Quarterly Progress Report

September 2025

Project Title

Sediment Mercury Concentrations in the Closed Area of Lavaca Bay and the Risk to Wildlife from Mercury Remobilization During Dredging

Contract # 041

Submitted to

Matagorda Bay Mitigation Trust

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Project Summary

The Closed Area of Lavaca Bay is a mercury (Hg) Superfund site that is undergoing long-term environmental monitoring. The proposed Matagorda ship channel expansion project will dredge in the Closed Area and could remobilize Hg stored in sediment back into the bay. This study will investigate how sediment Hg concentrations vary with depth throughout the proposed dredging area and undertake lab-based toxicity and bioaccumulation experiments to determine whether the Hg-rich sediment is toxic to benthic organisms. Agencies can use the data to make informed decisions about how to dredge and dispose of the Hg-rich sediment to minimize its environmental impact.

Project Goals and Objectives

The goal of this project is to investigate sediment Hg concentrations in the Closed Area of Lavaca Bay (with a focus on the area that will be dredged) and determine whether sediment Hg concentrations are high enough to pose a threat to the health of benthic organisms if Hg is remobilized during the proposed dredging activities. This study can be broken down into six objectives:

Objective 1: Investigate how THg concentrations change with sediment depth to determine 1) at what depth the greatest THg concentrations are found; 2) how thick the Hg layer is; and 3) how THg concentrations vary spatially throughout the Closed Area.

Objective 2: Map the bay floor and investigate the relationship between sediment THg concentrations and sediment characteristics (grain size and organic matter content).

Objective 3: Use radioisotopes (^{210}Pb and ^{137}Cs) to create sediment age-depth profiles and determine sedimentation rates.

Objective 4: Speciate THg in the surface and Hg layer sediment to determine the MeHg concentration and percent MeHg and determine the bacterial composition of the sediment.

Objective 5: Calculate how much Hg could potentially be released into Lavaca Bay from the proposed dredging activities.

Objective 6: Determine whether sediment Hg concentrations are high enough to cause toxicity to benthic organisms (polychaete worms, amphipods, bivalves, gastropods) using laboratory-based toxicity tests and bioaccumulation experiments.

Project Update

This quarter we completed work on Objectives 1, 2, 3, 4, and 6.

Objective 1

All sediment cores for this project have been collected. 32 cores were collected in June 2023 and 28 cores were collected in May 2024 (Fig. 1). All the cores have been sectioned into 1 cm or 2 cm depth intervals and each depth interval has been subsampled for different analyses.

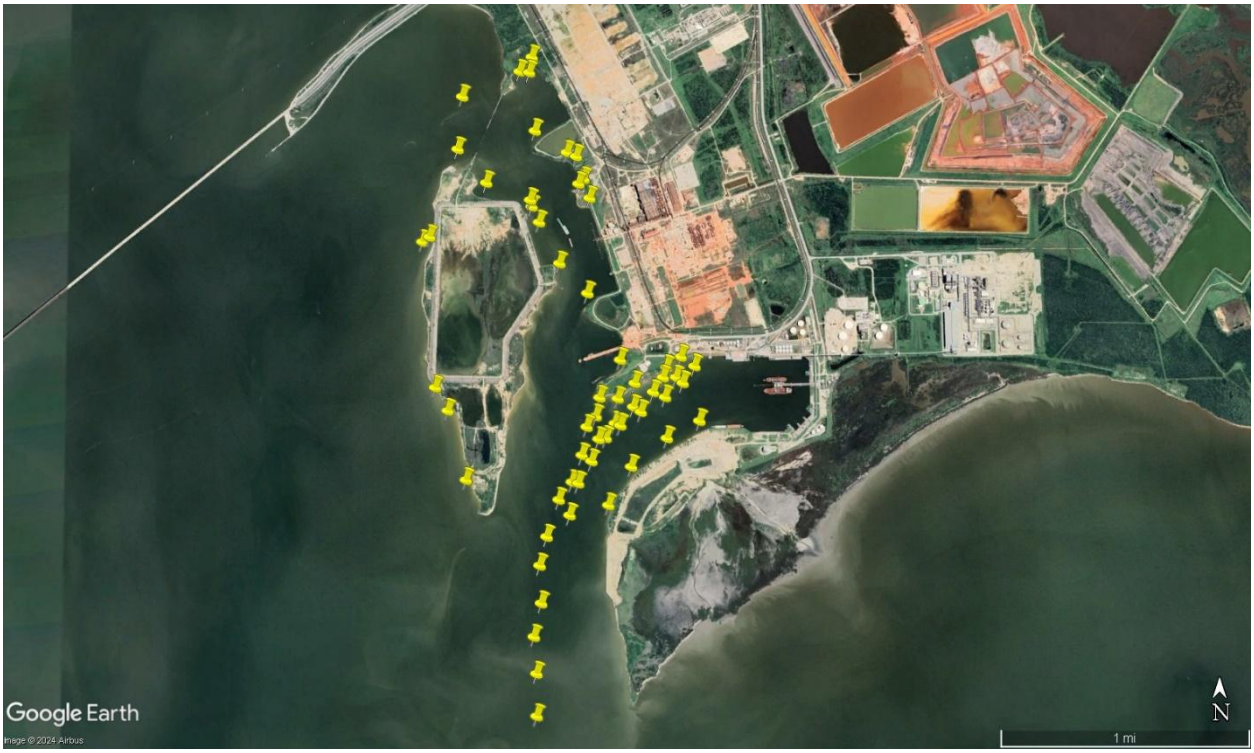

Figure 1. 2023 and 2024 sediment core collection locations. The yellow pins show the location of each core.

