# Planning Ahead: Phase 7 of the CBP Watershed Model

Gary Shenk – CBPO

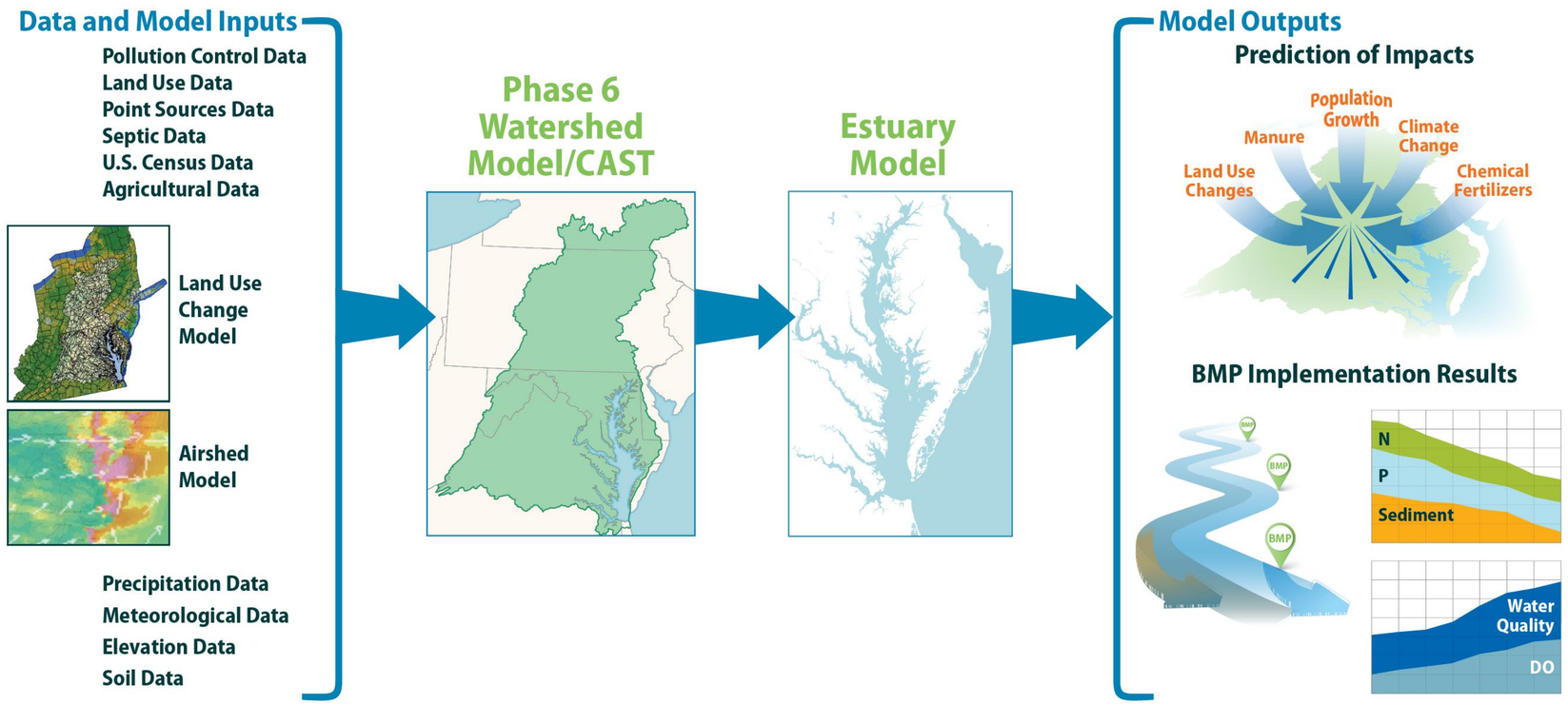
9/16/21

Ag Workgroup

# Plan with models; Assess with data

Success of TMDL judged by observed oxygen in the tidal Bay

Plan with the CBP system of models



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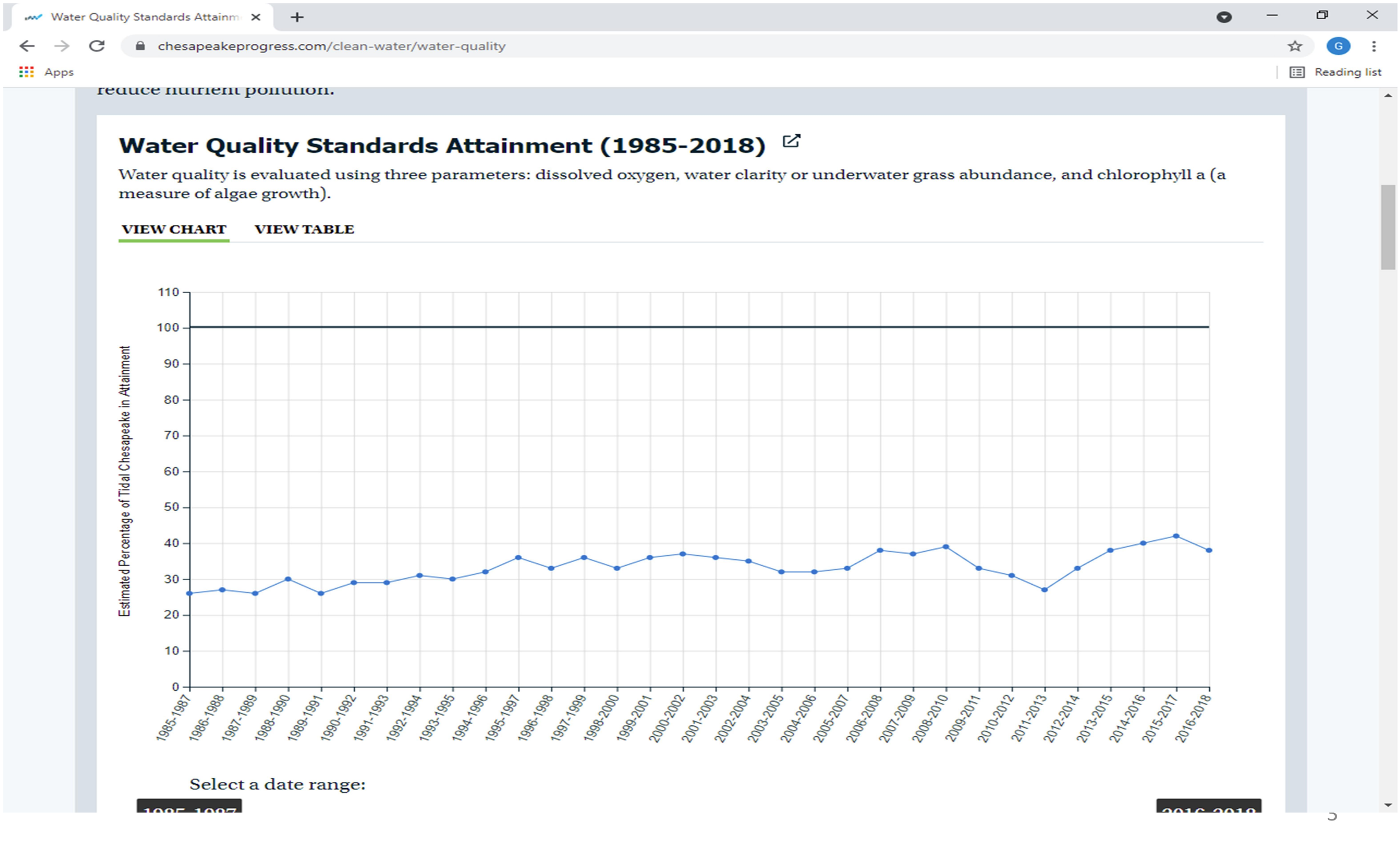

