



RMP PCB Workgroup Meeting

June 6, 2023
9:00 AM - 3:30 PM

Hybrid Meeting

Zoom Info

<https://zoom.us/my/sfeiconfcw1>

One tap mobile: +16699006833,,7699356044#

To dial in by phone: 1-669-900-6833

Meeting ID: 769-935-6044

AGENDA

1.	Introductions, Meeting Goals, Agenda Review Major goals for the meeting: <ol style="list-style-type: none"> 1. Discuss management updates for the TMDL and the PMUs 2. Review progress and plans on Steinberger Slough/Redwood Creek studies 3. Review progress and plans for San Leandro Bay studies 4. Review progress and plans for in-Bay model development 5. Review and prioritize proposed studies for 2024 6. Update the PCBWG multi-year plan Materials: None	9:00 Jay Davis
2.	Information: RMP/PCBWG Planning Overview An overview of the RMP and PCBWG planning process will be provided. Updates on management will be discussed, particularly information needs related to the PCBs TMDL. Materials: none Desired Outcome: Group understanding of the RMP/PCBWG planning process, management drivers, and existing plans for PCB studies.	9:15 Jay Davis
3.	Information: The Puget Sound Institute's Cross Program Contaminant Working Group This group was established to coordinate nationally on contaminant science and management, with a focus on PCBs. Their next (second) symposium is happening on June 15, focused on PCB source tracking. Materials: <ul style="list-style-type: none"> • Working Group website Desired Outcome: Informed Workgroup.	9:45 Andy James

4.	Information: Regulatory and Management Update on Steinberger Slough/Redwood Creek Opportunity for Workgroup members to share any information on the latest status of regulation and management actions in the SS/RC watershed. Materials: none Desired Outcome: Informed Workgroup.	10:00 Group
5.	Discussion: Steinberger Slough/Redwood Creek Passive Sampler Study (2020) An initial discussion of this study occurred at the 2022 PCBWG meeting. Subsequently Frank Gobas provided substantive comments and discussed them with the authors. The final report and a manuscript will be revised in response to the comments. Materials: Written comments from Frank Gobas (pages 4-7) Desired Outcome: Obtain Workgroup input on the study and plan for completion.	10:15 Diana Lin Yeo-Myoung Cho
6.	Information: Progress on Steinberger Slough/Redwood Creek Sediment and Prey Fish Study (2022, 2023) Year two of this two-year study (analysis of sediment and prey fish samples) was funded for 2023. A refresher on the scope and an update on progress will be provided. Materials: Powerpoint presented at the meeting Desired Outcome: Informed Workgroup.	10:35 Jay Davis
	Break	10:45
7.	Information: Regulatory and Management Update on San Leandro Bay Opportunity for Workgroup members to share any information on the latest status of regulation and management actions in the San Leandro Bay watershed. Materials: none Desired Outcome: Informed Workgroup.	10:55 Group
8.	Information: Update on PMU Stormwater Sampling (2019 SEP, 2022 Augment) Sampling PCBs in stormwater in PMU watersheds was funded with SEP funds in 2019. Additional funding for sampling stormwater in San Leandro Bay was approved by the Steering Committee in 2022. An update on the status of this work will be provided. Materials: Powerpoint presented at the meeting Desired Outcome: Informed Workgroup.	11:10 Alicia Gilbreath
9.	Discussion: Update on San Leandro Bay Passive Sampler Study (2021) A passive sampler study in San Leandro Bay was funded for 2021. A draft report is nearing completion. Preliminary results will be presented. Materials: Powerpoint presentation (pages 8-29) Desired Outcome: Discussion of preliminary results.	11:20 Yeo-Myoung Cho Diana Lin
	LUNCH	12:00
10.	Discussion: Bay Food Web Modeling The multi-year workplan for In-Bay Modeling includes a task, funded as part of the Destination Clean Bay WQIF project, to develop an updated PCB food	12:45

	<p>web model for the Bay. The work will be done by Frank Gobas and will begin this year.</p> <p>Materials: none</p> <p>Desired Outcome: Obtain Workgroup input on the proposed workplan.</p>	
11.	<p>Discussion: In-Bay Contaminant and Sediment Fate Modeling</p> <p>A multi-year workplan for In-Bay Modeling was initiated by the RMP and will be primarily funded by the Destination Clean Bay WQIF project. Progress to date and future plans will be presented and discussed.</p> <p>Materials: Powerpoint presentation (pages 30-61)</p> <p>Desired Outcome: Obtain Workgroup input on progress to date and the proposed workplan.</p>	<p>1:00</p> <p>Jay Davis Craig Jones</p>
12.	<p>Information: Integrated Watershed-Bay Modeling Strategy</p> <p>A brief update on this separate RMP SEP-funded project.</p> <p>Materials: Powerpoint presentation (pages 62-75)</p> <p>Desired Outcome: Informed Workgroup.</p>	<p>2:00</p> <p>Allie King</p>
13.	<p>Decision: PCBWG Proposals for 2024</p> <p>Two proposals for PCB work in 2024 will be discussed and prioritized. A third proposal will be briefly presented for information.</p> <ol style="list-style-type: none"> 1. PMU Shiner Surfperch Trend Monitoring 2. SLB Sediment Deposition 3. PCB Sniffing Dog (Information) <p>Materials: Proposal writeups (pages 76-91) (dog proposal not included)</p> <p>Desired Outcome: Workgroup recommendation on the proposed studies.</p>	<p>2:15</p> <p>Jay Davis Don Yee Alicia Gilbreath</p>
14.	<p>Discussion: Update of the PCBWG Multi-Year Plan</p> <p>The multi-year plan for RMP PCB studies will be updated based on the day's discussion.</p> <p>Materials: Draft multi-year plan presented at meeting</p> <p>Desired Outcome: Workgroup consensus on a revised multi-year plan.</p>	<p>3:10</p> <p>Jay Davis</p>
15.	<p>Review Next Steps and Action Items and Adjourn</p>	<p>3:30</p> <p>Jay and Group</p>

Comments on:

Study of Historic Loading and Spatial Distribution of Polychlorinated Biphenyls (PCBs) using Passive Sampling Devices (PSDs) in the Steinberger Slough and Redwood Creek Complex in San Francisco Bay, California, USA

This report by Cho et al. is a thorough and well-carried out study of the fate of PCBs in the Steinberger Slough and Redwood Creek Complex in San Francisco Bay. This work features the application of a passive sampling approach, which is relatively new to the SFEI monitoring effort and can be an asset in developing a better picture of the contribution of point source loadings of PCBs to the overall loading of PCBs to the food-web of the Bay as well as monitoring the success of remediation effort at the PMU in reducing PCB loadings to the Bay.

Some suggestions for the report and future studies at PMUs.

1. Executive summary: I suggest adding further context in the form of the larger management objectives that this study feeds into. In particular, the goal of assessing the contribution of PCB load from the PMU to the larger Bay and the application of passive samplers to monitor temporal changes of remediation efforts and to be an indicator of the success of remediation efforts.
2. The reported lack of adequate depletion of all the performance reference chemicals except PCB29 in the samplers is a significant issue limiting the usefulness of the passive samplers. In our work of passive water sampling for PCBs in the water column of the Salish Sea with low-density polyethylene (LDPE) sheets (20 cm x 20 cm x 51 um, i.e. of the same thickness as used in this study) inside metal cages for periods of 21-42 days, we saw adequate depletion of nearly all PCB congeners from the samplers to determine equilibration times. We did use deuterated PCB congeners as the reference chemicals.
3. The use of non-deuterated PCBs as reference chemicals may cause a reduced net elimination of PCB congeners from the samplers as PCBs from the PMU may be taken up by the samplers as the same reference PCBs deplete. I suggest considering deuterated or otherwise labeled PCBs as the reference chemicals or perhaps use reference chemicals other than PCBs but within the PCB's Kow range. On this topic, what were the concentrations of PRCs (perhaps add to p.13, l.15)? Also, p.14, l. 11 states that field blanks were used to determine the initial PRC concentrations. How was this done? Could PRC concentrations have been too low for net diffusion out of the samplers?
4. I am not sure that lengthening the exposure times from 1 to 2 months will make a significant improvement given that depletion of all but one PCB congener was <10% over 1 month.
5. Another reason for the low depletion rates of the performance reference chemicals may be the limited circulation of pore water in the sediment exposed part of the passive samplers.

Were there any differences in PRC depletion rates between the sediment and water exposed parts of the sampler?

6. The ex-situ PE uptake study is a very nice addition to the field study. Were PRCs added to the sheets? I do not think they were judging from the text. Were the depletion times of PRCs different from those in the in-situ study?

7. Perhaps, it may be better to do an ex-situ depuration study instead of an ex-situ uptake study as depuration rates are more useful than uptake rates for determining equilibrium conditions.

8. I am still unclear on how C_{free} was calculated (p 21, l.6). It looks like there was only a noticeable depletion of the PRC PCB29. How much was this depletion? Equation 3 on p. 20 was then used to estimate $k_{e,i}$ for all the other congeners, which in turn was used in equation 1 on p. 20 to estimate C_{free} . Were errors in CPE and KPE considered in the calculation of the error bars? For how many PCB congeners was this done? How was the sum-PCB concentration determined?

9. The finding of a major historic PCB contamination in site 1 is quite interesting and shows the passive sampling is useful. I agree that the deposition rate of 0.2 cm/year is likely an underestimate of the true deposition rate at this site. This rate is low for an estuarine site like this. The much lower C_{free} in surficial sediments at site 1 suggests that the highly contaminated historic sediments have little effect on current loadings of site 1 to SFB. Perhaps emphasize this.

10. Figure 15 is puzzling. I am not sure that I accept the explanation for the difference in profiles between PE uptake and C_{free} in the 3rd paragraph on p. 21. I do not think that the overestimation of the deeper PCB concentration is the reason for the difference in profile. In general, the correlation of the surficial PE uptake and C_{free} observations is reversed. This cannot be explained by the overestimate of the one concentration of PCB at the deepest sediment layer. Perhaps the unavoidable error of the extrapolation of equilibration times derived from PCB29 to higher chlorinated PCBs is playing a role here in Figure 15 and some similar figures (e.g. figure 17).

11. p. 21. L.38-42. The effect of differences in PCB congener profiles between samples may be an important factor controlling variability among samples and cause the “noisy profile”. To investigate this, it might be worthwhile to conduct a sensitivity analysis on the effect of congener composition differences among samples and C_{free} . Assuming I understand the C_{free} calculation correctly, it involves quite a large extrapolation from PCB29 to much more chlorinated PCB congeners. The associated error may be large.

12. p.43, l.1-2. I suggest to move-up the method of how the PCB concentrations were determined. Move it to the methods section. This information is important for the interpretation of the earlier results. It is unclear why there is such a big difference in the number of PCB congeners included in the PE and sediment analysis. Is the difference in

congener/homolog composition of the sediment versus the in-situ and ex-situ uptake a factor in the substantial differences in PCB composition.

Lessons Learned:

13. Given the lack of adequate depletion of the PRCs, it is remarkable how much was learned from the deployment of the samplers. However, to take full advantage of the samplers and to reduce error resulting from the extrapolation of depletion times from PCB29 to other PCBs, it is crucial that this problem is addressed. Extending the exposure time from 29 days to 1.5 to 2 months will help, but only marginally. I suggest (i) the use of labeled PCB congeners to increase the diffusion gradient; (ii) repositioning the sheets for better contact at both sites instead of one side of the samplers; (iii) deploying sediment and water-column samplers separately to optimize water circulation, (iv) conduct lab depuration experiments for the PRCs in the PE sheets in a flow through or continuous flow system to investigate the PRC depletion rates perhaps as a function of flow rates.

14. I agree with the authors that without reliable equilibration times, it will be difficult to use the results from the passive samplers for food-web modeling/analysis. However, measurements of C_{free} are crucial to the bioaccumulation modeling and passive samplers are the best tool that we have right now to gain knowledge of C_{free} . My suggestion is to fine-tune the existing method with a focus on (i) a better characterization of the PCB congener equilibration times and (ii) expanding the number of PCB congeners that are analyzed such that the number of congeners included in the sum-PCB measurements for the PE sampler are similar or close to the number of congeners included in the sum-PCB measurements for the sediment and biota samples.

15. The combination of in-situ and ex-situ experiments is excellent work. However, more information may be gained from this work. The description of the ex-situ experiments in the report can be expanded. Only on p.47, l.37 it is stated that ex-situ was “thermodynamically controlled”. Does that mean that equilibrium was reached? If so, it would be useful to report the equilibration times and to take advantage of the PE-Water partition coefficients in the derivation of C_{free} . Maybe this can still be done.

16. One area that can be expanded in the report is how the results of the passive samplers can be used to derive the contribution of PCB loadings from the PMU to the PCB levels in the Bay. In addition to applying hydrodynamic calculation of “flow” rates, it maybe useful to make measurements of C_{free} in the larger SFB. A simple comparison of C_{free} at the PMU and that in the “rest of the SFB” can be used to determine if the PMU is a source of PCBs to the Bay.

Conclusion:

The study was a success! Nice work on all levels, i.e. field and lab. In my view the main take-away message is that the passive sampling approach is both feasible and useful, but needs

further refinement. Also, some more thinking needs to go into how the results of passive sampling are to be used to address the management goals.

DRAFT

Monitoring the Impact of Remediation Actions on San Leandro Bay Recovery from PCB Contamination

YeoMyoung Cho, Diana Lin, Don Yee, Jay Davis, Dick Luthy



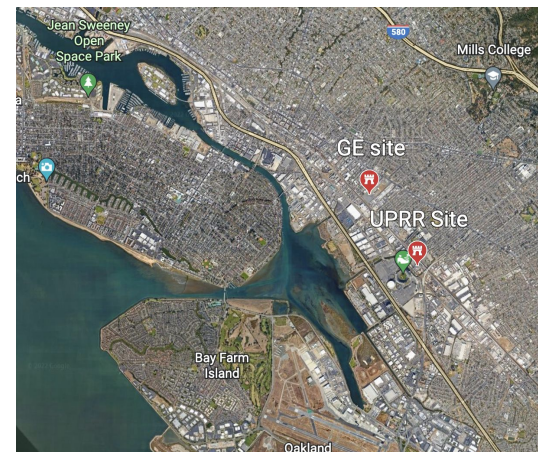
RMP
REGIONAL MONITORING
PROGRAM FOR WATER QUALITY
IN SAN FRANCISCO BAY

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Study Objective

Establish a baseline for monitoring the in-Bay response to expected PCB loading reductions from recent and pending cleanup actions at the GE and UPRR sites in San Leandro Bay



Study Design



- Downstream sampling from GE and UPRR
 - GE: Sites 1 (Line H), 9 (Line I), 2, and 3
 - UPRR: Sites 4, 5, and 6
- Mid-bay (SLB, Site 7) and background (G4g, Site 8) sampling
- Pro bono work in 2016 at SLBsub1 (Site 6), ECM20m (Site 3), and G4g (Site 8)

Study Design

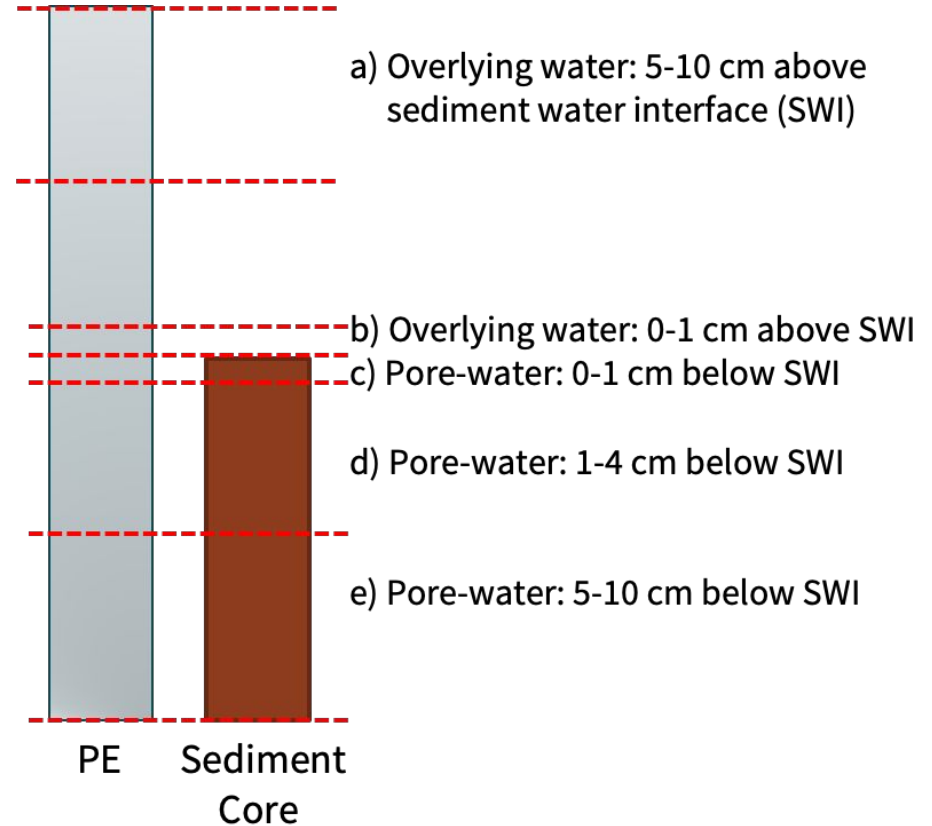
- Sediment trap and PSD (duplicates at each site)
- 2-month exposure, wet season sampling
- Captured Dec 21 & Jan 22 rain events (e.g. 12/23/21, 2 inches)
- Sites 4, 5, 9 samplers were tilted and buried by sediment influx : wet-season sampling risk

	Date	Sites
Deployment	12/14/21	1, 2, 3, 7, 9
	12/15/21	4, 5, 6, 8
Retrieval	2/10/22	all sites



Sample Analysis

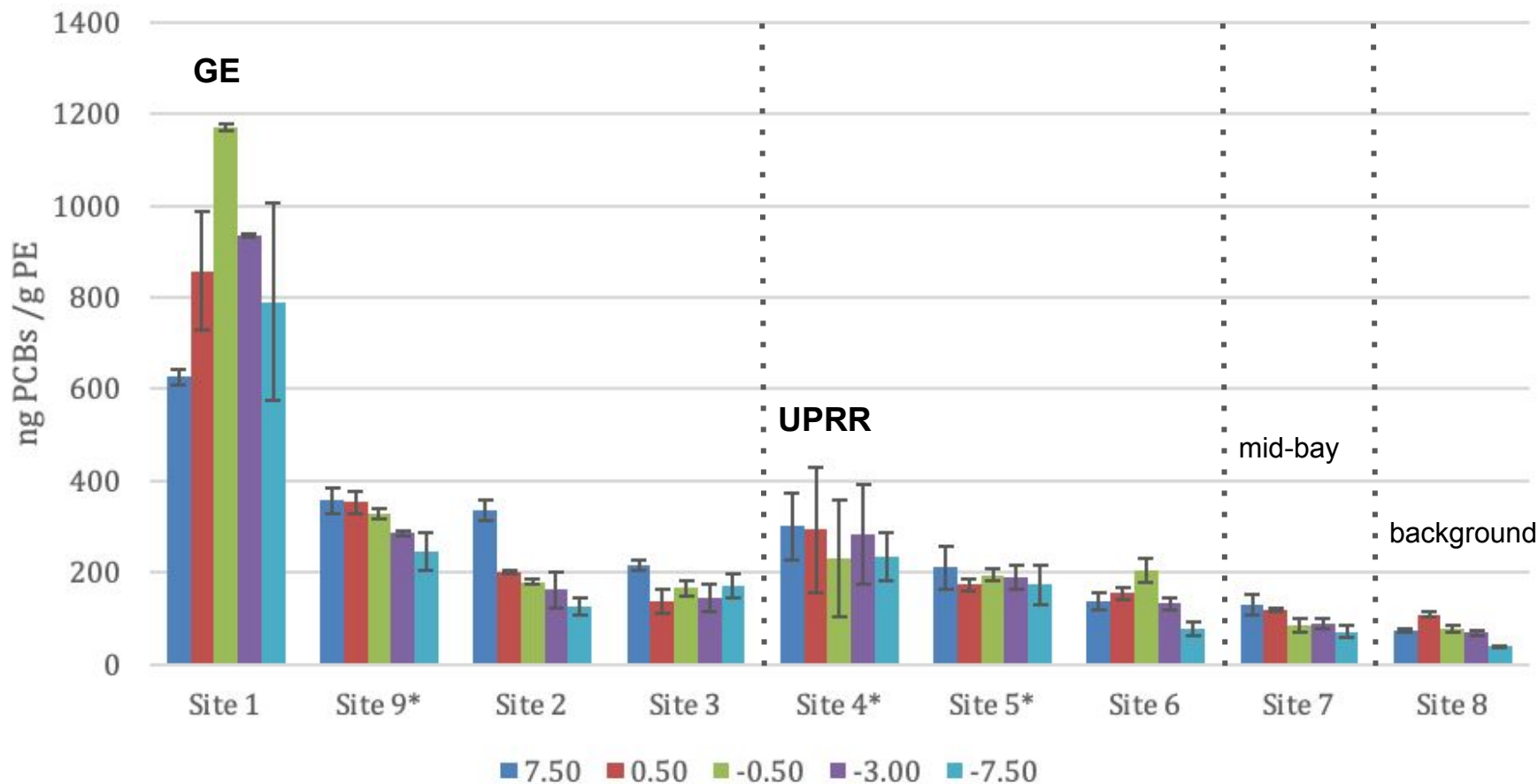
- PE analysis
 - 9 sites x 5 slices x duplicates
- Sediment Trap Samples analyzed for PCB, TOC, and grain size analysis
- PCB reported as RMP 40



Results

(a) PE Uptake, Winter 2021/22

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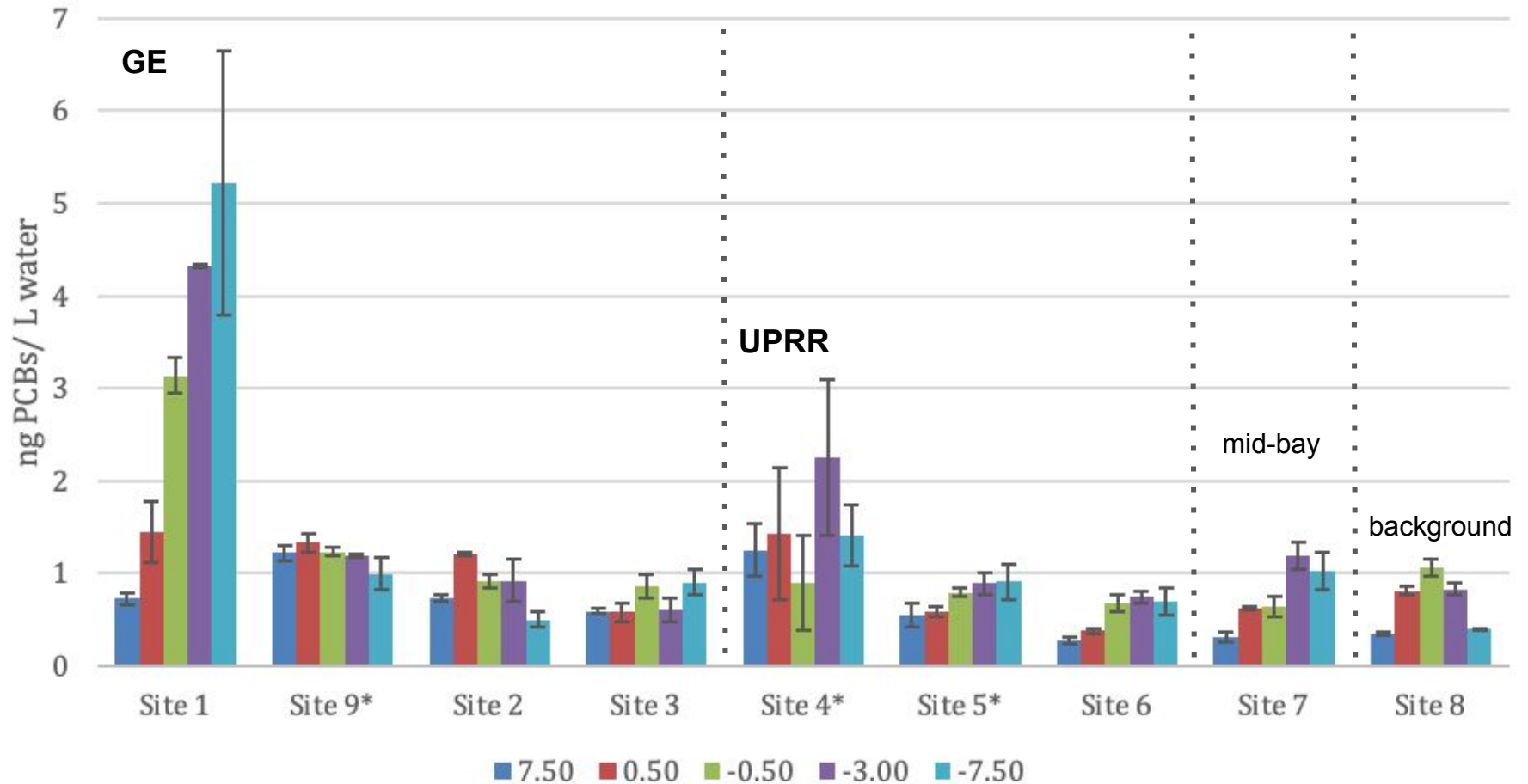
PE Uptake to C_{free} Calculation

