RESULTS OF BAYOU DUPONT GEOPHYSICAL SURVEY

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MISSISSIPPI RIVER SEDIMENT DELIVERY SYSTEM – BAYOU DUPONT (BA-39)

INTRODUCTION

The Mississippi River Sediment Delivery System – Bayou Dupont Project (Project No. BA-39) is located in the Barataria Basin about 3.7 miles (5.9 km) northwest of Myrtle Grove as shown in Figure 1.

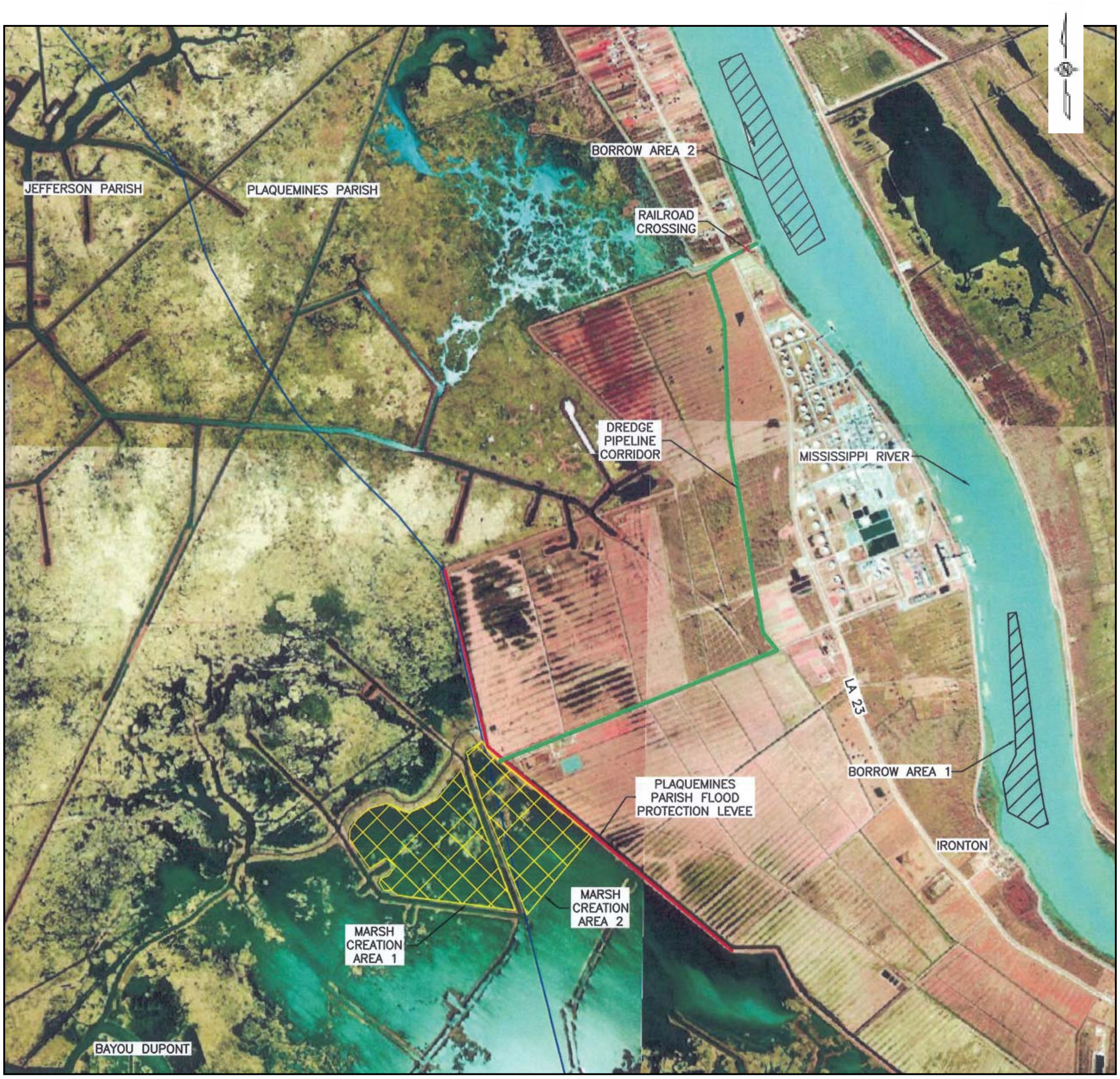

Figure 1 – Proposed Project Area and Features

The objective of the project is to create approximately 493 acres of sustainable marsh using the renewable resources of Mississippi River sediment. The project area is at present is mostly open water. The project area is located near the Mississippi River. The intent is to create marsh by hydraulically dredging sediment from the Mississippi River to fill the open water and broken marsh areas west of the Plaquemines parish flood protection levee. (Figure1). Availability of compatible and adequate sediment and its location is critical to the success of the project. Approximately 3.5 million cubic yards of sediment are required for restoration.

