Appendix C

Matagorda Ship Channel Oyster Resources Survey, Upper Reach Placement Area Project, Calhoun County, Texas, June 2017

OYSTER RESOURCES SURVEY
MATAGORDA SHIP CHANNEL
UPPER REACH PLACEMENT AREA PROJECT
CALHOUN COUNTY, TEXAS

Prepared for:

U.S. Department of the Army
Corps of Engineers, Galveston District
2000 Fort Point Road
Galveston, Texas 77550

Prepared by:

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June 2017

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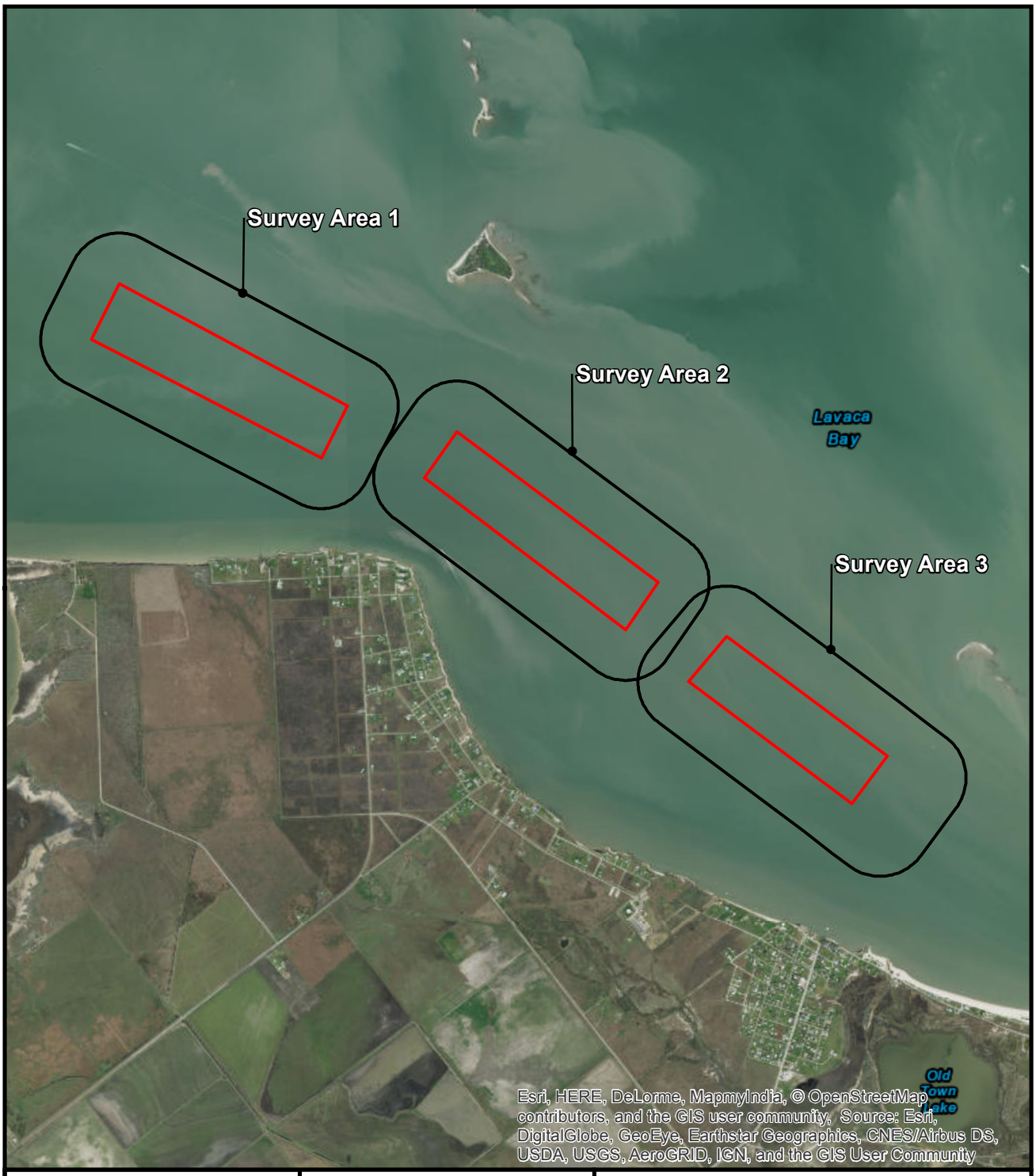
Acronyms and Abbreviations

Cº	degrees Celsius
CPUE	catch-per-unit-effort
GNSS	global navigation satellite system
LEI	Lloyd Engineering, Inc.
mg/l	milligrams per liter
MSC	Matagorda Ship Channel
NMFS	National Marine Fisheries Service
NTU	Nephelometric turbidity unit
oysters/ft^3	oysters per cubic foot
PA	placement area
psu	practical salinity unit
SA	Survey Area
SOL	SOL Engineering Services, LLC
SSS	side-scan sonar
su	standard unit
TPWD	Texas Parks and Wildlife Department
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

1.0 Introduction

SOL Engineering, LLC (SOL) subcontracted Lloyd Engineering, Inc. (LEI) to conduct an oyster resources survey on behalf of the U.S. Army Corps of Engineers (USACE), Galveston District to evaluate the potential impacts associated with the utilization of dredged material placement areas (PA) located west of the Matagorda Ship Channel (MSC). LEI conducted surveys to determine the presence or absence of oyster resources within PA numbers 16A, 15A, and 14A. Additionally, surveys were conducted approximately 1,000 feet beyond the limits of each PA to determine potential avoidance measures of oyster resources via minor modifications to the limits of the described PA's. This report details the findings of the oyster resources survey conducted and includes exhibits depicting the extent of oyster resources and potential oyster resources within the project area.

The project area is positioned south of the MSC within the Lavaca Bay complex, located in Calhoun County, Texas. Survey Area 1 encompassed PA 16A and measures approximately 7,100 feet long and 3,200 feet wide (500 acres). Survey Area 2 encompassed PA 15A and measures approximately 7,000 feet long and 3,100 feet wide (480 acres). Survey Area 3 encompasses PA 14A and measures approximately 6,600 feet long and 3,200 feet wide (466 acres). Refer to Figure 1 for a vicinity map depicting the location of the project area.



LLOYD ENGINEERING, INC.

Legend

- Survey Area
- Placement Area

Coordinate System: NAD 1983 StatePlane Texas South Central FIPS 4204 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
False Easting: 1,968,500.0000
False Northing: 13,123,333.3333
Central Meridian: -99.0000
Standard Parallel 1: 28.3833
Standard Parallel 2: 30.2833
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Units: Foot US

0 3,000 6,000 Feet

Figure 1

Vicinity Map
Oyster Resources Survey
Matagorda Ship Channel
Upper Reach Placement Area Project
U.S. Army Corps of Engineers

Calhoun County, Texas

Prepared By: J. Wiedeman	1 inch = 3,000 feet
	Date: Apr 17, 2017

American Oyster (*Crassostrea virginica*)

American oysters (*Crassostrea virginica*) are sessile, bi-valved mollusks that occur throughout the Gulf of Mexico in shallow bays, mud flats, and offshore sandy bars (Stanley and Sellers, 1986). Oysters grow well on a variety of substrates, ranging from rocky bottoms to some types of mud. The presence and growth of oysters are closely correlated with salinity and other abiotic variables.

Oysters spawn from March through November in the northern Gulf of Mexico (Bulter, 1954), and the peak of spawning season in Texas is between May and early June (Stanley and Sellers, 1986). Spawning is triggered mostly by temperature when it rises above 20 degrees Celsius (C^{o}) for normal spawn and above 25^{o}C for mass spawning (Pattillo, et al., 1997).

Eggs hatch six hours after fertilization, and oyster larvae remain in the water column as meroplankton for two to three weeks after hatching (Patillo, et al., 1997). As a reference, settling or attachment to substrate was first observed in Galveston Bay about two months after spawning when the larvae were approximately 0.2 millimeter in length (Hopkins, 1931).

Upon settling or attachment, the sessile juveniles are referred to as spat. Spat-fall on the Gulf Coast typically occurs from March to mid-November (Gunter, 1955; Hopkins, 1931). Juveniles begin to develop once larvae attach. In the Gulf, sexual maturity of oysters may occur as soon as four weeks after attachment (Menzel, 1955), but generally maturation occurs at 18 to 24 months of age (Quast, et al.,1988).

Growth rates of adult oysters can vary greatly depending on conditions. Some adult oysters have been documented to grow at a rate of 50 millimeters per year (Bulter, 1954). Gunter (1951) provides growth rates of 60 millimeters in the first year, 90 millimeters in the second year, and 115 millimeters in the third year. Based on these growth rates, it is possible for an oyster to reach harvestable size of 76.2 millimeters (3 inches) within two years.

During open season, anyone with a Texas Parks and Wildlife Department (TPWD) harvester's license may harvest oysters from areas open to harvesting and sell to dealers certified by the Texas Department of Health. The rest of the year, harvest occurs on private oyster leases, mainly in Galveston Bay, home to 60 to 70 percent of the oyster crop along the Texas coast.

Oyster season in Texas lasts from November 1 through April 30; however, the Texas Department of Health and Safety has the discretion to close the fishery if the water conditions become conducive to propagation of toxic bacteria making oysters unsafe for human consumption.

2.0 Methods

The oyster resources survey methodology was completed in two phases. Phase 1 involved the use of side-scan sonar (SSS) and single-beam bathymetry surveys to identify anomalies throughout the project area. Phase 2 included the verification and characterization of the identified anomalies to delineation any oyster resources or potential oyster resources located within the project area. The following sections describe the methods implemented in Phase 1 and Phase 2 of the oyster resources survey.

2.1 Phase 1

During Phase 1 of the oyster resources survey, Hydrographic Consultants Ltd. and BOB Hydrographics, LLC was contracted by LEI to perform a remote-sensing sonar survey within the project area. From January 25-30, February 27-28, and March 9, 2017, contractors used an Edgetech 4125 sonar towfish with Edgetech's Discovery data acquisition software to acquire high-resolution, geo-rectified imagery of the bay floor within the project area. The SSS was towed behind a survey boat along parallel transects spaced approximately 20 meters apart to ensure 100 percent coverage of the project area.

Sub-meter positioning of the survey boat was accomplished using a Trimble Geo 7X global navigation satellite system (GNSS). Hypack navigation software running on a laptop computer was used to guide the survey boat along the previously established transects. A geo-referenced digital drawing of the survey area was utilized as a real-time moving map display for the navigation software and raw sonar data was recorded by the Discovery software on a laptop computer.

Upon completion of the field data acquisition, a mosaic sonar image was created using Chesapeake SonarWiz software to form a composite image of the bay floor. The mosaic was exported as georeferenced tiff files and provided to LEI for analysis and use for verification and characterization efforts during Phase 2.

2.2 Phase 2

From March 8, 2017, LEI ecologist conducted oyster resources verifications within the designated survey areas. This survey was conducted according to the protocols used on previous oyster surveys accepted by the U.S. Fish and Wildlife Service (USFWS), TPWD, and the National Marine Fisheries Service (NMFS). LEI ecologist conducted the oyster resources survey under TPWD scientific collection permit (SPR-1016-263), as required for sampling oysters within Texas state waters.

The boundaries of the preliminary anomalies were refined by poling along the boundary of each anomaly and mapping changes to preliminary boundaries where required. During this process, field ecologists navigated to, and inspected, each identified anomaly using a 20-foot long aluminum sounding pole equipped with a density gauging point on one end and a 3-inch sounding disk on the other. Anomalies verified as consisting of oyster resources were characterized based on their composition as either scattered live oysters or consolidated oyster reefs. The areas classified and confirmed as consolidated oyster reefs exhibited distinct SSS signatures and were positioned within areas of increased elevations in relation to the

surrounding bay bottom. Due to the shallow nature of the project area, the boundaries of some of the consolidated oyster reefs were verified via visual inspection.

To characterize the anomalies, an oyster dredge was towed nine times to get a representative sample of substrate anomalies. Each dredge tow was recorded using a Trimble Geo 7X GNSS unit. The oyster dredge used consists of a steel frame with a 0.25-inch wire mesh collection basket anchored behind a row of steel digging teeth. The dimensions of the oyster dredge were 0.79 feet long by 1.35 feet wide and 0.82 feet deep. The wire mesh basket also allowed for the collection of shell, shell hash, and associated reef species.

