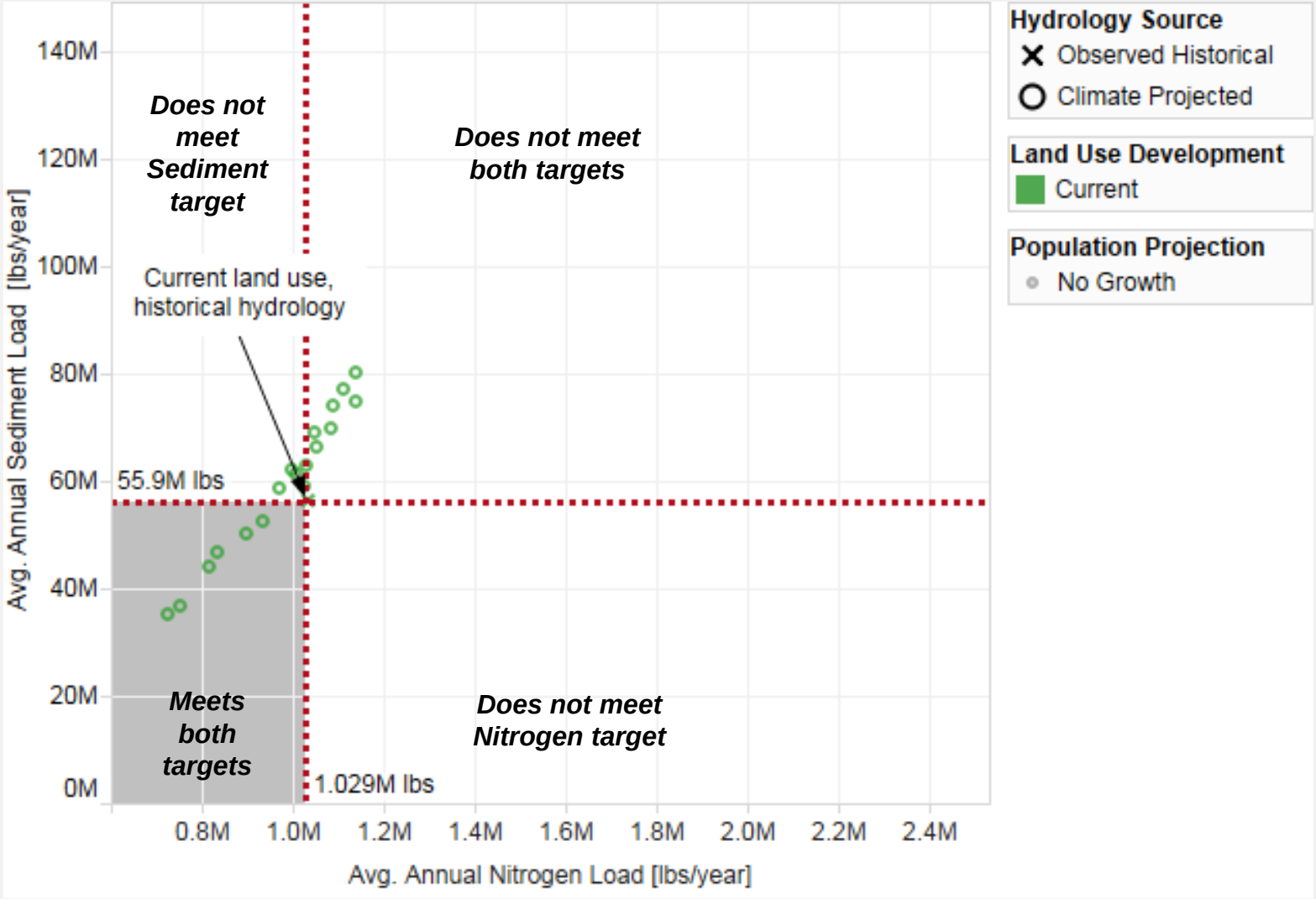
Phase II WIP Strategy Meets Intended Target In Current Conditions



Climate Projections Affect Attaining Targets in Some Futures (2035-2045)