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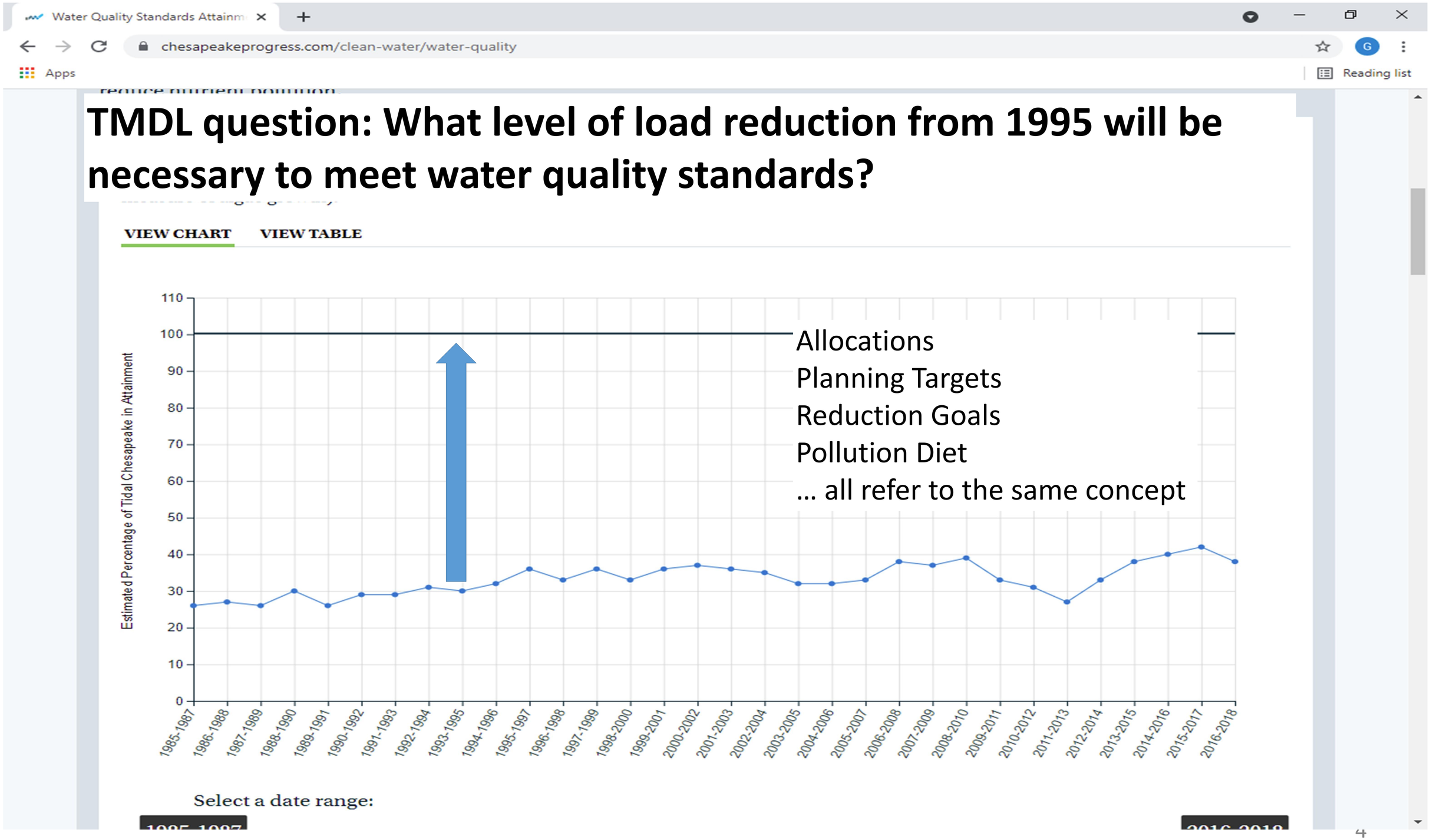

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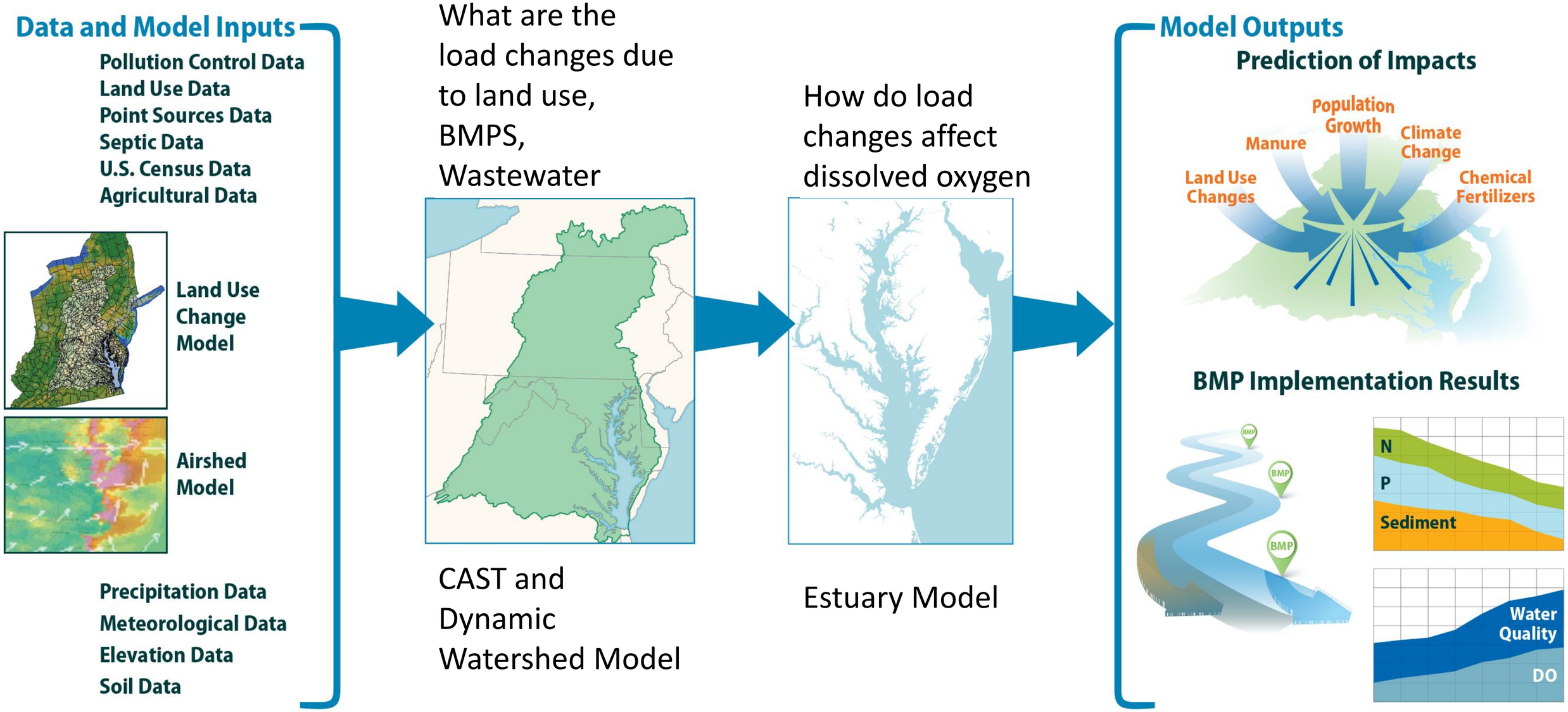