At the completion of each dredge tow, the dredge was retrieved and contents were photo-documented, described, and classified. When oysters were collected in the dredge, all whole, in-tact individuals were enumerated, measured to the nearest 0.01 inch, and classified according to size as spat ($\leq$ 0.98 inches), juvenile (0.99 – 1.06 inches), sub-adult (1.07 – 2.95 inches), or adult ($\geq$ 2.96 inches). Additionally, the percentages of live and dead individuals were determined by separating the live oysters from the dead and calculating a ratio of live/dead individuals to the total number of oysters collected. Oysters were considered live if they were fully in-tact and tightly closed. Oysters were considered dead if the shell was fully in-tact with the two valves connected at the umbo, but was slightly to completely open. Whole shells that were either connected by only a single valve or were broken or fragmented were not enumerated as individuals and were classified as oyster shell. Any shell or man-made hard substrate larger than 1.5 by 2.5 inches was considered potential oyster resources (per comm. Robinson, 2006).

Catch-per-unit-effort (CPUE) was calculated for each dredge tow by dividing the total numbers of live oysters collected by the volume (feet^3) of substrate sampled along each dredge transect. The volume of each dredge tow sample was determined by calculating the product of the length of the transect (feet), the width of the oyster dredge (1.35 feet), and the height of the oyster dredge (0.79 feet). These calculations provided an index of abundance for each oyster dredge transect. Below is the formula used in calculating CPUE for dredge tows:

$$\text{CPUE for Dredge Tows} = \frac{(\#\ Live\ Oysters\ Collected)}{Transect\ Length(ft) x\ 1.35\ ft\ x\ 0.79\ ft}$$

In order to quantify CPUE for oyster reefs that prohibited oyster dredge tows (due to shallow water), data from surrounding oyster reefs were averaged and used to represent these reefs. The mean CPUE for all transects in each PA were also calculated to represent oyster reefs in each survey area.

2.2.1 Water Quality Investigation

In situ standard water quality parameters were collected at the time of the field effort using a YSI 6920 V2 multi-parameter data sonde. Standard water quality parameters collected within the study area included temperature ºC, salinity practical salinity units (psu), dissolved oxygen milligrams per liter (mg/L) and percent saturation (%), turbidity Nephelometric turbidity units (NTU), and pH standard units (su). Data collection depths ranged from 1 – 3 feet below the surface of the water column, depending on the depth at the sampling location during the time of field surveys.

3.0 Results

The following sections describe the results and findings from Phase 1 and Phase 2 of the oyster resources survey conducted within the project area.

3.1 Phase 1

Results of the SSS identified several substrate anomaly signatures characteristic scattered live oysters and/or consolidated oyster reefs. SSS signatures indicate substrate within the survey boundaries vary between firm to moderately firm sand and soft to moderately firm mud. Refer to Appendix B for figures depicting the SSS imagery and the identified substrate anomalies.

3.2 Phase 2

Refer to Appendix A for site photographs showing the contents from each dredge transect, Appendix C for figures depicting the location of the identified oyster resources within the survey areas, and Appendix D for all data collected from each oyster dredged transect.

Survey Area 1

Within Survey Area 1, three areas totaling approximately 46.29 acres of scattered live oysters were identified (Table 1). Of those, approximately 0.66 acres of scattered live oysters were located within the limits PA 16A (Table 1). The remaining 45.63 acres of scattered live oysters are located outside of the designated PA, but within Survey Area 1. A total of two oyster dredged transects, DT-6 and DT-8, were towed within Survey Area 1 within strategically located positions to confirm the absence of live oysters within areas of minimal SSS signatures.

Within Survey Area 1, approximately 0 percent of the oysters collected were live and 100 percent were dead. The CPUE and overall mean CPUE of live oysters in Survey Area 1 was 0.0000 live oysters/ft^3 (Table 2).

Survey Area 2

Within Survey Area 2, three areas totaling approximately 102.35 acres of scattered live oysters and two areas totaling 3.71 acres of consolidated oyster reef were identified (Table 1). Of those, approximately 16.10 acres of scattered live oysters and 1.59 acres of oyster reef were located within the limits PA 15A (Table 1). The remaining 86.25 acres of scattered live oysters and 2.12 acres of oyster reef are located outside of the designated PA, but within Survey Area 2. A total of three oyster dredged transects were towed at representative locations within Survey Area 2.

Within Survey Area 2, approximately 55.69 percent of the oysters collected were live and 44.31 percent were dead. The CPUE of oysters in Survey Area 2 ranged from 0.1126 to 0.1291 live oysters per cubic foot (oysters/ft^3) with an overall mean CPUE of 0.1220 live oysters/ft^3 (Table 2).

Survey Area 3

Within Survey Area 3, five areas totaling approximately 9.58 acres of scattered live oysters and one area totaling 0.33 acre of consolidated oyster reef were identified (Table 1). Of those, approximately 1.28 acres of scattered live oysters were located within the limits PA 14A (Table 1). The remaining 8.30 acres of scattered live oysters and 0.33 acre of oyster reef are located outside of the designated PA, but within Survey Area 3. A total of three oyster dredged transects were towed at representative locations within Survey Area 3.

Within Survey Area 3, approximately 45.66 percent of the oysters collected were live and 54.34 percent were dead. The CPUE of oysters in Survey Area 3 ranged from 0.0485 to 0.1149 live oysters per cubic foot (oysters/ft^3) with an overall mean CPUE of 0.0801 live oysters/ft^3 (Table 2).

Table 1
Acreage of Oyster Resources Identified Within the Matagorda Ship Channel Project Area

Survey Area (SA)	Acreage of Scattered Live Oysters	Acreage of Oyster Reef	Placement Area (PA)	Acreage of Scattered Live Oysters	Acreage of Oyster Reef
SA 1	46.29	0.00	PA 16A	0.66	0.00
SA 2	102.35	3.71	PA 15A	16.10	1.59
SA 3	9.58	0.33	PA 14A	1.28	0.00
TOTALS	**158.22**	**4.04**	**TOTALS**	**18.04**	**1.59**

Table 2
Catch-per-Unit-Effort of Live Oysters Collected in Dredge Tows Within Survey Areas 1, 2, and 3

Survey Area	Dredge Town Number	CPUE (No. Live Oysters/ft^3)	Mean CPUE[1]
Survey Area 1	DT-08	0.0000	0.0000
	DT-06	0.0000	
Survey Area 2	DT-04	0.1244	0.1220
	DT-05	0.1129	
	DT-07	0.1291	
Survey Area 3	DT-01	0.0485	0.0801
	DT-02	0.1149	
	DT-03	0.0769	

1 Mean CPUE calculated using data from completed dredge tows

The majority of associated reef organisms observed during the surveys were competitors or obligate species. Hook mussels were the dominant reef associate at the time of the survey. However, several species of crabs and barnacles (*Balanus* spp.), as well as Rangia clams (*Rangia cuneata*) and fathead sleepers (*Dormitator maculatus*), were observed. Field ecologists observed very few predators (e.g., boring sponges) throughout the project area, and no oyster drills were observed.

3.2.1 Observed Water Quality

Standard water quality parameters collected at the time of the survey revealed salinities ranging from 16.8 to 18.5 (psu). Dissolved oxygen ranged from 9.74 to 12.03 mg/l with temperature ranges of 16.77 to

17.11°C. Turbidity ranged 44.4 to 56.1 (NTU). PH ranged from 6.34 to 7.73 (su). Refer to Appendix E for the standard water quality parameters data collected during field surveys.

4.0 Conclusions

LEI was contracted by USACE, Galveston District, to conduct an oyster resources survey to determine the presence or absence of oyster resources and potential for direct or indirect impacts as a result of the discharge of dredged material within PA 16A, 15A, and 14A. As a result, a combined total of 158.22 acres of oyster resources were identified within the Survey Areas, consisting of 46.29 acres in Survey Area 1, 106.06 acres in Survey Area 2, and 9.91 acres in Survey Area 3. The CPUE of oysters within the project area ranged from 0.000 to 0.1291 live oysters/ft^3 with an overall mean CPUE of 0.0674 live oysters/ft^3.

At the time of the survey, all water quality characteristics were indicative of normal conditions during the month of March. A majority of the oysters observed were spat (142 individuals) and sub-adult (120 individuals) size. Potential oyster resources that occurred in the project area were present under moderately soft to moderately firm mud. Based on the conditions observed during field investigations, sizable portions of area located within Survey Area 1 and Survey Area 3 consisted primarily of soft sediments and unfavorable conditions for the establishment of oyster resources.

5.0 References

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Appendix A

Site Photographs

Oyster Resources Survey
Matagorda Ship Channel Upper Reach Placement Area Project
Site Photographs

Photo 1: View of oysters from DT-01 within SA 3.

Photo 2: View of oysters from DT-02 within SA 3.

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Photo 3: View of dead oyster from DT-02 within SA 3.

Photo 4: View of oysters from DT-03 within SA 3.

Photo 5: Vegetative growth on oyster from DT-03 within SA 3.

Photo 6: View of oysters from DT-04 within SA 2.

Photo 7: View of associated oyster species from DT-04 within SA 2.

Photo 8: View of oysters from DT-05 within SA 2.

Photo 9: View of oysters from DT-06 within SA 1.

Photo 10: View of dead oysters from DT-06 within SA 1.

Photo 11: View of oysters from DT-07 within SA 2.

Photo 12: View of oysters from DT-08 within SA 1.

Photo 13: View of dead oysters from DT-08 within SA 1.

Appendix B

Side-Scan Sonar Maps

LLOYD ENGINEERING, INC.

Coordinate System: NAD 1983 StatePlane Texas South Central FIPS 4204 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
False Easting: 1,968,500.0000
False Northing: 13,123,333.3333
Central Meridian: -99.0000
Standard Parallel 1: 28.3833
Standard Parallel 2: 30.2833
Latitude Of Origin: 27.8333
Units: Foot US

Legend

- Survey Area
- Placement Area
- Consolidated Oyster Reef
- Scattered Live Oysters

0 1,200 2,400 Feet

Figure 1

Side-Scan-Sonar Map: Survey Area 1
Oyster Resources Survey
Matagorda Ship Channel
Upper Reach Placement Area Project
U.S. Army Corps of Engineers

Calhoun County, Texas

Prepared By: J. Wiedeman	1 inch = 1,200 feet
	Date: Jun 05, 2017

LLOYD ENGINEERING, INC.

Coordinate System: NAD 1983 StatePlane Texas South Central FIPS 4204 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
False Easting: 1,968,500.0000
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Latitude Of Origin: 27.8333
Units: Foot US

Legend

- Survey Area
- Placement Area
- Consolidated Oyster Reef
- Scattered Live Oysters