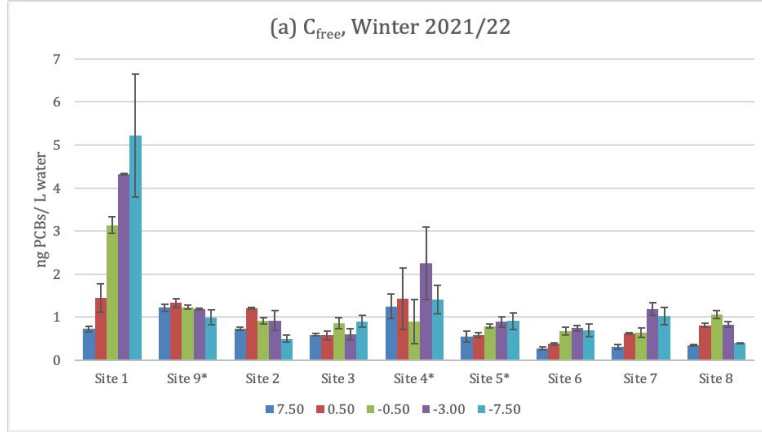
Reduced uncertainty in the calculation by

- Replicates
- Longer sampling period (1 mo \rightarrow 2 mo)
- Shallow depth (-10 cm) assessment

SLB 2016 study without an insufficient PRC depletion issue with 1 month deployment

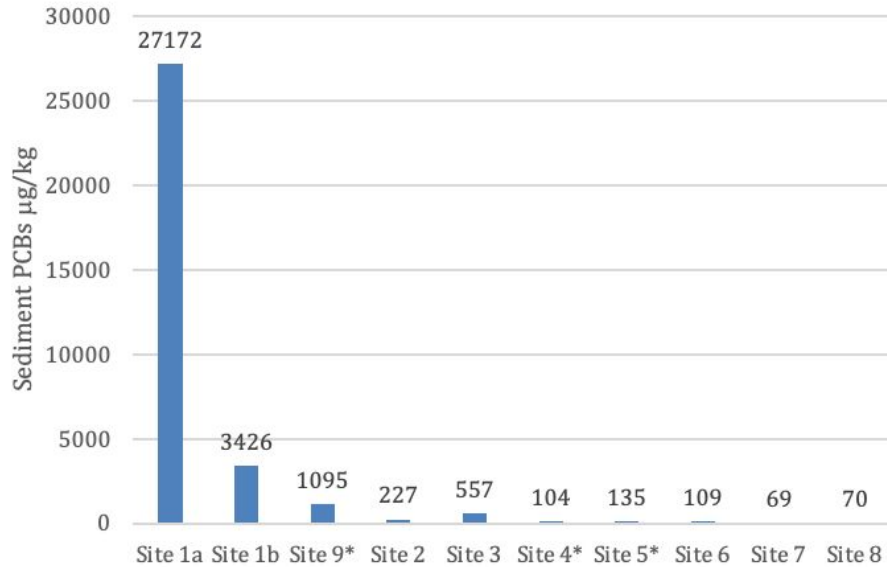
(a) C_{free} , Winter 2021/22





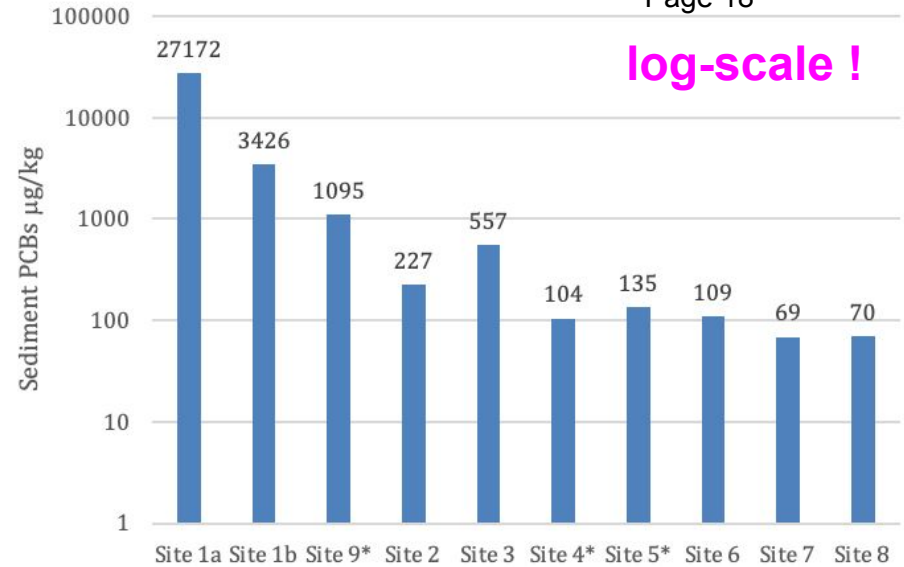
- Elevated PCB concentrations near the two sources (GE and UPRR)
- Concentration gradients in downstream samples
- Downstream of GE site showed higher C_{free} s/PE uptakes than downstream of UPRR site
- Decreasing concentration with depth: Sites 2 and 8

Sediment Trap, Winter 2021/22



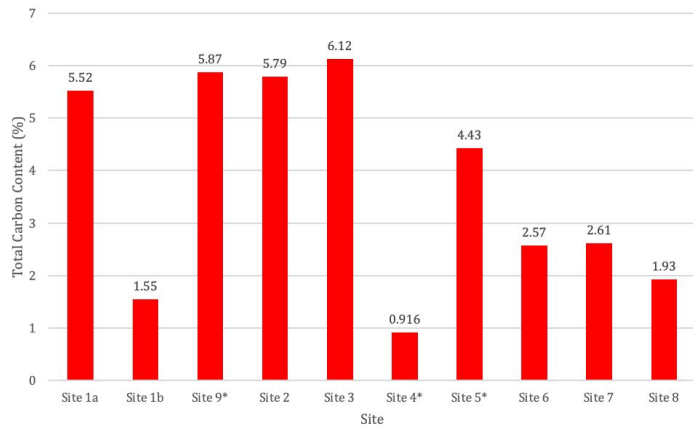
Sediment Trap, Winter 2021/22

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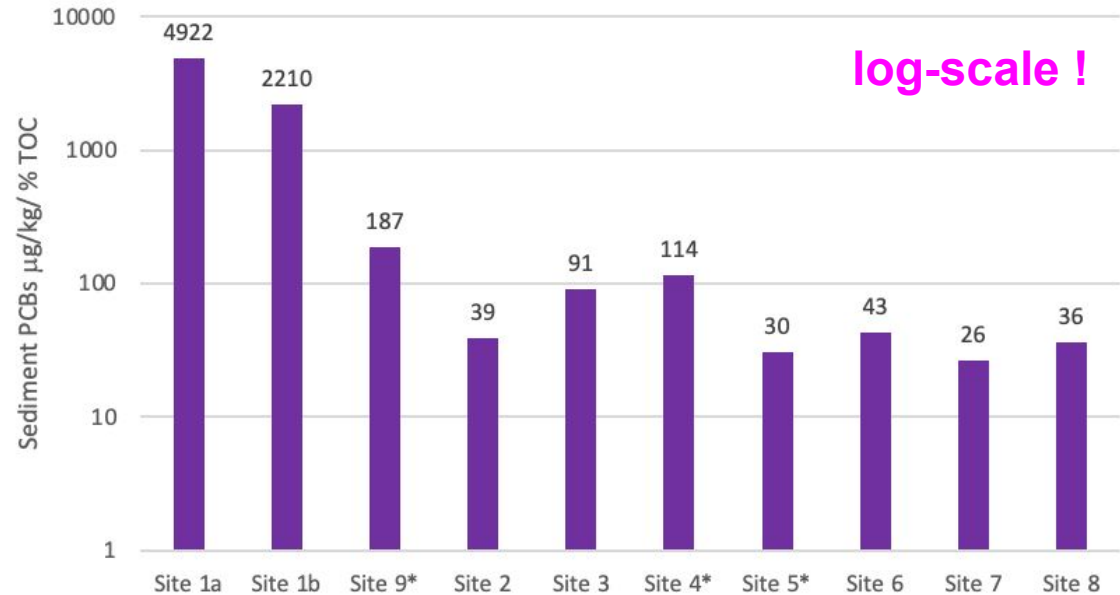
- **Very high** concentration observed near GE site (1-27 ppm)
- **Much higher** spatial variance than PE uptake or C_{free}
- re-confirmed heavier contamination in GE downstream than in UPRR downstream

Total Organic Carbon Content



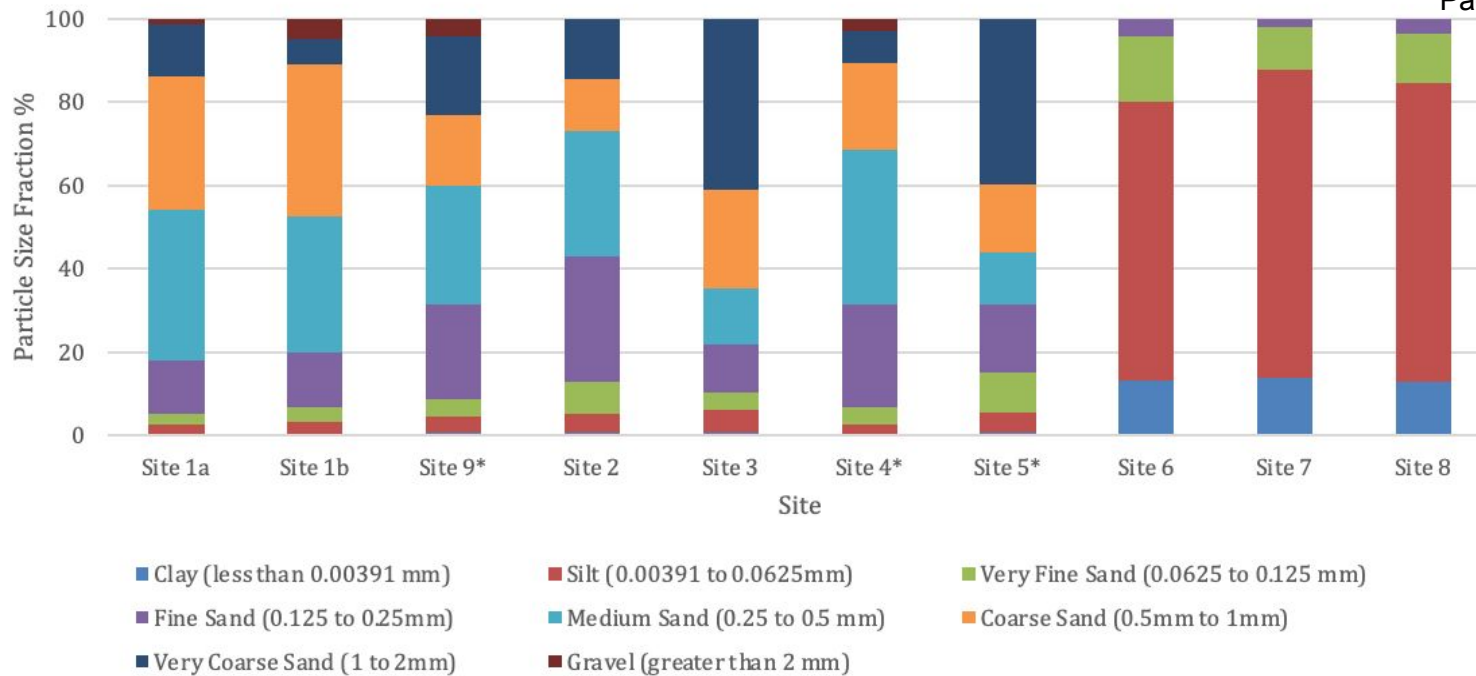
- Variability in TOC

TOC normalized Sediment Trap PCB



Particle Size Distribution

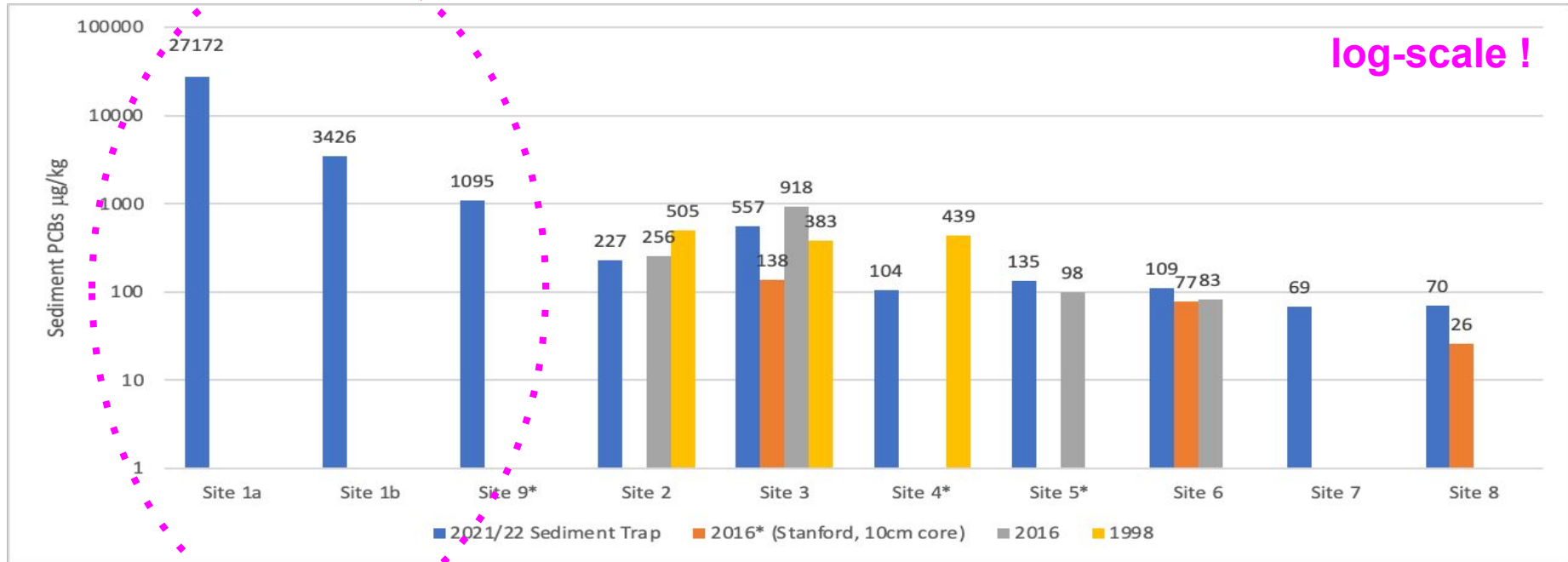
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- Downstream samples were very sandy, while bay samples (including Site 6) were very silty
- No correlation with PCB levels

Further Discussion

Sed Trap PCB vs Existing Sed Data

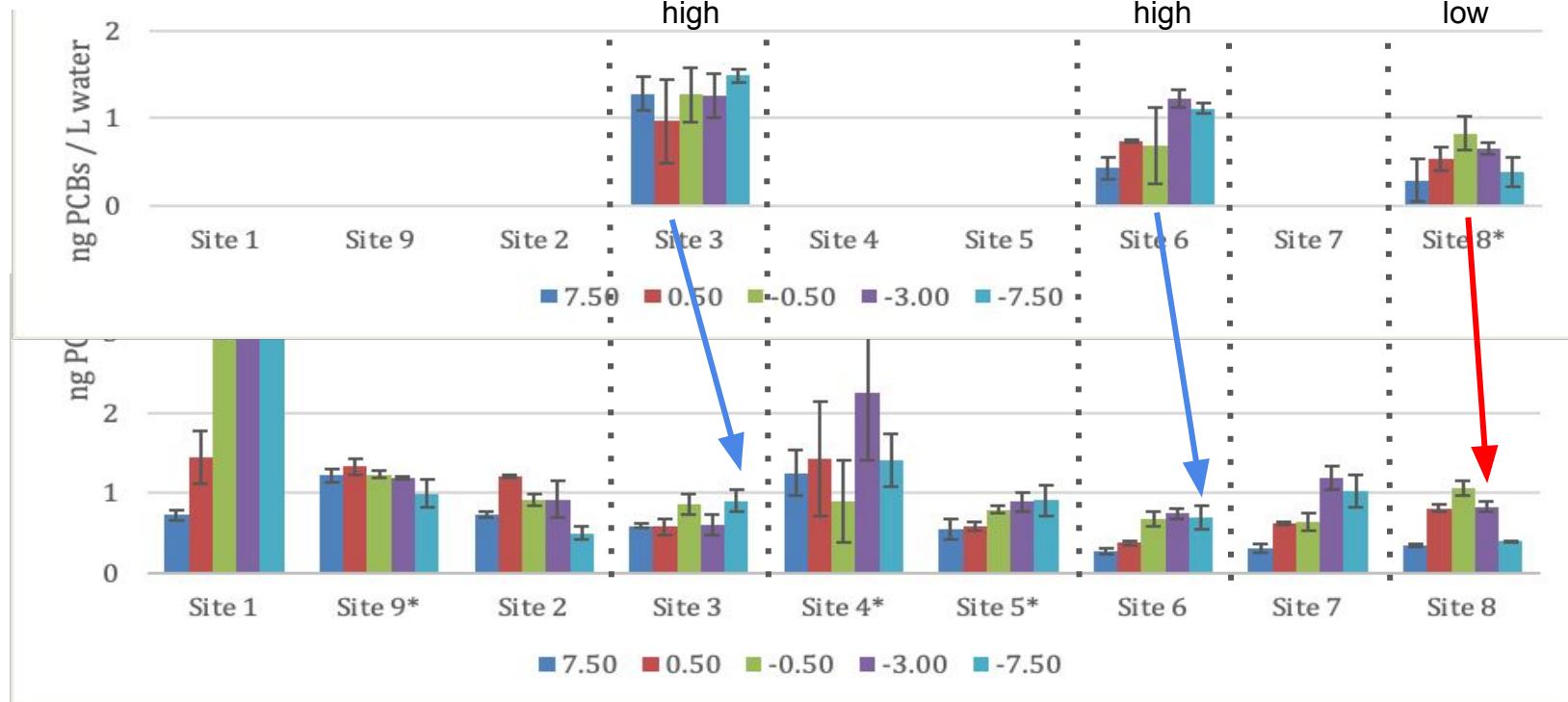


- On-going PCB loading from GE site
- Immediate response after potential remedial action can be captured by Sed Trap Samples near the source

C_{free} 2016 vs 2021/22

deposition rate

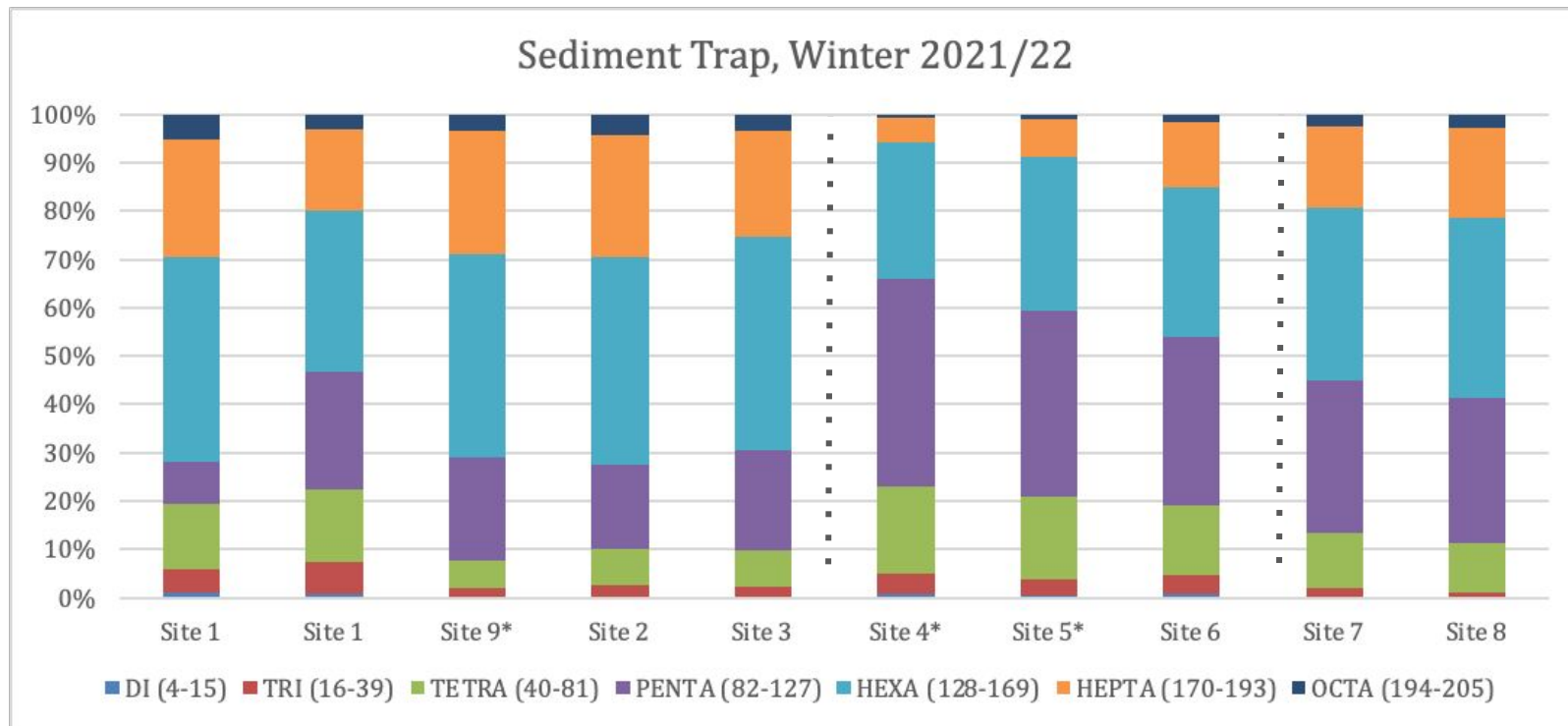
Page 23
high
low



- Similar depth profile implies similar loading pattern
- Sites 3 and 6: reduced PCB loading with high deposition rate
- Site 8: ongoing PCB loading with low deposition rate

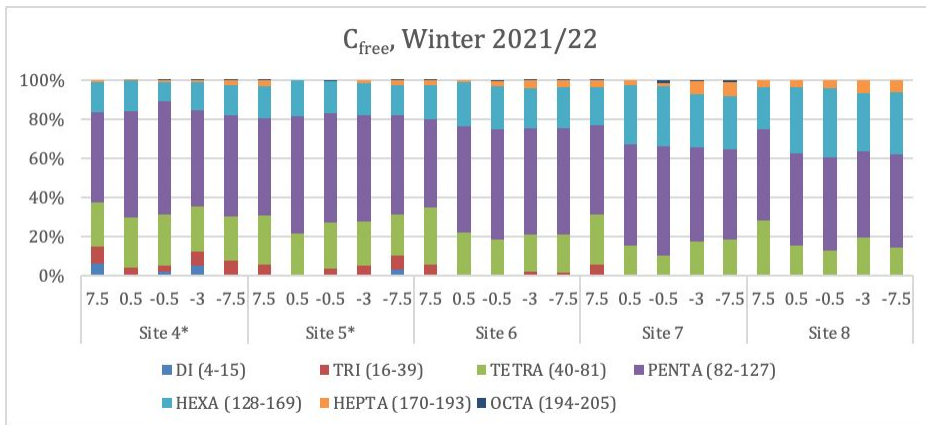
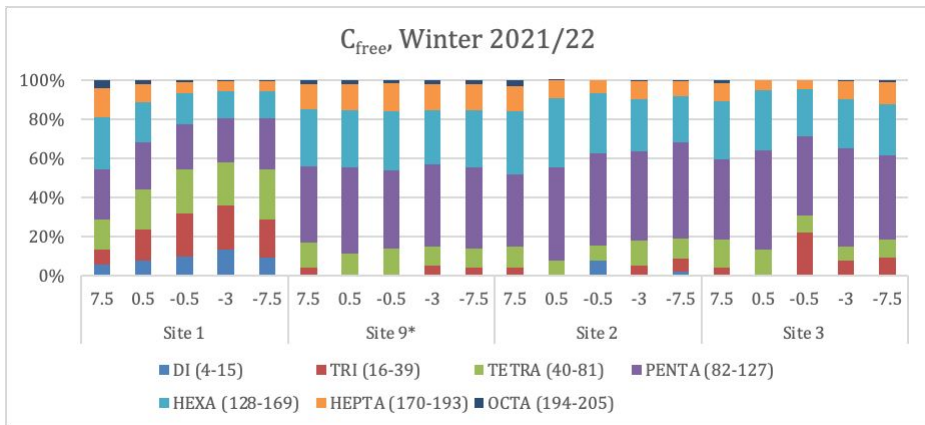
- Continuation of reduced loading (site recovery) can be tracked by PSD depth profiling over time
- Monitoring frequency will depend on deposition rate and resolution in depth profiles
- Uncertainties in
 - Site heterogeneity
 - C_{free} calculation

Congener Analysis



- downstream of GE site: hexa-CB dominant, Aroclor 1260 like
- downstream of UPRR site: penta-CB dominant, Aroclor 1254 like

Congener Analysis (cont.)

