San Francisco Bay Nutrient Management Strategy

FY2026 Program Plan

May 2025

SFEI Contribution #1327

SFEI | San Francisco Estuary Institute

San Francisco Bay
Nutrient Management Strategy
FY26 Program Plan

May 9, 2025

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1. INTRODUCTION

This Program Plan summarizes the planned work for the San Francisco Bay Nutrient Management Strategy (NMS) Program during FY26. The planned work includes a set of projects and priorities that target the updated NMS Management Questions, which are included in Appendix A.

The FY26 Program Plan was approved at the May 9, 2025 NMS Steering Committee (SC) meeting. Importantly, the FY26 Program Plan was developed under the LOW funding scenario for FY26 that is summarized in the 2025-2030 Science Plan. In the event that additional funding is received or removed, program staff will create an amended plan with modified budgets for the Steering Committee to review and approve.

An overview of the FY26 Program Plan budget is presented in Section 2, including FY26 revenue sources and estimated expenses. Section 3 opens with an overview of the FY26 projects, which is followed by write-ups for each of the projects that include project descriptions, work products, and budget justifications.

Section 4 includes two summary tables, the first of which summarizes funds from ongoing grants and continuing projects that will supplement the FY26 Program Plan projects. The second table outlines additional NMS-related work moving forward during FY26 that is completely supported by other sources.

At the NMS SC's March 2025 meeting, the introductory materials for the science planning item sparked a discussion about the NMS management questions. As a result of that discussion, the NMS Planning Subcommittee produced an updated set of NMS management questions, which are included in the 2025-2030 Science Plan.

2. FY26 PROGRAM PLAN BUDGET AND OVERVIEW

Table 1 summarizes the NMS FY26 revenue sources and amounts, which total to $4,240,000. The sources listed are: R.1 NMS FY26 Permit Funds ($2,200,000); R.2 RMP special study funds to support moored sensor monitoring ($250,000); R.3 RMP Status and Trends funds for ship-based monitoring ($290,000); and R.4 EPA-WQIF grant (Tracking Bay Health).

Table 1 NMS FY2026 Program Plan REVENUE

	FY2026 REVENUE		
1	R.1	Nutrient Permit: FY2026 Funds	2,200,000
2	R.2	RMP CY2026 special study funds	250,000
3	R.3	RMP Contribution to ship-based monitoring	290,000
4	R.4	EPA SFB-WQIF Grant	1,500,000
5		**TOTAL**	**4,240,000**

Table 2 provides an overview of work for FY26 and cost estimates. The total estimated cost for the work is $4,240,000, leaving a balance of $0.

Several of the projects included in Table 2 will be partially supported by funds from ongoing grants and continuing projects. Those Other Funds are included in the project budget descriptions in Section 3 as well as Table 3 in Section 4.

Table 2 NMS FY2026 Program Plan EXPENSES

	FY2026 EXPENSES		
	MODELING		
1	CMOD.1	Biogeochemical Model Development	$300,000
2	CMOD.2	Predicting the 2022 HAB Event's Progression and Effects	$200,000
3	CMOD.3	Investigate Environmental-Change Scenarios, Probability	$50,000
4	CMOD.5	Source Apportionment: Develop and Test Approaches	$30,000
5	CMOD.7	Model Infrastructure	$70,000
6	CMOD.8	Convene NMS Model Advisory Group	$35,000
7	EMOD.1-2	LSB Simulations: Fluxes; Transformations; System Responses	$50,000
8		*SUBTOTAL*	*$735,000*
	MONITORING		
9	CMON.1	Ship-based Monitoring	$600,000
10	CMON.2	Moored Sensor Monitoring	$700,000
11	CMON.3	Biogeochemical Mapping: A. South Bay; B. CB, SPB, SUI	$300,000
12	EMON.5	Data Management: QA/QC, documentation	$75,000
		SUBTOTAL	*$1,675,000*
	PROJECTS		
13	FLOB.1	Monitor Changes from POTW Load reductions	$100,000
14	FLHAB.1	Investigate the 2022 Heterosigma strain, recent arrival in SFB?	$100,000
15	FLHAB.2	Investigate Weak Top-down Pressure, Summer 2022	$100,000
16	FLHAB.3	Build Improved Understanding of HAB Biology	$100,000
17	AFHAB.1	Numeric Thresholds for Heterosigma Direct Lethality	$50,000
18	SYNOB.1	High-Priority Datasets: Zooplankton and Turbidity	$100,000
19	SYNOB.2	Semi-Empirical Estimates of N losses, Denitrification	$120,000
20	SYNHAB.1	Analysis/Interpretation of Multi-Year HAB and Toxin Datasets	$110,000
21	SYNHAB.2	Analysis of Long-term Forcing and Condition Data	$50,000
22	SYNLSB.1	Synthesis | PhyO2LSB: Lower South Bay	$50,000
23	SYNHLS.1	Science Communications Products	$100,000
24		*SUBTOTAL*	*$980,000*
	PROGRAM MANAGEMENT		
25	PM	Program Management	$850,000
26		**TOTAL EXPENSES**	**4,240,000**
27		**BALANCE**	**$0**

3. FY26 PROGRAM PLAN

The planned work in the FY26 Program Plan is based on the LOW funding scenario included in the 2025-2030 Science Plan. A prior version of the FY26 Program Plan was discussed at the March 24 2025 NMS SC meeting. The final plan was modified based on those discussions and feedback, with further changes incorporated to bring the budget in line with available resources.

Appendix B and Appendix C are included here to offer additional context for how the FY26 Program Plan fits into longer term work. Appendix B presents a summary view of the LOW funding scenario for FY26-FY30. Appendix C presents the LOW science plan at a project-level view.

The LOW funding scenario allocates funds over four years instead of five because the four-year timeline aligns better with grant expiration dates and the end of the 2024 Nutrient Watershed Permit. Distributing the EPA funds over four years instead of five also increases the annual budget in years one through four by approximately $300,000.

Appendix D is included to allow for project and program level comparisons between the LOW and MAX funding scenarios.

3.1 MODELING

CMOD.1 Biogeochemical Model Development	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI, external collaborators	$300,000	$0	$300,000

Project Description
Biogeochemical modeling work within CMOD.1 will target several priority model development projects, including recommendations made by the NMS Model Advisory Group's (MAG) in their 2023 review, which lists improving important biogeochemical modules and processes and pursuing model applications studies.

BGC Model Improvements: The biogeochemical model improvements include refinements to primary production-grazing parameterizations; incorporating an improved sediment diagenesis module (reparameterizing/recoding) that incorporates additional processes that prior results indicate may be important for quantifying space-time variability of benthic denitrification and sediment oxygen demand. The model will also be extended to recent years (2023-2024) in order to take advantage of higher-resolution data (moorings, mapping, remote-sensing) for model tuning and calibration. Incorporating these improvements will be important for other work in FY26, including understanding and predicting the 2022 HAB event (CMOD.2), investigating potential future scenarios (CMOD.3), and nutrient source apportionment (CMOD.4), along with the management application studies that will get underway in FY27 and beyond.

BGC Model Applications The BGC model will be applied to test and update current conceptual models of nutrient cycling and phytoplankton productivity in San Francisco Bay(SFB), as well as to build quantitative understanding of these processes and update key conceptual models of nutrient cycling and primary production in SFB. The updated conceptual models would be distinct products that will be developed in conjunction FY26 synthesis projects coming at the conceptual models from the empirical/data-analysis side (SYNOB.2, N cycling, phytoplankton production; and SYNHAB.1), including:

- *Nitrogen Sources, Cycling/Transformations, and Fate*: Transport and transformation mass budgets of dissolved inorganic nitrogen (DIN) and other related processes will be analyzed at various temporal and spatial scales to advance the understanding of nitrogen cycling within the Bay. Efforts will focus on explaining long-term channel observations, high frequency data collected at channel and off-channel locations, and mapping cruises conducted within South Bay and Central Bay.
- *Factors Regulating Phytoplankton Production:* Analyze bottom-up and top-down controls on primary production at both a local site and a subembayment scale using mass budgets. This analysis, along with insights on nitrogen cycling, will help refine conceptual models of long-term primary production and identify areas of chronically high primary production that may be more susceptible to larger blooms within the Bay.

Work Products
- Updated NMS hydrodynamic-biogeochemical model for use in upcoming applications.
- Technical report and draft manuscript(s): i) The model development and validation work will be written up as a technical report, and it will also be submitted to a peer-reviewed journal, either as a standalone publication or as part of model applications discussed below; ii) One or more technical reports focused on nitrogen cycling and/or phytoplankton dynamics.

Budget Justification: Funds will support SFEI labor (~0.75 FTE) and external collaborators.

CMOD.2 Predicting the 2022 HAB Event's Progression and Effects	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI	$300,000	$100,000*	$200,000

*2023 EPA-WQIF Grant (Destination Clean Bay)

Project Description

One major focus of the overall FY26 NMS modeling effort will be developing a numerical model for simulating the August 2022 HAB event, applying the model, and interpreting results to build our understanding of the underlying factors that contributed to the bloom's initiation, spread, and termination. Initial steps will include developing, testing, and improving a version of the NMS physical-biogeochemical model to simulate the August 2022 HAB-event. Model performance will be evaluated by comparing predicted and observed dissolved inorganic nitrogen (DIN), phytoplankton biomass (including its progression/evolution over space and time), and DO concentrations. Over the last year, we used the physical-biogeochemical model along with other modeling tools (e.g., numerical tracers) to investigate conditions within specific time-windows or regions and evaluate combinations of hypothesized factors (physical, chemical, biological) that had the potential to influence the bloom's progression. That work identified several hypotheses for explaining key features of the bloom.

FY26 will be year one of a multi-year project. During FY26, work will focus on incorporating the candidate processes/factors into the model and further developing and testing the model over the course of the full event, including by making extensive use of observational data to tune and test model performance. Model output will be analyzed and interpreted to narrow down or identify a set of factors (or more likely, combinations of factors) that are hypothesized to have played important roles shaping aspects of the bloom's progression, including: bloom initiation, extremely high biomass accumulation over a prolonged period, spatial occurrence over time (intensively spread throughout all of South Bay, spreading through Central Bay but apparently less severe, and even less further north), cause(s) of abrupt termination.

