West Bay 2015 Depth Analysis Process Report

Introduction

The report outlines the processes that occurred to generate and subsequently analyze bathymetric data, utilizing a Geospatial Information System (GIS), over time in a diversion project off of the Mississippi River delta in Southern Louisiana. Data from two bathymetric surveys were analyzed as part of a larger analysis of the effect a diversion has had on West Bay since its creation in 2003.

Task Scope

The Spatial Data Branch (CESAM-OP-J), Mobile District was tasked with performing an analysis of an existing bathymetric survey obtained in 2011 and a new survey obtained in 2015. The bathymetric survey comparison will be generated using ArcGIS Desktop Tools to display the subaqueous land contours and profile.

Engineering firm Morris P. Hebert, Inc. (mph) performed the 2015 surveys of West Bay and the Crevasse area. Several placement areas have been created between the dates of the 2011 and 2015 surveys which should be noted when comparing the surface models and the bathymetric surveys. In regards to placement areas residing in or near the West Bay Survey area, Contract W912P8-12-C-0021 in 2012 provided 1,251,785 cubic yards of material on the islands in West bay. Contract W912P8-13-C-0013 provided 2,962,616 cubic yards of material which was strategically placed along the eastern boundary of the survey area. A significant placement occurred in 2015 along the eastern boundary of the survey area. It has been determined that the 2015 survey commenced in January 2015 and was finished in February 2015. The 2015 placement areas indicate a large placement of 5,198,068 cubic yards via contract number W912P8-14-C-0055 along the eastern boundary of the survey area.

After further review and feedback from the New Orleans District Projects and Restoration Branch (CEMVN-PM-OR), the entirety of the documented volumes in cubic yards of material from the 2015 placement event cannot be applied to the study due to the scheduling of the survey while the placement of material may have been occurring simultaneously. Furthermore, the total volumes from the 2012 W912P8-12-C-0021 placement areas will be adjusted since the extents of the placement areas fall outside of the 2015 survey area. The combined total of 4,812,490 cubic yards from placement events between 2012 and 2015 will be incorporated into the findings of this report.

ArcGIS Tools and Models

All previous reporting data, models, and calculations were generated using the ECoastal Tools designed for USACE coastal engineering applications. The tools were designed for coastal engineers and other ArcGIS users to efficiently and consistently create products which aided in assessing different coastal land and sea conditions. ECoastal Tools are no longer supported in current software versions of ArcGIS.

Additional effort was allocated to replicate and validate the ECoastal Tool processes using ArcGIS Desktop tools. After a full review of the ECoastal Tools components, the appropriate ArcGIS Tools and process parameters were identified and validated. ECoastal Tools provided excellent reporting capabilities that summarized data to an end user level. ArcGIS Desktop tools produce the same results, but require a professional GIS Analyst to summarize and interpret the data.

Survey Data Preparation

The 2011 datasets were previously assessed in a previous project comparing the 2009 and the 2011 data. Transect lines were aligned laterally with the exception of the starting and ending points. The 2015 datasets were processed utilizing the same methodology as the 2009 and 2011 studies.

Due to inconsistencies in the extents and spacing of the survey points, the previous comparison year is always reassessed in the most recent study. The reassessment is necessary in order to ensure the most recent survey area (2015) and the previous survey area (2011) volumetric calculations can be compared with confidence. Due to the survey area modification over time, any previous volume calculations or any other spatial analysis performed on previous surveys will provide different volumetric and area calculation values than what was reported in previous studies.

The survey data was obtained from (mph) in Microsoft Excel format for both the West Bay and Crevasse Survey areas. The points provided northing and easting values in the NAD83 State Plane coordinate system, Louisiana South, FIPS zone 1702 coordinate system, U.S Survey Feet. The elevation values were acquired in the 2003 geoid. Both the 2011 and 2015 surveys were assessed using the 2003 geoid elevations. Previous studies encountered elevation values in different geoids which required additional spatial data transformations and conversion of previous deliverables into the geoid of the most recent survey. In most cases, the regeneration of the previous deliverables with new converted elevation values altered the volumetric calculations provided in previous studies. With the 2015 study utilizing the 2003 geoid, all survey data from 2009 through 2015 possesses the same elevation value coordinate system. Analysis of any future surveys would be most effective if the elevation values are captured in the same geoid for current and historical analysis.

The survey data points in Microsoft Excel formats were imported into ArcGIS as a table and spatially aligned using the provided northing, easting, and elevation values. The resulting point features created the baseline GIS data from which all deliverables were derived from. The elevation (z) value coordinate system for the deliverables reside in North_American_Vertical_Datum_1988 (US survey feet). A review of the 2011 deliverables confirmed the correct elevation (z) value coordinate system. A single boundary polygon was created to encompass the extents of both the 2011 and 2015 surveys for accurate comparison of spatially derived products and volumetric calculations. The single boundary polygon for both survey extents encompassed 3,404 survey data points from the 2011 survey and 6,113 survey data points from the 2015 survey. Upon closer review of the survey data from both years, the 2015 survey data contains approximately 2,709 more survey points than the 2011 survey of West Bay.

A separate analysis of the diversion cut (Crevasse) itself was performed utilizing the same processes as the West Bay survey data. The Crevasse surveys from both 2011 and 2015 possessed different extents. A new boundary polygon was created to incorporate the extents of both areas for accurate comparison of spatially derived products and volumetric calculations.

Data Analysis/Map Production

The abovementioned point features were utilized as input data sources for creating a variety of elevation products. The initial elevation product generated was a TIN image. A TIN image is the ArcGIS recommended data format for generating bathymetric or morphological surface models. All surface model products were produced directly or indirectly from the TIN images.

Map Products

Project Location

A map depicting the location of the West Bay and Crevasse study areas is provided for general reference.

- West Bay and Crevasse Project Location

West Bay Placement Areas 2012-2015

A map depicting the location of West Bay Placement Areas from 2012-2015

- West Bay 2012-2015 Placement Areas

Survey Overviews (5)

The survey overview category of maps depict the variety of survey extents, survey point locations and derived survey areas over time.

- West Bay Survey Extents
- Crevasse 2011 Survey Overview Revised
- Crevasse 2015 Survey Overview
- West Bay 2011 Survey Overview Revised
- West Bay 2015 Survey Overview

Depth Analysis (4)

Depth analysis surface models for each survey were generated to show the individual depths of each survey in feet. The surface models were derived from the TIN images with a common raster cell size for both surveys. Survey area and volume calculations are displayed on the map. Calculations for volume below sea level (0) and above sea level (0) are listed in cubic yards. The survey area is provided in square yards. The calculations for the Crevasse area only provide volume below sea level since the survey areas contain no elevation values above zero.

- Crevasse 2011 Depth Analysis Revised
- Crevasse 2015 Depth Analysis

- West Bay 2011 Depth Analysis Revised
- West Bay 2015 Depth Analysis

Cut/Fill Analysis (2)

A Cut/Fill Analysis was performed on the comparison of 2015 and 2011 surveys in the Bay as well as the Crevasse. These maps show the amount of material gained and lost as quantified through the Cut Fill ArcGIS tool. The following analysis results are displayed on the map: Net Gain (Cubic Yards), Net Loss (Cubic Yards) and Net Difference (Cubic Yards). Net Volume gain and loss are indicated by different colors. The Cut Fill tool also provides the quantities that are displayed on the depth difference maps.

