

Phase 7 Watershed Model Plans

Gary Shenk – CBPO

WGIT

04/25/2022

Web page

- Current plan under “Watershed Modeling”

The screenshot shows a web browser window displaying the Chesapeake Bay Program website. The page title is "Partnership Planning Documents". The navigation menu includes "Discover the Chesapeake", "Learn the Issues", "State of the Chesapeake", "Take Action", "In the News", "Who We Are", and "What We Do". The main content area features several sections:

- Partnership Planning Documents**
 - Initial description of potential modeling priorities – presented to WQGIT 8/26/2022
 - Revised priorities with WQGIT feedback – presented to WQGIT 1/24/2022
- High resolution land use**

CBPO lead – [Peter Claggett](#)

High resolution land use products are being developed at the meter scale for delivery in 2024. They will do directly into the watershed modeling efforts and provide information for other CBP partnership goals and outcomes.
- CAST**

CBPO Lead – [Olivia Devereux](#)

CAST will receive upgrades to improve transparency and usability as part of a project that will also redesign the process for submitting management practice data. A spatial interface to CAST will be designed to give output for a user-defined spatial extent.

[View the current upgrade timeline \(3/1/2022\) >](#)

[View the current versions for evaluation timeline \(3/1/2022\) >](#)
- Optimization**

CBPO Lead – [Lewis Linker](#)

Optimization software is being developed so that CAST scenarios can be generated representing the least cost to achieve a desired level of nutrient and sediment reduction.

[View the current planning spreadsheet >](#)
- Watershed Modeling**

CBPO Lead – [Gary Shenk](#)

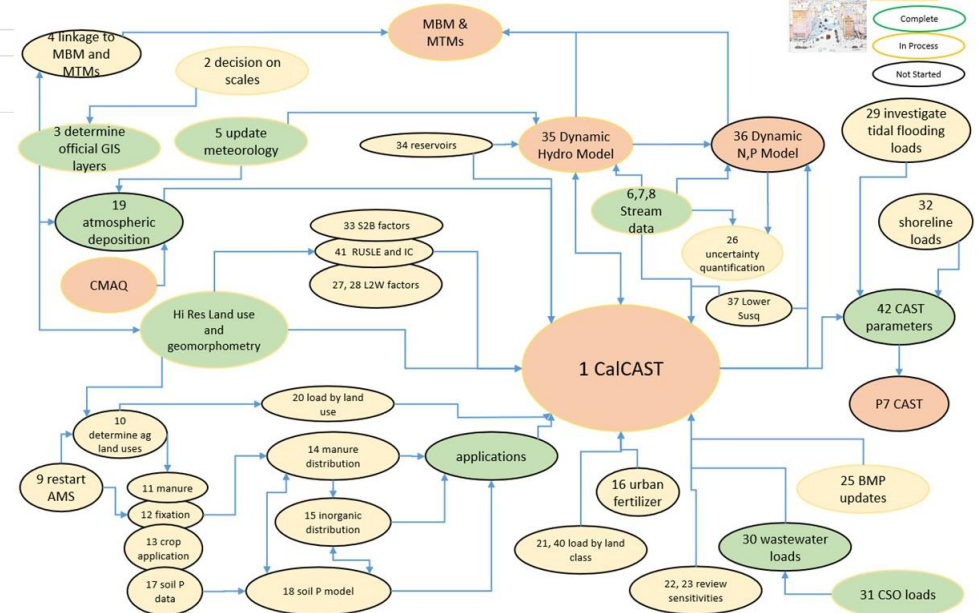
The watershed model underlying the CAST calculations is being updated for better representation of physical processes, improved nutrient application calculations, and variable-scale modeling.

[View the current planning spreadsheet >](#)

Watershed Model Planning Documents

	2022	2022	2022	2022	2023	2023	2023	2023	2024	2024	2024	2024	2025	2025	2025	2025
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Phase 7 Activity	Work plan				Build	Work plan	Build Models				Work plan	Build Models				
General	1 Develop CalCAST using P6 data				1 Use CalCAST as primary calibration tool											
	3 Determine official CBPO GIS layers															
	5 system of annual meteorology updates															
	25 BMP updates															
	35 Dynamic model for hydrology, sediment, and temperature															
Variable Scale Modeling					29 Investigate tidal flooding loads											
									30 Update to Wastewater							
					31 Update to CSOs											

