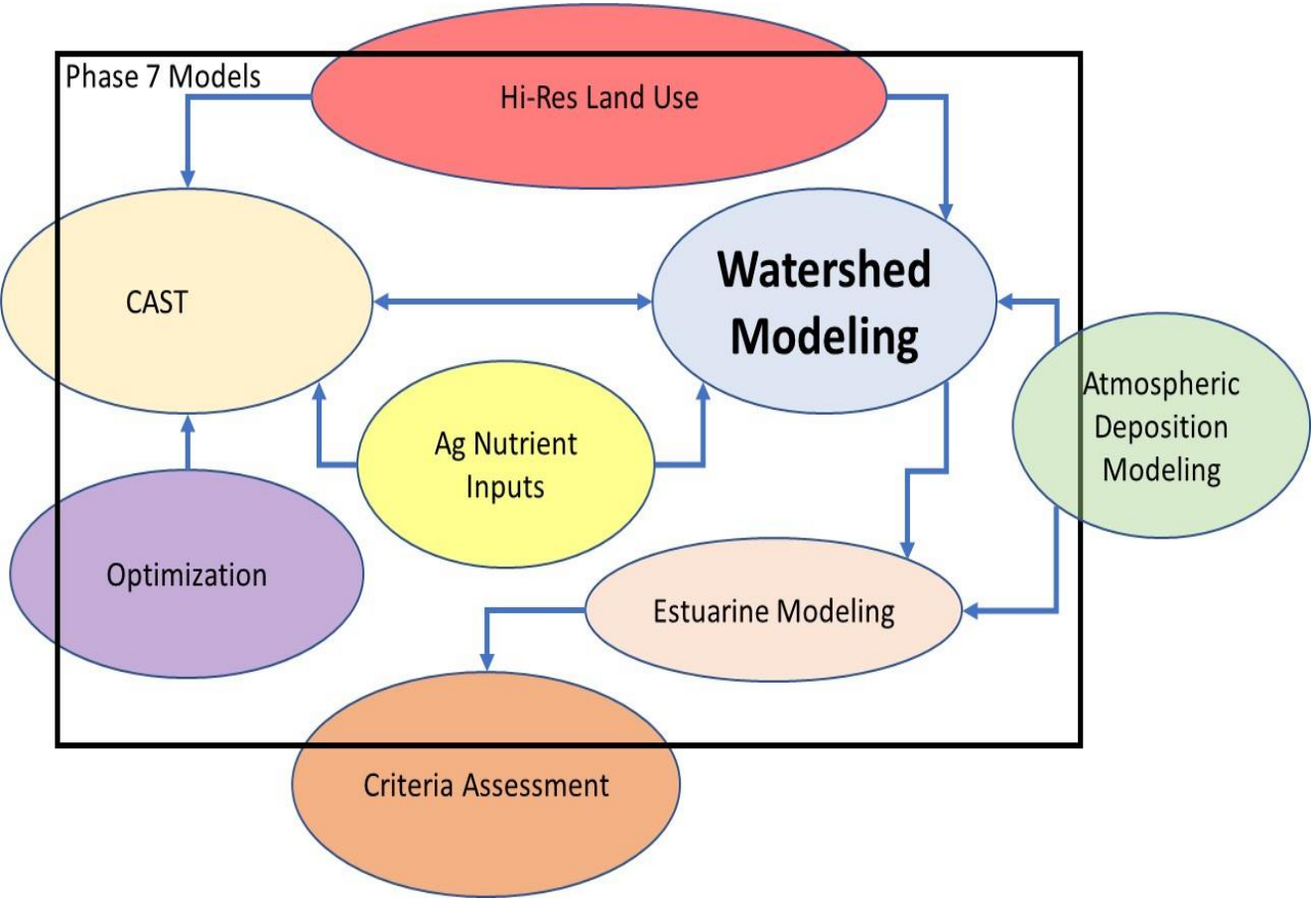
Phase 7 Watershed Model Development Emphasizing Scale

Gary Shenk – CBPO

WQGIT

2/26/2024

Phase 7 Development Tracks



Phase 7 Model Development

chesapeakebay.net/what/programs/modeling/phase-7-model-development

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MODELING >

Phase 7 Model Development

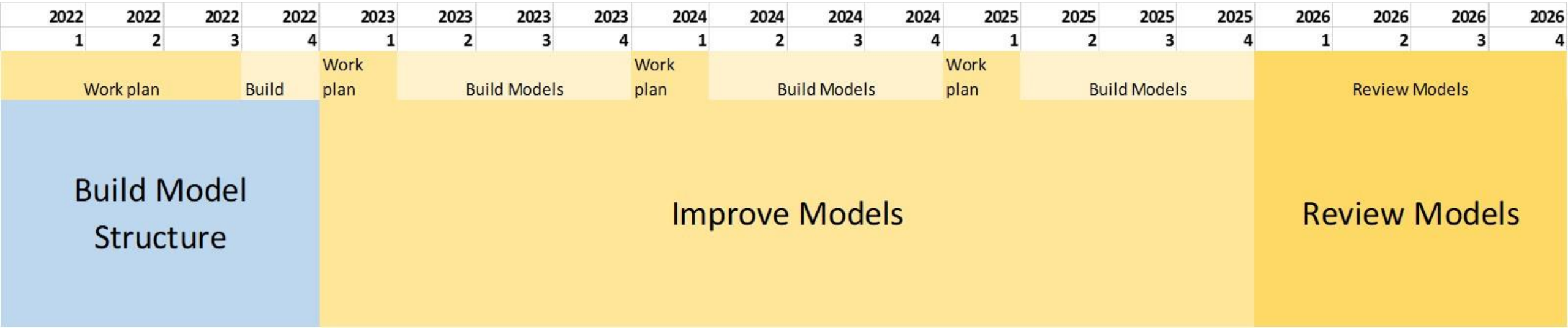
The Chesapeake Bay Program is updating its modeling and analysis tools used i

Currently in development, the Phase 7 Modeling Tools will be used by the partnership to inform decisions related to nutrient and sediment reduction goals outlined in the Chesapeake Bay Watershed Agreement. Integral to this updated suite of tools is the ability to project climate change effect through 2035. The model, which will be ready for use by 2027, consists of seven interrelated projects:

1. High Resolution Land Use
2. Chesapeake Assessment Scenario Tool (CAST)
3. Optimization
4. Agricultural Inputs
5. Atmospheric Deposition Modeling
6. Watershed Modeling
7. Estuarine Modeling
8. Criteria Assessment

Interactive segmentation viewer of the airshed, watershed, and estuarine models >

Watershed Model Plan – Big Picture



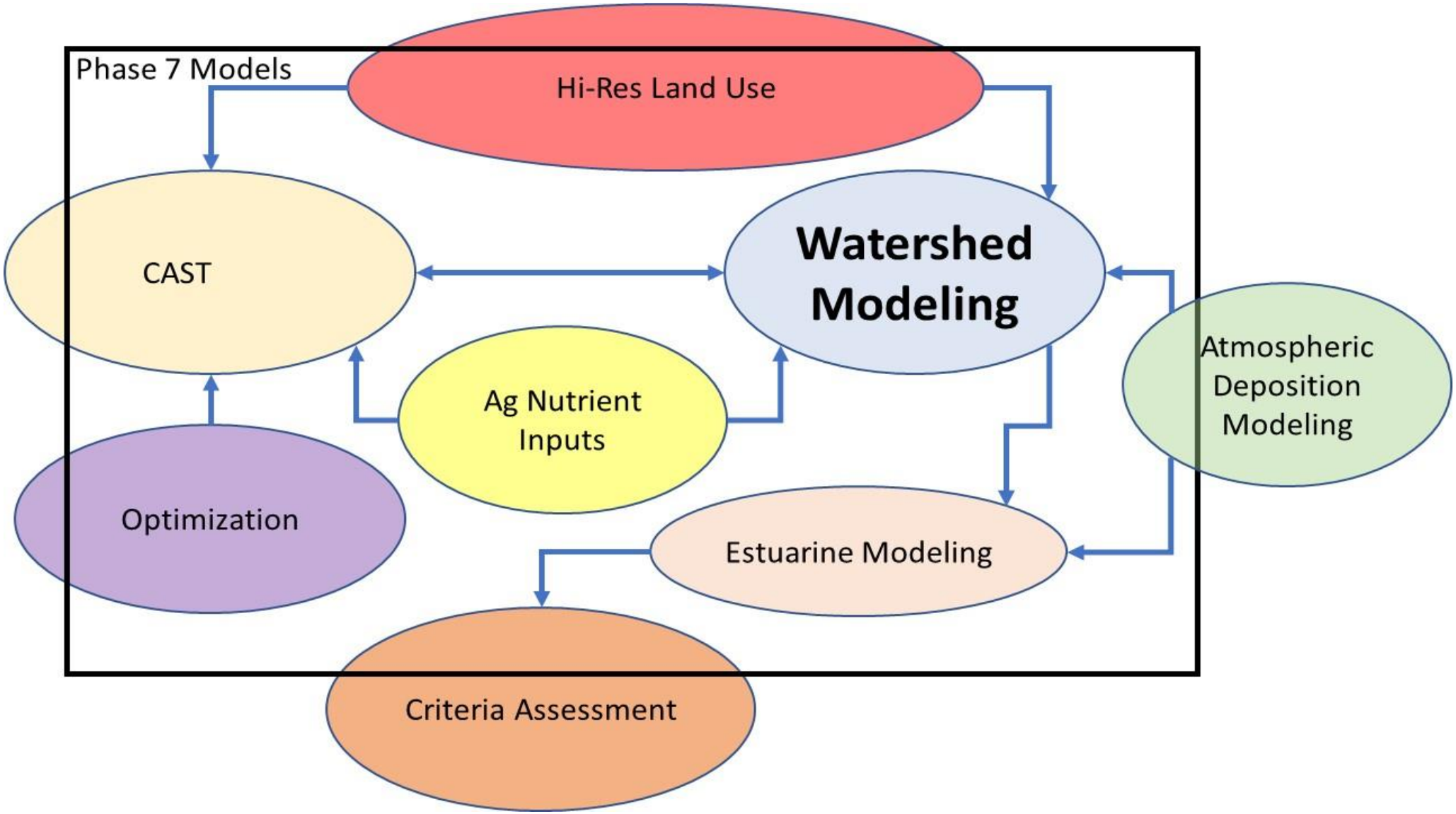
STAC reviews

- Independent - STAC administers the reviews, but reviewers are primarily external
- Process
  - CBP develops review questions
  - Review involves presentations and draft model documentation
  - Reviewers produce document
  - CBP responds to review in detail
- CBP will decide what needs to be reviewed.