- Crevasse 2015 Cut Fill Analysis
- West Bay 2015 Cut Fill Analysis

Depth Difference (2)

Depth difference surface models were produced to identify places within the survey extents where the most significant changes in material and/or elevation values in comparison of the 2015 and 2011 surveys. The depth difference products were generated using the ArcGIS Minus Tool. Calculations for accretion (cubic yards), erosion (cubic yards), total difference (cubic yards), maximum difference (feet), and minimum difference (feet) are displayed on the map. The ArcGIS Minus tool does not provide any volumetric calculations. The volumetric calculations are derived from the ArcGIS Cut Fill Analysis Tool.

- Crevasse 2011 and 2015 Depth Difference
- West Bay 2011 and 2015 Depth Difference

Cross Section Profiles

17 cross section profiles for West Bay were generated throughout the 2015 Survey Area using the ArcGIS Stack Profile Tool. These are coincident with the 2011 and 2015 survey transects and plot both elevation surfaces. A map was generated to indicate the location of the cut lines and numbered based on the survey data provided by (mph) in reference to the appropriate profile graph.

- West Bay 2015 Survey Cross Section Profiles

Individual JPG files were created for each cross section along with a single PDF document which includes all 17 profiles.

- West Bay 2015 Profiles.pdf

15 cross section profiles for the Crevasse were generated throughout the 2015 Survey Area using the ArcGIS Stack Profile Tool. These are coincident with the 2011 and 2015 survey transects and plot both elevation surfaces. A map was generated to indicate the

location of the cut lines and numbered based on the survey data provided by (mph) in reference to the appropriate profile graph.

- Crevasse 2015 Survey Cross Section Profiles

- Individual JPG files were created for each cross section along with a single PDF document which includes all 15 profiles.
- Crevasse 2015 Profiles.pdf

General GIS Analysis Findings

The Crevasse itself has gained 2,972 cubic yards of water volume. Most of the differences are rather minute in comparison to the West Bay volume differences.

The remainder of West Bay has gained 17,235,348 cubic yards. It appears the 4,812,490* cubic yards of confirmed placement material have yielded a significant gain in material throughout the West Bay Survey Area. While the 2011 findings may have only shown some increase in sedimentation, the 2015 findings clearly indicate a strong pattern of increasing sedimentation within the survey area. When subtracting the cubic yards of the confirmed placement material, 12,422,858* cubic yards of material gained could be attributed to areas in the survey area that do not fall within the location of the placement areas. Several placement events have transpired in or around the 2015 survey area of West Bay between 2012 and 2015. Furthermore, the 2015 survey according to dredging log books was conducted while material was being placed in West Bay at a beneficial use placement area. While the ArcGIS surface modeling tools clearly show a strong gain in material, it is difficult to assess the exact amount of gain in the studied area from riverine processes versus beneficial use placement of dredged material. The West Bay receiving area is an open system which could allow sediment inputs from other natural sources besides the diversion, as well as the placement of material from dredging events that could move within the area. However, it is clear that a significant gain has taken place in the time period analyzed in this report, and much of the gain appears to have occurred naturally after subtracting the mechanically placed quantities from the total yardage.

No attempt was made in this effort to model the impact of islands (shreds) and the potential effect they have had on enhancing the capture of sediment that might otherwise be lost in the system. For the purposes of optimizing future designs of diversions, it is recommended that a modeling effort be considered that could better quantify the impact on sediment gain from the shreds. This should allow better design and adaptive management for future island construction that could enhance the land building potential of the diversion.

It is recommended for consistency and improved future analysis, that survey operations do not conflict with any maintenance dredging operations and include the same baseline, boundary of the previous survey, number of points, and geoid. The elimination of potential sources of error will strengthen the data collection and analysis. Therefore

coordination with the responsible parties (USACE, CPRA, monitoring teams) will be enhanced.

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*Assumptions: From January 2012 – August 2015, approximately 12 million cy were placed in the receiving area mechanically from various dredging and beneficial use operations. However, due to of the timeframe of survey activities (concluded in Feb 2015), and the location of some placement areas outside of the 2015 surveyed boundary (See fig. titled West Bay 2012-2015 Placement Area History), only 4.8 mcy were accounted for in the study area. Calculations and assumptions were made after careful analysis of aerial photography and dredging operator logs. Therefore, the following quantities were estimated for each calendar year: 2012- 250,357 cy; 2013-2,962,616 cy; 2015-1,599,517 cy.

West Bay and Crevasse Project Location

N
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Date: 4/18/2016

Legend

West Bay Sediment Diversion Area

0 5 10 20 Miles

Spatial Data
MOBILE DISTRICT

US Army Corps of Engineers
Mobile District

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West Bay Survey Extents and Boundaries

Legend

- West Bay 2015 Survey Area
- West Bay 2011 Survey Extent
- West Bay 2003 to 2009 Survey Extents
- West Bay Original Survey Area

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Date: 4/18/2016

0 0.5 1 2 Miles

Spatial Data
MOBILE DISTRICT

US Army Corps of Engineers
Mobile District

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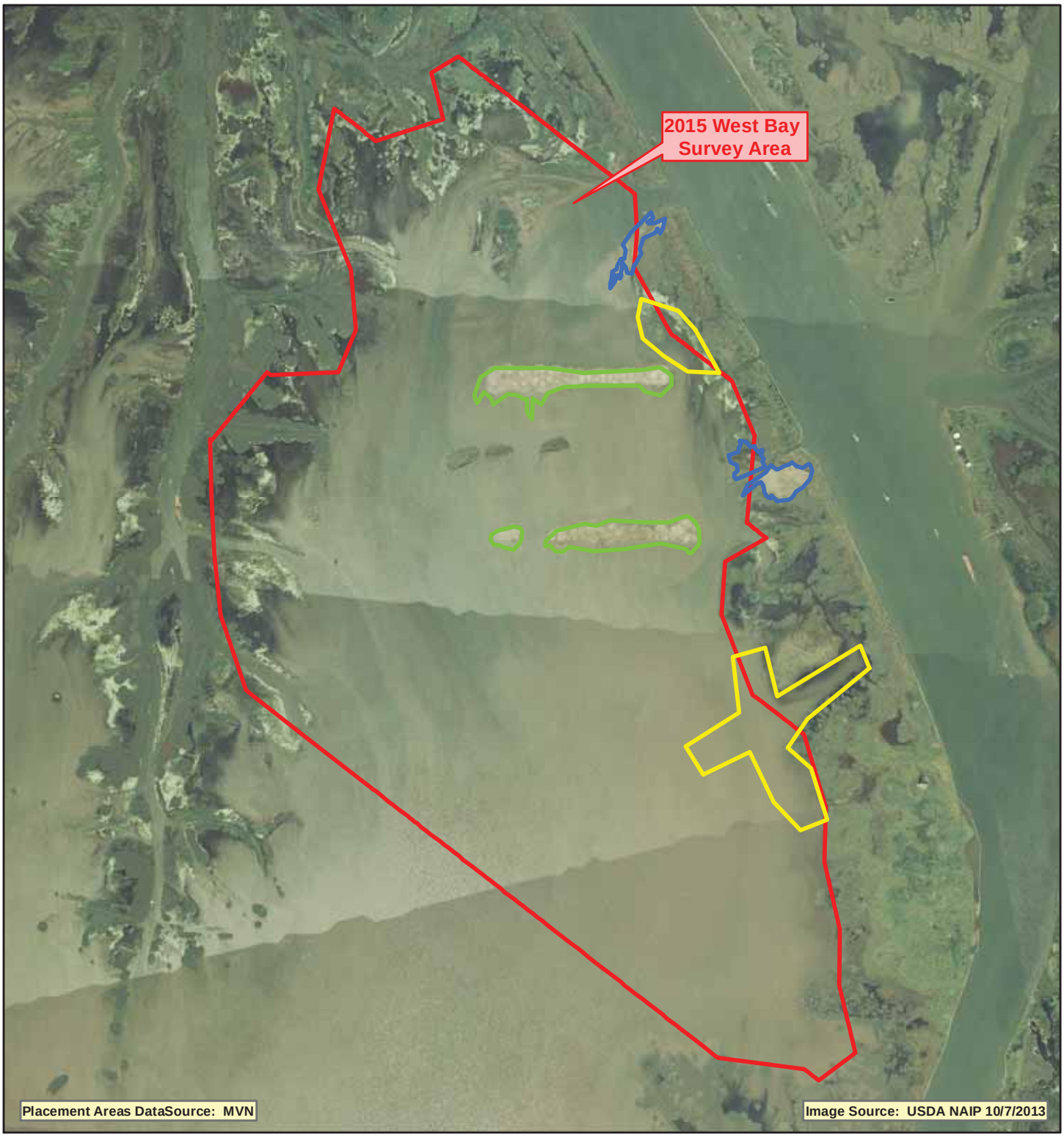
West Bay 2012-2015 Placement Area History