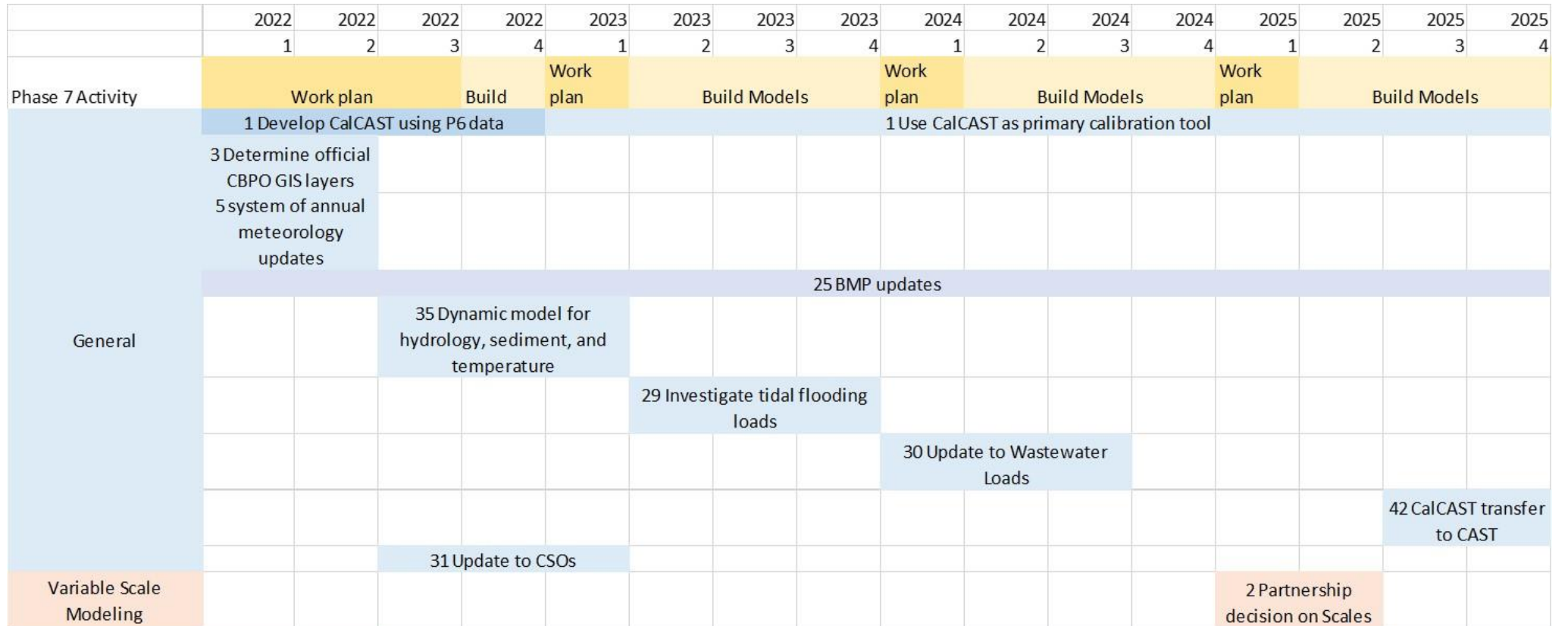
CBP Watershed Modeling Process



Item	Category	What: short description	Why: who asked for it or why is it necessary	Who is C else when the work	development time		
1	General	Develop CalCAST. CalCAST will be a tool for comparing estimated load to monitored loads given a set of inputs and parameters. It will be used in the calibration	CalCAST allows the CBP to test various data sets and strategies to see which match monitoring data best. Primary suggestion of STAC Phase 6 STAC review and Future of Modeling workshop. Allows efficient incorporation of all other development priorities	Bertani; Bhatt; Shenk	MWG	First priority. The rest of development depends on CalCAST. Need decisions on scale. 2022	A model of loads at a point is developed in Section 12 of the documentation. It will be implemented for speed of calculation with the potential to wrap parameter estimation techniques around it
2	variable scale modeling	Discuss scale and reach decision	Development of various Phase 7 tasks will benefit from knowledge of the output scale	Shenk	WQGIT, MWG	2022-2025	Presentation to WQGIT and MWG on various aspects, discussed in section 2
3	General	determine official versions of GIS layers: NHD, county, shoreline, Lrseg	Counties have updated boundaries. NHD necessary to use many important data sets, shoreline determines watershed/estuarine parameters. Lrseg may change for NHD boundaries	McDonald, Fitch, Ahmed, Bhatt	MWG	early 2022	CBPO discussions, with results to be written into section 2
4	Main bay and tributary models	physical and chemical linkage with estuarine model	Needed to run estuarine models	Bhatt	MWG	late 2022. Need to determine form of dynamic model first for the variable description.	Identify set of terminal segments. Identify estuarine cell for each terminal segment. Compare old ICM variables for the variable description. Do new WSM variables match up?

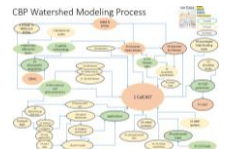
Watershed Model Planning Documents

Gantt Chart



Task ID	Task Name	Start	End	Duration	Dependencies	Notes
1	Develop CalCAST using P6 data	2022-01-01	2022-04-01	3 Months		
2	Partnership decision on Scales	2024-01-01	2024-04-01	3 Months	1	
3	Determine official CBPO GIS layers	2022-01-01	2022-02-01	1 Month		
4	System of annual meteorology updates	2022-01-01	2022-02-01	1 Month		
5	BMP updates	2022-01-01	2022-04-01	3 Months		
6	Dynamic model for hydrology, sediment, and temperature	2022-03-01	2022-06-01	3 Months		
7	Investigate tidal flooding loads	2022-05-01	2022-08-01	3 Months		
8	Update to Wastewater Loads	2022-07-01	2022-10-01	3 Months		
9	Update to CSOs	2022-03-01	2022-06-01	3 Months		
10	CalCAST transfer to CAST	2022-04-01	2022-07-01	3 Months		

Format will vary by Track



Watershed Model Planning Documents

Task List

Item	Category	What: short description	Why: who asked for it or why is it necessary	Who in CBPO or elsewhere will do the work	Where in the CBP organizational chart do the decisions lie	When does this need to be done, including general dependencies and development time	How: A very short description with a link to the longer documentation
1	General	Develop CalCAST. CalCAST will be a tool for comparing estimated load to monitored loads given a set of inputs and parameters. It will be used in the calibration	CalCAST allows the CBP to test various data sets and strategies to see which match monitoring data best. Primary suggestion of STAC Phase 6 STAC review and Future of Modeling workshop. Allows efficient incorporation of all other development priorities	Bertani; Bhatt; Shenk	MWG	First priority. The rest of development depends on CalCAST. Need decisions on scale. 2022	A model of loads at a point is developed in Section 12 of the documentation. It will be implemented for speed of calculation with the potential to wrap parameter estimation techniques around it
2	variable scale modeling	Discuss scale and reach decision	Development of various Phase 7 tasks will benefit from knowledge of the output scale	Shenk	WQGIT, MWG	2022-2025	Presentation to WQGIT and MWG on various aspects, discussed in section 2
3	General	determine official versions of GIS layers: NHD, county, shoreline, Lrseg	Counties have updated boundaries. NHD necessary to use many important data sets, shoreline determines watershed/estuarine parameters. Lrseg may change for NHD boundaries	McDonald, Fitch, Ahmed, Bhatt	MWG	early 2022	CBPO discussions, with results to be written into section 2
4	Main bay and tributary models	physical and chemical linkage with estuarine model	Needed to run estuarine models	Bhatt	MWG	late 2022. Need to determine form of dynamic model first for the variable description.	Identify set of terminal segments. Identify estuarine cell for each terminal segment. Compare old ICM variables with new ICM variables. Do new WSM variables match up?