Historical STAC reviews related to the TMDL

Year	Criteria	WQSTM	WSM	WSM inputs	Land Use
1999		WQSTM			
2000					
2001					
2002	standards				
2003					
2004				BMPs	
2005			P4 WSM		
2006	CFD				
2007				BMPs	
2008			P5 WSM	BMPs	LULC
2009	Reference Curves				
2010		WQSTM			LULC
2011			Limnotech		
2012					
2013					
2014			P dynamics		
2015					
2016	James Standards			Ag inputs	
2017	Bay standards		P6 WSM		
2018		WQSTM			

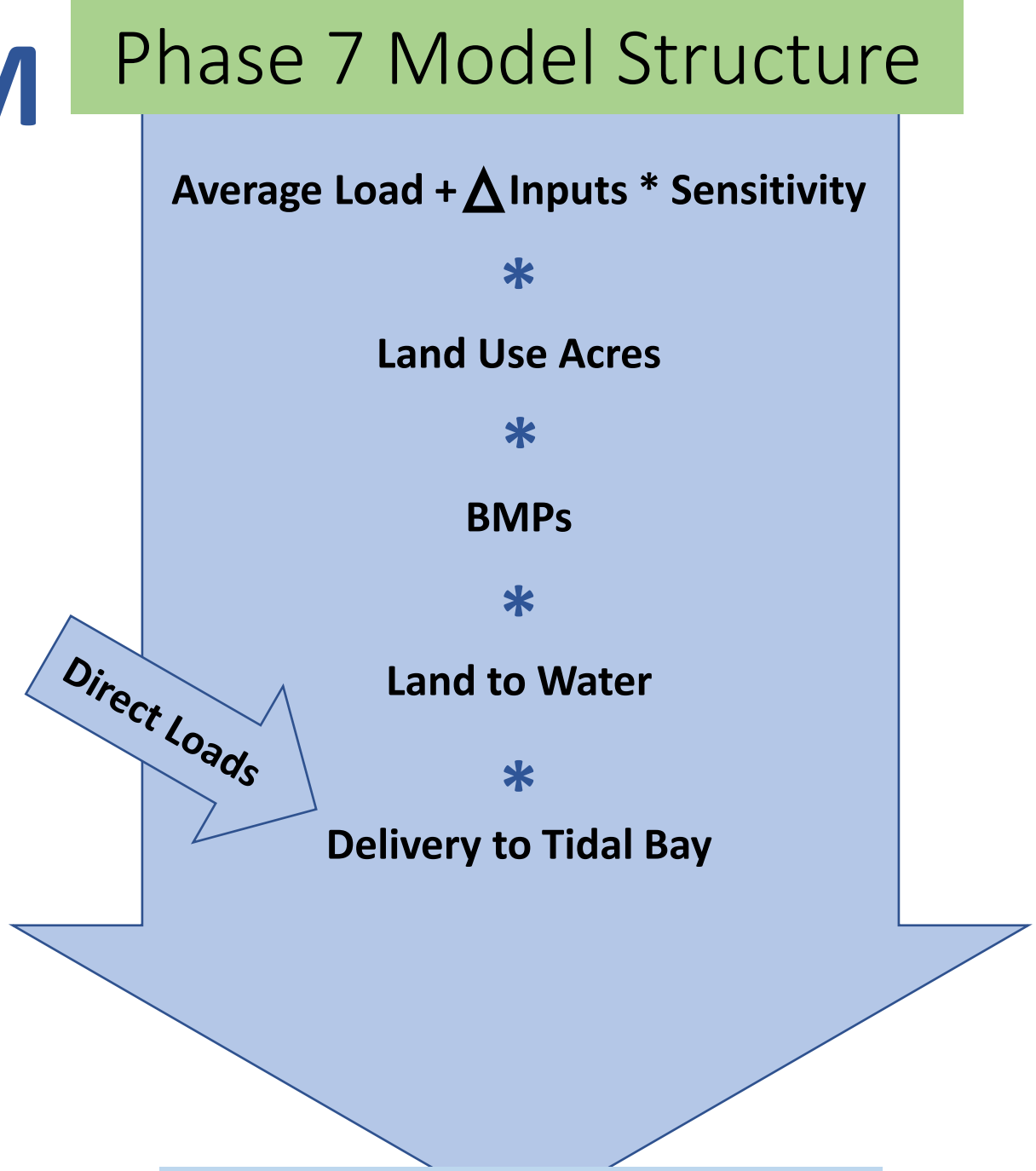
Phase 7 Development Tracks



Cast/CalCast/DM

Phase 7
CAST

Deterministic Scenario Tool:
1 set of loads for 1 set of inputs



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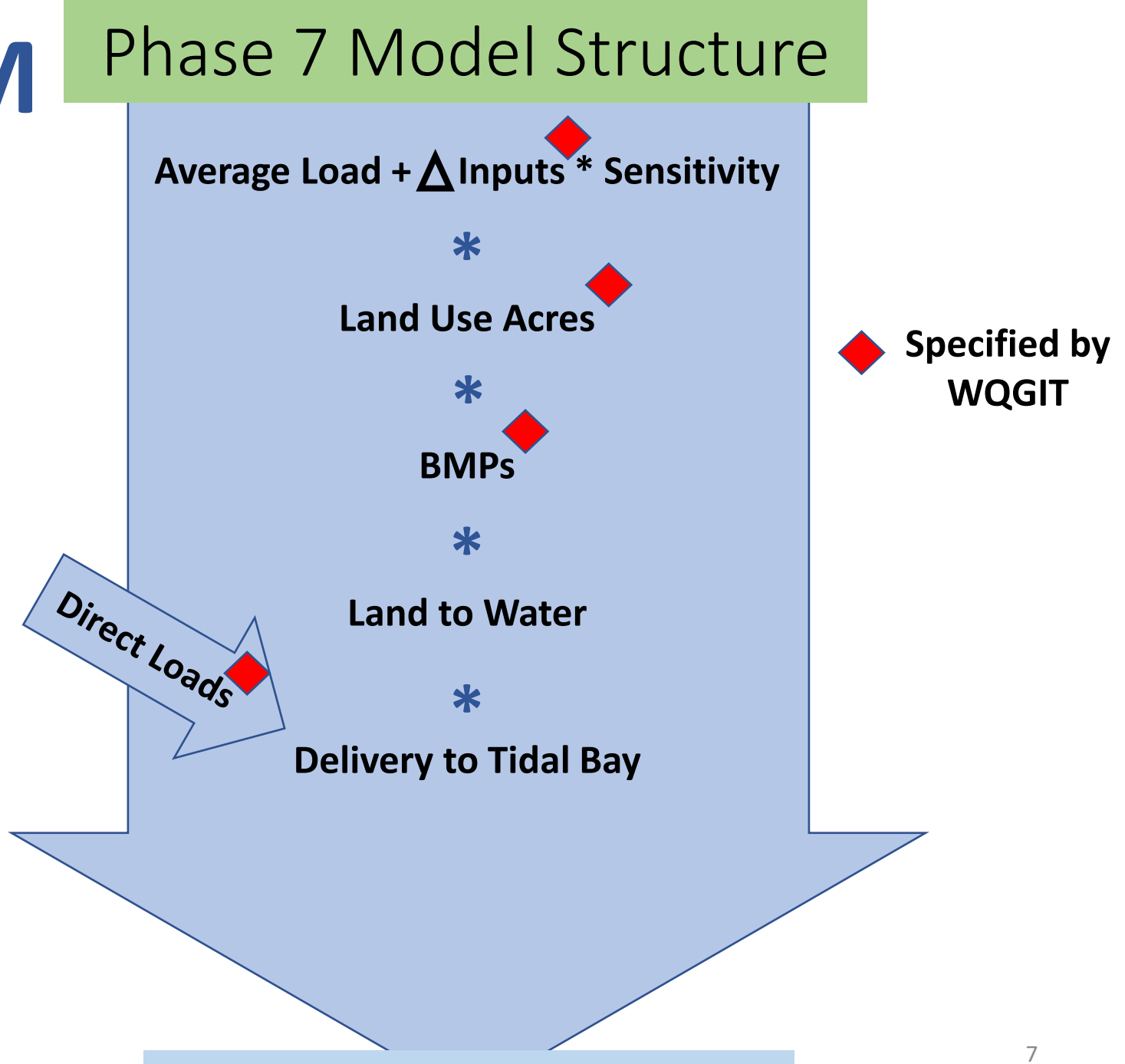
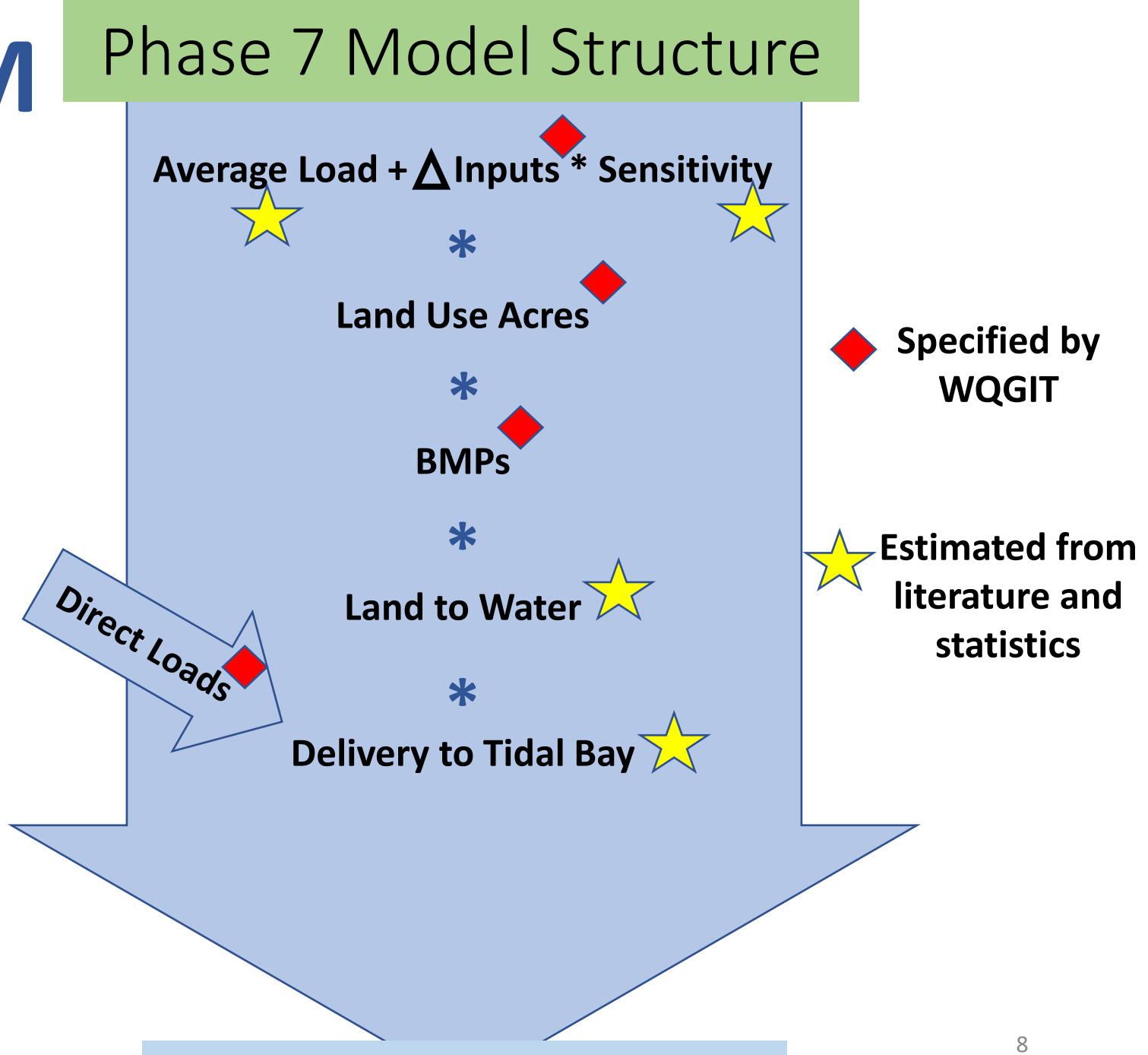