Legend

- 2012 O & M West Bay
- 2013 CWPPRA PAA West Bay
- 2015 O & M West Bay
- West Bay 2015 Survey Area

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Date: 4/18/2016

Miles
0 0.5 1 2

Spatial Data
MOBILE DISTRICT

US Army Corps
of Engineers
Mobile District

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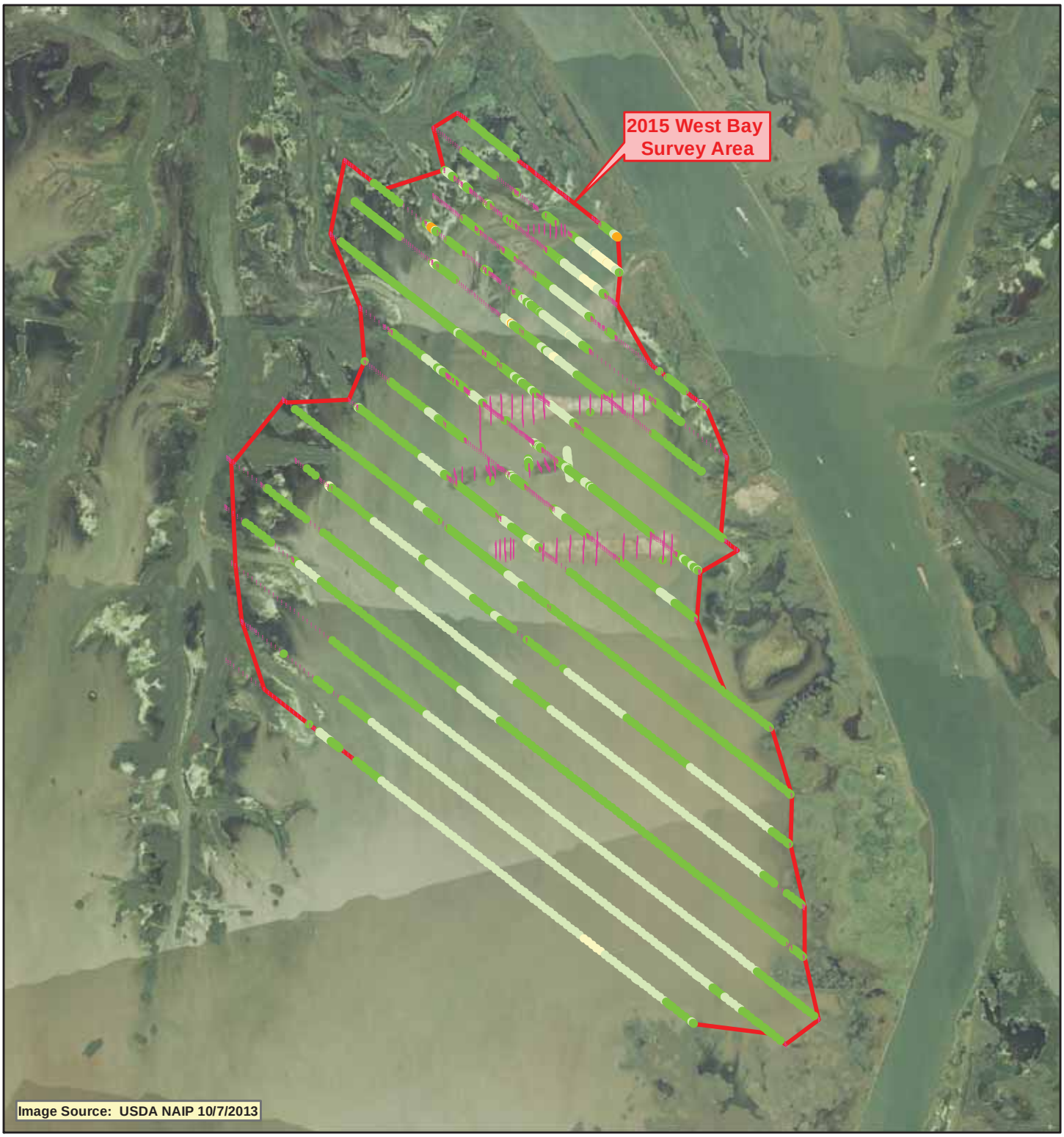
West Bay 2015 Survey Overview



West Bay 2015 Survey Area

2015 Survey Point Elevation > 0

2015 Survey Point Elevation <0

ElevGeoid03

- -11.67 - -9.00 Ft
- -8.99 - -6 Ft
- -5.99 - -3 Ft
- -2.99 - 0 Ft

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Date: 4/18/2016

Miles

0 0.5 1 2

Spatial Data
MOBILE DISTRICT

US Army Corps
of Engineers
Mobile District

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West Bay 2011 Survey Overview Revised

West Bay 2015 Survey Area

2011 Survey Point Elevation > 0

2011 Survey Point Elevation < 0

ELEVATION_FT

- -17.42 - -15 Ft
- -14.88 - -12 Ft
- -11.99 - -9 Ft
- -8.99 - -6 Ft
- -5.99 - -3 Ft
- -2.99 - 0.00 Ft