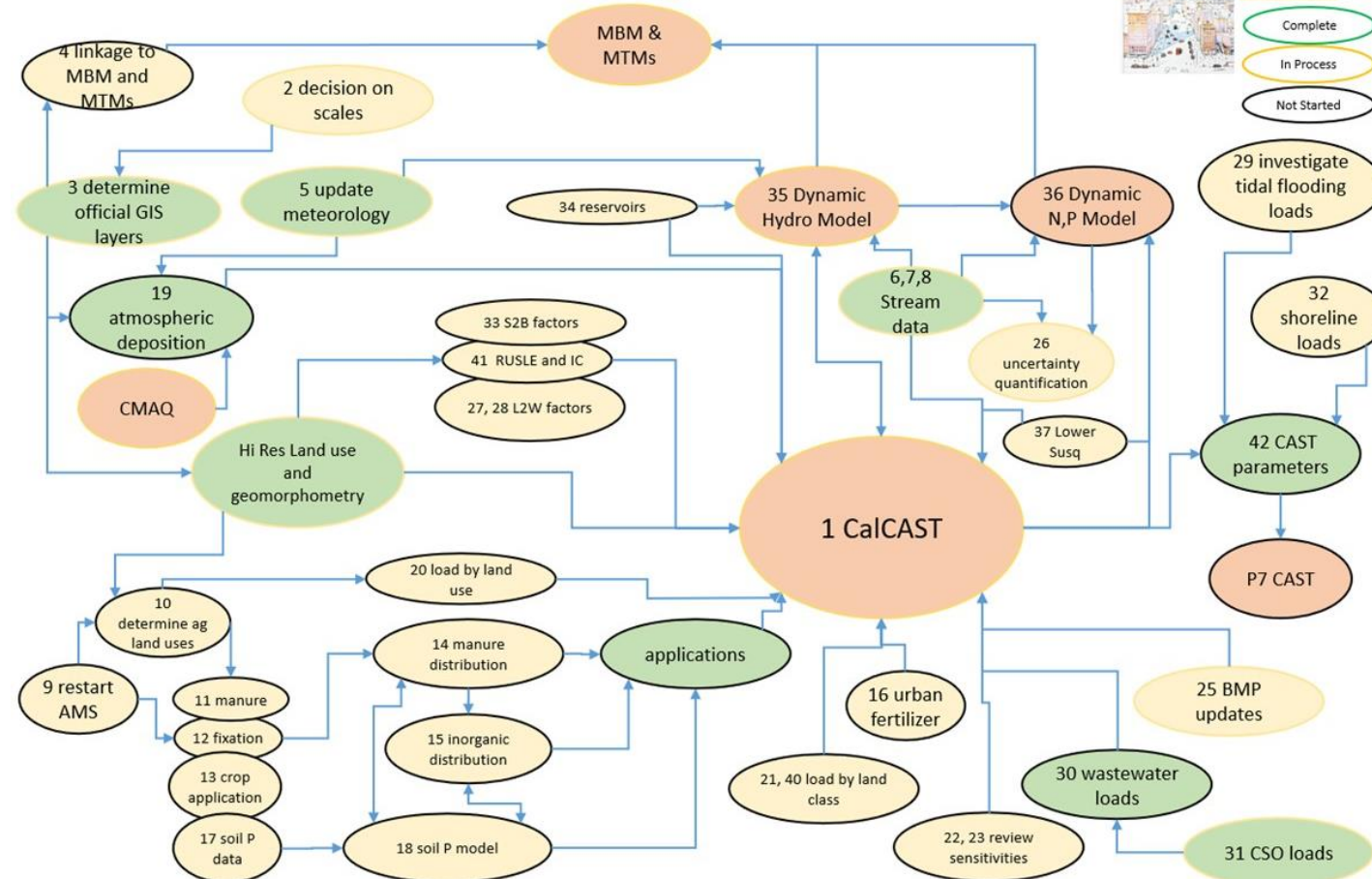
Format will vary by Track



Watershed Model Planning Documents

Flow Chart

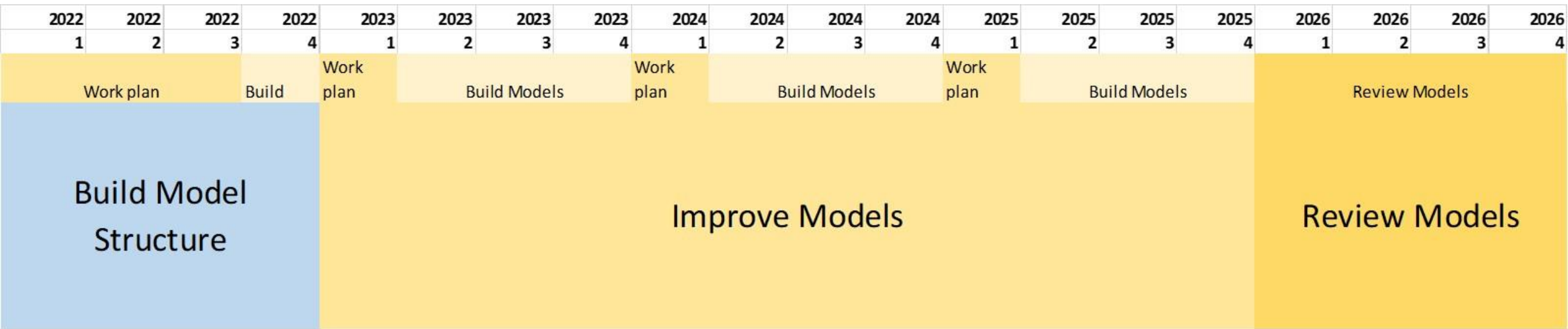
CBP Watershed Modeling Process



Task ID	Task Name	Status	Start Date	End Date
1	1 CalCAST	In Process	2023-01-01	2023-06-30
2	2 decision on scales	Complete	2022-12-15	2023-01-15
3	3 determine official GIS layers	In Process	2023-02-01	2023-05-31
4	4 linkage to MBM and MTMs	Complete	2022-11-01	2022-11-30
5	5 update meteorology	In Process	2023-03-01	2023-04-30
6	6,7,8 Stream data	In Process	2023-01-15	2023-05-15
7	7	In Process	2023-01-15	2023-05-15
8	8	In Process	2023-01-15	2023-05-15
9	9 restart AMS	Complete	2022-10-01	2022-10-31
10	10 determine ag land uses	In Process	2023-02-15	2023-04-15
11	11 manure	In Process	2023-03-01	2023-04-30
12	12 fixation	In Process	2023-03-01	2023-04-30
13	13 crop application	In Process	2023-03-01	2023-04-30
14	14 manure distribution	In Process	2023-03-01	2023-04-30
15	15 inorganic distribution	In Process	2023-03-01	2023-04-30
16	16 urban fertilizer	In Process	2023-03-01	2023-04-30
17	17 soil P data	In Process	2023-03-01	2023-04-30
18	18 soil P model	In Process	2023-03-01	2023-04-30
19	19 atmospheric deposition	In Process	2023-02-01	2023-05-31
20	20 load by land use	In Process	2023-02-15	2023-04-15
21	21, 40 load by land class	In Process	2023-02-15	2023-04-15
22	22, 23 review sensitivities	In Process	2023-03-01	2023-04-30
23	23	In Process	2023-03-01	2023-04-30
24	24	In Process	2023-03-01	2023-04-30
25	25 BMP updates	In Process	2023-03-01	2023-04-30
26	26 uncertainty quantification	In Process	2023-03-01	2023-04-30
27	27, 28 L2W factors	In Process	2023-03-01	2023-04-30
28	28	In Process	2023-03-01	2023-04-30
29	29 investigate tidal flooding loads	In Process	2023-03-01	2023-04-30
30	30 wastewater loads	In Process	2023-03-01	2023-04-30
31	31 CSO loads	In Process	2023-03-01	2023-04-30
32	32 shoreline loads	In Process	2023-03-01	2023-04-30
33	33 S2B factors	In Process	2023-03-01	2023-04-30
34	34 reservoirs	In Process	2023-03-01	2023-04-30
35	35 Dynamic Hydro Model	In Process	2023-03-01	2023-04-30
36	36 Dynamic N,P Model	In Process	2023-03-01	2023-04-30
37	37 Lower Susq	In Process	2023-03-01	2023-04-30
38	38	In Process	2023-03-01	2023-04-30
39	39	In Process	2023-03-01	2023-04-30
40	40	In Process	2023-03-01	2023-04-30
41	41 RUSLE and IC	In Process	2023-03-01	2023-04-30
42	42 CAST parameters	In Process	2023-03-01	2023-04-30
43	43	In Process	2023-03-01	2023-04-30
44	44	In Process	2023-03-01	2023-04-30
45	45	In Process	2023-03-01	2023-04-30
46	46	In Process	2023-03-01	2023-04-30
47	47	In Process	2023-03-01	2023-04-30
48	48	In Process	2023-03-01	2023-04-30
49	49	In Process	2023-03-01	2023-04-30
50	50	In Process	2023-03-01	2023-04-30