Approximately 8.4 line miles (13.5 km) of bathymetric, side-scan sonar, high resolution seismic, and magnetic data were collected along preselected tracklines on August 2, 2007. This narrative describes the methodology and the results of the survey in the borrow area.

METHODS OF DATA COLLECTION AND ANALYSIS

A high resolution acoustic and magnetometer data collection survey was conducted for the proposed Bayou Dupont sand borrow area (Figure 1). Magnetometer data were collected simultaneously with side-scan sonar data, chirp sonar subbottom profiles, and bathymetry using standard procedures for riverine and shallow marine geophysical surveys (Roberts et al., 1999; Roberts et al., 2000, Finkl et al., 2006). The magnetometer was deployed approximately 100 ft (30 m) off the stern of the survey vessel. A full spectrum subbottom profiler was deployed just below the waterline on the starboard around mid-vessel position. The side-scan fish was deployed on a bowsprit 5 ft (1.5 m) ahead of the vessel in order to minimize turbulence and cavitation. This configuration mitigates vessel related noise in the acoustic data. Geographical coordinates were recorded for all the geophysical data collected, which is essential for integration of the various data sets.

Survey Vessel – R/V Coastal Profiler

The survey was accomplished using the R/V Coastal Profiler. Figure 2 shows this vessel which has an overall length of 41 ft (12.5 m) and a beam of 17 ft (5.2 m). The Profiler is a Lafitte Skiff style vessel designed primarily for shallow water operations. From the outset, this vessel was custom built for shallow water geophysical data acquisition and vibracoring. Special ribbing and other supports were included in the construction to accommodate lifting heavy loads and withstanding substantial sea states. Booms, davits, and wenches were custom built and located on the vessel at optimal sites for towing a variety of data-collection systems. The cabin was built to specifications for accomodation of our computer-based data acquisition units. Two 450 hp Catepillar (model 3126 B) engines power the Profiler. The vessel is equipped with a Simrad Auto Pilot which is essential for running straight survey lines. A 750 gallon fuel tank provides the capacity to run several days without refueling. The hull design and two diesel engines allow us to quickly run to the field sites (cruising speed ~ 22 kts). The Profiler can work comfortably on the continental shelf as well as in Louisiana’s shallow bays and rivers. This vessel can operate in water depths as shallow as ~ 3 ft (1 m).

Navigation

Geographical coordinates were recorded simultaneously with all the geophysical data collected. Navigation data were acquired via a C&C Technologies GPS receiver system utilizing SatLoc3 differential GPS with sub-meter accuracy. The navigational data were delivered in real-time and these data were incorporated in the header information magnetometer, echo sounder, side-scan sonar and chirp digital data sets. The GPS-fix data were sent to the data acquisition systems at a rate of one fix per second. Navigational control was maintained on an IBM compatible PC running ChartView Pro and ArcGIS software. A navigational chart with the plot of the survey plan was displayed by ChartView Pro along with the vessel's position, orientation, course, and speed.

Figure 2. The R/V Coastal Profiler, a custom built vessel for shallow water geophysical survey work and coring.

Magnetometer

A Geometrics Model G882 marine cesium magnetometer was used on the Bayou Dupont survey. The cesium magnetometer sensor and associated electronics modules are housed in a waterproof non-magnetic fiberglass tow body approximately 5 ft (1.5 m) length. This tow body or "fish" is easy to deploy and is equipped with 200 ft (61 m) of tow cable. The system has Maglog software which allows the operator to receive, display, and otherwise manage data from the fish on a PC. In addition, this software allows for integration of magnetometer data with GPS-derived location data.

The raw magnetometer data files were exported as text files to the Geometric software Magmap 2000 and the significant anomalies were flagged. The positions of these flagged anomalies were exported as text files and then imported into ArcGIS for mapping purposes. The offset related to magnetometer sensor position relative to the GPS antenna location on the vessel was calculated for each flagged position exported to ArcGIS. The magnetic anomalies were then superimposed along the tracklines of the side-scan sonar mosaic of the survey area. A table of magnetic anomaly positions and amplitudes was created and included in the Results section of this report (Table 1).

