STAC Review of Chesapeake Bay Program Phase 6 Watershed Model

Gary Shenk – USGS - Chesapeake Bay Program

9/14/16

Partnership Feedback on Modeling

- **Water Quality Goal Implementation Team**
  - Need more **transparent and easier** to understand decision-support tools to enable successful engagement of local partners

- **Scientific and Technical Advisory Committee**
  - Multiple Models
  - Phosphorus
  - Complex Reservoir Dynamics
  - Fine-scale processes

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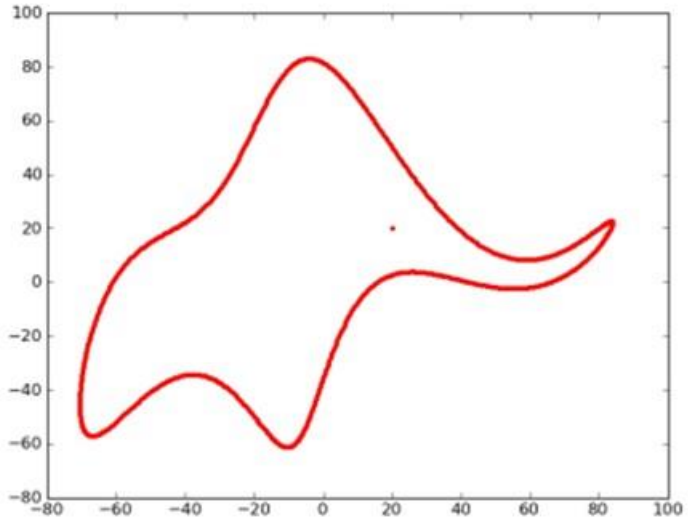
Keep it Simple!!

Include Everything!!!

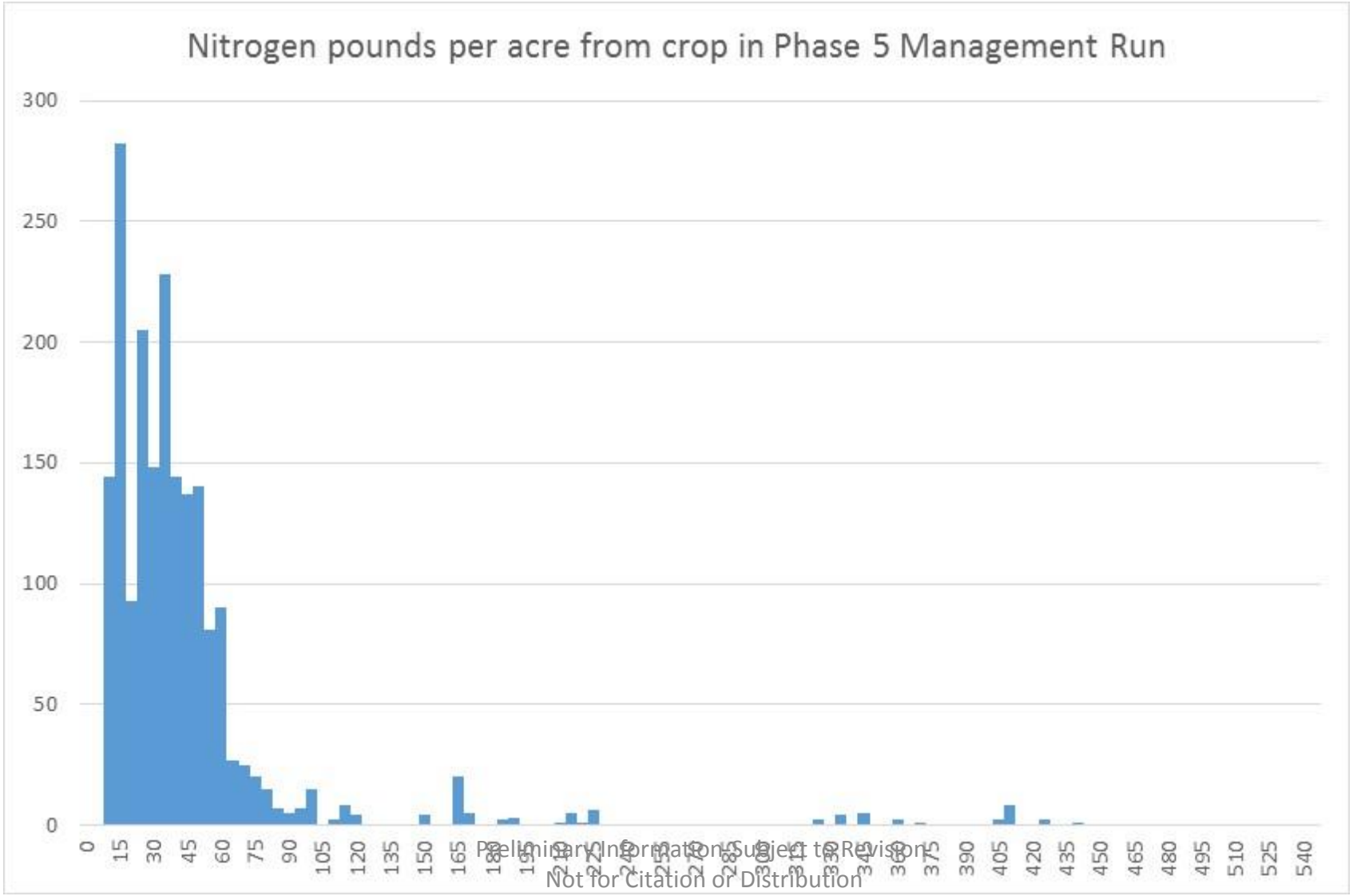
Model Complexity

- Von Neumann: With four parameters I can fit an elephant, and with five I can make him wiggle his trunk.



"Drawing an elephant with four complex parameters" by Jurgen Mayer, Khaled Khairy, and Jonathon Howard, Am. J. Phys. 78, 648 (2010), DOI:10.1119/1.3254017

Wiggling Trunks in Phase 5



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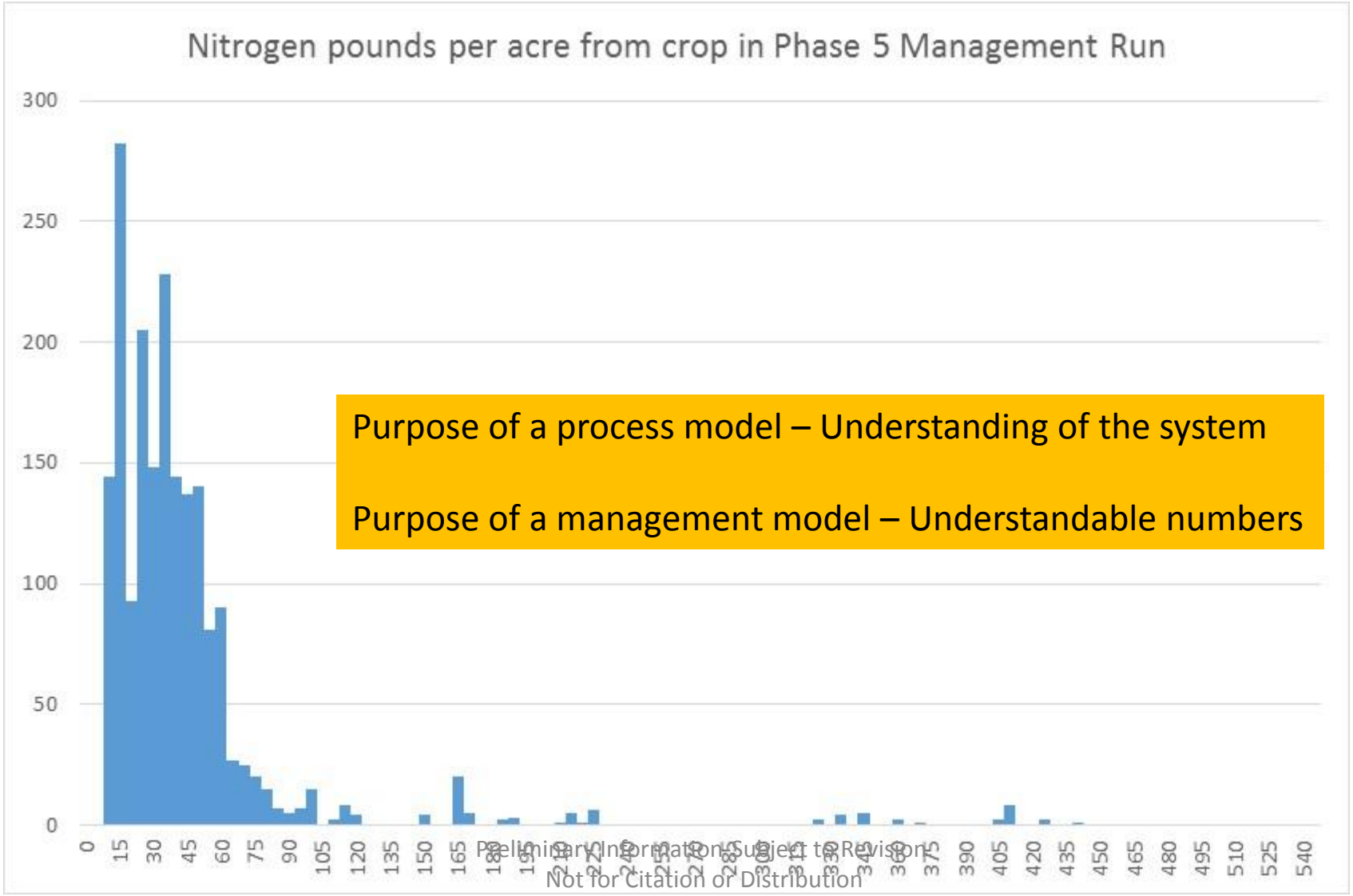