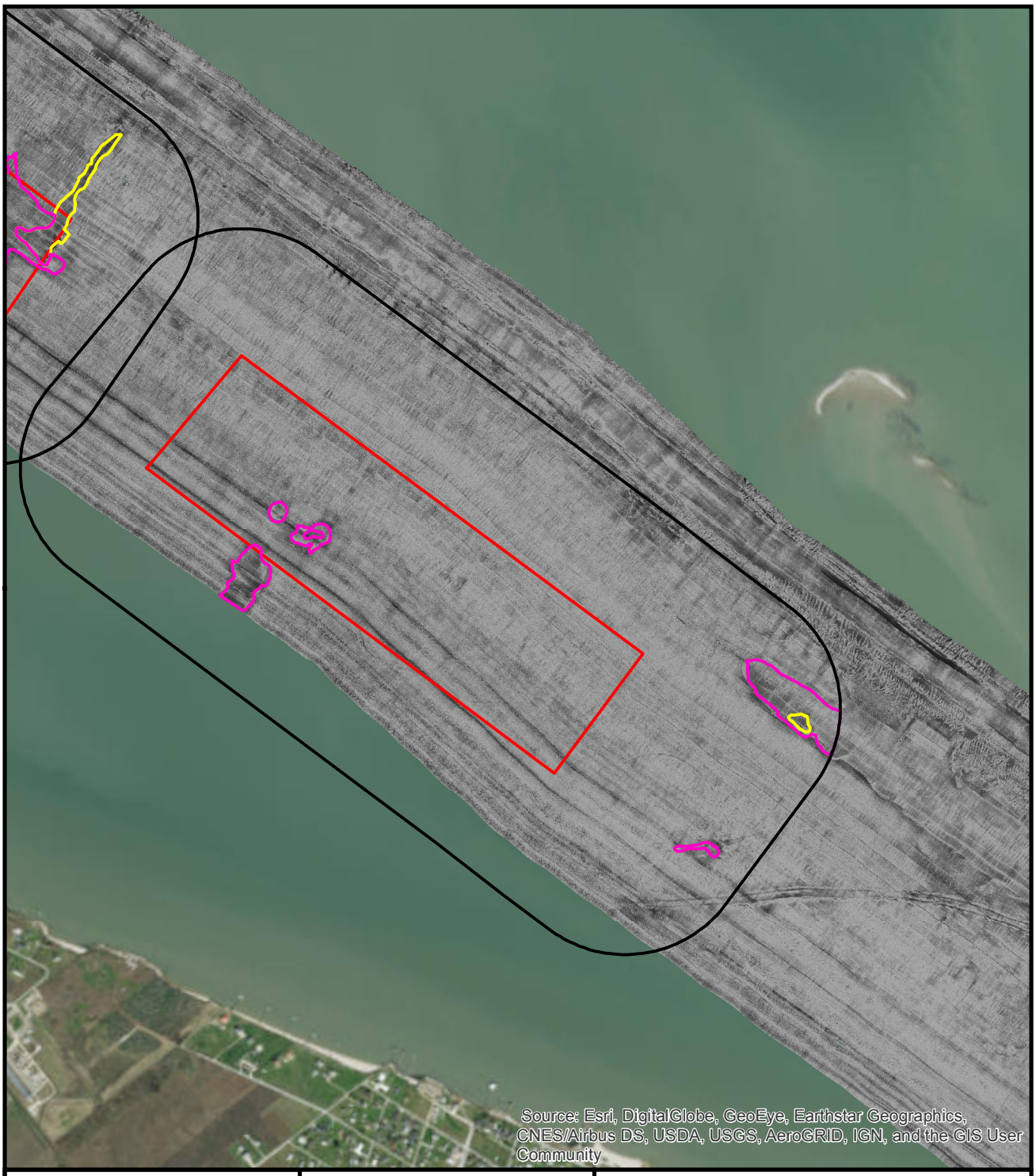
0 1,200 2,400 Feet

Figure 2

Side-Scan-Sonar Map: Survey Area 2
Oyster Resources Survey
Matagorda Ship Channel
Upper Reach Placement Area Project
U.S. Army Corps of Engineers

Calhoun County, Texas

Prepared By: J. Wiedeman	1 inch = 1,200 feet
	Date: Jun 05, 2017



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Coordinate System: NAD 1983 StatePlane Texas South Central FIPS 4204 Feet
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Legend

- Survey Area
- Placement Area
- Consolidated Oyster Reef
- Scattered Live Oysters

0 1,200 2,400 Feet

Figure 3

Side-Scan-Sonar Map: Survey Area 3
Oyster Resources Survey
Matagorda Ship Channel
Upper Reach Placement Area Project
U.S. Army Corps of Engineers

Calhoun County, Texas

Prepared By: J. Wiedeman	1 inch = 1,200 feet
	Date: Jun 05, 2017

Appendix C

Oyster Resources Maps

LLOYD ENGINEERING, INC.

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Legend

- Dredge Tow
- Survey Area
- Placement Area
- Consolidated Oyster Reef
- Scattered Live Oysters

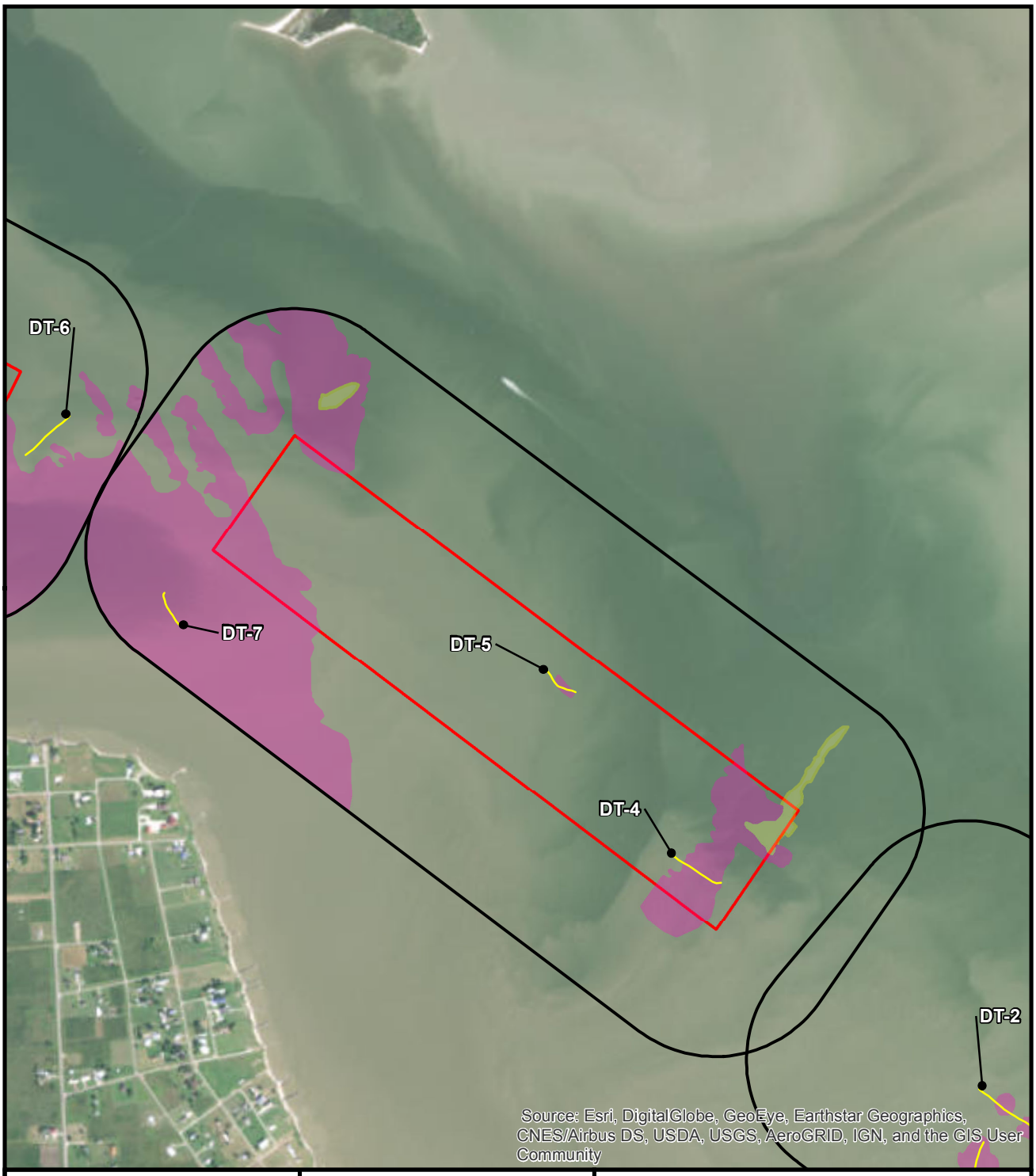
0 1,200 2,400 Feet

Figure 1

Oyster Resources Map: Survey Area 1
Resources Survey Matagorda Ship Channel
Upper Reach Placement Area Project
U.S. Army Corps of Engineers

Calhoun County, Texas

Prepared By: J. Wiedeman	1 inch = 1,200 feet
	Date: Jun 05, 2017



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Coordinate System: NAD 1983 StatePlane Texas South Central FIPS 4204 Feet
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Legend

- Dredge Tow
- Survey Area
- Placement Area
- Consolidated Oyster Reef
- Scattered Live Oysters

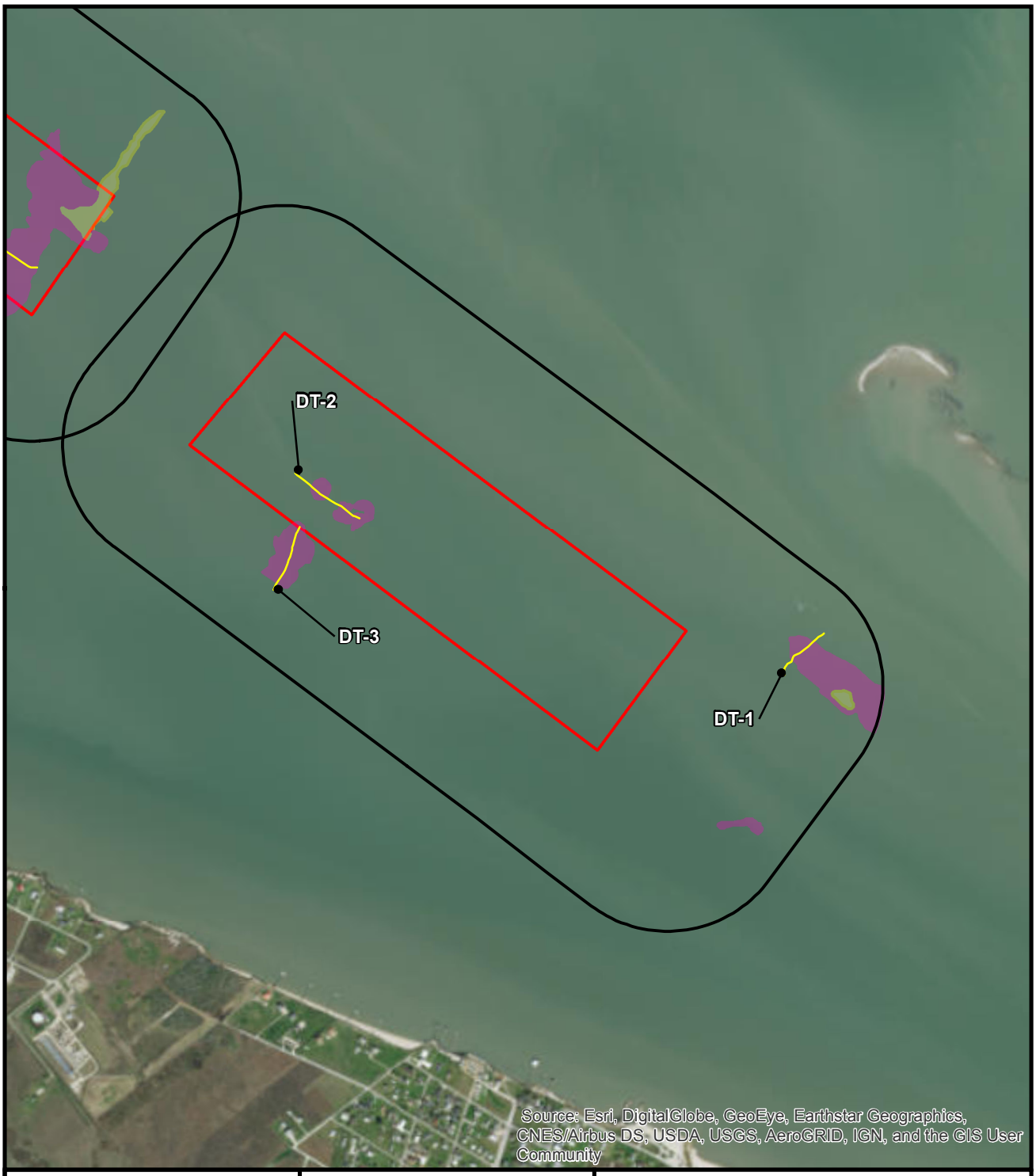
0 1,200 2,400 Feet

Figure 2

Oyster Resources Map: Survey Area 2
Oyster Resources Survey
Matagorda Ship Channel
Upper Reach Placement Area Project
U.S. Army Corps of Engineers

Calhoun County, Texas

Prepared By: J. Wiedeman	1 inch = 1,200 feet
	Date: Jun 05, 2017



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Legend

- Dredge Tow
- Survey Area
- Placement Area
- Consolidated Oyster Reef
- Scattered Live Oysters

0 1,200 2,400 Feet

Figure 3

Oyster Resources Map: Survey Area 3
Oyster Resources Survey
Matagorda Ship Channel
Upper Reach Placement Area Project
U.S. Army Corps of Engineers

Calhoun County, Texas

Prepared By: J. Wiedeman	1 inch = 1,200 feet
	Date: Jun 05, 2017

Appendix D

Oyster Data Sheets

LLOYD ENGINEERING, INC.