Table 1
Magnetometer Anomaly Summary

Number	Signature Type	Description	Amplitude Relative (nT)	Counts (Seconds)	Longitude (dec deg)	Latitude (dec deg)	Interpretation
1	**Monopolar**	**Extra large negative**	**900.820**	**160**	**-89.9772010**	**29.6945820**	**Dock, Pipelines and Cables**
2	**Dipolar**	**Small**	**24.310**	**30.6**	**-89.9801610**	**29.6995700**	**Unknown**
3	**Complex**	**Medium**	**37.180**	**48.9**	**-89.9836570**	**29.7071140**	**Unknown**
4	**Monopolar**	**Medium -**	**28.410**	**35.2**	**-89.9846110**	**29.7091890**	**Unknown**
5	**Monopolar**	**Medium -**	**31.110**	**34**	**-89.9862830**	**29.7127460**	**Unknown**
6	**Monopolar**	**Medium +**	**11.110**	**21.5**	**-89.9878920**	**29.7161480**	**Unknown**
7	**Complex**	**Medium**	**13.000**	**28**	**-89.9872280**	**29.7174120**	**Unknown**
8	**Monopolar**	**Small -**	**36.130**	**89.5**	**-89.9852070**	**29.7132880**	**Unknown**
9	**Monopolar**	**Small +**	**17.780**	**39**	**-89.9833200**	**29.7092630**	**Unknown**
10	Dipolar	Small	9.120	28.7	-89.9816450	29.7059580	Unknown
11	**Monopolar**	**Small -**	**14.070**	**19.4**	**-89.9803660**	**29.7036800**	Unknown
12	**Monopolar**	**Large -**	**107.870**	**80.3**	**-89.9765060**	**29.6953950**	**Dock, Pipelines and Cables**
13	**Monopolar**	**Medium -**	**26.010**	**51**	**-89.9759620**	**29.6976100**	**Pipelines and Cables**
14	Monopolar	Small -	6.960	35.8	-89.9777410	29.7011480	Unknown
15	Monopolar	Small -	5.740	33.6	-89.9793100	29.7042670	Unknown
16	Complex	Very Small	4.610	80.2	-89.9840420	29.7137020	Unknown
17	**Dipolar (Complex)**	**Medium**	**13.730**	**59.4**	**-89.9854780**	**29.7107010**	**Unknown**
18	Complex	Small -	9.690	25	-89.9870590	29.7104750	Unknown
19	Monopolar	Small -	5.540	32	-89.9861300	29.7112740	Unknown
20	**Monopolar**	**Small +**	**14.820**	**62.4**	**-89.9821570**	**29.7038670**	Unknown
21	**Dipole**	**Large**	**78.270**	**48.4**	**-89.9797380**	**29.6996410**	**Siphon Possible**
22	**Monopolar (Incomplete)**	**Large -**	**293.630**	**79.7**	**-89.9774350**	**29.6952010**	**Dock, Pipelines and Cables**
23	**Negative Drift**	**Small -**	**8.680**	**132.9**	**-89.9761070**	**29.6990370**	**Cable Crossing**
24	Monopolar	Small +	5.940	15.7	-89.9887680	29.7151040	Unknown

Side-Scan Sonar

Side-scan sonar efficiently maps the water bottom, producing an image of the various features and sediment texture that occur there. Side-scan data show reflection amplitudes from acoustic energy output by the side-scan fish and reflected back from the water bottom. Bottom features such as sand waves and ripples are clearly imaged in side-scan data. Also, differences in bottom sediment types can be distinguished from reflection amplitude signatures. With ground truth calibration, discrimination and identification of bottom sediments, such as sand versus clay, is possible from reflection differences.

Side-scan data were acquired simultaneously on port and starboard channels using a Klein model 2260NV digital dual frequency (100 kHz/500 kHz) tow fish and a high fidelity, low loss armored single conductor coaxial tow cable, using methods described in Allen et al. (2005). The swath range of the sonograph was 200 m. Isis software was used for data acquisition and processing (Version 6.9.29.0, Triton Elics International Inc.). Slant, layback, and boat speed corrections were made with data collected during side-scan data acquisition. For these analyses, the 500 kHz channel data were used, since they provide better spatial surface resolution. The individual side-scan lines were converted to a georeferenced TIFF image with 0.7 ft (0.2 m) resolution in both latitude and longitude for representing the river bed of the potential borrow area.

Full Spectrum Subbottom Profiler

High frequency chirp subbottom profiling systems produce high resolution imaging of the shallow subsurface without strong “multiples” associated with other high resolution seismic sources such as boomers and sparkers. This feature makes the chirp sonar an ideal tool for imaging the shallow subsurface in sand searches. Different sediment types reflect the acoustic signal with different strengths, recorded in the chirp data. Therefore, bottom “hardness” can be interpreted from the amplitude of the sediment-water interface or initial bottom reflector. Subbottom data are useful for: 1) discrimination of shallow subsurface stratigraphy, different sediment types, and interpretation of deposition and erosion; and 2) improving the interpretation of geological controls of surface reflectance (side-scan sonar) data.