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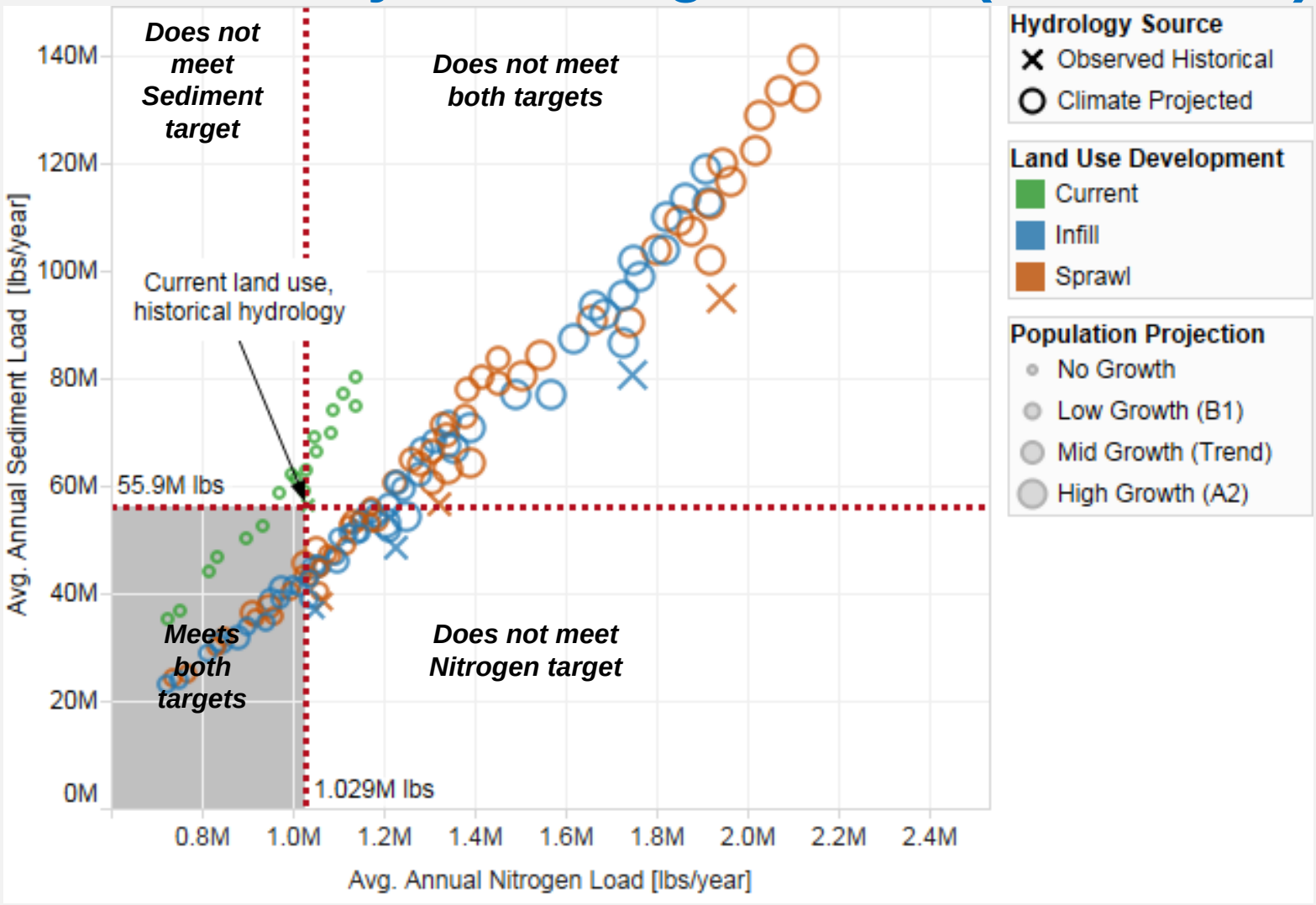
Under Phase II WIP, Climate and Land Use Lead to Many Stressing Futures (2035-2045)