OYSTER SURVEY DATA FORM

Project: Matagorda Ship Channel Upper Reach Placement Area Project
Loction: Lavaca Bay, Calhoun County, Texas
Names: Justin Wiedeman / Dillon Johnston
Date: March 8, 2017

Weather Conditions: See Weather Data Sheet
Water Conditions: See Weather Data Sheet
Tide Conditions: See Tide Data Sheet

Station ID	Water Depth (ft)	Dredge, Probe or Grab	Time of Dredge (sec)	Length of Dredge (ft)	Substrate Compostion	Oyster Composition								Picture Number on Photo Page
						% Live	% Dead	Number of Live Oysters by Size				Total Dead Oysters	Total Live Oysters	
								Spat (<25mm) (<0.98")	Juvenile (26-50mm) (0.99-1.06")	Sub-Adult (51-75mm) (1.07-2.95")	Adult (>76mm) (>2.96")			
DT-01: SA 3	4.2	Dredge	60	550.0	Firm	39.13%	60.87%	6	4	10	16	56	36	1
DT-02: SA 3	4.6	Dredge	60	580.0	Firm	56.96%	43.04%	26	7	32	25	68	90	2-3
DT-03: SA 3	5.1	Dredge	60	510.0	Firm	37.32%	62.68%	22	10	15	6	89	53	4-5
DT-04: SA 2	4.3	Dredge	60	405.0	Firm	41.46%	58.54%	36	9	14	9	96	68	6-7
DT-05: SA 2	5.0	Dredge	60	375.0	Firm	64.04%	35.96%	47	0	6	4	32	57	8
DT-06: SA 1	4.5	Dredge	60	510.0	Firm	0.00%	100.00%	0	0	0	0	99	0	9-10
DT-07: SA 2	5.3	Dredge	60	350.0	Firm	75.31%	24.69%	5	4	43	9	20	61	11
DT-08: SA 1	4.7	Dredge	60	315.0	Firm	0.00%	100.00%	0	0	0	0	5	0	12

		% Live	% Dead	Total Spat	Total Juvenile	Total Sub-Adult	Total Adult	Total Dead Oysters	Total Live Oysters
OVERALL TOTALS		43.98%	56.02%	142	34	120	69	465	365
SURVEY AREA TOTALS	SA 3	45.66%	54.34%	54	21	57	47	213	179
	SA 2	55.69%	44.31%	88	13	63	22	148	186
	SA 1	0.00%	100.00%	0	0	0	0	104	0

Appendix E

Tides, Water Quality, and Weather

LLOYD ENGINEERING, INC.

WATER QUALITY DATA

Project: Matagorda Ship Channel Upper Reach Placement Area Project
Location: Lavaca Bay, Calhoun County, Texas
Names: Justin Wiedeman / Dillon Johnston
Date(s) Collected: March 8, 2017

Weather and Water Conditions: See Weather data
Wind Direction: See Weather Data
Tide, MLT: See Tide Data
Wind Speed: See Weather Data

Date	3/8/2017	3/8/2017	3/8/2017						
Station	DT-3	DT-5	DT-6						
Depth of Measurement (ft)	1.5	1.5	1.5						
Water Depth MLT (ft)	3.5	5.5	4.1						
DO (mg/L)	10.96	9.74	12.03						
pH (s.u.)	6.34	7.50	7.73						
Salinity ($^0/_{00}$)	18.5	18.2	16.8						
Specific Cond. (mS/cm)	26.7	26.4	24.6						
Water Temp (ºC)	19.55	19.61	19.71						
Air Temp (ºC)	17.11	17.0	16.77						
Turbidity (NTU)	44.4	48.5	56.1						
Time	11:12	11:50	12:10						
Comments									

Remarks:

LLOYD ENGINEERING, INC.

Tide Data Sheet

Project:	Matagorda Ship Channel Upper Reach Placement Area Project
Location:	Lavaca Bay, Calhoun County, Texas
Names:	Justin Wiedeman / Dillon Johnston
Date:	3/8/2017

Port Lavaca (TCOON), TX - Station ID: 8773259

28° 38.4' N 96° 35.7' W

Wednesday March 8, 2017

2017-03-08 - 03.53 CDT - Moon Set
2017-03-08 - 06:42 CDT - Sun Rise
2017-03-08 - 11:19 CDT - Low Tide
2017-03-08 - 14:54 CDT - Moon Rise
2017-03-08 - 18:32 CDT - Sun Set
2017-03-08 - 21:58 CDT - High Tide

* Tide Datum Mean Low Tide (MLT)

March 8, 2017	Air Temp (°C)		Wind (MPH)	Gust Speed (MPH)	Wind Direction
	High	Low			
	17.78	11.67	23	31	NNE

Morgans Point is locate 1.25 miles Southwest of Project area

Appendix D

Information, Planning and Conservation database search results for Calhoun County, Texas, June 2017

IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Calhoun County, Texas

Local office

Texas Coastal Ecological Services Field Office

(281) 286-8282
(281) 488-5882

17629 El Camino Real #211
Houston, TX 77058

http://www.fws.gov/southwest/es/TexasCoastal/
http://www.fws.gov/southwest/es/ES_Lists_Main2.html

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).

4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Gulf Coast Jaguarundi Herpailurus (=Felis) yagouaroundi cacomitli No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/3945	Endangered
West Indian Manatee Trichechus manatus There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/4469	Threatened

Birds

NAME	STATUS
Least Tern Sterna antillarum This species only needs to be considered if the following condition applies: • Wind Related Projects Within Migratory Route No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8505	Endangered
Northern Aplomado Falcon Falco femoralis septentrionalis No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1923	Endangered
Piping Plover Charadrius melodus There is a **final** critical habitat designated for this species. Your location overlaps the designated critical habitat. https://ecos.fws.gov/ecp/species/6039	Threatened
Red Knot Calidris canutus rufa No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1864	Threatened
Whooping Crane Grus americana There is a **final** critical habitat designated for this species. Your location overlaps the designated critical habitat. https://ecos.fws.gov/ecp/species/758	Endangered

Reptiles

NAME	STATUS
Hawksbill Sea Turtle Eretmochelys imbricata There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/3656	Endangered
Kemp's Ridley Sea Turtle Lepidochelys kempii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5523	Endangered
Leatherback Sea Turtle Dermochelys coriacea There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/1493	Endangered

NAME	STATUS
Loggerhead Sea Turtle Caretta caretta There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/1110	Threatened

Clams

NAME	STATUS
Golden Orb Quadrula aurea No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9042	Candidate
Texas Pimpleback Quadrula petrina No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8966	Candidate

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Piping Plover Charadrius melodus https://ecos.fws.gov/ecp/species/6039#crithab	Final designated
Whooping Crane Grus americana https://ecos.fws.gov/ecp/species/758#crithab	Final designated

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any activity that results in the take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service[3]. There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data http://www.birdscanada.org/birdmon/default/datasummaries.jsp

The migratory birds species listed below are species of particular conservation concern (e.g. Birds of Conservation Concern) that may be potentially affected by activities in this location. It is not a list of every bird species you may find in this location, nor a guarantee that all of the bird species on this list will be found on or near this location. Although it is important to try to avoid and minimize impacts to all birds, special attention should be made to avoid and minimize impacts to birds of priority concern. To view available data on other bird species that may occur in your project area, please visit the AKN Histogram Tools and Other Bird Data Resources. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

NAME	SEASON(S)
American Oystercatcher Haematopus palliatus https://ecos.fws.gov/ecp/species/8935	Year-round

Bald Eagle Haliaeetus leucocephalus https://ecos.fws.gov/ecp/species/1626	Year-round
Black Rail Laterallus jamaicensis https://ecos.fws.gov/ecp/species/7717	Year-round
Black Skimmer Rynchops niger https://ecos.fws.gov/ecp/species/5234	Year-round
Buff-bellied Hummingbird Amazilia yucatanensis	Year-round
Burrowing Owl Athene cunicularia https://ecos.fws.gov/ecp/species/9737	Year-round
Dickcissel Spiza americana	Breeding
Fox Sparrow Passerella iliaca	Wintering
Gull-billed Tern Gelochelidon nilotica https://ecos.fws.gov/ecp/species/9501	Year-round
Harris's Sparrow Zonotrichia querula	Wintering
Hudsonian Godwit Limosa haemastica	Migrating
Lark Bunting Calamospiza melanocorys	Wintering
Le Conte's Sparrow Ammodramus leconteii	Wintering
Least Bittern Ixobrychus exilis https://ecos.fws.gov/ecp/species/6175	Breeding
Least Tern Sterna antillarum	Breeding
Lesser Yellowlegs Tringa flavipes https://ecos.fws.gov/ecp/species/9679	Wintering
Loggerhead Shrike Lanius ludovicianus https://ecos.fws.gov/ecp/species/8833	Year-round
Long-billed Curlew Numenius americanus https://ecos.fws.gov/ecp/species/5511	Wintering
Magnificent Frigatebird Fregata magnificens	Wintering
Marbled Godwit Limosa fedoa https://ecos.fws.gov/ecp/species/9481	Wintering
Nelson's Sparrow Ammodramus nelsoni	Wintering
Peregrine Falcon Falco peregrinus https://ecos.fws.gov/ecp/species/8831	Wintering
Red-headed Woodpecker Melanerpes erythrocephalus	Wintering
Reddish Egret Egretta rufescens https://ecos.fws.gov/ecp/species/7617	Year-round
Rusty Blackbird Euphagus carolinus	Wintering

Sandwich Tern Thalasseus sandvicensis	Year-round
Seaside Sparrow Ammodramus maritimus	Year-round
Sedge Wren Cistothorus platensis	Wintering
Short-billed Dowitcher Limnodromus griseus https://ecos.fws.gov/ecp/species/9480	Wintering
Short-eared Owl Asio flammeus https://ecos.fws.gov/ecp/species/9295	Wintering
Snowy Plover Charadrius alexandrinus	Breeding
Solitary Sandpiper Tringa solitaria	Wintering
Sprague's Pipit Anthus spragueii https://ecos.fws.gov/ecp/species/8964	Wintering
Swainson's Warbler Limnothlypis swainsonii	Migrating
Whimbrel Numenius phaeopus https://ecos.fws.gov/ecp/species/9483	Wintering
White-tailed Hawk Buteo albicaudatus	Year-round
Wilson's Plover Charadrius wilsonia	Breeding
Worm Eating Warbler Helmitheros vermivorum	Migrating
Yellow Rail Coturnicops noveboracensis https://ecos.fws.gov/ecp/species/9476	Wintering

What does IPaC use to generate the list of migratory bird species potentially occurring in my specified location?

Landbirds:

Migratory birds that are displayed on the IPaC species list are based on ranges in the latest edition of the National Geographic Guide, Birds of North America (6th Edition, 2011 by Jon L. Dunn, and Jonathan Alderfer). Although these ranges are coarse in nature, a number of U.S. Fish and Wildlife Service migratory bird biologists agree that these maps are some of the best range maps to date. These ranges were clipped to a specific Bird Conservation Region (BCR) or USFWS Region/Regions, if it was indicated in the 2008 list of Birds of Conservation Concern (BCC) that a species was a BCC species only in a particular Region/Regions. Additional modifications have been made to some ranges based on more local or refined range information and/or information provided by U.S. Fish and Wildlife Service biologists with species expertise. All migratory birds that show in areas on land in IPaC are those that appear in the 2008 Birds of Conservation Concern report.

Atlantic Seabirds:

Ranges in IPaC for birds off the Atlantic coast are derived from species distribution models developed by the National Oceanic and Atmospheric Association (NOAA) National Centers for Coastal Ocean Science (NCCOS) using the best available seabird survey data for the offshore Atlantic Coastal region to date. NOAANCCOS assisted USFWS in developing seasonal species ranges from their models for specific use in IPaC. Some of these birds are not BCC species but were of interest for inclusion because they may occur in high abundance off the coast at different times throughout the year, which potentially makes them more susceptible to certain types of development and activities taking place in that area. For more refined details about the abundance and richness of bird species within your project area off the Atlantic Coast, see the Northeast Ocean Data Portal. The Portal also offers data and information about other types of taxa that may be helpful in your project review.