Purpose of a process model – Understanding of the system

Purpose of a management model – Understandable numbers





Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

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Land Use Acres

*

BMPs

*

Land to Water

*

Stream Delivery

*

River Delivery

Direct Loads

Phase 6

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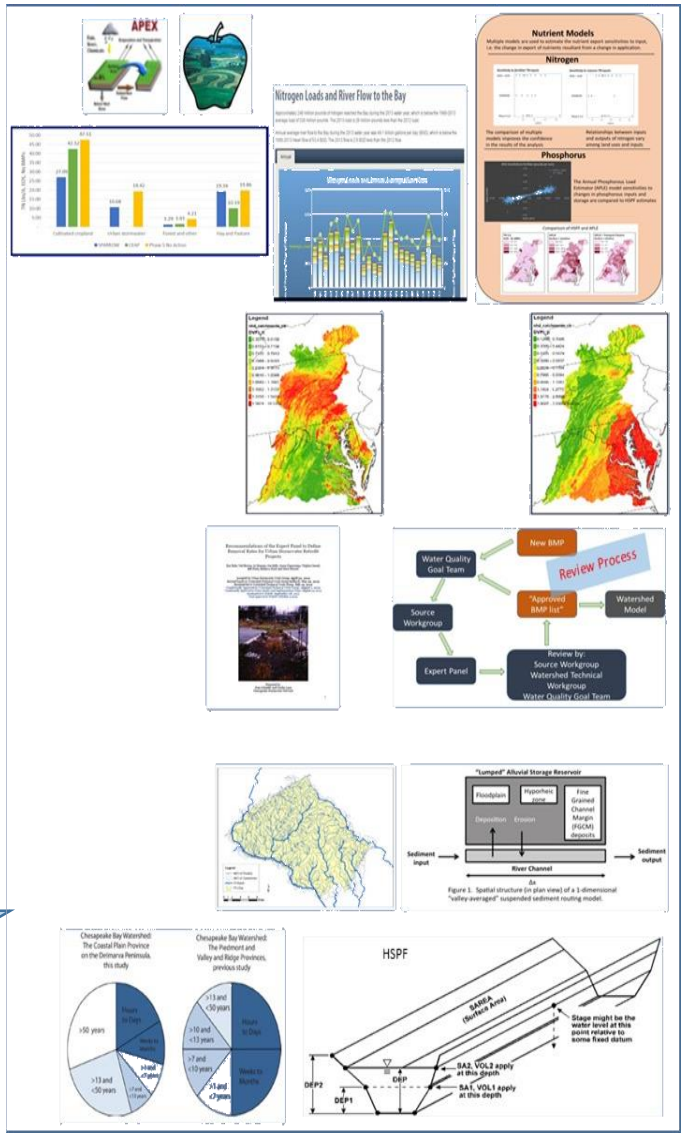
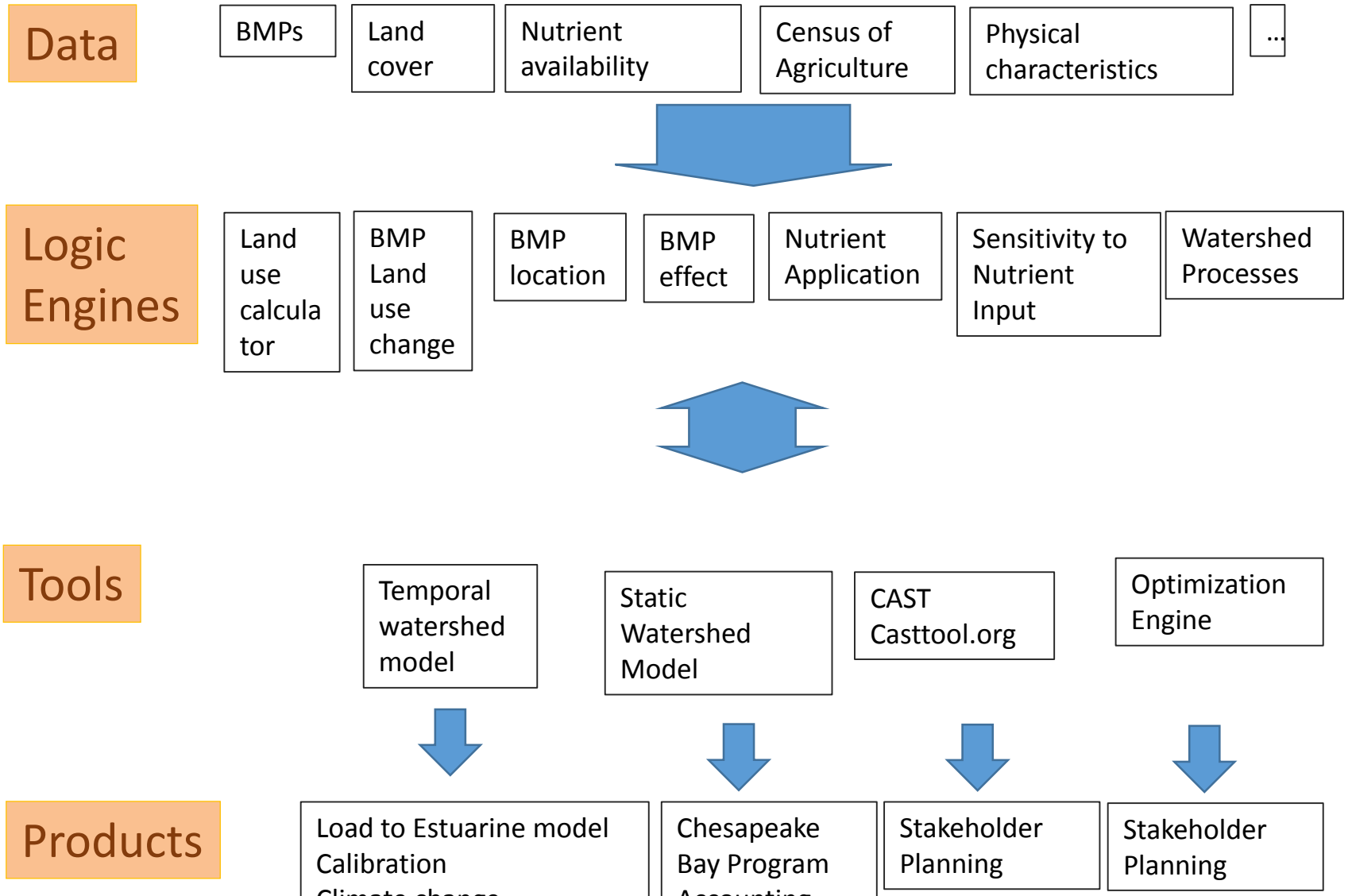
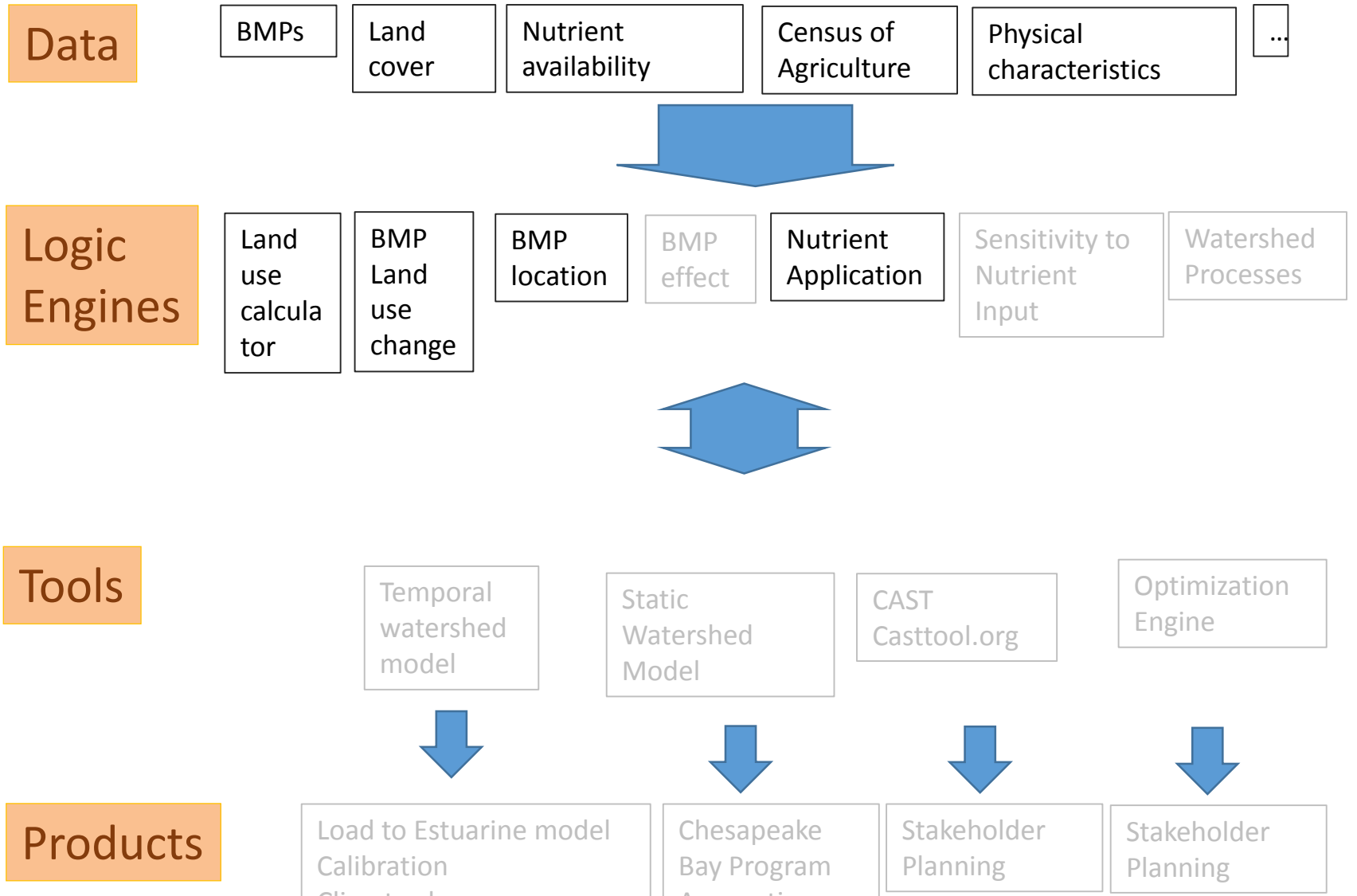