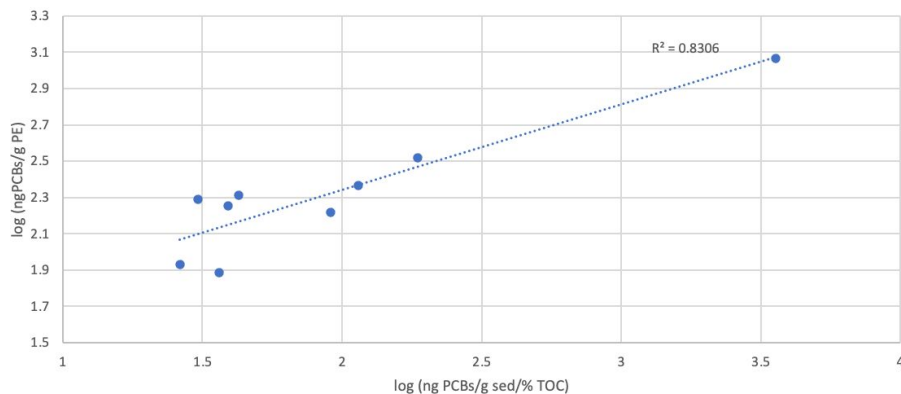


- C_{free} congener profiles also show the difference between GE and UPRR sites
- GE downstream samples generally contain more highly chlorinated CBs (hexa, hepta, octa-CBs) than UPRR samples
- Increased portions of di- and tri-CBs were also observed in Site 1

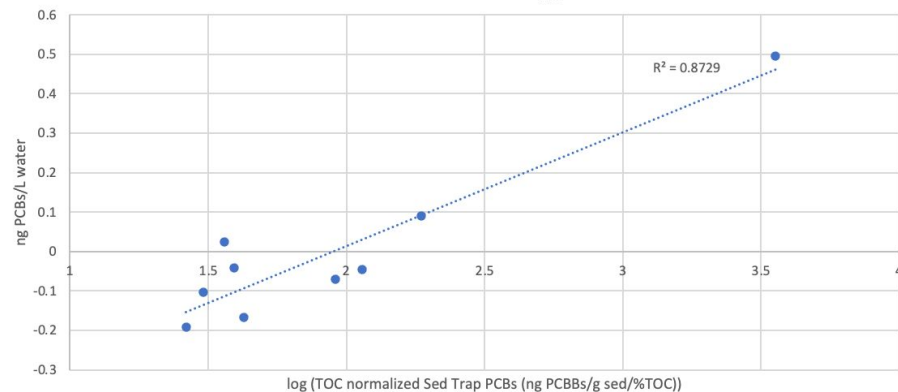
Correlation between Sediment Trap and PSD data

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TOC normalized Sed Trap PCB vs PE Uptake (0-1cm below)



TOC normalized Sed Trap PCB vs C_{free} (0-1 cm below)



- **Logarithmic** correlation between TOC normalized C_{ss} and both C_{free} and C_{PE}
- Correlations were strong near the sediment-water interface

Lessons Learned

- Successful PSD sampling with increased confidence in C_{free} assessment
- Risk in wet-season sampling
- Significant ongoing PCB loading from GE site
- Immediate effect after potential remedial action can be captured by short term sediment trap sampling near the source during wet season, and site recovery can be confirmed by long-term site-wide PSD depth profiling during dry season
- Comparison with 2016 data **may** indicate site recovery is underway
- Logarithmic correlation between near surface PSD signals and sediment trap data

THANK YOU!





11. Discussion: In-Bay Fate Modeling to Support Contaminant and Sediment Management in San Francisco Bay (60 minutes)

Desired Outcome: Obtain Workgroup input on progress to date and the proposed multi-year workplan.

- Draft strategy discussed at April 2022 PCBWG meeting, finalized in August 2022
- General foundation for beginning a multi-year, adaptive workplan
- Addresses management questions for:
 - PCBs
 - Sediment
 - CECs
 - ECWG
 - RMP Status & Trends
- Building on and coordinated with extensive nutrient modeling



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IN SAN FRANCISCO BAY

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Strategy for In-Bay Fate Modeling to Support Contaminant and Sediment Management in San Francisco Bay

Prepared by:

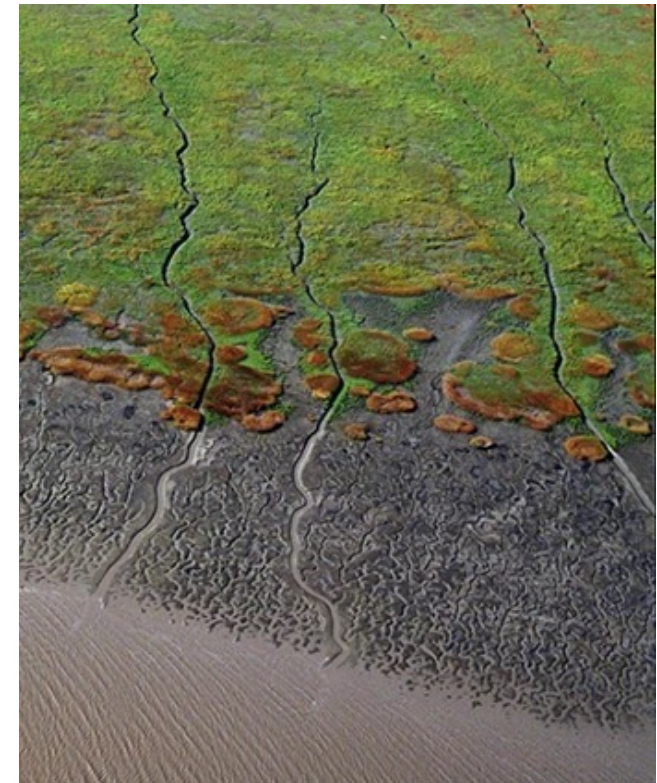
Craig Jones
Integral Consulting

Don Yee and Jay Davis
San Francisco Estuary Institute

CONTRIBUTION #1090 / AUGUST 2022

In-Bay Modeling Connects Multiple Projects and Funding Sources

- RMP
 - Special Study 2022: \$75K
 - **RMP** part of USEPA WQIF: **\$960K**
- RMP/NMS
 - SEP Sediment Transport and Fate Modeling: \$408K
- NMS
 - Additional funds from NMS and WQIF related to light attenuation modeling
- Substantial funding has already been committed
- Primary focus is PCBs and nutrients, but intent is to also address ECWG and SedWG questions



Gies (2018)

The Modeling Team

- Craig Jones (Integral)
- Sam McWilliams (Integral)
- Allie King (SFEI)
- Don Yee (SFEI)
- Frank Gobas (Simon Fraser University)
- David Senn (SFEI)
- Jay Davis (SFEI)
- Others TBD



Priority Management Questions: PCB Workgroup

1. What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination?
 - a. What would be the impact of focused management of priority margin unit (PMU) watersheds?
 - b. What would be the impact of management of in-Bay contaminated sites (e.g., removing and/or capping hotspots), both within the sites and at a regional scale?

Priority Management Questions: Emerging Contaminant Workgroup

1. Which CECs have the potential to adversely impact beneficial uses in the Bay?
2. What are the sources, pathways, and loadings leading to the presence of individual CECs or groups of CECs in the Bay?
3. What are the physical, chemical, and biological processes that may affect the transport and fate of individual CECs or groups of CECs in the Bay?
4. Have the concentrations of individual CECs or groups of CECs increased or decreased
5. Are the concentrations of individual CECs or groups of CECs predicted to increase or decrease in the future?
6. What are the effects of management actions?

Priority Management Questions: Emerging Contaminants

- What is the predicted spatial and temporal extent of potential impact of CECs?
- What are areas of management interest where CECs should be monitored to assess S&T in water and sediment?

Priority Management Questions: Sediment

3. What are the sources, sinks, pathways and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?
4. How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be affected by management actions?
5. What are the concentrations of suspended sediment in the Estuary and its segments?

Phase	Goals	Duration
Phase 1—Site Model for San Leandro Bay and Whole-Bay Dilution Model	Use existing NMS model to address specific PCB loading and sediment recovery questions in SLB. Investigate transport and dilution patterns of dissolved phase CECs from various sources of interest at the whole-Bay scale.	1 year starting in Q1 of 2023
Phase 2—Site Model for Steinberger Slough/Redwood Creek (SS/RC)	Use existing NMS model to address specific PCB loading and sediment recovery questions in SS/RC.	1 year starting in Q3 of 2023
Phase 3—Whole-Bay Model Development	Develop and validate a whole-Bay sediment and contaminant fate model for use in addressing management questions.	2 years starting in Q2 of 2023
Phase 4—Bioaccumulation Model Development	Develop and validate a bioaccumulation model suitable for application with the PMU models.	2 years starting in Q3 of 2023
Phase 5—Model Maintenance and Future Applications	Investigate long-term scenarios, maintain the model, and provide model applications to other management challenges in the Bay.	Ongoing

Challenges

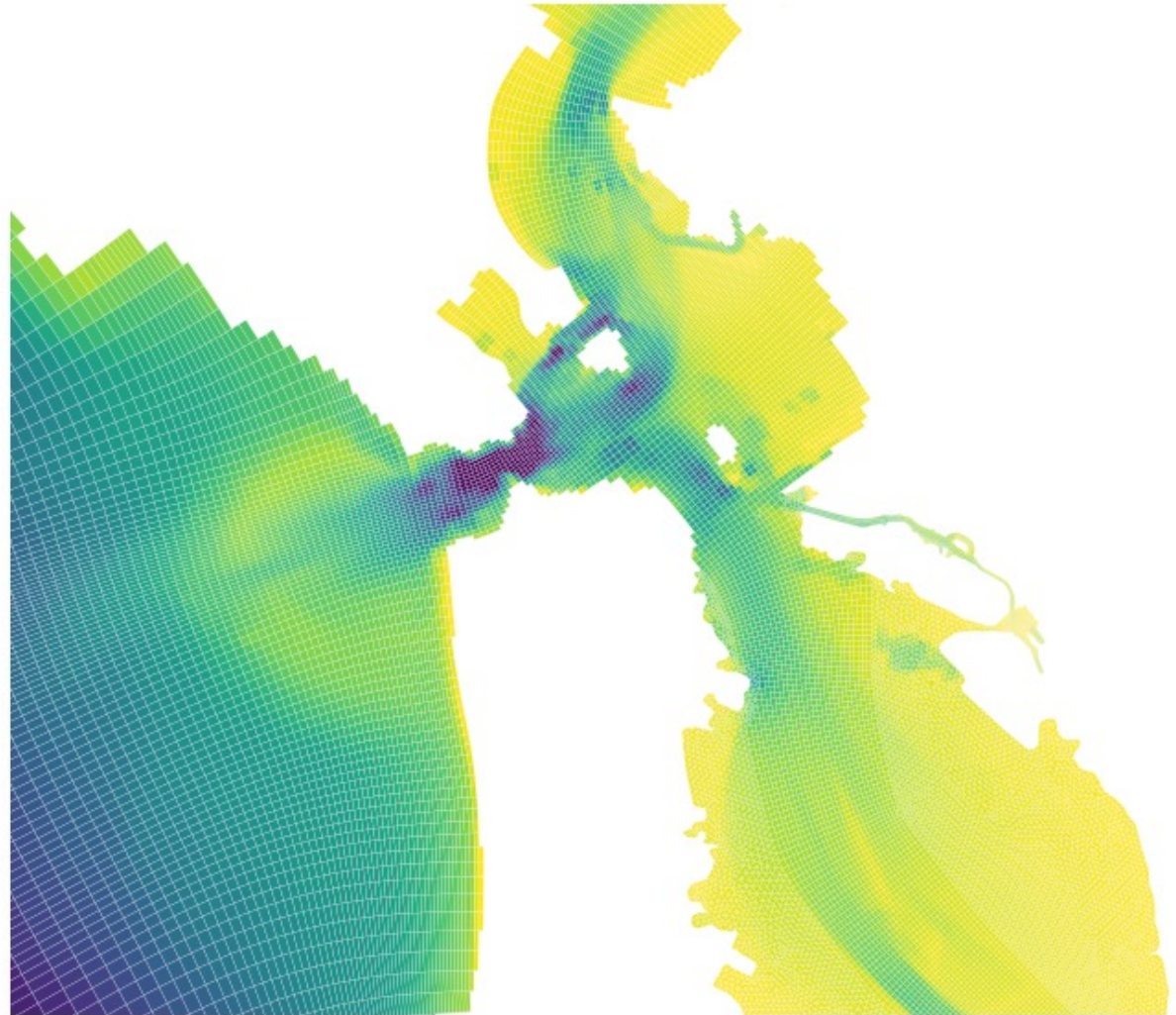
- No one model scale, setup, calibration will address all questions
- Each question requires specific metrics to address, which in turn requires specific data for calibration and validation
- Various workgroup needs will have model convergence and divergence points within the same modeling framework



Builds on a Lot of Previous Work

- Monitoring
- PCB modeling
- Nutrient modeling

3D model reproduces water levels, velocities, and salinities well throughout the Bay



Longer-term Timeline

- June PCBWG – Outline of conceptual site model, data gaps, and selected modeling approach; refine timeline
- October 2023 - Model documentation (part 1): compilation of existing information on (a) sediment loadings and boundary conditions and (b) sediment properties and parameters
- November 2023 – Outline of hydrodynamic, sediment transport, and sediment bed model development, validation, and results
- May 2024 – Draft report addressing the PCB management questions for San Leandro Bay and illustrating how the approach can be broadly applied
- After that – Whole Bay model, Steinberger Slough model, food web model



Current Status and Immediate Next Steps

- Model development has begun
- Initial focus on San Leandro Bay
- Grid development
- Bathymetry, physical structures
- Apply tidal boundary conditions
- Incorporate watershed loadings



General Workplan

Phase 1 - Site Model for San Leandro Bay and Whole-Bay Dilution Model

- Goals: Use existing NMS model to address specific PCB loading and sediment recovery questions in San Leandro Bay. Investigate transport and dilution patterns of CECs from various sources of interest in the Bay.

Phase 2 - Site Model for Redwood Creek

- Goal: Use existing NMS model to address specific PCB loading and sediment recovery questions in Redwood Creek.

Phase 3 - Whole-Bay Model Development

- Goal: Develop and validate a whole-bay sediment and contaminant transport model for use in addressing management questions.

Phase 4 - Bioaccumulation Model Development

- Goal: Develop and validate a bioaccumulation model suitable for application with the PMU models.

Phase 5 - Model Maintenance and Future Applications

- Goals: Investigate long-term scenarios, maintain the model, and provide model applications to other management challenges in the Bay.

Phase/Task 1 - San Leandro Bay (SLB) Model Development and Evaluation

Subtask 1.1 - Define local model goals and tasks in terms of management questions

Subtask 1.2 - Evaluate NMS model grid

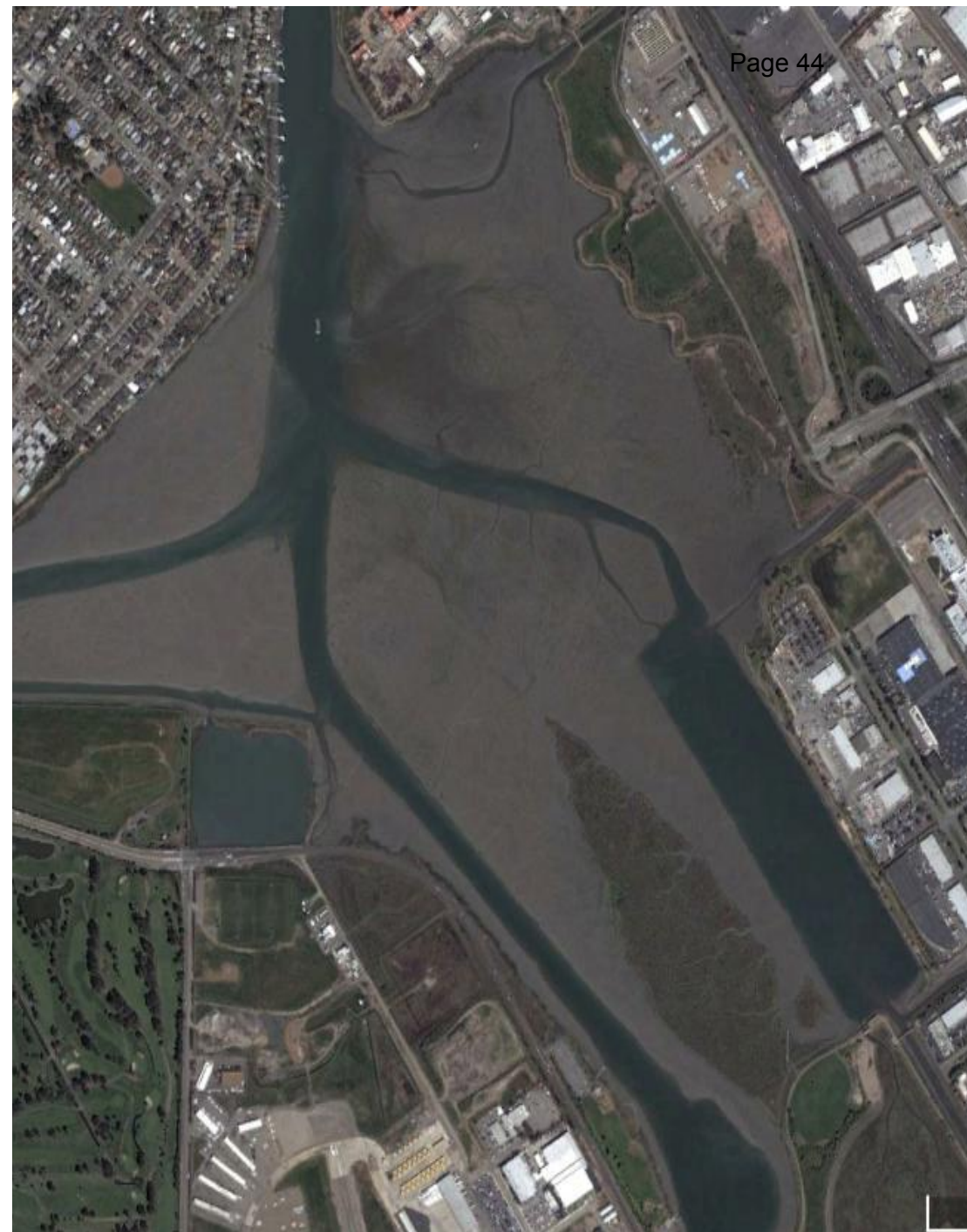
Subtask 1.3 - Compile sediment boundary conditions for tributaries and local sediment evaluation data

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Subtask 1.5 – Conduct diagnostic model simulations

Subtask 1.7 – Develop additional scenarios for CEC model evaluation and diagnostics

Subtask 1.6 – Reporting on model analysis and lessons learned for larger scale model



Partial excerpt of Table 2

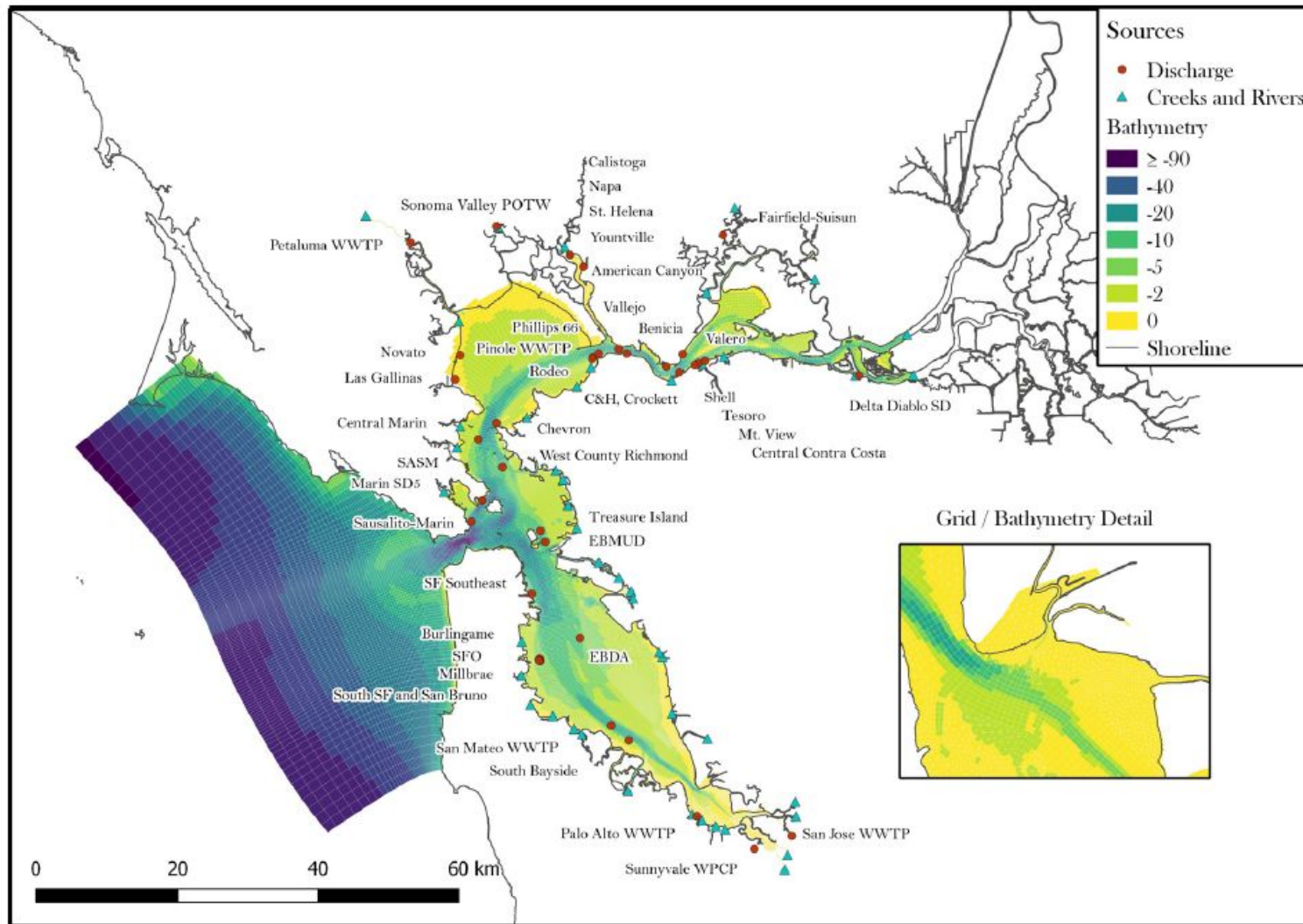
Table 2. Summary of management questions addressable by an in-Bay fate model and the relevant spatial and temporal scales of modeling needed.