Background:
https://www.chesapeakebay.net/documents/Understanding_Chesapeake_Bay_Modeling_Tools.pdf

# CBP Watershed Modeling Products

| | Existing | Long term |
|---|---|---|
| TMDL tracking | CAST6-2017, CAST6-2019… CAST6-2025<br><br>CAST is updated for each milestone period.<br>Updates are constrained.<br>1995 load cannot be changed<br>Modifications can be made that better reflect trends from 1995 through current. | CAST7-2025, CAST7-2027…<br><br>Phase 7 CAST can incorporate any changes from Phase 6<br><br>2-year updates will be similarly constrained |
| Calibration, Estuarine loading Water supply | P6 Dynamic Model | P7 Dynamic Model |

2022
Development

2023
Development

2024
Review
Refine

2025
Apply

1. TMDL implementation deadline 2025
2. Reassess 2035 climate in 2025
3. Don’t change planning targets until 2025

PSC directives

- WQGIT gives priorities – October 2021
- Modeling team ideas; WQGIT may suggest additional priorities
- Can’t do everything; some may be longer-term projects
- Considered directions, not final decisions
- Will be revisited

| Potential Areas of Focus | Recommend-ations | Impacts Estuarine Model | Impacts CAST | Level of effort | Benefits |
|---|---|---|---|---|---|
| Finer-scale modeling | WQGIT, other GITs, STAC | ✓ | ✓ | High | Greater accuracy watershed modeling; Enables fine scale targeting of practices; Needed for some co-benefits |
| Spatially explicit CAST | Non-CB TMDL partners | | ✓ | Medium | Enables CAST output on a fine scale |
| Physical process simulation | STAC, WQGIT other GITs, CBPO | ✓ | ✓ | Low-High | Greater watershed model accuracy overall |
| Nutrient Application calculation | CBPO | | ✓ | Medium-High | Increases transparency of CAST scenarios; Reduces unintended consequences of model and data changes |
| Land use change 1985-2035 | CBPO, WQGIT | ✓ | ✓ | High | Greater accuracy of land use changes through time. Allows direct use of fine-scale land use data in CAST |
| Improve climate change modeling | PSC, WQGIT | ✓ | ✓ | Low | Directly addresses PSC priorities; improves confidence in 2025 climate decision. |
| Uncertainty Quantification | WQGIT, STAC | | | Medium | Helps prioritize model updates; Incorporates trends in monitored data |
| Co-benefits and ecosystem services | WQGIT, other GITs, STAC | | ✓ | Low-High | Helps partners develop comprehensive plans that benefit local citizens. |
| WQ standards Assessment | WQGIT, STAC | | | Low-Medium | Potential to assess all tidal oxygen standards and to delist segments |

https://www.chesapeakebay.net/channel_files/41830/watershed_modeling_workplan_options_for_2025_v2021_08_26_clean.pdf

# Existing Priorities – these are happening

- Land use change 1985-2035
  - Resources in place
  - Use land use directly rather than combining with other data sets
  - Consistent land use from meter-scale through watershed scale
- Estuarine model development (separate document)
  - Much finer scale in shallow water
  - Allow analysis of local influence on water quality
  - Address climate change in the shallows

To be prioritized

# WQ Standards Assessment

*INDICATOR Water Quality Standards Attainment Assessment for Chesapeake Bay DO, Water Clarity and Chlorophyll a*

| Bay Attainment | Segments[1] | Designated Uses[2] | Criteria | Season | Thresholds |
|---|---|---|---|---|---|
| Bay Attainment | 1 Segment<br>2 Segment<br>45 Segment<br>46 Segment<br>47 Segment<br>91 Segment<br>92 Segment | Migratory | DO | Feb-May | 30-day mean[6]<br>Instantaneous minimum |
| | | | | June-Jan[5] | TF= 30 day mean; OH-PH 30 day mean<br>7-day mean<br>Instantaneous minimum |
| | | Open Water | DO | June-Sept | TF= 30 day mean; OH-PH 30 day mean<br>7-day mean<br>Instantaneous minimum |
| | | | Chla[3,4] | Spring | $TF_{up}$=10 $TF_{lo}$=15 OH=15 MH=12 PH=12 |
| | | | | Summer | $TF_{up}$=25 $TF_{lo}$=23 OH=22 MH=10 PH=10; DC = 25 |
| | | Deep Water | DO | June-Sept | 30 day mean<br>1-day mean<br>Instantaneous minimum |
| | | | | Oct-May | TF= 30 day mean; OH-PH 30 day mean<br>7-day mean<br>Instantaneous minimum |
| | | Deep Channel | DO | June-Sept | Instantaneous minimum |
| | | | | Oct-May | TF= 30 day mean; OH-PH 30 day mean<br>7-day mean<br>Instantaneous minimum |
| | | Shallow water Bay grasses | DO | June-Sept | Dependent upon Open Water attainment assessment |
| | | | Water Clarity/SAV | SAV season | Segment-specific water clarity/Bay grasses acreage goals. |

Currently only able to assess 8 of 22 standards

No segment can currently be taken off the TMDL 303d list

To be prioritized

# Co-Benefits and Ecosystem Services

- CAST currently generates N, P, S, and cost based on land use, management actions and wastewater loads.
- Co-Benefits are other CBP outcomes that could be affected by BMP implementation
  - Fish Habitat
  - Brook Trout
  - Tree canopy …
- Ecosystem Services are anything that have a value to people
  - Carbon sequestration
  - Scenic Views …
- Adding Co-Benefits would account for non-TMDL incentives to implementation

To be prioritized

# Uncertainty Quantification

- Answers to the questions
  - How certain are we that we are getting the reductions we estimate?
  - What parts of the model have the largest impact on the nutrient load estimation?
- AgWG requested uncertainty quantification in Phase 6 review

To be prioritized

# Improve Climate Change Modeling

- Only task specifically given by PSC
- Thoroughly dealt with in the watershed model in 2019
- Do we want to spend a lot of time on the final 10% that we didn’t get to or revisiting decisions from 2019?

