# Phase 7 Optimization Progress

## Water Quality Goal Implementation Team
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- The CBP Optimization Project period is six years.
- The CBP Optimization Project was initiated in the second quarter of 2020 and will be completed in the first quarter of 2026.
- The CBP Optimization is being developed so that CAST scenarios can be generated representing the least cost to achieve a desired level of nutrient and sediment reduction.
- The optimization can be done on land-river segments, counties, states, or the entire watershed providing a baseline of cost efficiency at different spatial scales.

# EPA Optimization Project Plan (6 years)

- Develop efficient optimization algorithms
  - Integration with CAST system
  - County, multi-county, state, multi-state, and watershed level
  - Hybrid and customized approach

- Min. Cost subject to Loading constraints

- Multi-objective: Min. (Cost, Loadings)
  - MCDM with stake-holders
  - Robust solutions
  - Knowledge-based optimization

- Implementation through validation and discussion with CBP users



Overall Plan
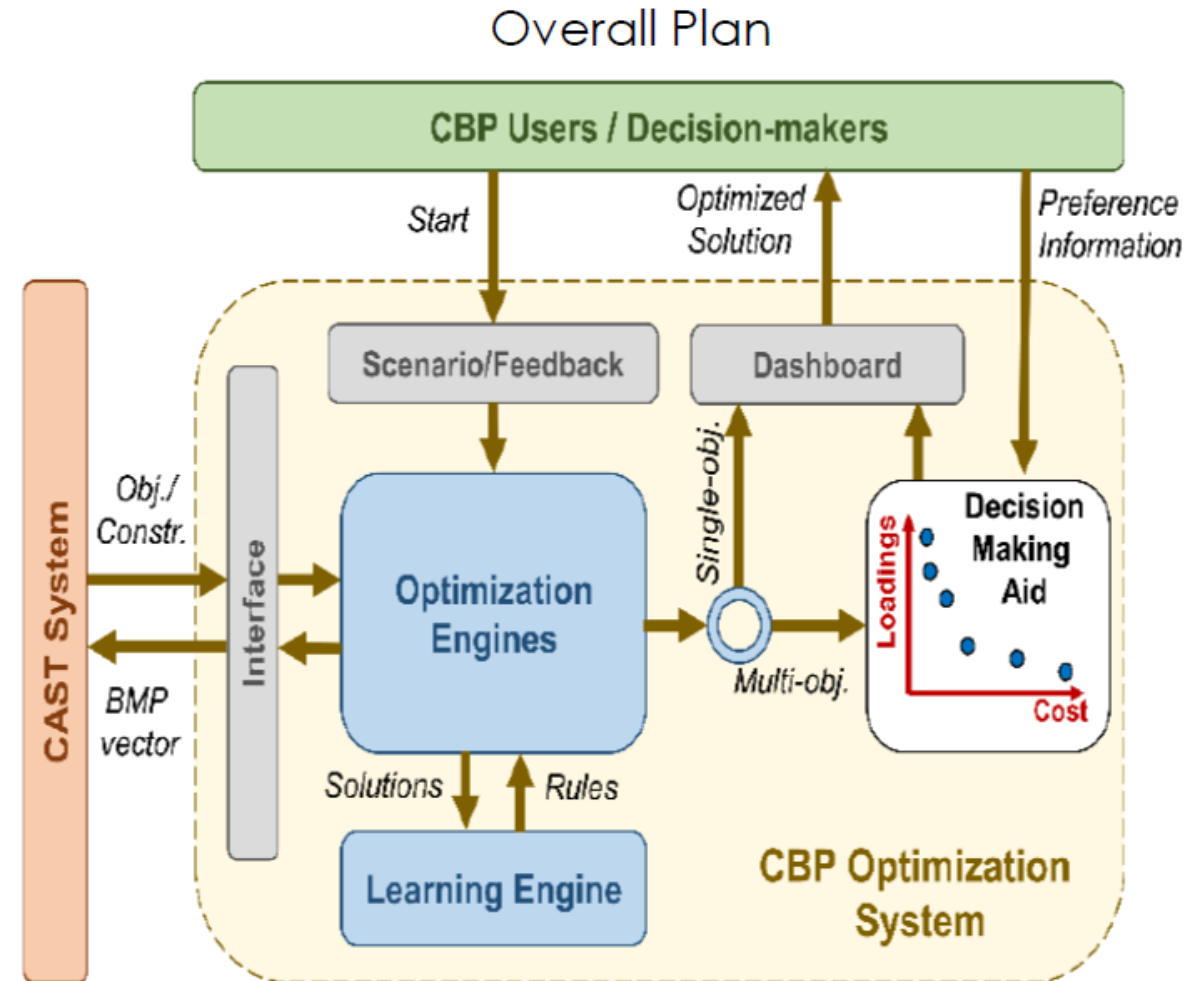
| Calendar Year | 2020 | | | 2021 | | | | 2022 | | | | 2023 | | | | 2024 | | | | 2025 | | | | 2026 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Calendar Quarter | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 |
| Project Year | Year 1 | | | | | | Year 2 | | | | | Year 3 | | | | Year 4 | | | | Year 5 | | | | Year 6 |
| **Task 1: Development of an efficient single-objective hybrid optimization procedure** | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | | | | | | | | | | | | | | | | | | |
| 1.1: Understanding CAST modules and effect of BMPs on objectives and constraints | ░ | ░ | | | | | | | | | | | | | | | | | | | | | | |
| 1.2: Development of a simplified point-based structured single-objective optimization procedure | | ░ | ░ | ░ | | | | | | | | | | | | | | | | | | | | |
| 1.3: Development of a hybrid customized single-objective optimization procedure | | | | ░ | ░ | | | | | | | | | | | | | | | | | | | |