About the NOAANCCOS models: the models were developed as part of the NOAANCCOS project: Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf. The models resulting from this project are being used in a number of decision-support/mapping products in order to help guide decision-making on activities off the Atlantic Coast with the goal of reducing impacts to migratory birds. One such product is the Northeast Ocean Data Portal, which can be used to explore details about the relative occurrence and abundance of bird species in a particular area off the Atlantic Coast.

All migratory bird range maps within IPaC are continuously being updated as new and better information becomes available.

Can I get additional information about the levels of occurrence in my project area of specific birds or groups of birds listed in IPaC?

Landbirds:

The Avian Knowledge Network (AKN) provides a tool currently called the "Histogram Tool", which draws from the data within the AKN (latest,survey, point count, citizen science datasets) to create a view of relative abundance of species within a particular location over the course of the year. The results of the tool depict the frequency of detection of a species in survey events, averaged between multiple datasets within AKN in a particular week of the year. You may access the histogram tools through the Migratory Bird Programs AKN Histogram Tools webpage.

The tool is currently available for 4 regions (California, Northeast U.S., Southeast U.S. and Midwest), which encompasses the following 32 states: Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North, Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin.

In the near future, there are plans to expand this tool nationwide within the AKN, and allow the graphs produced to appear with the list of trust resources generated by IPaC, providing you with an additional level of detail about the level of occurrence of the species of particular concern potentially occurring in your project area throughout the course of the year.

Atlantic Seabirds:

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAANCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Facilities

Wildlife refuges and fish hatcheries

REFUGE AND FISH HATCHERY INFORMATION IS NOT AVAILABLE AT THIS TIME

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

WETLAND INFORMATION IS NOT AVAILABLE AT THIS TIME

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix E

Matagorda Ship Channel – Matagorda Peninsula to Point Comfort Contaminant Assessment, June 2006

Matagorda Ship Channel –
Matagorda Peninsula to Point Comfort
Contaminant Assessment

Document No. 060151
PBS&J Job No. 441654

MATAGORDA SHIP CHANNEL – MATAGORDA PENINSULA TO POINT COMFORT CONTAMINANT ASSESSMENT

CONTRACT W912HY-05-D0001
DELIVERY ORDER 0023

Prepared for:

U.S. Army Corps of Engineers
Galveston District
2000 Fort Point Road
Galveston, Texas 77550

Prepared by:

PBS&J
6504 Bridge Point Parkway
Suite 200
Austin, Texas 78730

June 2006

Printed on recycled paper

Contents

Figures

Tables

Acronyms and Abbreviations

°C	degrees Celsius
µm	micrometer
μw	microwatt
Anacon	Anacon, Inc.
ANOVA	Analysis of Variance
ARO	Aquatic Research Organisms, Inc.
cm^2	square centimeters
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
ERL	Effects Range Low
FDA	U.S. Food and Drug Administration
g	gram
HMM	Hawaiian Marine Mix®
m^2	square meter
ml	milliliter
mm	millimeter
MSC-EC	Matagorda Ship Channel - Entrance Channel
NOAA	National Oceanic and Atmospheric Administration
RIA	Regional Implementation Agreement
SP	solid phase
SPP	Suspended Particulate Phase
TCEQ	Texas Commission on Environmental Quality
TO	Task Order
TOC	total organic carbon
TWQS	Texas Surface Water Quality Standards
USACE	U.S. Army Corps of Engineers
WCQ	Water Quality Criteria

1.0 INTRODUCTION

In January 2006, the Galveston District of the U.S. Army Corps of Engineers (USACE) awarded Task Order 0023 (TO) of Contract No. W912HY-05-D-0001. The TO requires specific testing of maintenance material from the Matagorda Ship Channel – Matagorda Peninsula to Point Comfort (MSC-PC). The purpose of the work performed for this TO was to determine the potential environmental impact from the dredging and/or placement of material to be dredged from the MSC-PC. The analyses on these samples have been completed and are the subject of this report. Procedures for the testing are detailed in the TO, the Inland Testing Manual (U.S. Environmental Protection Agency [EPA]/USACE, 1998), and the Regional Implementation Agreement (RIA) (EPA/USACE, 2003). Any deviations by PBS&J from these procedures were approved in advance by the designated representative of the USACE Contract Officer.

The work performed consisted of chemical analyses of sediment samples, solid phase (SP) bioassays, and bioaccumulation studies. The chemical analyses of the sediment samples provide data concerning background levels of specified potential toxins. Concern had been expressed concerning the concentrations of metals in some sediment samples collected earlier in this reach of the MSC, so chemical analysis of sediments and tissue was for metals only. The SP bioassays are designed to determine the potential impact of the placement of the dredged material on designated sensitive marine organisms living on the bottom of Matagorda Bay. The bioaccumulation studies are designed to indicate any uptake of potential toxins by sensitive benthic organisms. All chemical analyses were performed by Anacon, Inc. (Anacon), Houston, Texas.

2.0 METHODS AND MATERIALS

The methods and materials for the work performed followed the specifications of the TO, the Green Book, and the RIA and are detailed in the following sections. All equipment was cleaned according to specifications, which included a detergent wash, an acid soak, and a deionized-water rinse.

2.1 STATION LOCATIONS

Twelve channel sites were sampled (Figure 1) for sediment; composited into three samples; and submitted for chemical analyses. The latitude and longitude of each site is presented in Table 1.

The reference sediment used in the chemical analyses, SP bioassays, and bioaccumulation studies was a composite of samples from the three sites noted on Figure 1 and listed in Table 1 as REF-A, REF-B, and REF-C. The latitude and longitude of each of these sites is also presented in Table 1.

Water depths at the sampling sites and Reference material collection sites are also presented in Table 1. Samples were collected on 21 February 2006.

The clean sand for the True Control was collected from Galveston East Beach, near the south jetty, with acid-rinsed plastic scoops.

2.2 SAMPLE COLLECTION AND STORAGE

Sediment was collected with a stainless steel, GOM Box Corer. Test sediment was collected at depths noted in Table 1 for each station. The clean sand for the True Control was collected with a clean, non-contaminating, acid-rinsed plastic scoop. All samples were put in airtight linear polyethylene containers, which were filled to beyond capacity, sealed to exclude air, and stored in the dark at 2–4°C until used.

2.3 LABORATORY FACILITIES

The PBS&J Environmental Toxicology Laboratory has separate areas for water and sediment storage, culture of test organisms, and testing. Testing was performed in 20°C test chambers for the SPP and SP bioassays and for the bioaccumulation studies with the polychaetes. Testing was performed in 14°C test chambers for the bioaccumulation studies with the clams. Lighting was arranged for each test phase so that light intensity was approximately 1200 microwatt (μw)/square centimeters (cm^2) using cool-white fluorescent bulbs with a 16-hour light and 8-hour dark cycle.

2.4 ORGANISM ACQUISITION

Two organisms were tested in the SP bioassay: the amphipod, *Leptocheirus plumulosus,* and the mysid shrimp, *Americamysis bahia* (4 days old). The sand worm, *Nereis virens,* and the bentnose clam, *Macoma nasuta*, were exposed to the SP for 10 days and analyzed for bioaccumulation.

Projection: UTM
Datum: NAD83
Ellipsoid: GRS80
Zone: 15 N
Units: Meters

Aerial Imagery: TNRIS

Sample Sites

0 3,250 6,500 13,000
Feet

PBS&J
1250 Wood Branch Park Drive, Ste. 300
Houston, Texas 77079
Phone (281) 493-5100 Fax: (281) 493-1047

Matagorda Ship Channel Matagorda Peninsula to Point Comfort

Prepared By: PBS&J/19998	Scale: 1" = 6,500'
Job No.: 441654.00	Date: Mar 20, 2006

File: N:\441654_00\projects\mxd\matagorda_channel_sites.mxd

TABLE 1

STANDARD PARAMETERS
MATAGORDA SHIP CHANNEL - MATAGORDA PENINSULA TO POINT COMFORT

STATION	Date	Time	Water Depth (ft)	Water Temp (°C)	Salinity (‰)	Dissolved Oxygen (mg/L)	pH	Coordinates
MPC-06-13A	2/21/2006	1450	40	12.4	32.1	8.18	7.97	28°32'22.2"N, 96°30'54.9"W
MPC-06-13B	2/21/2006	1508	40	12.7	32.2	8.22	7.96	28°32'21.6"N, 96°30'54.4"W
MPC-06-13C	2/21/2006	1435	32	12.4	32.1	8.19	7.94	28°32'21.0"N, 96°30'53.8"W
MPC-06-14A	2/21/2006	1544	40	12.6	32.0	8.22	7.96	28°32'53.0"N, 96°30'11.0"W
MPC-06-14B	2/21/2006	1606	37	12.5	32.0	8.17	7.95	28°32'52.4"N, 96°30'10.5"W
MPC-06-14C	2/21/2006	1620	33	12.5	32.0	8.16	7.98	28°32'51.9"N, 96°30'10.0"W
MPC-06-15A	2/21/2006	1808	35	12.9	31.8	8.13	7.98	28°33'22.7"N, 96°29'26.1"W
MPC-06-15B	2/21/2006	1745	38	12.9	32.0	8.44	8.00	28°33'23.3"N, 96°29'26.7"W
MPC-06-15C	2/21/2006	1730	37	12.6	31.8	8.36	7.97	28°33'23.9"N, 96°29'27.2"W
MPC-06-17A	2/21/2006	1337	32	11.5	31.0	8.30	7.91	28°34'24.4"N, 96°28'58.5"W
MPC-06-17B	2/21/2006	1342	27	11.6	31.3	8.32	7.92	28°34'25.0"N, 96°28'59.0"W
MPC-06-17C	2/21/2006	1332	33	11.6	31.1	8.26	7.90	28°34'25.6"N, 96°28'59.5"W
REF-A	2/21/2006	1656	11	12.9	32.0	8.31	7.97	28°32'38.4"N, 96°29'55.8"W
REF-B	2/21/2006	1645	11	12.8	31.9	8.28	7.95	28°32'37.0"N, 96°29'56.8"W
REF-C	2/21/2006	1708	10	12.9	32.0	8.26	7.96	28°32'37.0"N, 96°29'54.7"W

All of the organisms used in the SP bioassay and the bioaccumulation test were purchased from commercial dealers and shipped to PBS&J overnight. *L. plumulosus* were purchased from Cheasapeake Cultures, Hayes, Virginia. *N. virens* were purchased from Aquatic Research Organisms, Inc. (ARO), Hampton, New Hampshire and *M. nasuta* were purchased from Brezina and Associates, Dillon Beach, California. The mysids for the SP bioassay were all cultured at the PBS&J ETOX Laboratory.

The polychaetes were shipped in seaweed and were allowed to come to test temperature in the shipping containers, from which they were introduced into the test vessels. *Macoma* were shipped in bags of seawater, which, upon receipt, were aerated and allowed to come to test temperature. The clams and polychaetes were then randomly introduced into the test or control sediment. The amphipods were shipped to the PBS&J laboratory in a polyethylene bags filled with natural seawater, packaged in an insulated cooler with freeze gels to prevent overheating during transit. Any polychaetes, clams, or amphipods that did not burrow and any organisms that exhibited abnormal behavior in the first four hours after being put into the test vessels were replaced by healthy organisms. No organisms were held for more than three weeks.

2.5 TEST MEDIA PREPARATION

All sediment used in the SP bioassays was sieved through a 1.0-millimeter (mm) screen, using no seawater. All animal tissue was removed and the remaining material recombined with the sediment from which it had been removed. All sediment was screened as soon as possible after collection to prevent the decay of organic material. Following this, the sediment was stored at 2–4°C until needed.

2.6 CHEMICAL ANALYSES

2.6.1 Sediment and Tissue

Sediment samples from each station and tissues from the bioaccumulation studies were analyzed for the parameters listed in Table 2. The methods of analysis and the minimum detection limits are included in Appendix A, Tables A-1 and A-2.

TABLE 2
PARAMETERS DETERMINED BY CHEMICAL ANALYSIS

METALS	
Antimony	Lead
Arsenic	Mercury
Cadmium	Nickel
Chromium (total)	Selenium
Chromium (3+)	Silver
Chromium (6+)	Thallium
Copper	Zinc

Sediment and tissue.