Work Products

One or more technical report(s) describing modeling approach and progress or status, including an initial evaluation of model performance (at capturing various bloom features), and identifying and characterizing/quantifying the influence of important processes. The technical report will also be submitted to a peer reviewed journal for publication.

Budget Justification

Funding will support SFEI labor (0.75 FTE), and contributions from core collaborators (RMA, Four Peaks). The overall project will be supported by a combination of NMS FY26 funds (Permit + EPA), and funds from a closely integrated EPA-WQIF project with a HAB/future-scenario modeling module.

CMOD.3 Environmental-Change Scenarios: Evaluate Potential Impacts and Probability	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI	$150,000	$100,000*	$50,000

*2023 EPA-WQIF Grant (Destination Clean Bay)

Project Description

This project will investigate the potential for extreme or episodic nutrient-related impacts to occur due to changes in anomalous environmental forcings (episodic/anomalous or gradual shift). The extreme or episodic events may manifest as high-phytoplankton-biomass / low-DO, HAB toxin production, or direct lethality of HABs on wildlife. A key component of the project will be using numerical models to identify the factors or combinations of factors that could result in a critical water quality condition and would potentially be among the priority scenarios against which management actions would aim to protect. The factors could be any of the biological or physical factors (alone or in combination) that have the potential to strongly influence phytoplankton growth rates (bottom-up) or mortality/loss rates (top-down) accumulation.

During FY26, work will begin as a continuation of the 2022 HAB-event analysis, probing specific features or stages of the bloom's progression to identify key mechanisms and quantify their relative importance. One of the initial 'future scenarios' will be the investments into the 2022 event in CMOD.2. In addition, we also propose to frame the observed changes in South & Central Bay gross primary production (GPP) and chlorophyll (1990s-2020) as a scenario to assess the model's ability to reproduce the biomass increases in both regions, followed by the regions that have strongly differing responses between 2010 and 2020. Additional critical conditions to explore include blooms caused by other HAB-forming organisms in summer. Mechanisms/factors or variables to be considered for these investigations include: growth rates as a function of light and nutrients, swimming speeds, susceptibility to grazing, mixotrophy (or not), biomass at which toxicity is reached, and physical factors like turbidity and temperature.

During the very early stages of this project (e.g., late-fall 2025), we propose to convene an expert advisory group and work with that group to develop a future-scenario / critical-condition work plan. The work plan will include: conceptual model(s), informed by management priorities; a prioritized set of scenarios to investigate (based on conceptual model); and recommended approach(es). The Recommended approaches will address characterizing the effects, along with approaches for evaluating the probability or return frequency. Scenarios will include some events analogous to the August 2022 HAB event. Critical event scenarios that may occur during other time periods or within other regions may also be investigated (e.g., *timing*: during the typical Mar-Apr spring bloom period; *location*: how might the likelihood/susceptibility, or key drivers of severe events differ among subembayments). Work on the latter topics would start in a subsequent year and will benefit from the experience during FY26 testing other scenarios.

Work Products: i) Workplan, developed with input from external advisors (possibly the MAG, augmented with additional expert(s)). ii) Technical update after the completion of year 1, in the form of a section within an overall modeling update report); iii) Technical report, to be submitted to a peer-reviewed journal.

Budget Justification: Work will be conducted by SFEI staff as well as external collaborators. The budget for FY26 includes approximately 0.5 FTE and funding for collaborator contracts.The overall project will be supported by a combination of NMS FY26 funds (Permit + EPA), and funds from a closely integrated EPA-WQIF project with a HAB/future-scenario modeling module.

CMOD.5 Source Apportionment: Techniques for Determining DIN Zones of Influence	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI, core collaborators	$100,000	$70,000*	$30,000

*2023 EPA-WQIF Grant (Destination Clean Bay)

Project Description

San Francisco Bay (SFB) receives the majority of its dissolved inorganic nitrogen (DIN) from the discharge of treated effluent from the region's 40 Publicly Owned Treatment Works (POTWs). Accurate estimates of how individual DIN sources contribute to ambient DIN concentrations over space and time are essential information for evaluating nutrient management options. However, estimating an individual source's zone of influence (ZOI) is not straightforward. Once a point source's DIN enters SFB, it is transported away from the input location by tidal action and wind-driven currents. During transport, the DIN also undergoes transformations and losses. Quantitatively determining the ZOIs for every point source, therefore, requires predicting and individually tracking the transport and transformations of each point source's nutrients after they enter SFB. Tracking, or tracing, individual source contributions through the numerous transformations and recycling can not be carried out with standard numerical tracer approaches.

This project will develop numerical modeling tools that enable an individual source's ZOI to be accurately and efficiently predicted, and it will superimpose ZOIs from all sources to quantify a source's relative contribution to the total DIN over space and time. In general, the approach will involve combining reactive numerical tracers in conjunction with space-time varying DIN transformation rates (e.g., net loss, net gain), extracted from calibrated biogeochemical model simulations for the time period of interest.

Work Products

- Technical report describing the approach(es) and results from applying the technique.
- The technique will be applied within multiple projects in FY26, including SYNOB.2 and CMOD.1.

Budget Justification

FY26 work on this project will be partially supported by funding from EPA-WQIF grant (Destination Clean Bay). The combined funding of $100,000 will support ~0.3 FTE SFEI labor ($75,000) and core collaborator labor ($25,000).

CMOD.7 Model Infrastructure	**Total FY26 Work**	**Other Funds**	**Proposed FY26 Funds**
Team: SFEI, core collaborators	$100,000	30,000*	$70,000

*2023 EPA-WQIF Grant (Destination Clean Bay)

Project Description
This project will support some or all of the following:

- Beyond the routine best-practice documentation that is built into the team's workflow, additional investments will be made into documenting model-related code and datasets and maintaining these on the SFEI/NMS github repo.
- Alongside the above documentation, postprocessing scripts will be updated and streamlined, including: i) incorporating performance metrics codes (calculating metrics, associated plots) so they run automatically; ii) fine-tuning the NMS' mass balance scripts and incorporating mass balance results into standard workflow.
- Migrate to running fully coupled hydrodynamic-biogeochemical simulations. As part of this effort, investigate (working with Deltares or collaborators) the potential to achieve faster run-times by shifting to running on supercomputers.
- As needed, purchase additional HPCs or storage. During FY25, our in-house computing capacity occasionally became a rate-limiting step on efficiently moving modeling work forward. We addressed this by increasing capacity, and FY26 could funds support further increases, if needed.

Budget Justification
FY26 work on this project is partially funded by the Destination Clean Bay Grant, which dedicates effort towards developing the community model. Funding will support SFEI labor, core collaborator labor, and direct costs (as needed).

CMOD.8 Convene NMS Model Advisory Group	**Total FY26 Work**	**Other Funds**	**Proposed FY26 Funds**
Team: SFEI	$75,000	$40,000*	$35,000

*Unused funds allocated in FY25 for the MAG

Project Description

The first round of Model Advisory Group (MAG) meetings were held in May 2022, November 2022, and February 2023 (see MAG report, April 2023). The MAG's report-out recommended several priority areas for biogeochemical model performance (see CMOD.1), suggestions for ways to evaluate model performance, and relevant modeling applications to pursue.

Since there were no good windows for reconvening the MAG in 2024, a MAG meeting in FY26 would be valuable for the purpose of updating them on progress relative to their recommendations. In addition, the February 2023 MAG meeting wrapped up before the third Bay-wide nutrient permit was released. The permit requirements have reshaped some of the high-priority management questions, which has in turn has introduced important changes in some of the priorities for model development and applications. MAG feedback on model development related to these management priorities will also be valuable and would be an important focus of the upcoming meeting.

This project will support re-engaging the MAG for 1-2 meetings during FY26.

Preparation for meetings will include developing technical materials (and summaries) to update the MAG on progress and status of work relative to their 2023 recommendations and working with a subcommittee of the NMS-SC to develop goals and charge questions for the meeting.

Work Products

- Meeting materials, including technical updates, prepared in advance of the meeting.
- Convening meetings with the NMS-SC modeling subcommittee and establishing meeting goals and charge questions.
- Holding a MAG meeting sometime in the window of Sep-Oct 2025
- MAG report out post-meeting to be prepared by MAG chair in coordination with MAG members

Budget Justification

Costs include honoraria (6-7 MAG members); travel and lodging expenses of $5,000-$10,000 (2 meetings in FY26, if possible); and additional funds for the MAG chair to support engagement on meeting organization and producing summary materials. SFEI labor will be covered within the other modeling projects.

EMOD.1 & 2 LSB model Refinements, Tracer Simulations, and Workplan development	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: RMA, SFEI	$50,000	$0	$50,000

The work below is a hybrid of EMOD.1 and EMOD.2 in the Science Plan.
See Science Plan for more details.

Project Description
Investigations in Lower South Bay (LSB) indicate that tidal sloughs connected to managed ponds experience high phytoplankton biomass and frequent low-DO events. These conditions develop due to the combination of LSB's high nutrient concentrations, strong tides that induce nutrient transport into managed ponds, high phytoplankton production rates within ponds, and tidally-induced fluxes of biomass from pond to slough. Field observations and mass balance estimates suggest that substantial DIN removal occurs within LSB within pond pond complexes.

LSB is a physically and biogeochemically complex system, and representing the processes above requires using a higher-resolution version of the NMS hydrodynamic-biogeochemical model. A LSB-focused model that fully resolves LSB sloughs and connections to restored and managed ponds has been developed by SFEI/NMS and RMA and has undergone several rounds of refinements and recalibration over the last several years.

The work below aims to move ahead a subset of the EMOD.1-2 activities that will be useful for informing on-going priorities for LSB work and also support developing improved estimates of nitrogen cycling and losses south of the Dumbarton Bridge (necessary for Bay-wide modeling work). Work will include:

1. In coordination with project SYNLSB.1, develop a workplan describing a proposed approach for simulating a prioritized set of restoration scenarios. The workplan would be developed in coordination with the SBSPRP, regulators, other stakeholders, and technical experts. The workplan will also be discussed with and reviewed by the MAG.
2. Extend hydrodynamic simulations to additional time periods to include a wider range of environmental forcings (e.g., freshwater flows), seasons, and gate openings. Use the updated/tuned model to run numerical tracer simulations. Results from those tracer runs will be used i) to develop improved estimates of DIN loss in LSB and identify potential approaches for incorporating those losses using the full-Bay model; and ii) as input data for the SYNLSB.1 synthesis project described below.