Format will vary by Track

Watershed Model Plan – Big Picture

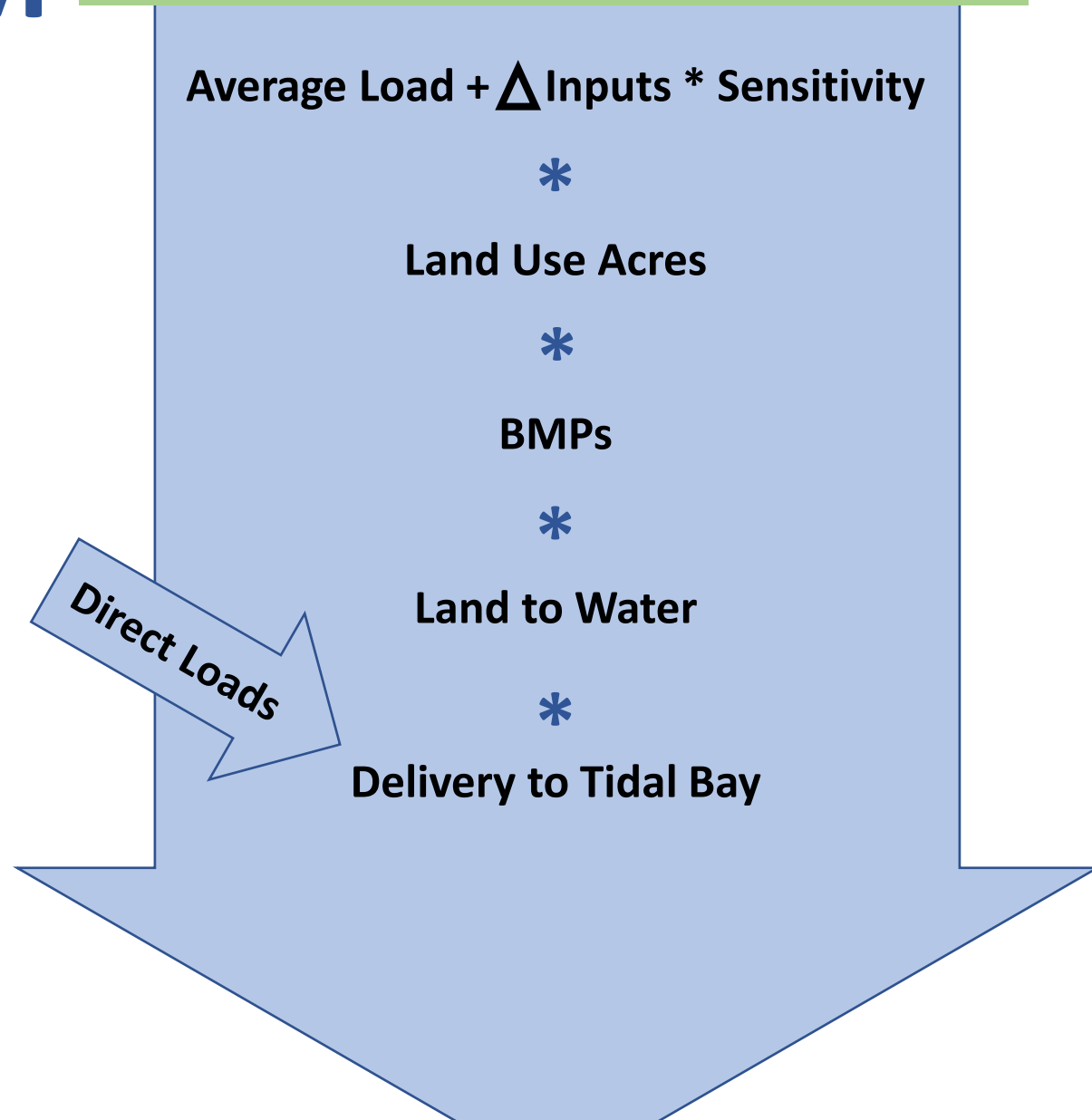


Cast/CalCast/DM

Phase 7 Model Structure

Phase 7 Cast

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