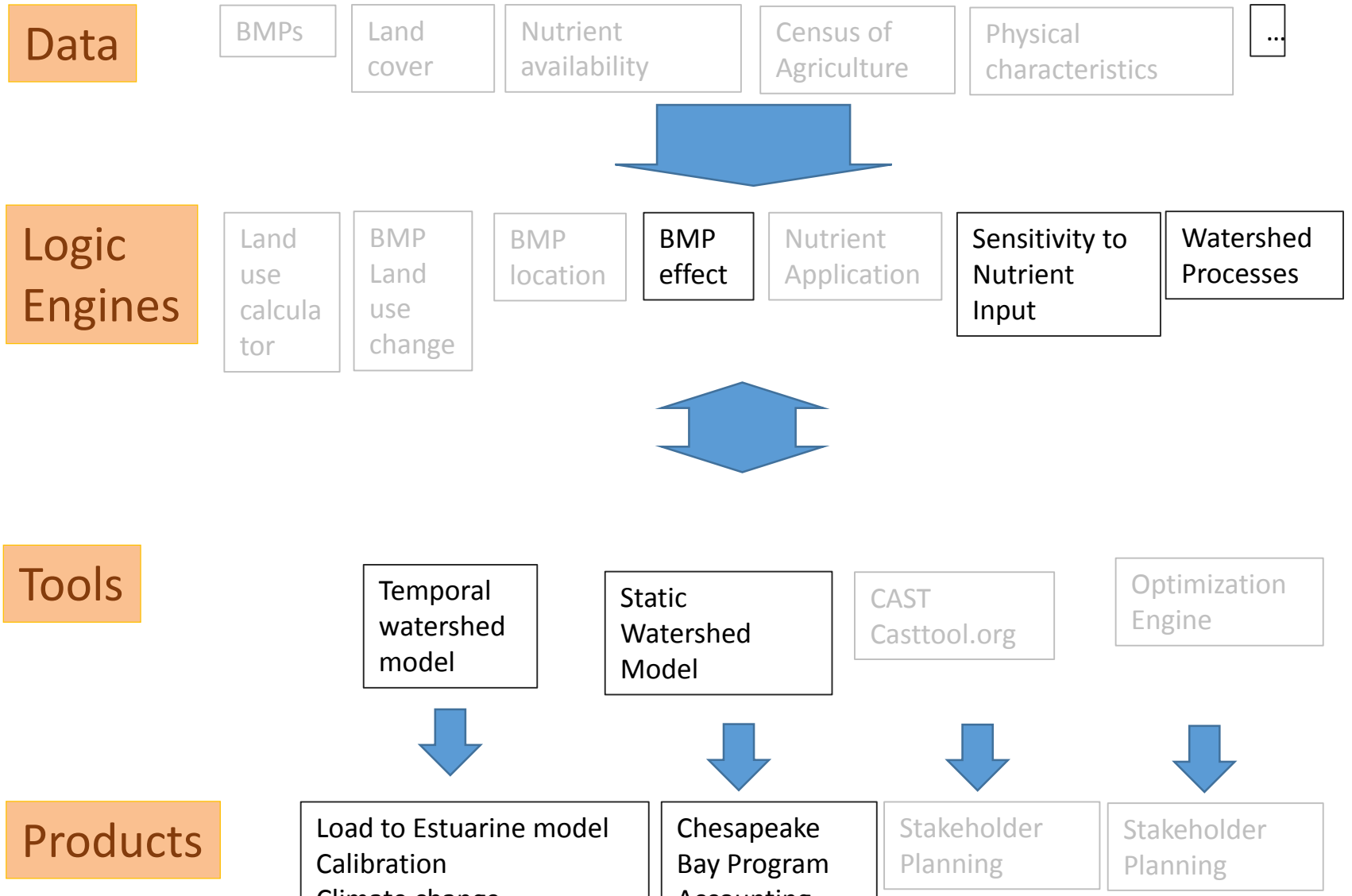
CBP Watershed Simulation



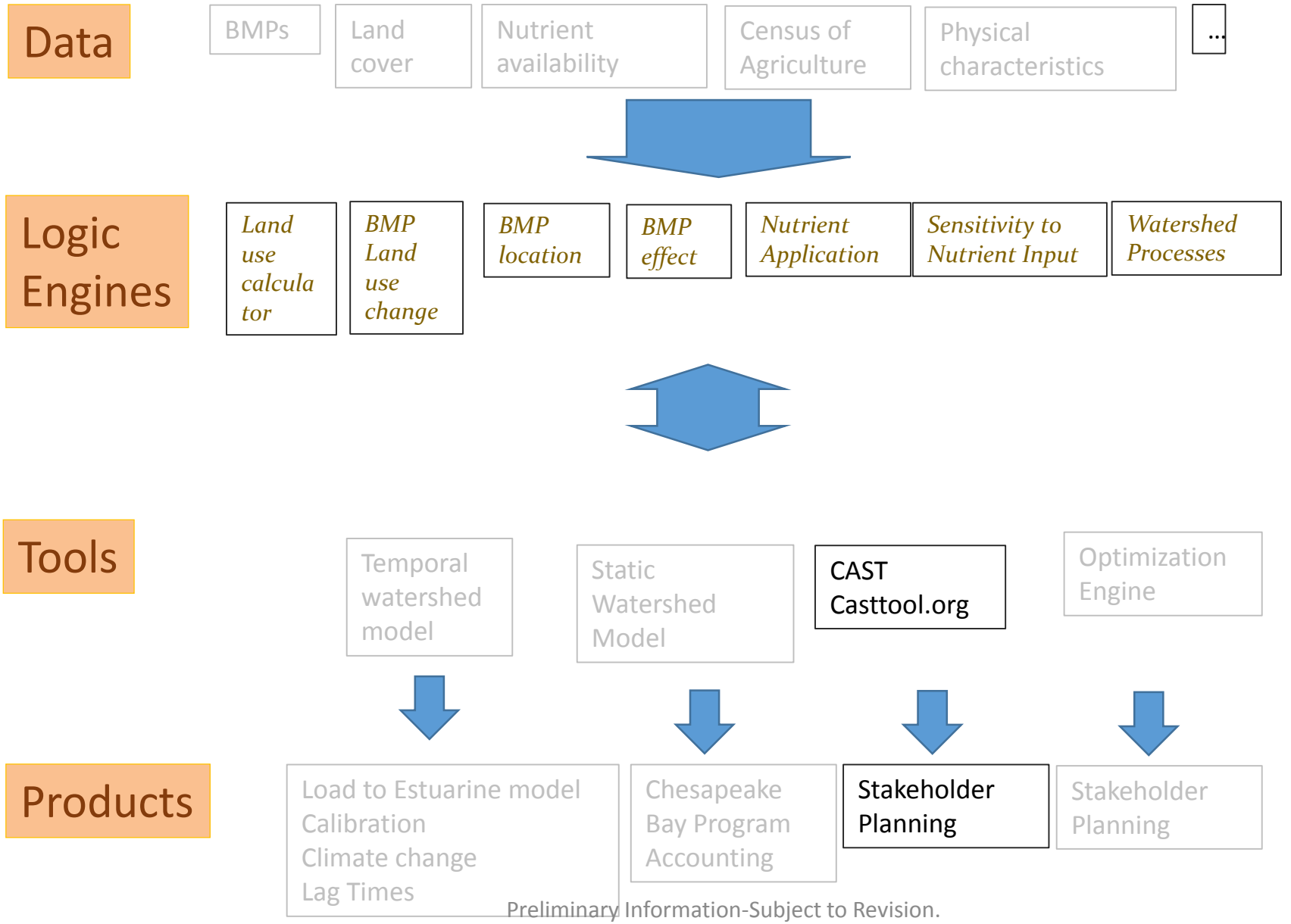
‘ Phase 5 Scenario Builder’