Cast/CalCast/DM

Phase 7
CalCAST

Tool for finding parameters that best match observations

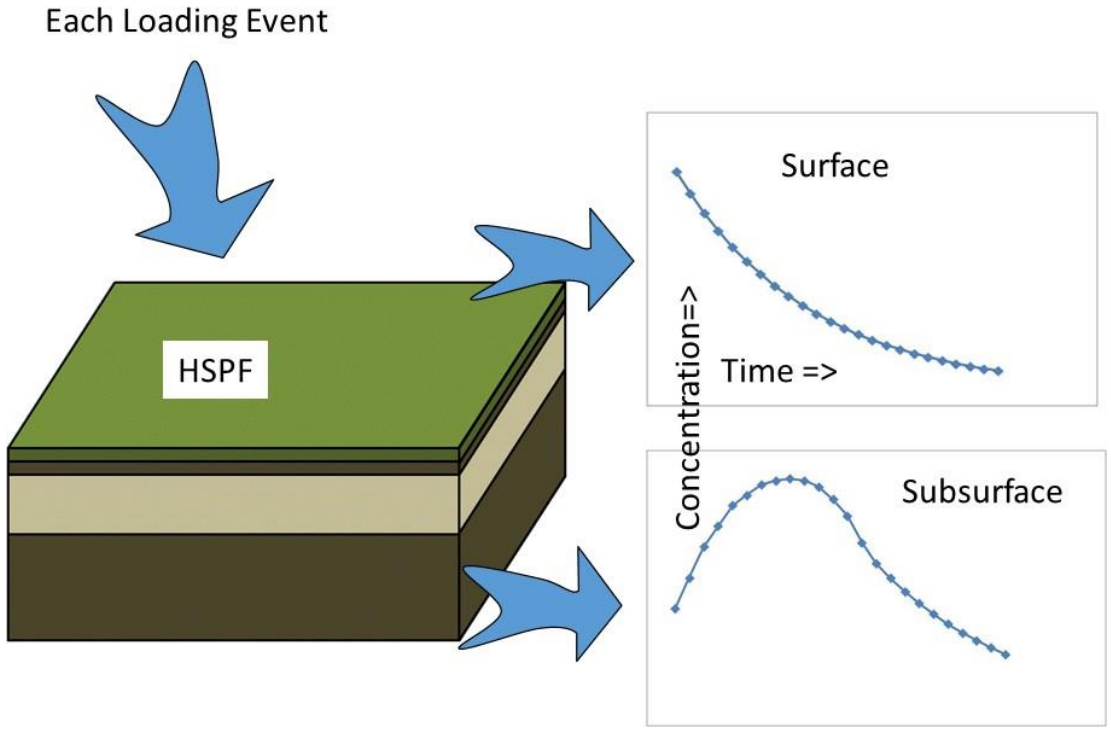
Isabella Bertani



Cast/CalCast/DM

Phase 7
Dynamic Model

Tool for
- loading estuarine models
- Comparing against observations
- Other potential collaborative projects



Gopal Bhatt

Phase 7 CAST Structure

Inform

Constrain

CalCAST

Average Load
+
Δ Inputs * Sensitivity
*
BMPs
*
Acres
*
Land to Water
*
River Delivery

Load by land-river segment and land use

Phase 7 CAST Structure

Average Load
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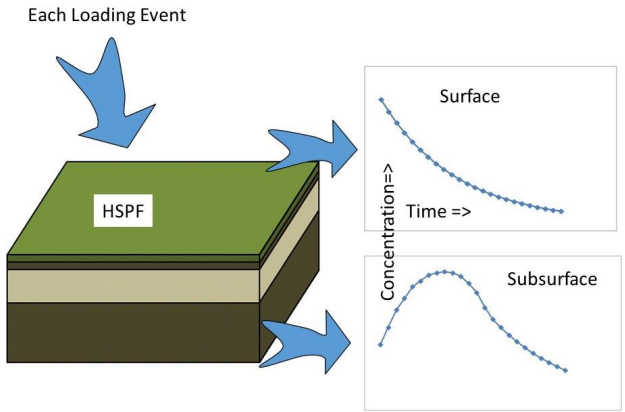
Load by land-river segment and land use

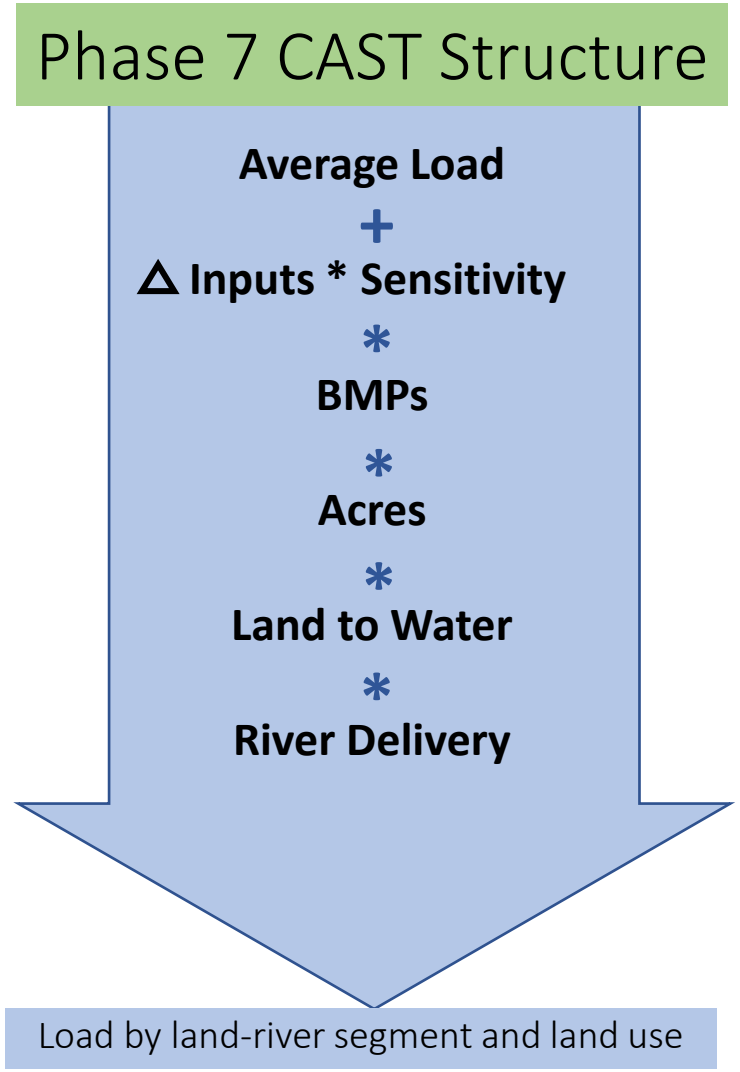
Dynamic Model



CAST model documentation; section 1
https://cast.chesapeakebay.net/Documentation/ModelDocumentation

Workgroup Discussions

- Urban Stormwater
- Waste Water Treatment
- Forestry Workgroup
- Watershed Technical
- Do you want to change
  - Land uses
  - Other Load sources
  - Relative loading rates
  - Sensitivities
  - BMPs



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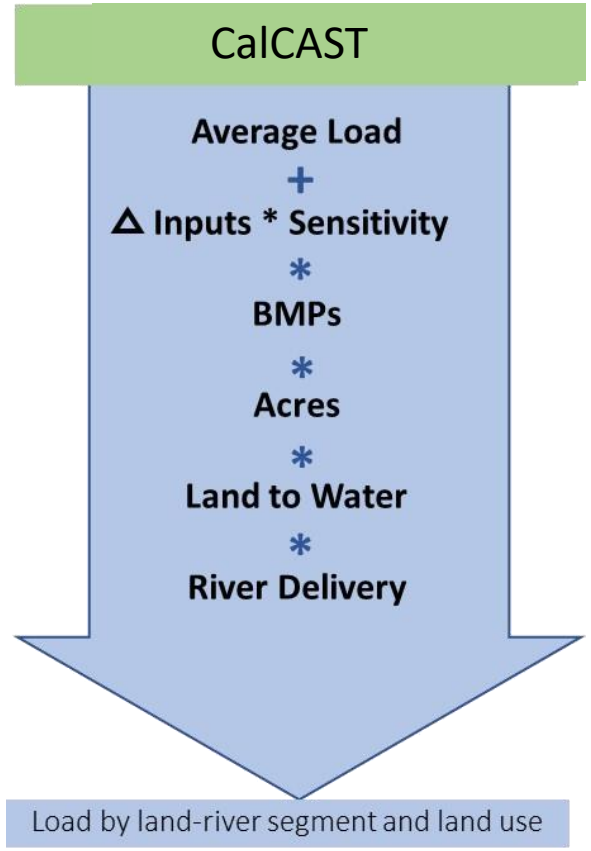
CalCAST

