Multibeam Hydrographic Survey Use for Construction Control of Filling and Ground Improvement Activities

WEDA Cincinnati
April 10, 2014

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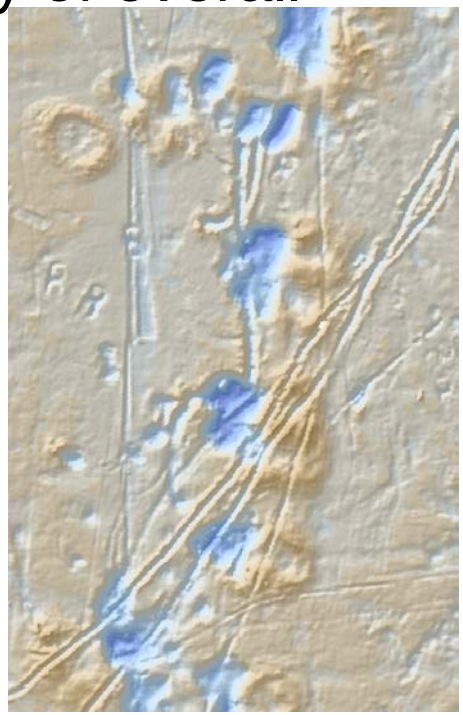
Advantages of High Resolution MBES Survey Technology

- High accuracy and precision of data collection
- Clearly define site sea/river bed conditions through remote detection
- Minimize probability of encountering site hazards/obstructions while maximizing safety of overall project
- Provide guidance during project planning and geotechnical survey
- Easily integrated with side scan sonar, sub bottom profiling, magnetometer surveys to provide cost effective site characterisation
- Good data minimises Contractor's pricing of risk contingencies

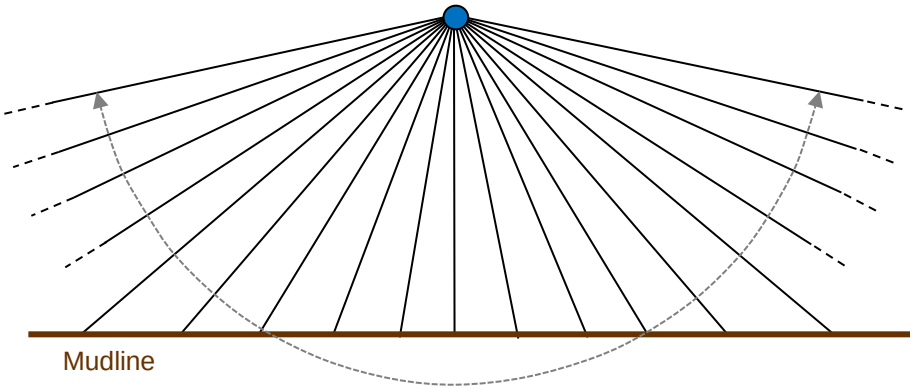


Hydrographic Survey Systems:
R2 Sonic 2024 Multibeam Overview

- Acquisition system uses 256 beams at a 0.5 degree beam angle and is recorded at 200 to 400 kHz
- Beam angles can be electronically adjusted to :
  1. Provide increased data density in narrower swath
  2. Rotate and focus energy at desired angle
- Adjustments to swath and rotation can be made during real-time survey operations

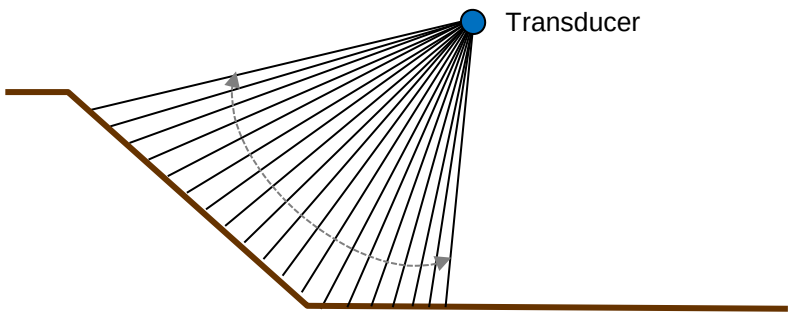
WIDE SWATH

256 Beams with 160˚ Swath



ROTATED NARROW SWATH

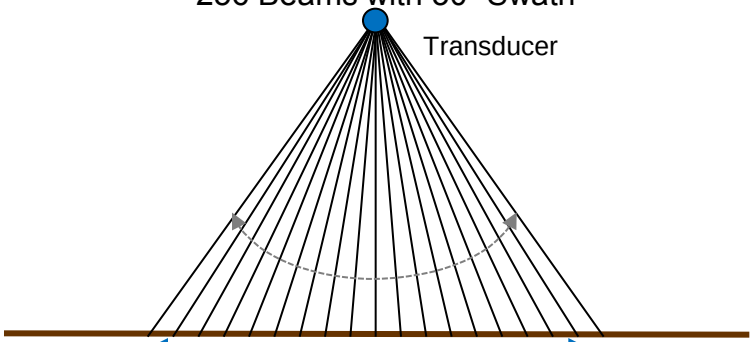
256 Beams with 30˚ Swath - Rotated



Beams Steered to Focus on Toe of Slope

NARROW SWATH

256 Beams with 30˚ Swath



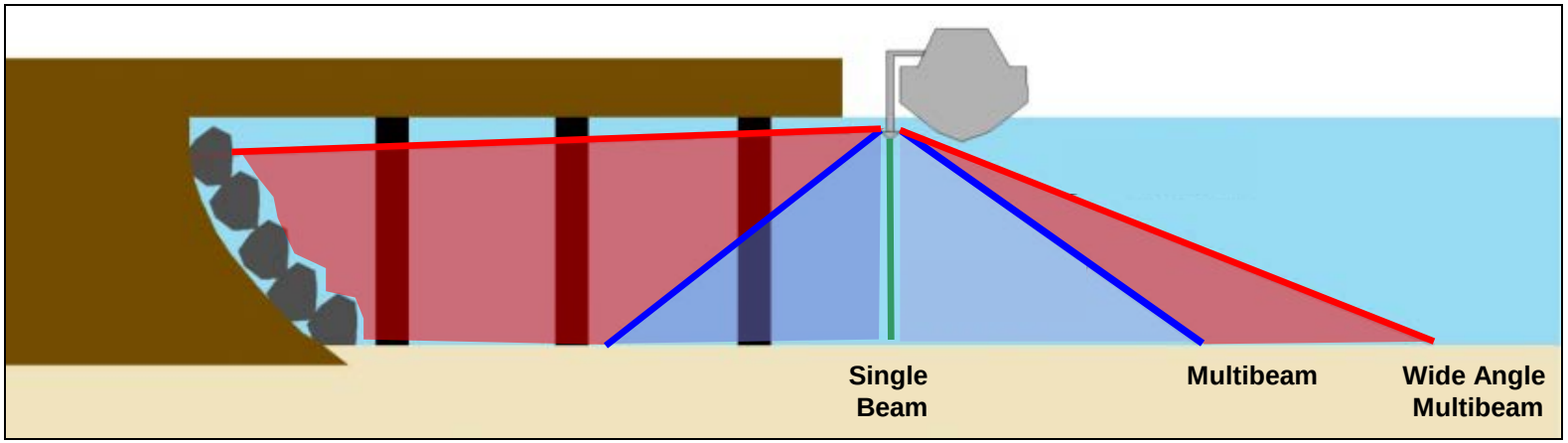
Increased Data Density

Schematic drawings – angles are approximate

Advantages of Swath Bathymetry

- Ideal solution for shallow water
- Complete coverage of riverbed
- Uses sound (sonar) pulses to map the seafloor
- Optimum seafloor detail for engineering, construction, scour monitoring, dredge programs, and environmental projects
- Fewer boat passes than single beam survey = faster survey