Out of the 60 cores, Hg analysis has been completed for 91.7% (n = 55) of them. The breakdown by year is as follows:

2023

- Number of cores subsampled for the different analyses = 32
- Number of cores that have been freeze-dried = 30
- Number of cores that have had the Hg concentration measured in each depth interval = 30

2024

- Number of cores subsampled for the different analyses = 28
- Number of cores that have been freeze-dried = 27
- Number of cores that have had the Hg concentration measured in each depth interval = 25

The Hg concentration in each sediment sample (190 – 220 mg) was measured using a Direct Mercury Analyzer (DMA-80; Milestone Inc., Shelton, CT) which utilizes thermal decomposition, amalgamation, and atomic absorption spectrophotometry. One set of quality control, including a blank, certified reference material (either MESS-4 marine sediment; PACS-3 marine sediment; DORM-5 fish protein; or ERM CE-464 tuna), and duplicate sample was included with every 10 samples analyzed.

Objective 2

CHIRP profiling and detailed grain size analysis

The two sets of CHIRP profiles that were collected in June 2024 from greater Lavaca Bay and from the Superfund site (Closed Area) in Lavaca Bay (Fig. 2) have been fully processed for noise, artifacts, and conversion of the vertical scale to depth. Final interpretations of these processed CHIRP profiles will be achievable once the detailed grain size datasets for all relevant cores are available to inform them.

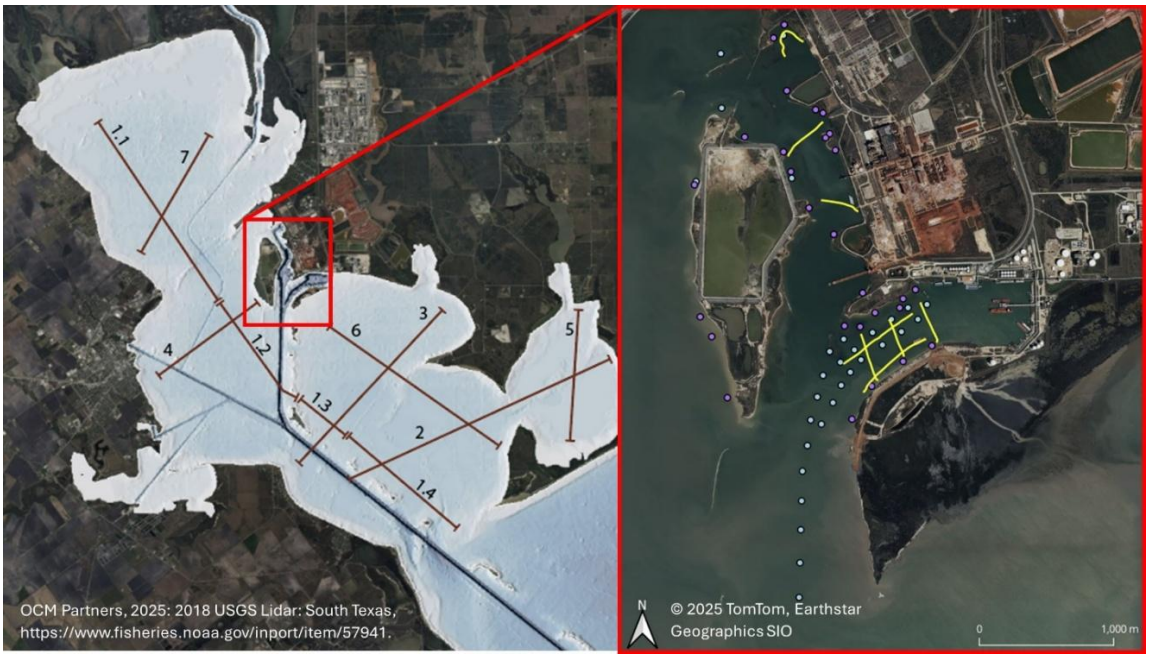

Figure 2. Location of greater Lavaca Bay CHIRP profiles (left) and Closed Area (Superfund site) CHIRP profiles displayed with 2023 core locations in blue and 2024 core locations in purple (right).