The EdgeTech SB512i towfish (frequency of 5-12 kHz) and Model FS 5B Signal Processor constitutes the chirp sonar system used on the survey. The subbottom data were acquired by selecting the frequency range of 2-12 kHz at 20 ms. This system is augmented with a CODA DA50 portable computer-based seismic data acquisition system. The system is equipped with a FSSB Network Interface, an analog acquisition card (for use with any analog SBP system), internal 60GB hard drive, and a DVD-RAM storage drive. CODA Geosurvey Windows Office Replay software was used as a digital data acquisition system and for displaying the data in real-time during the acquisition phase.

Subbottom data were saved in the industry standard SEG-Y format. Navigational data were retained for each shotpoint in the SEG-Y data.

RESULTS

Borings of the proposed Bayou Dupont sand borrow site indicate an abundance of sand (Figure 3). The boring logs indicate two distinctive sand types: (1) firm brown sand with occasional seams and disseminated woody organic particles and (2) firm gray sand containing both clay partings and layers of woody organics. It is unclear if both units represent channel sand or if the lower unit is distributary mouth bar sand associated with early progradation of the latest phase of Mississippi River delta-building. For the purpose of restoration, it is not important. What is important is that adequate sand resources are available for the Bayou Dupont project needs. Geophysical data from this survey certainly support the contention that adequate sand resources exist in the project area.

The side-scan sonar mosaic of Figure 4 images a dynamic channel bottom with sands moving down-river primarily as bedload transport by migrating bedforms of various dimensions. Analysis of echo-sounder profiles, chirp sonar profiles (Figure 5), and swaths of side-scan sonar images indicate that the most prevalent bedforms in the area are sand waves. Bigger waves**,** in general, are confined and best defined mostly to the western part of the potential borrow area as seen in the side sonar scan mosaic (Figure - 5). They are both symmetrical and asymmetrical. Slip faces of asymmetrical waves indicate downstream direction. In the western portion of the area these waves range in height from about 3 feet (1 m) to more than 6.5 feet (2 m) with a wave length of about 130 feet (40 m). These mobile bedforms are of a smaller dimension in the eastern part of the area with the height ranging from 1 to 3 feet (0.3 to 1 m) and amplitude 16 to 50 feet (5 to 15 m). The lighter reflection tone observed on the side scan sonar mosaic also indicates the sand. No prominent man-made sonar targets were observed within the study area except for a short section of the BP pipeline in the southwestern part of the site (Figure 4).

Figure 5 illustrates the chirp sonar subbottom profiles acquired along the middle NW-SE oriented survey line shown in the side-scan sonar mosaic of Figure 4. The chirp sonar profile illustrates little subbottom structure. This response on subbottom records in common in sand-dominated settings where sediments have a rather uniform grain size and therefore there are few internal horizons to create the acoustic impedance difference necessary to create reflection horizons. In addition, sand is very reflective. So, much of the energy is simply reflected at he sediment-water interface. Regardless, the response recorded on the chirp sonar records further substantiates the presence of sand throughout the project's proposed borrow area as documented by the borings of Figure 3.

Analysis of the magnetometer data generated by the Bayou Dupont survey identified 24 magnetic anomalies (Table 1). Close inspection of the side-scan sonar data associated with each survey line indicated that the only "hard target" corresponding to a magnetic anomaly was the western portions of the 20 inch and 24 inch BP pipelines (see Figure 4). No side-scan sonar targets were found for the other 23 magnetic anomalies. Because the river bed is composed of highly mobile sand deposits, burial of scattered magnetic debris is highly probable.

Figure 6 is a plot of the locations and relative strengths of the magnetic anomalies superimposed on the side-scan sonar mosaic. Table 1 summarizes the location data, amplitudes shapes, and durations of the anomalies. As is very clear from these data, magnetic anomalies 1, 12, and 22 (Figure 6) are very large deflections that reflect the combined magnetic deviations related to the massive steel dock at the Alliance Refinery and the two pipelines (20 inch and 24 inch BP pipelines) that cross the river in the southeastern part of the survey area. The very strong magnetic anomalies (1, 12, 22 in Table 1) associated with the massive steel dock had durations or peak widths (counts in Table 1) that obscure more subtle deflections associated with the BP pipelines. Rather uniform depression of the survey line oriented NE-SW that crosses the area of interest roughly parallel to and overlapping the Entergy cable crossing is uniformly depressed below background levels and either is responding to the cables (if they are metallic) or perhaps the neighboring pipelines.