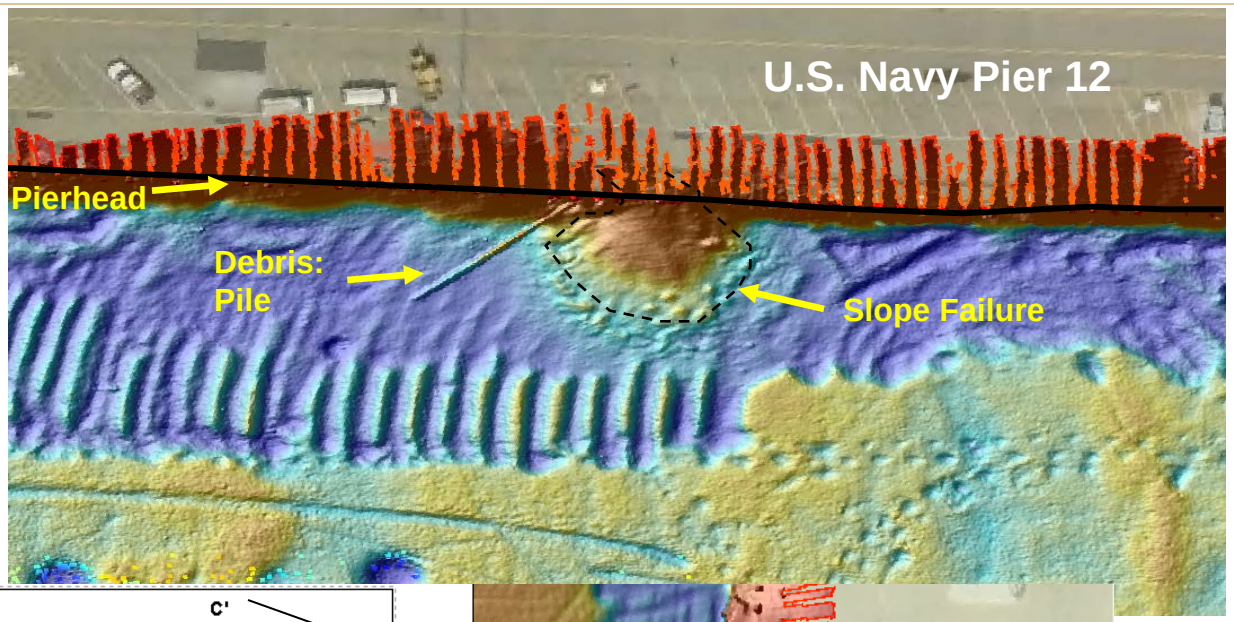
Comparison of Survey System Footprints



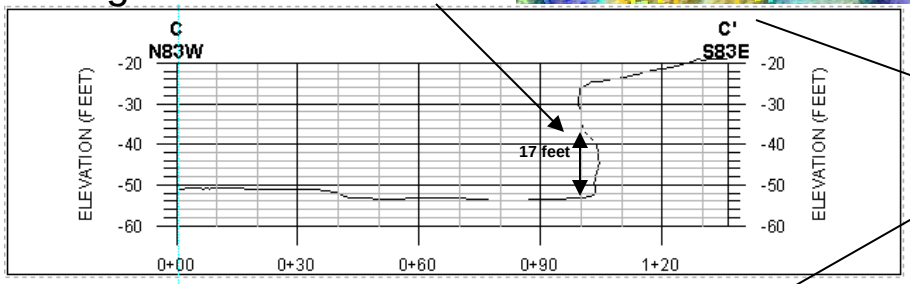
Schematic drawing – actual swath apertures will vary depending on system and system settings

Hydrographic Survey Systems: Pierhead Survey

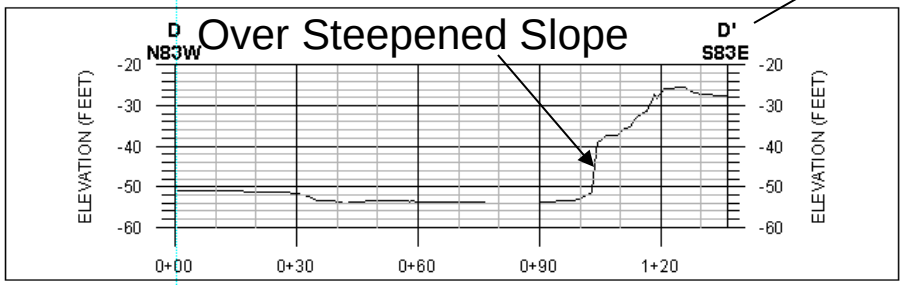
- Steerable multibeam
  - -Identify debris
  - -Slope Failures
  - -Q/A Dredge Cuts
  - -Image behind pierhead