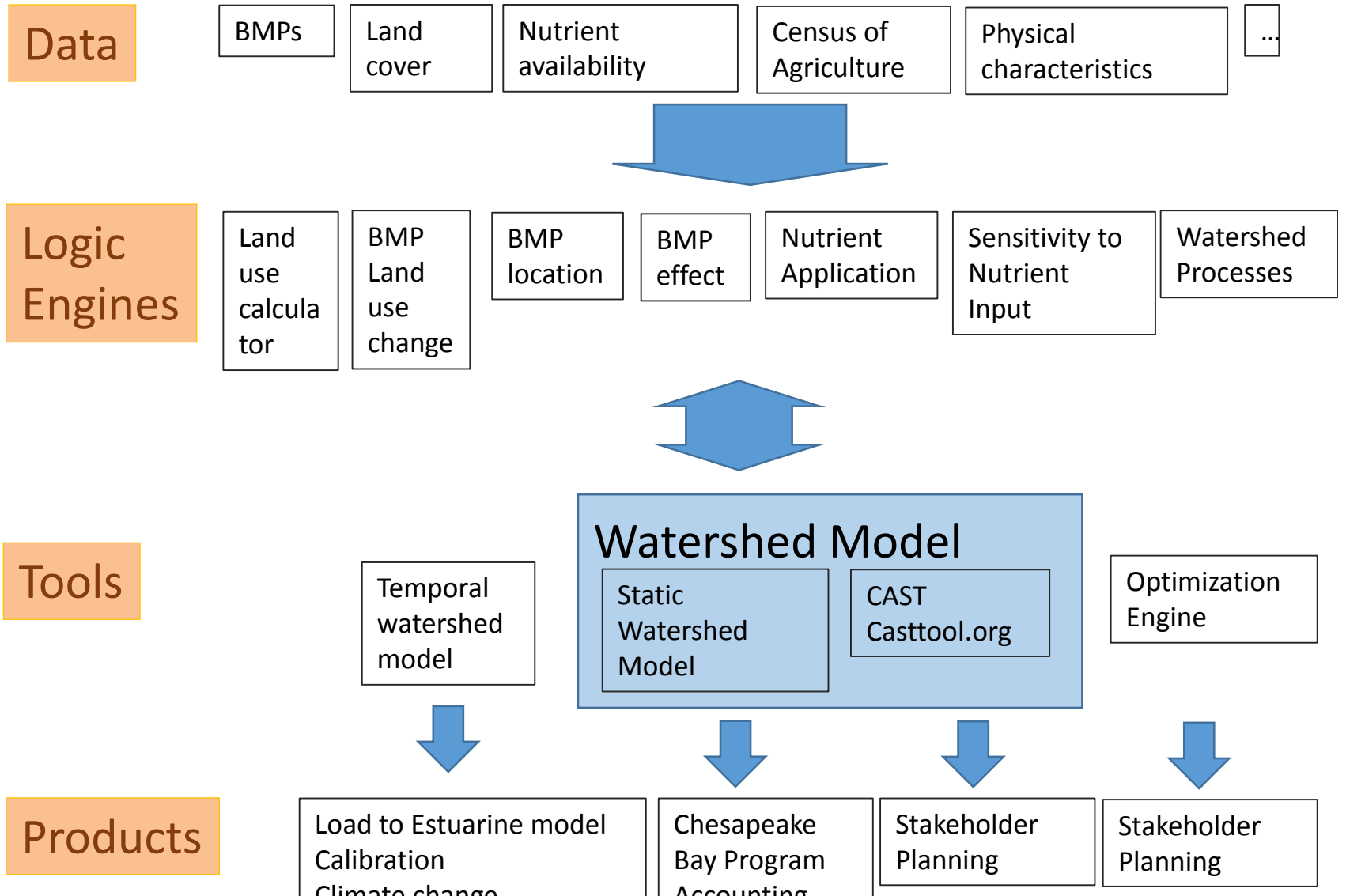
‘ Phase 5 Watershed Model’



‘Phase 5 CAST’



CAST = WSM = Scenario Builder







Phase 6 Model Structure

Average Load + ΔInputs * Sensitivity

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River Delivery

Direct Loads

Phase 6





Phase 6 Model Documentation

Section 1: Overview

Section 2: Average Loads + Section 3: Inputs * Section 4: Sensitivity

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Section 5: Land Use

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Section 6: BMPs

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Section 7: Land to Water

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Section 9: Stream Delivery

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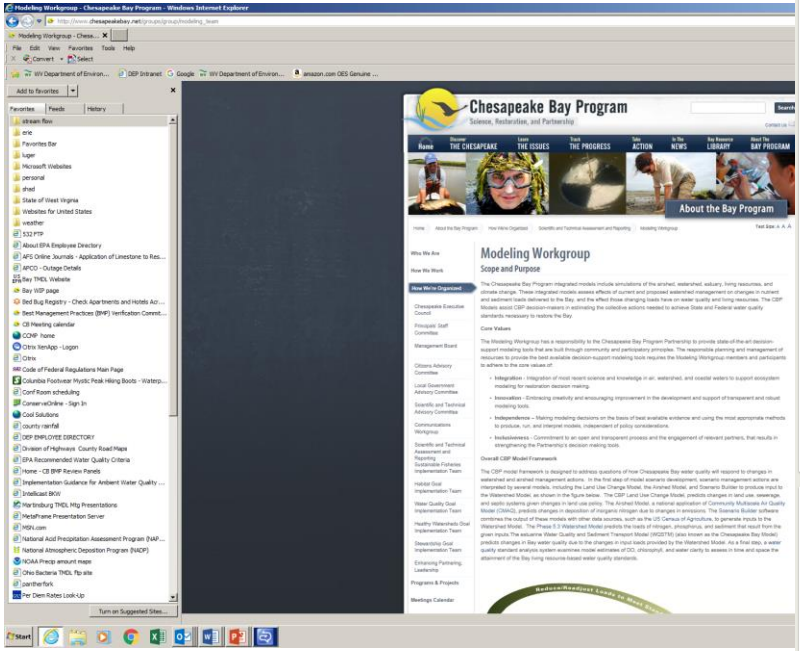
Section 10: River Delivery

Section 8: Direct Loads

Section 11: Applications

Documentation



Members | Meetings | Workgroups & Task Groups | Projects & Resources | Publications

Phase 6 Beta 2 Draft Documentation - June 2016

The Phase 6 Beta 2 Watershed Model is available for partnership review. The purpose of making the draft documentation available to the Partnership is to provide the Partnership with a written record of the results of the many partnership decisions that have been made in the Management Board, the Modeling Workgroup, the Water Quality Goal Implementation Team, and the WQGIT's many workgroups.

Documentation

Documentation pdf and excel files can be found here:
ftp://ftp.chesapeakebay.net/Modeling/Phase6/Ph6Calibration_Beta2/20160401/Documentation/

Calibration Plots

Graphics showing the calibration to individual stations and aggregate statistics are found here: ftp://ftp.chesapeakebay.net/Modeling/gbhatt/Phase_6_Beta_2/

Inputs

Inputs for Beta 2 were produced in April and do not reflect the latest versions of the nutrient spread and other partnership decisions that will be included in Beta 2. Inputs used in Beta 2 are available here: ftp://ftp.chesapeakebay.net/Modeling/Phase6/Ph6Calibration_Beta2/20160401/inputs/. A more conveniently summarized version of the the Beta 2 inputs can be found in excel files at this ftp site: ftp://ftp.chesapeakebay.net/Modeling/Phase6/Ph6Calibration_Beta2/20160401/inputs/ScenarioBuilder/

Load Outputs

The 'AllLoads' excel files are the annual average loads in raw format and can be found at this FTP site: ftp://ftp.chesapeakebay.net/Modeling/Phase6/Ph6Calibration_Beta2/20160401/

Phase 6 Beta 1 - January 2016

The Phase 6 Beta 1 Watershed Model is available for partnership review. Draft documentation files are available in the series of attached documents below. Calibration plots are available on the CBP FTP site by constituent, or in a single file (hyperlinks below). Information and data regarding Scenario Builder inputs can also be accessed from another linked FTP below.

Calibration Plots, by Constituent: ftp://ftp.chesapeakebay.net/Modeling/gbhatt/Phase_6_Beta_1/20151231_Calibration_Graphics/

All Calibration Plots (large file size): http://ftp.chesapeakebay.net/Modeling/gbhatt/Phase_6_Beta_1/20151231_Calibration_Graphics/Calibration%20Graphics%20Binder%2020151231.pdf

Scenario Builder Inputs: ftp://ftp.chesapeakebay.net/Modeling/Phase6

- See MWG Webpage
- http://www.chesapeakebay.net/groups/group/modeling_team
- Will be periodically updated
- Webinars here too





Phase 6 Model Documentation

Section 1: Overview

Section 2: Average Loads + Section 3: Inputs * Section 4: Sensitivity

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Section 5: Land Use

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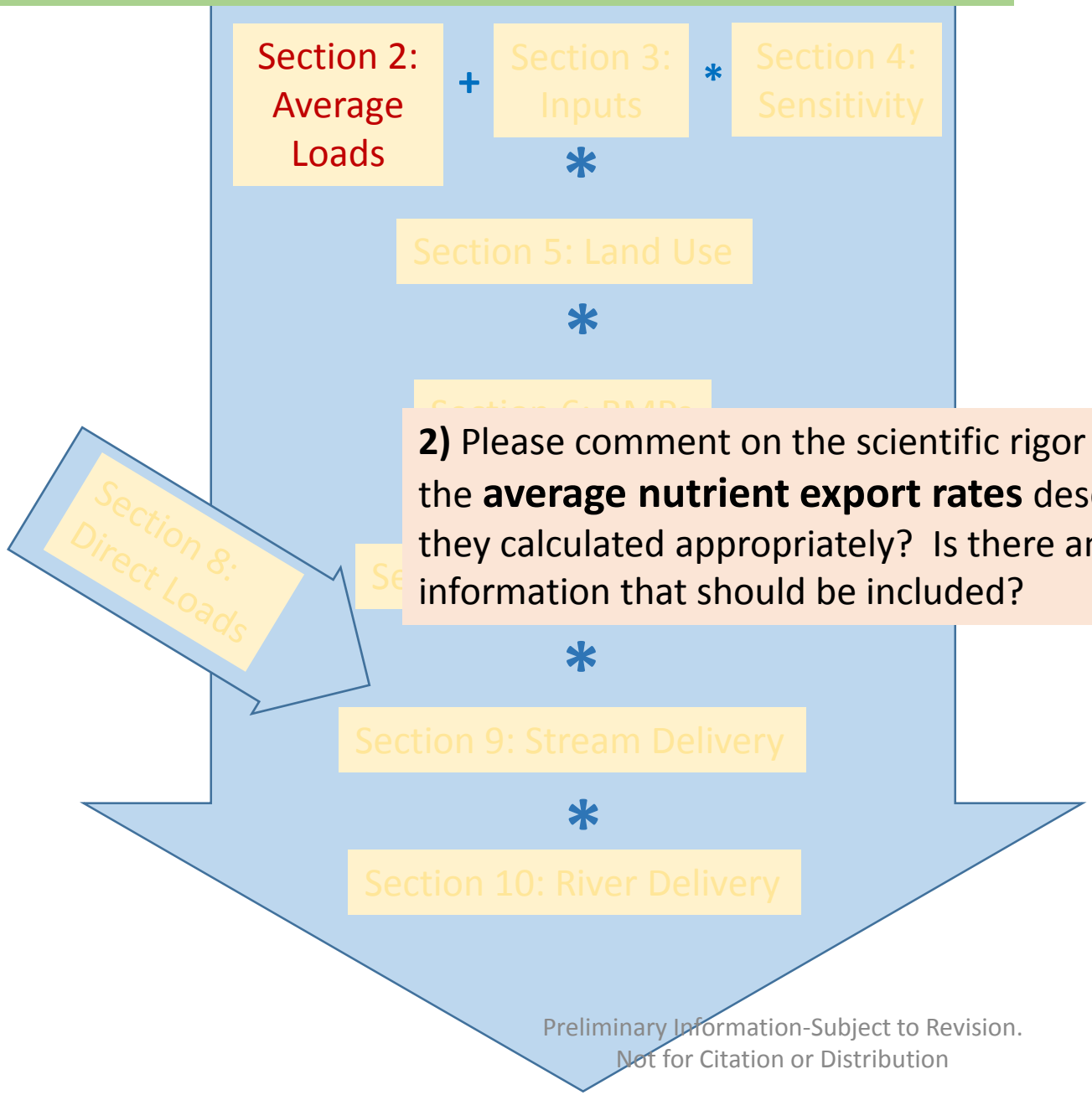
Section 11: Applications