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To be prioritized

- Scale Topics
  - Finer-scale modeling – changing scale of the underlying model
  - Spatially explicit CAST – Allowing the use of CAST at a user-defined scale
- Process Topics
  - Physical processes – improving the accuracy of nutrient and sediment transport and other important processes.
  - Nutrient applications – improving the process of determining the inputs of fertilizer and manure

# Finer-Scale Modeling

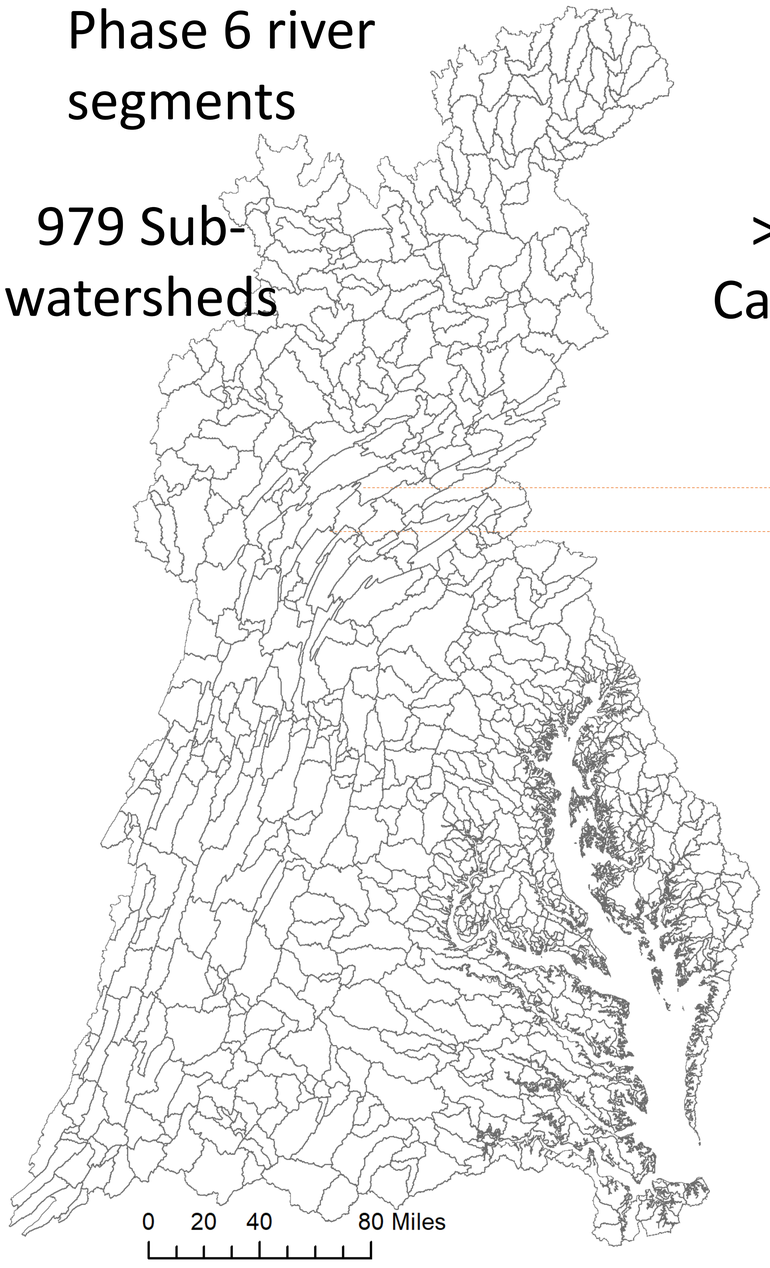
Transport information on a 10-meter scale