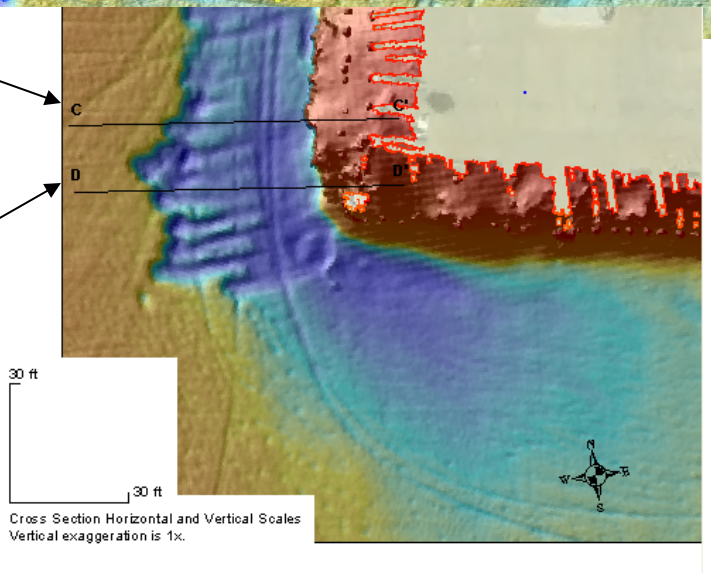


Overhang from Cutterhead



Over Steepened Slope

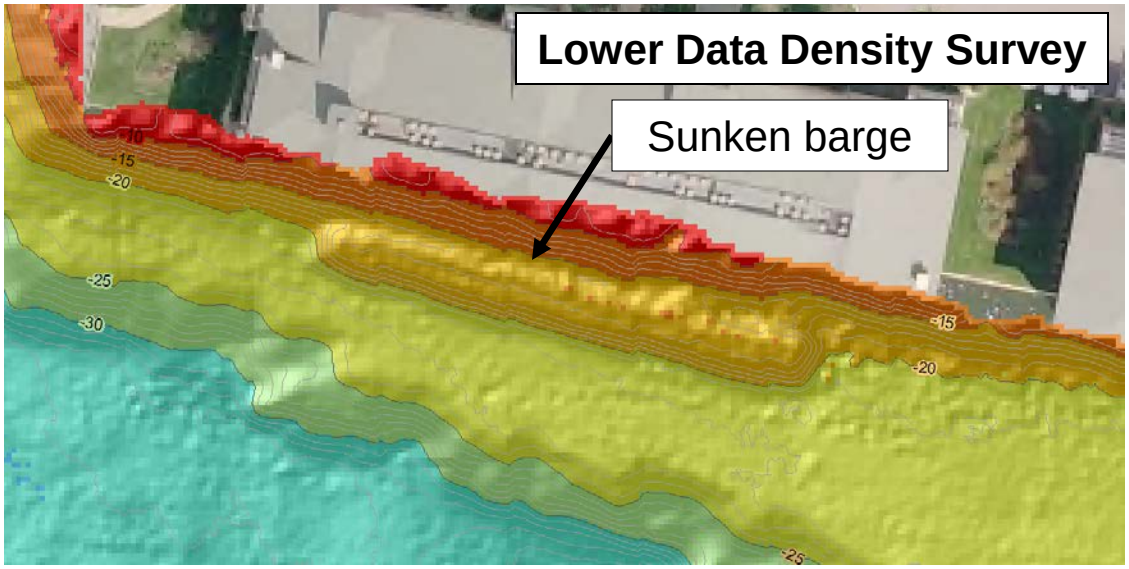


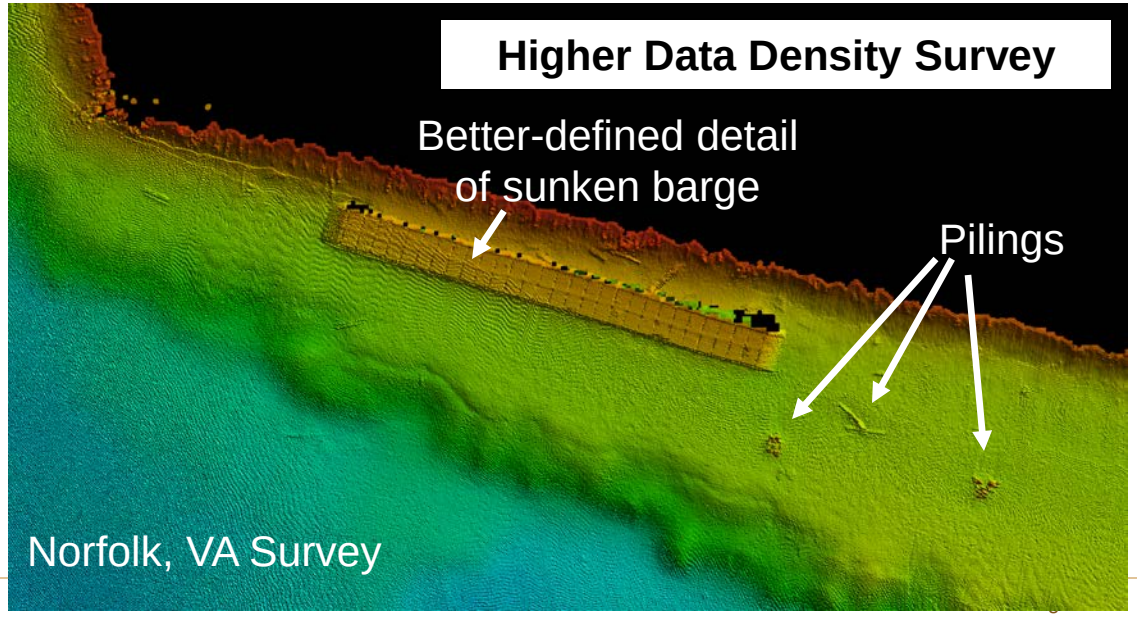


Hydrographic Survey Systems: Data Density Example

- Higher density data can provide:
  1. Better water depth definition
  2. Better resolution of features in the dredge cut or on the riverbed
     - Obstructions, slope failures, shoals

- R2 Sonic multibeam beams can be focused to collect narrower swath and denser data in dredge cut than shallower water flanks outside of cut





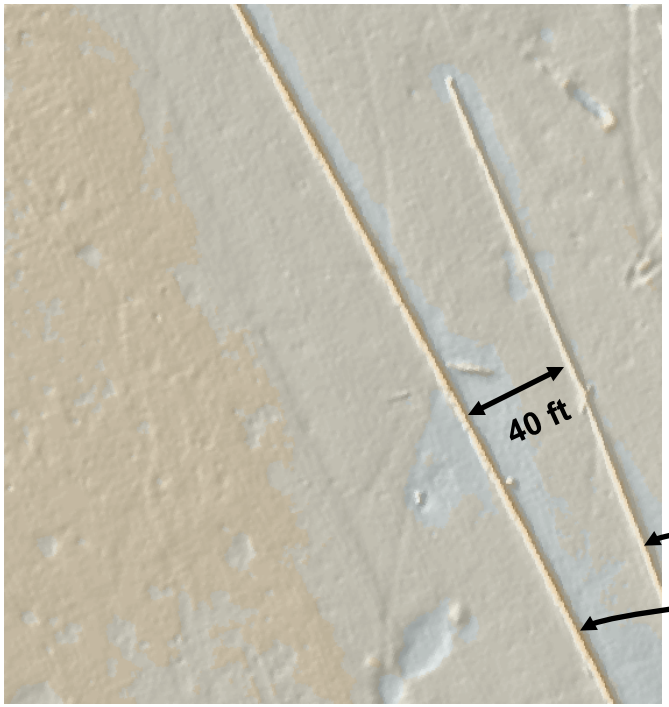
Multibeam Survey Comparison of Same Site

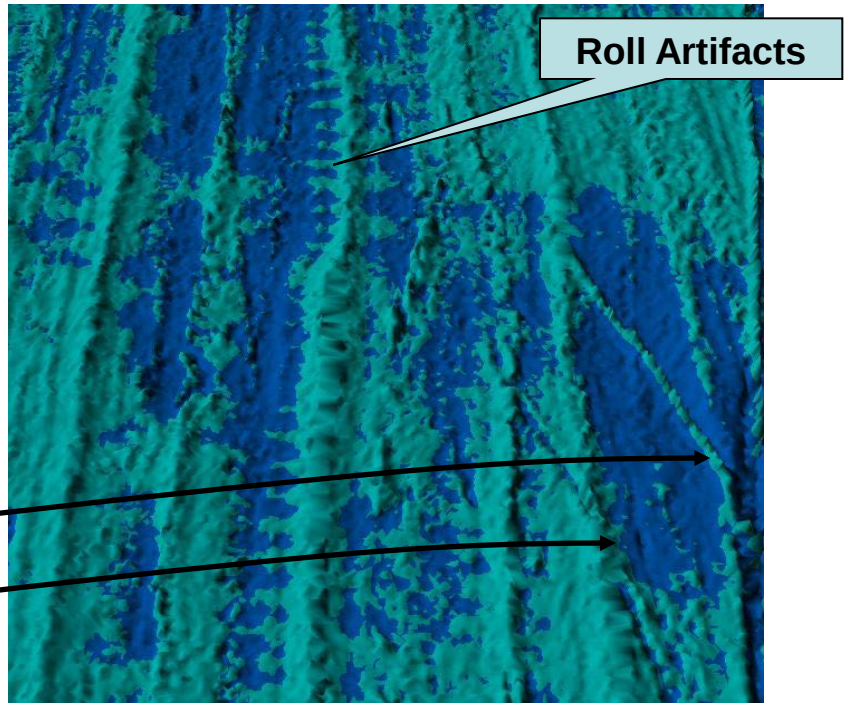
Fugro Survey

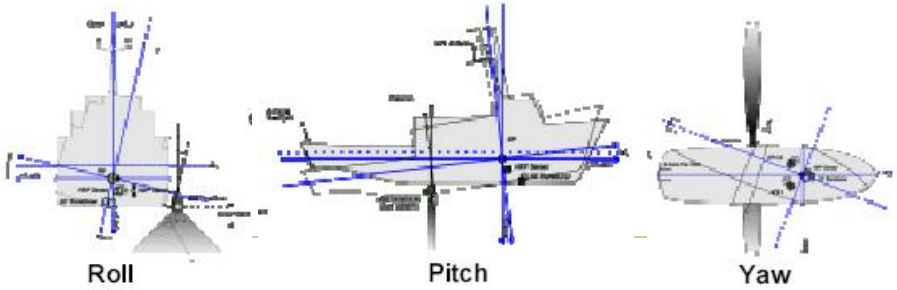
- No offset in riverbed
- No offset in pipelines