Detailed grain size analysis of the eight cores that will inform CHIRP profile interpretations and assist with regional correlations are underway. Subsamples from each interval in the core must be collected and freeze-dried before being subjected to treatment with hydrogen peroxide to digest organic matter. Sediment must then undergo a series of washes to remove residual hydrogen peroxide before being freeze-dried again. After a dry weight is obtained for a sample, it is wet-sieved to isolate the fine fraction that will be analyzed on the Sedigraph. To date, Sedigraph analysis has been completed for three cores (4, 14B, 6), whereas ~50% of the intervals have been analyzed for core 36. The remaining four cores are at various stages of sample preparation.

Grain size analysis

To date, basic grain size analysis (coarse vs fine fraction) has been completed for 28 cores collected in 2023 and 26 cores collected in 2024.

Basic grain size analysis was completed by washing sediment through a 63 μm mesh sieve to determine the percent coarse (sand and larger sized particles) versus fine (silt and clay sized particles). Between 5 and 5.5 g of dried sediment was rehydrated for 24 hours and washed through a 63 μm mesh sieve, after which the retained coarse fraction was dried at 105℃ for 18 to 24 hours and weighed. Samples that had particles > 2 mm (e.g., gravel, small shells, or shell fragments) were passed through a 2 mm mesh sieve and the sediment retained in the mesh weighed. The weight of the coarse fraction (< 2mm) was then divided by the weight of the bulk sediment prior to rehydration to determine the percent coarse fraction. The percentage difference between the coarse fraction and 100 was the percent fine grain sediment. Quality control included a duplicate sample for one depth interval in each core.

Organic matter content

To date, organic matter content has been determined for 27 cores collected in 2023 and 25 cores collected in 2024.

The organic matter content in each depth interval from each core is determined using the loss-on-ignition (LOI) method. Freeze dried sediment is heated in an oven at 105℃ for 1 hour to make sure there is no residual moisture. 3 – 3.5 g of weighed sediment is then burned in a muffle furnace at 550℃ for 4 hours and allowed to cool overnight, after which it is weighed again. The percent organic matter content is then calculated using the following equation:

$$\% \text{ organic matter content} = [(\text{weight}_{105} - \text{weight}_{550})/\text{weight}_{105}] * 100$$

where weight_{105} is the sample weight prior to burning and weight_{550} is the sample weight after burning. Quality control included a duplicate sample for two depth intervals in each core.

Objective 3

All depth intervals from two cores (16, 25) were shipped to the Science Museum of Minnesota for ^{210}Pb and ^{137}Cs dating in April 2025. Prior to shipment, the salt was removed from all samples, and the samples were freeze-dried, powdered, and packaged into individual tubes.

The initial results were received at the start of August. Results from the gamma spectrometers showed no detectable ^{137}Cs in both cores, suggesting that ^{137}Cs is highly mobile in the pore water of the sediment at both sites, and as a result will not be a dependable chronological marker. The ^{210}Pb activity from the gamma measurements showed that ^{210}Pb activity was very low at the sediment surface (< 1.5 pCi/g), indicating ^{210}Pb dilution due to high sedimentation rates, which is not unexpected at these sites. Core 25 will now be analyzed for alpha ^{210}Pb since there was a general decay gradient down the core in the gamma ^{210}Pb results. In comparison, core 16 displayed no decay gradient with depth, so will not be further examined using alpha ^{210}Pb.

Depth intervals from another core (5) have been processed and shipped to the Science Museum of Minnesota. Due to the gamma findings for the previous two cores, core 5 will only be analyzed for alpha ^{210}Pb.

Objective 4

Sediment microbial community

The sediment microbial composition is being investigated in 10 cores collected in 2023. For each core, depending on the thickness of the Hg layer, between five and 11 different depths have been investigated. In total, 68 samples have been included in the study, and each sample has been analyzed twice. The forward and reverse primer sequence data has been collected, and data analysis is ongoing.

Mercury speciation to determine percent methylmercury in the sediment

43 of the samples used to determine the sediment microbial community composition have been shipped to the USGS Mercury Research Lab in Madison, WI to determine the methylmercury (MeHg) concentration. The MeHg analysis has been completed for 32 of the samples.

Objective 6

Now that the Hg concentrations have been measured in most of the cores, PI Dutton's group have started planning the laboratory-based toxicity tests and bioaccumulation experiments. The aqueous and sediment toxicity tests using the benthic amphipod *Leptocheirus plumulosus* are scheduled to begin in October 2025.

Goals for the Next Quarter

- Finish measuring the Hg concentration in the remaining sediment cores (Objective 1)
- Complete the Sedigraph measurements and begin the integration of grain size data with CHIRP profiles to generate final CHIRP interpretations (Objective 2)
- Finish the basic grain size analysis and organic matter content analysis (Objective 2)
- Finish the ^{210}Pb and ^{137}Cs dating (Objective 3)
- Finish the sediment microbial community analysis (Objective 4)
- Finish the MeHg analysis (Objective 4)
- Start the sediment toxicity tests (Objective 6)