Work Products:

- Updated LSB model for use in informing full-Bay modeling work and LSB specific studies, including model output from a series of numerical tracer simulations.
- Work Plan describing potential modeling/analysis scenarios and proposed approach(es), developed jointly with Project SYNLSB.1 and in coordination with SBSPRP, regulators, and interested parties.

Budget Justification: Core collaborator labor on model updates and tracer simulations (RMA, $35k), SFEI modeling labor ($7.5k), SFEI workplan development labor ($7.5k, also supported by SYNLSB.1)

3.2 MONITORING

CMON.1 Ship-based Monitoring	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: USGS, UCSC, Bend Genetics, BSA, SFEI	$600,000	$0	$600,000

Project Description

This project supports biweekly to monthly ship-based water quality cruises along San Francisco Bay's (SFB) deep channel. Work is pursued through an on-going collaboration with the USGS aboard the *R/V* Peterson, continuing the USGS' long-term SFB water quality measurements The overall program is jointly funded by USGS, the RMP, and the NMS.

Monitoring work includes:

- Vertical water column profiles using submersible water quality sensors (CTD casts) and continuous surface water measurements while underway by optical sensors plumbed into the vessel's flow-through system.
- Surface water grab samples at a subset of stations, including the following measurements: inorganic and organic nutrients, chlorophyll-*a*, phytoplankton taxonomy by microscopy, molecular techniques for quantifying phytoplankton taxa (18s, 16s sequencing, dissolved harmful algae (HA) toxins using SPATT
- In addition to the Peterson's standard set of flow-through sensors, USGS recently incorporated a YSI EXO2 multi-parameter instrument (same instrumentation as the NMS mooring sites) into the vessel's flow through system, which will enable better cross-comparisons and cross-validation among monitoring approaches (channel cruises, moored sensors, shoal mapping).

Plans for FY26

- 12 full-Bay cruises and 8 South+Central Bay cruises.
- An SFEI staff member will join the cruises to help collect and filter nutrient samples. This will address a USGS staffing gap since previous volunteers are no longer available.

Work Products:

- Datasets for nutrients, chlorophyll-a, phytoplankton community, and toxins, which will be made publicly available through the USGS website.
- Results summarized in NMS Multi-year Report, and data will be used in other NMS program areas (model calibration, synthesis, condition assessment, AF development).

Budget Justification: The total funding of $600,000 includes both RMP and NMS funds. RMP funding ($290,000) supports 1-1.5 FTE USGS technicians who carry out the field work, analyze a subset of samples (chl-a, SPM, etc.), and manage datasets. NMS and EPA funds support: nutrient measurements, including: ammonium, nitrate + nitrite, reactive phosphorus, dissolved silicate, total N, and total P in approximately half of the samples (Chesapeake Bay Laboratory, $25,000); phytoplankton taxonomy by microscopy (BSA, $50,000); dissolved toxin measurements (UCSC, $25,000); molecular techniques for detecting and quantifying HA abundance and characterizing phytoplankton assemblage, including: 18s,16s amplicon sequencing; qPCR (Bend Genetics, $43,000); SFEI labor joining fieldwork; and inter-program coordination and data management. USGS in-kind programmatic funds cover: ship captain, direct costs (fuel, maintenance, transportation), program management support, and remaining technician costs (field, lab, data-management).

CMON.2 Moored Sensor Monitoring	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI, USGS-BGC, USGS-MarFac	$700,000	$0	$700,000*

Project Description
This project will support the collection of high-frequency water quality data (15-min) at the SFEI-NMS network of 15 mooring sites, distributed throughout the South, Lower South, and Central Bays, as well as the addition of a pilot mooring site in San Pablo Bay. Work includes:

- Monthly maintenance trips to each site (approximately 3 boat days/month).
- Instrument maintenance and calibration.
- Standard data QA/QC and management, along with refinements to data management tools.

Work in FY25

- Collected high-frequency sensor measurements at 15 stations (13 full stations with multi-parameter instruments, 2 oxygen-focused sites), along with periodic discrete sample collection for sensor validation.
- Conducted monthly calibration and servicing of water quality instruments.
- In collaboration with USGS, continued chlorophyll and DO measurements at Alcatraz station. DO measurements also continued for Jul-Sep 2024 at the near-bottom sensors at Dumbarton Bridge (DMB) and San Mateo Bridge before removing the DO sensors.
- Continued nitrate measurements at DMB, a shoal mooring site, and in Alviso Slough.
- Continued updates/improvements of data management codebase, including a shift to Aquarius software to reduce QA/QC processing time and improve data accessibility for the creation of a publicly facing data dashboard.

Plans for FY26

- Continue water quality measurements at 15 existing stations in South, Lower South, and Central Bays, including maintenance trips at 3-4 week intervals. See list of stations below.
- Install a pilot station in San Pablo Bay.
- Data QA/QC and data management.

*Two federal grants are contributing additional funds ($310,000) to support the expanded mooring network. *NOAA MERHAB*, $70,000: network expansion, maintenance, telemetry,equipment; *EPA WQIF BayInsight* $240,000: labor, equipment, boat time.

Work Products

a. Curated 15-minute dataset of water quality parameters from 15 stations (T, S, DO, chl, turbidity, fDOM).
b. Curated 15-minute dataset of nitrate data from three stations.
c. Updated QA/QC scripts and documentation, maintained and versioned on GitHub.
d. Moored Sensor Program update reports (semi-annually) summarizing status of stations, data QA/QC and data visualizations.

Budget Justification
The Moored Sensor Program costs for FY26 funds include:

- Field support: boat support and field/deployment logistics from both USGS-Pacific Marine Facility (MARFAC) and USGS-Water Science Center (WSC), and with USGS-WSC also contributing to instrument troubleshooting and discrete sample collection and processing

($250,000)

- Analysis of discrete samples ($10,000)
- SFEI labor for field and laboratory work, fieldwork planning and logistics, documentation, and overall project management ($300,000)
- Data processing and QA/QC, review, and report outs ($100,000)
- Direct expenses, including: instrument and sensor repair/factory-calibration/replacement, reagents, equipment, and other direct expenses ($40,000)

RMP funding (planned) of $250,000 will be used to support the moored sensor program.

SFEI-NMS Moored Sensor Stations

	Multiparameter (EXO)	**SUNA NO3**	**DO-focus (DO, T, S)**
Alcatraz	X		
Emmeryville	X		
South Bay shoal (3 sites): HAY, SLM, SHL	X	X (SHL)	
San Mateo Bridge	X		
Dumbarton Bridge	X	X	
Newark Slough	X		
Guadalupe Slough #1	X		
Alviso Slough #1	X	X	
Pond A8 notch	X		
Pond A8	X		
Pond A4	X		
Guadalupe Slough #2			X
Alviso Slough #2			X

CMON.3 Biogeochemical Mapping: South Bay + Central-SanPablo-Suisun	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI, USGS-BGC	$300,000	$0	$300,00

Project Description

This project will continue shoal water quality monitoring through high-resolution biogeochemical mapping surveys in the South Bay and Central Bay and adding new mapping surveys in the North Bay. The plan is to support nine to eleven mapping surveys in FY26 (uncertainty is due to the active contracting process with USGS as the time of this document's approval), collecting a combination of flow-through optical sensor data (e.g., chl-a, nitrate, turbidity, temperature, salinity) along with discrete samples (e.g., nutrients, phytoplankton community including HABs). To the extent possible, mapping surveys will be timed to coincide with USGS R/V Peterson cruises (C1: Deep channel monitoring) or satellite flyovers to allow for continued opportunities to calibrate/validate remote-sensed data for some relevant parameters (e.g., turbidity/SSC, chl-a).

Progress in FY25

- Six spring/summer water quality mapping trips were completed, capturing valuable information about spatial gradients in nutrient concentrations, GPP, and other parameters.
- Mapping work has now been conducted for five years (2021-2025), with six surveys each year between March and October. Funding from the NOAA MERHAB grant supported 4 of the surveys over the last 1.5 years.
- Data usage:
  - A second technical report analyzing the mapping data was completed in October 2024.
  - Mapping data from 2021-2024 (calendar years) will be used extensively for upcoming modeling work (CMOD.1) tuning/validating the biogeochemical model.
  - Data from 2021-2025 will be used extensively in three FY26 projects (SYNOB.1, SYNOB.2, SYNHAB.1).

Plans for FY26

- Planned mapping surveys (June 2025- June 2026): *South / Central Bay*: 6-7 surveys ; *Central / San Pablo / Suisun*: 3-4 surveys
- Data from the FY25 surveys, along with the data from 2021-2025, will play a central role in the FY26 work focused on establishing pre-upgrade baseline conditions.

Work Products

- Data from nine to eleven mapping cruises, yielding two-dimensional water quality maps for parameters measured.
- Corresponding discrete sample data from 15-20 locations per cruise: nutrients, chlorophyll-a, suspended sediment samples, phytoplankton assemblage (including HABs).

Budget Justification

The budget will cover the cost of up to 11 mapping surveys, including: mapping boat preparation, field time, and data curation; discrete sample analysis (nutrients, chl-a, phytoplankton by 18s/16s sequencing); and SFEI labor (joining subset of cruises, post-survey sample processing, data curation, and project management).

EMON.5 Data Management, QA/QC, Documentation	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI	$75,000	$0	$75,000

Project Description
All current and completed NMS data collection projects have included appropriate QA/QC and data management over the course of the projects. However, there are additional (and nontrivial) hurdles related to making data publicly available and hosted in public data repositories. These include: additional documentation (e.g., site descriptions, sampling approaches, analytical methods), QA/QC summaries, compiling data into merged files (across sites, analytes, dates), and reformatting to conform with repository-specific formatting requirements. There are similar requirements for publishing data compilations (e.g. compiled and processed data used for synthesis/desktop studies).