Survey by Others

- Vessel motion artifacts present
- Incorrect roll, pitch, or yaw/azimuth offsets
- Corrected through patch test

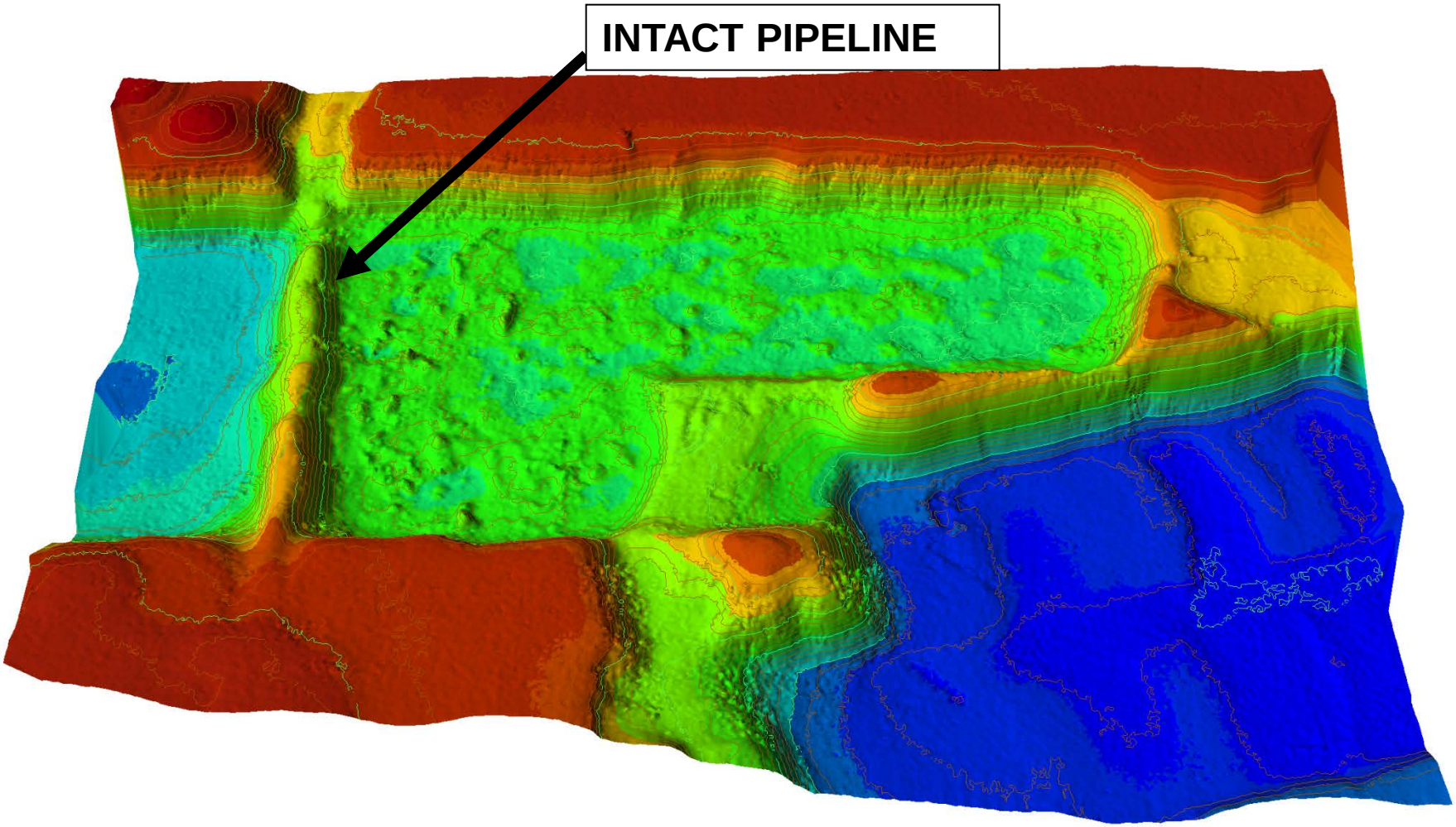






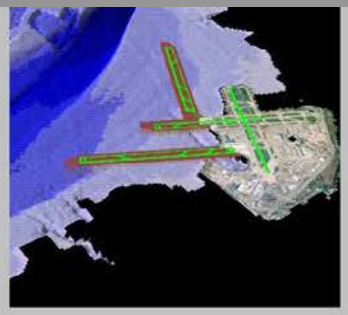
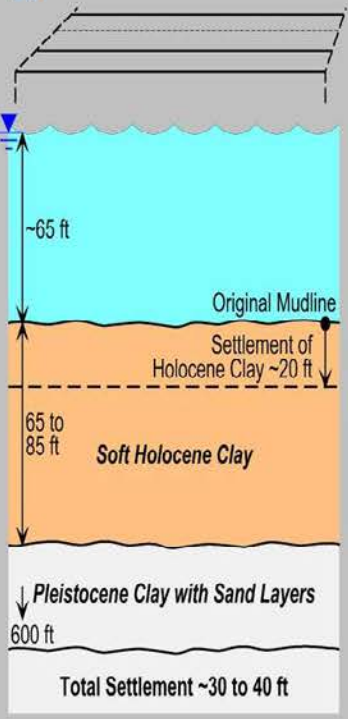
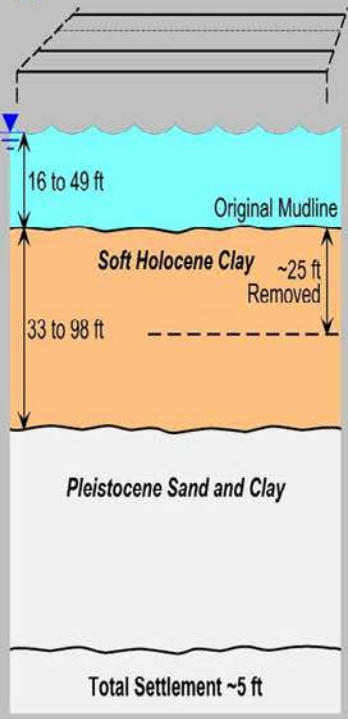
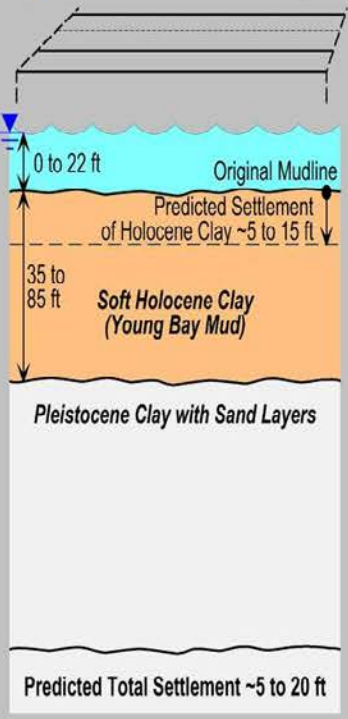
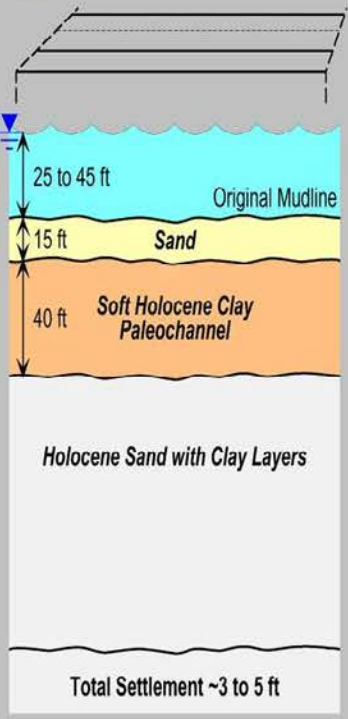
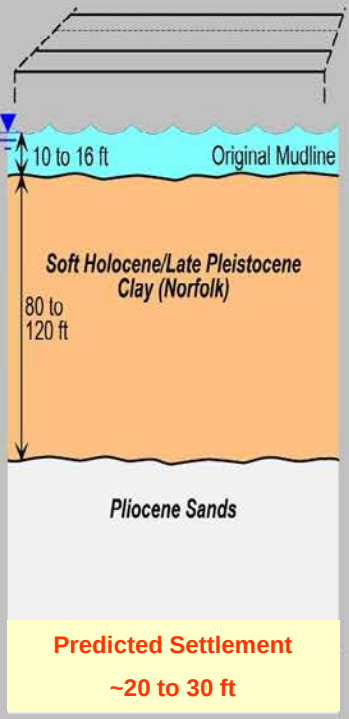
Poor motion (roll, pitch, and yaw) compensation measurements from bad patch tests or sensor misalignment and offsets may result in significant vessel motion artifacts