| 1.4: Verification and validation with CBP users and decision-makers and update of optimization procedure | | | | | | ░ | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **Task 2: Development of efficient multi-objective (MO) optimization procedures** | | | | | | | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | ▓ | | | | | | | | | | | |
| 2.1: Develop generative MO optimization using hybrid optimization procedure developed at Task 1 | | | | | | | ░ | ░ | ░ | | | | | | | | | | | | | | | |
| 2.2: Develop simultaneous MO customized optimization using population-based evolutionary algorithms | | | | | | | | ░ | ░ | ░ | ░ | | | | | | | | | | | | | |
| 2.3: Comparison of generative & simultaneous procedures and validation with CBP users & decision-makers | | | | | | | | | | | | ░ | ░ | | | | | | | | | | | |
| 2.4: Develop an interactive multi-criterion decision-making aid for choosing a single preferred solution | | | | | | | | | | | | | ░ | ░ | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **Task 3: Scalability Studies and Improvements using Learning Engine and Parallel Computing** | | | | | | | | | | | | | | | | ▓ | ▓ | ▓ | ▓ | | | | | |
| 3.1: Comparative study to choose a few best performing methods | | | | | | | | | | | | | | | | ░ | | | | | | | | |
| 3.2: Scalability to State and Watershed level Scenarios | | | | | | | | | | | | | | | | | ░ | ░ | | | | | | |
| 3.3: "Innovization" approach for improving scalability | | | | | | | | | | | | | | | | | | ░ | ░ | | | | | |
| 4.4: Distributed computing approach for improving scalability | | | | | | | | | | | | | | | | | | | ░ | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **Task 4: User-friendly and routine applications with enhanced optimization procedures** | | | | | | | | | | | | | | | | | | | | ▓ | ▓ | ▓ | ▓ | ▓ |
| 4.1: User-friendly optimization through a dashboard | | | | | | | | | | | | | | | | | | | | ░ | ░ | | | |
| 4.2: Surrogate-assisted optimization procedures | | | | | | | | | | | | | | | | | | | | | | ░ | | |
| 4.3: Robust optimization method for handling uncertainties in variables and parameters | | | | | | | | | | | | | | | | | | | | | | | ░ | ░ |
| 4.4: Sustainable watershed management practices | | | | | | | | | | | | | | | | | | | | | | | | ░ |