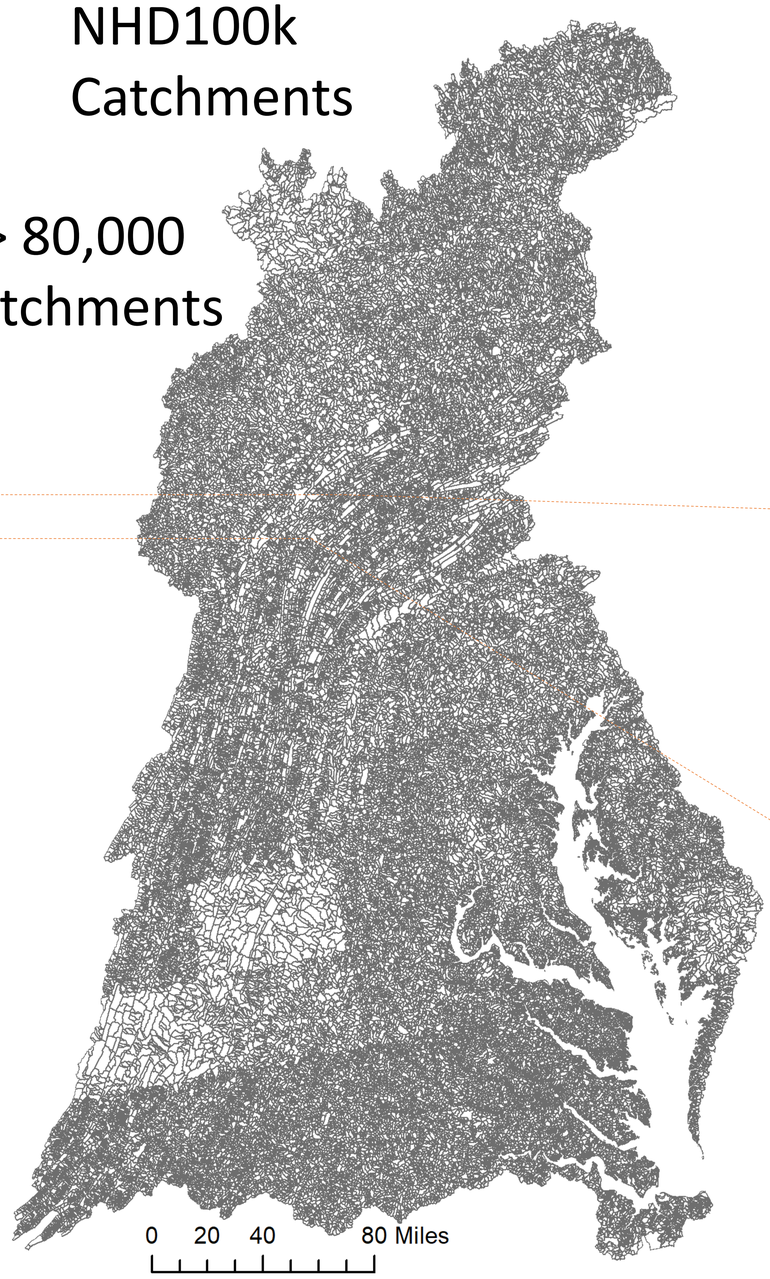
Phase 6 river segments

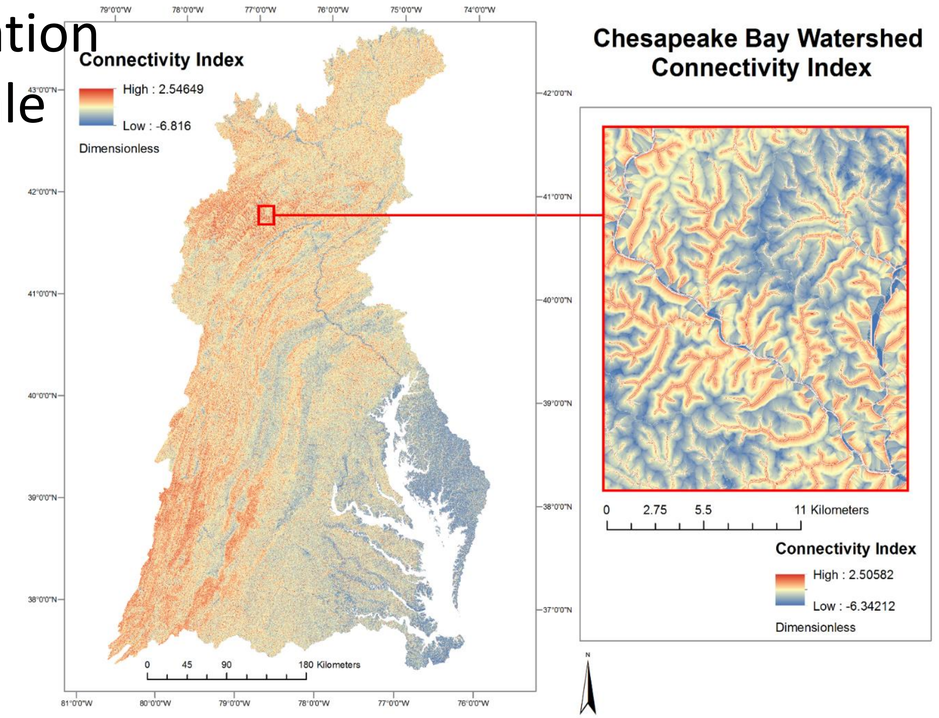
979 Sub-watersheds

NHD100k Catchments

> 80,000 Catchments



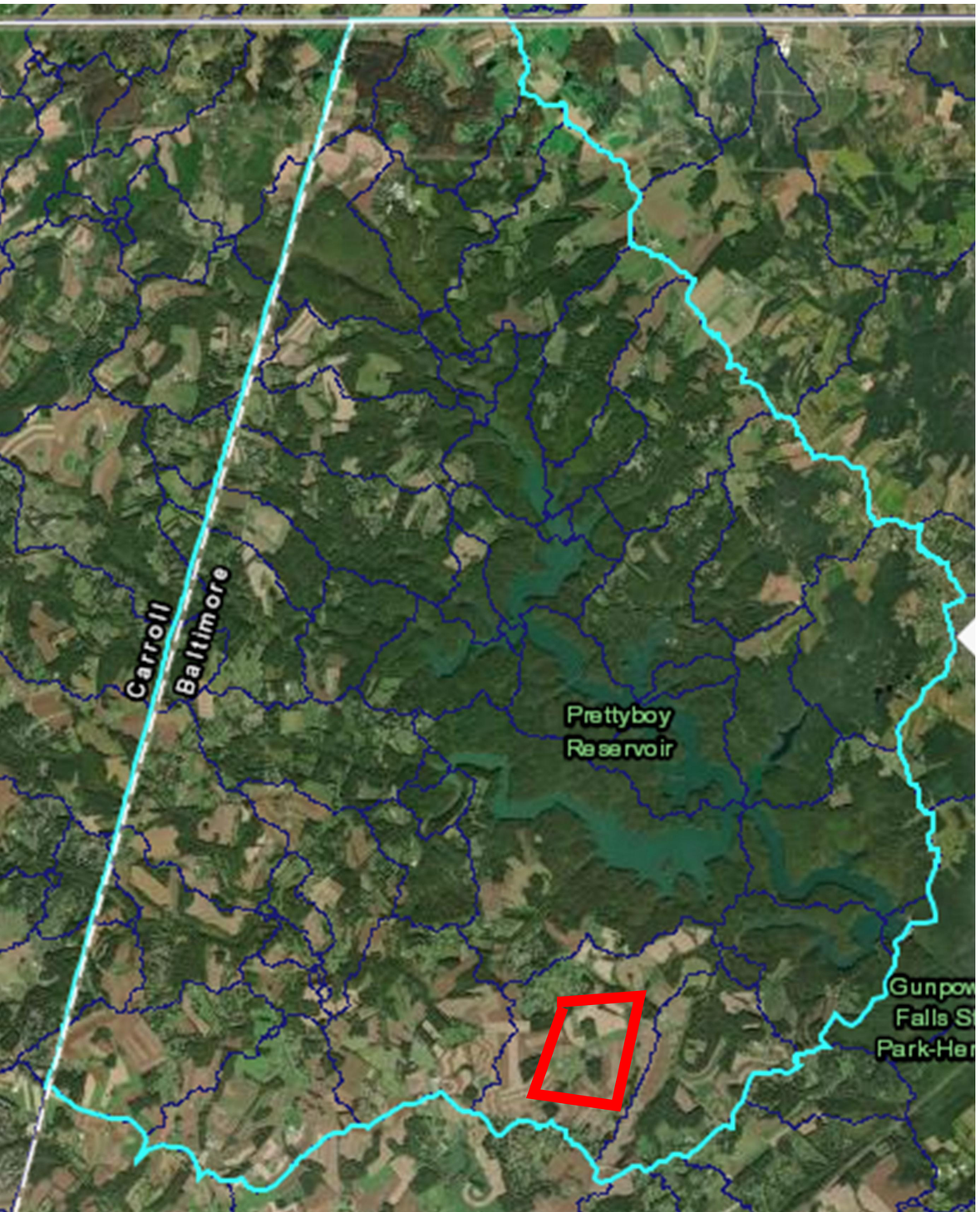


**Greater accuracy watershed modeling; Enables fine scale targeting of practices;**
**Needed for some co-benefits**

To be prioritized

To be prioritized

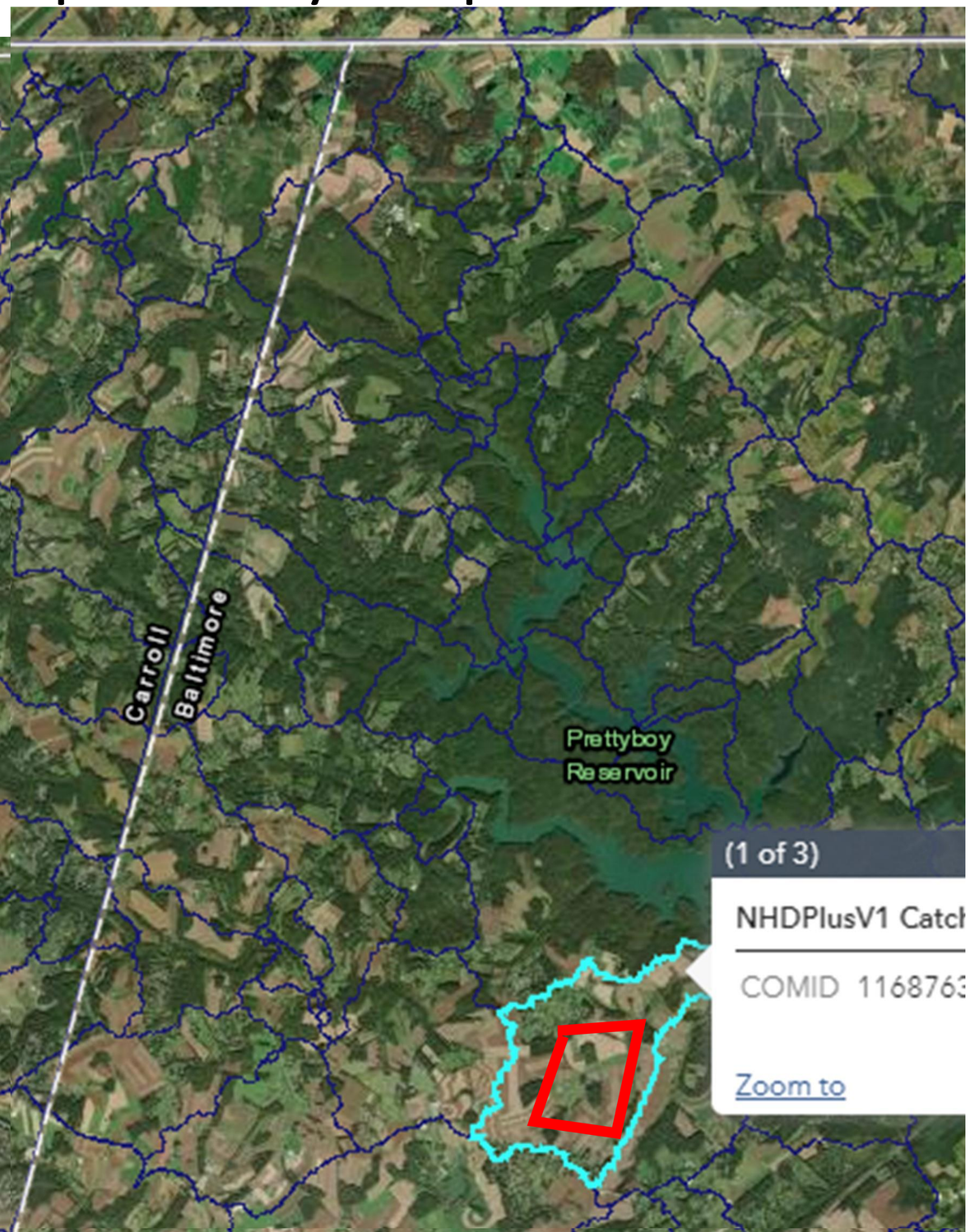
# Spatially Explicit CAST




- Allow calculation of load from within user-defined area
- based on **land-river segment** averages applied to the land uses in the area

To be prioritized

# Spatially Explicit CAST with Fine-Scale Modeling




- Allow calculation of load from within user-defined area
- based on **NHD or finer segment** averages applied to the land uses in the area

To be prioritized