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Question	Notes	Relevant Spatial Scales ¹	Relevant Temporal Scales ¹
PCB1: What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination?	Sediment recovery is dependent on stable net deposition of clean sediment.	Coincident with region in question. Key risk points for shiner surfperch are on the scale of priority management units geomorphic features.	Recovery occurs over decades; but seasonal processes (e.g., wet seasons) are generally responsible for the majority of recovery
PCB1a: What would be the impact of focused management of PMU watersheds?	The key assumption is that recovery of local PMUs is reduced by continued PCB delivery from local watersheds.	Local PMU geomorphic features with consideration of Bay segments	Seasonal, tidal, and event scale
PCB1b: What would be the impact of management of in-Bay contaminated sites, both within the sites and at a regional scale?	Bay segment scale is best investigated by looking at average PCB trends.	Bay segment with consideration of local PMUs and geomorphic features	Seasonal to interannual
CEC1: Which CECs have the potential to adversely impact beneficial uses in the Bay?	Need to estimate distributions of concentrations in space and time.	All spatial scales	All temporal scales
CEC3: What are the physical, chemical, and biological processes that may affect the transport and fate of individual CECs or groups of CECs in the Bay?	CECs will generally need to be considered on the basis of their individual chemistry and primary sources.	Geomorphic features, Bay segments, and whole Bay	Event to interannual

SFEI's San Francisco Bay Biogeochemical Model

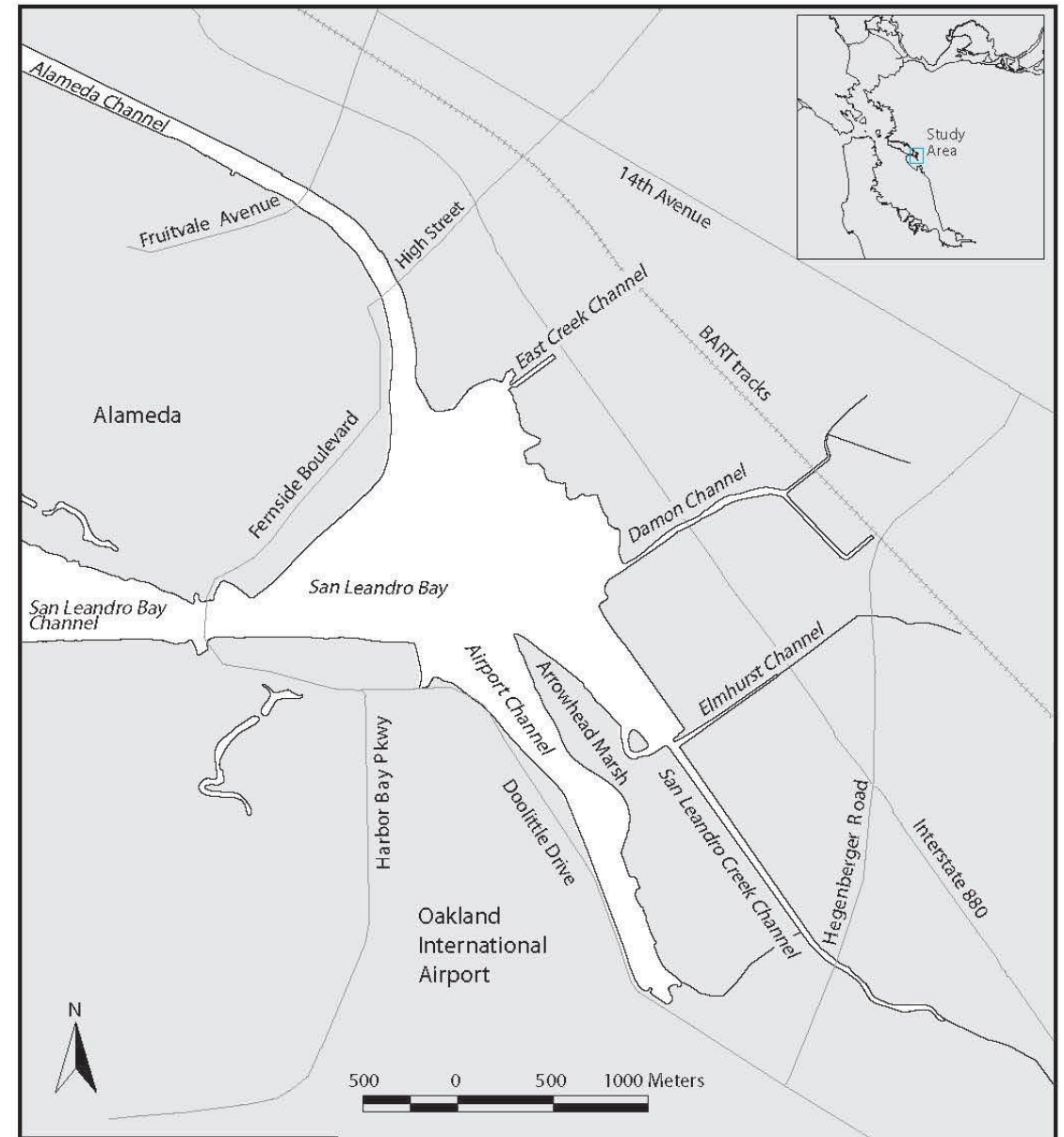
Spatial Domain



- Lower South Bay through Suisun Bay
- Driven by 3D hydrodynamic model
- 49,996 cells in the horizontal direction
- 10 sigma layers in the vertical direction
- 30 minute time step
- Applied to WY2013 and WY2017 so far
- Working on WY2013 - WY2018 long run to tune sediment processes

Subtask 1.1

Define local model goals and tasks in terms of management questions (focus on PCBs but consider other questions)



Subtask 1.3

Compile sediment boundary conditions for tributaries and local sediment evaluation data (focus on PCBs)

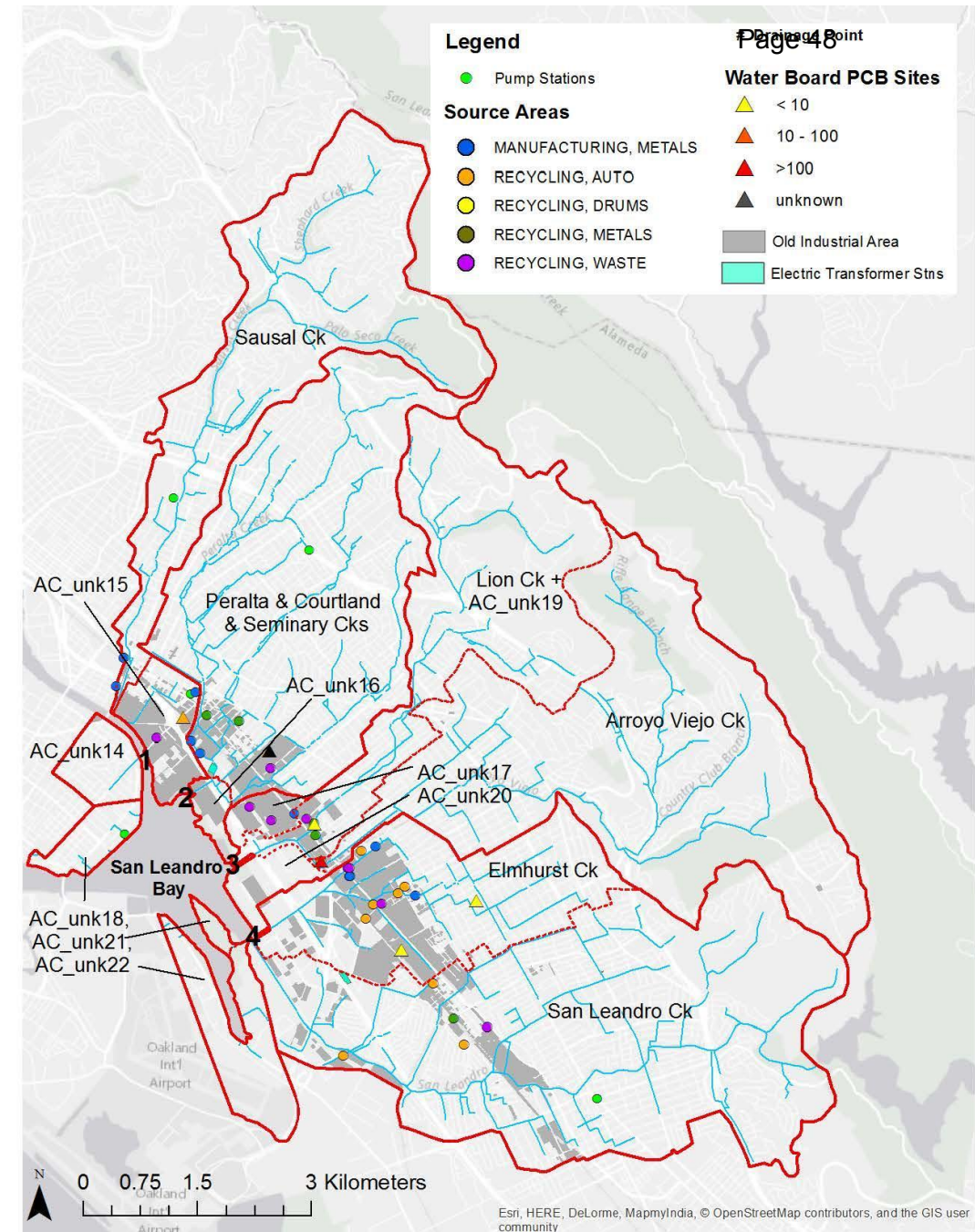
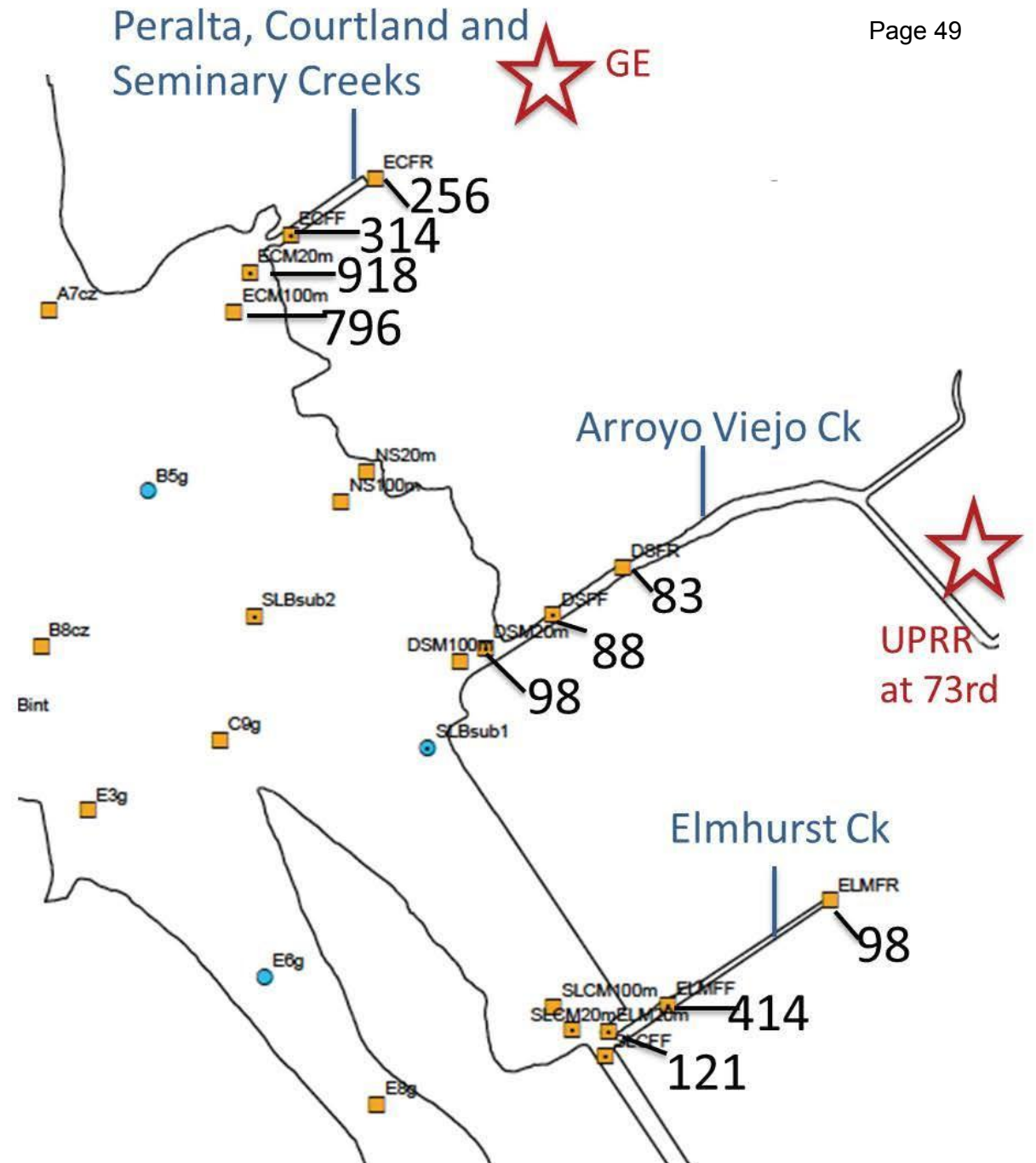


Figure 2-1. Main tributary watersheds to the San Leandro Bay PMU.

Subtask 1.4

Setup diagnostic model
for local SLB
simulations for dry and
wet conditions
scenarios (focus on
sediment associated
PCBs)



Subtask 1.5 – Conduct diagnostic simulations

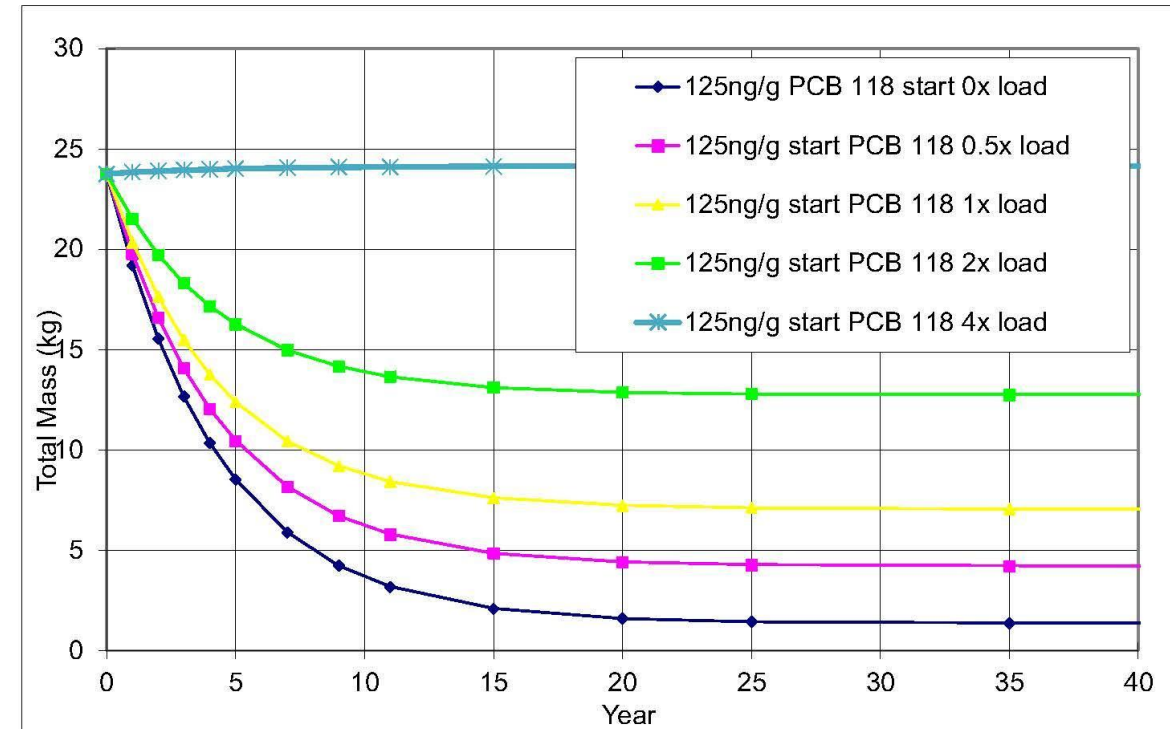
Subtask 1.5.1 - Compare modeled sediment distribution with available sediment data (e.g., accumulation rates, sediment chemistry)

Subtask 1.5.2 - Iteratively calibrate parameters (e.g., boundary conditions, loadings, sediment parameters) to refine model

Subtask 1.5.3 – Sensitivity testing

Table 2-1. Average annual load estimates for the San Leandro Bay Margin Unit watersheds.

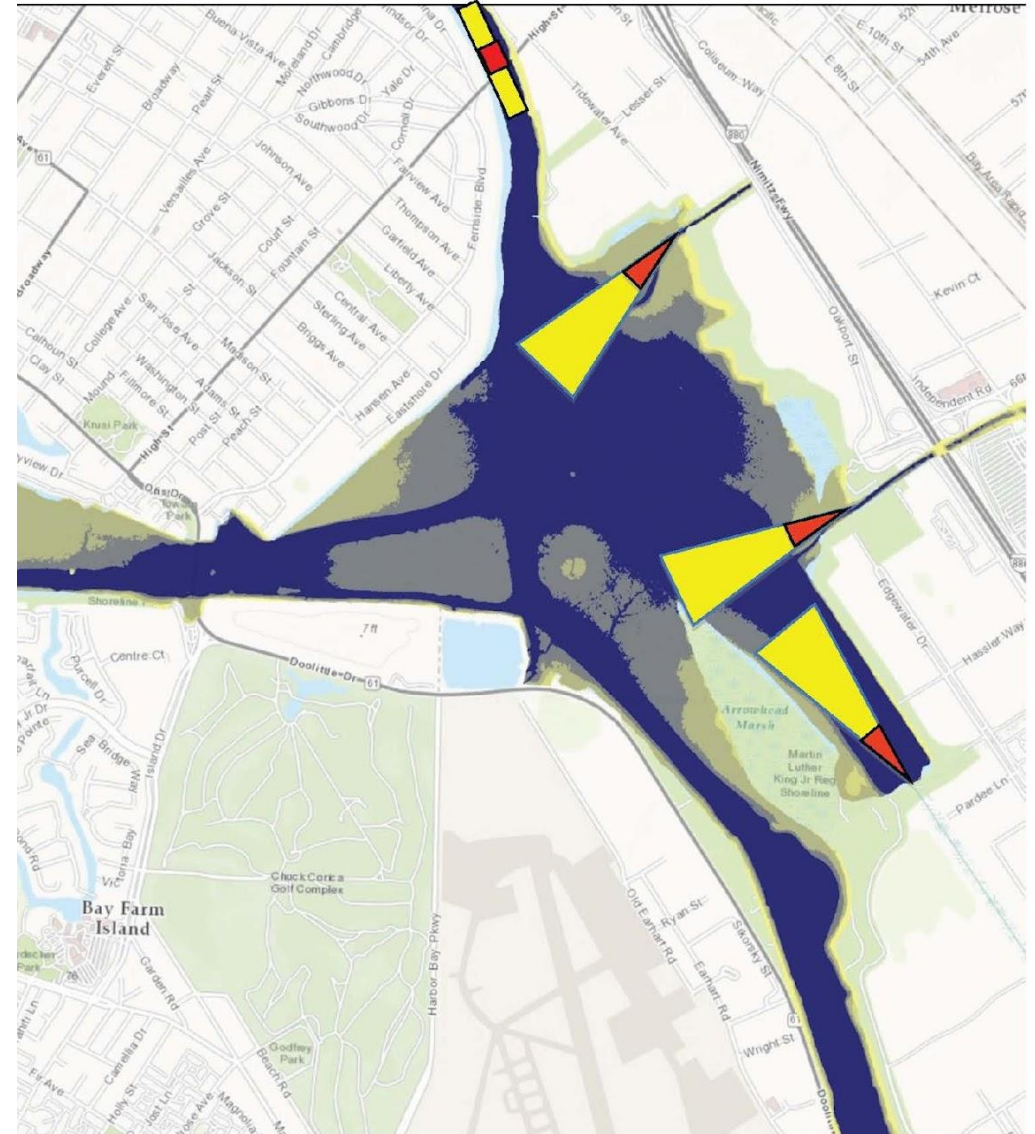
Page 50						
Watershed	Total Area (km ²)	Total Runoff Volume (Mm ³)	PCB Load - Low Estimate (g)	PCB Load - Best Estimate (g)	PCB Load - High Estimate (g)	PCB Yield - Best Estimate (ug/m ²)
Sausal Ck, AC unk14, AC unk15	13.2	4.4	64	136	242	10.3
Peralta and Courtland and Seminary Creeks, AC unk16	15.0	4.9	82	175	307	11.6
Arroyo Viejo Ck, Lion Ck, AC unk17, ACunk19 and AC unk20	26.6	9.4	106	234	389	8.8
San Leandro Ck and Elmhurst Ck	25.7	7.1	166	350	635	13.6
AC unk18, AC unk21, AC unk22	2.9	0.8	44	91	175	31.2
Total for Margin Unit	83.4	26.6	462	986	1747	11.8



Phase/Task 1 - San Leandro Bay (SLB) Model Development and Evaluation Page 51

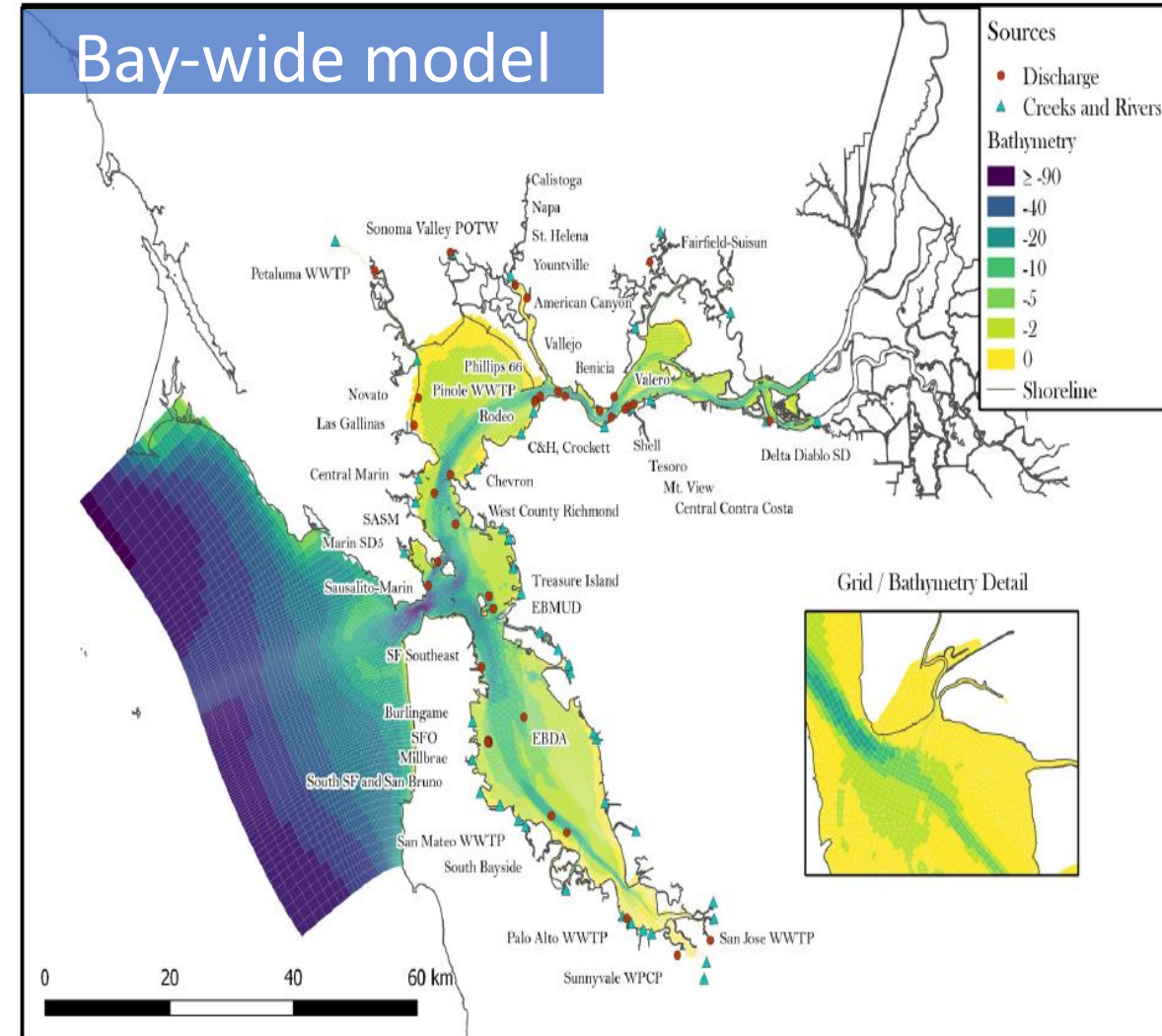
Subtask 1.7 – Develop additional scenarios for CEC model evaluation and diagnostics (focus on dissolved phase transport)

Subtask 1.6 – Reporting on model analysis and lessons learned for larger scale model