This project will be year 1 of an ongoing effort to support the additional documentation and data management needed to publish (make publicly available) NMS-related datasets. Work during FY26 will focus on several datasets that are already in-house, including:

- moored sensor data
- phytoplankton community and HAB-taxa data (18s/16s sequencing, and qPCR for several taxa): 2015-2024 channel monitoring cruises, 2021-2024 mapping surveys
- harmful-algae toxin data: mussels (2015-2022), anchovies (2018-2019 special study)
- discrete nutrient samples (cruises, mapping, mooring validation)
- remote-sensed chlorophyll and turbidity

The majority of the FY26 funds will be used to support an SFEI staffer taking on a program-wide data-manager role (0.25 FTE), with dedicated time for (gradually) maintaining all monitoring datasets. Funds will also support the role of other SFEI staff (~0.1 FTE) during year 1 working on sequencing (18s, 16s) datasets. The NMS data manager would take on the role of keeping the publicly available datasets updated (augmenting with new data), and keeping water quality dashboards up-to-date (NMS water quality dashboards are under development with funding from NOAA and EPA grants. Several interim dashboards are available here).

Work Products
FY26 products: documentation, QA/QC descriptions, and data-publication (web repository) for a subset of priority NMS datasets. Priority datasets include: phytoplankton/HAB data (sequencing, 18s/16s community), toxin data (mussels, anchovies), discrete nutrient samples (cruises, mapping, mooring validation), remote-sensed chlorophyll and turbidity, and moored sensor data.

Budget Justification
The funding will support 0.30-0.35 FTE SFEI labor ($70,000), data-publication fees, and web-hosting fees ($5,000).

3.3 PROJECTS: FIELD/LAB STUDIES, SYNTHESIS

FLOB.1 Monitor Changes from POTW Load Reductions	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI, USGS collaborators	$100,000	$0	$100,00.00

Project Description
The primary goal of this multi-year project is to establish baseline estimates of water quality conditions in San Francisco Bay prior to upcoming nutrient load-reductions by POTWs that post-upgrade conditions can be compared with. Year 1 (FY26) of this project will focus primarily on the analysis of existing data to inform study design, including long-term monitoring data, the augmented monitoring datasets collected from 2021-present, monitoring data collected during F2026 (CMON.1-3), and numerical model output. A detailed work plan for the multi-year project will also be developed during the first quarter of FY26 and shared with the NMS Steering Committee.

The data analysis effort will initially focus on dissolved inorganic nitrogen (DIN) concentrations to quantitatively characterize how those concentrations vary spatially, seasonally, and interannually. The DIN data, including variability or uncertainty, will be explored in terms of concentration and mass to support comparisons with mass loads and anticipated changes in mass loads. Results from numerical model simulations will be explored to guide data analysis and planning for on-going monitoring. Other nutrient parameters will also be analyzed (e.g., phosphate, total nitrogen, total phosphorus). We expect that the strongest signal may be with nitrogen and phosphorus. Some targeted, low-cost/high-value data collection may also be undertaken, depending on results from early exploratory analysis and feasibility. For example vertical nitrate profiles could be collected during planned cruises using an in-situ nitrate sensor linked to CTD (i.e., in coordination with CMON.1) or during supplemental cruises in Central Bay in summer 2025.

The results from these analyses will inform the continued evolution of the workplan for on-going monitoring to detect changes in ambient DIN concentrations resulting from load reductions, including identifying any priority data gaps.

Work Products: i) Technical memo, presenting results from the data analysis, and identification of any priority data gaps. ii) Work plan, including proposed approach(es) for addressing data gaps, and proposed approaches for analyzing observational data to characterize changes in response to load reductions

Budget Justification: SFEI labor (0.3 FTE), external collaborator labor (USGS).

FLHAB.1 Investigate Whether the 2022 Heterosigma was a Recent Arrival to SFB	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: H Bowers (Moss Landing), S Jungbluth (SFSU), SFEI	$100,000	$0	$100,000

Project Description

This project will test the hypothesis that the *Heterosigma* strain that caused the August 2022 HAB event was a recent arrival in San Francisco Bay (SFB), e.g., recently transported (coast-bay exchange) or recently delivered e.g., via ballast water release. It is well-established in the literature that *Heterosigma* has been transported from region to region by shipping/ballast-water releases (cyst forming organisms can survive weeks to months in ballast water tanks with no sunlight).

This hypothesis will be tested by sequencing well-studied regions of the *Heterosigma* genome in isolates from two *Heterosigma* events within SFB, separated by 20 years. Strain #1, from the 2022 *Heterosigma* event, has been isolated and maintained in culture by collaborator H Bowers (Moss Landing Marine Lab). Strain #2 was isolated from a 2002 *Heterosigma* event that occurred in Richardson Bay, which was submitted to a phytoplankton archive and can be readily obtained. A third strain of *Heterosigma*, isolated during *Heterosigma*'s reemergence during a short-lived bloom in summer 2023, will also be analyzed.

This study will follow an experimental design that was used in a series of recent studies that demonstrated these regions can be genetically-probed to detect strain-level differences within the same species (Higashi et al, 2017a,b; Ueki 2019). The studies also found that these genetic markers can be used to identify a strain's region of origin (Higashi et al, 2017a,b; Ueki 2019). The sequenced regions from Strains #1, #2, and #3 will be compared against each other and against sequences from approximately 50 other *Heterosigma* strains that were investigated in the above studies.

The distinct-strain hypothesis is critical to test in order to inform our understanding of factors that contributed to the 2022 event. If Strain #1 and Strain #2 are found to be distinct, that distinction has the potential to explain some important features of the 2022 bloom's progression. There are multiple reasons to consider this to be a reasonable hypothesis: the proximity of event's initiation to the Port of Oakland, *Heterosigma* being a well-known hitchhiker to other regions via shipping, and there have been large increases in ballast water releases within SFB over the last 2 decades. This difference may also be relevant to questions that will be explored through project FLHAB1, because *Heterosigma*'s vulnerability to infection by marine viruses has been shown to vary substantially among strains. Depending on the outcome of FLHAB1, a follow-up study may be proposed in FY27 (see 2025-2030 Science Plan).

Work Products

- Genetic 'fingerprint' data: i) from SFB 2002, 2022, and 2023 *Heterosigma* strains, generated through this project's analyses; ii) compiled *Heterosigma* data from other coastal regions.
- Technical memo describing results and initial interpretations. Depending on the results, follow-up resources may be sought to support a more comprehensive write-up in FY27.

Budget Justification: Multi-locus sequencing: primers and sample analysis ($5,000). External collaborators' labor for study design, including identifying appropriate primers; wet lab work; sample preparation; data analysis, including comparisons with other *Heterosigma* data; and interpretation and report preparation ($75,000). SFEI labor for contributions to data interpretation and report preparation and project management ($20,000).

FLHAB.2 Investigate Weak Top-down Pressure During During the Summer 2022 Event	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI, S Jungbluth (SFSU), F Schulz (LBNL)	$100,000	$0	$100,000

Project Description

This study will investigate the hypothesis that marine viruses played an important role in the termination of the 2022 Heterosigma event. This project is a two-part study that can be pursued in series, with a decision to pursue part two depending on whether results from FY26 work indicate that viruses were important players.

We originally hypothesized that viruses were responsible for ending the bloom based on analysis of field data. During the bloom's termination, chl concentrations decreased by ~20-30x decrease over 1-2 days (from 100 ug/L to <5 ug/L), and this crash occurred simultaneously at four distinct sites with moored instruments. The sharp decrease in chl was accompanied by a sharp drop in dissolved oxygen (DO). The rate at which DO decreased was comparable to first order rates that would be expected in the presence of abundant and highly-labile dissolved organic carbon, which would be consistent with viral lysis. The *Heterosigma* literature emphasizes that viruses are often the dominant top-down control (preventing high biomass from developing or terminating active blooms). Some studies go further, calling out viruses as the main controlling factor, with grazers generally playing a minor role in controlling *Heterosigma*. At the same time, *Heterosigma* strains isolated from the same estuary can exhibit starkly different susceptibility to naturally occurring marine viruses. In other words, if the 2022 bloom strain was recently introduced, there is a reasonable likelihood that, early in the event, the 2022 strain was unaffected by San Francisco Bay's (SFB) endemic viruses, consistent with there having been weak top-down pressure early in the event. Lastly, while interstrain differences in immunity are common, the rapid mutations that viruses undergo means the *Heterosigma* strain could have relative immunity to the prevailing viruses at the event's outset but be vulnerable to infection of the evolved viral community a few weeks later.

To test this hypothesis with field samples, we will: i) Assemble a time-series of archived filters (stored at -80C), which were collected over the course of the event. ii) Extract filters and analyze them following established methods that target the DNA of viruses that infect *Heterosigma*. If viruses played an important role in the bloom's termination, viral loads in viable *Heterosigma* cells collected near the bloom's end would have viral loads several orders of magnitude greater than cells from early August.

Work Products

- Data on DNA-based measurements (e.g., metagenomes) of viral abundance and speciation as well as compiled data from other studies/systems.
- Technical Memo summarizing results. Depending on the results, follow-up resources may be sought for FY27 for a more comprehensive write-up.

Budget Justification

Analytical costs for broad-scan and targeted sequencing techniques ($45,000). External collaborator labor on in-depth study design; sample processing; and data analysis/metagenomics, including comparison with other viruses($40,000). SFEI labor for study design, contributions to data interpretation and writing, and project management ($15,000).

FLHAB.3 Improved HAB Understanding Biology: Toxin Production by the 2022-*Heterosigma* Strain?	**Total FY26 Work**	**Other Funds**	**Proposed FY26 Funds**
Team: R Kudela (UCSC), SFEI, expert group	$100,000	$0	$100,000

Project A: This project will test if a *Heterosigma* strain that was isolated during the 2022 bloom produces toxins when grown under conditions similar to those in South Bay in Aug 2022 or under environmentally-relevant conditions (ranges of light, temperature, salinity).

Heterosigma has a well-established record of causing massive fish kills in coastal waters and estuaries around the globe. Nonetheless, considerable uncertainty remains around the specific factor(s) responsible for fish mortalities it induces. Multiple causal factors for *Heterosigma*'s lethality have been hypothesized, including production of toxins or reactive oxygen species (ROS) and physical mechanisms like mucous production that clogs fish gills. Compounds similar to the brevetoxins produced by *Karenia brevis* have been proposed as candidate toxins.