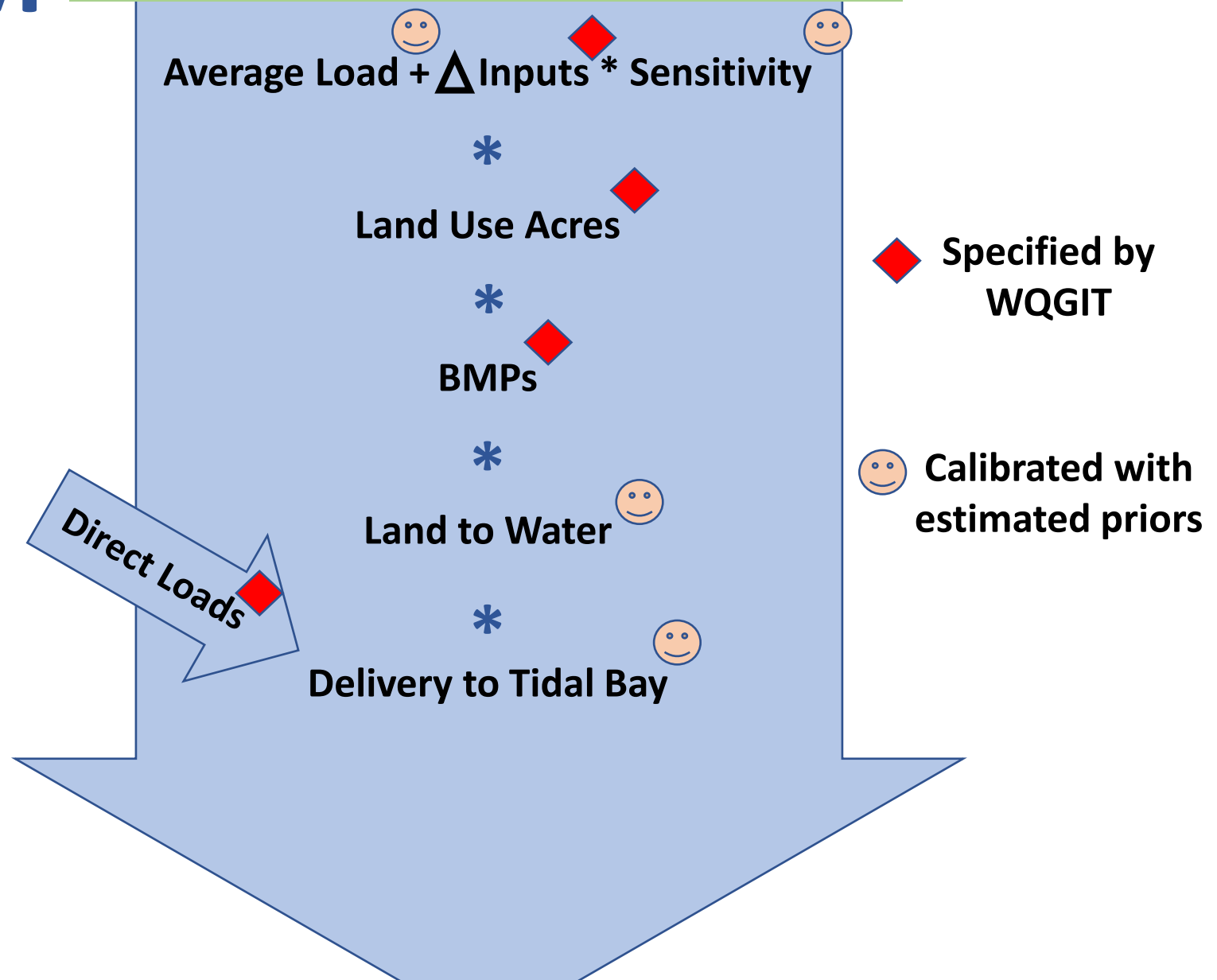


Cast/CalCast/DM

Phase 7 Model Structure

Phase 7 CalCast

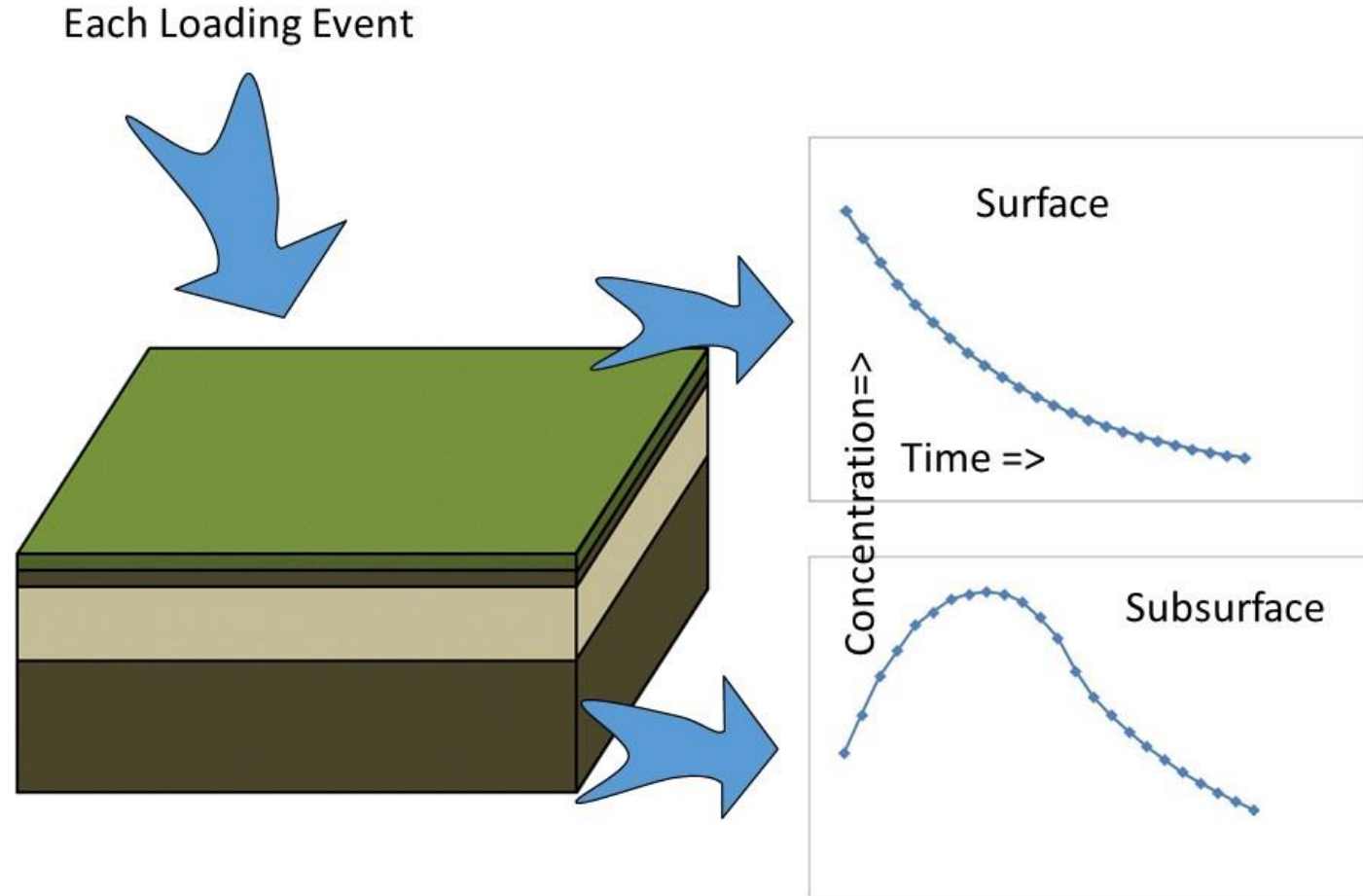
Tool for finding parameters that best match observations