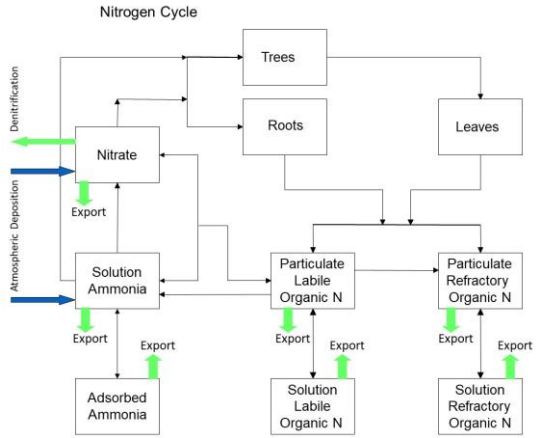


- Evaluate land to water factors
- Evaluate river delivery factors
- Evaluate sensitivities
- *Lead: Isabella Bertani*
- *Support: Joseph Delesantro*

Dynamic Model

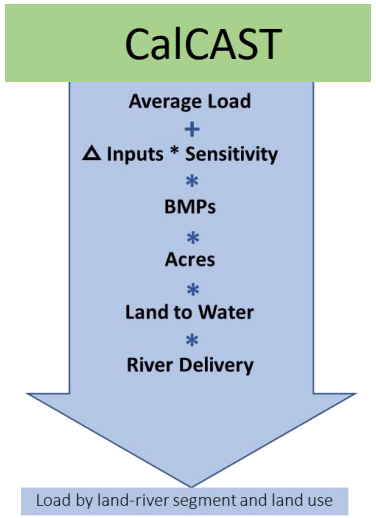
- Develop NHD100k scale simulation and outputs
- Update weather
- Update climate
- *Lead: Gopal Bhatt*

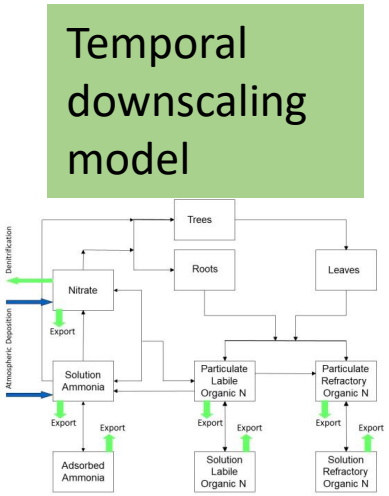
Temporal downscaling model



Machine learning

- Potential Improvement
  - Fine-scale land use and geomorphology data use in transport
  - Time-variable concentrations
- *Penn State: Kim Van Meter; Chaopeng Shen*

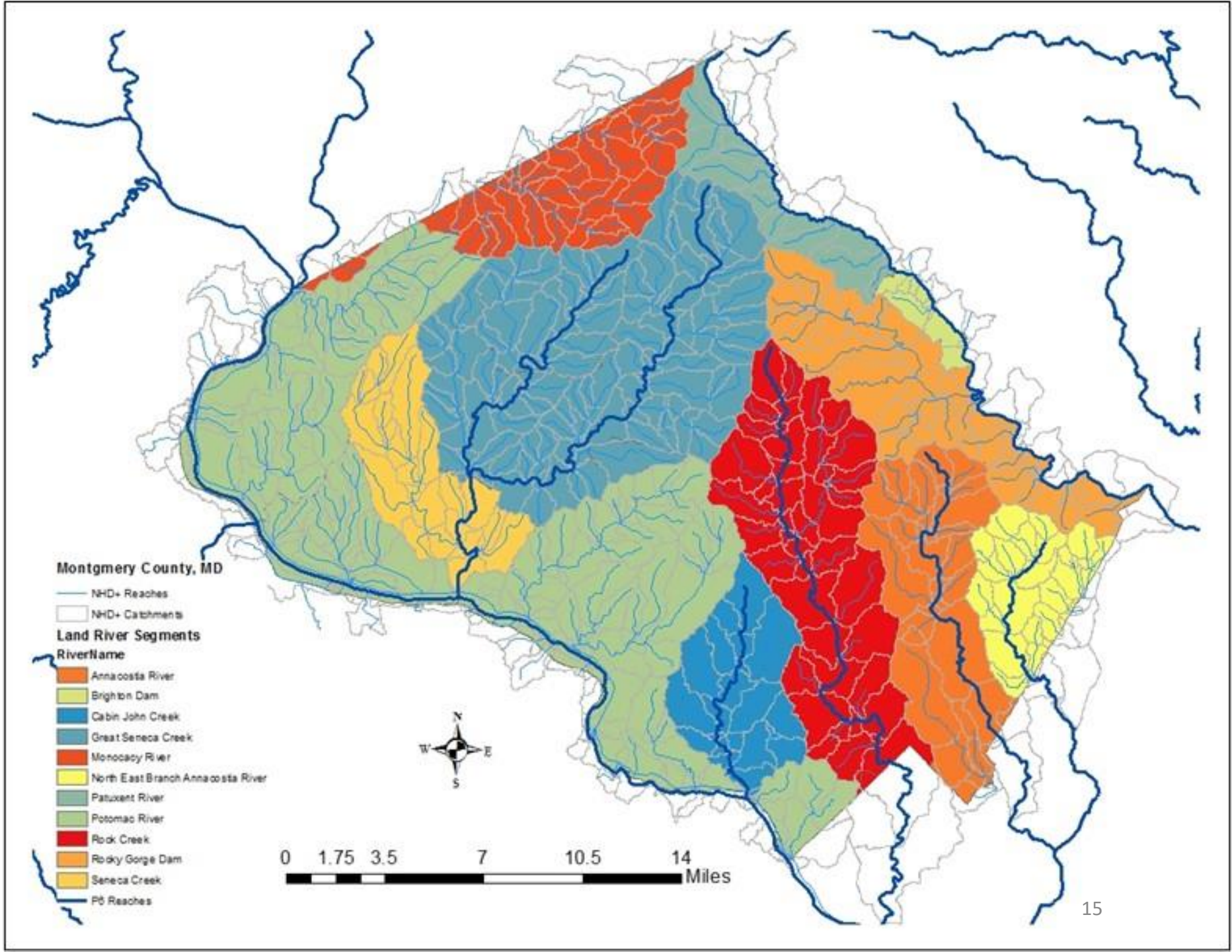




Scale

Definitions

- Land segment
- Land-river segment
- NHD catchment

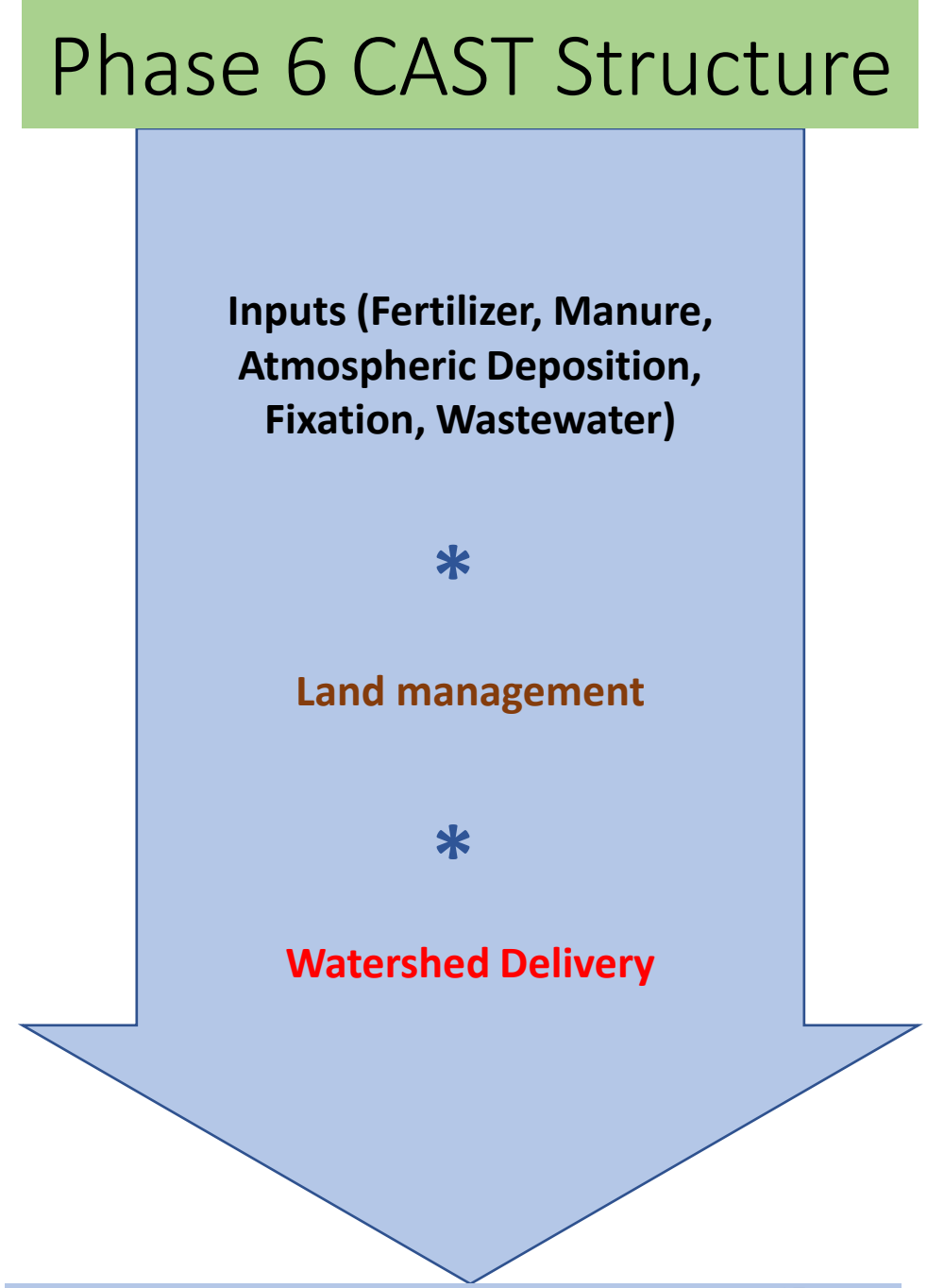


Watershed Models Scales

- **CalCAST** will is being developed at the **NHD100k** scale to incorporate more monitoring data and to support finer scale modeling
- The **Dynamic Model** will run at the **NHD100k** scale because it is required by the estuarine model
- **Phase 7 CAST will be built at the scale that the WQGIT decides**