Beginning in late-2022, Raphe Kudela (UCSC) conducted a series of growth experiments using the strain of *Heterosigma* responsible for the Aug 2022 HAB event in San Francisco Bay (SFB). The aim of those experiments was to quantify *Heterosigma* growth rates across environmentally-relevant ranges of physical and chemical conditions, including temperature, salinity, light exposure, and varying concentrations and chemical forms of dissolved nitrogen (nitrate, ammonium, urea). At the close of each experiment, subsamples were collected and archived from each exposure condition for potential follow-up measurements.

Although those experiments were not pursued with the goal of studying *Heterosigma* toxin production, HAB studies often employ similarly-designed environmental gradient experiments to investigate toxin production. As such, the archived samples present a valuable opportunity to measure for toxin production by the 2022 *Heterosigma* strain. An initial subset of the available samples will be identified, processed following established protocols, and analyzed for brevetoxins and related compounds by liquid chromatography mass spectrometry (LC-MS). The LC-MS results from the initial subset of samples will be used to guide the selection of other samples to process and analyze. Results from the LC-MS analyses will be written-up as a technical report. To the extent possible (within available budget), funds will also be used to support writing up the results from the growth experiment work.

Project B: This portion of the study will include a literature review and expert workshop to gather input on HAB research directions that have the potential to yield improved understanding of HAB biology, and ultimately address management questions. If possible, this literature review and expert panel could be combined with the targeted panel identified for project AFHAB.1.

Work Products:

Project A*:* Toxin data from *Heterosigma* exposed to a range of environmental conditions. A Technical report describing the results, potential manuscript (depending on findings).

Project B: Expert workshop, including report-out and related literature review, with input and recommendations from expert group on potential directions for HAB-related experiments.

Budget Justification:
Project A: Sample preparation and analysis by LC-MS (n ~ 50) ($12,500). Labor for data analysis, interpretation, and report preparation ($37,500).
Project B: Honoraria for 4-5 experts ($27,500). Expenses for a 1-2 day in-person meeting (travel, hotels, meals: $7,500). SFEI labor for meeting planning, contributing to literature review and to report preparation ($15,000).

AFHAB.1 Thresholds for *Heterosigma* Direct Lethality: Evaluating/Identifying potential approaches	**Total FY26 Work**	**Other Funds**	**Proposed FY26 Funds**
Team: WB, SFEI, expert group	$50,000	$0	$50,000

Project Description
Through a combination of literature review and convening an expert panel, this project will investigate options for studying the mechanism(s) and dose:response levels that induce lethality. An initial literature review by SFEI staff will inform discussions with experts, who will be assembled for focused discussions about: what is known/unknown about the hypothesized mechanisms for *Heterosigma's* lethality, relationships that have been developed in the literature (e.g., cells/mL or other related measures), and viable experimental techniques. A workgroup report-out will be prepared by one or more of the expert participants, and that information will be used to inform next steps in future fiscal years.

Work Products

- Convene the expert workgroup
- Work group write-up that includes: an assessment of the feasibility, strengths, and limitations of potential approaches; evaluation of what can be estimated from literature and existing studies; a summary of relevant literature; and work group recommendations for future study

Budget Justification
Honoraria for 4-5 experts ($25,000-$30,000).
Expenses for a 1-2 day in-person meeting (travel, hotels, meals: $7,500).
SFEI labor for meeting planning, identifying potential express, working with stakeholders to develop meeting goals and charge questions, and, time permitting, contributing to the report document ($15,000).

SYNOB.1 Priority Datasets: Zooplankton and Turbidity	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI, RMA / R Holleman, S Junbgluth (SFSU)	$100,000	$0	$100,000

Project Description

Zooplankton:

Results from early NMS modeling work indicated that microzooplankton have the potential to strongly regulate phytoplankton biomass accumulation and shape community composition by size-selective grazing. This pilot project will analyze NMS 18s data, focusing on microzooplankton relative abundance and community structure, to explore the feasibility of using these data to develop proxies or indicators for potential grazing pressure (space-time varying). There will be 7-8 years of ship-based data and 4 years of shoal mapping data to use.

Light attenuation, K_D:

Early modeling results also suggested that light attenuation coefficient estimates (K_D) were among the most important variables influencing nutrient cycling and phytoplankton growth, but space-time varying K_D estimates are a priority data gap (e.g., SFEI 2020). To begin addressing this data gap, the modeling team developed, and has been iteratively improving, a semi-empirical, statistically-based approach for generating space-time varying estimates for $K_D(x,y,t)$, which are used as biogeochemical model input. The analysis approach incorporates physical forcing data (wind speed, wind direction), bathymetry, hydrodynamic model output (tidal velocity), and other forcings to predict K_D. High-frequency turbidity data measured at stations along the Bay's deep channel and measured K_D from monthly cruises are used for model training, with a subset of the data set aside to evaluate performance and characterize uncertainty.

This project will incorporate a next iteration of improvements by incorporating remote-sensed estimates of K_D, which will greatly increase the information used for tuning model predictions along shallow shoals. The primary output of this work will be an updated version of the K_D dataset and documentation of the process, including how incorporating the remote sensed data influenced K_D predictions.

Work Products

Zooplankton: A processed and documented dataset, processing scripts, and a technical memo.

Turbidity/K_D: An updated K_D dataset that incorporates RS-turbidity estimates, technical documentation of the approach (e.g. a technical memo), and related data processing scripts

Budget Justification

Zooplankton: External collaborator data analysis and technical memo drafting by S Jungbluth ($35,000)

Turbidity/K_D: SFEI labor (0.2-0.25FTE) and/or labor for core collaborator, RMA ($65,000)

SYNOB.2 Semi-Empirical Estimates of Biogeochemical Transformation Rates (denitrification)	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI, RMA / R Holleman, S Junbgluth (SFSU)	$120,000	$0	$120,000

Project Description: *Note: Year 1 of a multi-year project*

Early NMS science planning and prioritization studies (e.g., SFEI 2014) identified numerous data gaps that were considered high priority in order to support achieving accurate predictions of nutrient cycling, concentrations, and nutrient-related responses. Thus far, only a limited number of those priorities have been pursued due to limited funds.This project will undertake targeted field/lab studies to address high-priority data gaps.

The NMS has, however, been able to greatly expand the data collection of relevant water quality parameters, or state variables, and has made substantial advances in the development of numerical model capacity. While the state variables do not tell us the rates, those variables do however represent the conditions that the balance of the underlying processes are creating. The variables are valuable individually but even more so when used in combination (i.e., related cycles of nitrogen, oxygen, carbon, etc.).

An initial step for this project will be to develop an updated set of conceptual models, focusing primarily on nutrients and phytoplankton, while still being informed by other data. Those conceptual models and the related hypotheses for new types of observations or changing conditions will be used to guide the approach for the second phase of the project.

In the second component of the project, we will leverage the intensive monitoring work and rich datasets collected over the last several years to pursue a range of data analysis approaches and develop ecosystem-scale rate estimates of underlying biogeochemical processes. A semi-empirical modeling approach will be pursued, combining statistical approaches (mechanistic equations, solving for rates) with numerical modeling/simulation techniques (conservative tracer, reactive tracers), to analyze several years of high-resolution/high-frequency field measurements (mapping data, mooring data) and estimate ecosystem-scale rates for biogeochemical processes that are expected to substantially influence nitrogen concentrations, nitrogen, cycling and other water quality parameters (example target processes: net DIN loss/gain rate, net O2 loss/gain rate, net biomass production rate, pelagic respiration, and benthic respiration). The key outputs from this work will be the estimates for biogeochemical rates, which will be estimated (through optimization) by maximizing the ‘goodness’ of state variable predictions (i.e., minimizing the residuals between observed and predicted concentrations). This information will be used for two primary purposes. The estimates will be used to interpret/synthesize and to update the conceptual models for nitrogen, phytoplankton, and other biogeochemical cycles, while the interpretations above, in particular the rate estimates, will be used to help inform biogeochemical model tuning or as a semi-independent validation of biogeochemical model performance

Work Product: Year 1 report-out, in the form of a technical memo or in-depth technical presentation. Work will likely need to continue in Year 2 (with additional funding), and the end product will be one or more technical reports

Budget Justification: 0.3 FTE SFEI labor ($75,000). Labor for external collaborators (e.g. USGS, RMA, UC Berkeley) data analysis ($75,000).

SYNHAB.1 Analysis of Multi-year HAB and Toxin Datasets	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI; Collaborators: SFSU, UCSC, UCB	$110,000	$0	$110,000

Project Description

This HABs-focused synthesis work will cover space-time variability in HAB detection/abundance, and influential factors. Beginning in 2019-2020, NMS funds were directed toward building the technical capacity to use high-throughput sequencing (18s and 16s rRNA gene amplicon sequencing) to detect and quantify HAB taxa, and to characterize phytoplankton community composition. We subsequently sequenced biweekly cruise samples from 2020-2023 (n ~ 600), along with archived samples from 2015-2019 (n ~ 800). These analyses have also been performed on samples collected during all shoal mapping surveys (data available for 2021-2023; 6 surveys per year, 15 samples per survey, n ~ 270).

This project will analyze and interpret this 9-year record of phytoplankton and HAB data (18s, 16s), with an emphasis on HABs, to explore the space/time variability in HAB-species occurrence and how HAB species differ from other phytoplankton taxa. We will also examine relationships between HAB space-time variability and water quality variables (nutrients, T, S, turbidity), alongside the rest of the microbial community (16s; bacteria, archaea).

This work will be carried out within an overarching goal of developing an updated HAB/phytoplankton-community conceptual model. As work during year 1 progresses, early observations will be incorporated into an updated conceptual model of HAB occurrence and relative abundance within the broader context of phytoplankton community spatial and seasonal/interannual variability, including explanations or emerging hypotheses for the drivers of these patterns. One working hypothesis to begin exploring in year 1 is that space-time variability of some HAB taxa occurrence and abundance will covary with that of the broader phytoplankton and bacterial communities, and that these cooccurrences or covariations a) offer source-community-fingerprint information about the source/origins of HAB taxa, including whether a HAB taxa is growing/prospering within the Bay or is primarily transported into the system and shortlived; and b) contain information about underlying mechanisms that shaped the community features that can be explored to improve our understanding of HAB dynamics.

The analyses, conceptual model, and hypothesis-generating during Year 1 will shape the direction of work for Year 2.