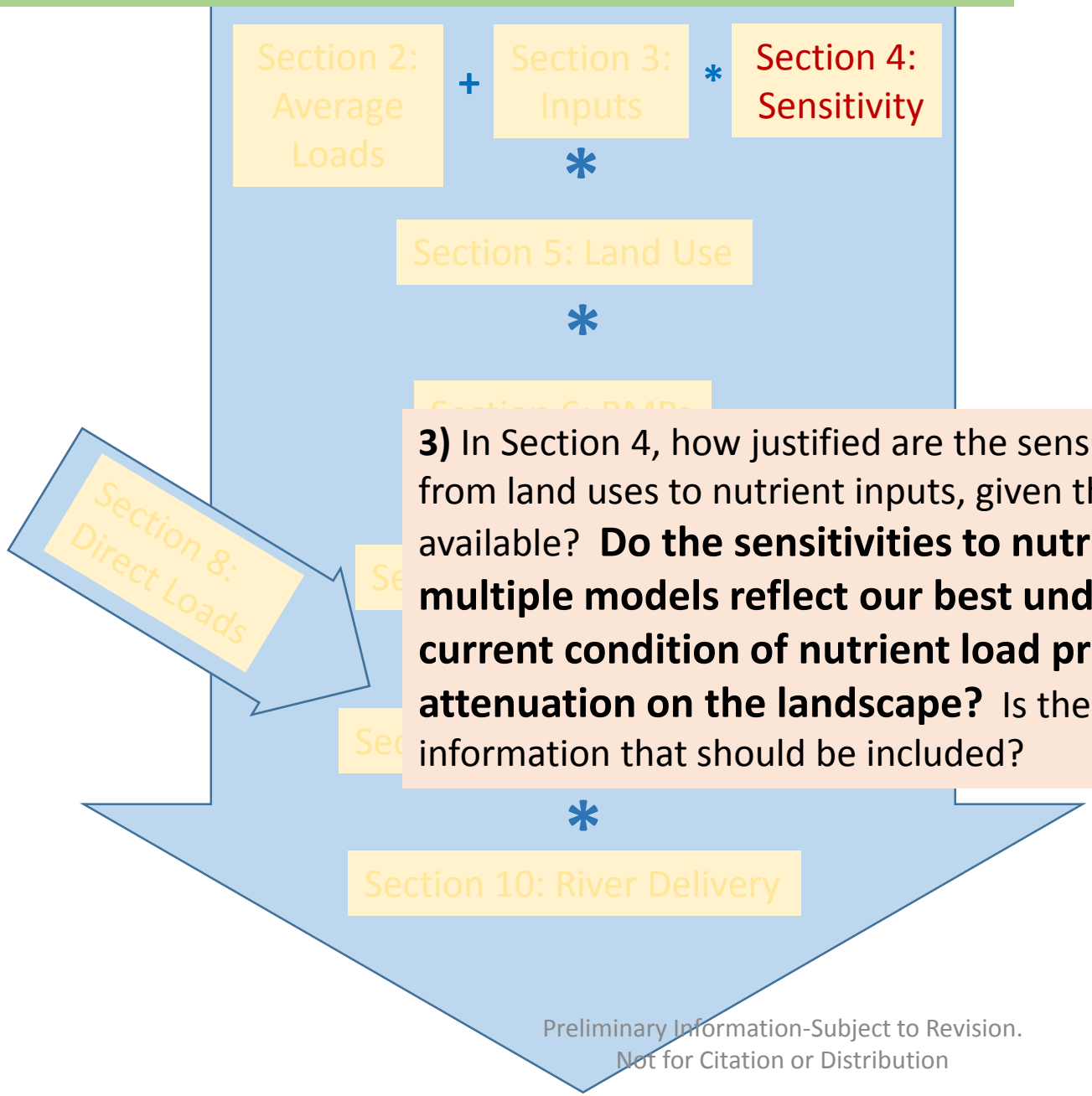
1) Please comment on the **overall appropriateness of the approach** taken in the Phase 6 structure of a deterministic hydrology and sediment transport management model combined with a nutrient model informed by **multiple models and multiple lines of evidence** as described in Section 1. Please comment on the multiple model structure of the Phase 6 nutrient simulation particularly to its utility to watershed management in the Chesapeake restoration? How can the Phase 6 multiple model approach be **improved going forward**?

Phase 6 Model Documentation



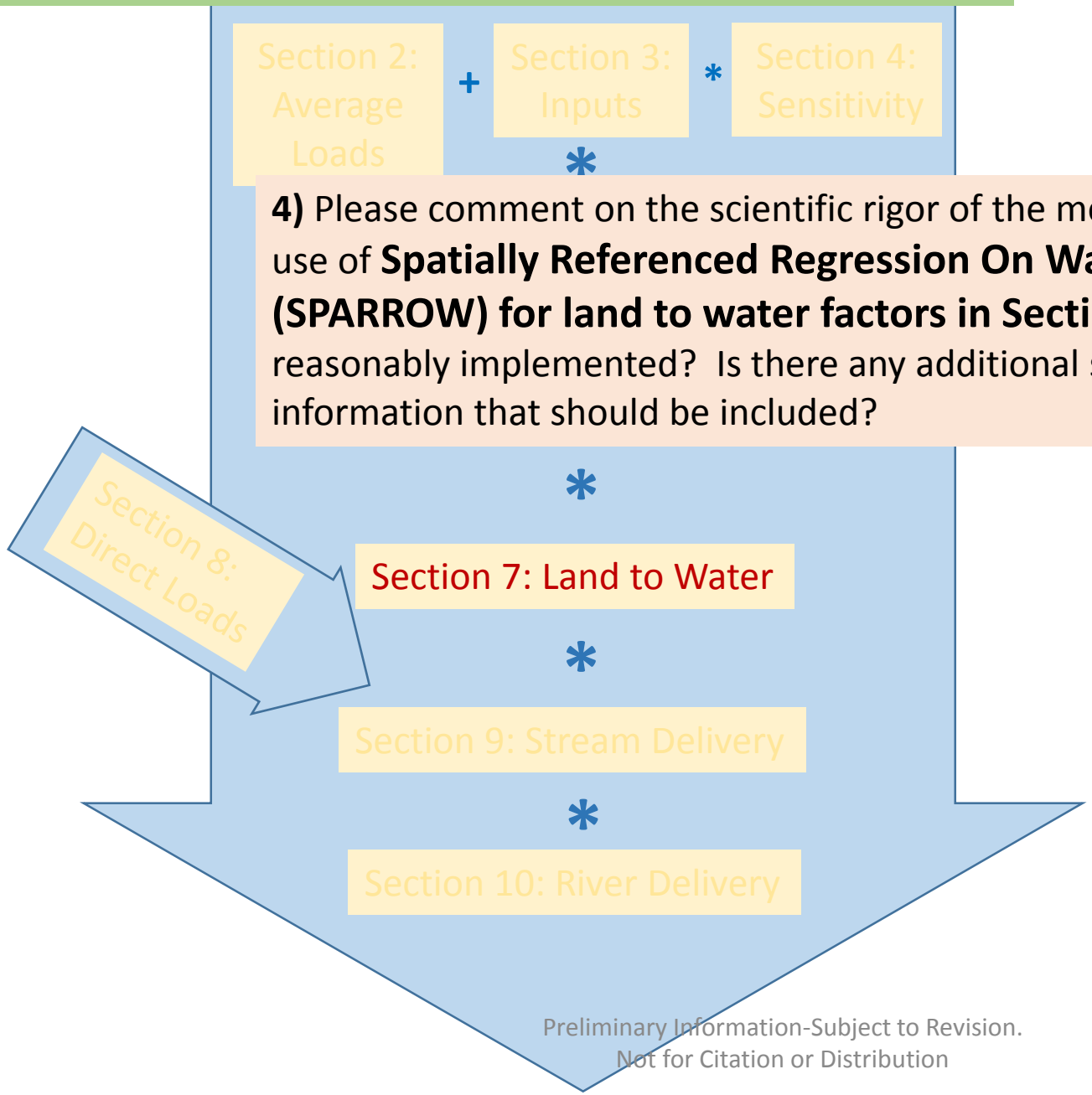
2) Please comment on the scientific rigor of the methods used for the **average nutrient export rates** described in Section 2. Are they calculated appropriately? Is there any additional scientific information that should be included?