N W E S

Date: 4/18/2016

Miles

0 0.5 1 2

Spatial Data MOBILE DISTRICT

US Army Corps of Engineers Mobile District

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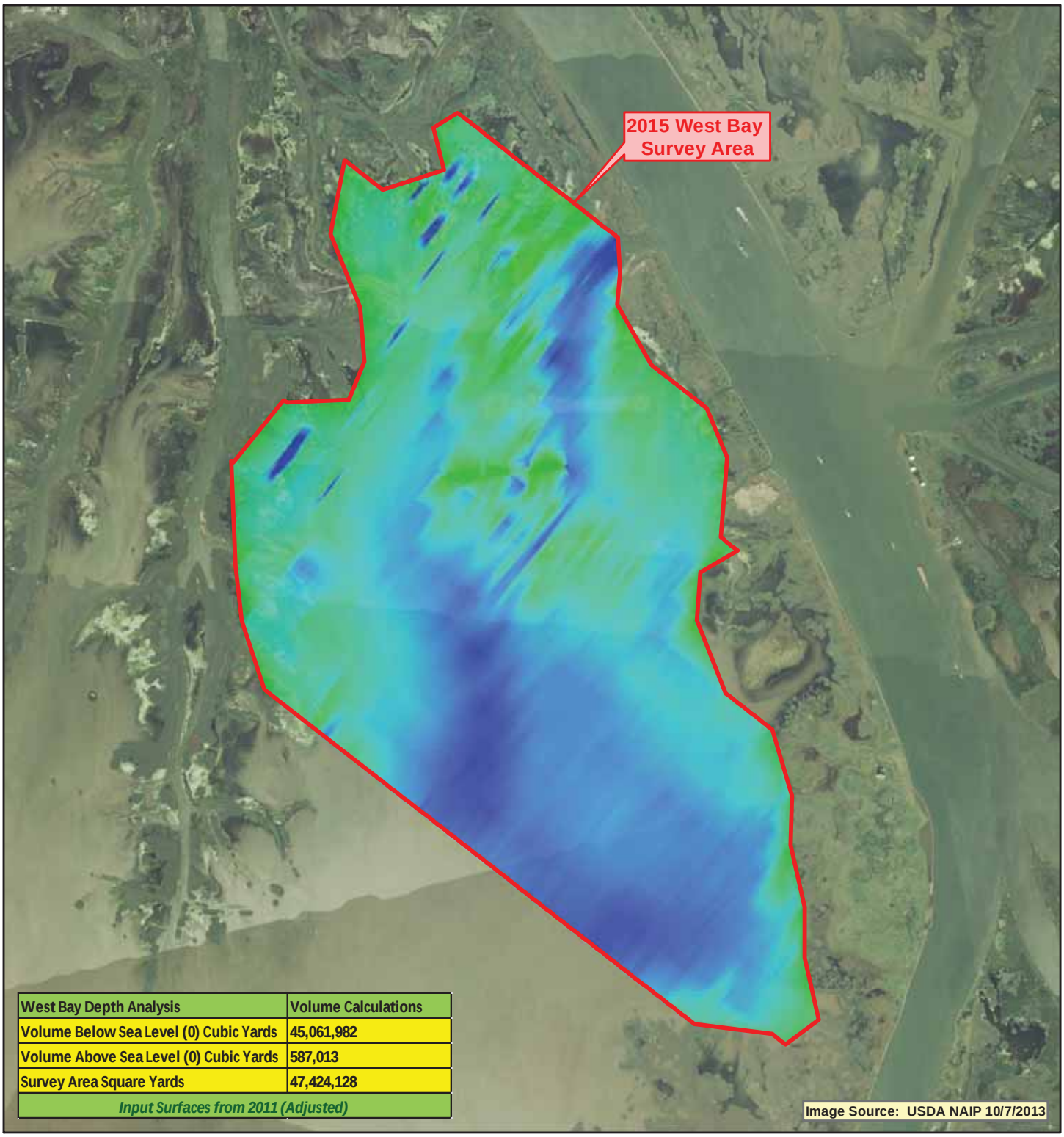
West Bay 2011 Depth Analysis Revised



West Bay Depth Analysis	Volume Calculations
Volume Below Sea Level (0) Cubic Yards	45,061,982
Volume Above Sea Level (0) Cubic Yards	587,013
Survey Area Square Yards	47,424,128
Input Surfaces from 2011 (Adjusted)	

West Bay 2015 Survey Area

West Bay 2011 Surface Revised

Value

High : 3.27659

Low : -17.2202

N W E S

Date: 4/18/2016

0 0.5 1 2 Miles

Spatial Data MOBILE DISTRICT

US Army Corps of Engineers Mobile District

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West Bay 2015 Depth Analysis

West Bay Depth Analysis	Volume Calculations
Volume Below Sea Level (0) Cubic Yards	30,069,135
Volume Above Sea Level (0) Cubic Yards	2,811,372
Survey Area Square Yards	47,424,128
Input Surfaces from 2015	

West Bay 2015 Survey Area

West Bay 2015 Surface
Value

High : 4.55708

Low : -11.3109

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Date: 4/18/2016

0 0.5 1 2 Miles

Spatial Data
MOBILE DISTRICT

US Army Corps of Engineers
Mobile District

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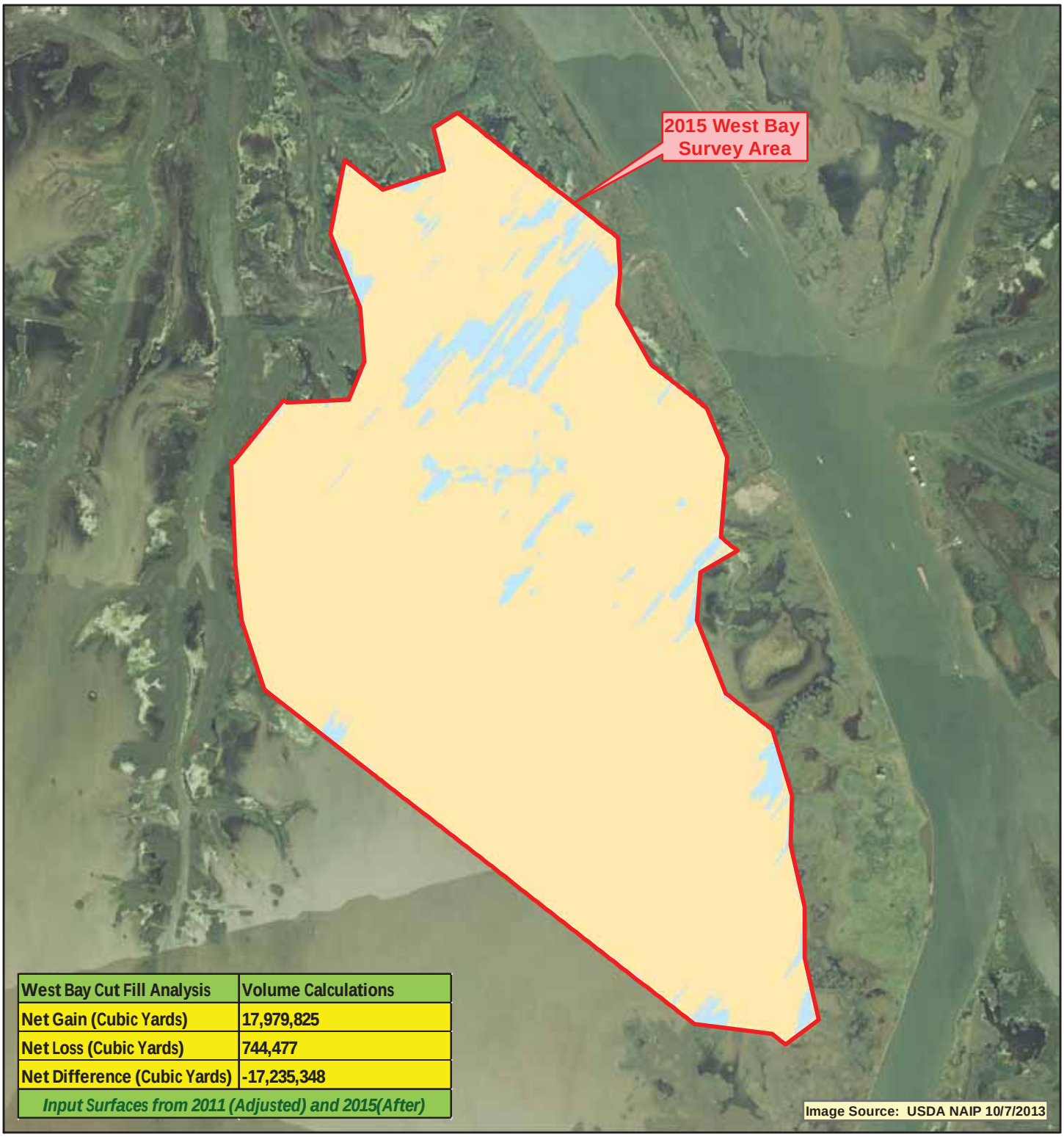
West Bay 2015 Cut Fill Analysis