- Infrastructure Conditions

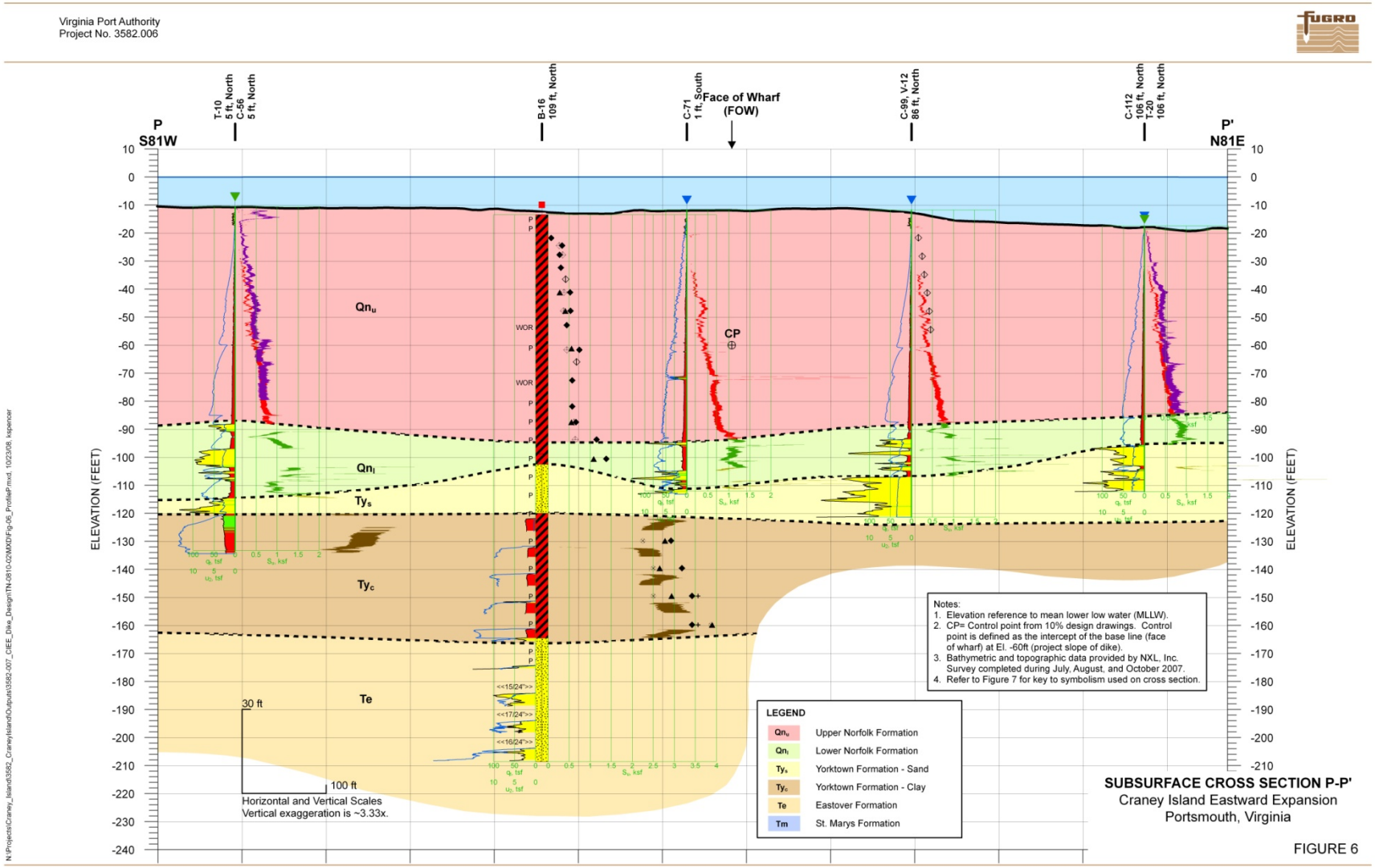


Craney Island Eastward Expansion

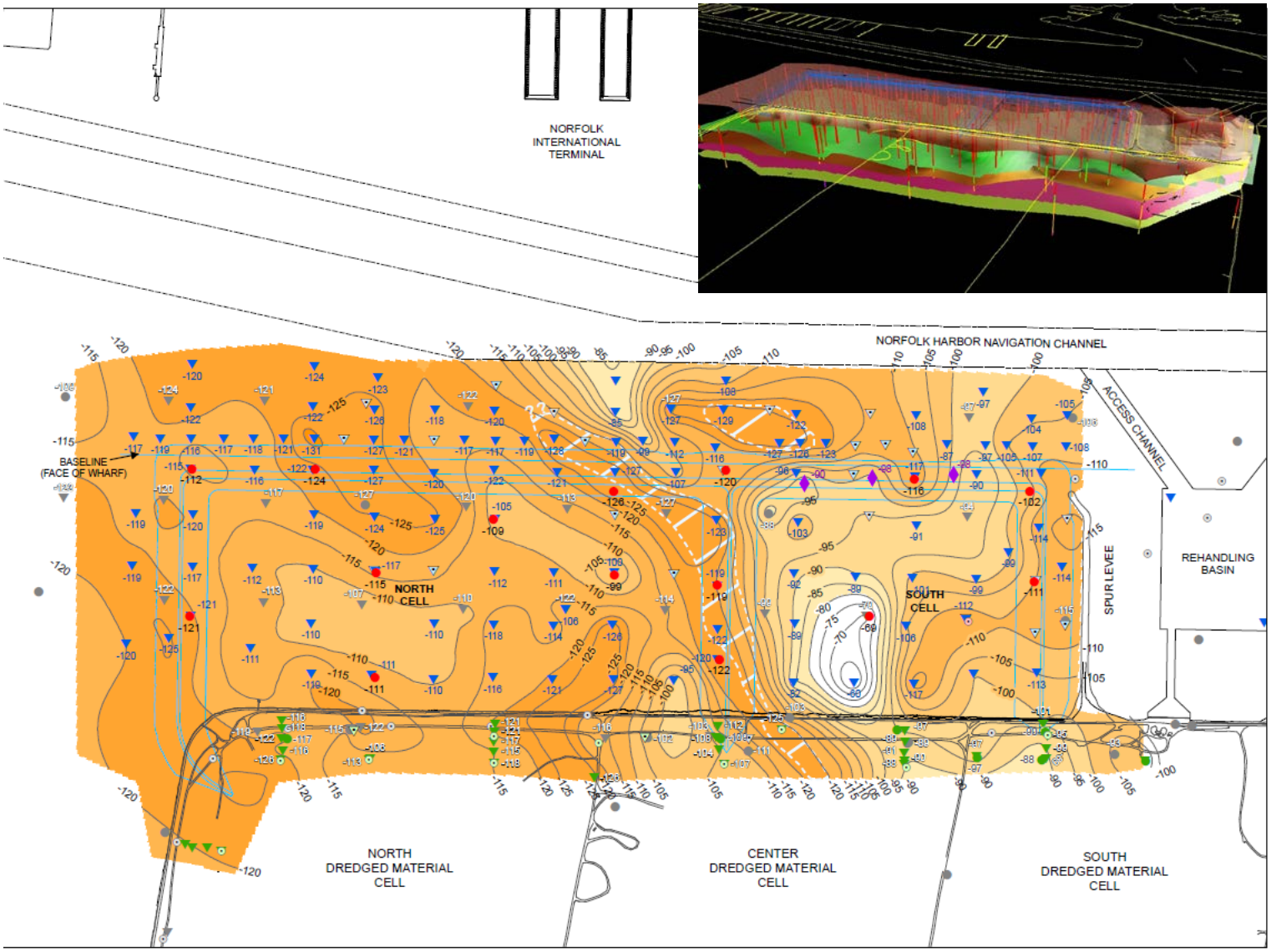
Craney Island Eastward Expansion

Kansai Airport Japan	Hong Kong Airport	San Francisco Airport	Pier 400 Port of LA	Craney Island
				
Fill Area 1,263 acres Fill Volume 235 million cubic yards	Fill Area 3,084 acres Fill Volume 197 million cubic yards	Fill Area 430 - 950 acres Fill Volume 25 - 50 million cubic yards	Fill Area 580 acres Fill Volume 50 million cubic yards	Fill Area 600 acres Fill Volume 20 million cubic yards
				
Total Settlement ~30 to 40 ft	Total Settlement ~5 ft	Predicted Total Settlement ~5 to 20 ft	Total Settlement ~3 to 5 ft	Predicted Settlement ~20 to 30 ft

Cross Section



Isopach and Structural Maps of 7 Units



LEGEND

Elevation of Top of Plio-Pleistocene Unit (QTs), (incl. Yorktown Sand) Feet (MLLW)