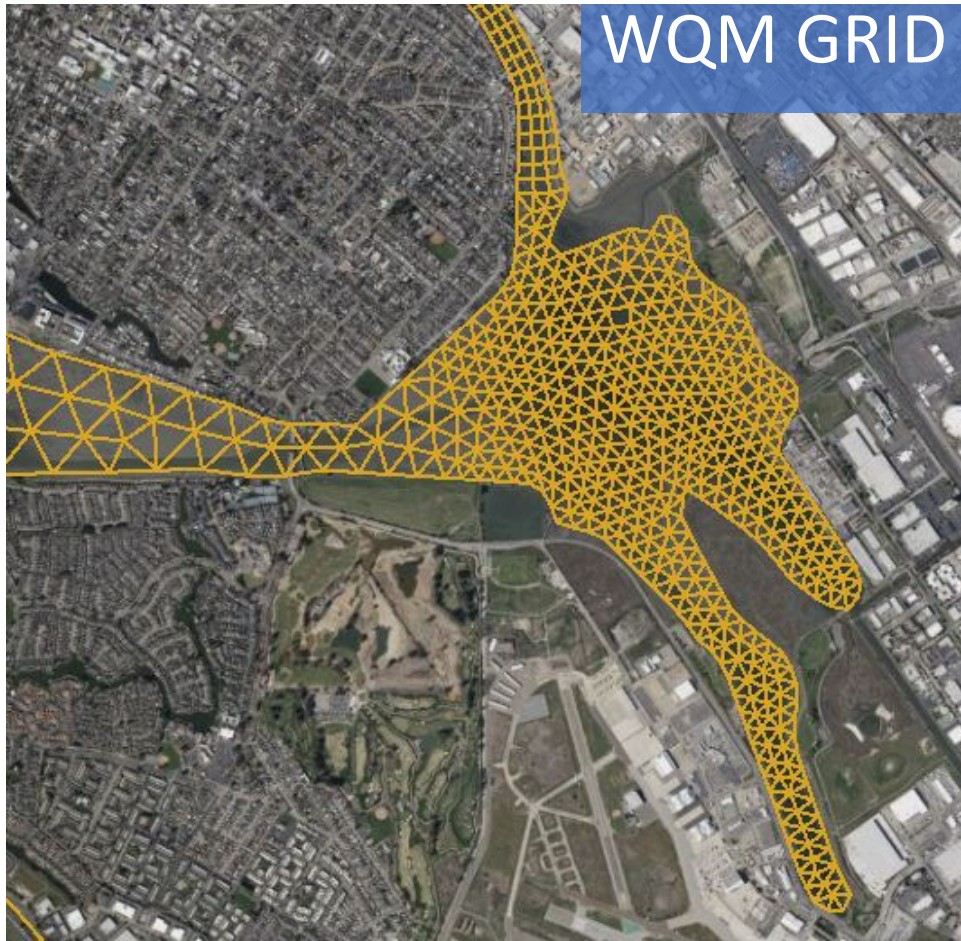
San Leandro Bay Model Development

- Leverage pre-existing model developed for hydrodynamics and water quality
- Refine areas of interest. i.e. San Leandro Bay- **Ongoing**
 - Increased grid resolution
 - Upland Watershed loadings
- Incorporate sediment transport parameters-**Upcoming**
 - Size classes
 - Suspended sediment concentrations
 - Ultimately characterize sediment bed



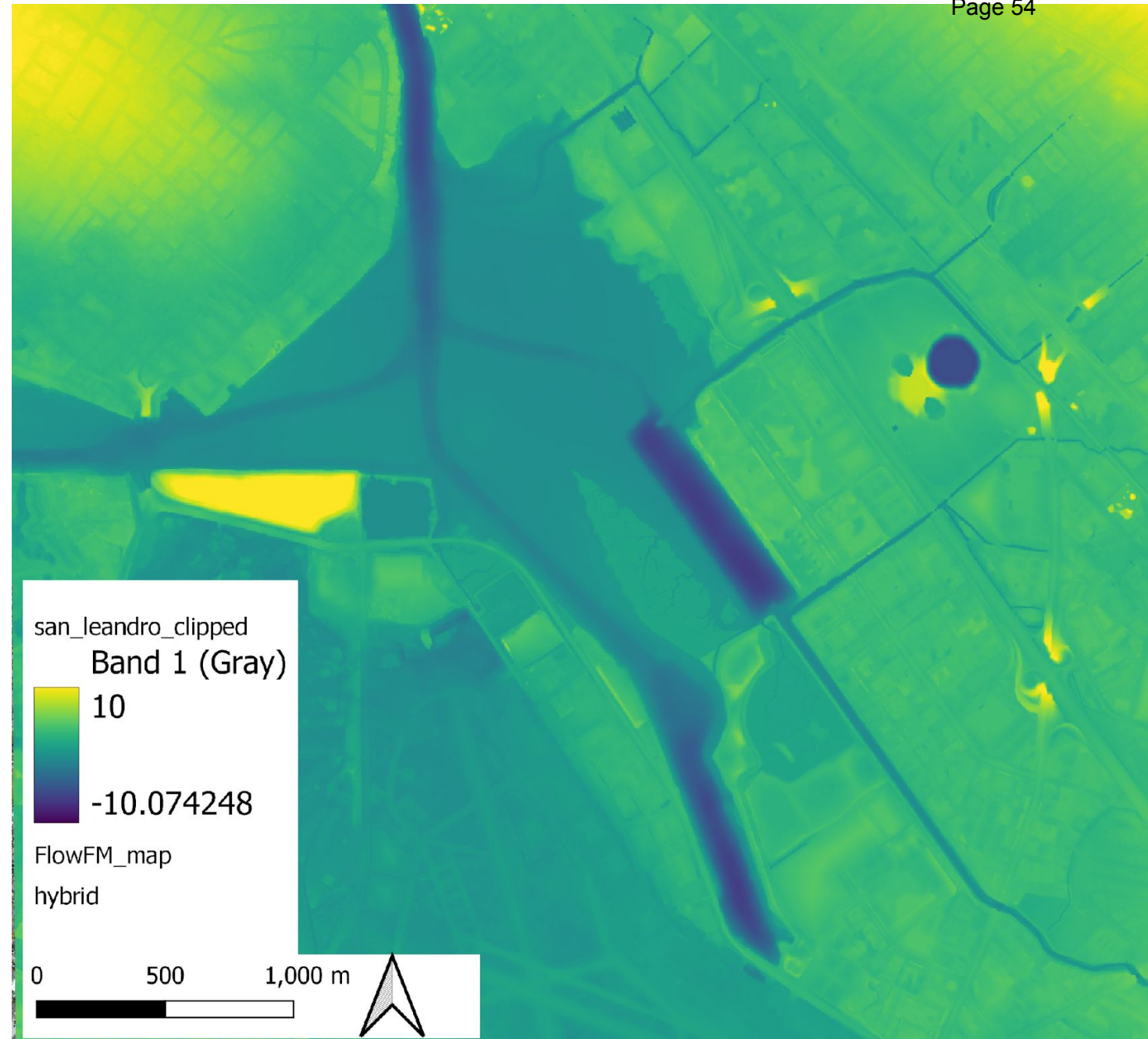
San Leandro Model Grid Refinement

- Refinement of San Leandro Bay focused on resolving channels and intertidal areas.
- Resolution is 10-15 m in refined model.



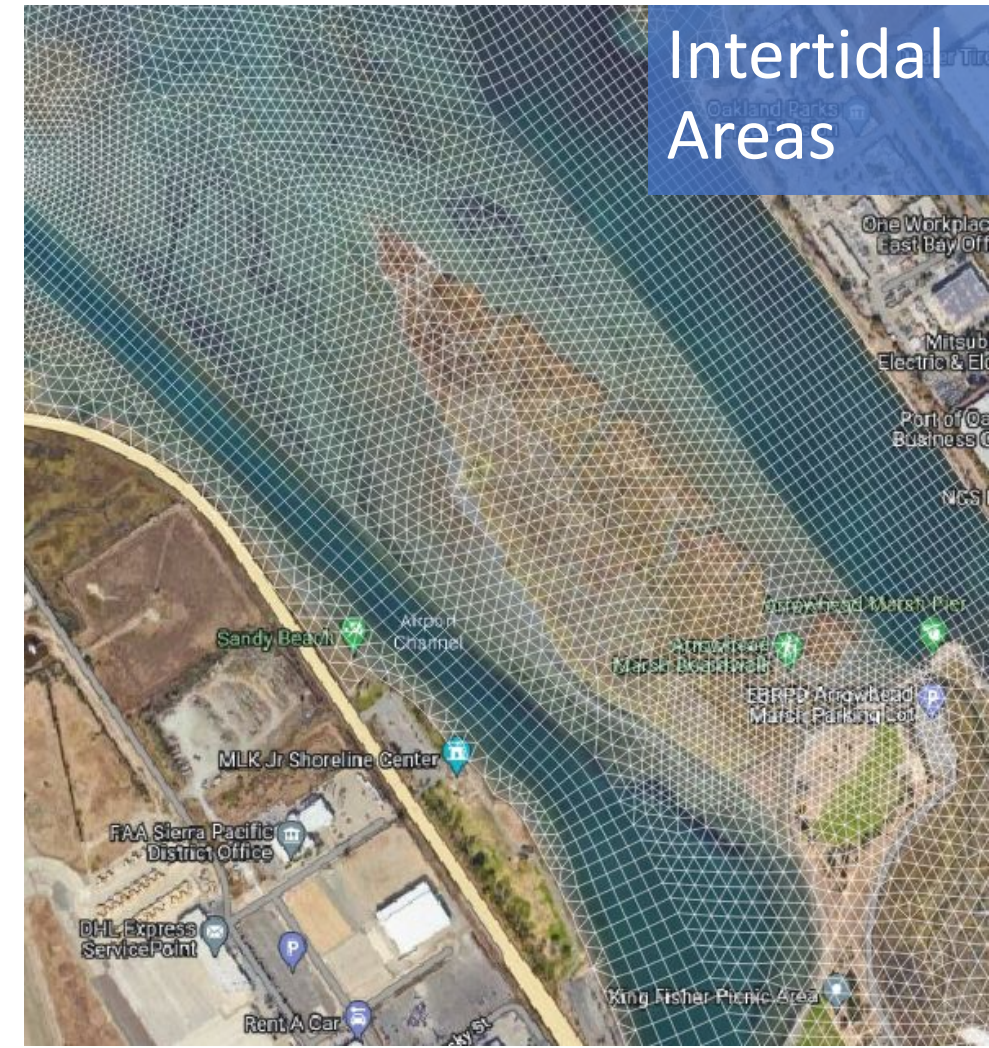
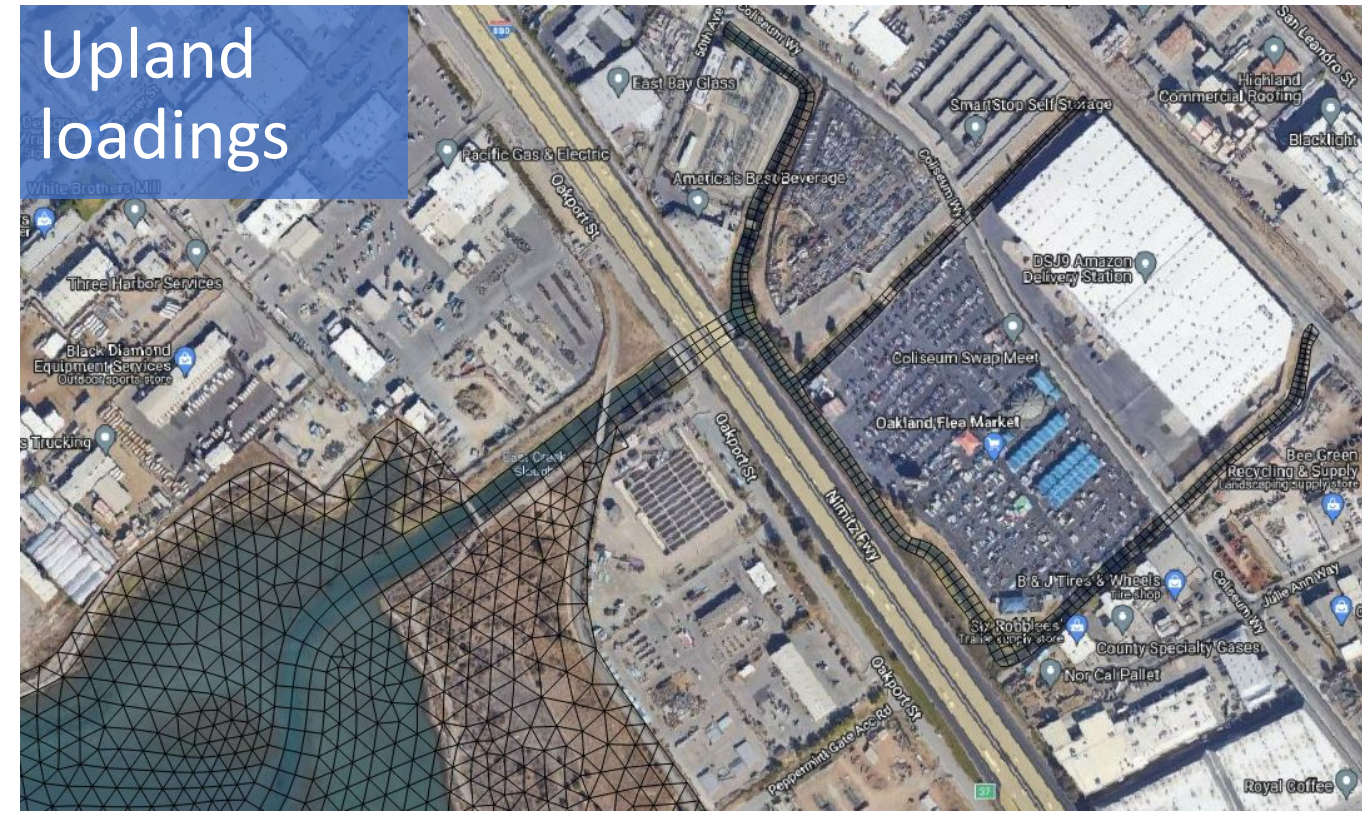
Model Bathymetry

- Ninth- arcsecond ($\sim 3\text{m}$) digital elevation model sourced from NOAA
- Interpolated onto model grid in San Leandro Bay
- Wider bay bathymetry consistent with source model



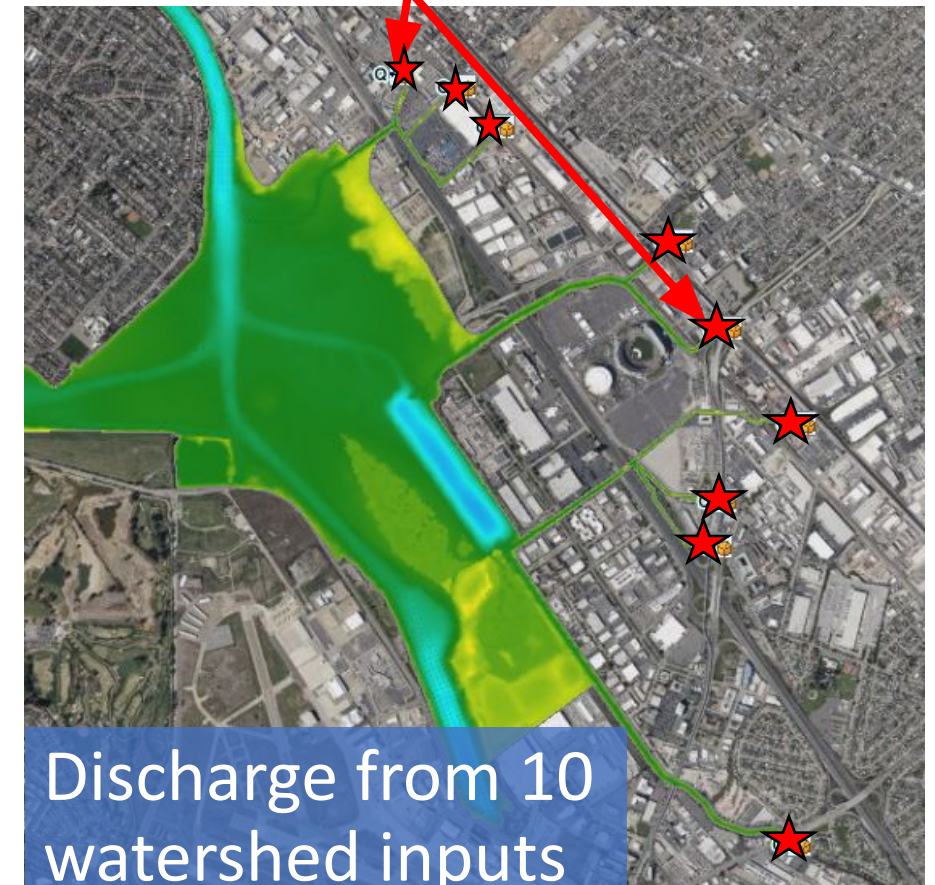
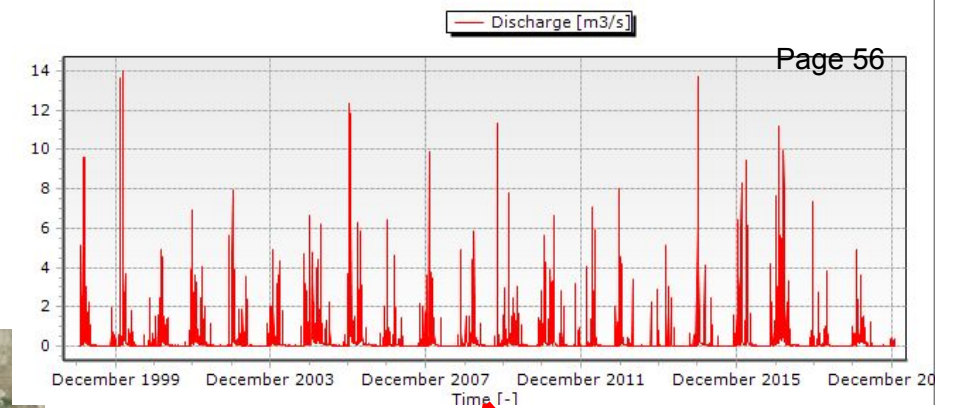
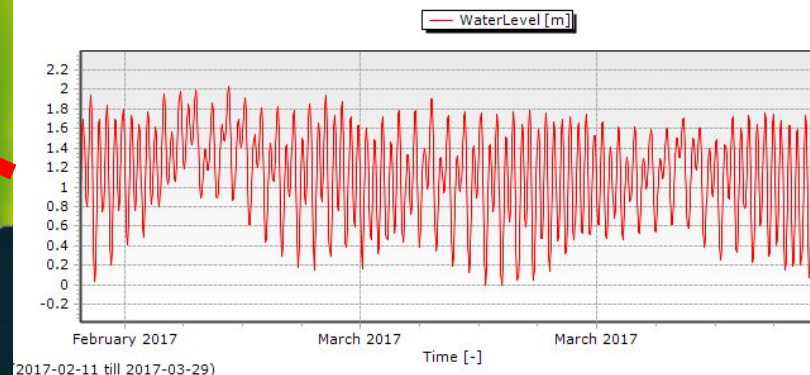
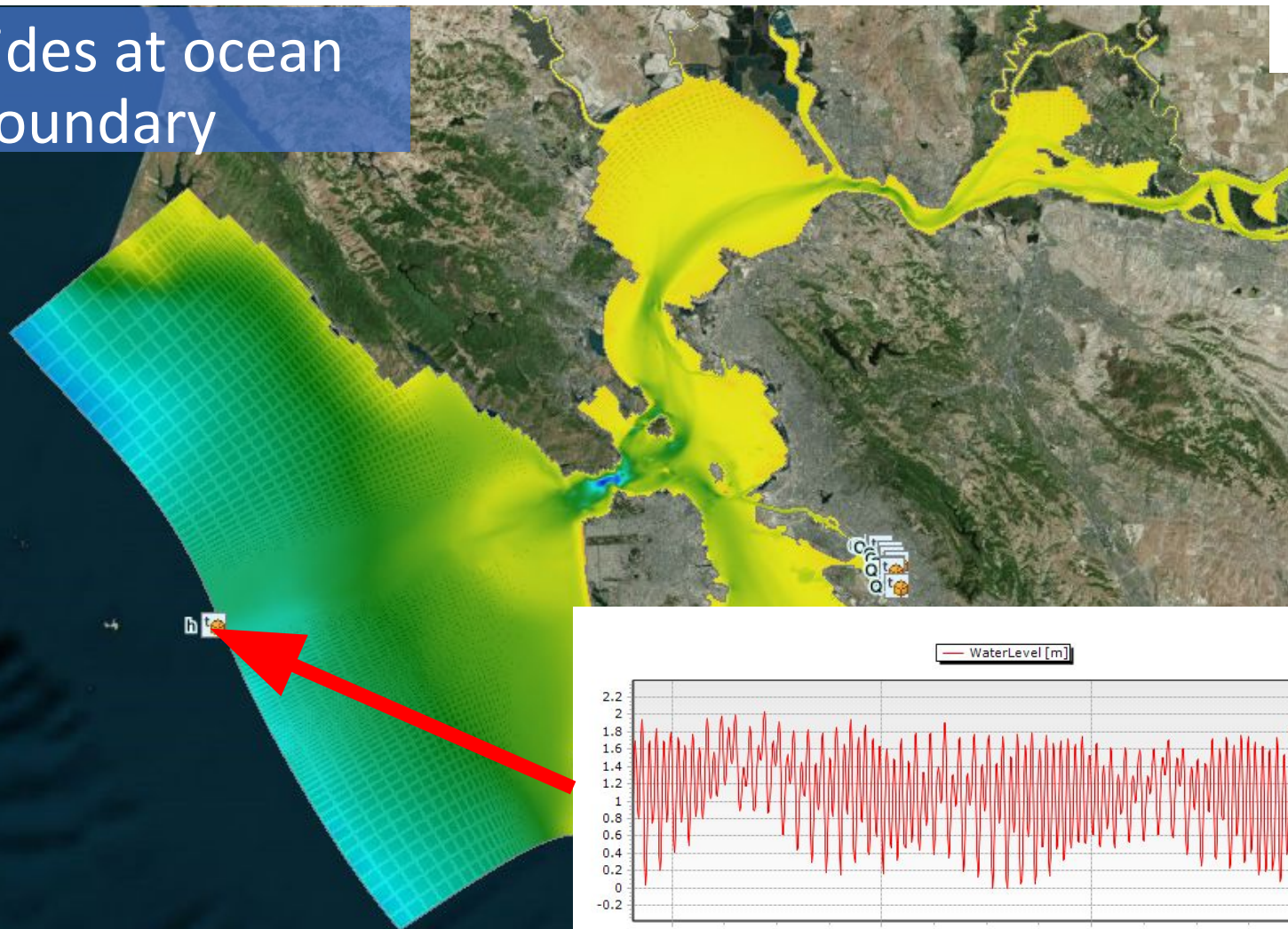
Highlights of Model Refinement

- Upland channels resolved to allow for watershed inputs to San Leandro Bay
- Intertidal areas where sediment may accumulate