# Physical Process Improvement

- Phosphorus simulation in urban areas
  - Only watershed modeling need identified in the STAR SRS science needs database
- Change in load due to change in input (sensitivities)
- Stream bed and bank loads
  - Partnership wanted them broken out from land use loads for P6
  - Causing some confusion when natural category changes due to management actions in other category.

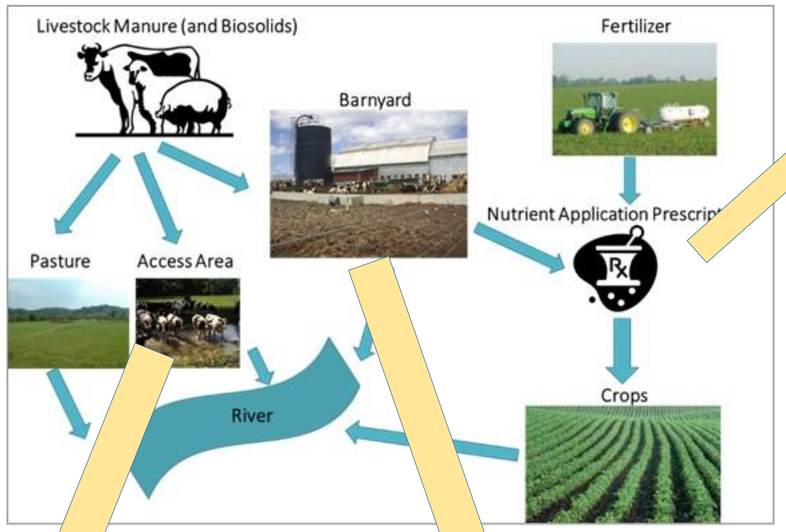
To be prioritized

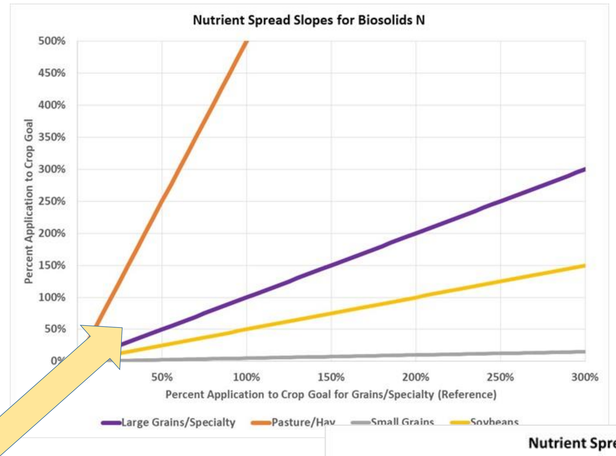
# Physical Process Improvement

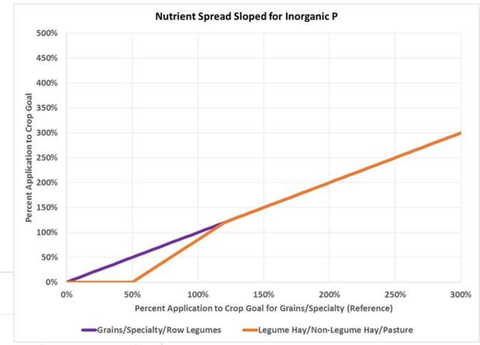
- Temperature simulation at fine scale
  - Impacts co-benefits
- Nutrient speciation
  - Allow for targeting management that reduces inorganics
- Sediment Processes
  - Important for understanding nutrient lag times.
  - Affects health of non-tidal streams