- -80 to -90
- -90 to -100
- -100 to -110
- -110 to -120
- -120 to -130
- -130 to -140

Contour interval is 5 feet.

Area where QT_s is less than 5 feet thick and may be absent due to incision and erosion. Extent is approximate.

EXPLORATION DATA

Numbers represent elevations (in feet) of mapped stratigraphic surface.

2007 Fugro Marine Exploration Locations

- 2007 Boring
- 2007 CPT

S&ME Exploration Locations

- 2008 Sonic Core Exploration Locations
- 2007 Boring - Land
- 2007 CPT - Land

Historical Exploration Locations

- Boring
- CPT

Exploration Locations - No Data

- Surface Not Reached - Boring (Color Coded)
- Surface Not Reached - CPT (Color Coded)
- Proposed Dike Alignment

0 500 1,000 2,000 Feet

ELEVATION OF TOP OF PLIO-PLEISTOCENE UNIT (incl. Yorktown Sand)

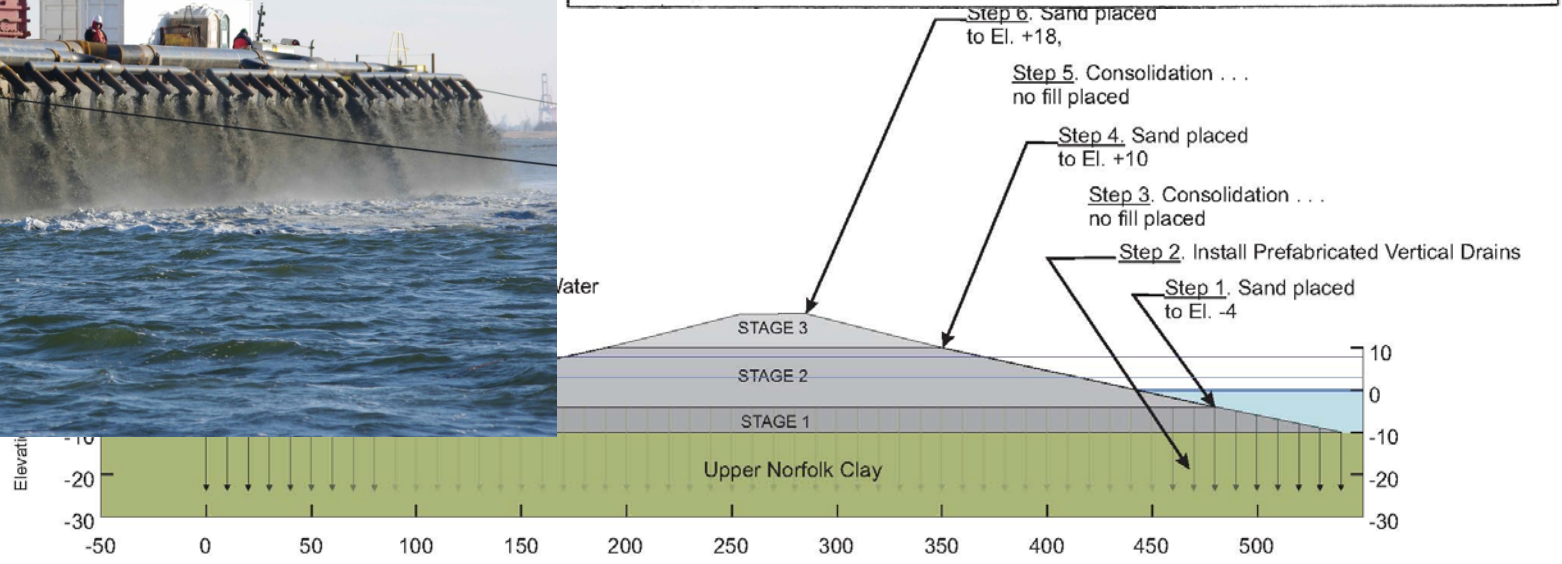
Craney Island Eastward Expansion
Portsmouth, Virginia