Hydrodynamic Model forcing

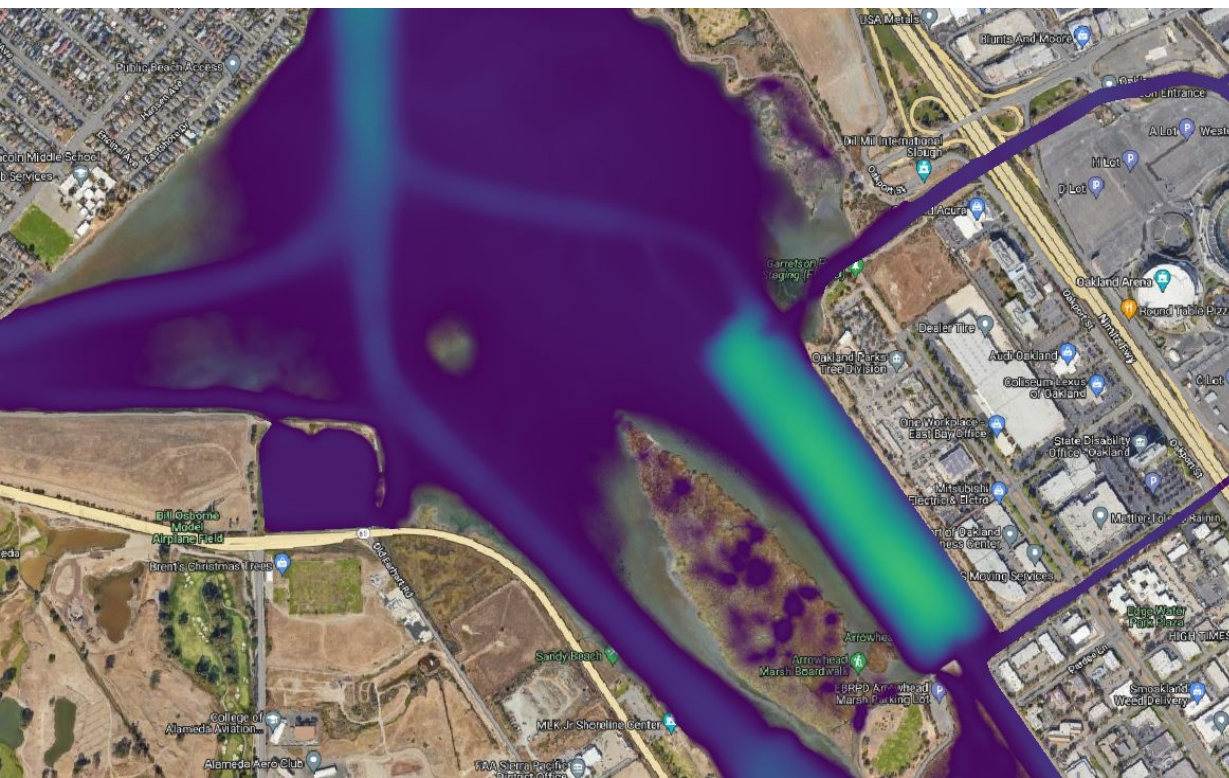
Tides at ocean boundary



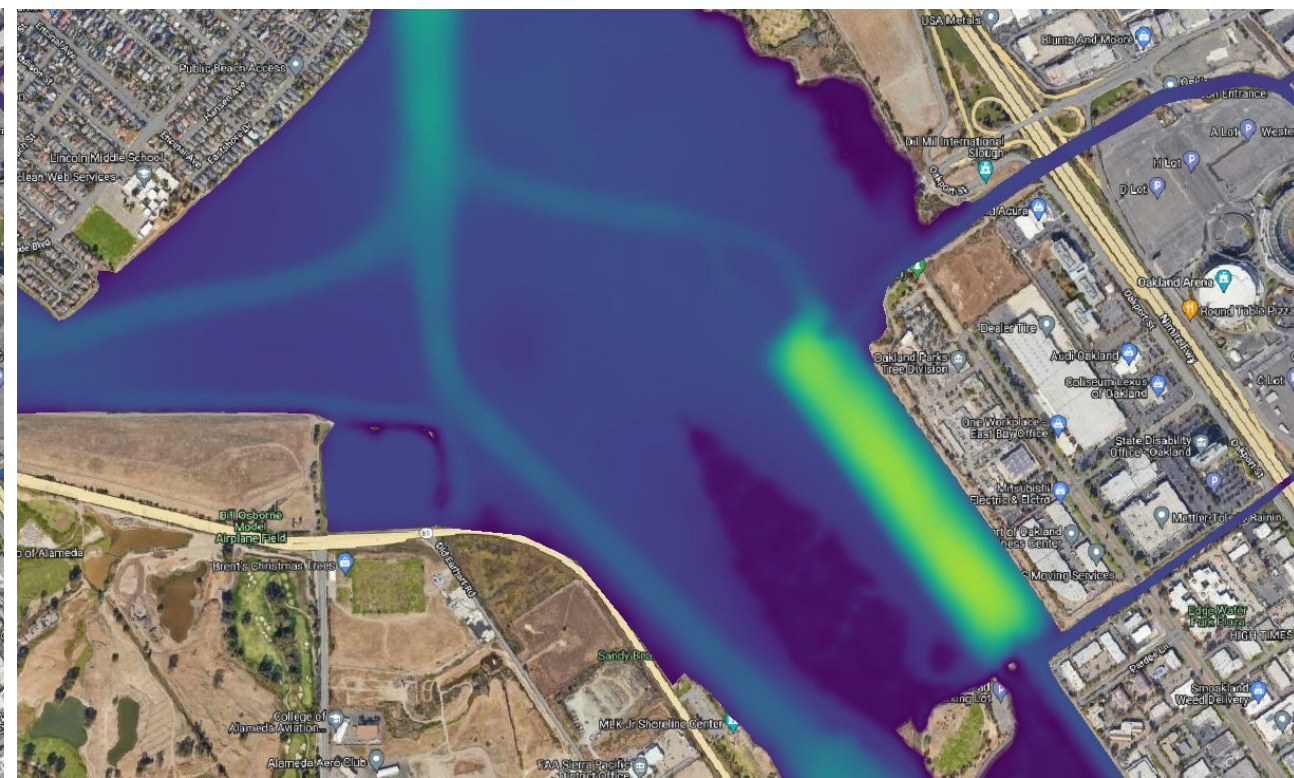
Discharge from 10 watershed inputs

Example hydrodynamic model results

- Model forces with tides at ocean boundary
- Intertidal areas in San Leandro Bay wet and dry as tides change
 - Capturing this process is one key to ensuring sediment loads are distributed properly



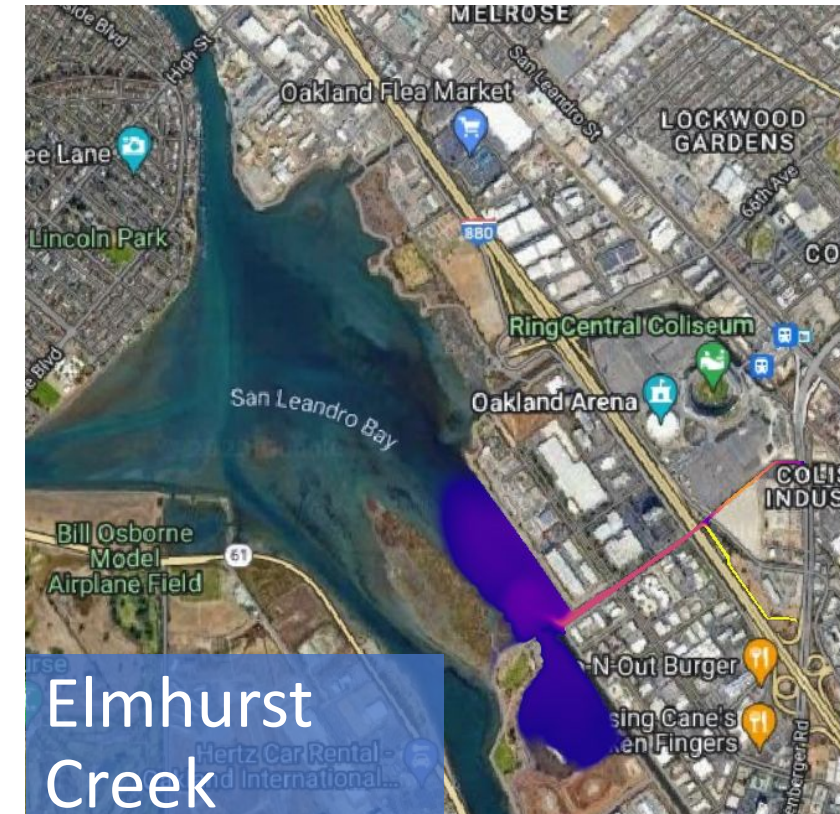
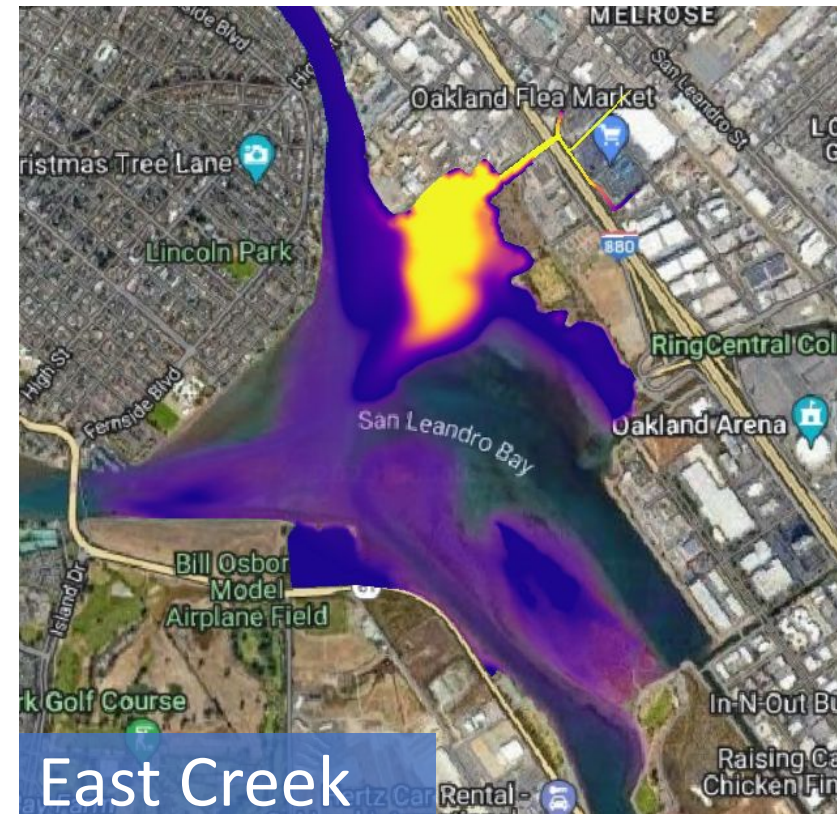
Low Tide



High Tide

Example Tracer Dispersal

- A Passive tracer was introduced to show dispersal from three watershed loading areas.
- Results presented are at conclusion of three simulated days (4 tidal cycles)



Next Steps in Model Development

Subtask 1.1 - Define local model goals and tasks in terms of management questions

Subtask 1.2 - Evaluate NMS model grid

Subtask 1.3 - Compile sediment boundary conditions for tributaries and local sediment evaluation data

Subtask 1.4 – Setup diagnostic model for local SLB

Subtask 1.5 – Conduct diagnostic model simulations

Subtask 1.7 – Develop additional scenarios for CEC model evaluation and diagnostics

Subtask 1.6 – Reporting on model analysis and lessons learned for larger scale model



Phase/Task 2 - Steinberger Slough/Redwood Creek (SS/RC) Model Development

Subtask 2.1 - Define local model goals and tasks in terms of management questions (focus on PCBs)

Subtask 2.2 - Compile sediment boundary conditions for tributaries and local sediment evaluation data (focus on PCBs)

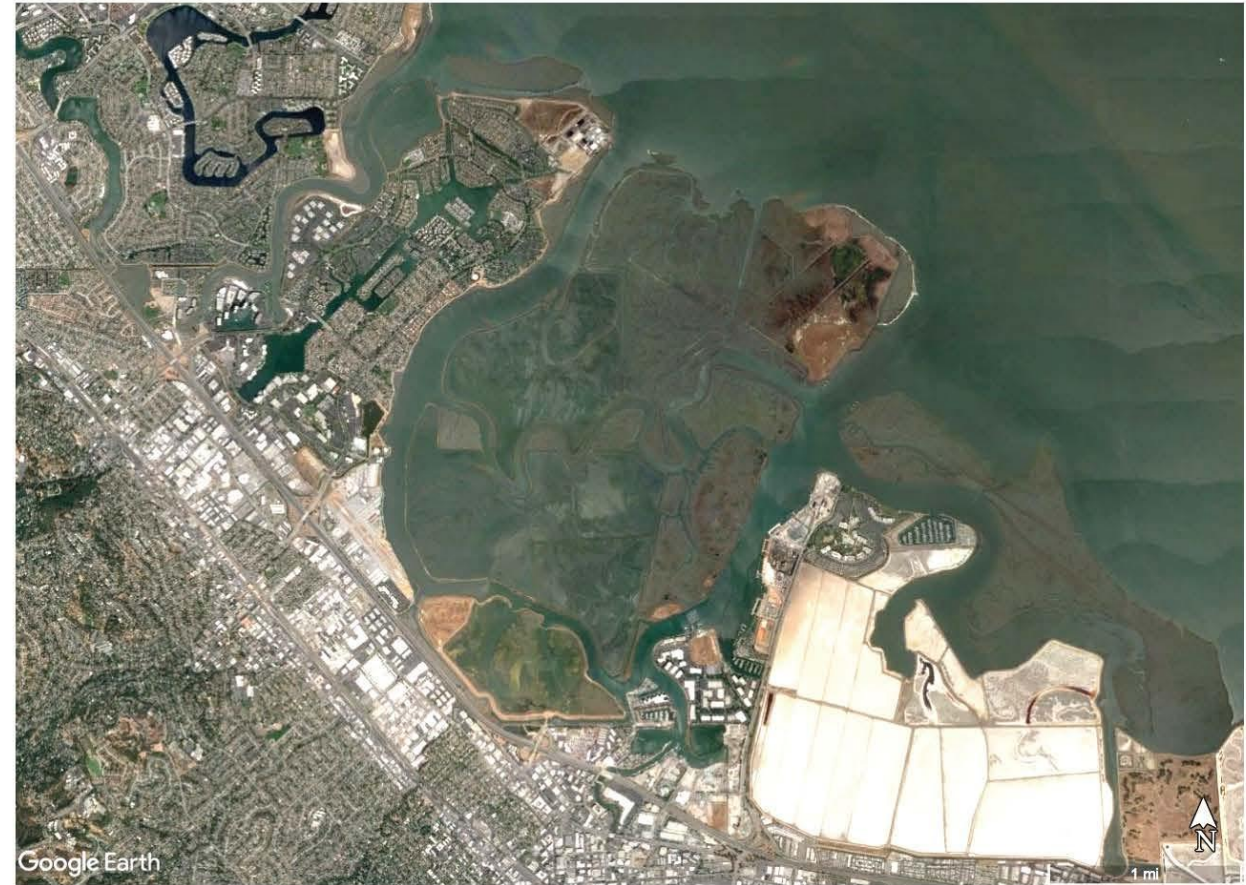
Subtask 2.3 - Evaluate NMS model grid

Subtask 2.4 – Setup diagnostic model for local SLB simulations for dry and wet conditions scenarios (focus on sediment associated PCBs)

Subtask 2.5 – Conduct diagnostic model simulations

Subtask 2.7 – Develop additional scenarios for CEC model evaluation and diagnostics (focus on dissolved phase transport)

Subtask 2.6 – Reporting on model analysis and lessons learned for larger scale model



Phase/Task 3 – Whole-Bay Model Development

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Subtask 3.1 - Evaluate model goals and tasks in terms of management questions

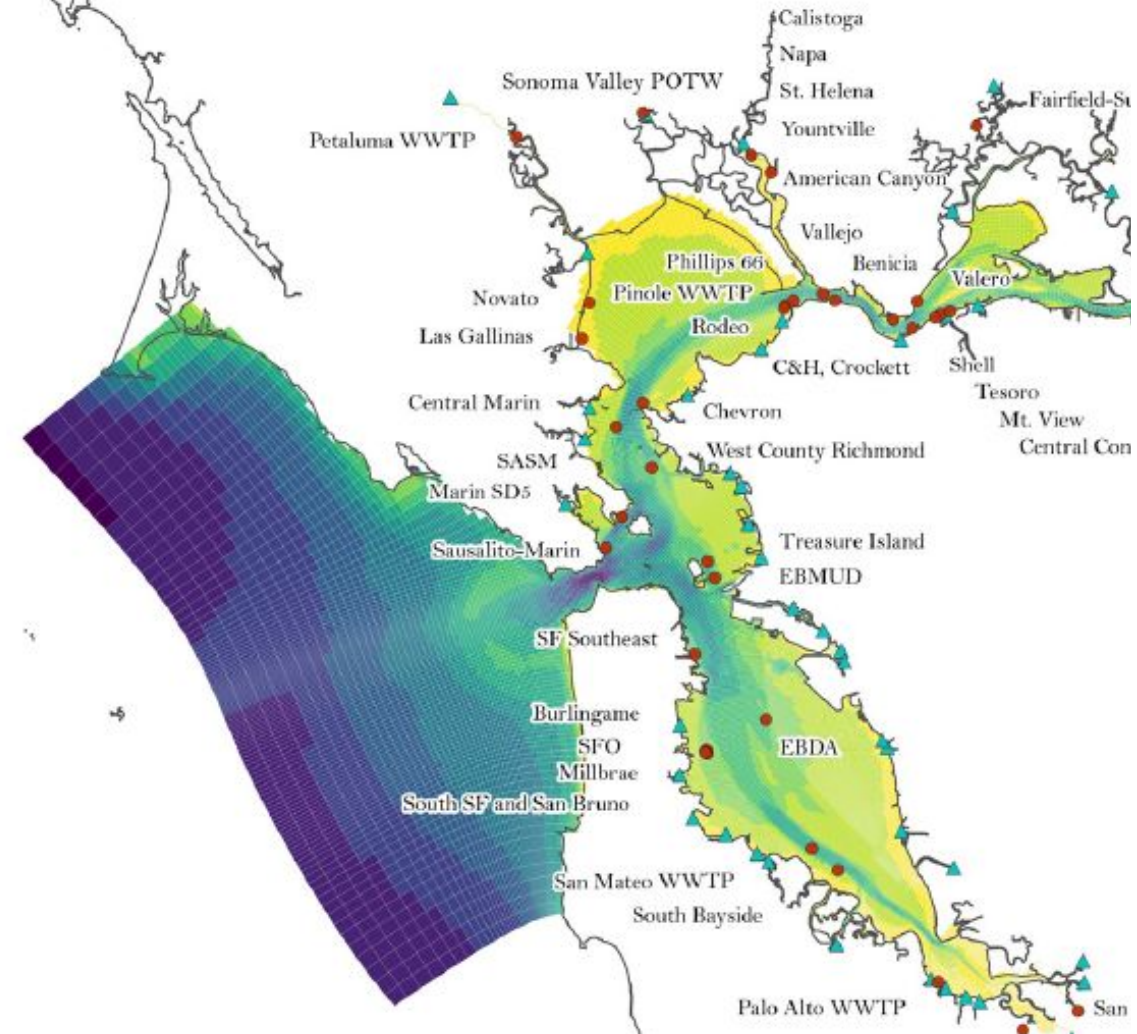
Subtask 3.2 – Develop Boundary Conditions

Subtask 3.4 – Diagnostic Sediment transport modeling

Subtask 3.5 – Conduct prognostic model analysis

Subtask 3.6 – Develop additional scenarios for CEC model evaluation and diagnostics

Subtask 3.7 – Reporting on model analysis and lessons learned for future modeling





Integrated Watershed-Bay Modeling Strategy

Allie King, Pradeep Mugunthan, Tan Zi

RMP Sediment Workgroup Meeting

June 6, 2023

Goal of Presentation

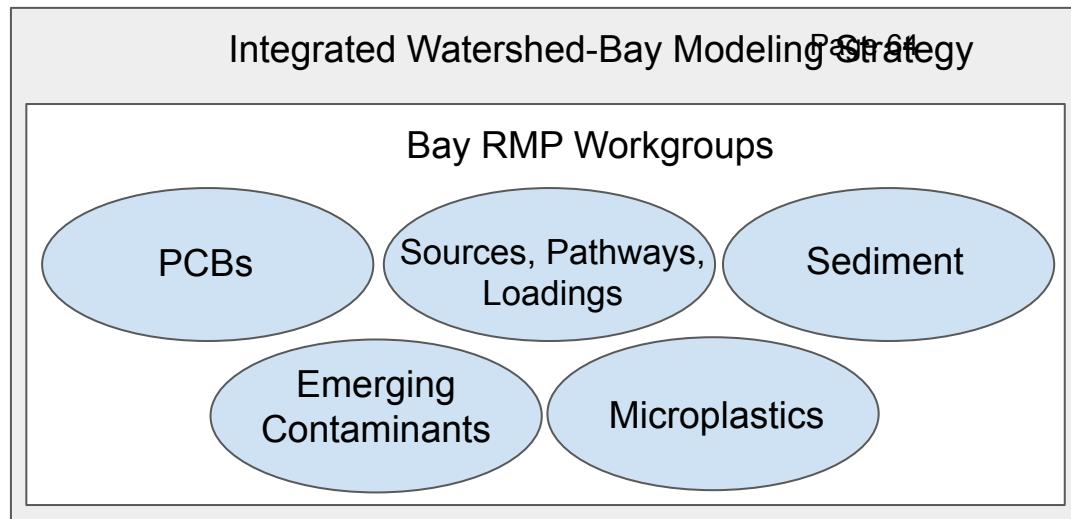
- Introduce the general integrated modeling framework and strategy
- Example application to CEC management question
- Feedback on capabilities needed from the watershed model for in-bay PCB management scenarios

Project Introduction

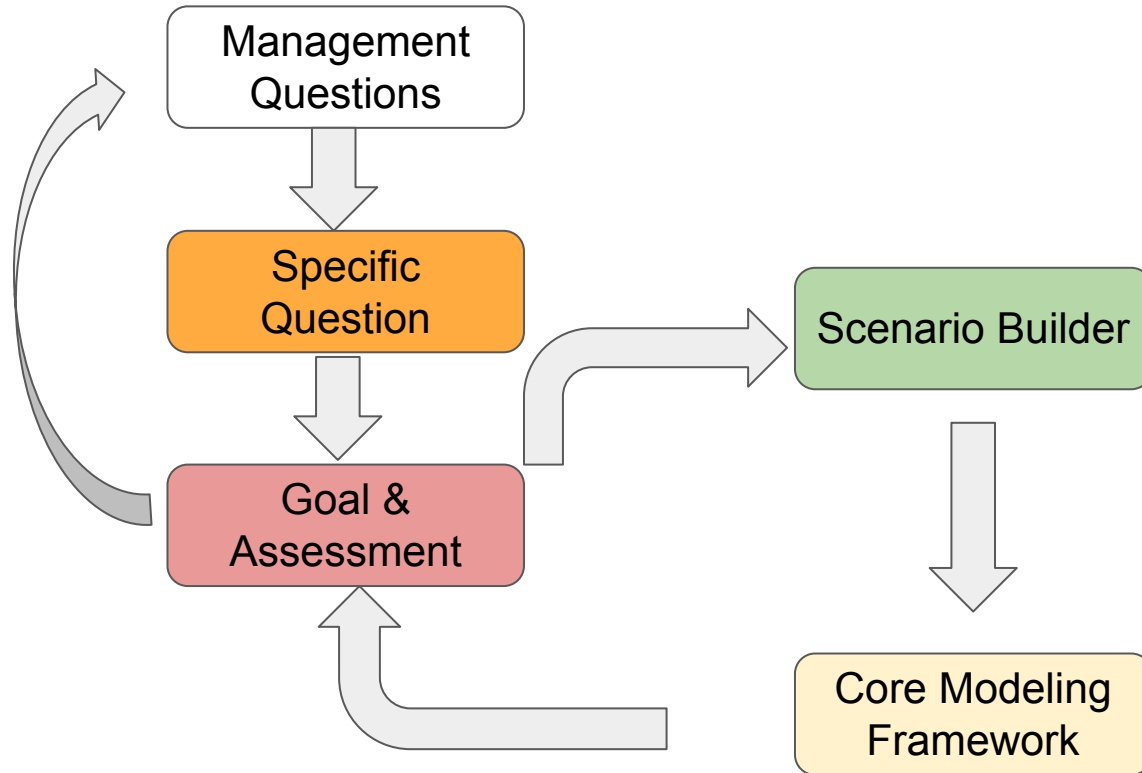
- This is a SEP project (\$200K)

- This project will develop an integrated watershed Bay modeling **strategy** for the Bay RMP (applies across all workgroups)

- We will do one **pilot study** to implement the strategy, to answer a management question from one workgroup