West Bay Cut Fill Analysis	Volume Calculations
Net Gain (Cubic Yards)	17,979,825
Net Loss (Cubic Yards)	744,477
Net Difference (Cubic Yards)	-17,235,348
Input Surfaces from 2011 (Adjusted) and 2015(After)	

Legend

West Bay 2015 Survey Area

Cut Fill Analysis- VOLUME

Net Gain

Unchanged

Net Loss

N W E S

Date: 4/18/2016

0 0.5 1 2 Miles

Spatial Data Mobile District

US Army Corps of Engineers Mobile District

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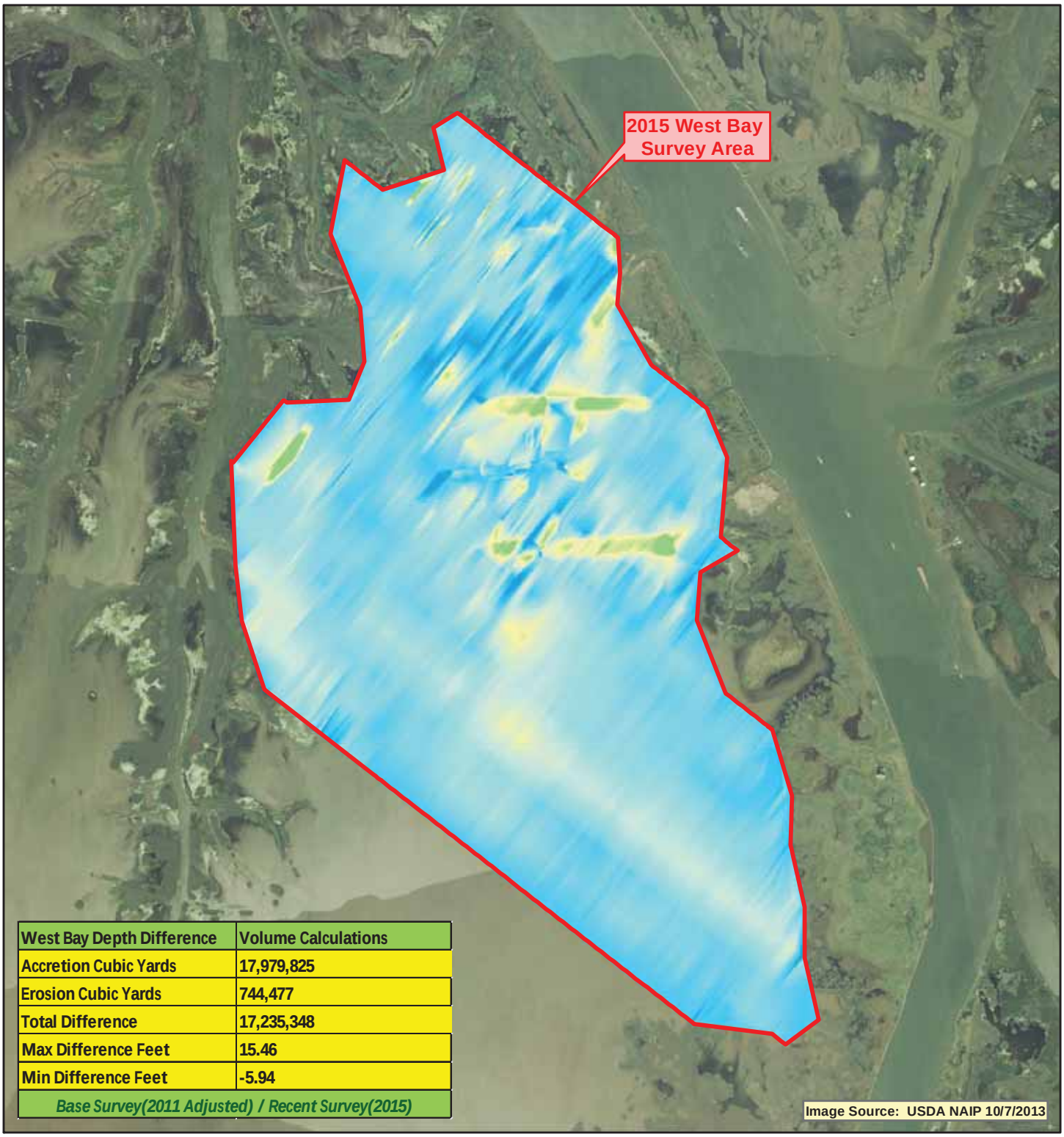
West Bay 2011-2015 Depth Difference



West Bay Depth Difference	Volume Calculations
Accretion Cubic Yards	17,979,825
Erosion Cubic Yards	744,477
Total Difference	17,235,348
Max Difference Feet	15.46
Min Difference Feet	-5.94
Base Survey(2011 Adjusted) / Recent Survey(2015)	