Work Products

This project would be a multi-year project, with work continuing and wrapping up in FY27. An interim technical report will be developed as an update on FY26 work status.

Budget Justification

The budget will support 0.35 FTE SFEI labor, along with support for external collaborator(s).

SYNHAB.2 Analysis of Long-term Forcing and Condition Data	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI, UCSC, NOAA	$100,000	$50,000*	$50,000

*continuing funds from a related FY25 project

Project Description

This project will investigate the environmental forcings that are known (or hypothesized) to influence phytoplankton production in San Francisco Bay (SFB). Analyses will focus on characterizing seasonal variability, interannual variability, and long-term trends.

Candidate forcings or parameters include: suspended sediment concentrations (including remote-sensed data); temperature (air and water); wind (speed and direction); solar insolation (or cloud/fog-cover); rainfall and freshwater flows entering SFB; and basin-scale climate forcings (e.g., upwelling indices, el Nino, PDO). While the aim is to explore as many relevant forcings as feasible, work will focus first on a high-priority subset that will be analyzed to near-completion (e.g., 90%), before shifting to the next tier. High-priority parameters include suspended sediment concentrations, wind, air/water temperature, and solar insolation.

Work on suspended sediments got underway during FY25 (NMS-funded project). Work thus far has been investigating the potential to use remote-sensed (RS) turbidity estimates, in particular comparing estimates from Sentinel-3 (2016-present) with those from MERIS (2002-2011).

The primary focus of the work is on investigating these forcings for evidence of long-term changes (individually or in tandem) and characterizing their extremes, including changes in the magnitudes of upper/lower quantiles or the occurrence of extreme/episodic events. In addition to a technical report on this work, its results will also inform the planning related to future scenario work.

Work Products

- Compiled datasets
- Technical report at the project's completion

Budget Justification

The FY26 funding and FY25 continuation funds will support SFEI labor (0.2 FTE x 2) to continue the sediment/turbidity work, add more parameters, and prepare a technical report. There is also support ($10,000) for an external collaborator/expert advisor. Funding from the NOAA MERHAB grant is supporting the processing of remote-sensed imagery and developing/testing algorithms for MERIS. Remote-sensing staff from NOAA are participating as unfunded collaborators.

SYNLSB.1 Lower South Bay DIN-Phyto-O2 Synthesis	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI, RMA / R Holleman, external advisors	$50,000	$0	$50,000

Project Description

Field data and analyses from NMS studies indicate that the combination of high nutrient concentrations and tidally-driven transport between Lower South Bay's (LSB) sloughs/creeks and managed ponds have substantial near-field effects on water quality in some sloughs (high phytoplankton biomass, extremely high respiration rates, low dissolved oxygen).

Using a combination of observational data, numerical models, and mass balance approaches, this project will develop quantitative estimates for fluxes of N, organic carbon(OC), and DO between sloughs and ponds under a range of conditions. The work will incorporate results from hydrodynamic and numerical tracer simulations to estimate exchange-rate relationships. It will then combine model-derived exchange rates with concentration estimates from mooring data (chl, DO) to estimate: DIN mass flux into managed ponds, phytoplankton productivity and potential DIN loss within restored ponds, and OC export to sloughs. The results and interpretations from this work will be written up in a technical report. The numerical tracer work will be carried within Project EMOD.1-2 (above).

The results from these analyses will be used to inform the development of a work plan focused on identifying proposed approaches for simulating a prioritized set of restoration scenarios. The workplan will be developed jointly with EMOD.1-2. The workplan would be developed in coordination with the SBSPRP, regulators, other stakeholders, and technical experts. We will also plan to include modeling-related work identified in the work plan at an upcoming Model Advisory Group meeting.

Work Products:

- A technical report
- A work plan describing potential modeling/analysis scenarios and proposed approach(es) that is developed jointly with Project SYNLSB.1 in coordination with SBSPRP, regulators, and stakeholders.

Budget Justification: SFEI labor for data analysis, interpretation, and report preparation ($40,000). Funding to support work plan development, either as SFEI labor, core collaborator labor, or technical advisor time ($10,000, also supported by EMOD.1-2).

SYNHLS.1 High Level Science Communications Products	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI	$100,000	$0	$100,000

Project Description
Funding for this project will support the development of high-level science communication products for distribution to the NMS Steering Committee, decision-makers (e.g., boards and managers), and other interested parties. Work in the near-term will focus on completing a high-level 'state-of-the-science' synthesis report. Another priority for FY26 is preparing executive summaries for a subset of NMS reports identified as priorities by the NMS-SC and other stakeholders.

During the first quarter of FY26, a communication plan will be developed in coordination with NMS Planning Subcommittee and interested NMS-SC members, which will be shared prior to the fall 2026 NMS-SC meeting for discussion and input.

Work Products
- State of the Science report
- Executive Summaries for priority NMS technical reports
- NMS communication plan

Budget Justification
The budget includes time for SFEI labor (0.30 FTE), graphics support, and publication costs.
EPA SFB-WQIF Grant[4]

3.4 Program Management

PM Program Management	Total FY26 Work	Other Funds	Proposed FY26 Funds
Team: SFEI	$850,000	$0	$850,000

Project Description

This funding covers the costs associated with NMS program management, including:

- Science oversight for the NMS, including study design, scientific contributions to projects, review of work products, and identifying on-going NMS science priorities.
- Program management, including working with the NMS Steering Committee, Planning Subcommittee, other subcommittees, and additional stakeholder engagement.
- Increased investment in FY26 in 'internal' program management, including managing workflow and resource allocation for NMS technical projects, deliverable tracking, and budget reporting.
- Program budget tracking, including external contract management, accounting, invoicing, etc.
- Fundraising to support NMS work.

Budget Justification

The vast majority of the PM budget supports labor ($840k), including the lead scientist, program manager, and project manager's efforts across the range of NMS scientific activities. It also covers Steering Committee and partner engagement; SFEI staff time for attending NMS-SC and NTW meetings, and internal team meetings; and work on other NMS business (e.g., hiring). Minimal expense funds ($10,000) are used for travel as well as supplies/food for Steering Committee meetings and related meetings.

4. SUMMARY OF OTHER NMS FUNDING FOR FY26

Table 3: Other funds (e.g. ongoing grants and continuing projects) used to partially support Program Plan projects in FY26, FY27, and FY28. FY26 funds are listed in the projects above.

	FY2026	FY2027	FY2028
CMOD.2 HAB Events Funding Source: EPA-WQIF	$100,000		
CMOD.3 Future Scenarios Funding Source: EPA-WQIF	$100,000	$75,000	
CMOD.4 Management Appl. Funding Source: EPA-WQIF	$0	$125,000	
CMOD.5 Source Apportionment Funding Source: EPA-WQIF	$70,000		
CMOD.7 Model Infrastructure Funding Source: EPA-WQIF	$30,000	$70,000	
CMOD.8 Convene the MAG Funding Source: Continuing Funds	$40,000		
SYN.HAB.2 Analysis of Long-term Forcing and Condition Data Funding Source: Continuing Funds	$50,000		
	$390,000	**$270,000**	

Table 4: Other projects supporting priority NMS work in FY26 that are not included within Table 2 in Section 3 or the projects listed above, because no funds will to come from the NMS permit in FY26. The projects are, however, included in the Science Plan, and work is ongoing.

	FY2026	FY2027	FY2028
EMOD.5 Sediment Transport Funding Source: EPA-WQIF	$100,000	$100,000	$100,000
EMOD.4 Coastal modeling Funding Source: NMS-FY21	$50,000	$65,000	$65,000
EMOD.3 Delta-Suisun focus Funding Source: Delta RMP	$175,000	$175,000	
	$325,000	**$340,000**	**$165,000**

Appendix A. NMS Management Questions for 2025-2030

A.1 Overview

Since 2014, the San Francisco Bay Nutrient Management Strategy (NMS) has been operating from a set of management questions developed initially in 2014.[1] They were designed to establish a scientifically rigorous framework for assessing and managing nutrient-related water quality issues in San Francisco Bay. The questions focused on identifying current and future nutrient impairment risks, understanding nutrient dynamics, assessing ecosystem responses, and evaluating management strategies to protect beneficial uses of the Bay:

1. Is SF Bay experiencing nutrient-related impairment or likely to experience impairment in the future?
2. What nutrient loads can SF Bay assimilate without impairment?
3. What are the major sources of nutrients to SF Bay?
4. How do nutrients move, transform, and accumulate within SF Bay?
5. What is the relationship between nutrient loads and phytoplankton biomass and productivity?
6. Are nutrient loads contributing to low dissolved oxygen conditions?
7. Are nutrient loads contributing to changes in phytoplankton community composition or promoting harmful algal blooms (HABs)?
8. What are effective and economical nutrient management strategies to prevent or mitigate impairment?

These management questions guided the development and implementation of two sequential five-year Science Plans. From 2014 to 2024, the NMS established foundational knowledge about nutrient dynamics, ecological responses, and key processes influencing nutrient-related conditions. Additionally, they supported the establishment of a robust monitoring and modeling program that continues to generate critical information to inform nutrient management decisions.

In response to the 2022 Bay-wide HAB, subsequent fish kills, and the Water Board's regulatory decision in July 2024 to require 40% nutrient load reductions, the goals for the NMS from 2025-2029 have shifted from broad scientific collection goals to more specific Water Board information needs designed to inform load reductions and other near-term management actions. This shift has focused efforts on understanding the particular conditions that led to the 2022 *Heterosigma akashiwo* bloom, quantifying the relationships between nutrient loads and HAB events, evaluating scenarios for load reductions, and assessing whether the existing loads established in the 2024 Nutrient Watershed Permit are sufficient or require revisions and targeted management approaches to prevent future bloom impacts.

In light of this shift, the NMS Planning Subcommittee developed a set of Priorities to address in the near term as well as an update to the Management Questions, which are listed below.

[1] "Scientific Foundation for the San Francisco Bay Nutrient Management Strategy" (Senn and Novick, 2014)

A.2 Programmatic Priorities - 2025-2029

- Enhance NMS program management through hiring of a new program manager and continued funding for project management staff.
- Enhance scientific communication to ensure that the steering committee and interested parties understand NMS work, findings, and implications through the creation of synthesis materials and the expansion of science communication staff.
- Deliver timely technical information to the Water Board to inform the reissuance of the Nutrient Watershed Permit in 2029.