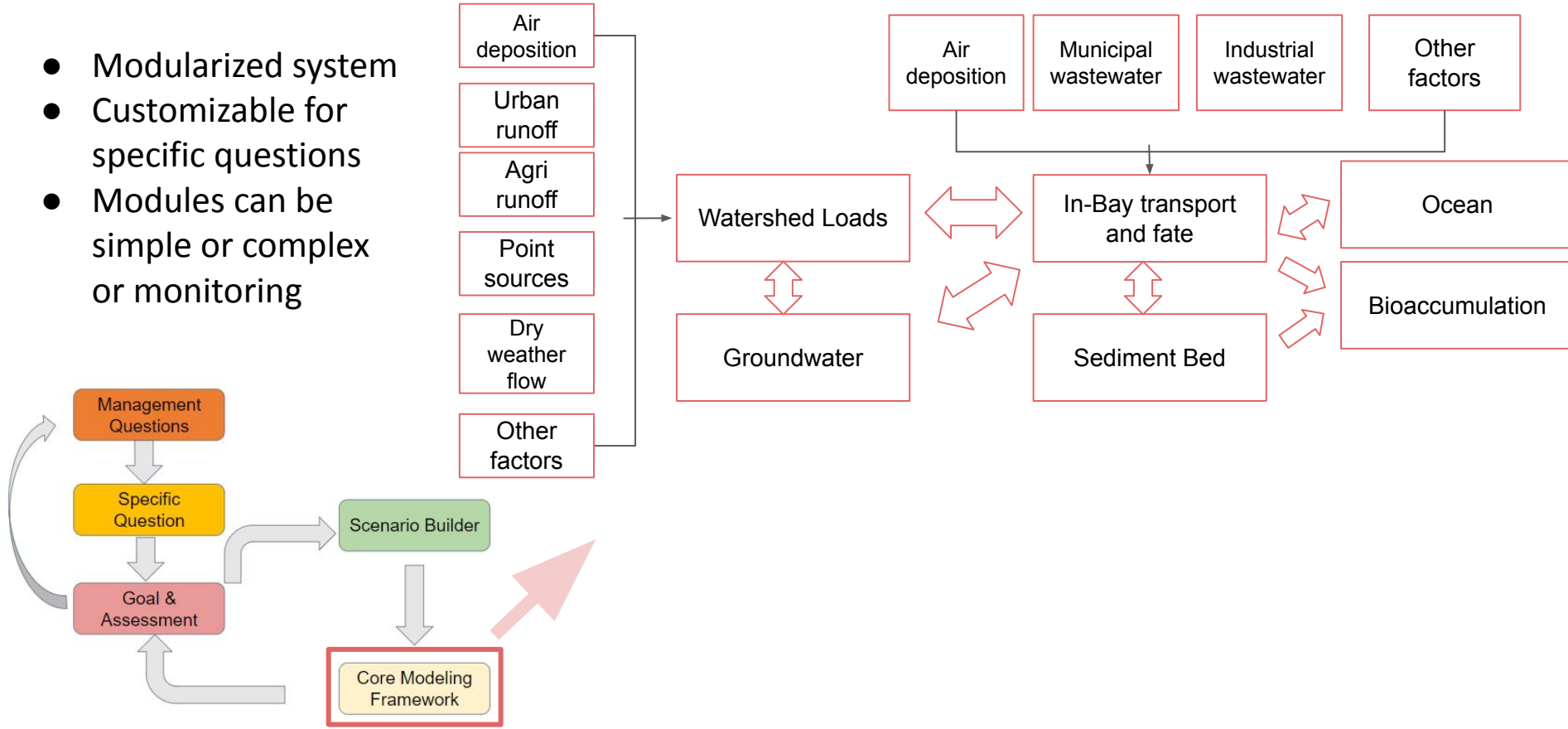


General Modeling Strategy



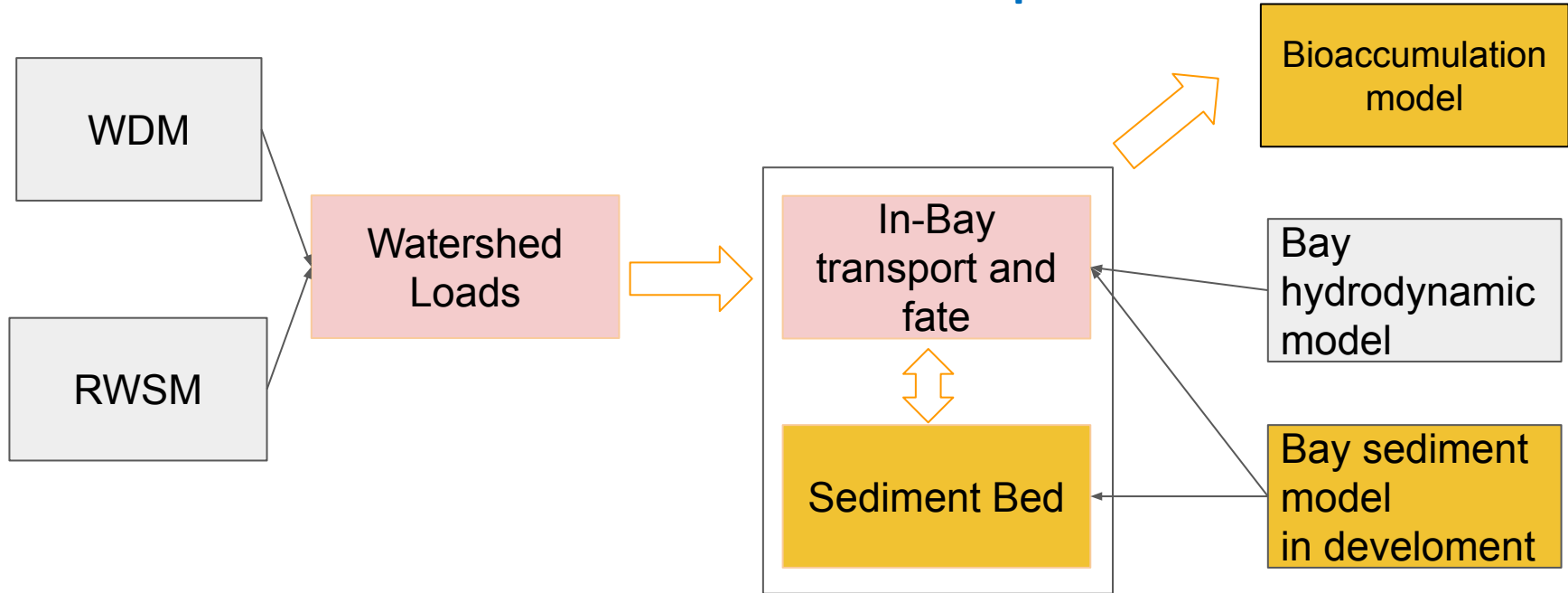
General Modeling Strategy - Core Modeling Framework

- Modularized system
- Customizable for specific questions
- Modules can be simple or complex or monitoring



Models In House and In Development

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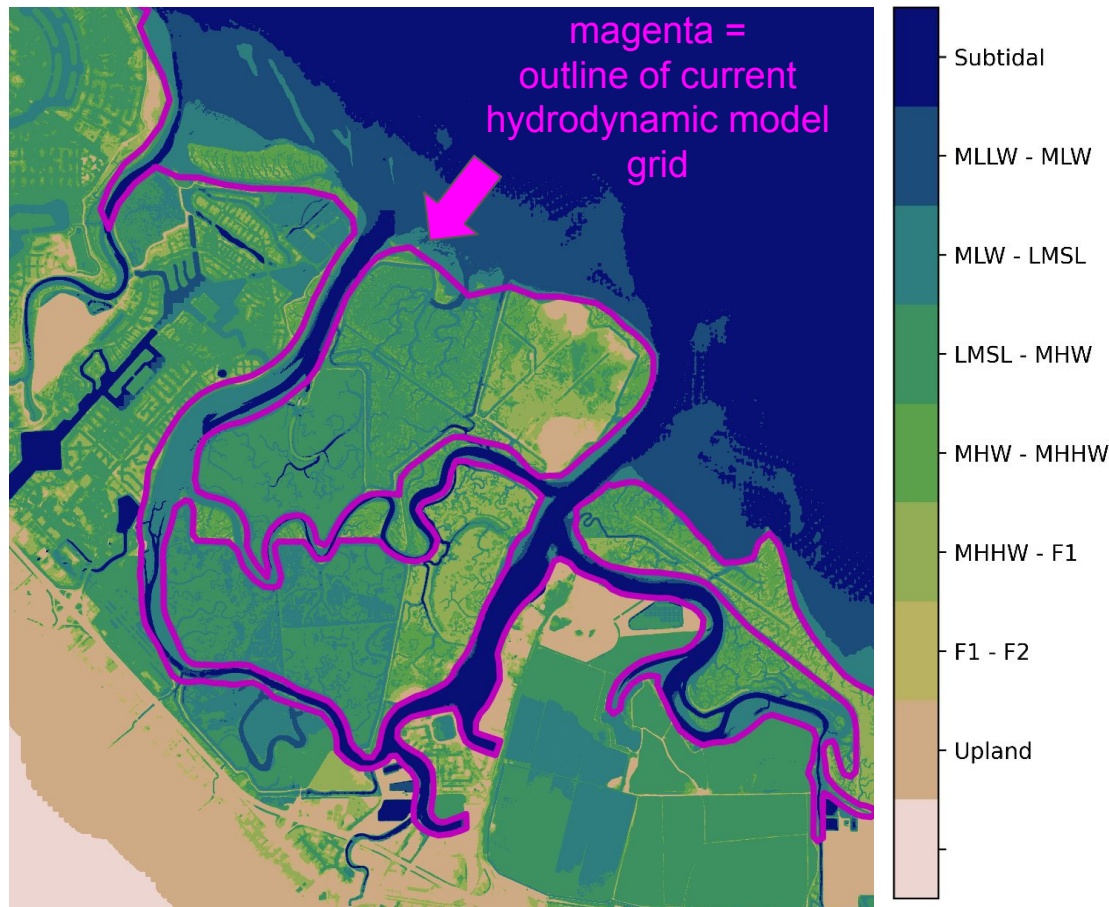
Gaps in Core Modeling Framework

- Tidal channels
- Marsh
- Ocean

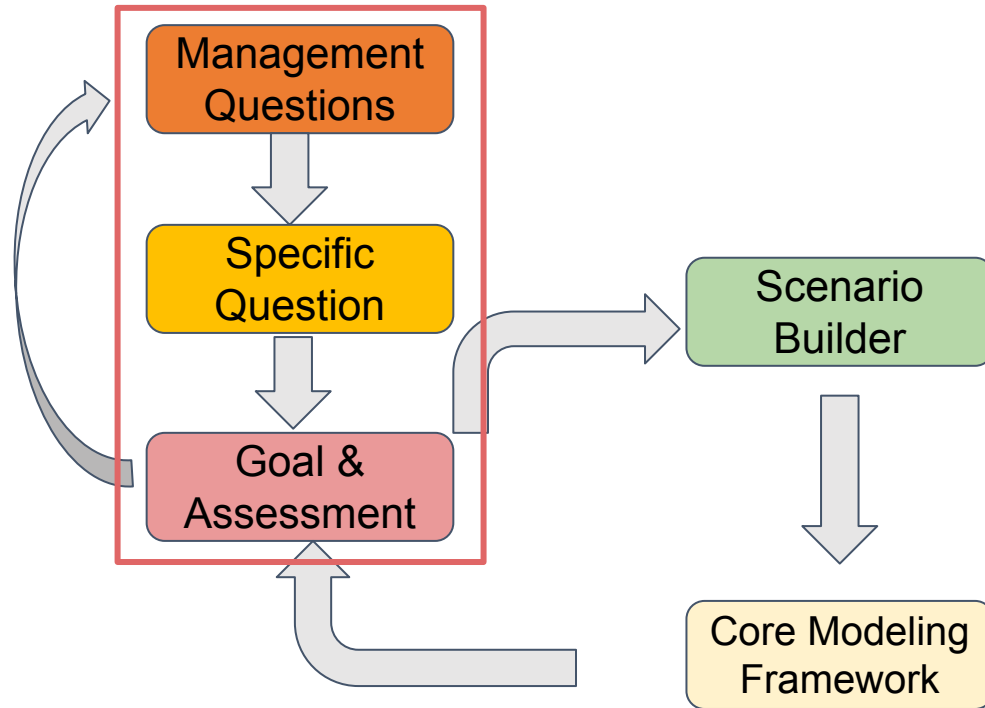
The in-Bay model domain currently includes some tidal channels and few marshes, could include more if domain is expanded and grid is refined in targeted areas

SedWG considering development of a 1D marsh accretion model (e.g. WARMER), to be driven by sediment concentrations at the marsh edge predicted by the in-Bay model

Nutrients team will collaborate with SCCWRP to couple Bay and ocean biogeochemical models



Example – CEC X



ECWG MQ2: What are the sources, pathways and loadings leading to the presence of individual CECs or groups of CECs in the Bay?



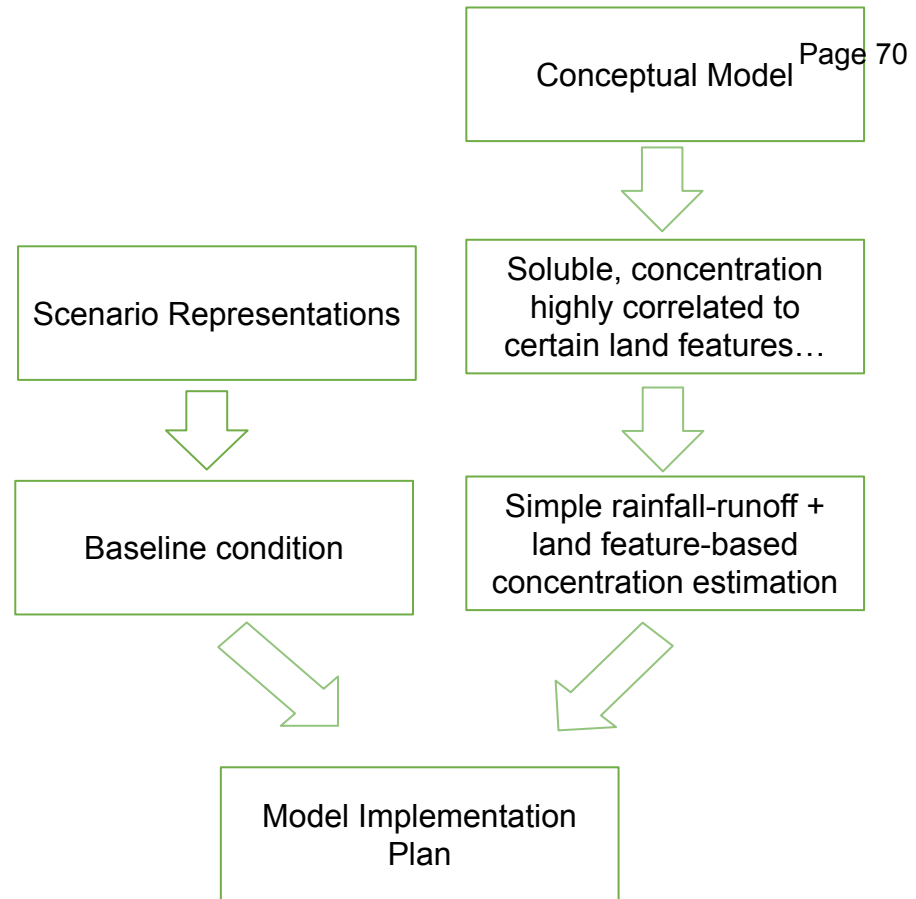
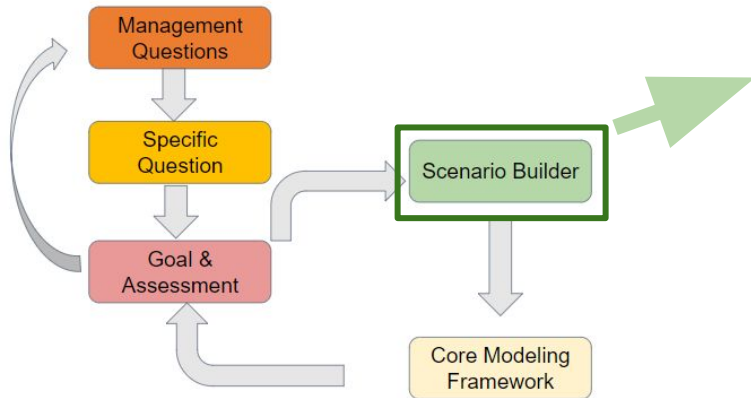
Specific Question: How do the wastewater and stormwater load influence the concentration of CEC X in the Bay?



Goal: Assess the relative contributions of different pathways.

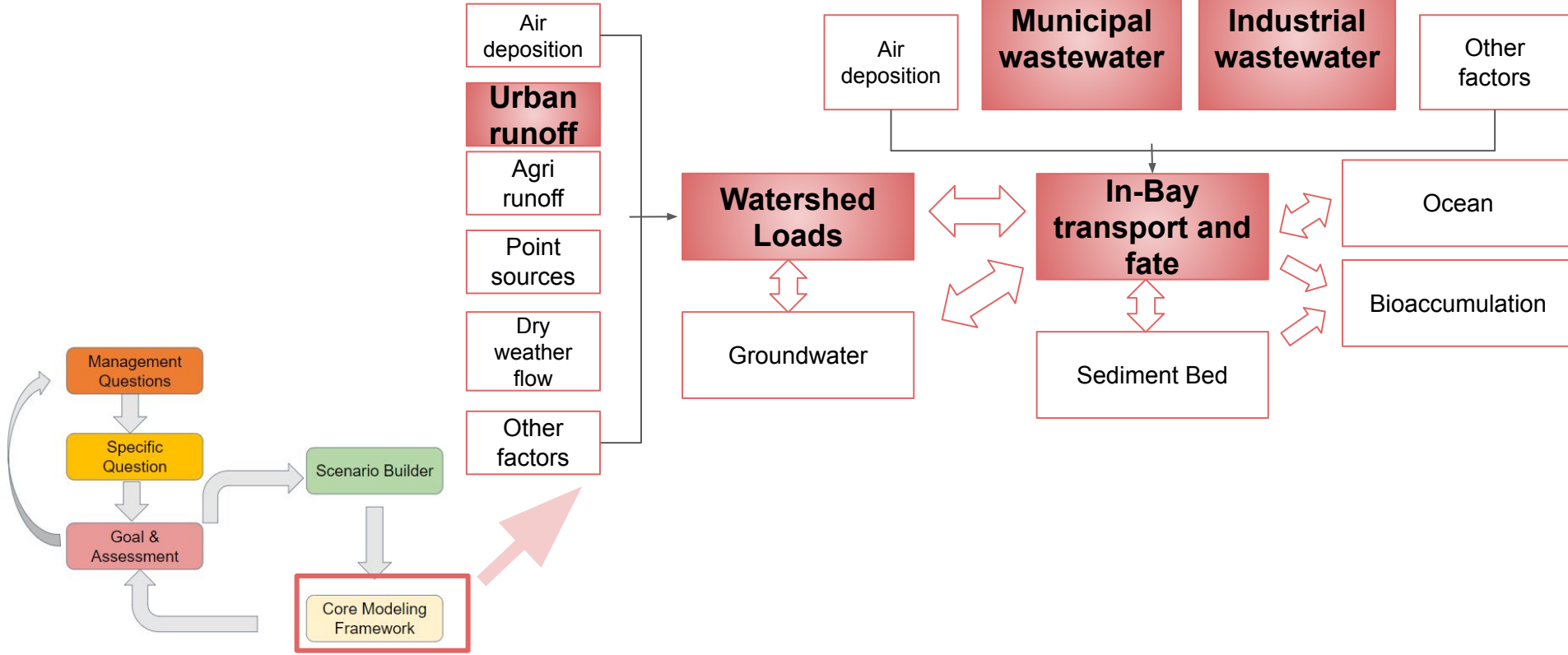
Example - CEC X

1. Evaluate input and output needs
2. Identify components of the modular framework
3. Build scenario(s)



Example - CEC X

1. Select necessary modules
2. Model simulations/interpretations





What About PCBs?

- In-Bay sediment transport model development for San Leandro Bay PMU and whole Bay is underway
- Bioaccumulation model development is underway
- What is needed from the watershed model?
 - Concentrations of sediment in water delivered to the Bay
 - Concentrations of PCBs (dissolved and bound to sediment) delivered to the Bay

Watershed Dynamic Model (WDM) Status Update

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- Calibrated for flow ([Zi et al., 2021](#)) 
- Calibrated for sediment concentration ([Zi et al., 2022](#)) 
 - sediment size classes may be adjusted in collaboration with in-Bay modelers
- Calibration for PCBs is underway
 - currently PCBs are in particulate phase only
 - assumption that PCB concentration in sediment can be predicted by land use groups, in absence of spatially distributed source information
 - concentrations associated with different land use types will be optimized using available data across the whole bay watersheds
 - potential to associate different PCB concentrations with different size classes
- RMP Sources, Pathways, and Loading (SPL) Workgroup is reviewing the watershed model

Next Steps

- Modeling strategy in fall
- Pilot study design
- Modeling COW meeting
 - Feedback on modeling strategy
 - Feedback on proposed pilot study
- Implement pilot study
- Pilot study report



Thank you



PCBWG Proposal: Priority Margin Unit Shiner Surfperch PCB Trend Monitoring

Oversight group: PCB Workgroup
Proposed by: Jay Davis, SFEI

Summary

Conceptual site models for PCBs developed for several priority margin units in the Bay identified shiner surfperch as a crucial indicator of impairment in these areas, due to their explicit inclusion as an indicator species in the TMDL, their importance as a sport fish species, their tendency to accumulate high concentrations, their site fidelity, and other factors. The conceptual site models recommend periodic monitoring of shiner surfperch to track trends in the PMUs, and as the ultimate indicator of progress in reduction of impairment. A coordinated sampling of PCBs in shiner surfperch in four PMUs was conducted as an add-on to the 2019 Status and Trends sport fish sampling. Sampling for shiner was attempted but unsuccessful in two PMU areas: Emeryville Crescent and Steinberger Slough. Shiner were successfully collected and analyzed from San Leandro Bay and Richmond Harbor. The mean concentration in San Leandro Bay in 2019 was the highest observed at any of the S&T or PMU stations. Sampling at three stations in Richmond Harbor documented significant spatial variation with in this PMU, and high concentrations at two locations farther away from the open Bay. Repeat sampling of the San Leandro Bay and Richmond Harbor stations is needed to track long-term trends in support of management. Coordination with S&T sampling will yield significant savings in data management and reporting. In addition, a dataset for shiner surfperch will be obtained that is directly comparable across the PMUs and the five locations that are sampled in S&T.

Proposed Funding

1) \$39,000 (could be reduced with a reduced effort in Richmond Harbor)

Proposed Deliverables and Timeline

Deliverable	Due Date
Draft section in report on RMP S&T Sport Fish Sampling	Dec 2025
Final section in report on RMP S&T Sport Fish Sampling	Feb 2026

Introduction and Background

A thorough and thoughtful planning effort is warranted given the large expenditures of funding and effort that will be needed to implement management actions to reduce PCB loads from urban stormwater. Therefore, the RMP has a PCB Strategy that outlines a multi-year effort to implement the recommendations of the PCB Synthesis Report (Davis et al. 2014) pertaining to:

1. identifying margin units that are high priorities for management and monitoring (priority margin units, or “PMUs”),
2. development of conceptual models and mass budgets for margin units downstream of watersheds where management actions will occur, and
3. monitoring in these units as a performance measure.

The first step (Gilbreath et al. 2015) consisted of a preliminary assessment of margin units downstream of six pilot watersheds that have been prioritized for management actions. The second phase of the PMU workplan consisted of developing conceptual site models for four PMUs: Emeryville Crescent, San Leandro Bay, Steinberger Slough/Redwood Creek, and Richmond Harbor. Conceptual model reports have been completed for Emeryville Crescent, San Leandro Bay, and Steinberger Slough/Redwood Creek (Davis et al. 2017, Yee et al. 2019, 2021). A conceptual model for Richmond Harbor has not yet been developed.

The conceptual model reports included recommendations for efficient long-term monitoring of trends in the PMUs and their response to reductions in loads from the watersheds. The conceptual site models identified shiner surfperch as a crucial indicator of impairment in these areas, due to their explicit inclusion as an indicator species in the TMDL, their importance as a sport fish species, their tendency to accumulate high concentrations, their site fidelity, and other factors. The conceptual site models recommended periodic monitoring of shiner surfperch to track trends in the PMUs, and as the ultimate indicator of progress in reduction of impairment.

A coordinated sampling of PCBs in shiner surfperch in four PMUs was conducted as an add-on to the 2019 Status and Trends sport fish sampling. Sampling for shiner was attempted but unsuccessful in two PMU areas: Emeryville Crescent and Steinberger Slough. Shiner were successfully collected and analyzed from San Leandro Bay and Richmond Harbor. The mean concentration in San Leandro Bay in 2019 was the highest observed at any of the S&T or PMU stations (Figure 1). Sampling at three stations in Richmond Harbor documented significant spatial variation within this PMU, and high concentrations at two locations farther away from the open Bay (Figure 2).

This proposal outlines a project that would provide sampling of PCBs in shiner surfperch in two of the PMUs, at the same stations sampled in 2019. This can be done in a cost-effective manner in 2024 by piggybacking on to the 2024 S&T sport fish sampling (Figure 3). This coordination will yield significant savings in data management and reporting, because these results can be easily added to the S&T activities with negligible additional cost. In addition, a dataset for the same species (shiner surfperch) will be

1 obtained that is directly comparable across the PMUs and the five locations that are
2 sampled in S&T. The vision is to continue this approach in future rounds of S&T sport fish
3 sampling, providing data on PCBs in the San Leandro Bay and Richmond Harbor PMUs on a
4 five-year cycle. This sampling design would provide a key element needed to track long-
5 term trends in recovery of the PMUs.

6
7
8

Study Objective and Applicable RMP Management Questions

The objectives of this study are:

1. to establish baselines for long-term monitoring of PCB concentrations in shiner surfperch in the four PMUs, and
2. to understand local spatial variation in shiner PCB concentrations to support optimization of the long-term sampling design.

PCB Strategy Questions Addressed

1. What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination?
6. What are the near-term effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

RMP Management Questions Addressed

4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
 - B. What are the effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

Study Approach

The proposed sampling would be added to the RMP S&T sport fish sampling in 2024. Sampling shiner surfperch at five locations is a critical component of the S&T sampling, with collections made at the San Pablo Bay, Berkeley, San Francisco Waterfront, Oakland, and South Bay locations shown on Figure 3. The proposed sampling would add four more sites as indicated in Figure 4. These PMU sites could be included in the Sampling and Analysis Plan, data management, and the technical report on the S&T sampling, with the negligible additional cost covered by the S&T budget.

Three composites (20 fish per composite – the standard approach used in S&T) would be collected and analyzed from each PMU site by Moss Landing Marine Lab (MLML). MLML would also measure weight and length of the fish. PCBs would be analyzed as 209 congeners by SGS AXYS. Moisture and lipid would also be determined.