West Bay 2015 Survey Area

West Bay Depth Difference Value

High : 15.4625

Low : -5.94177

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Date: 4/18/2016

Miles
0 0.5 1 2

Spatial Data
MOBILE DISTRICT

US Army Corps of Engineers
Mobile District

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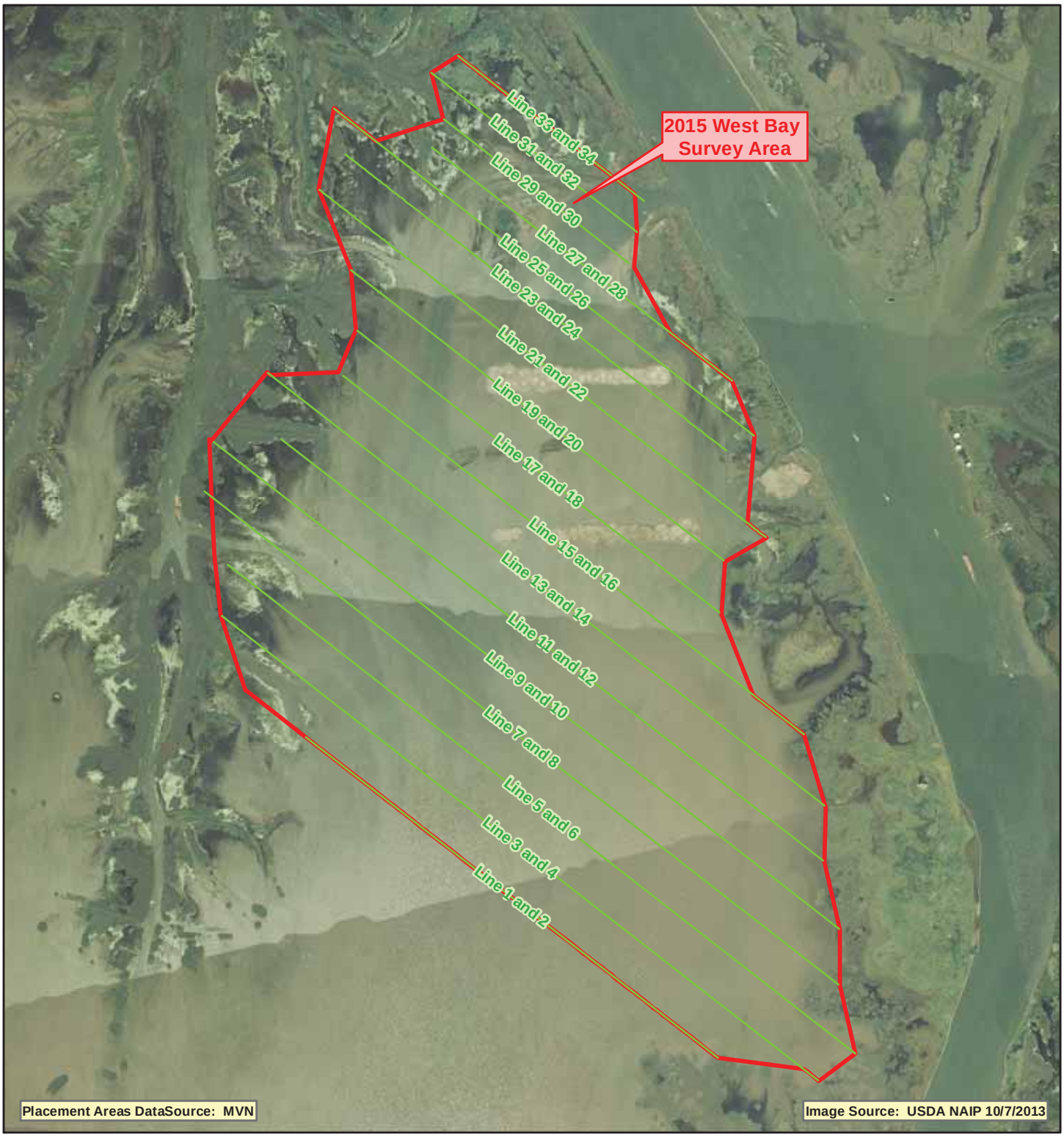
West Bay 2015 Survey Cross Section Profiles



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Date: 4/18/2016

Legend

- West Bay 2015 Survey Cross Section Lines
- West Bay 2015 Survey Area

0 0.5 1 2 Miles

Spatial Data
MOBILE DISTRICT

US Army Corps of Engineers
Mobile District

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Crevasse 2015 Survey Overview

Crevasse 2015 Survey Area

Crevasse 2015 Survey Points

ElevGeoid03

- -93.55 - -73.95 ft
- -71.76 - -56.22 ft
- -55.82 - -43.99 ft
- -43.76 - -33.72 ft
- -33.42 - -24.40 ft
- -23.69 - -17.39 ft
- -17.22 - -11.22 ft
- -11.12 - -6.79 ft
- -6.71 - -4.90 ft
- -4.81 - -1.04 ft

N
W E
S

Date: 4/18/2016

Miles

0 0.05 0.1 0.2

Spatial Data
MOBILE DISTRICT

US Army Corps of Engineers
Mobile District

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Crevasse 2011 Survey Overview Revised

Legend

Crevasse 2015 Survey Area

Crevasse 2011 Survey Points

ELEVATION_FT

- -93.550 - -73.95
- -71.76 - -56.22
- -55.82 - -43.99
- -43.76 - -33.72
- -33.42 - -24.4
- -23.69 - -17.39
- -17.22 - -11.22
- -11.12 - -6.79
- -6.71 - -4.90
- -4.81 - -1.04

N W E S

Date: 4/18/2016

0 0.05 0.1 0.2 Miles

Spatial Data MOBILE DISTRICT

US Army Corps of Engineers Mobile District

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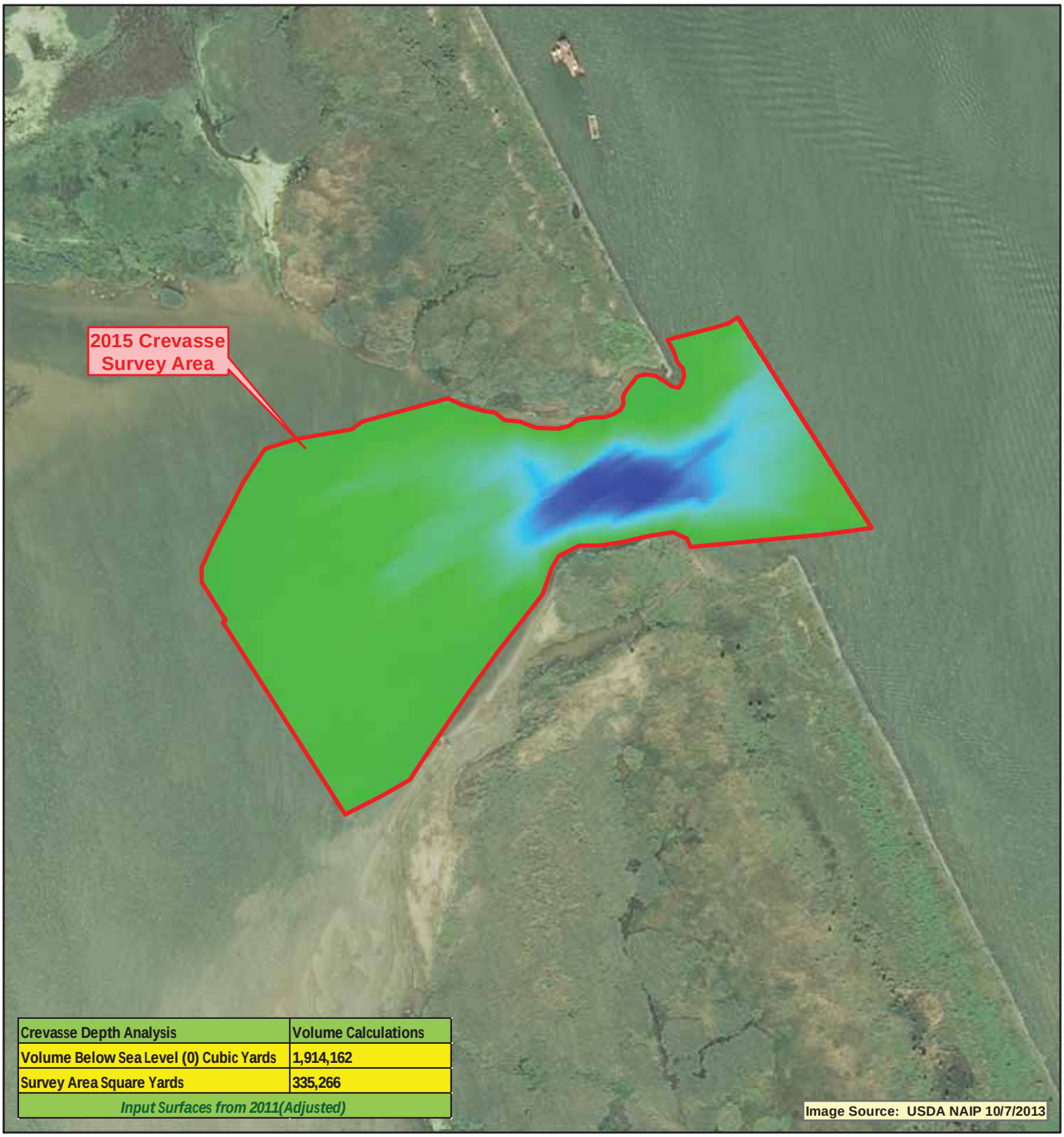
Crevasse 2011 Depth Analysis Revised