Magnetic anomalies 2-11, 13-20, and 24 are small to medium sized deflections that are scattered throughout the survey area with no compelling trend. Figure 6 illustrates the distribution of these anomalies and the associated color coding provides an indicator of relative amplitude. These anomalies have monoploar, dipolar, or complex signatures and are of limited amplitude and duration when compared to anomalies 1, 12, and 22. They have characteristics consistent with isolated ferrous objects such as anchors, lengths of pipe, chains vessel equipment, trawl gear, discarded cable, and other metallic objects. Aside from the large magnetic deflections caused by the combined influence of the Alliance Refinery docking facility and the two BP pipelines, anomaly 21 stands out. This anomaly has a dipolar signature and occurs near the western margin of the survey area between the Entergy cable crossing and the siphons along the western bank of the river (see Figures 3 and 6). No targets were identified from the side-scan sonar data at this site and the site seems too far from the siphons to be strongly affected. This anomaly is isolated, but should be treated with respect if dredging operations are initiated in the proposed borrow area. In my opinion, there are no indications of shipwrecks, sunken barges, or other large-scale metallic objects in the proposed borrow area.

SUMMARY

High resolution acoustic data collected on the Bayou Dupont survey underscore that this site has abundant sand resources. The primary data set from this survey, the magnetometer data, identify 24 magnetic anomalies within the project area. Three of the anomalies are huge (1, 12, and 22). The peaks of these anomalies are so large that they are interpreted to incorporate several features, the Alliance Refiner docking facility as well as the two BP pipelines and possibly the Entergy cables. Certainly, extraction of sand resources for the Bayou Dupont project should be confined to areas well north of the pipeline and cable crossings.

Except for anomaly 21, the remaining magnetic anomalies north of the cable crossing are small scattered throughout the project area. These anomalies are consistent with localized metallic debris such as pieces of pipe, anchors, etc. and do not represent large-scale obstructions to dredging. However, anomaly 21 is large enough to warrant concern in a dredging operation. There are no indictors of man-made debris on the side-scan or chirp sonar records for anomaly 21 or any of the other anomalies north of the cable crossing. Therefore, they are considered to be buried by the migrating sand waves common to this part of the Mississippi River channel.

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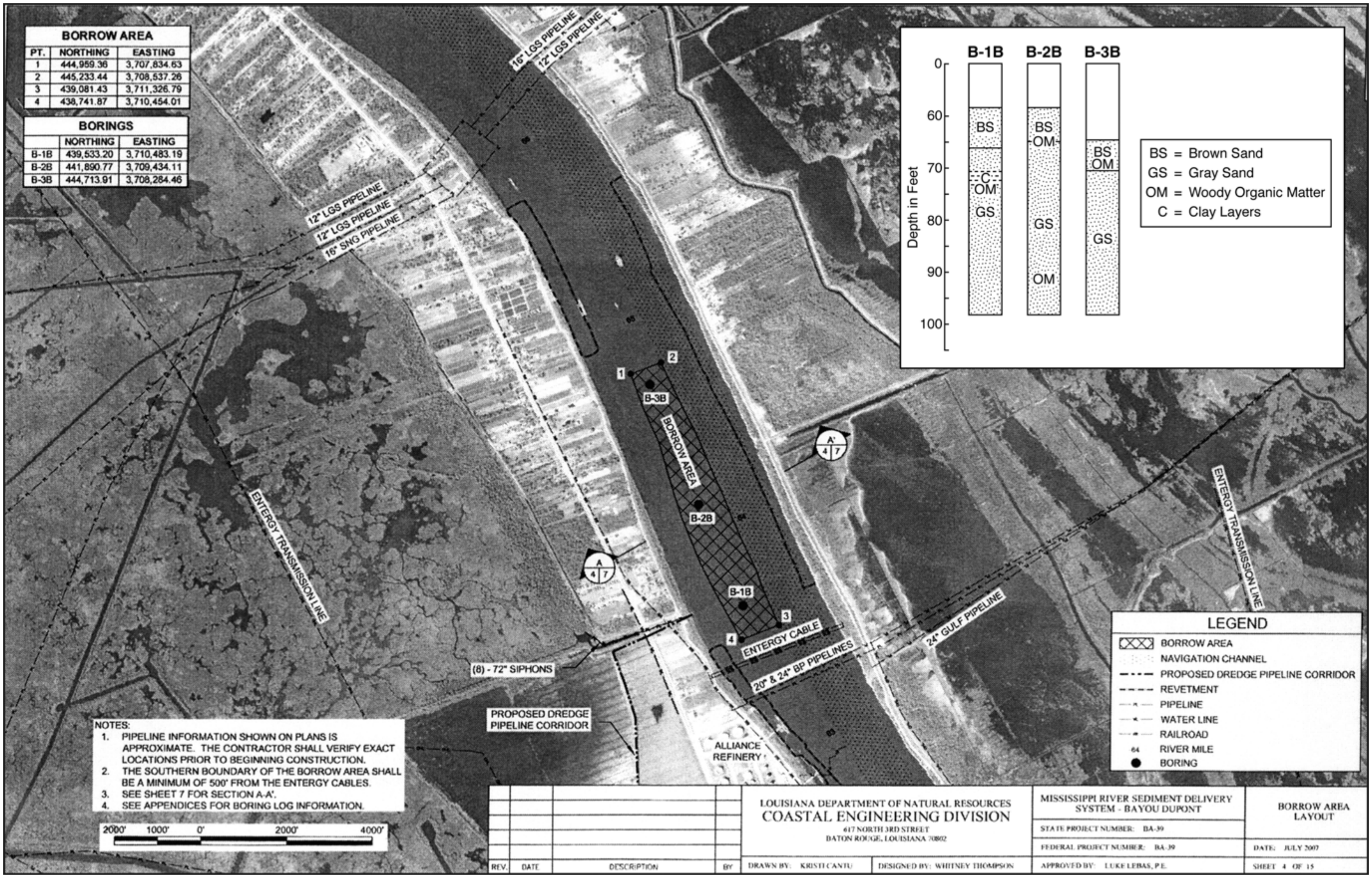