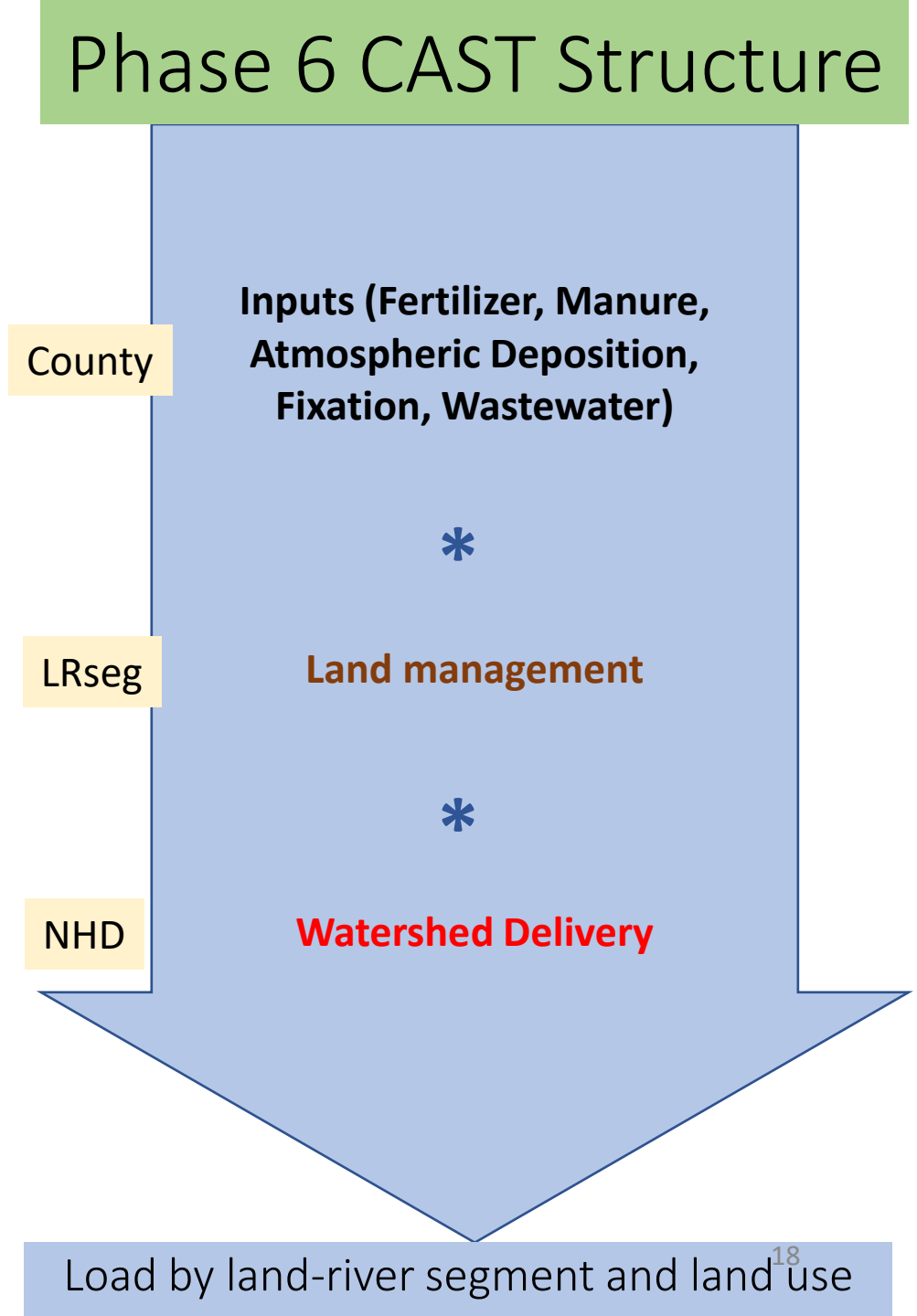
Multiple Scales in Phase 6

- Phase 6 is based on
  - Inputs to the land surface
  - Land management
  - Watershed Delivery



Multiple Scales in Phase 6

- In general,
  - Inputs are estimated at the county level
  - Land management is estimated at the LRseg level
  - Watershed delivery is estimated at the NHD level
- Information is upscaled or downscaled and calculations are made at the land-river segment scale



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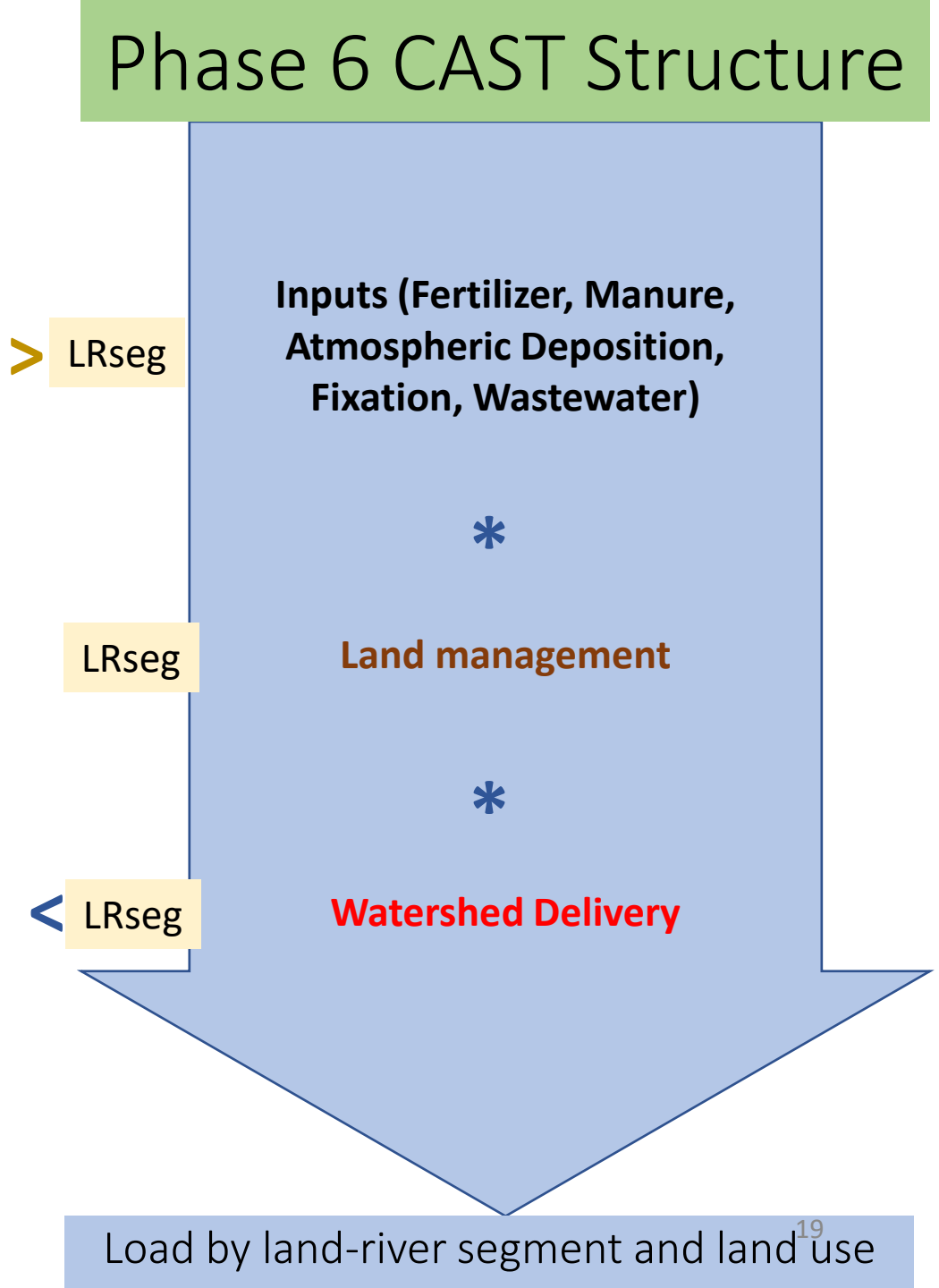
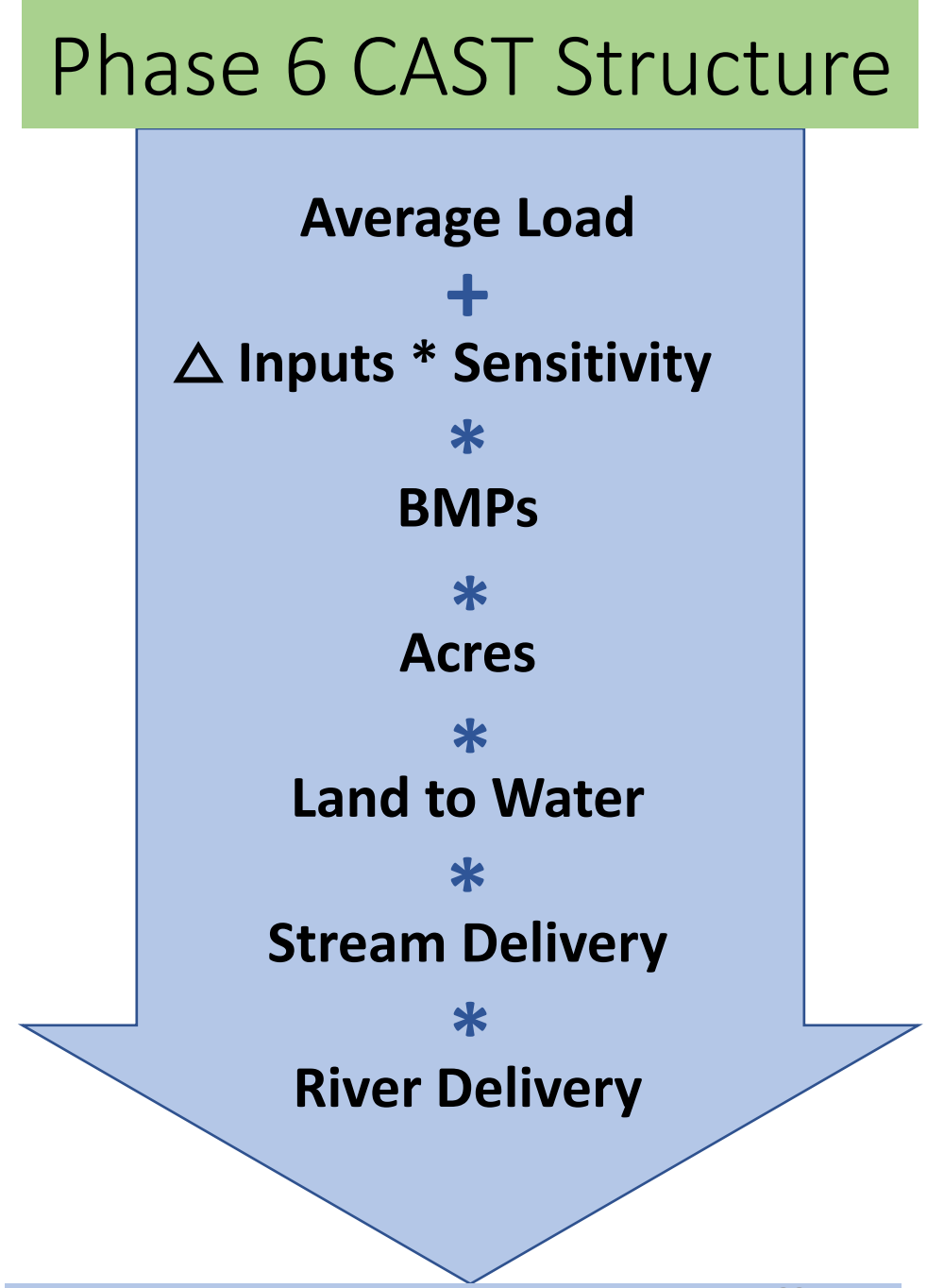