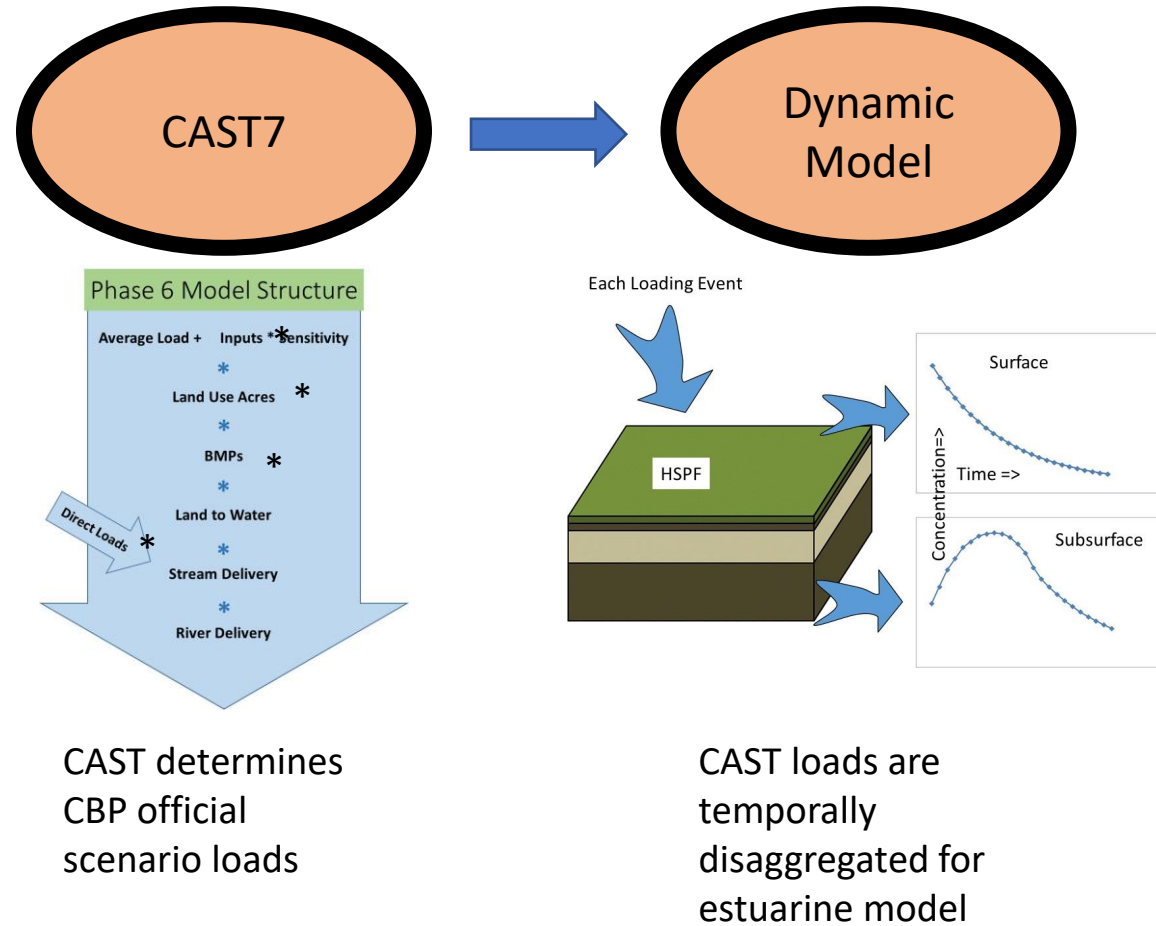
Cast/CalCast/DM

Phase 7 Dynamic Model

Takes output of
CAST/CalCAST and
breaks it into
hourly values



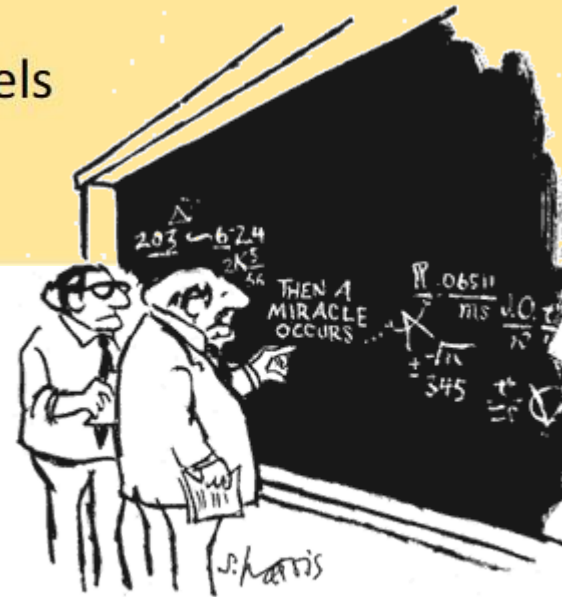
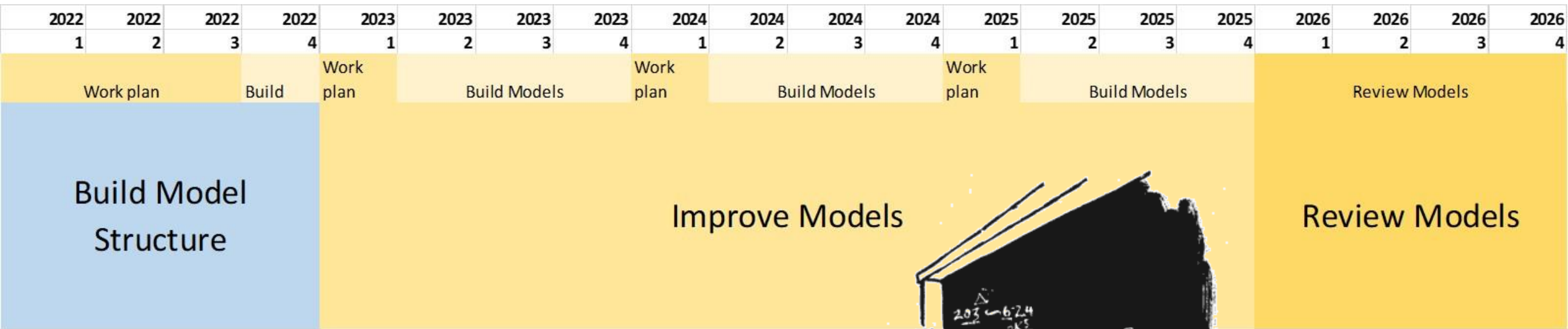
CBP Phase 7 Model – Scenario Mode



Watershed Model Plan – Year 1 - slightly more detail

	2022	2022	2022	2022
	1	2	3	4
Phase 7 Activity	Work plan			Build
General	1 Develop CalCAST using P6 data			
	3 Determine official CBPO GIS layers			
	5 system of annual meteorology updates			
		35 Dynamic model for hydrology, sediment, and temperature		
		36 Dynamic model for nutrients		
Physical Process Simulation	6 Streamflow data			
	7 stream conc data			
		8 Stream load data		
Uncertainty Quantification	26 Methods			

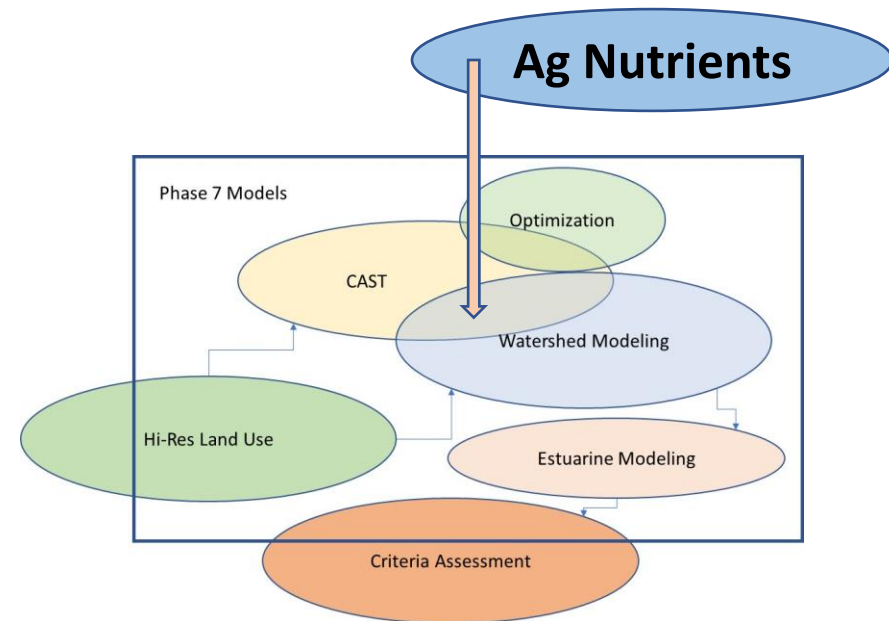
Watershed Model Plan – Big Picture



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

Ag Nutrient Applications (2022-2025)

- 9 Bring back Ag Modeling Subcommittee
- 10 Consider revising the types of ag land uses simulated in the model
- 11 Manure nutrient generation
- 12 Fixation
- 13 Crop application goals
- 14 Manure distribution on Crops
- 15 Inorganic applications
- 17 soil P data
- 18 soil P model
- *Other duties as assigned*



Average Load + Δ Inputs * Sensitivity

*

Land Use Acres

*

BMPs

*

Land to Water

*

Delivery to Tidal Bay

Load by land-river segment and land use

Physical Processes (2022-2025)

- | | | |
|------|--|-----------|
| • 20 | Review relative loading rates by land use | 2022-2023 |
| • 21 | Review relative loading rates by land class | 2023-2025 |
| • 22 | Review of sensitivities to inputs | 2023-2025 |
| • 27 | Investigate land to water factors (geomorph data) | 2023-2025 |
| • 28 | Incorporate local data in land to water factors | 2023-2025 |
| • 33 | Stream to Bay factors (geomorph data) | 2024-2025 |
| • 34 | Reservoir consideration | 2023-2025 |
| • 37 | Lower Susquehanna Simulation | 2023-2025 |
| • 32 | Tidal Shoreline loads | 2022-2023 |
| • 40 | Add solar fields as land use in developed land class | 2024-2025 |
| • 41 | recalculate EOS sediment | 2024-2025 |