Figure 3. Project Site and Boring Characteristics.

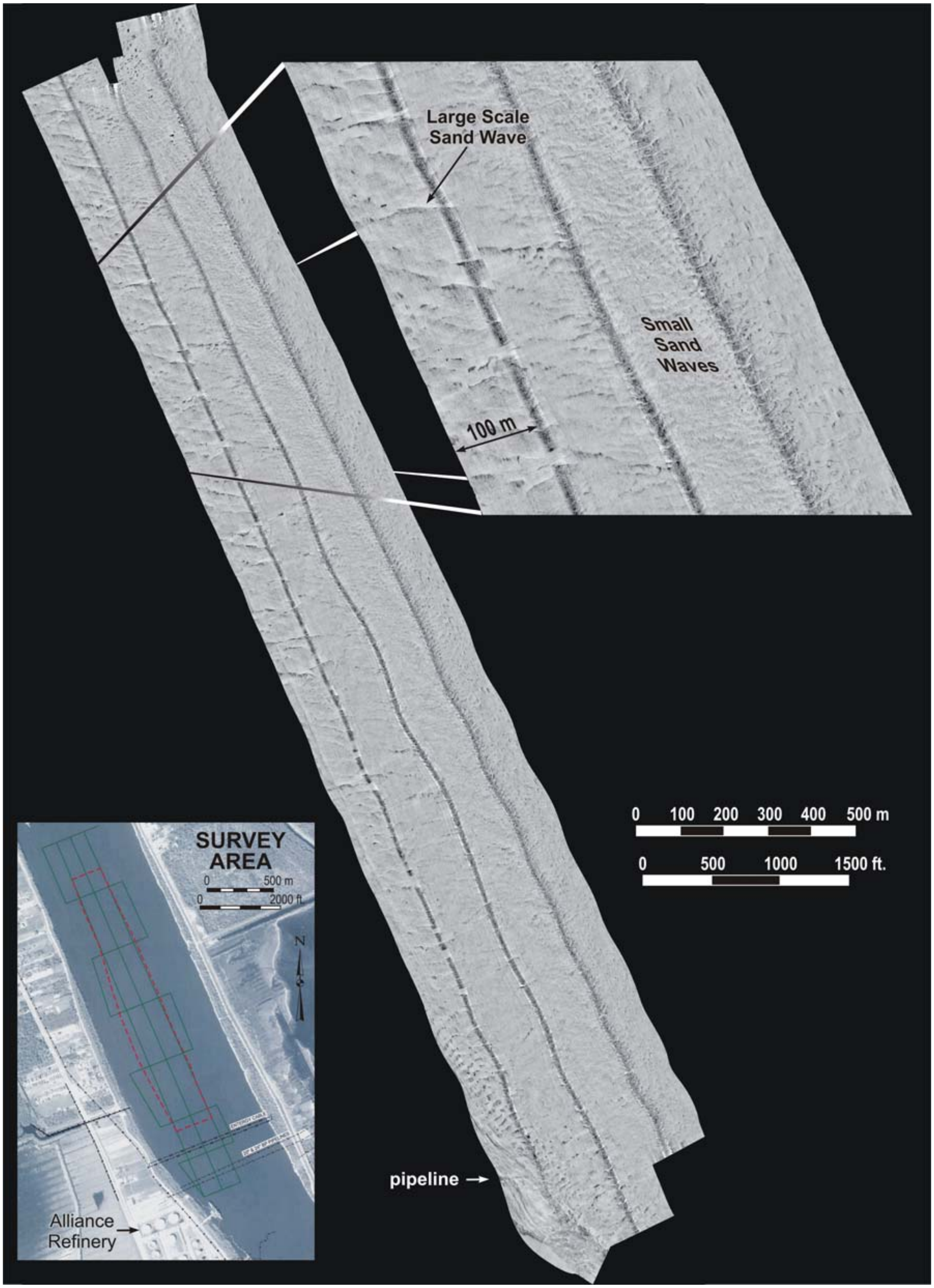


Figure 4. Side-Scan Sonar Mosaic.