2.6.2 Grain Size Analyses

Samples of sediments from the test stations and the reference area were collected for grain size analysis. Samples were subjected to standard sieve analysis (sieve sizes 4, 10, 20, 40, 50, 70, 100, 140, and 200) to determine the percent of fine sand and larger particles. Hydrometer analyses (elapsed time reading of 2, 4, 30, 60, 120, 240 and 1,440 minutes), complemented by specific gravity determinations, were conducted to determine the percent silt, clay, and colloidal material in the sediments. Cutoff points between medium and fine sand, fine sand and silt, silt and clay, and clay and colloidal material are sieve size 40, sieve size 200, 0.005 mm and 0.001 mm, respectively.

2.7 BIOASSESSMENT PROCEDURES

2.7.1 Randomization

Test and control vessel locations in the testing chambers were randomized using numbers from a PC random number generator.

2.7.2 Solid Phase Bioassay/Bioaccumulation Assessment

The SP bioassay consisted of a 1-day settling period after the sediment was added, followed by 10 days (Days 1–10) of test-organism exposure at 20°C. The bioassay vessels were partially filled with artificial seawater and enough sediment (test station, Reference, or True Control) was placed in each vessel to meet the needs of the test organisms and to make at least a 2-cm layer on the bottom. Five replicates were prepared for each of the test stations, for the Reference Control, and for the True Control. Different 1-liter jars were used for the amphipods and for the mysids. Ten-gallon aquaria were used in the bioaccumulation study for both clams and polychaetes. A loading factor of no more than one-half gram of tissue per liter of test or control medium was maintained.

Twenty-four hours after the addition of the sediment, the water was changed, and 20 organisms per replicate for the SP bioassay and the bioaccumulation study (25 for the clams) were placed in the test vessels.

Temperature, dissolved oxygen, pH, salinity, and ammonia were recorded daily (Appendices B [Table B-1] and C [Table C-1]). Seventy-five percent of the water was siphoned off and replaced 1 hour before and 48 hours after test initiation and at 48-hour intervals thereafter. Aeration was supplied to the clams and polychaetes to keep the dissolved oxygen level above 40% of saturation.

After ten days, the SP bioassay was terminated. The sediment was wet-sieved (0.5-mm screen) to remove surviving organisms and both species were counted.

The bioaccumulation study was conducted for 10 days (since the concern was for metals and not organics) following the same procedures as the SP bioassay. After 10 days, the bioaccumulation study was terminated and the clams and polychaetes were placed, by replicate, in clean aquaria filled with

artificial seawater and allowed to purge for 24 hours. After the purge period, these organisms were sacrificed, the clams were removed from their shells, and all animals were frozen and delivered to the chemistry laboratory for tissue analysis.

2.8 STATISTICAL ANALYSES

Statistical analyses are described in detail in the TO and the Green Book and are designed to determine whether the test results are significantly different from the results of the Reference Control. All statistical comparisons were at the 95% confidence level and are included in Appendices B, C, and D, if needed.

2.8.1 Use

For the SP bioassay, statistical comparisons of mean survival were made for each species and for the total number of organisms, if (1) mean survival for any station test was less than that for the Reference Control and (2) the difference between Control and test survival exceeded 10% (20% for the amphipods). For the bioaccumulation assessment, statistical comparisons of mean concentrations were made for each parameter and species, if the mean concentration of the parameter for any station test tissue was greater than that for the mean Reference Control.

2.8.2 Methods

The Shapiro-Wilks test was used to determine if the data were normally distributed. Bartlett's test was first tried to determine the homogeneity or heterogeneity of the variances. If Bartlett's test failed because of zero variance in any test, Cochran's test was used.

To determine if the difference between the mean survival of organisms in the 100% SPP and the control

$$t_{calc} = \frac{\left|X_{control} - X_{test}\right|}{[(S_p^2) / (1/n_{control} + 1/n_{test}]^{1/2}}$$

was statistically significant the two-sample t-test (EPA/CE, 1991) was used. The t-test is calculated as:

where, X is the mean survival, n is the number of replicates in the treatment, and S_p^2 is the pooled

$$S_p^2 = [(n_{control} - 1)(S_{control}^2) + (n_{test} - 1)(S_{test}^2)] / [n_{control} + n_{test} - 2]$$

variance and is calculated as:

If t_{calc} is less than the tabulated t-value at the 95% confidence level and for the appropriate degrees of freedom, the means are not statistically different. If t_{calc} is greater than the tabulated t-value, the difference between the means is statistically significant.

To determine if the difference among the mean survival of organisms, or concentration in tissues, in the SP bioassays or bioaccumulation studies, and in the control was statistically significant the following were used:

1) If the data were normally distributed and the variances were homogeneous, with or without data transformation, an Analysis of Variance (ANOVA) was conducted (Box 9.1, Sokal and Rohlf, 1981) and the calculated F-value was compared to the tabulated F-value for the appropriate degrees of freedom at the 95% confidence level. If the calculated F-value was less than the tabulated F-value, the difference is not statistically significant.

2) If the calculated F-value, determined by the ANOVA, was greater than the tabulated F-value, indicating a significant difference among the means, Dunnett's Procedure was used to determine which, if any, test mean was significantly different from the control mean. The Dunnett's Procedure is similar to the Student's t-test except that the within-treatments mean square is used in place of the variances of the two treatments being compared:

3) Probable outliers were examined with the Dixon Test. This test compares the ratio, $(X_2 - X_1)/(X_n - X_1)$, to a tabulated value based on the number of points in the data set. X_1 is the possible outlier, X_2 is the datum nearest in value to X_1 and X_n is the datum most distant in value from X_1.

4) If the data were not normally distributed or the variances were heterogeneous, and could not be made normal or homogeneous by transformation, a rank sum test, the Kruskal-Wallis Test, was used to determine if there was a significant difference among the means. If so, Dunn's Multiple Comparison was used to compare the mean of each test data set to the mean of the Reference Control, unless the test mean was less than the reference control mean.

3.0 RESULTS AND DISCUSSION

3.1 CHEMISTRY

The only consistent trend in the standard parameter data (see Table 1) is that the temperature tended to increase slightly as the day wore on. Dissolved oxygen (DO) was good at all stations and there was essentially no change in salinity, DO, or pH.

Sediment concentrations of detected compounds are presented in Table 3. The sediment chemistry are interesting in that the Reference station samples consistently have the lowest concentrations of metals, which is not surprising since the Reference site has the lowest percentage of fines. However, the station with the second-lowest percentage of fines, MPC-06-13, consistently has the highest metals concentrations. However, the range of percent sand is not large nor is the range of trace metals concentrations of the channel-station samples.

There are no sediment quality criteria with which to compare concentrations in the sediment. However, there are several different guidelines that are used to look for a cause for concern in sediment samples, one of which is the Effects Range Low, or ERL. ERLs were developed by a technique that demonstrates no cause and effect from the chemicals in the data set and when ERLs derived from sets of data from different areas are compared, the results are inconsistent (USACE, 1998). Since the ERLs are not based on cause and effect data, they are used only to determine a possible "cause of concern." The ERLs presented in Table 3 are those given in the National Oceanic and Atmospheric Administration (NOAA) 1999 Screening Quick Reference Tables (Buchman, 1999).

No ERLs were exceeded. The maintenance materials are generally fine, ranging from 76.9.0% to 93.3% silt and clay. The reference material contained 66.6% silt and clay

3.2 BIOASSESSMENT STUDIES

3.2.1 Solid Phase Bioassay

Survival data from the SP bioassays and the bioaccumulation studies are presented in Table 4, both by species and for total organisms. The survival data for the bioaccumulation study organisms are included for informational purposes only and no analyses of these data are pertinent. The ranges of physical parameters and statistical analyses of the data, if necessary, are presented in Appendix B.

There were no tests in which survival in the Reference Control was greater than survival in the treatments and the difference exceeded 10% (20% for the amphipods), requiring statistical analysis. The survival data from the SP bioassay indicate that the dredged material is not more toxic than the reference sediment and the LPC for the SP has been met. Therefore, no potential for environmentally unacceptable toxic impacts to benthic organisms from the placement of sediments from MSC stations onto nearby bottom sediments is indicated.

TABLE 3

CONCENTRATIONS (dry wt) OF DETECTED COMPOUNDS
SEDIMENT
MATAGORDA SHIP CHANNEL - MATAGORDA PENINSULA TO POINT COMFORT

Date Sampled: February 21, 2006

Parameter	Units	Detection Limit	NOAA ERL	MPC-06-13	MPC-06-14	MPC-06-15	MPC-06-17	MPC-06-REF
Arsenic	mg/kg	0.30	8.2	6.48	6.17	5.79	5.76	4.49
Beryllium	mg/kg	1.00	NA	0.99 J	0.93 J	0.95 J	0.85 J	0.57 J
Cadmium	mg/kg	0.10	1.2	0.20	BDL	BDL	0.15	0.12
Chromium	mg/kg	1.00	81	12.4	11.3	11.3	11.1	7.76
Copper	mg/kg	1.00	34	9.21	8.54	8.34	8.45	5.43
Lead	mg/kg	0.30	46.7	16.9	14.7	15.7	15.1	10.5
Mercury	mg/kg	0.20	0.15	0.06 J	BDL	BDL	0.07 J	0.12 J
Nickel	mg/kg	0.50	20.9	5.05	4.31	4.47	4.16	2.48
Selenium	mg/kg	0.50	NA	0.13 J	0.15 J	0.16 J	0.19 J	0.12 J
Silver	mg/kg	0.20	1.0	0.08 J	0.10 J	0.11 J	0.07 J	BDL
Thallium	mg/kg	0.20	NA	0.33	0.39	0.16 J	0.17 J	0.14 J
Zinc	mg/kg	2.00	150	11.7	11.5	11.8	11.0	4.67
Gravel	%	NA	NA	8.0	0.0	0	0.5	2.5
Sand	%	NA	NA	15.1	6.7	8.2	12.8	30.9
Silt	%	NA	NA	20.5	33.4	25.6	23.6	25.8
Clay	%	NA	NA	56.4	59.9	66.2	63.1	40.8
D50	mm	NA	NA	0.00	0.00	0.00	0.00	0.03

TABLE 4
THE NUMBER AND PERCENTAGES OF SURVIVING ORGANISMS
10-DAY SOLID PHASE BIOASSAYS & 10-DAY BIOACCUMULATION STUDY
MATAGORDA SHIP CHANNEL - MATAGORDA PENINSULA TO POINT COMFORT - 2006

		Number of Survivors				
	Replicate	True	Reference	M-PC-06-		
	(n=5)	Control	Control	13	14	15
10-DAY	1	20	20	20	20	20
L. plumulosus	2	20	20	20	18	19
20/replicate	3	20	18	20	20	20
	4	20	19	20	20	19
	5	19	19	20	20	19
	Average	19.8	19.2	20.0	19.6	19.4
	(%)	99.0%	96.0%	100.0%	98.0%	97.0%
A. bahia	1	20	19	18	19	20
20/replicate	2	20	20	19	20	19
	3	20	20	20	19	19
	4	20	20	20	20	20
	5	20	20	19	20	19
	Average	20.0	19.8	19.2	19.6	19.4
	(%)	100.0%	99.0%	96.0%	98.0%	97.0%
Total Organisms	1	40	39	38	39	40
40/replicate	2	40	40	39	38	38
	3	40	38	40	39	39
	4	40	39	40	40	39
	5	39	39	39	40	38
	Average	39.8	39.0	39.2	39.2	38.8
	(%)	99.5%	97.5%	98.0%	98.0%	97.0%
10-DAY	1	10	10	10	10	10
N. virens	2	10	10	10	10	10
10/replicate	3	10	10	10	10	10
	4	10	10	10	10	10
	5	10	10	10	10	10
	Average	10.0	10.0	10.0	10.0	10.0
	(%)	100.0%	100.0%	100.0%	100.0%	100.0%
	1	10	10	10	10	10

3.2.2 Bioaccumulation

The concentrations of detected metals in the tissue samples can be found in Tables 5 and 6. The range of physical parameters in the 10-day study can be found in Appendix C (Table C-1).

Arsenic, chromium, copper, lead, nickel, selenium, and zinc were found in tissue samples above detection limits. The concentrations of none of the metals in tissues of *N. virens* or *M. mercenaria* exposed to test sediments were significantly higher than the respective concentrations in Reference Control organisms (Tables 5 and 6; Appendix C, Tables C-2 through C-8). Therefore, no bioaccumulation is exhibited from exposure to these sediments and the LPC for the SP is met and there is no indication that placement of dredged material from the Matagorda Peninsula to Point Comfort reach of the MSC would result in increased environmental hazard or human health risk.