A.3 Draft NMS Management Questions for 2025-2029

1. What factors contributed to the 2022 *Heterosigma* harmful algal bloom (HAB) event, including mechanisms that led to impacts on fisheries, and why did the 2023 *Heterosigma* bloom not exhibit similar Bay-wide spread?
2. What is the risk and potential frequency of future large-scale HAB events in the Bay?
3. What are the potential future spatial and temporal dissolved oxygen impacts and toxicity effects from large-scale HAB events?
4. What additional knowledge is required about HAB biology, ecology, and species-specific dynamics to anticipate and mitigate future bloom events?
5. Are the water quality-based effluent limits established in the 2024 Nutrient Watershed Permit protective of beneficial uses?
6. What core nutrient, water quality, and phytoplankton monitoring and assessment activities must be maintained, adjusted, or expanded spatially, temporally, or through the collection of new parameters to address evolving priorities and assess the status and trends of key eutrophication-related indicators?
7. How can the current numerical model be improved to more accurately represent nutrient sources, transport, and transformations, including under current and projected future nutrient loading scenarios?
8. What region-specific or topic-specific modeling developments or applications are needed to address critical nutrient management questions related to HAB risk and low dissolved oxygen?
9. What additional management actions, beyond nutrient reduction, could protect or enhance the resilience of the Bay ecosystem to nutrient-related impairments, including post-bloom control measures, wetland restoration, and salt pond management?

Appendix B: NMS Science Plan 2025-2030, LOW Scenario Summary Table

Note: Totals in this table include FY26 funds as well supplemental funds listed in Table 4 above.

		Lower Funding					
		FY26	FY27	FY28	FY29	FY30	Total
MOD	**MODELING**	**$1,400**	**$1,215**	**$865**	**$650**	TBD	**$4,130**
CMOD	**Core Modeling**	$1,025	$800	$625	$575	TBD	$3,025
EMOD	**Expanded Modeling**	$375	$415	$240	$75	TBD	$1,105
MON	**MONITORING**	**$1,675**	**$1,775**	**$1,850**	**$1,800**	TBD	**$7,100**
CMON	**Core Monitoring**	$1,600	$1,600	$1,700	$1,700	TBD	$6,600
EMON	**Expanded Monitoring**	$75	$175	$150	$100	TBD	$500
	PROJECTS or SPECIAL STUDIES	**$1,030**	**$1,145**	**$970**	**$775**	TBD	**$3,920**
FL	**Field and Lab Studies**	$400	$675	$550	$275	TBD	$1,900
FLOB	**Open-Bay Nutrients, Phyto-Blooms, Low-DO**	$100	$200	$200	$200	TBD	$700
FLHAB	**HABs**	$300	$475	$350	$75	TBD	$1,200
FLLSB	**LSB Nutrients, Phyto-Production, Low-DO**	$0	$0	$0	$0	TBD	$0
AF	**Assessment Framework**	$50	$20	$45	$125	TBD	$240
SYN	**Synthesis**	$580	$450	$375	$375	TBD	$1,780
SYNOB	**Open-Bay Nutrients, Phyto-Blooms, Low-DO**	$220	$125	$50	$50	TBD	$445
SYNHAB	**HABs**	$210	$225	$225	$225	TBD	$885
SYNLSB	**LSB Nutrients, Phyto-Production, Low-DO**	$50	$0	$0	$0	TBD	$50
SYNHLS	**High-Level Synthesis**	$100	$100	$100	$100	TBD	$400
PM	**PROGRAM MANAGEMENT**	**$850**	**$850**	**$850**	**$850**	TBD	**$3,400**
	Annual Total	**$4,955**	**$4,985**	**$4,535**	**$4,075**	**$2,750**	**$21,300**

Appendix C: NMS Science Plan 2025-2030, LOW Scenario Detailed Table

Note: Totals in this table include FY26 funds as well supplemental funds listed in Table 4 above.

		Lower Funding					
		FY26	FY27	FY28	FY29	FY30	Total
MOD	**MODELING**	**$1,400**	**$1,215**	**$865**	**$650**	TBD	**$4,130**
CMOD	**Core Modeling**	$1,025	$800	$625	$575	TBD	$3,025
CMOD.1	Biogeochemical Model Development	$300	$200	$25	$50	TBD	$575
CMOD.2	Predicting the 2022 HAB Event's Progression and Effects	$300	$150	$100	$0	TBD	$550
CMOD.3	Environmental-Change Scenarios: Potential Impacts, Probability	$150	$250	$250	$250	TBD	$900
CMOD.4	Simulate Load Reduction Scenarios & Influence on Water Quality	$0	$50	$100	$100	TBD	$250
CMOD.5	Source Apportionment: Techniques for determining DIN ZOI	$100	$50	$25	$25	TBD	$200
CMOD.6	Nutrient Trading: Develop and Apply Approaches	$0	$0	$50	$100	TBD	$150
CMOD.7	Model Infrastructure	$100	$50	$0	$0	TBD	$150
CMOD.8	Convene NMS Model Advisory Group	$75	$50	$75	$50	TBD	$250
EMOD	**Expanded Modeling**	$375	$415	$240	$75	TBD	$1,105
EMOD.1	LSB model refinements, tracer simulations, and workplan development	$25	$0	$0	$0	TBD	$25
EMOD.2	LSB Simulations: Fluxes; Transformations; System Responses	$25	$75	$75	$75	TBD	$250
EMOD.3	Integrating Delta and Open Bay Models	$175	$175	$0	$0	TBD	$350
EMOD.4	Coastal Modeling	$50	$65	$65	$0	TBD	$180
EMOD.5	Sediment Transport: Estimate Light attenuation	$100	$100	$100	$0	TBD	$300
MON	**MONITORING**	**$1,675**	**$1,775**	**$1,850**	**$1,800**	TBD	**$7,100**
CMON	**Core Monitoring**	$1,600	$1,600	$1,700	$1,700	TBD	$6,600
CMON.1	Ship-based Monitoring	$600	$600	$600	$600	TBD	$2,400
CMON.2	Moored Sensor Monitoring	$700	$700	$800	$800	TBD	$3,000
CMON.3	Biogeochemical Mapping: South Bay + Central-SanPablo-Suisun	$300	$300	$300	$300	TBD	$1,200
EMON	**Expanded Monitoring**	$75	$175	$150	$100	TBD	$500
	PROJECTS or SPECIAL STUDIES	**$1,030**	**$1,145**	**$970**	**$775**	TBD	**$3,920**
FL	**Field and Lab Studies**	$400	$675	$550	$275	TBD	$1,900
FLOB	**Open-Bay Nutrients, Phyto-Blooms, Low-DO**	$100	$200	$200	$200	TBD	$700
FLOB.1	Monitor Changes from POTW Load reductions	$100	$200	$100	$100	TBD	$500
FLOB.2	System-Scale Estimates of N, C, DO fluxes and transformations	$0	$0	$100	$100	TBD	$200
FLHAB	**HABs**	$300	$475	$350	$75	TBD	$1,200
FLHAB.1	Investigate 2022 *Heterosigma* strain: recent arrival in SFB?	$100	$100	$0	$0	TBD	$200
FLHAB.2	Weak Top-down Pressure, Summer 2022 Event: viruses?	$100	$100	$0	$0	TBD	$200
FLHAB.3	HAB Biology: Does 2022 *Heterosigma* strain producte toxins?	$100	$0	$0	$0	TBD	$100
FLHAB.4	Investigate Resistance/Resiliance to future HABs	$0	$75	$75	$0	TBD	$150
FLHAB.5	Investigate Post-bloom Anthropogenic Control	$0	$0	$75	$75	TBD	$150

		Lower Funding					
		FY26	FY27	FY28	FY29	FY30	Total
FLHAB.6	HAB Organisms and Toxins in LSB Managed Ponds	$0	$50	$50	$0	TBD	$100
FLHAB.7	Investigate Additional HAB-Toxins in Mussels	$0	$0	$0	$0	TBD	$0
FLHAB.8	Experimental: Numeric Thresholds, Heterosigma Direct Lethality	$0	$150	$150	$0	TBD	$300
FLLSB	**LSB Nutrients, Phyto-Production, Low-DO**	$0	$0	$0	$0	TBD	$0
FLLSB.1	Lower South Bay nutrients, phyto-production, low-DO	$0	$0	$0	$0	TBD	$0
AF	**Assessment Framework**	$50	$20	$45	$125	TBD	$240
AFHAB.1	Numeric Thresholds for Heterosigma Direct Lethality	$50	$0	$0	$50	TBD	$100
AFHAB.2	Numeric Thresholds for Other HABs or Toxins	$0	$0	$0	$50	TBD	$50
AFHAB.3A	Incorporate Space-Time Considerations Cond. Assessment	$0	$20	$20	$0	TBD	$40
AFHAB.3B	Condition Assessment: Incorporate Space-Time Considerations	$0	$0	$25	$25	TBD	$50
AFLSB.1	LSB DO Assessment Framework	$0	$0	$0	$0	TBD	$0
SYN	**Synthesis**	$580	$450	$375	$375	TBD	$1,780
SYNOB	**Open-Bay Nutrients, Phyto-Blooms, Low-DO**	$220	$125	$50	$50	TBD	$445
SYNOB.1	High-Priority Datasets: Zooplankton and Turbidity	$100	$0	$0	$50	TBD	$150
SYNOB.2	Semi-Empirical Estimates: biogeochem transformation rates	$120	$125	$50	$0	TBD	$295
SYNHAB	**HABs**	$210	$225	$225	$225	TBD	$885
SYNHAB.1	HABs: HABs and Toxins	$110	$150	$150	$150	TBD	$560
SYNHAB.2	Analysis of Long-term Forcing and Condition Data	$100	$75	$75	$75	TBD	$325
SYNLSB	**LSB Nutrients, Phyto-Production, Low-DO**	$50	$0	$0	$0	TBD	$50
SYNLSB.1	Synthesis | PhyO2LSB: Lower South Bay	$50	$0	$0	$0	TBD	$50
SYNHLS	**High-Level Synthesis**	$100	$100	$100	$100	TBD	$400
SYNHLS.1	High-Level Science Communications Products	$100	$100	$100	$100	TBD	$400
PM	**PROGRAM MANAGEMENT**	**$850**	**$850**	**$850**	**$850**	TBD	**$3,400**
	Annual Total	**$4,955**	**$4,985**	**$4,535**	**$4,075**	**$2,750**	**$21,300**

Appendix D: NMS Science Plan 2025-2030, MAX and LOW Scenario Detailed Table

Note: Totals in this table include FY26 funds as well supplemental funds listed in Table 4 above.