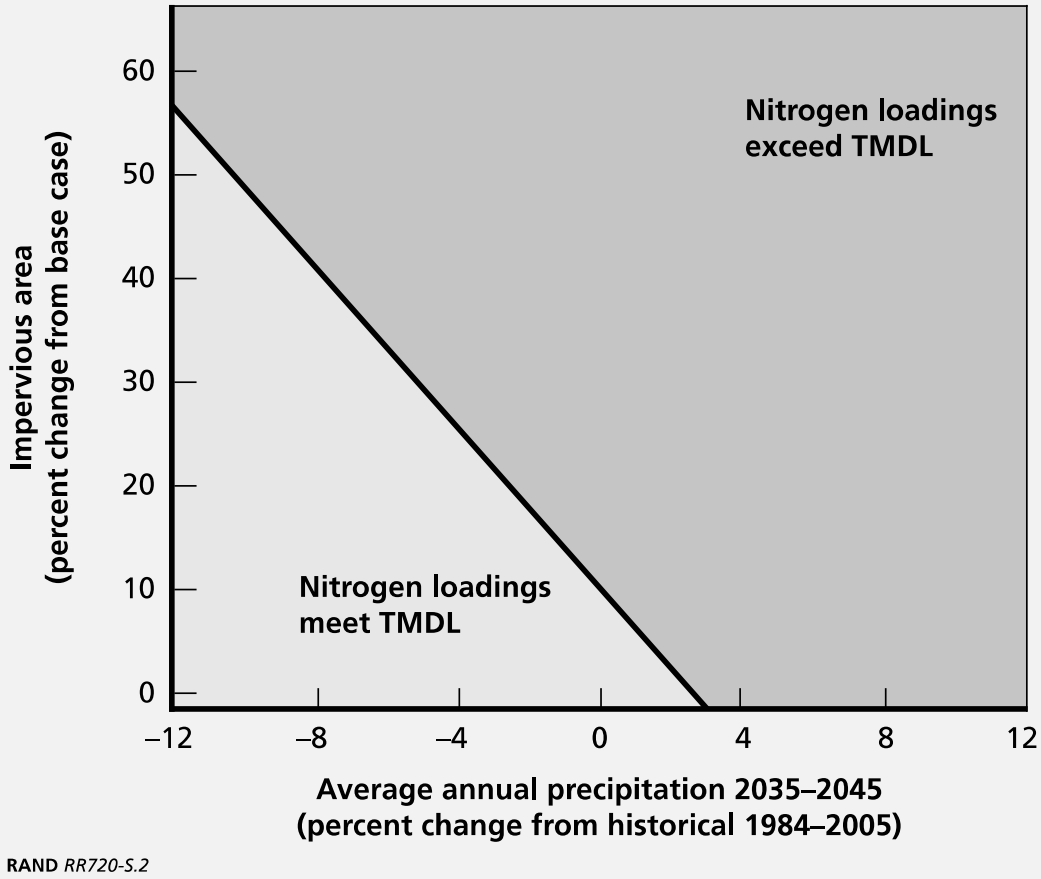


We Identified Sets of Vulnerable Futures for Two BMP Portfolios

Vulnerability Type	Number of futures exceeding the Phase II target (2035-2045 hydrology)	
	2010 Progress	Phase II WIP Strategy
Nitrogen target	114 (93%)	91 (72%)
Phosphorous target	120 (95%)	84 (67%)
Sediments target	111 (88%)	67 (53%)
Exceeding all three targets	109 (87%)	62 (49%)

Most Vulnerability Explained by Increase in Impervious Runoff (2035-2045)

- Nitrogen's Vulnerability Region in MD's Phase II WIP:
  - Higher precipitation increases runoff, leads to higher nitrogen loads
  - Impervious area growth leads to missing target even if average precipitation declines
  - Need low impervious area growth *as well as* precipitation declines to meet target