Crevasse Depth Analysis	Volume Calculations
Volume Below Sea Level (0) Cubic Yards	1,914,162
Survey Area Square Yards	335,266
Input Surfaces from 2011(Adjusted)	

Crevasse 2015 Survey Area

Crevasse 2011 Surface Revised

Value

High : 0.00 Ft

Low : -92.99 Ft

N W E S

Date: 4/18/2016

0 0.05 0.1 0.2 Miles

Spatial Data MOBILE DISTRICT

US Army Corps of Engineers Mobile District

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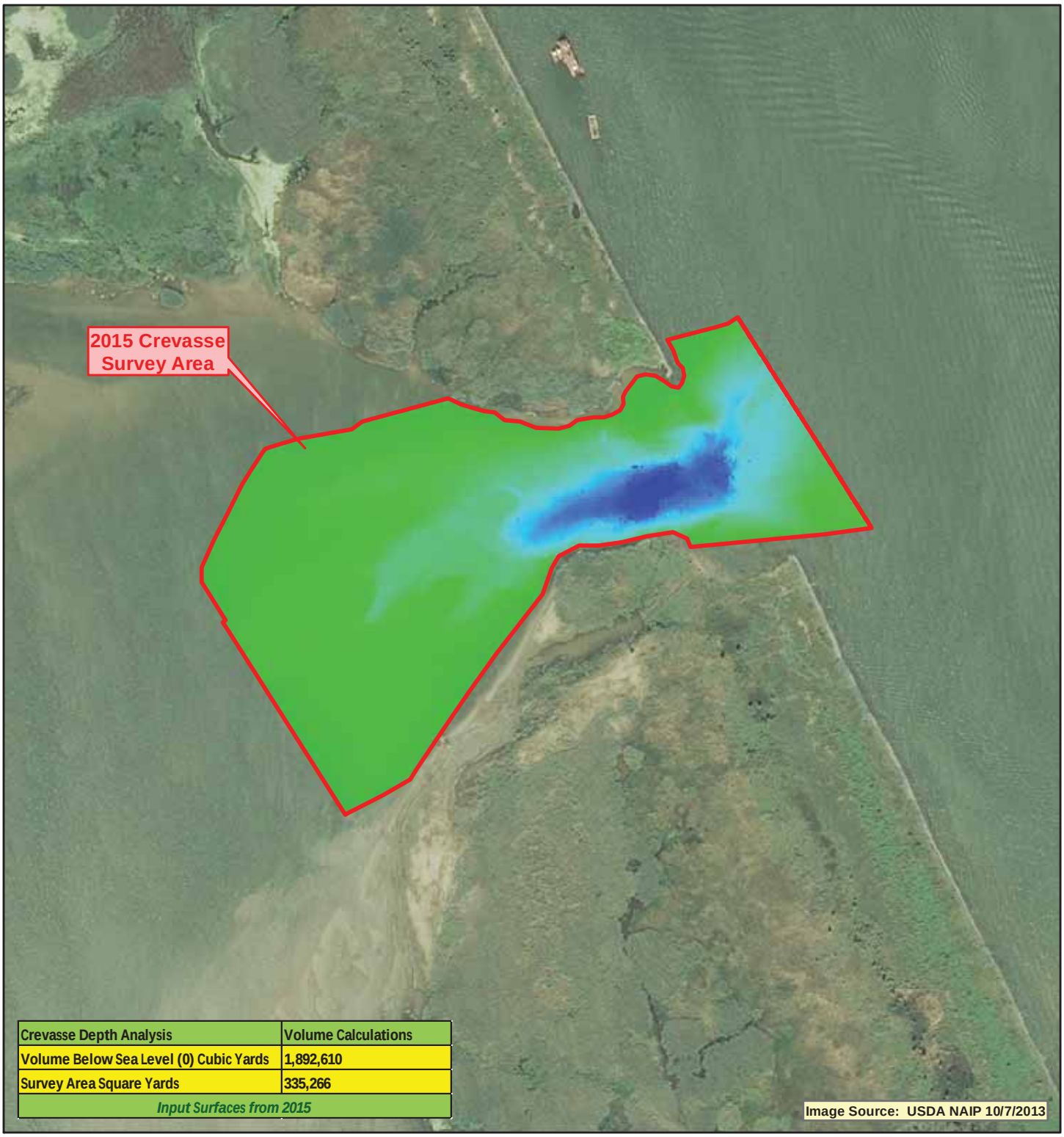
Crevasse 2015 Depth Analysis



Crevasse Depth Analysis	Volume Calculations
Volume Below Sea Level (0) Cubic Yards	1,892,610
Survey Area Square Yards	335,266
Input Surfaces from 2015	