		Max Funding						Lower Funding					
		FY26	FY27	FY28	FY29	FY30	5 yr Total	FY26	FY27	FY28	FY29	FY30	Total
MOD	**MODELING**	**$1,600**	**$1,475**	**$1,250**	**$1,075**	**$925**	**$6,325**	**$1,400**	**$1,215**	**$865**	**$650**	TBD	**$4,130**
CMOD	**Core Modeling**	$1,075	$925	$750	$675	$675	$4,100	$1,025	$800	$625	$575	TBD	$3,025
CMOD.1	Biogeochemical Model Development	$300	$200	$100	$50	$0	$650	$300	$200	$25	$50	TBD	$575
CMOD.2	Predicting the 2022 HAB Event's Progression and Effects	$300	$200	$50	$0	$0	$550	$300	$150	$100	$0	TBD	$550
CMOD.3	Environmental-Change Scenarios: Potential Impacts, Probability	$150	$250	$250	$200	$200	$1,050	$150	$250	$250	$250	TBD	$900
CMOD.4	Simulate Load Reduction Scenarios & Influence on Water Quality	$0	$0	$100	$100	$100	$300	$0	$50	$100	$100	TBD	$250
CMOD.5	Source Apportionment: Techniques for determining DIN ZOI	$150	$100	$50	$50	$50	$400	$100	$50	$25	$25	TBD	$200
CMOD.6	Nutrient Trading: Develop and Apply Approaches	$0	$0	$100	$150	$200	$450	$0	$0	$50	$100	TBD	$150
CMOD.7	Model Infrastructure	$100	$100	$25	$50	$50	$325	$100	$50	$0	$0	TBD	$150
CMOD.8	Convene NMS Model Advisory Group	$75	$75	$75	$75	$75	$375	$75	$50	$75	$50	TBD	$250
EMOD	**Expanded Modeling**	$525	$550	$500	$400	$250	$2,225	$375	$415	$240	$75	TBD	$1,105
EMOD.1	LSB model refinements, tracer simulations, and workplan development	$50	$75	$50	$50	$0	$225	$25	$0	$0	$0	TBD	$25
EMOD.2	LSB Simulations: Fluxes; Transformations; System Responses	$75	$75	$100	$100	$50	$400	$25	$75	$75	$75	TBD	$250
EMOD.3	Integrating Delta and Open Bay Models	$100	$100	$50	$50	$0	$300	$175	$175	$0	$0	TBD	$350
EMOD.4	Coastal Modeling	$150	$150	$150	$100	$100	$650	$50	$65	$65	$0	TBD	$180
EMOD.5	Sediment Transport: Estimate Light attenuation	$150	$150	$150	$100	$100	$650	$100	$100	$100	$0	TBD	$300
MON	**MONITORING**	**$2,150**	**$2,150**	**$2,150**	**$2,150**	**$2,150**	**$10,750**	**$1,675**	**$1,775**	**$1,850**	**$1,800**	TBD	**$7,100**
CMON	**Core Monitoring**	$1,400	$1,400	$1,400	$1,400	$1,400	$7,000	$1,600	$1,600	$1,700	$1,700	TBD	$6,600
CMON.1	Ship-based Monitoring	$600	$600	$600	$600	$600	$3,000	$600	$600	$600	$600	TBD	$2,400
CMON.2	Moored Sensor Monitoring	$550	$550	$550	$550	$550	$2,750	$700	$700	$800	$800	TBD	$3,000
CMON.3	Biogeochemical Mapping: South Bay + Central-SanPablo-Suisun	$250	$250	$250	$250	$250	$1,250	$300	$300	$300	$300	TBD	$1,200
EMON	**Expanded Monitoring**	$750	$750	$750	$750	$750	$3,750	$75	$175	$150	$100	TBD	$500
	PROJECTS or SPECIAL STUDIES	**$1,875**	**$2,245**	**$2,470**	**$1,925**	**$1,575**	**$10,090**	**$1,030**	**$1,145**	**$970**	**$775**	TBD	**$3,920**
FL	**Field and Lab Studies**	$575	$900	$975	$700	$350	$3,500	$400	$675	$550	$275	TBD	$1,900
FLOB	**Open-Bay Nutrients, Phyto-Blooms, Low-DO**	$200	$300	$300	$200	$0	$1,000	$100	$200	$200	$200	TBD	$700
FLOB.1	Monitor Changes from POTW Load reductions	$200	$200	$100	$0	$0	$500	$100	$200	$100	$100	TBD	$500

		Max Funding						Lower Funding					
		FY26	FY27	FY28	FY29	FY30	5 yr Total	FY26	FY27	FY28	FY29	FY30	Total
FLOB.2	System-Scale Estimates of N, C, DO fluxes and transformations	$0	$100	$200	$200	$0	$500	$0	$0	$100	$100	TBD	$200
FLHAB	**HABs**	$375	$500	$525	$400	$350	$2,150	$300	$475	$350	$75	TBD	$1,200
FLHAB.1	Investigate 2022 *Heterosigma* strain: recent arrival in SFB?	$100	$100	$50	$0	$0	$250	$100	$100	$0	$0	TBD	$200
FLHAB.2	Weak Top-down Pressure, Summer 2022 Event: viruses?	$100	$100	$50	$0	$0	$250	$100	$100	$0	$0	TBD	$200
FLHAB.3	HAB Biology: Does 2022 *Heterosigma* strain producte toxins?	$75	$50	$100	$100	$150	$475	$100	$0	$0	$0	TBD	$100
FLHAB.4	Investigate Resistance/Resiliance to future HABs	$0	$0	$50	$100	$100	$250	$0	$75	$75	$0	TBD	$150
FLHAB.5	Investigate Post-bloom Anthropogenic Control	$0	$0	$50	$100	$100	$250	$0	$0	$75	$75	TBD	$150
FLHAB.6	HAB Organisms and Toxins in LSB Managed Ponds	$100	$100	$0	$0	$0	$200	$0	$50	$50	$0	TBD	$100
FLHAB.7	Investigate Additional HAB-Toxins in Mussels	$0	$0	$75	$100	$0	$175	$0	$0	$0	$0	TBD	$0
FLHAB.8	Experimental: Numeric Thresholds, Heterosigma Direct Lethality	$0	$150	$150	$0	$0	$300	$0	$150	$150	$0	TBD	$300
FLLSB	**LSB Nutrients, Phyto-Production, Low-DO**	$0	$100	$150	$100	$0	$350	$0	$0	$0	$0	TBD	$0
FLLSB.1	Lower South Bay nutrients, phyto-production, low-DO	$0	$100	$150	$100	$0	$350	$0	$0	$0	$0	TBD	$0
AF	**Assessment Framework**	$100	$145	$145	$125	$75	$590	$50	$20	$45	$125	TBD	$240
AFHAB.1	Numeric Thresholds for Heterosigma Direct Lethality	$50	$50	$0	$0	$0	$100	$50	$0	$0	$50	TBD	$100
AFHAB.2	Numeric Thresholds for Other HABs or Toxins	$0	$25	$75	$75	$75	$250	$0	$0	$0	$50	TBD	$50
AFHAB.3A	Incorporate Space-Time Considerations Cond. Assessment	$0	$20	$20	$0	$0	$40	$0	$20	$20	$0	TBD	$40
AFHAB.3B	Condition Assessment: Incorporate Space-Time Considerations	$0	$50	$50	$50	$0	$150	$0	$0	$25	$25	TBD	$50
AFLSB.1	LSB DO Assessment Framework	$50	$0	$0	$0	$0	$50	$0	$0	$0	$0	TBD	$0
SYN	**Synthesis**	$1,200	$1,200	$1,350	$1,100	$1,150	$6,000	$580	$450	$375	$375	TBD	$1,780
SYNOB	**Open-Bay Nutrients, Phyto-Blooms, Low-DO**	$300	$200	$150	$0	$50	$700	$220	$125	$50	$50	TBD	$445
SYNOB.1	High-Priority Datasets: Zooplankton and Turbidity	$150	$0	$100	$0	$50	$300	$100	$0	$0	$50	TBD	$150
SYNOB.2	Semi-Empirical Estimates: biogeochem transformation rates	$150	$200	$50	$0	$0	$400	$120	$125	$50	$0	TBD	$295
SYNHAB	**HABs**	$250	$250	$350	$350	$350	$1,550	$210	$225	$225	$225	TBD	$885
SYNHAB.1	HABs: HABs and Toxins	$200	$200	$200	$200	$200	$1,000	$110	$150	$150	$150	TBD	$560
SYNHAB.2	Analysis of Long-term Forcing and Condition Data	$50	$50	$150	$150	$150	$550	$100	$75	$75	$75	TBD	$325

		Max Funding							Lower Funding					
		FY26	FY27	FY28	FY29	FY30	5 yr Total		FY26	FY27	FY28	FY29	FY30	Total
SYNLSB	**LSB Nutrients, Phyto-Production, Low-DO**	$50	$100	$100	$50	$50	$350		$50	$0	$0	$0	TBD	$50
SYNLSB.1	Synthesis|PhyO2LSB: Lower South Bay	$50	$100	$100	$50	$50	$350		$50	$0	$0	$0	TBD	$50
SYNHLS	**High-Level Synthesis**	$150	$150	$150	$150	$150	$750		$100	$100	$100	$100	TBD	$400
SYNHLS.1	High-Level Science Communications Products	$150	$150	$150	$150	$150	$750		$100	$100	$100	$100	TBD	$400
PM	**PROGRAM MANAGEMENT**	**$1,030**	**$1,030**	**$1,030**	**$1,030**	**$1,030**	**$5,150**		**$850**	**$850**	**$850**	**$850**	TBD	**$3,400**
	Annual Total	**$6,655**	**$6,900**	**$6,900**	**$6,180**	**$5,680**	**$32,315**		**$4,955**	**$4,985**	**$4,535**	**$4,075**	**$2,750**	**$21,300**