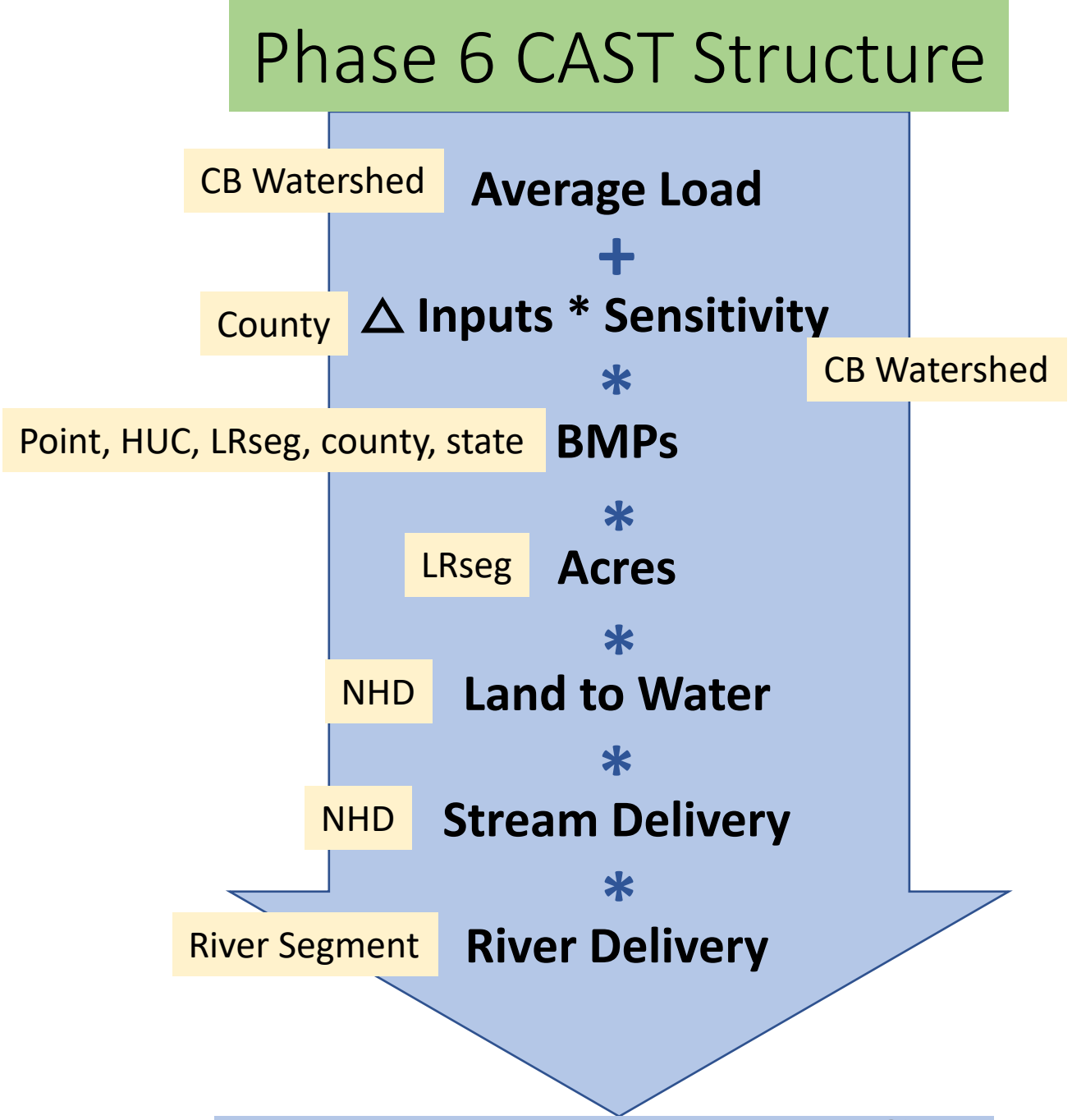
Multiples Scales in Phase 6

- The full CAST equation with terms broken out



Multiple Scales in Phase 6

- The terms are known at various scales
- Computations are made at the land-river segment
- County-level data are disaggregated to land-river segment
- Watershed delivery is aggregated up to land-river segment



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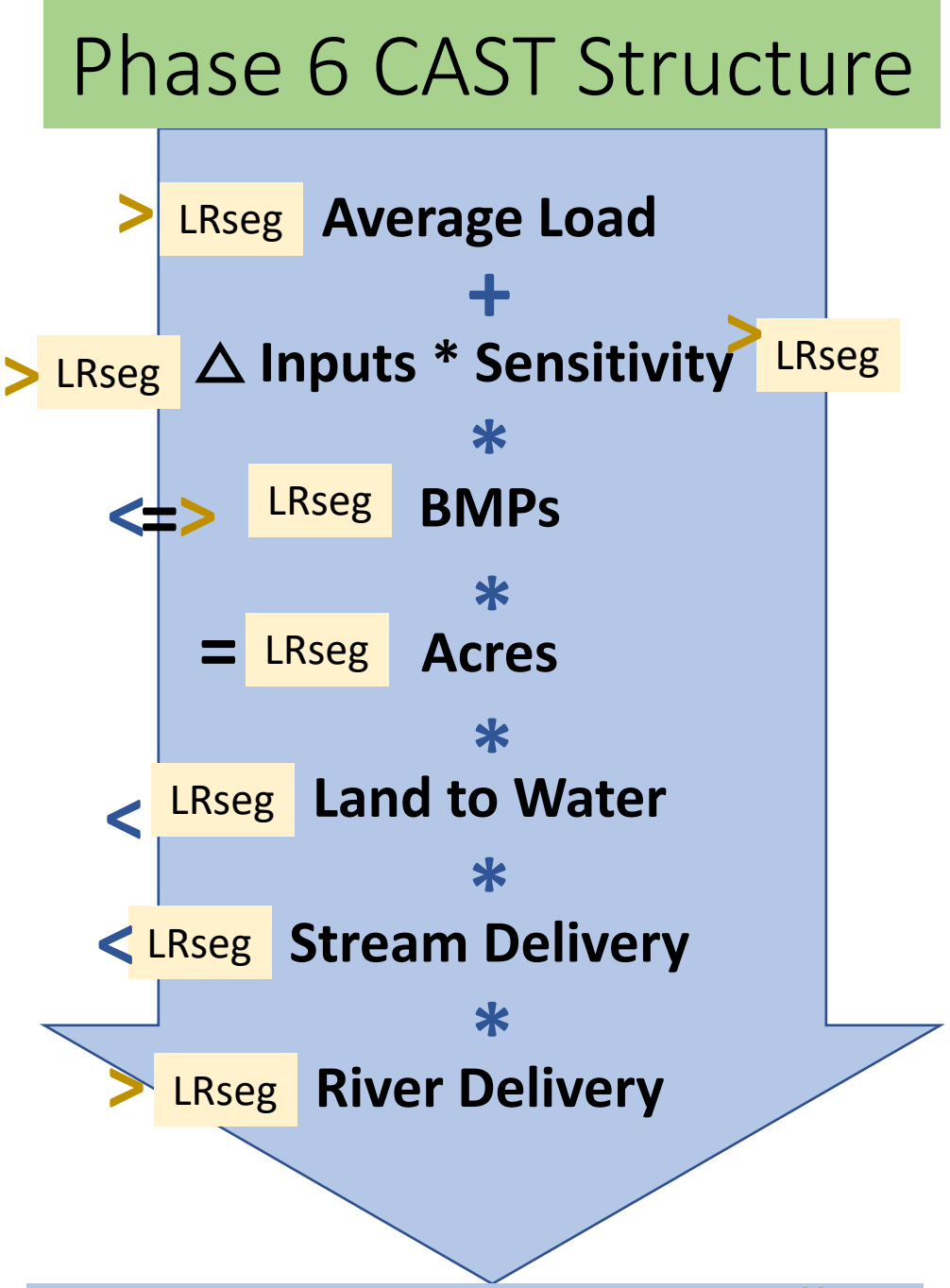
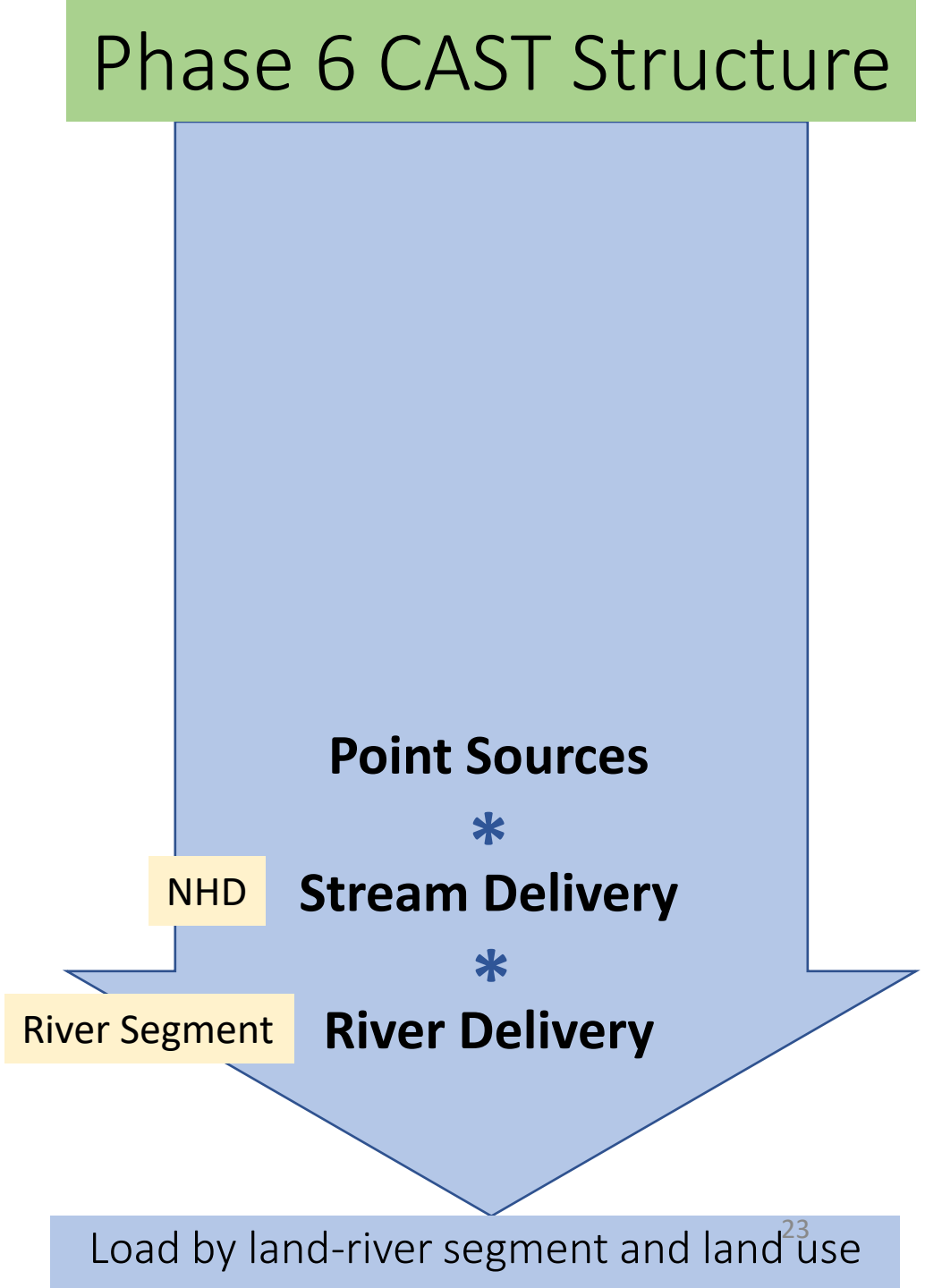


