Quarterly Progress Report

June 2026

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

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.

Mercury analysis has been completed on all cores. In total, once sectioned, 60 cores resulted in ~3,000 sediment samples. For each core, a Hg concentration vs depth profile is now being plotted to 1) investigate how the Hg concentration changes with sediment depth; 2) determine at what depth the Hg-rich layer is at; 3) determine how thick the Hg layer is; and 4) assess how the Hg profiles vary spatially throughout the Superfund site.

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.

An abstract has been submitted to present the results of this objective at a national conference in November 2026.

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. Interpretations of CHIRP profiles have been completed.

The CHIRP profile interpretations were used to inform the selection of shell samples for radiocarbon dating at Woods Hole Oceanographic Institution (Woods Hole, MA). Twelve mollusk samples from various depths in cores 5, 7, 9, 10, 14B, 19, 27, 36, 49 were radiocarbon-dated at the National Ocean Sciences Accelerator Mass Spectrometry Facility (NOSAMS) to determine if certain sedimentary units were relatively modern or if cores had penetrated into older Pleistocene strata. The data were also used to help inform whether cores exhibit signs of disturbance (e.g., successive samples exhibiting out-of-order ages). The dating was completed this quarter.

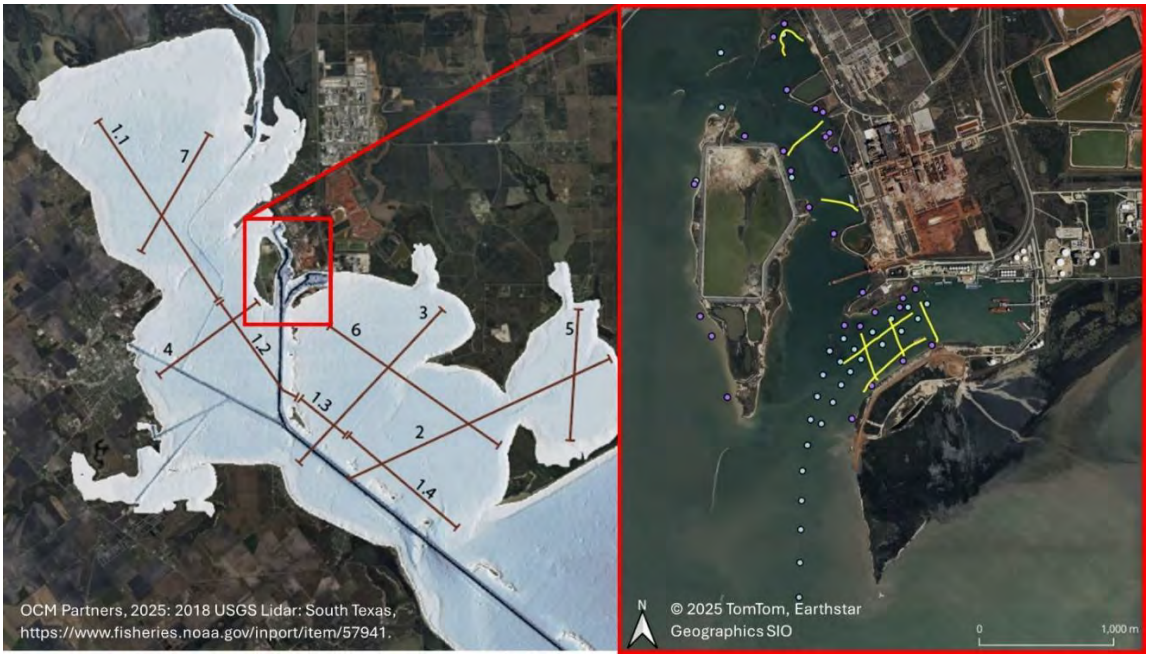

Figure 2. Location of greater Lavaca Bay CHIRP profiles (left) and Closed Area (Superfund site) CHIRP profiles displayed with 2023 core locations in blue and 2024 core locations in purple (right).

Grain size analysis for the eight cores (1, 4, 6, 9, 14B, 36, 37, 49) selected for detailed granulometry using the SediGraph particle size analyzer was completed this quarter. With these measurements, the mud fraction (<63 µm in diameter) was isolated and examined in greater detail to determine the background sedimentation conditions across Lavaca Bay. The sand fraction (63 µm – 2 mm diameter) was removed via sieving and excluded from SediGraph analysis due to instrument analytical limits and because it is largely composed of carbonate shell fragments that may not necessarily reflect local current velocity and sediment transport conditions. Data generated by the SediGraph include grain size mean, mode, percent (by mass) of clay (<4 µm diameter), and percent (by mass) of silt (4 µm – 63 µm diameter). Downcore trends will be evaluated in the context of changes in natural energy conditions and anthropogenic disturbances. Cores are being interpreted alongside broader subsurface context provided by CHIRP profile interpretations.

Basic grain size fractionation

Basic grain size analysis (coarse vs fine fraction) has been completed for all 60 cores. Sediment at each depth interval from each core was passed through a 63 µm mesh sieve to determine the percent coarse (sand and larger sized particles) versus fine (silt and clay sized particles). A depth profile is now being created for each core.

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°C 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 was 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

Organic matter content has been completed for all 60 cores.

The organic matter content in each depth interval from each core was determined using the loss-on-ignition (LOI) method. Freeze dried sediment was heated in an oven at 105°C for 1 hour to make sure there is no residual moisture. 3 – 3.5 g of weighed sediment was then burned in a muffle furnace at 550°C for 4 hours and allowed to cool overnight, after which it was weighed again. The percent organic matter content was 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. A depth profile is now being created for 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 2025. 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 was 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. Alpha ^{210}Pb dating was completed for core 25 this quarter and the analysis of the results is ongoing. Initial results show there is a ^{210}Pb decay profile, but a possible major spike in sedimentation between 18 and 40 cm depth is causing the ^{210}Pb signature to be diluted compared to the section above and below it.

Depth intervals from another core (5) were shipped to the Science Museum of Minnesota in September 2025 for alpha ^{210}Pb analysis. There was no clear ^{210}Pb signature with depth, most likely due to a high sedimentation rate and/or physical or bioturbation.

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 were shipped to the USGS Mercury Research Lab in Madison, WI to determine the methylmercury (MeHg) concentration. The MeHg analysis has been completed for all the samples.

Another ~60 sediment samples are being selected for MeHg analysis to increase the sample size of the dataset.

Objective 6

The acute aqueous toxicity tests using neonate (1-2 mm), juvenile (2-3 mm), and adult (4-5 mm) *Leptocheirus plumulosus*, a species of benthic amphipod commonly used in toxicity tests was completed this quarter. The results of the study were presented at a conference in April 2026.

Weeks, T., J. Kuntz, and J. Dutton (2026) Investigating the impact of mercury exposure on the mortality of benthic amphipods in a Superfund site (Lavaca Bay, Texas) using acute aqueous toxicity tests. South-Central Regional Chapter of the Society of Environmental Toxicology and Chemistry Annual Meeting. San Marcos, TX.

Trials began for the sediment toxicity tests this quarter.

Goals for the Next Quarter

- Continue data analysis and interpretation (Objectives 1-4)
- Select and ship more sediment samples for MeHg analysis (Objective 4)
- Start the sediment toxicity tests (Objective 6)