Tasks and Budget

Task 1: Study planning, include PMU shiner in S&T Sampling and Analysis Plan

Task 2: Collect and process samples, include PMU shiner in S&T cruise report

Task 3: PCB analysis

Task 4: Data management and QA, include PMU shiner surfperch in S&T dataset and QA report

Task 5: Include PMU shiner surfperch in S&T technical report

Budget: \$39K

Budget breakdown

# of Sites	4
# of Fish Composites per Site	3
# of Samples to Collect	12
Collection Cost per Sample	\$ 2,000
Sample collection cost	\$ 24,000
Dissection and Comp per Sample	\$ 110
Total Dissection and Comp	\$ 1,320
Analytical Cost per Sample	\$ 930
# of Field Samples to Analyze	12
QA Samples	2
Total Analytical Cost	\$ 13,020
Data Management	\$ -
Total Cost	\$ 38,340

Cost per station: ~\$9000

Timing and Deliverables:

All deliverables will be incorporated in S&T sport fish deliverables:

- S&T sampling and analysis plan – March 2024
- S&T cruise report – December 2024
- Draft S&T technical report – December 2025
- Final S&T technical report – February 2026

References

- Davis, J.A., D. Yee, A.N. Gilbreath, and L.J. McKee. 2017. Conceptual Model to Support PCB Management and Monitoring in the Emeryville Crescent Priority Margin Unit. San Francisco Estuary Institute, Richmond, CA. Contribution #824.
- Yee, D., A.N. Gilbreath, L.J. McKee, and J.A. Davis. 2019. Conceptual Model to Support PCB Management and Monitoring in the San Leandro Bay Priority Margin Unit – Final Report. SFEI Contribution No. 928. San Francisco Estuary Institute Richmond, CA.
- Yee, D., A.N. Gilbreath, L.J. McKee, and J.A. Davis. 2021. Conceptual Model to Support PCB Management and Monitoring in the Steinberger Slough/Redwood Creek Priority Margin Unit – Final Report. SFEI Contribution #1009. San Francisco Estuary Institute, Richmond, CA.

1 Figure 1. PCB concentrations (ppb ww) in shiner surfperch in San Francisco Bay, 2019. Bars indicate average concentrations.
 2 Points represent composite samples with 20 fish in each composite. Locations labeled with the same letter did not
 3 have significantly different means (Tukey HSD, alpha = 0.05). The colored lines indicating ATL thresholds show the
 4 lower end of the ATL ranges. Richmond Harbor and San Leandro Bay were sampled as part of the shiner surfperch
 5 special study in 2019.
 6

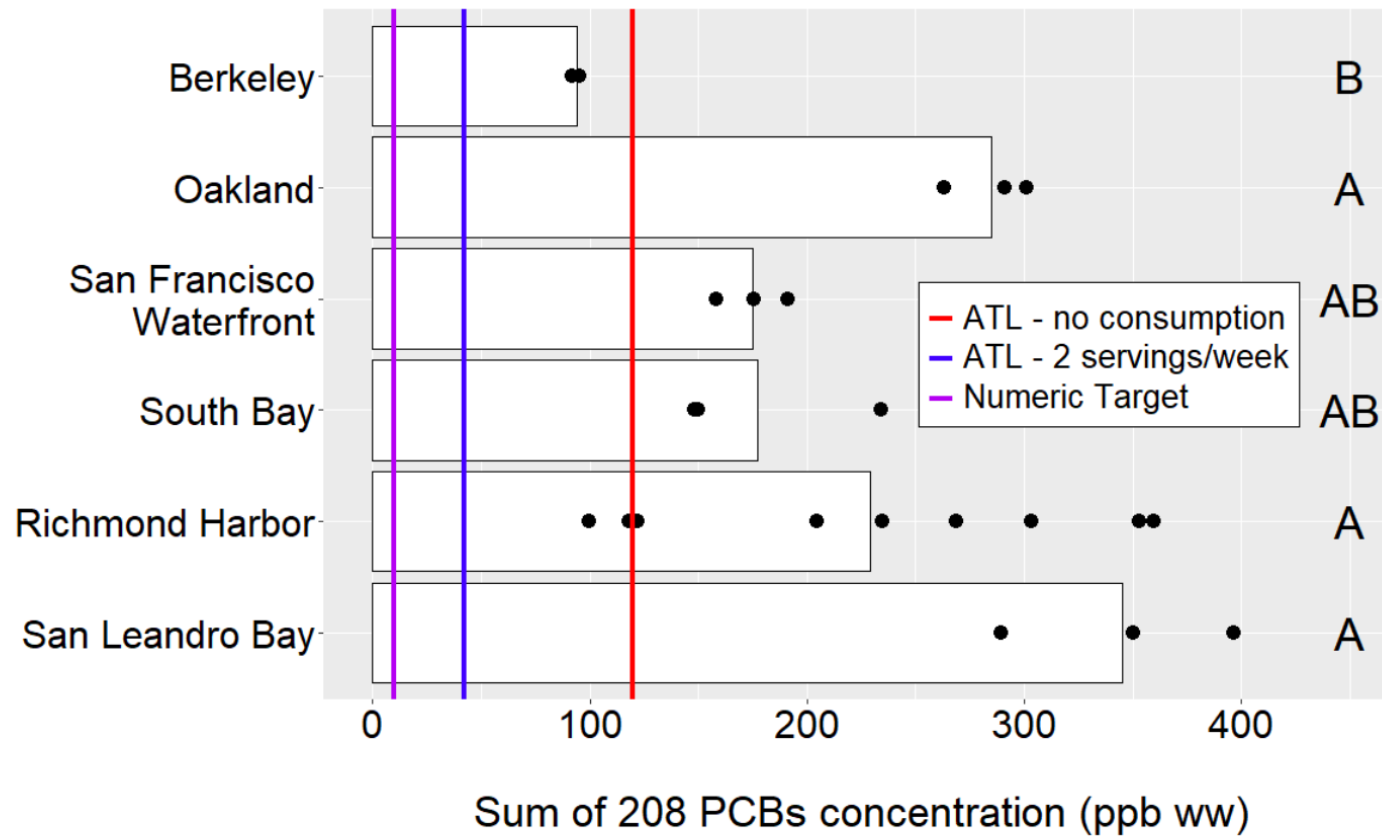


Figure 2. PCB concentrations (ppb ww) in shiner surfperch in Richmond Harbor, 2019. Bars indicate average concentrations. Points represent composite samples with 20 fish in each composite. Locations labeled with the same letter did not have significantly different means (Tukey HSD, $\alpha = 0.05$). The colored lines indicating ATL thresholds show the lower end of the ATL ranges.

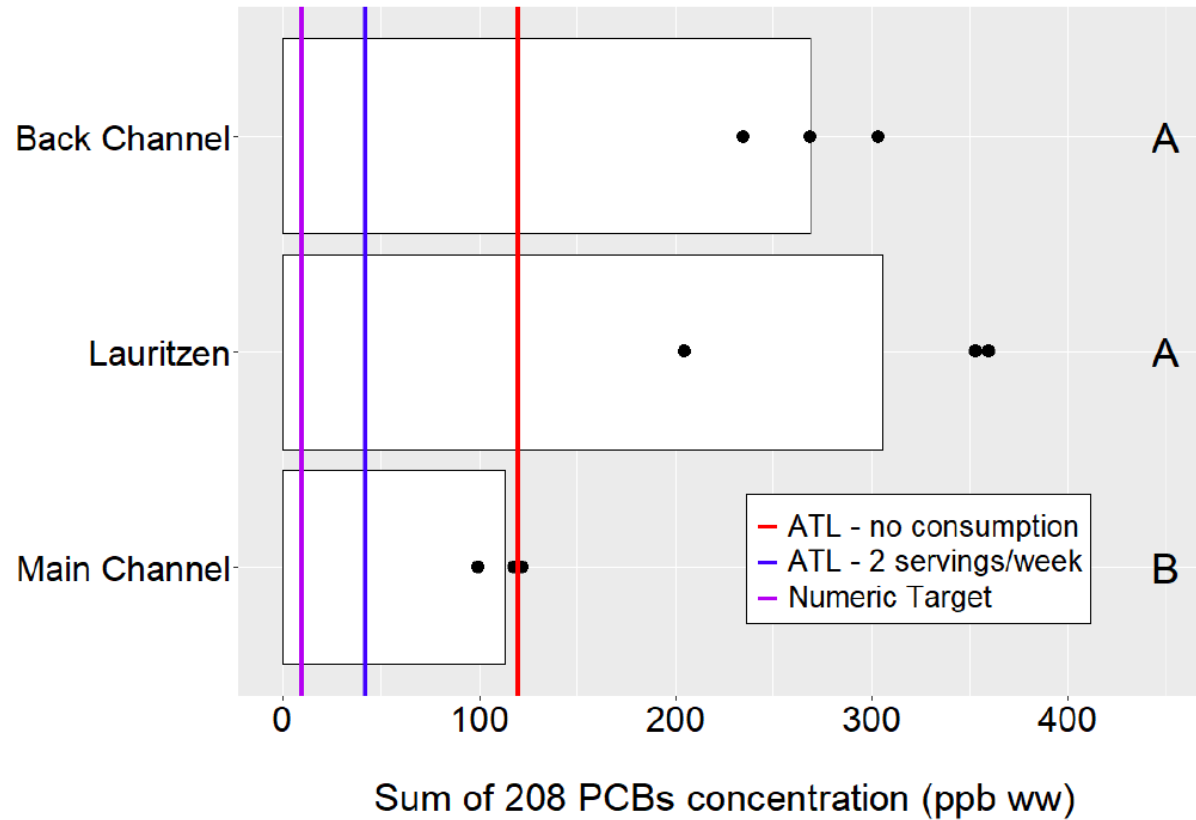
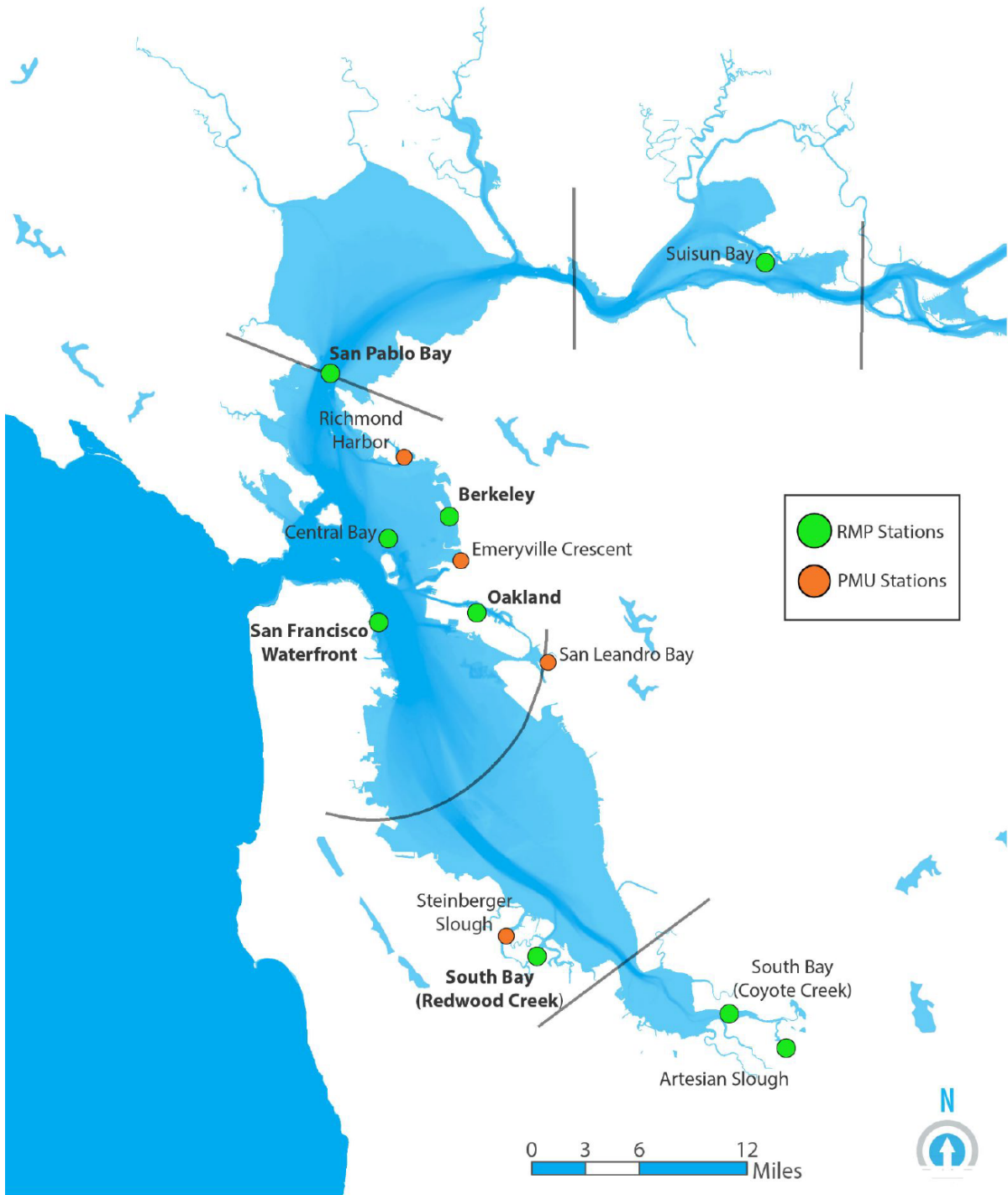


Figure 3. RMP S&T and PMU sport fish sampling locations, 2019.



1 Figure 4. Proposed shiner surfperch sampling locations in the PMUs.
2



3

PCBWG Proposal: Monitoring of Sediment Deposition in San Leandro Bay Intertidal Areas

Summary

This study proposes to measure sediment deposition within the San Leandro Bay (SLB) priority margin unit (PMU) using an array of tools, including sediment marker horizons, sediment pins, surface elevation tables, and sediment traps. Areas across a span of distances nearer and further from discharge areas in SLB for watersheds of interest for PCB loading (East Creek, Damon Slough) will be monitored for sedimentation and net sedimentation (i.e., either net deposition or erosion) quarterly over the course of one year to capture seasonal-scale processes. One potentially useful add-on to the effort is measurement of grain size in sediment trap material and in surface sediment adjacent to the monitored points, which may help the parameterization of particle sizes for both the Watershed Dynamic Model (WDM) and in-Bay fate model locally. A second add-on would be measurement of PCBs in sediment trap material, which will be useful in distinguishing the PCBs in newly settling mobile sediment in comparison to previous sampling efforts characterizing consolidated bed surface sediment.

Estimated Cost:	\$67-99k
Oversight Group:	PCBWG
Proposed by:	Don Yee
Time Sensitive:	Yes, for summer 2024 SLB model completion (most useful if available before model fully calibrated). Late fall 2023 deployment needed to capture at least one wet season for model validation.

Background

Priority margin units (PMUs) are areas in the Bay near known upland sources of legacy contaminants that are likely to be most impacted by management-driven increases or decreases in pollutant loading. Cores in some vegetated wetlands have shown evidence of reductions in some legacy contaminants. Downward mixing in vegetated wetland areas is reduced due to the vegetation limiting resuspension and bioturbation. However, in many intertidal mudflats, it is unknown if contaminants present in sediment accessible to biota are due to sediment accretion, downward mixing, or some combination of both.

Models of long-term sediment and contaminant fate in PMUs, and the Bay in general, are in development and will require empirical data for the variables being simulated, including net sediment accretion or erosion. Accurate predictions of net sedimentation are critical to

estimates of recovery time for persistent legacy pollutants such as PCBs, since a major PCB loss pathway via sediment burial is anticipated to be highly sensitive to net sedimentation rate in both the regional-scale PCB fate model (Davis 2004) and local-scale conceptual models for PMUs such as SLB (Yee et al., 2019).

This study would monitor net sedimentation at sites within San Leandro Bay (SLB) in order to locally calibrate or validate estimates of expected sedimentation obtained by the integration of watershed models of flow and sediment supply (the Watershed Dynamic Model, WDM, Zi et al., 2022) being currently developed at SFEI, and high-resolution hydrodynamic and sediment transport models being developed for SLB, extended from Bay-wide hydrodynamic modeling efforts in DelftFM for the Nutrient Management Strategy (King et al., 2019).

Both WDM and DelftFM have been primarily focused to date on Bay-scale processes and have been initially calibrated to capture average responses at a regional scale, rather than within localized areas like SLB. As a result, data to locally calibrate and validate processes for SLB specifically will be needed to make predictions of recovery rates sufficiently accurate to project recovery rates from legacy contamination, and responses to reductions in inputs of sediment-bound pollutants.

Study Objectives and Applicable RMP Management Questions

Table 1. Study objectives and questions relevant to RMP PCBWG management questions.

Management Question	Study Objective	Example Information Application
1. What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination? a. What would be the impact of focused management of PMU watersheds?	Empirical sediment downward and net flux (Optionally PCBs and/or grainsize in new settling sediment).	1a. Sediment burial rate input to simple PCB box model, or downward flux and net sedimentation target for dynamic sediment loading and fate models (Seasonal settling PCBs compared to event stormwater PCBs, grainsize validation for WDM loads and SLB transport models)
b. What would be the impact of management of in-Bay contaminated sites?		1b. Not directly addressed

Approach

This study proposes to measure sediment deposition rates within the San Leandro Bay PMU using an array of tools, including sediment marker horizons, sediment pins, surface elevation tables, and sediment traps. Net sediment accretion or erosion estimated using these methods will be useful for calibrating and validating models of long-term sediment fate.

Sediment marker horizon methods planned will include feldspar clay, and plastic lighting grids (<http://www.tidalmarshmonitoring.net/monitoring-methods-marker-horizons.php>). Feldspar layers may potentially be eroded away or bioturbated, and repeated measurements can deplete or disturb the layer over time. However, if the layer is not eroded away, a handful of measurements in the course of a year can be systematically sampled to avoid already disturbed portions of the marker plot. The plastic grid marker will be resistant to erosion and may be able to show net erosion (up to the thickness of the grid). However, larger degrees of erosion would not be shown as the grid would simply drop down to the eroded surface.

Sediment pins placed on the corners of the marker horizon plots will be used as visual markers to find the plots and provide evidence of net accretion or erosion. Sediment pins are somewhat subject to localized erosion around their points of insertion (larger for larger diameter pins), so paired sediment pins driven to equal heights spaced several feet apart, with a contractor's level carried to the field spanning them, can be used as a portable surface elevation table (SET), by measuring the distance to the sediment surface at several points from the spanning level (Prof. John Rybczyk, pers. comm.).

About 1-2m away, but at approximately the same elevation as the marker/pin/SET assemblies, mason jars equipped with coarse mesh (¼") stainless steel screened lids will be placed as sediment traps to capture downward sediment flux, which combined with the net sedimentation rate can be used to back-calculate resuspension flux. The screening will reduce disturbance of the trap contents by biota or waves and currents.

The proposed scope is for eight areas (Figure 1), with two tidal elevations each (16 installations total). Measurements in East Creek and Damon Slough are proposed at areas near (~20 m) and further (~100 m) from the main channels. An additional site pair midway between these two areas will provide information on processes further from those inputs. Site pairs further away from these inputs on the east and west sides of Arrowhead Marsh, areas without immediately proximate tributary input, and near the channel on the south end of Alameda, near SLB's exchange point with Central Bay, can provide information on longer distance transport processes, and interactions near the Bay boundary.

The deployments will be visited quarterly to check on their status and measure estimates of sediment accretion or erosion. Deployment is estimated to require several days of field work for

a crew of two people. An initial site visit about a month after deployment is planned to inspect the integrity of the installations and make adjustments as needed (e.g., copper screening may be used instead if excessive biofouling occurs).

If the deployments remain intact, subsequent quarterly visits are planned to make measurements and collect sediment traps. The effort is scalable, and could include more areas (e.g., sites near the entry of Elmhurst Slough and San Leandro Creek, and Alameda Channel), or more elevations in each area.

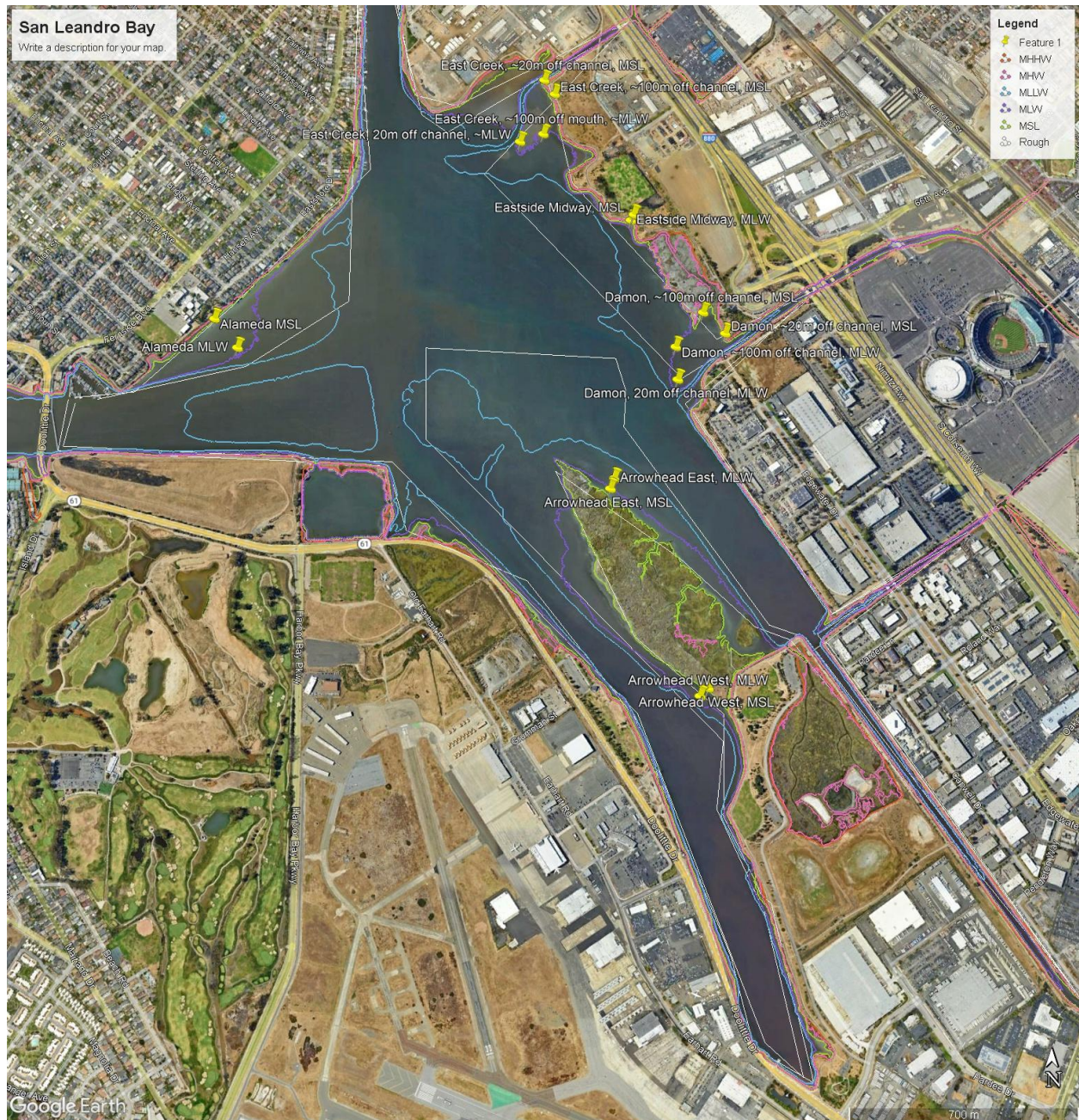


Figure 1. Proposed locations for sediment markers and traps

Locations are placed at elevations around MSL and MLW near boundary inputs of sediment and water, and in central areas around Arrowhead Marsh to capture the interaction of inputs with local transport processes.

A possible add-on is grain size characterization of sediment trap material and in surface sediment near the deployments (16 points in 4 seasons, + QC = ~70 samples). A second add-on would be measurement of PCBs in sediment trap material, with the approximate cost of (8 deeper points + QC = ~10 samples). Costs for the monitoring plan and these options are shown

in Table 1. The study duration, frequency of visits, and number of sites can also be scaled somewhat.

Table 1. Estimated Cost:

Expense	Estimated hours	\$ Cost
Labor		
Planning & mgmt	60	10500
Field Work, pre & post	250	40000
Reporting	80	14000
Direct Costs		
Equipment		2000
Travel		400
Subtotal		66900
Subcontracts		
Grainsize (4 events+ 1x bed sed +QC)		12900
Data mgmt/reporting	30	4500
Shipping		600
Subtotal grainsize		18000
PCBs (Feb 2024 MLW traps+QC)		9200
Data mgmt/reporting	30	4500
Shipping		600
Subtotal PCBs		14300

Deliverables and Schedule

Monitoring plan development	Oct 2023
Marker deployment	Mid-late Nov 2023
Site Revisits & Measurements	Dec 2023, Feb, May, Aug, Nov 2024
Lab analysis grainsize	Feb, May, Aug, Nov 2024 (+2mo lab turnaround)
Lab analysis PCBs	Feb 2024 (+2mo)
Technical report and data upload	March 2025

References

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