# Overview of the Optimization Workplan and Progress Over the Last Nine Quarters

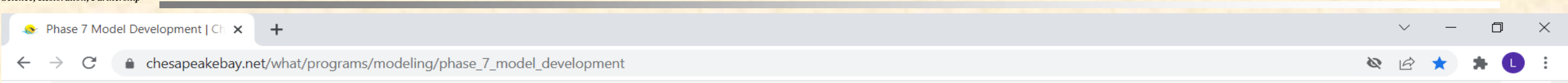**Task 1: Development of an efficient single-objective hybrid optimization procedure (Q2 2020 – Q3 2021)**

1-1. Understanding CAST modules and effect of BMPs on objectives and constraints (Q2-Q3 2020). **Completed**

1-2. Development of a simplified point-based structured single-objective optimization procedure (Q3 2020-Q1: 2021). **Completed**

1-3. Development of a hybrid customized single-objective optimization procedure (Q1-Q3: 2021). **Completed**

1-4. Verification and validation with CBP users and decision-makers and update of optimization procedure (Q2-Q3: 2021). **Completed**

# Overview of the Optimization Workplan and Progress For Task 2

**Task 2: Development of efficient multi-objective (MO) optimization procedures (Q4 2021 – Q3 2023)**

2.1. Develop generative MO optimization using hybrid optimization procedure developed at Task 1 (Q4 2021-Q2 2022). **Ongoing**

2.2. Develop simultaneous MO customized optimization using population-based evolutionary algorithms (Q1 2022-Q1: 2023). **Initiated**

2.3. Comparison of generative & simultaneous procedures and validation with CBP users & decision-makers (Q4 2022-Q2: 2023). **Planned**

Gantt chart — project schedule (Calendar Year / Calendar Quarter / Project Year)

| Task / Subtask | 2020 Q2 | Q3 | Q4 | 2021 Q1 | Q2 | Q3 | Q4 | 2022 Q1 | Q2 | Q3 | Q4 | 2023 Q1 | Q2 | Q3 | Q4 | 2024 Q1 | Q2 | Q3 | Q4 | 2025 Q1 | Q2 | Q3 | Q4 | 2026 Q1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project Year | Year 1 | | | | Year 2 | | | | Year 3 | | | | Year 4 | | | | Year 5 | | | | Year 6 | | | |
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| 1.3: Development of a hybrid customized single-objective optimization procedure | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | |
| 1.4: Verification and validation with CBP users and decision-makers and update of optimization procedure | | | | | | ■ | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | | | | | |
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| 3.1: Comparative study to choose a few best performing methods | | | | | | | | | | | | | | | | ■ | | | | | | | | |
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(Note: A red outline highlights the 2022 Q2 column across the Task 2, 2.1, and 2.2 rows.)

Phase 7 Model Development | Ch

🔒 chesapeakebay.net/what/programs/modeling/phase_7_model_development

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# 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 >**

# Estuarine Modeling

CBPO Lead – Lewis Linker

A new estuarine model is being developed for the entire tidal Chesapeake (the Main Bay Model) incorporating the latest techniques.  Multiple Tributary Models will also be developed as testbeds for improved overall model performance.

**View the current planning spreadsheet >**

# Criteria assessment

CBPO Lead – Peter Tango

The estuarine water quality criteria assessment procedures are being considered for revision based on climate change considerations.  A separate effort looks to create a new Bay interpolator using vertical profiler data which can evaluate criteria which could not previously be evaluated.

📊 MBM_Tasks__Time....xlsx    ∧

Show all    ✕