FIGURE 4.5-3

Construction Monitoring – Cross Dikes

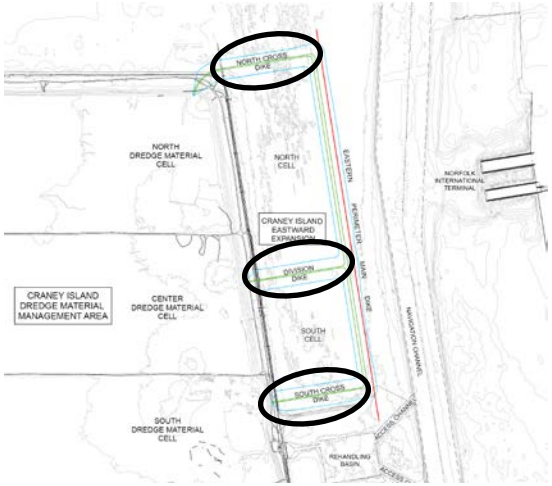
- Monitoring placement of cross dike construction fill
  - If sand is placed too much too fast, will induce a mud wave or failure like 1954 Craney construction
  - Placing 1.5 to 2 ft sand lifts

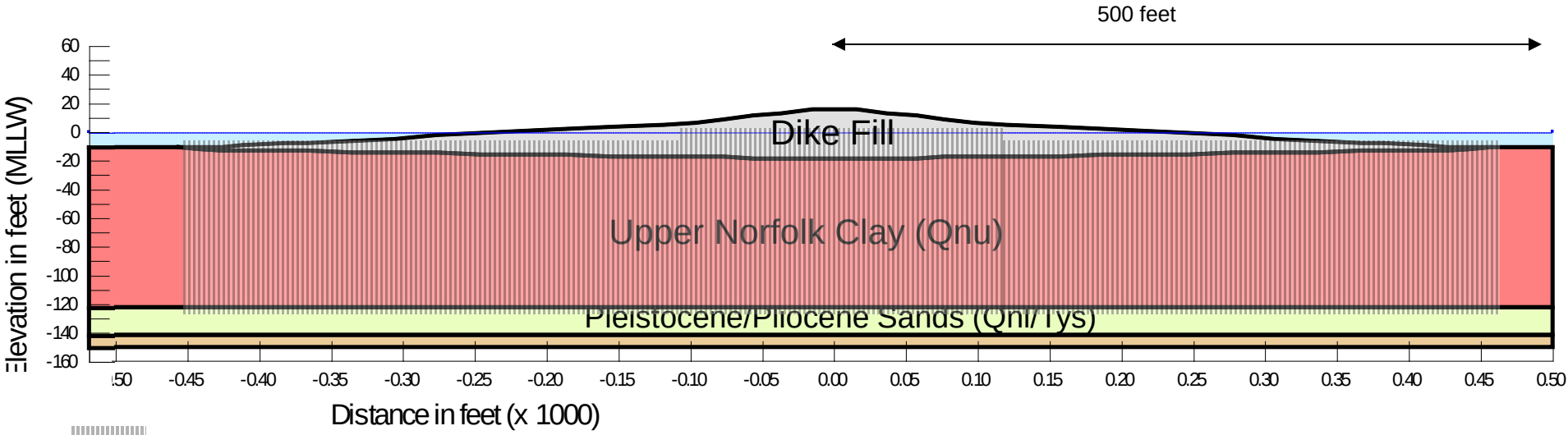
DEPARTMENT OF THE ARMY	CORPS OF ENGINEERS	NORFOLK DISTRICT
Craney Island Disposal Area Construction of West Levee Aerial view of West Levee, showing mud wave.	28 September 1954	Serial No. 17176 Contract No. DA-44-110-eng-3116 28 June 1954 Contractor: Norfolk Dredging Company Funds Civil – Construction General



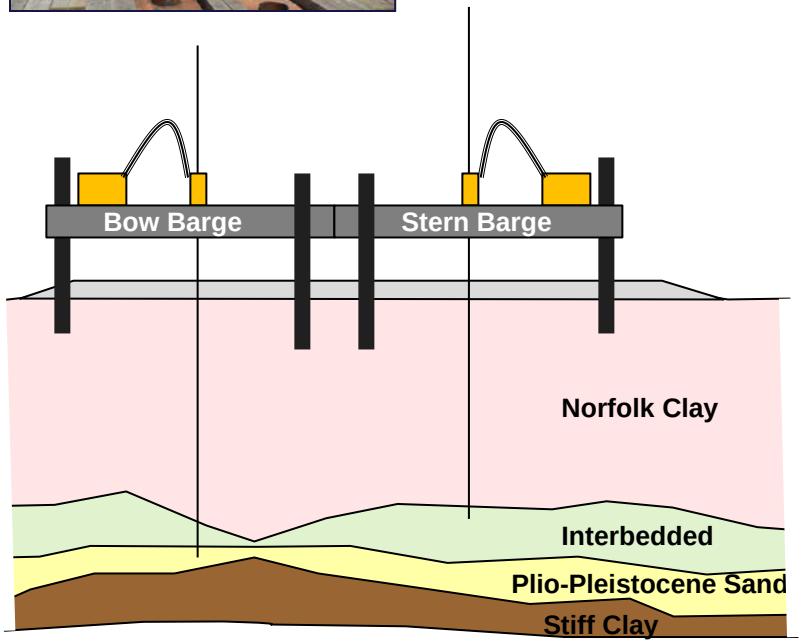
Project Design - Cross Dikes

- Final target elevation = +18 ft (MLLW)
- Length of cross dike ≈ 2400 lf
- Constructed on soft clay
- Required PVDs





PVD Program Overview



Ground Model Used to Design PVD Program

↓

GPS Navigation System Used to Position Barges

↓

GPS Navigation System Records:
XY Position Coordinate,
Depth, Elevation, Tide
Thrust Pressure, Penetration Rate
Date/Time