Phase 6 Model Documentation



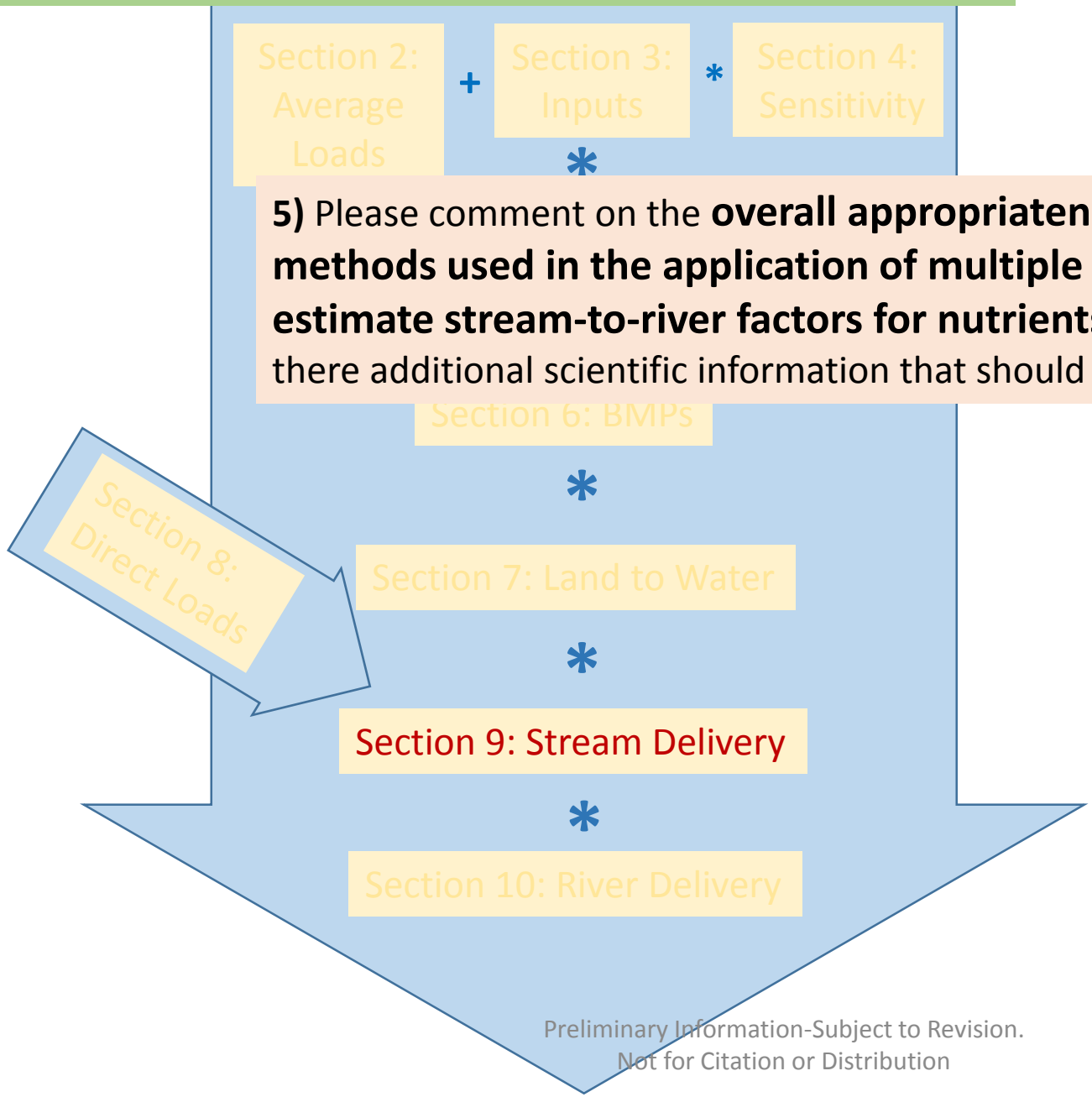
3) In Section 4, how justified are the sensitivities of nutrient export from land uses to nutrient inputs, given the approach used and data available? **Do the sensitivities to nutrient inputs derived from multiple models reflect our best understanding of the current condition of nutrient load processing and attenuation on the landscape?** Is there any additional scientific information that should be included?

Phase 6 Model Documentation



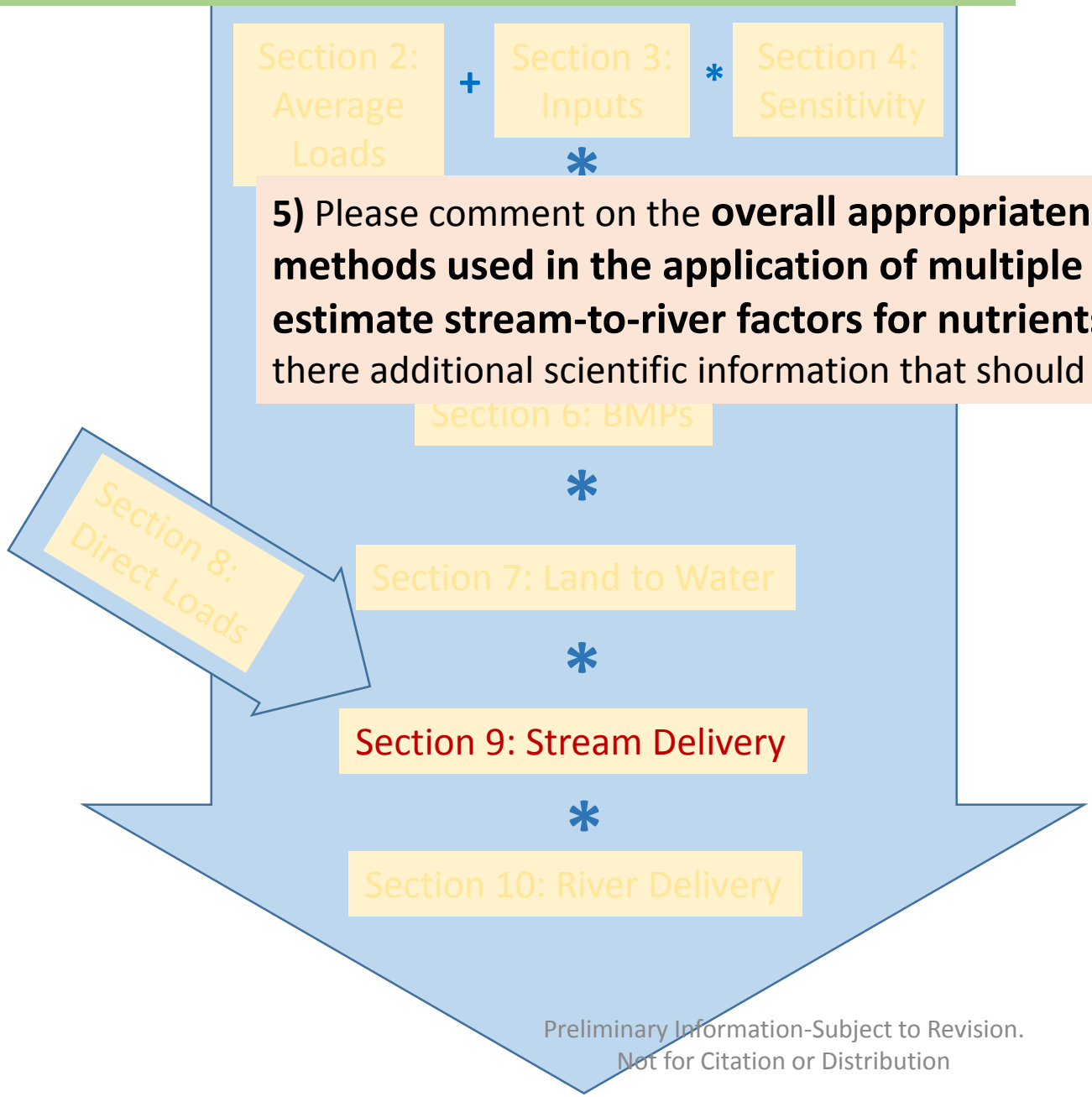
4) Please comment on the scientific rigor of the methods used in the use of **Spatially Referenced Regression On Watersheds (SPARROW) for land to water factors in Section 7**. Are they reasonably implemented? Is there any additional scientific information that should be included?

Phase 6 Model Documentation



5) Please comment on the **overall appropriateness of the methods used in the application of multiple methods to estimate stream-to-river factors for nutrients in Section 9?** Is there additional scientific information that should be included?