General Updates

- 2 Determine Scale of CAST 2022-2025
- 16 Urban Fertilizer applications 2022-2025
- 19 New atmospheric deposition data 2023-2025
- 24 Convert fine-scale land use to CAST land use 2024
- 25 BMP updates ongoing
- 29 Investigate tidal flooding loads any time 2023-2025
- 30 Update to Wastewater Loads any time 2023-2025
- 31 Update to CSOs any time 2023-2025
- 42 transfer CalCAST values to CAST end of 2025
- 43 Point source location checks any time 2023-2025

Watershed Model Planning Documents

Task List

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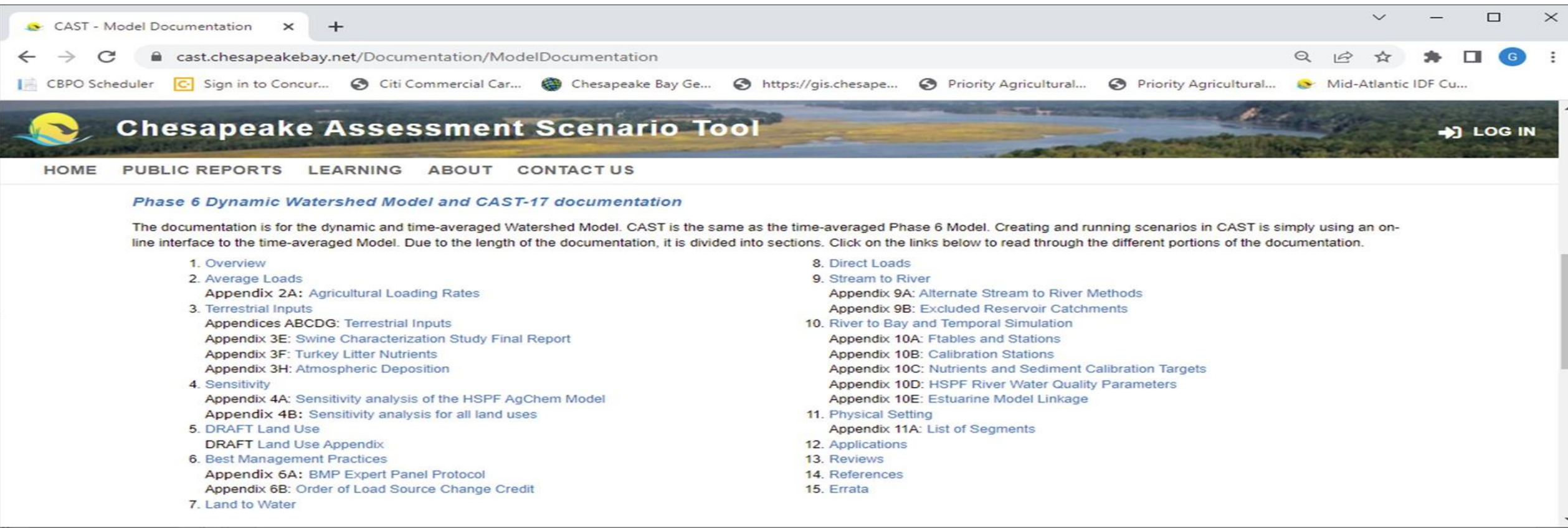


Watershed Model Plan – sample task

Item	4
Category	Main bay and tributary models
What: short description	physical and chemical linkage with estuarine model
Why: who asked for it or why is it necessary	Needed to run estuarine models
Who in CBPO or elsewhere will do the work	Bhatt
Where in the CBP organizational chart do the decisions lie	MWG
When does this need to be done, including general dependencies and development time	late 2022. Need to determine form of dynamic model first for the variable description.
How: A very short description with a link to the longer documentation	Section 2 of P7 documentation. Identify set of terminal segments. Identify estuarine cell for each terminal segment. Compare old ICM variables with new ICM variables. Do new WSM variables match up?

Full Details in Draft Documentation

- P6 documentation being updated to P7
- Expect rolling releases as we complete sections



The screenshot shows a web browser window with the URL cast.chesapeakebay.net/Documentation/ModelDocumentation. The page title is "Chesapeake Assessment Scenario Tool" and includes a "LOG IN" button. The main content area is titled "Phase 6 Dynamic Watershed Model and CAST-17 documentation" and contains a paragraph explaining the documentation's structure. Below the paragraph is a two-column list of 15 numbered sections, each with associated appendices.

Chesapeake Assessment Scenario Tool [LOG IN](#)

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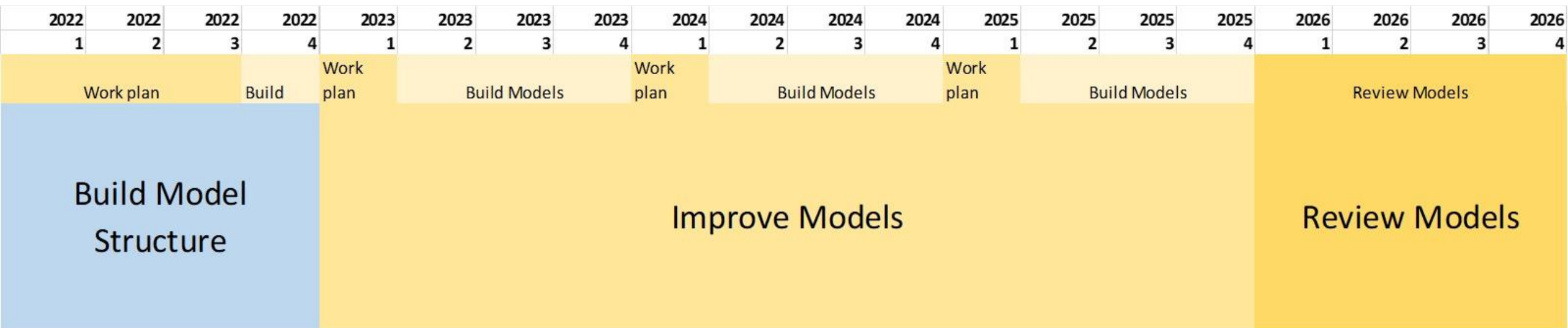
Phase 6 Dynamic Watershed Model and CAST-17 documentation

The documentation is for the dynamic and time-averaged Watershed Model. CAST is the same as the time-averaged Phase 6 Model. Creating and running scenarios in CAST is simply using an on-line interface to the time-averaged Model. Due to the length of the documentation, it is divided into sections. Click on the links below to read through the different portions of the documentation.