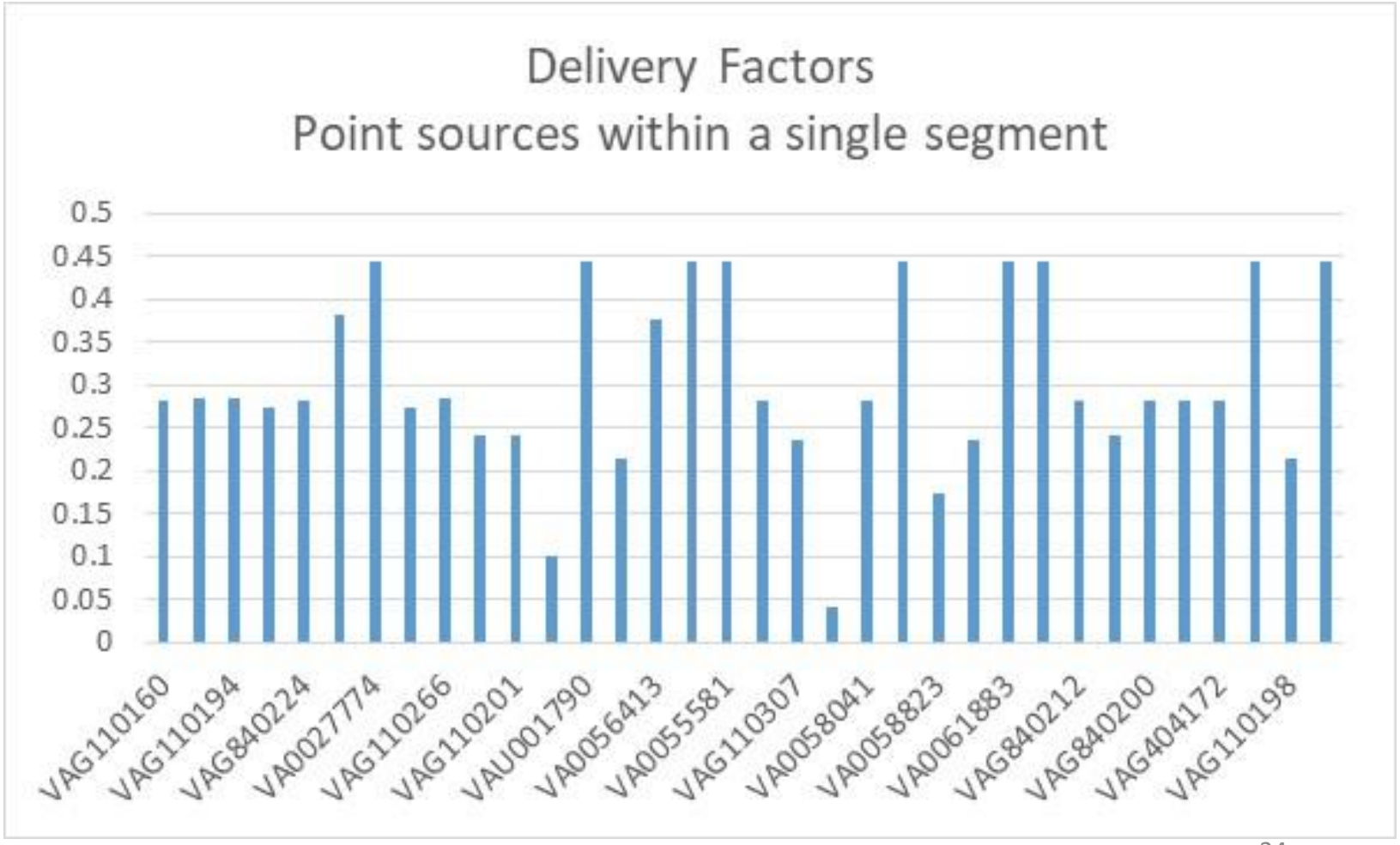
Multiple Scales in Phase 6

- Point Sources are kept a the NHD scale



Multiple Scales in Phase 6

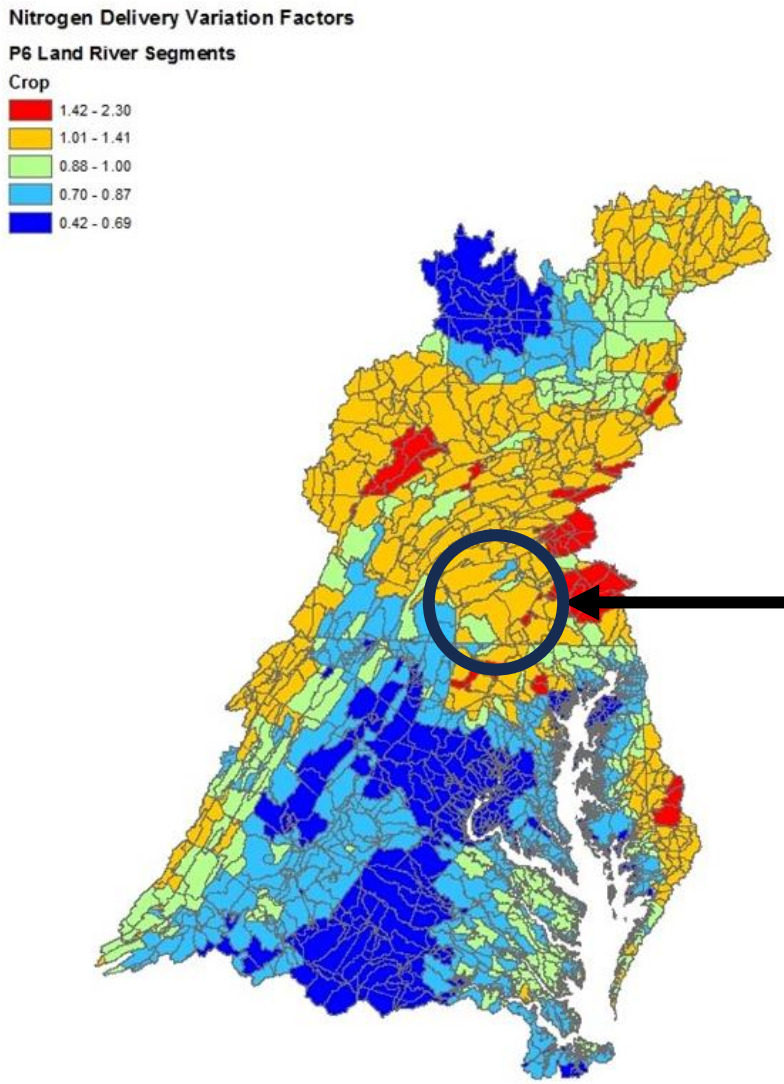
- Delivery Factors for point sources are based on the NHD scale in Phase 6