Phase 6 Model Documentation



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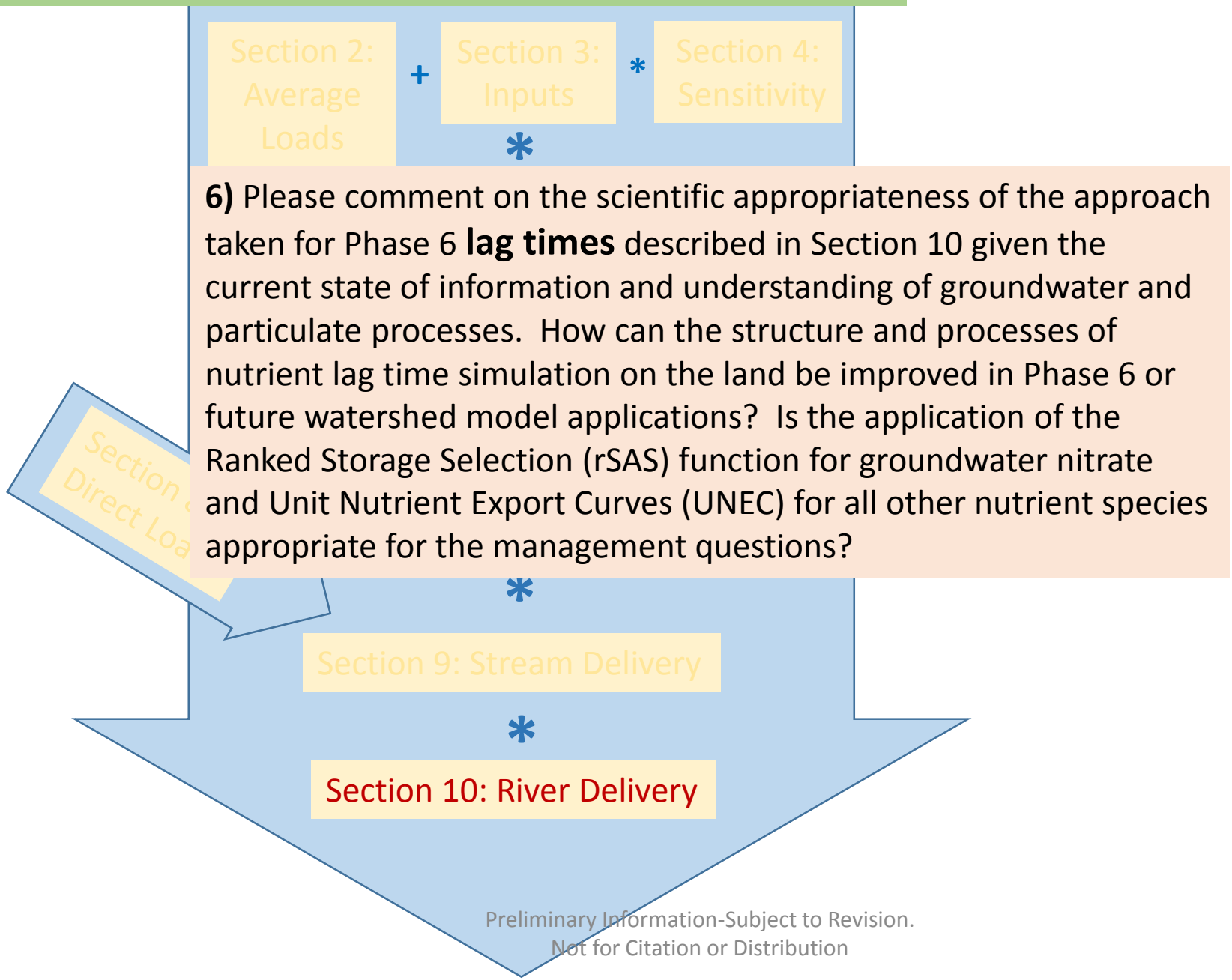
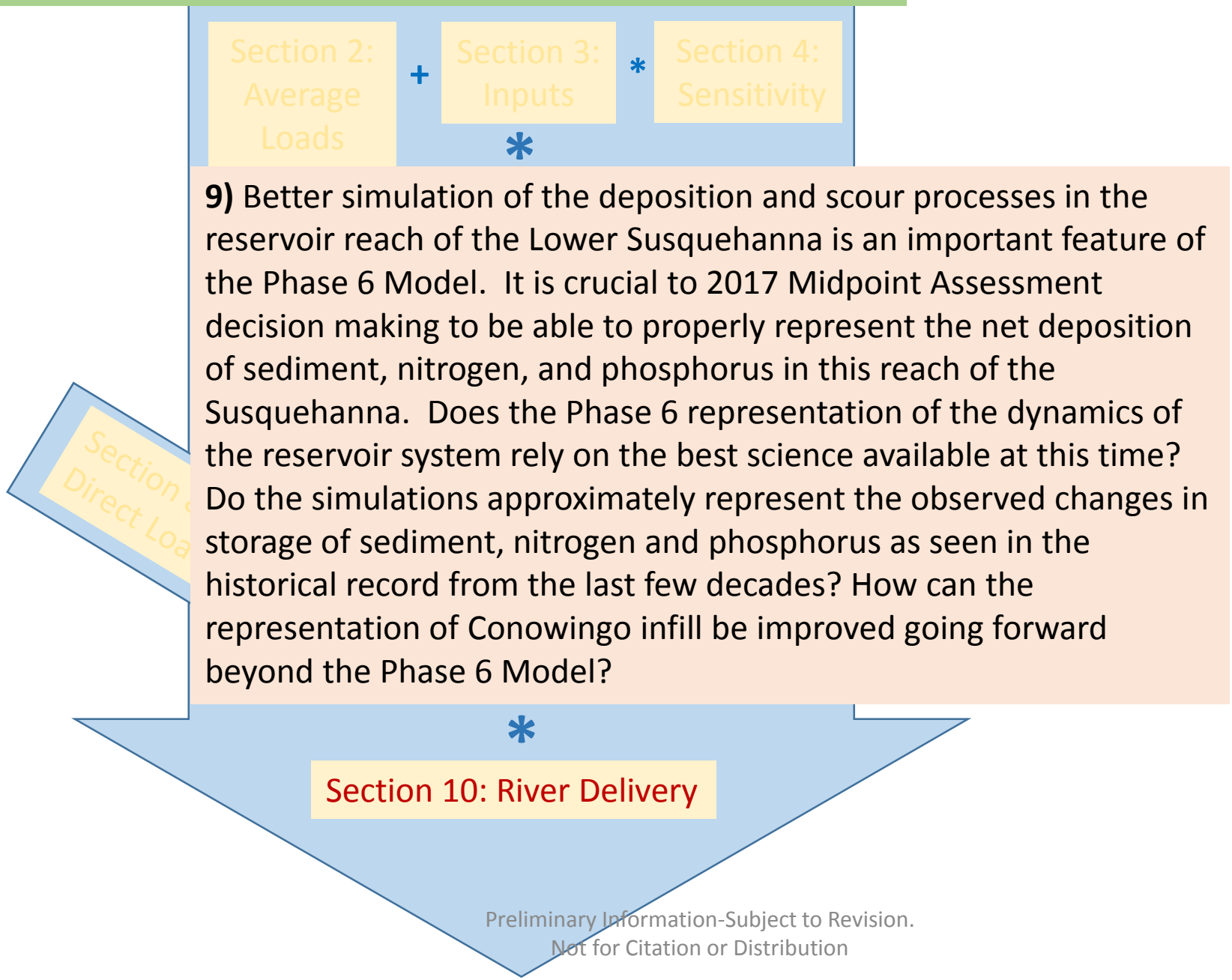
Phase 6 Model Documentation



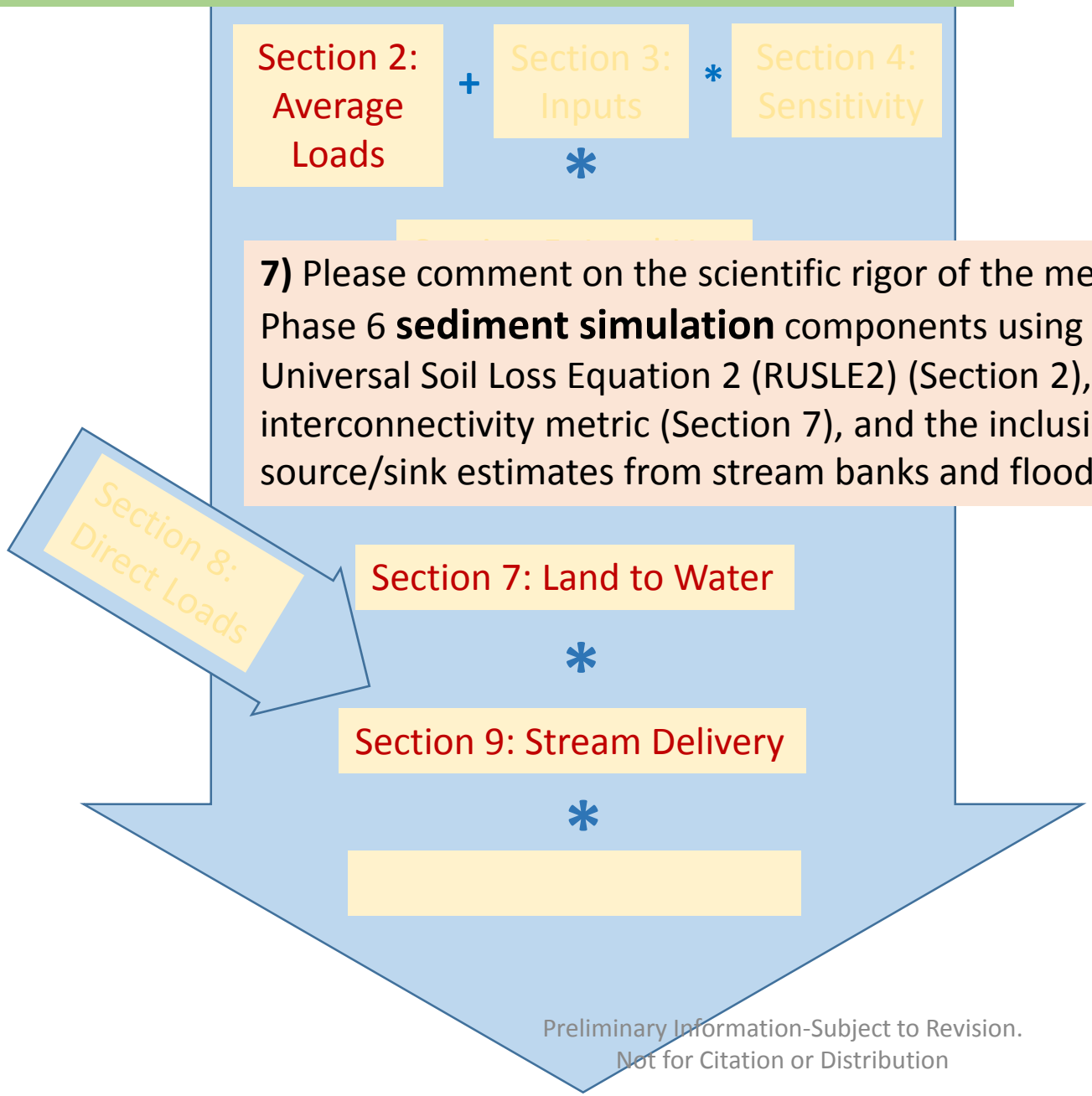
6) Please comment on the scientific appropriateness of the approach taken for Phase 6 **lag times** described in Section 10 given the current state of information and understanding of groundwater and particulate processes. How can the structure and processes of nutrient lag time simulation on the land be improved in Phase 6 or future watershed model applications? Is the application of the Ranked Storage Selection (rSAS) function for groundwater nitrate and Unit Nutrient Export Curves (UNEC) for all other nutrient species appropriate for the management questions?