3.3 SUMMARY

There is nothing in the chemical analyses, bioassays, or the bioaccumulation study that would indicate a concern with the open bay placement of these sediments, under the guidance provided by EPA/USACE (1998), RIA, or the TO.

TABLE 5
CONCENTRATIONS OF DETECTED COMPOUNDS
IN TISSUE SAMPLES OF
N. virens
MSC MATAGORDA PENINSULA TO POINT COMFORT

		STATION				
Parameter	Replicate	Archive	Reference Control	M-PC-06-13	M-PC-06-14	M-PC-06-15
Arsenic (mg/kg) [a]	1	1.80	2.16	2.34	2.18	1.91
	2	2.02	2.24	2.22	2.13	2.25
	3	1.97	2.96	2.32	2.50	2.12
	4	1.86	2.76	2.65	2.52	2.08
	5	1.99	2.49	2.77	1.88	1.74
	Total	9.64	12.61	12.30	11.21	10.10
	Average	1.93	2.52	2.46	2.24	2.02
Chromium (mg/kg) [b]	1	0.17	0.41	0.18	0.10	0.12
	2	0.12	0.30	0.17	0.16	0.11
	3	0.28	0.25	0.14	0.09	0.12
	4	0.17	0.12	0.15	0.09	0.13
	5	0.18	0.21	0.14	0.10	0.14
	Total	0.92	1.29	0.78	0.54	0.62
	Average	0.18	0.26	0.16	0.11	0.12
Copper (mg/kg) [a]	1	1.06	1.44	0.87	0.78	1.00
	2	0.84	1.33	1.17	1.02	0.76
	3	2.02	0.70	1.01	0.75	0.80
	4	1.36	0.85	0.90	0.72	0.81
	5	1.46	1.04	0.78	0.67	1.17
	Total	6.74	5.36	4.73	3.94	4.54
	Average	1.35	1.07	0.95	0.79	0.91
Lead (mg/kg) [a]	1	0.13	0.17	0.16	0.14	0.12
	2	0.19	0.16	0.12	0.17	0.16
	3	0.19	0.16	0.13	0.15	0.17
	4	0.13	0.19	0.17	0.14	0.16
	5	0.16	0.17	0.17	0.10	0.16
	Total	0.80	0.85	0.75	0.70	0.77
	Average	0.16	0.17	0.15	0.14	0.15
Nickel (mg/kg) [a]	1	0.10	0.19	0.09	0.10	0.10
	2	0.08	0.17	0.12	0.10	0.09
	3	0.17	0.14	0.10	0.10	0.10
	4	0.12	0.10	0.10	0.15	0.08
	5	0.12	0.12	0.10	0.10	0.09
	Total	0.59	0.72	0.51	0.55	0.46
	Average	0.12	0.14	0.10	0.11	0.09
Selenium (mg/kg) [a]	1	0.25	0.21	0.26	0.23	0.32
	2	0.23	0.39	0.34	0.29	0.28
	3	0.45	0.23	0.32	0.25	0.28
	4	0.28	0.26	0.30	0.26	0.27
	5	0.35	0.31	0.26	0.22	0.28
	Total	1.56	1.40	1.48	1.25	1.43
	Average	0.31	0.28	0.30	0.25	0.29

TABLE 5 (Continued)

Parameter	Replicate	STATION Archive	Reference Control	MSC-EC-05-01	MSC-EC-05-02	MSC-EC-05-03
Zinc (mg/kg) [b]	1	5.55	4.91	4.62	4.18	4.03
	2	5.49	27.0	6.09	5.08	4.68
	3	21.7	5.00	14.6	3.87	4.99
	4	6.39	4.90	4.68	4.16	14.8
	5	6.15	16.0	4.34	3.44	4.42
	Total	45.3	57.8	34.3	20.7	32.9
	Average	9.06	11.6	6.87	4.15	6.6

[a] Parameter concentration in test tissues are not greater than in reference tissues; therefore, no statistical analyses of the data are required.

[b] Parameter concentration in test tissues are greater than in reference tissues and statistical analyses of the data are required.

TABLE 6
CONCENTRATIONS OF DETECTED COMPOUNDS
IN TISSUE SAMPLES OF
M. nasuta
MSC MATAGORDA PENINSULA TO POINT COMFORT

Parameter	Replicate	STATION Archive	Reference Control	MSC-PC-06-13	MSC-PC-06-14	MSC-PC-06-15
Arsenic (mg/kg) [a]	1	2.02	2.31	2.13	2.00	2.79
	2	2.35	2.54	2.48	2.20	2.50
	3	1.87	2.59	2.61	2.02	2.52
	4	2.19	1.97	2.03	1.75	2.62
	5	2.26	1.98	2.11	2.22	2.39
	Total	10.69	11.39	11.36	10.19	12.82
	Average	2.14	2.28	2.27	2.04	2.56
Chromium (mg/kg) [a]	1	0.13	0.25	0.26	0.53	1.03
	2	0.09	0.39	0.34	0.35	2.14
	3	0.09	0.21	0.53	0.52	0.52
	4	0.09	0.62	0.83	0.44	0.83
	5	0.09	0.56	0.31	0.83	0.89
	Total	0.49	2.03	2.27	2.67	5.41
	Average	0.10	0.41	0.45	0.53	1.08
Copper (mg/kg) [a]	1	1.42	1.17	1.15	1.46	1.71
	2	1.52	1.39	1.28	1.20	1.32
	3	1.89	1.48	1.56	1.45	1.54
	4	1.55	1.33	1.10	0.92	1.39
	5	1.72	1.49	1.66	1.20	2.16
	Total	8.10	6.86	6.75	6.23	8.12
	Average	1.62	1.37	1.35	1.25	1.62
Lead (mg/kg) [a]	1	< 0.10	0.20	0.14	0.14	0.15
	2	0.11	0.15	0.16	0.14	0.20
	3	0.12	0.17	0.20	0.18	0.23
	4	0.11	0.22	0.16	0.12	0.15
	5	0.11	0.16	0.24	0.16	0.22
	Total	0.55	0.90	0.90	0.74	0.95
	Average	0.11	0.18	0.18	0.15	0.19
Nickel (mg/kg) [a]	1	0.22	0.27	0.19	0.20	0.26
	2	0.20	0.27	0.29	0.21	0.26
	3	0.18	0.23	0.26	0.23	0.33
	4	0.22	0.22	0.24	0.20	0.31
	5	0.23	0.24	0.25	0.23	0.23
	Total	1.05	1.23	1.23	1.07	1.39
	Average	0.21	0.25	0.25	0.21	0.28
Selenium (mg/kg) [b]	1	0.35	0.41	0.38	0.31	0.34
	2	0.35	0.40	0.33	0.31	0.33
	3	0.39	0.40	0.33	0.29	0.37
	4	0.35	0.36	0.32	0.25	0.28
	5	0.36	0.35	0.34	0.27	0.31
	Total	1.80	1.92	1.70	1.43	1.63
	Average	0.36	0.38	0.34	0.29	0.33

TABLE 6 (Continued)

Parameter	Replicate	STATION Archive	Reference Control	MSC-PC-06-13	MSC-PC-06-14	MSC-PC-06-15
Zinc (mg/kg) [a]	1	7.10	5.72	7.14	6.97	8.71
	2	6.93	6.06	6.60	6.99	8.20
	3	7.20	7.90	7.50	6.45	9.92
	4	7.26	5.74	8.30	7.97	6.20
	5	7.31	7.54	6.57	8.24	6.80
	Total	35.8	33.0	36.1	36.6	39.8
	Average	7.16	6.59	7.22	7.32	7.97

There was also an instance of the detection of another constituent above the detection limit: thallium in MSC-PC-06-014 Rep 2 @ 0.11 mg/kg versus a detection limit of 0.10 mg/kg.

[a] Parameter concentration in test tissues are not greater than in reference tissues; therefore, no statistical analyses of the data are required.
[b] Parameter concentration in test tissues are greater than in reference tissues and statistical analyses of the data are required.

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Appendix A

Chemical Methods

TABLE A-1

ANALYTICAL METHODOLOGY AND MINIMUM DETECTION LIMITS

Parameter	Detection Limit		EPA Method [1]
	Sediment		
METALS			
Antimony	2.5	mg/kg	7060A
Arsenic	0.3	mg/kg	7060A
Beryllium	1.0	mg/kg	6010B
Cadmium	0.1	mg/kg	7131A
Chromium (total)	1.0	mg/kg	6010B
Chromium (3+)	1.0	mg/kg	6010B
Chromium (6+)	1.0	mg/kg	6010B
Copper	1.0	mg/kg	6010B
Lead	0.3	mg/kg	7421
Mercury	0.2	mg/kg	7471A
Nickel	0.5	mg/kg	6010B
Selenium	0.5	mg/kg	7740
Silver	0.2	mg/kg	7761
Thallium	0.2	mg/kg	7761
Zinc	2.0	mg/kg	6010B

[1] EPA, "Test Methods for the Evaluation of Solid Waste," SW-846, November, 1996.

TABLE A-2

ANALYTICAL METHODOLOGY AND MINIMUM DETECTION LIMITS

Parameter	Detection Limit		EPA Method [1]
	Tissue		
METALS			
Antimony	0.1	mg/kg	7060A
Arsenic	0.1	mg/kg	7060A
Barium	0.1	mg/kg	6010B
Cadmium	0.1	mg/kg	7131A
Chromium (total)	0.05	mg/kg	6010B
Chromium (3+)	50	mg/kg	6010B
Chromium (6+)	50	mg/kg	6010B
Copper	0.1	mg/kg	6010B
Lead	0.1	mg/kg	7421
Mercury	0.01	mg/kg	7471A
Nickel	0.1	mg/kg	6010B
Selenium	0.2	mg/kg	7740
Silver	0.1	mg/kg	7761
Thallium	0.1	mg/kg	7761
Zinc	0.1	mg/kg	6010B

[1] U.S. EPA, "Test Methods for the Evaluation of Solid Waste," SW-846, November, 1996.

Appendix B

Solid Phase Bioassays

TABLE B-1

RANGE OF PHYSICAL PARAMETERS
SOLID PHASE BIOASSAYS
MATAGORDA SHIP CHANNEL - MATAGORDA PENINSULA TO POINT COMFORT

Day	Temperature	Salinity	Dissolved O_2	pH	Ammonia				
Day	(°C)	(‰)	(ppm)		Con-trol	MSC -REF	MSC-PC -13	MSC-PC -14	MSC-PC -15
				Americamysis bahia					
0	20	25 - 26	7.6 - 7.7	7.8 - 8.0	0.16	0.71	1.33	1.13	2.36
1	20	26	7.6	7.9	0.58	<0.01	0.63	0.67	2.09
2	20	26	7.6 - 7.7	7.9	0.46	0.23	0.76	0.91	1.94
3	20	26	7.7	7.8	<0.01	0.24	0.62	1.70	1.19
4	20	25 - 26	7.6	7.9 - 8.1	<0.01	<0.01	0.09	0.16	1.31
5	20	25 - 27	7.7	8.1 - 8.2	<0.01	<0.01	<0.01	<0.01	<0.01
6	19	25 - 27	7.6 - 7.7	8.0 - 8.2	1.12	0.52	<0.01	0.30	0.25
7	19	25 - 26	7.8 - 7.9	7.9 - 8.0	<0.01	<0.01	<0.01	<0.01	<0.01
8	20	25	7.7 - 7.8	7.9 - 8.1	0.26	0.26	<0.01	<0.01	0.36
9	20	25	7.7 - 7.8	7.9 - 8.0	0.12	0.17	0.22	0.09	0.28
10	20	25 - 27	7.3 - 7.6	7.8 - 8.1	2.18	<0.01	<0.01	<0.01	<0.01
				Leptocheirus plumulosus					
0	20	25 - 26	7.5	8.0 - 8.1	-	<0.01	1.34	1.45	2.22
1	20	25	7.5 - 7.6	8.0	1.60	<0.01	2.69	3.03	4.20
2	20	25 - 26	7.4 - 7.5	7.8 - 8.0	0.70	<0.01	1.31	1.24	2.19
3	20	25 - 26	7.6	8.0 - 8.3	2.65	0.82	1.89	1.70	2.83
4	20	25 - 26	7.6	8.0 - 8.1	2.07	1.16	1.92	2.02	2.29
5	20	25 - 26	7.5 - 7.6	7.9 - 8.0	2.14	0.96	2.19	2.84	0.80
6	20	25 - 26	8.3 - 8.4	8.1 - 8.3	4.18	0.46	0.56	0.51	0.25
7	20	25 - 26	7.5 - 7.6	8.0 - 8.3	4.46	0.28	0.20	0.13	0.09
8	20	25 - 26	7.6 - 8.0	8.0 - 8.2	4.48	0.12	<0.01	<0.01	<0.01
9	20	25 - 27	8.1 - 8.3	8.0 - 8.3	3.18	<0.01	<0.01	<0.01	<0.01
10	20	25 - 27	7.9 - 8.0	8.0 - 8.3	3.67	0.37	0.20	<0.01	<0.01