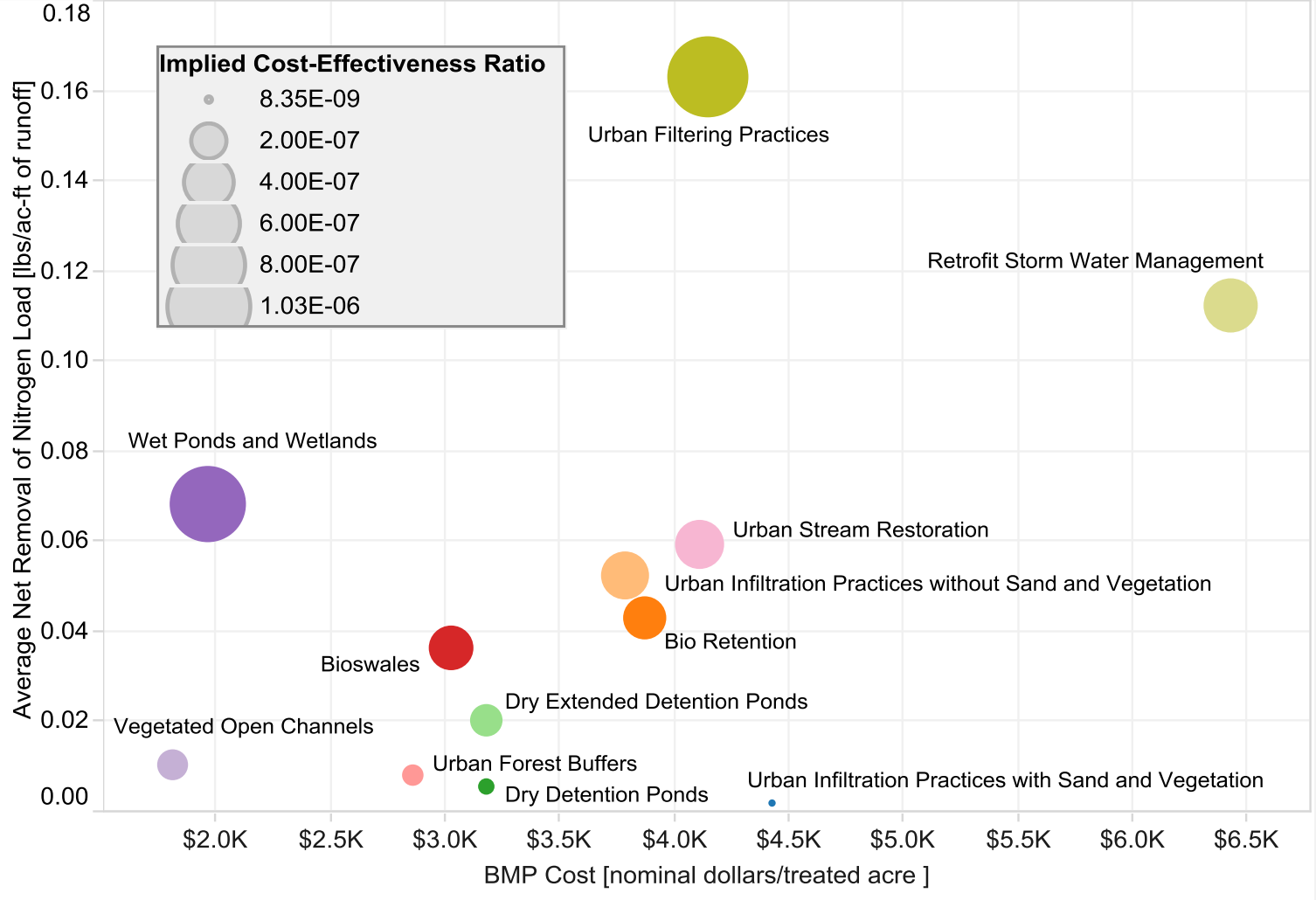


*Impervious Area Change (%) + 5.05 * Precipitation Change (%) > 11%*

OR

Impervious Runoff > 115 acre feet/year

We Identified Additional Cost-Effective BMPs to Help Reduce Nitrogen Vulnerability as an Initial Next Step



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Conclusions

- Under historic climate and no change in land uses, Maryland Phase II WIP meets TMDL targets
  - With future population growth or precipitation increases, targets are almost always missed
- Vulnerability is driven by increased runoff from impervious areas
  - Precip increases over historic average
  - Impervious land cover increases
  - Both precip and impervious cover increase
- Consider cost-effective options to hedge against future changes
  - For example, greater investments in wetland BMPs or urban filtering practices
- Next steps
  - Monitor BMPs; test additional BMPs; adaptively manage; revisit targets

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Thank you!

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