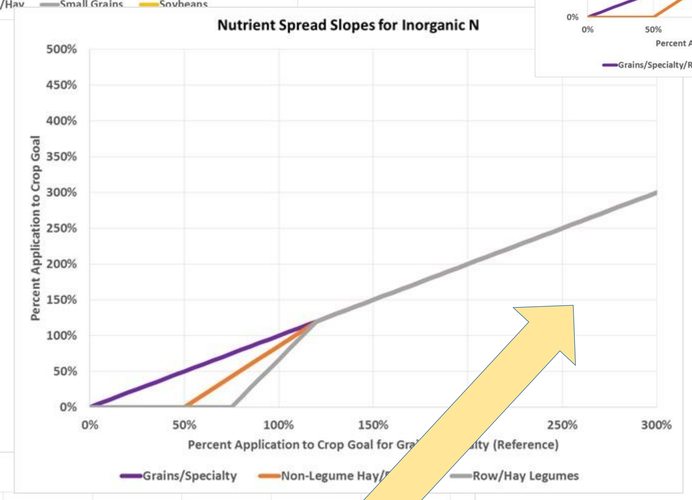
# Nutrient Applications

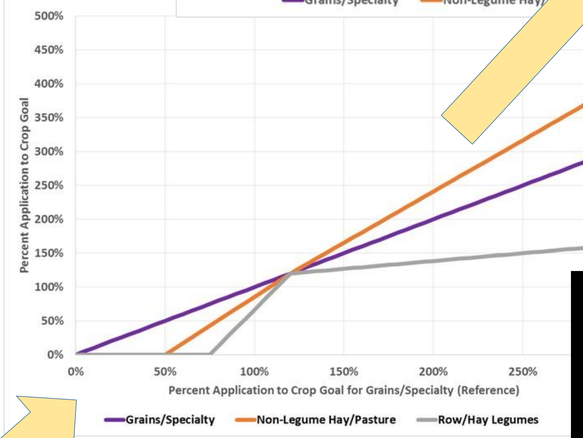
To be prioritized

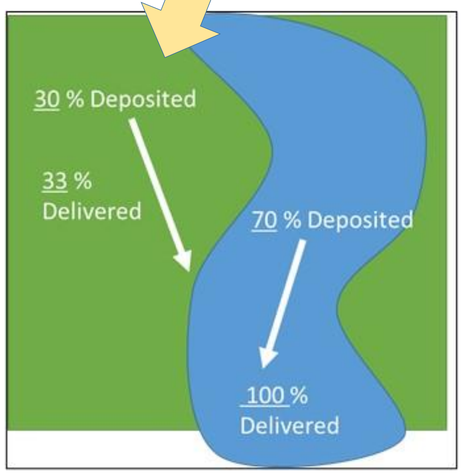


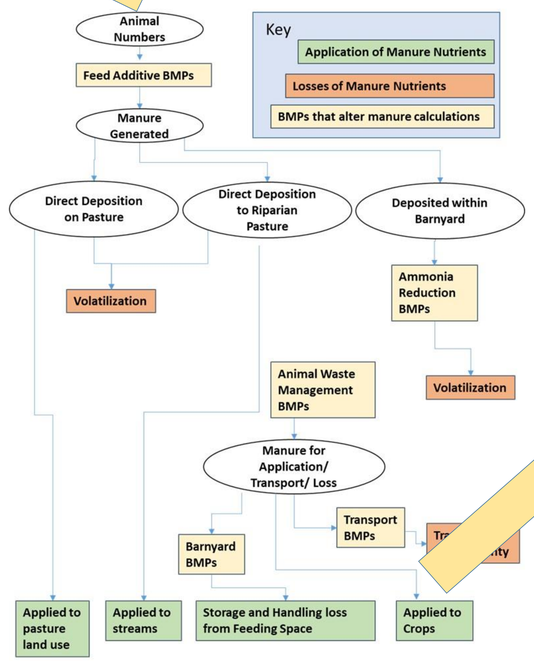



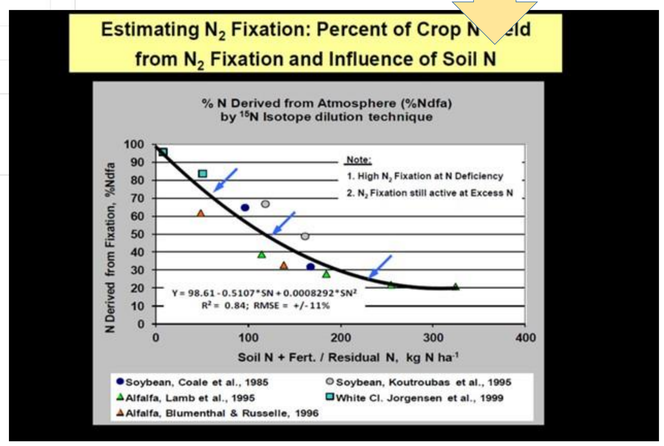



# Lessons Learned through TMDL

- The CBP Partnership wants transparency:
  - Simplicity
  - Scalability
  - Ease of Use
  - Understandability

- Quote from State Government Representative:

  "***We*** *want to be able to explain the models to our stakeholders and have them be* relevant *at the local scale*."

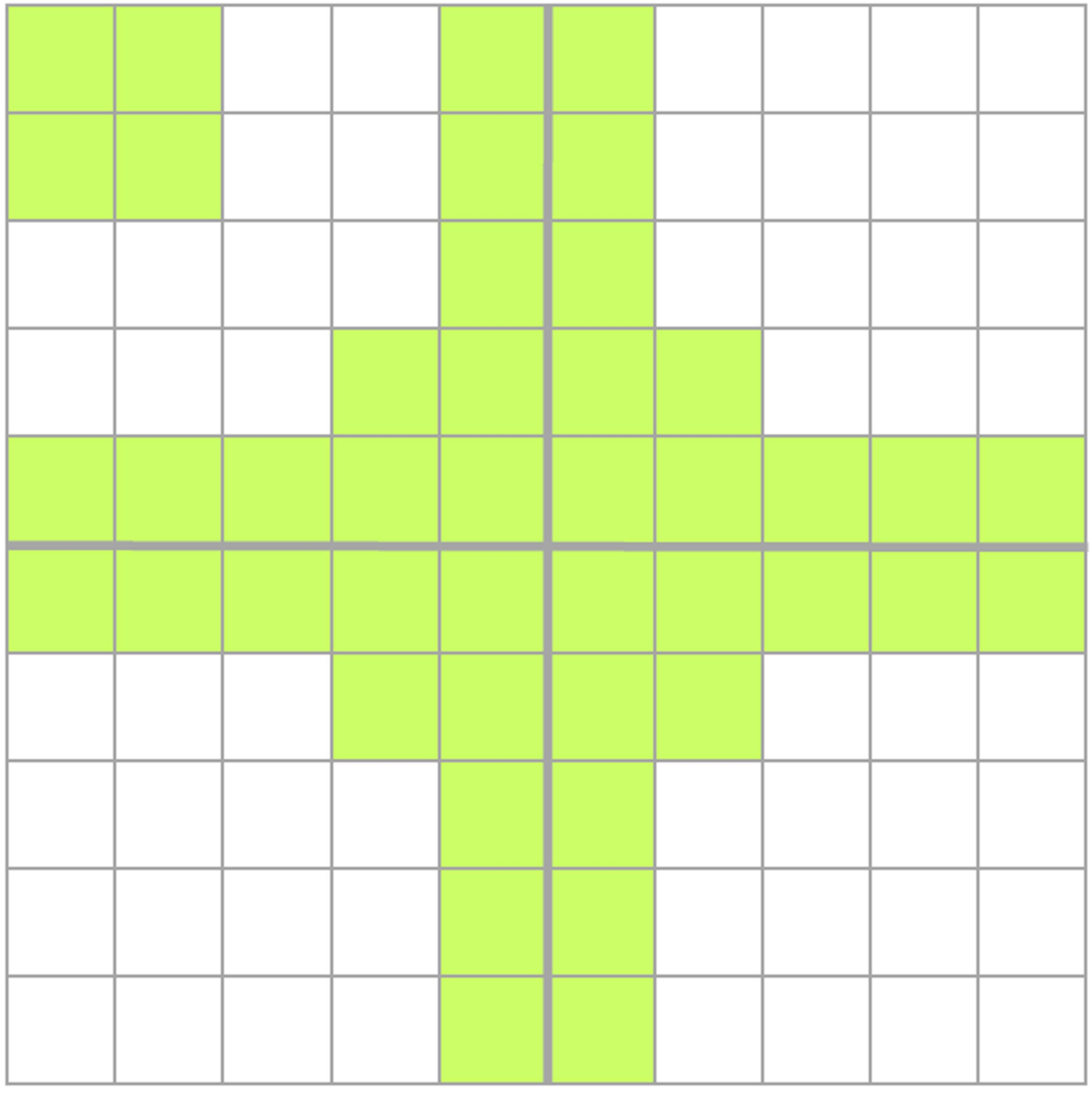
**Slide from 2012 – discussing the building of P6**