Appendix C

Bioaccumulation Studies

TABLE C-1

RANGE OF PHYSICAL PARAMETERS
BIOACCUMULATION STUDY
MATAGORDA SHIP CHANNEL - MATAGORDA PENINSULA TO POINT COMFORT

Day	Temperature (°C)	Salinity (‰)	Dissolved O_2 (ppm)	pH	Ammonia				
					Con-trol	REF	MSC-PC -13	MSC-PC -14	MSC-PC -15
			Nereis virens						
0	20	25	7.5 - 7.9	7.9 - 8.1	<0.01	<0.01	<0.01	<0.01	0.18
1	19	25 - 26	7.7 - 8.0	8.0 - 8.1	<0.01	<0.01	0.16	<0.01	1.09
2	19-20	25 - 27	7.6 - 7.8	7.9 - 8.1	0.87	0.77	2.15	2.10	2.63
3	19	25 - 26	7.9	7.9 - 8.0	0.14	<0.01	0.40	1.60	1.49
4	20	25 - 26	7.7 - 7.9	7.9 - 8.0	0.62	0.81	0.92	1.39	1.56
5	20	25 - 26	7.7 - 7.8	7.9 - 8.0	0.39	0.47	0.26	1.02	1.10
6	20	25 - 26	7.9 - 8.0	8.0 - 8.1	0.31	<0.01	<0.01	1.78	2.01
7	19	25 - 26	8.2 - 8.3	7.9	<0.01	<0.01	<0.01	0.05	0.27
8	19	26 - 27	7.7 - 8.1	8.0 - 8.1	0.45	0.06	<0.01	0.68	<0.01
9	19	25 - 26	7.9 - 8.0	7.9 - 8.0	1.34	0.39	0.61	0.75	0.52
10	19-20	25 - 26	7.5 - 7.6	7.9	0.45	<0.01	0.04	0.23	0.11
			Macoma nasuta						
0	14	25 - 26	8.6 - 9.1	7.8 - 7.9	<0.01	<0.01	0.30	0.19	0.65
1	14	25	8.6 - 8.7	7.9 - 8.0	<0.01	0.42	0.37	1.09	1.27
2	14	25	8.6 - 8.7	7.9 - 8.0	0.27	0.36	1.12	1.17	0.82
3	14	25 - 26	8.9 - 9.4	8.0 - 8.1	1.31	1.48	0.71	1.18	1.85
4	13-14	25	8.4 - 8.9	7.9 - 8.2	2.97	2.84	3.62	2.42	3.27
5	14	25	8.6 - 8.7	7.9	1.98	0.77	1.75	1.07	1.66
6	14	25 - 26	8.4 - 8.6	7.4 - 7.6	0.85	0.44	1.24	1.04	1.23
7	14	26	8.8 - 9.1	8.0 - 8.1	0.81	0.82	1.06	0.97	1.69
8	13	25 - 26	8.4 - 8.9	7.7 - 7.9	1.14	1.17	0.99	1.26	2.08
9	13	25 - 26	8.4 - 8.5	7.8	1.01	1.39	1.66	1.40	1.88
10	14	25 - 27	9.0 - 9.7	7.6 - 8.1	1.08	0.85	2.02	0.91	1.24

TABLE C-2
STATISTICAL ANALYSIS
OF *N. virens*
SELENIUM AFTER 10-DAY EXPOSURE
TO MSC MATAGORDA PENINSULA TO POINT COMFORT SEDIM

REPLICATE	Reference	MSC-PC-13	MSC-PC-14	MSC-PC-15
1	0.210	0.260	0.230	0.320
2	0.390	0.340	0.290	0.280
3	0.230	0.320	0.250	0.280
4	0.260	0.300	0.260	0.270
5	0.310	0.260	0.220	0.280
TOTAL	1.400	1.480	1.250	1.430
MEAN X	0.280	0.296	0.250	0.286
COEF VAR	25.75	12.09	10.95	6.82

THE VARIANCES ARE HETEROGENEOUS AND TRANSFORMATION WILL NOT HELP.

THE KRUSKAL/WALLIS TEST.

CALCULATED H= 4.381 CRITICAL H= 7.915 df= 3

SINCE CALC H <= CRIT H, ACCEPT Ho: ALL GROUPS ARE EQUAL AT ALPHA = 0.05.

TABLE C-3
STATISTICAL ANALYSIS
OF *M. nasuta*
ARSENIC AFTER 10-DAY EXPOSURE
TO MSC MATAGORDA PENINSULA TO POINT COMFORT SEDIMENT

REPLICATE	Reference	MSC-PC-13	MSC-PC-14	MSC-PC-15
1	2.310	2.130	2.000	2.790
2	2.540	2.480	2.200	2.500
3	2.590	2.610	2.020	2.520
4	1.970	2.030	1.750	2.620
5	1.980	2.110	2.220	2.390
TOTAL	11.390	11.360	10.19012.820	
MEAN X	2.278	2.272	2.038	2.564
COEF VAR	13.00	11.27	9.31	5.87

	DF	SUM SQUARES	MEAN SQUARE	F-CALC
TREATMENTS	3	0.695	0.232	4.373
ERROR	16	0.848	0.053	
F-TABULATED				3.240

SINCE F-CALCULATED > F-TABULATED, THE DIFFERENCE AMONG THE MEANS IS SIGNIFICANT AT P=0.05 AND THE DUNNETTS COMPARISON WILL BE PERFORMED.

MEAN COMPARISONS

DIFFERENCE IN MEANS

MSC-PC-15 VS Reference
2.564 - 2.278 = 0.286 NOT SIGNIFICANT
Reference VS MSC-PC-13
2.278 - 2.272 = 0.006 NOT SIGNIFICANT
Reference VS MSC-PC-14
2.278 - 2.038 = 0.240 NOT SIGNIFICANT

THE MINIMUM DETECTABLE DIFFERENCE = 0.32
DUNNETTS CRITICAL VALUE = 2.23

TABLE C-4
STATISTICAL ANALYSIS
OF *M. nasuta*
CHROMIUM AFTER 10-DAY EXPOSURE
TO MSC MATAGORDA PENINSULA TO POINT COMFORT SEDIMENT

REPLICATE	Reference	MSC-PC-13	MSC-PC-14	MSC-PC-15
1	0.250	0.260	0.530	1.030
2	0.390	0.340	0.350	2.140
3	0.210	0.530	0.520	0.520
4	0.620	0.830	0.440	0.830
5	0.560	0.310	0.830	0.890
TOTAL	2.030	2.270	2.670	5.410
MEAN X	0.406	0.454	0.534	1.082
COEF VAR	44.83	51.48	33.83	57.31

THE DATA ARE NOT NORMALLY DISTRIBUTED AND TRANSFORMATION WILL NOT HELP.
THE KRUSKAL/WALLIS TEST.
CALCULATED H= 7.528 CRITICAL H= 7.915 df= 3
SINCE CALC H <= CRIT H, ACCEPT Ho: ALL GROUPS ARE EQUAL AT ALPHA = 0.05.

TABLE C-5
STATISTICAL ANALYSIS
OF *M. nasuta*
COPPER AFTER 10-DAY EXPOSURE
TO MSC MATAGORDA PENINSULA TO POINT COMFORT SEDIMENT

REPLICATE	Reference	MSC-PC-13	MSC-PC-14	MSC-PC-15
1	1.170	1.150	1.460	1.710
2	1.390	1.280	1.200	1.320
3	1.480	1.560	1.450	1.540
4	1.330	1.100	0.920	1.390
5	1.490	1.660	1.200	2.160
TOTAL	6.860	6.750	6.230	8.120
MEAN X	1.372	1.350	1.246	1.624
COEF VAR	9.54	18.43	17.85	20.63

	DF	SUM SQUARES	MEAN SQUARE	F-CALC
TREATMENTS	3	0.386	0.129	2.137
ERROR	16	0.963	0.060	
F-TABULATED				3.240

F-CALC < F-TAB AND THE DIFFERENCE AMONG THE MEANS IS NOT SIGNIFICANT AT P=0.05.

TABLE C-6
STATISTICAL ANALYSIS
OF *M. nasuta*
NICKEL AFTER 10-DAY EXPOSURE
TO MSC MATAGORDA PENINSULA TO POINT COMFORT SEDIMENT

REPLICATE	Reference	MSC-PC-13	MSC-PC-14	MSC-PC-15
1	0.270	0.190	0.200	0.260
2	0.270	0.290	0.210	0.260
3	0.230	0.260	0.230	0.330
4	0.220	0.240	0.200	0.310
5	0.240	0.250	0.230	0.230
TOTAL	1.230	1.230	1.070	1.390
MEAN X	0.246	0.246	0.214	0.278
COEF VAR	9.36	14.82	7.09	14.70

	DF	SUM SQUARES	MEAN SQUARE	F-CALC
TREATMENTS	3	0.010	0.003	3.631
ERROR	16	0.015	0.001	
F-TABULATED				3.240

SINCE F-CALCULATED > F-TABULATED, THE DIFFERENCE AMONG THE MEANS IS SIGNIFICANT AT P=0.05 AND THE DUNNETTS COMPARISON WILL BE PERFORMED.

MEAN COMPARISONS

DIFFERENCE IN MEANS

MSC-PC- 15 VS Reference
0.278 - 0.246 = 0.032 NOT SIGNIFICANT
Reference VS MSC-PC-13
0.246 - 0.246 = 0.000 NOT SIGNIFICANT
Reference VS MSC-PC-14
0.246 - 0.214 = 0.032 NOT SIGNIFICANT

THE MINIMUM DETECTABLE DIFFERENCE = 0.04

DUNNETTS CRITICAL VALUE = 2.23

TABLE C-7
STATISTICAL ANALYSIS
OF *M. nasuta*
LEAD AFTER 10-DAY EXPOSURE
TO MSC MATAGORDA PENINSULA TO POINT COMFORT SEDIMENT

REPLICATE	Reference	MSC-PC-13	MSC-PC-14	MSC-PC-15
1	0.200	0.140	0.140	0.150
2	0.150	0.160	0.140	0.200
3	0.170	0.200	0.180	0.230
4	0.220	0.160	0.120	0.150
5	0.160	0.240	0.160	0.220
TOTAL	0.900	0.900	0.740	0.950
MEAN X	0.180	0.180	0.148	0.190
COEF VAR	16.20	22.22	15.41	20.04

	DF	SUM SQUARES	MEAN SQUARE	F-CALC
TREATMENTS	3	0.005	0.002	1.513
ERROR	16	0.018	0.001	
F-TABULATED				3.240

F-CALC < F-TAB AND THE DIFFERENCE AMONG THE MEANS IS NOT SIGNIFICANT AT P=0.05.

TABLE C-8
STATISTICAL ANALYSIS
OF *M. nasuta*
ZINC AFTER 10-DAY EXPOSURE
TO MSC MATAGORDA PENINSULA TO POINT COMFORT SEDIMENTS

REPLICATE	Reference	MSC-PC-13	MSC-PC-14	MSC-PC-15
1	5.720	7.140	6.970	8.710
2	6.060	6.600	6.990	8.260
3	7.900	7.500	6.450	9.920
4	5.740	8.300	7.970	6.210
5	7.540	6.570	8.240	6.830
TOTAL	32.960	36.110	36.620	39.930
MEAN X	6.592	7.222	7.324	7.986
COEF VAR	16.00	9.93	10.26	18.60

	DF	SUM SQUARES	MEAN SQUARE	F-CALC
TREATMENTS	3	4.844	1.615	1.468
ERROR	16	17.603	1.100	
F-TABULATED				3.240

F-CALC < F-TAB AND THE DIFFERENCE AMONG THE MEANS IS NOT SIGNIFICANT AT P=0.05.