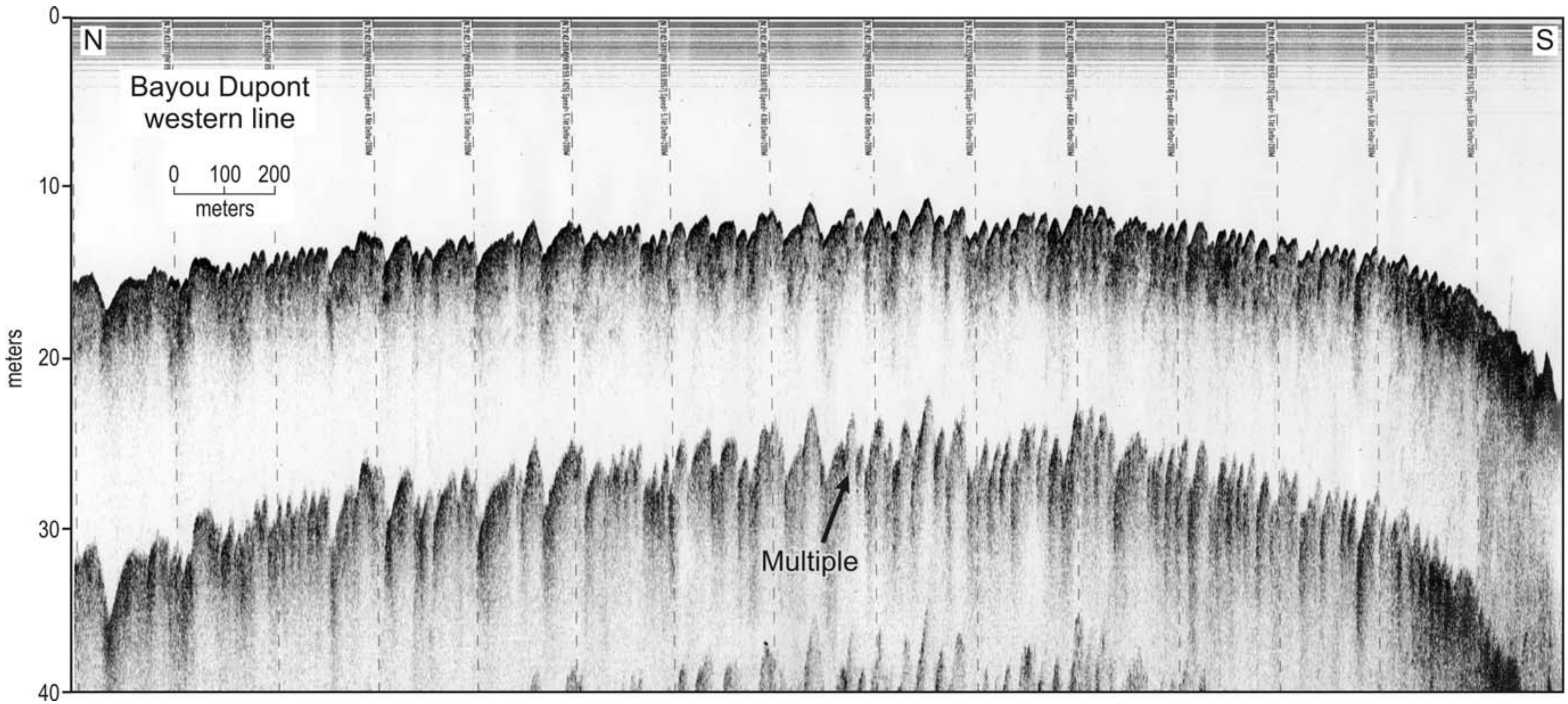
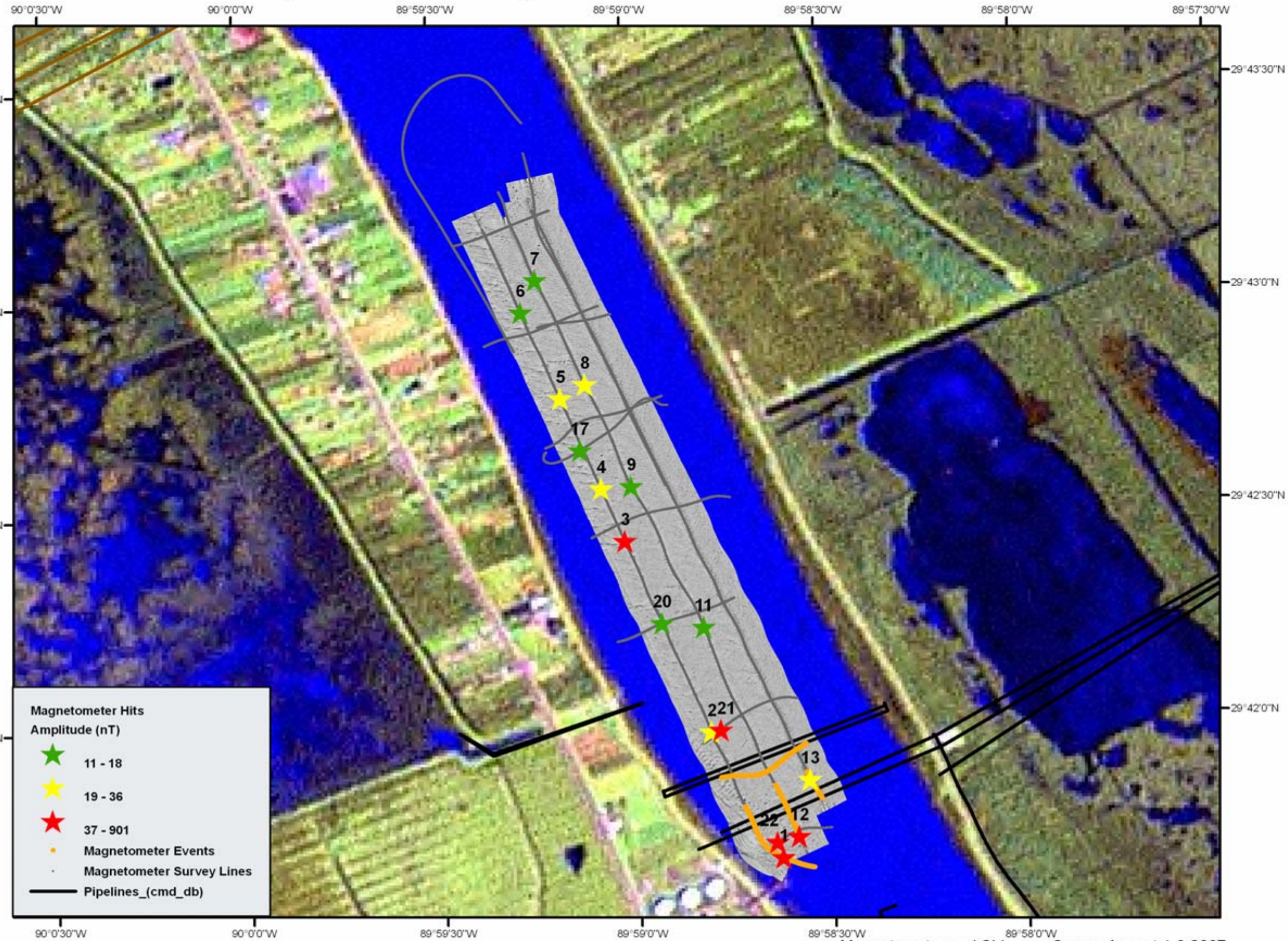


Figure 5. Chirp Sonar Profile (Middle Survey Line of Figure 4).

Bayou Dupont Magnetometer and Sidescan Survey



Magnetometer and Sidescan Survey August 1-3 2007
Coastal Studies Institute, Louisiana State University
Datum: NAD 83 Projection: UTM Zone 15 N