Phase 6 Model Documentation



9) Better simulation of the deposition and scour processes in the reservoir reach of the Lower Susquehanna is an important feature of the Phase 6 Model. It is crucial to 2017 Midpoint Assessment decision making to be able to properly represent the net deposition of sediment, nitrogen, and phosphorus in this reach of the Susquehanna. Does the Phase 6 representation of the dynamics of the reservoir system rely on the best science available at this time? Do the simulations approximately represent the observed changes in storage of sediment, nitrogen and phosphorus as seen in the historical record from the last few decades? How can the representation of Conowingo infill be improved going forward beyond the Phase 6 Model?

Phase 6 Model Documentation



7) Please comment on the scientific rigor of the methods used in the Phase 6 **sediment simulation** components using a detailed Revised Universal Soil Loss Equation 2 (RUSLE2) (Section 2), an interconnectivity metric (Section 7), and the inclusion of sediment source/sink estimates from stream banks and flood plains (Section 9).





Phase 6 Model Documentation

Section 2: Average Loads + Section 3: Inputs * Section 4: Sensitivity

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Section 5: Land Use

Section 1:

10) Please comment on the scientific appropriateness of the methods used in the representation of **climate change i**n watershed nutrient and sediment loads estimated for the 2025 and 2050 time periods. How well to the models used for producing future climate scenarios show skill in hindcasting the actual climatic and hydrologic changes that have happened over the past several decades?

Section 9: Stream Delivery

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Section 10: River Delivery

Section 11: Applications





Phase 6 Model Documentation

Section 2: Average + Section 3: Inputs * Section 4: Sensitivity

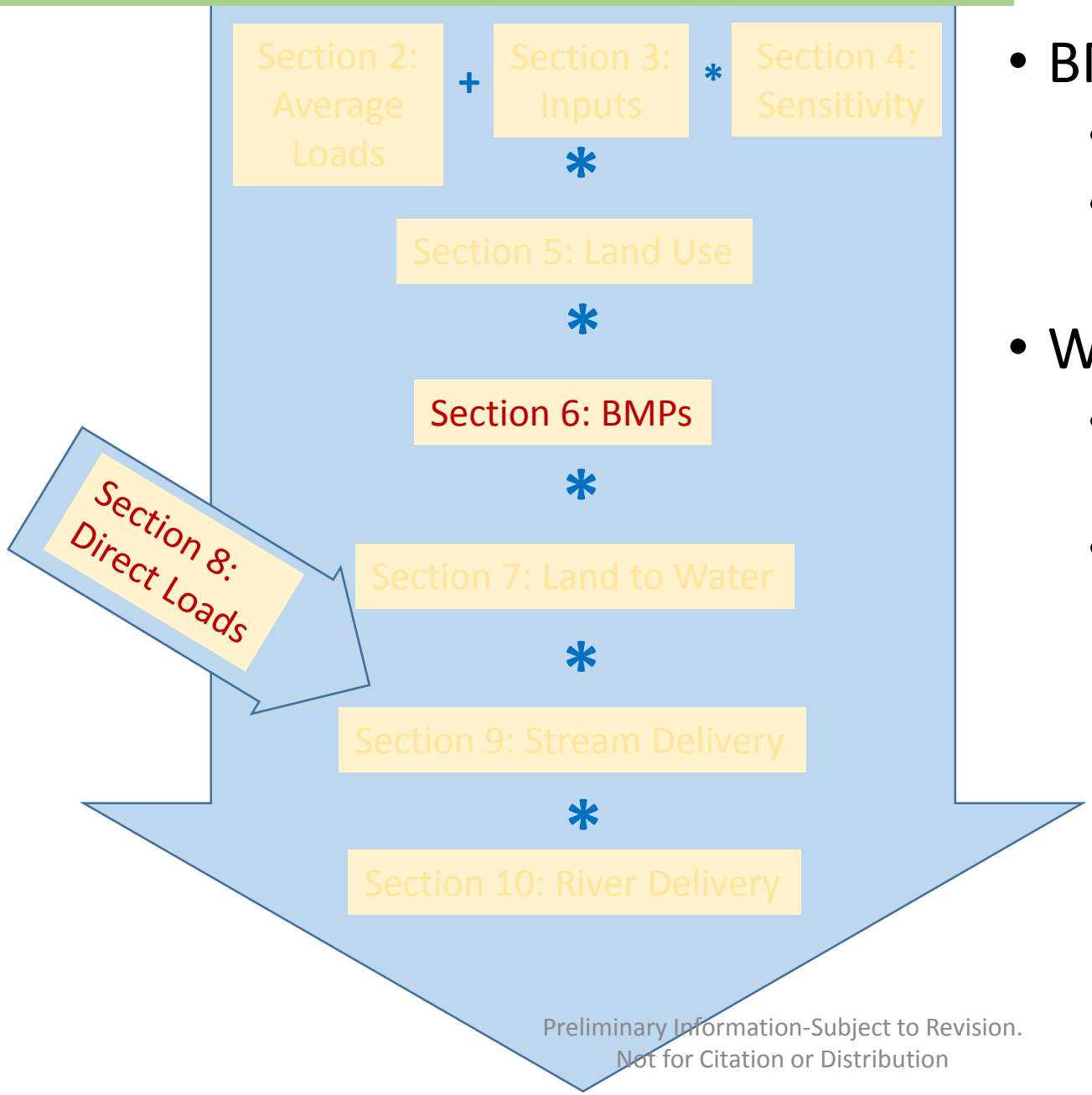
11) For longer term CBP considerations, how can the overall approaches and procedures used in Phase 6 be improved and what alternative approaches and data gathering might you recommend?

12) Please comment on the Phase 6 documentation. Is it clear, well organized, concise, and complete (taking into account that it is the second Beta out of an expected four Beta versions and about a year ahead of final release)?

8) Given the fine scale 1m x 1m land use data that's used in Phase 6, what opportunities does this open to the CBP and scientific community in the next phase of watershed model development? What are the advantages in a distributed representation of hydrology, land cover, and sediment? Given the availability of nutrient inputs from Agricultural Censes at the county scale only does a higher resolution of the watershed model make sense?

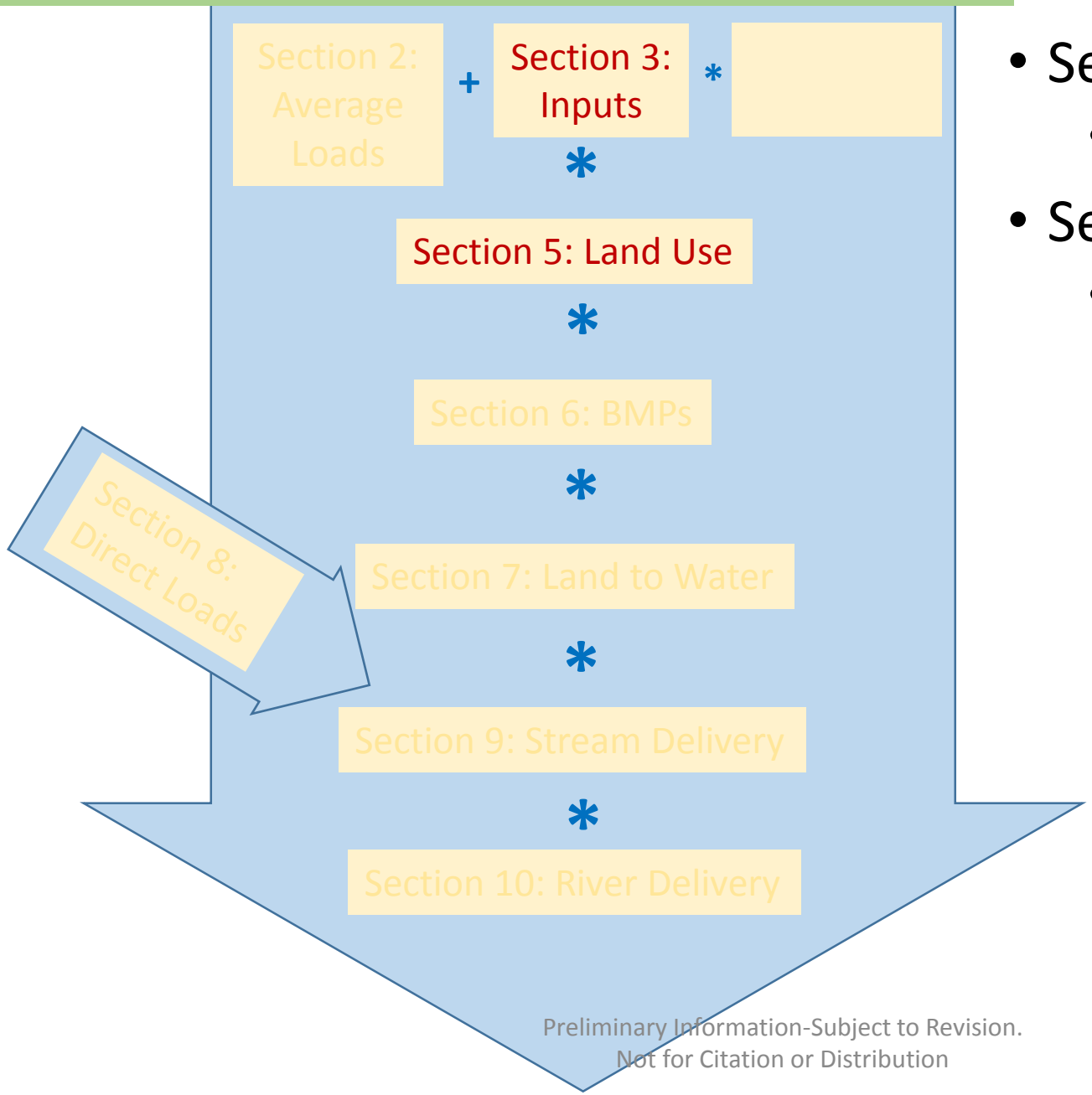
Section 11: Applications

Phase 6 Model Documentation



- BMPs
  - Section 6 BMPs
  - Separate review process
- WWTP
  - Section 8 Direct Loads
  - Submitted Data

Phase 6 Model Documentation



- Section 3: Inputs
  - Scenario Builder
- Section 5: Land Use
  - CBLCM