# Simulated BMPs vs Percent Reduction

- **Which Description Works Best for Management?**
- **What's my reduction from Nutrient Management?**
  - Well, based on the rules developed by the partnership and the data supplied by national sources and the states, the balance of inputs and outputs for your land use is such that there is an overabundance of manure in your county, as opposed to the next county over where nutrient management has almost no effect. Now when you apply nutrient management, that will attract manure to the nutrient management land use, so it will have a higher load, but since it's pulling manure from other land uses, the total segment load will usually decrease, however in some circumstances when nutrient management is applied to pasture, it can push so much manure back on to other land uses, that the marginal effect …
- **What's my reduction from Cover Crops?**
  - Based on the Cover Crop Panel, who based their decision on multiple referenced data sources and models, your reduction for Early Drilled Barley in the Valley and Ridge Carbonate region is 38%

**Slide from 2012 – discussing the building of P6**

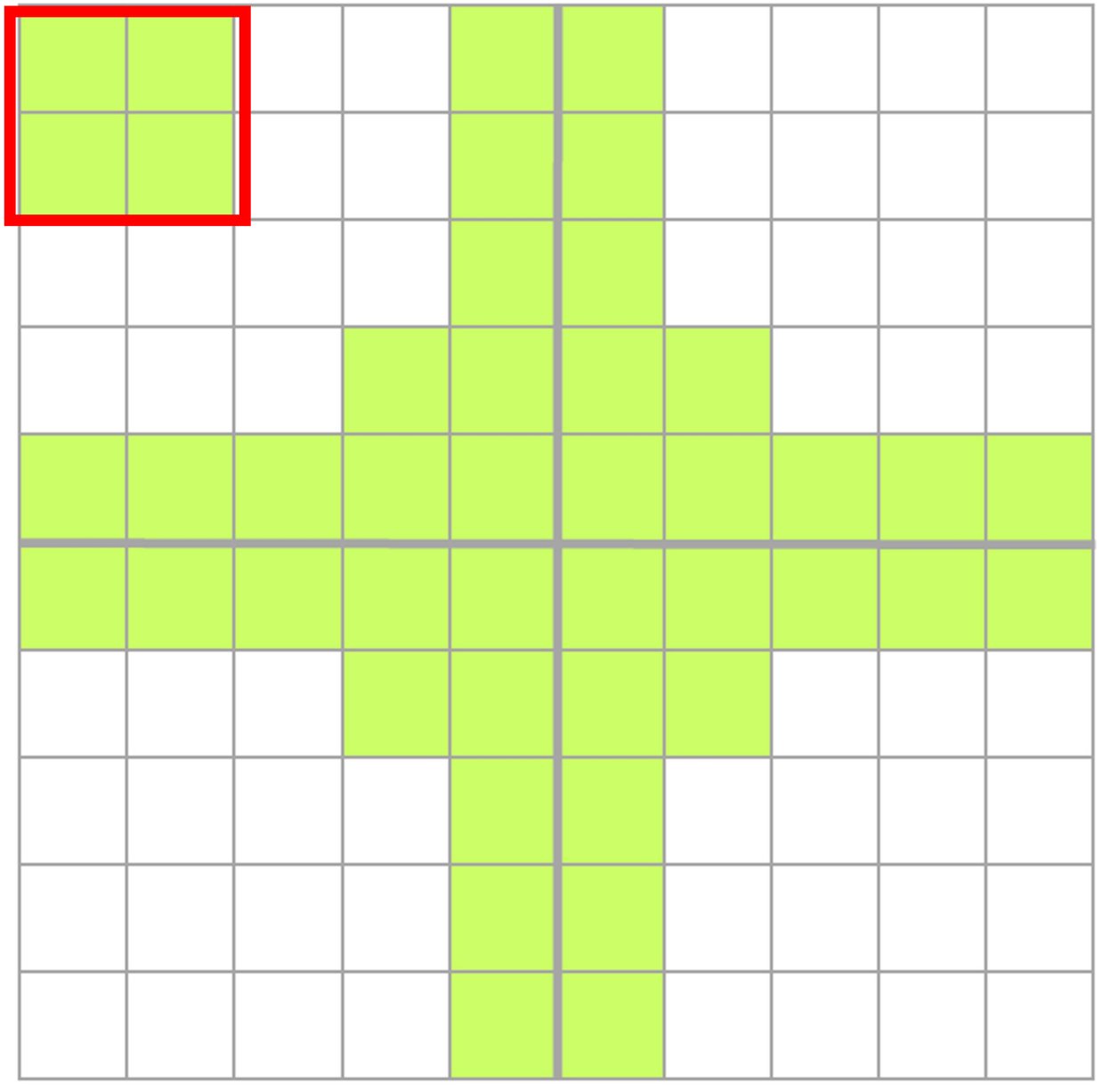
- Challenge: make the figure symmetrical top-to-bottom and right-to-left by changing the color of the fewest boxes



# People tend to add rather than subtract in problem solving

- Fewer than half realized that the best solution was subtracting the four boxes rather than adding 12 boxes in the other quadrants

- …but given practice, most recognized the subtractive solution



Adams, G.S., Converse, B.A., Hales, A.H. and Klotz, L.E., 2021. People systematically overlook subtractive changes. *Nature*, *592*(7853), pp.258-261.

# Next Steps

- Now: Olivia to follow with examples of potential simplification
- Next few weeks: Meeting with individual WQGIT members to discuss options.  Available to discuss with anyone.
- Oct 25-26: WQGIT prioritizes
- 2022-2023: work on models and evolve priorities