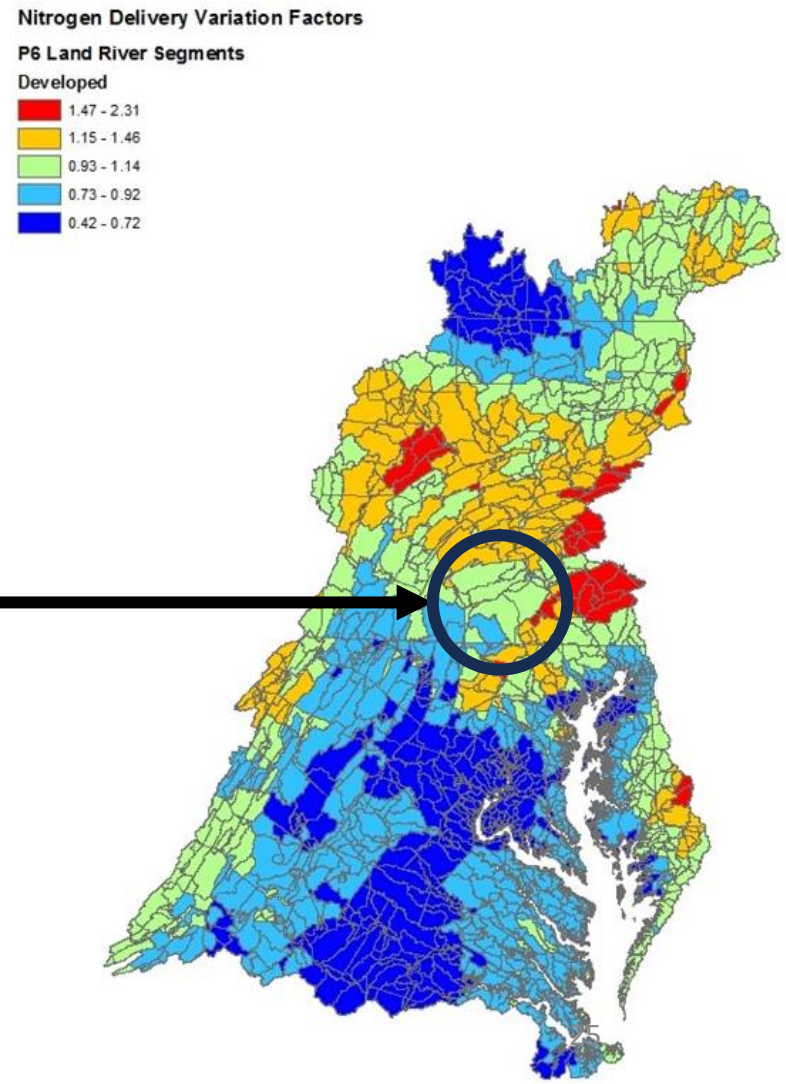
Multiple Scales in Phase 6

- Delivery Factors for nonpoint sources vary based on where that land use exists within a land-river segment

Crop Land to Water

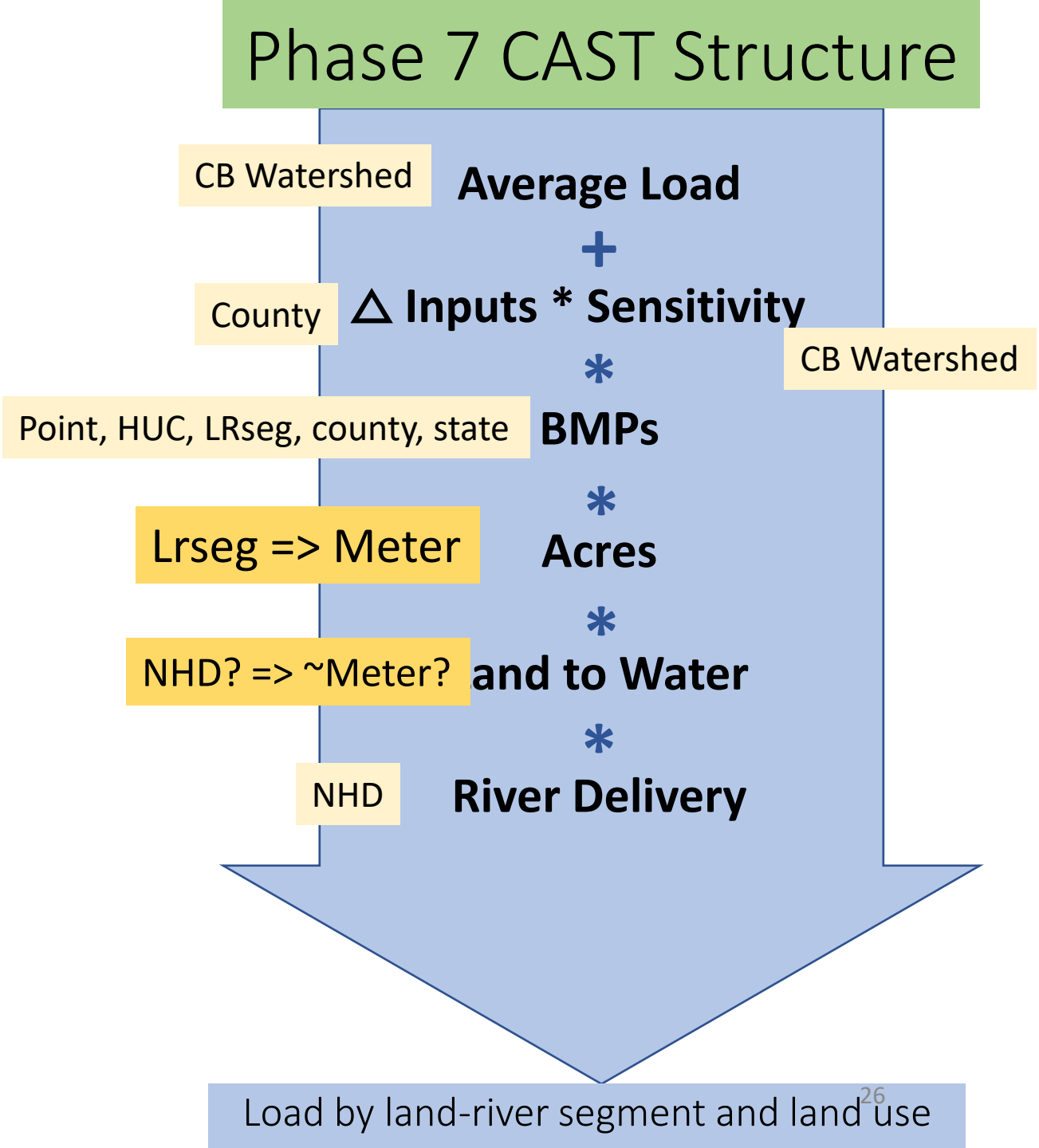


Developed Land to Water



Multiple Scales in Phase 7

- Change for phase 7
  - We will have land use at the meter scale
  - We may have some land to water delivery at finer scales
- Will allow us to upscale and downscale with more accuracy



Scientific Questions for Multi-Scale Modeling

- What scale incorporates the most observed data, including local data NHD
- What scale allows the best understanding of load differences based on landscape features NHD or finer
- What scale is needed for the new Main Bay Model and potential Tributary Models NHD

Management Questions for Multi-Scale Modeling

- For Official TMDL accounting purposes:
  - When you use Phase 7 CAST, what scale do you want for output?
  - What would be the finest scale you would want to specify BMP placement in CAST?
- For non-official purposes, do you support the opportunity for receiving results at a finer scale that approximate the official results?
- What scale do you want optimization result on?
- What scale is needed for some co-benefits for flow and temperature
- What scale is needed for water supply partners (flow only) NHD

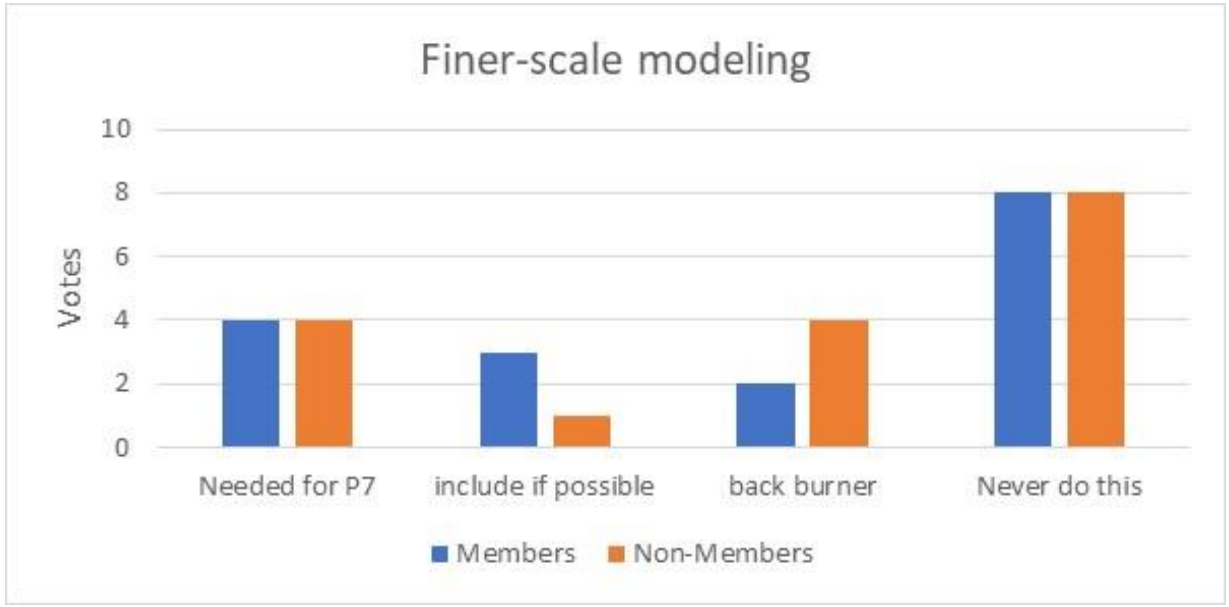
The Watershed Model does not have to be one-size-fits-all

- Development and calibration can happen at the NHD scale
- CAST scenarios can be run at the LRseg scale
- CAST scenario results can be downscaled for the estuarine models
- Unofficial CAST scenarios could potentially be run at a finer scale

- The WQGIT decides the CAST scale…and you don’t have to decide now.
  - Development and calibration happen now
  - CAST gets built in 2025 for 2026

Phase 7 CAST will be built at the scale that the partnership wants

- The modeling team proposed a scale that was met with mixed reviews
- The modeling team is revising the proposal based on the feedback



- Few comments
- Half of comments favored use for targeting
- Half opposed
  - Resources better used elsewhere
  - Greater uncertainty at finer scales