Crevasse 2015 Survey Area

Crevasse 2015 Surface

Value

High : 0.00 Ft

Low : -88.58 Ft

N W E S

Date: 4/18/2016

Miles

0 0.05 0.1 0.2

Spatial Data

US Army Corps of Engineers
Mobile District

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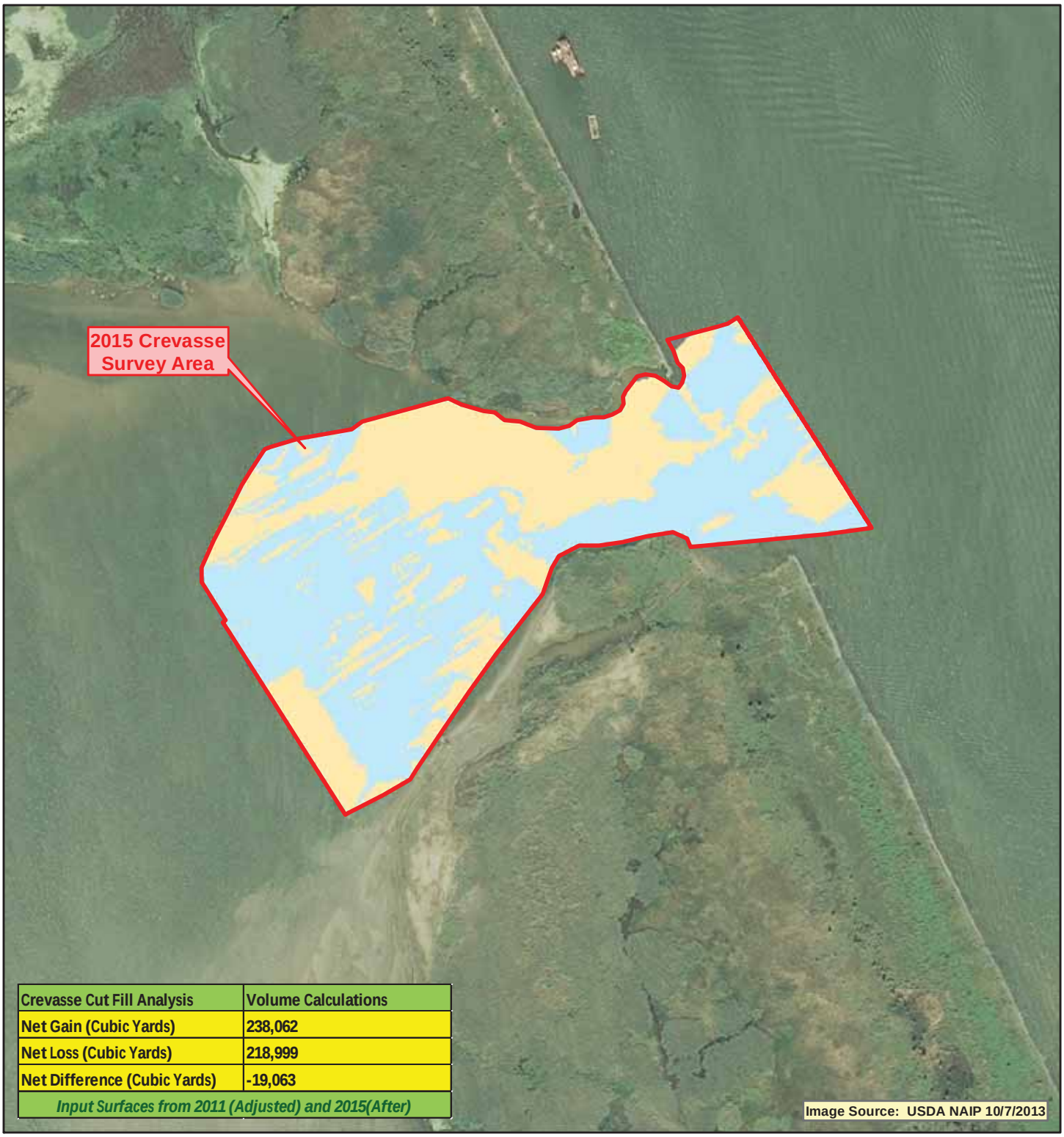
Crevasse 2015 Cut Fill Analysis



Crevasse Cut Fill Analysis	Volume Calculations
Net Gain (Cubic Yards)	238,062
Net Loss (Cubic Yards)	218,999
Net Difference (Cubic Yards)	-19,063
Input Surfaces from 2011 (Adjusted) and 2015(After)	

Crevasse 2015 Survey Area

Crevasse Cut Fill Analysis

VOLUME

Net Gain

Unchanged

Net Loss

N W E S

Date: 4/18/2016

0 0.05 0.1 0.2 Miles

Spatial Data MOBILE DISTRICT

US Army Corps of Engineers Mobile District

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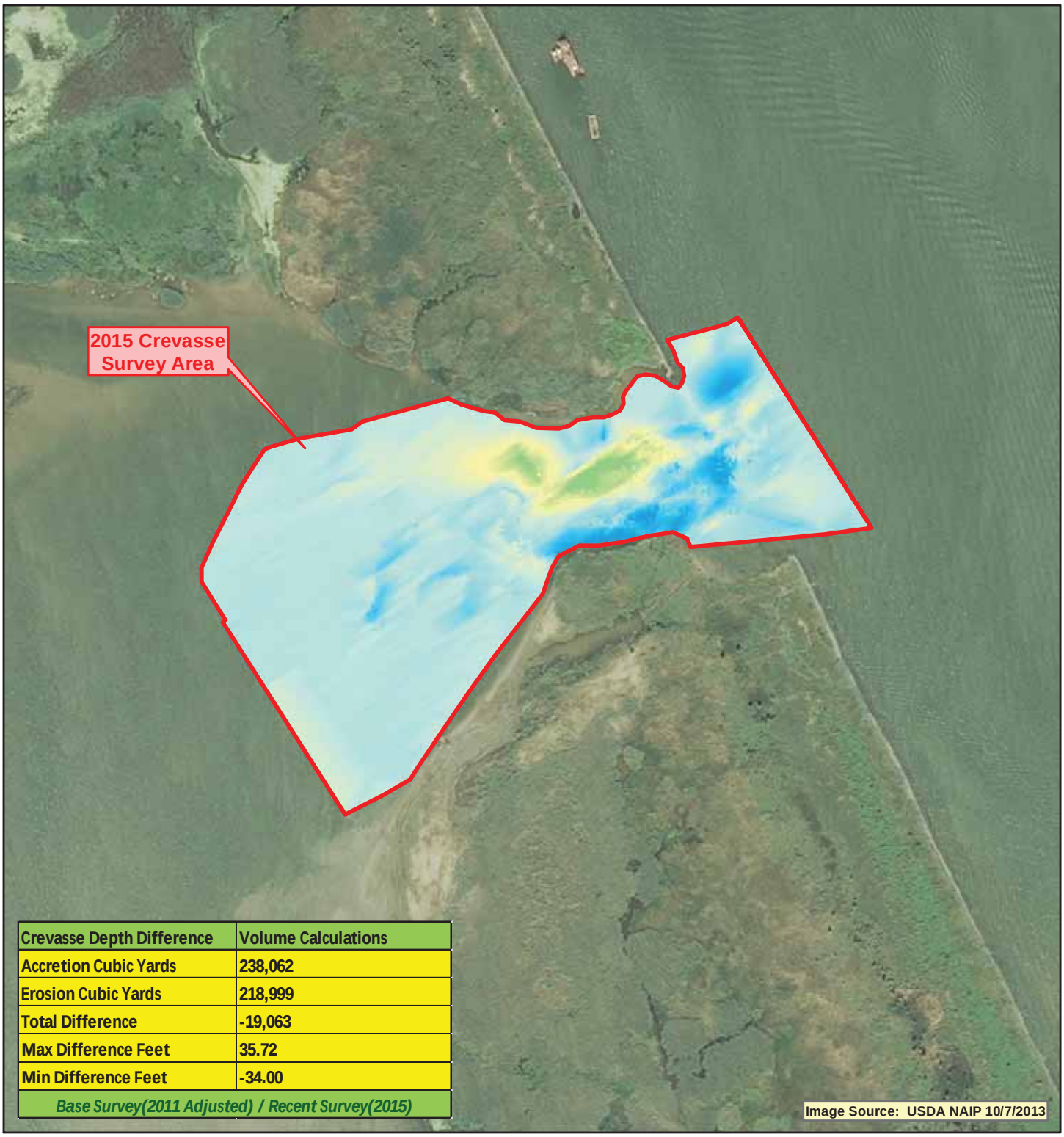
Crevasse 2011-2015 Depth Difference



Crevasse Depth Difference	Volume Calculations
Accretion Cubic Yards	238,062
Erosion Cubic Yards	218,999
Total Difference	-19,063
Max Difference Feet	35.72
Min Difference Feet	-34.00
Base Survey(2011 Adjusted) / Recent Survey(2015)	

Crevasse 2015 Survey Area

Crevasse Depth Difference

Value

High : 35.72 Ft

Low : -34.00 Ft

N W E S

Date: 4/18/2016

0 0.05 0.1 0.2 Miles

Spatial Data MOBILE DISTRICT

US Army Corps of Engineers Mobile District

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Crevasse 2015 Survey Cross Section Profiles

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Date: 4/18/2016

Crevasse 2015 Cross Section Profiles
Crevasse 2015 Survey Area

0 0.05 0.1 0.2 Miles

Spatial Data
MOBILE DISTRICT

US Army Corps of Engineers
Mobile District

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