1. [Overview](#)
2. [Average Loads](#)
 - [Appendix 2A: Agricultural Loading Rates](#)
3. [Terrestrial Inputs](#)
 - [Appendices ABCDG: Terrestrial Inputs](#)
 - [Appendix 3E: Swine Characterization Study Final Report](#)
 - [Appendix 3F: Turkey Litter Nutrients](#)
 - [Appendix 3H: Atmospheric Deposition](#)
4. [Sensitivity](#)
 - [Appendix 4A: Sensitivity analysis of the HSPF AgChem Model](#)
 - [Appendix 4B: Sensitivity analysis for all land uses](#)
5. [DRAFT Land Use](#)
 - [DRAFT Land Use Appendix](#)
6. [Best Management Practices](#)
 - [Appendix 6A: BMP Expert Panel Protocol](#)
 - [Appendix 6B: Order of Load Source Change Credit](#)
7. [Land to Water](#)
8. [Direct Loads](#)
9. [Stream to River](#)
 - [Appendix 9A: Alternate Stream to River Methods](#)
 - [Appendix 9B: Excluded Reservoir Catchments](#)
10. [River to Bay and Temporal Simulation](#)
 - [Appendix 10A: Ftables and Stations](#)
 - [Appendix 10B: Calibration Stations](#)
 - [Appendix 10C: Nutrients and Sediment Calibration Targets](#)
 - [Appendix 10D: HSPF River Water Quality Parameters](#)
 - [Appendix 10E: Estuarine Model Linkage](#)
11. [Physical Setting](#)
 - [Appendix 11A: List of Segments](#)
12. [Applications](#)
13. [Reviews](#)
14. [References](#)
15. [Errata](#)

Summary and next steps

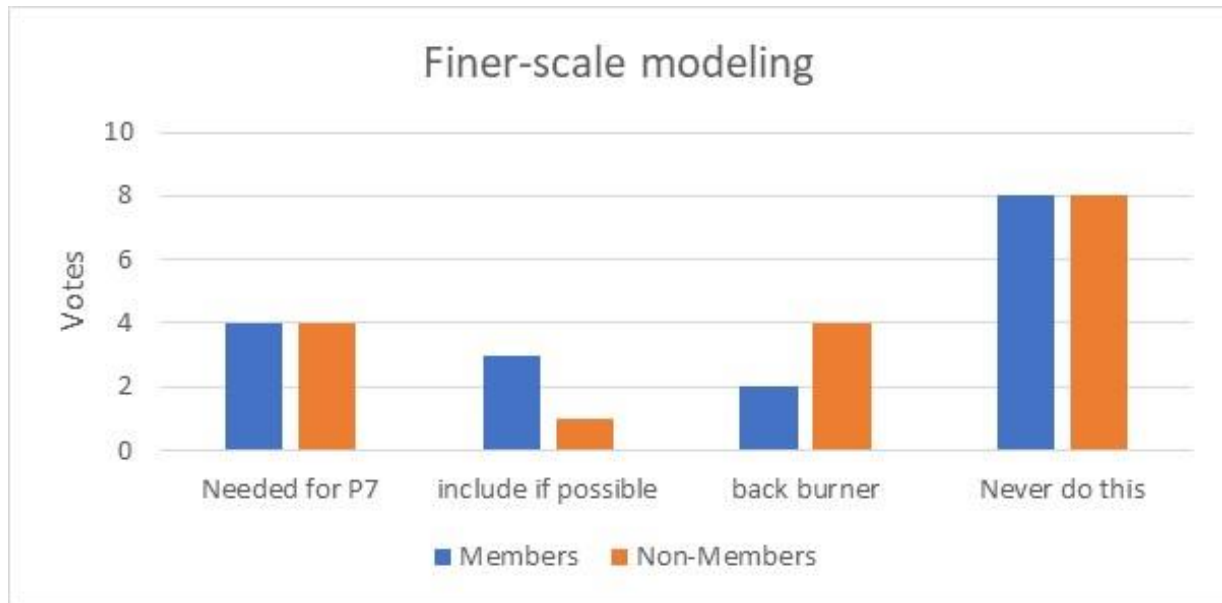
- Expect updates on development of the structure this year
- Expect improvements in inputs and calibration through 2025
- Expect documentation as tasks are complete



- Extra slides for scale discussion if needed

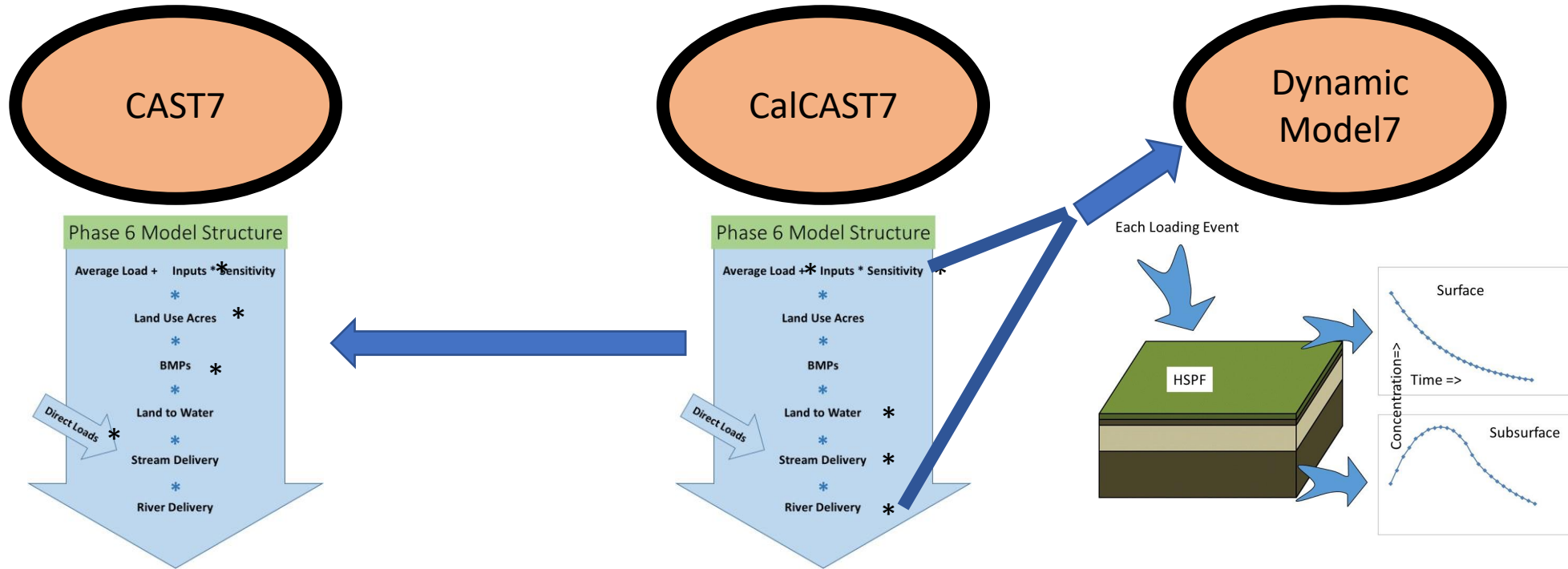
Phase 7 CAST will be built at the scale that the partnership wants

- 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

Scale



Whatever scale is needed for management

NHD scale to capture local monitoring

NHD scale to load the estuarine models

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

- The current Phase 6 CAST scale is land-river segment for nonpoint source and NHD for point source
- Development and calibration can happen at the NHD scale
- CAST scenarios can be run at an aggregated scale
- CAST scenario results can be downscaled for the estuarine models
- Unofficial CAST scenarios could potentially be run at a finer scale

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