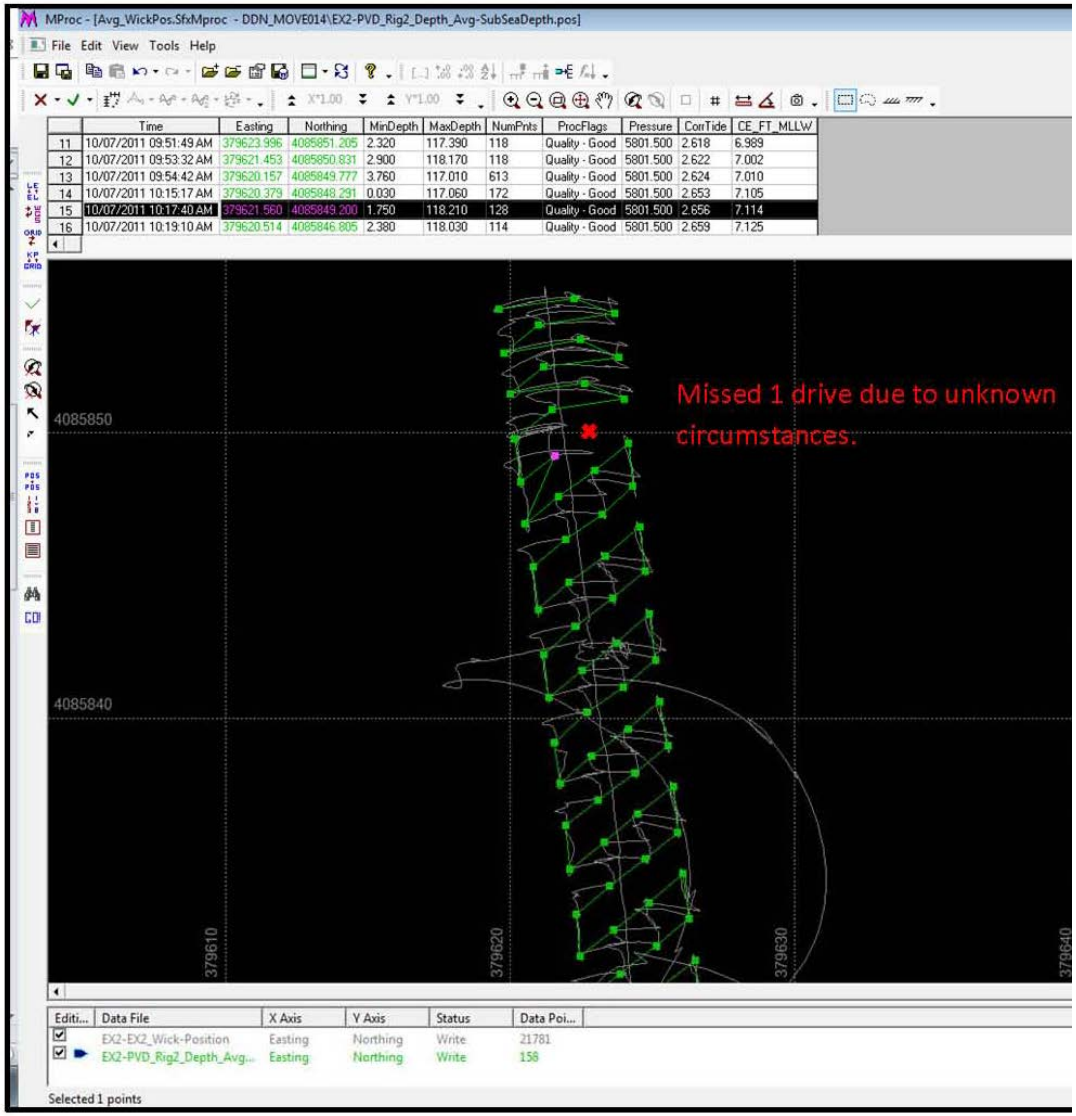
↓

As-built PVD Installation Data Stored and Managed in GIS Database

↓

PVD As-built Data Integrated with Ground Model and Reviewed

PVD Installation



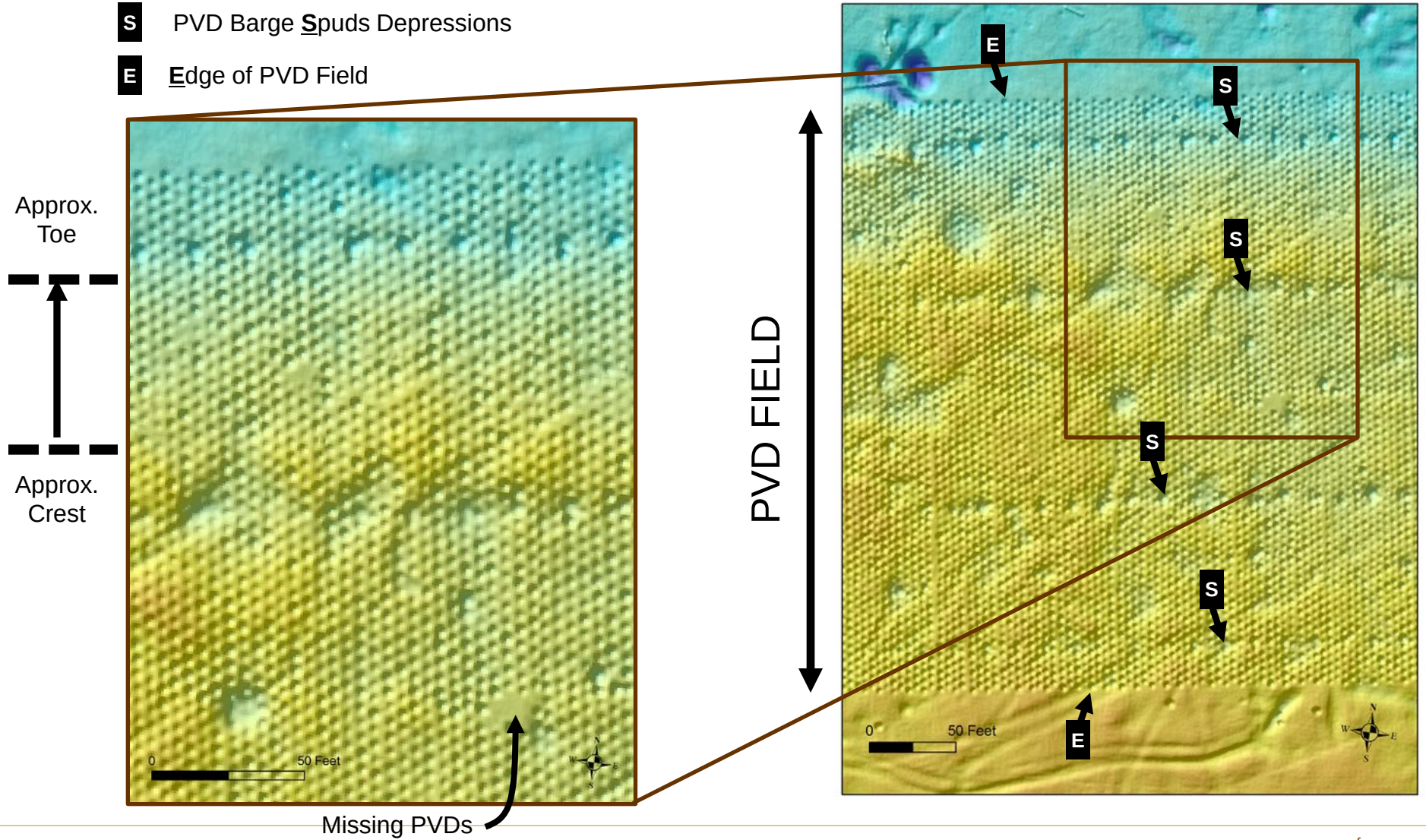
PVD Locations Verified using Multibeam Data

PVD depressions are approximately 0.5ft deep by 1ft diameter

S PVD Barge **S**puds Depressions

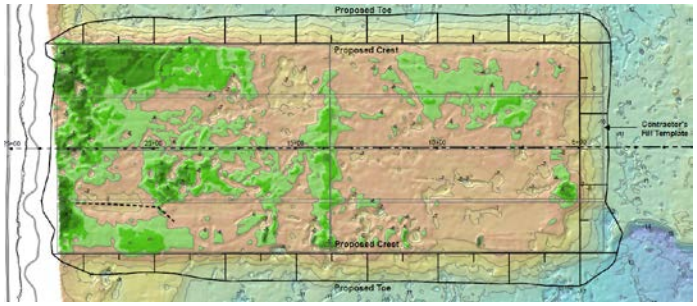
E **E**dge of PVD Field

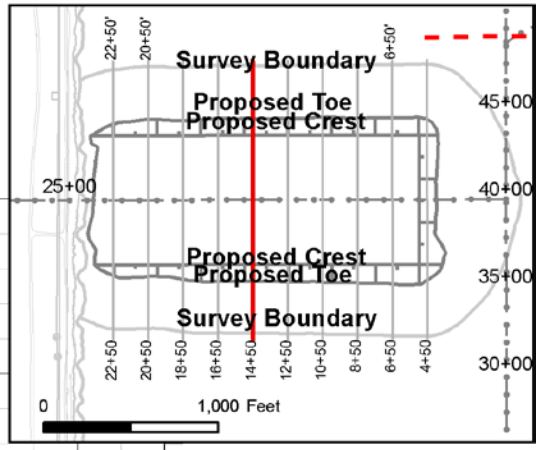
South Cross Dike North PVD Zone



Fill Placement Monitoring

- Multibeam surveys used to monitor material placement
- GIS managed data and used to create evaluation documents
  - Profiles, isopach, elevation, morphologic evaluation for slope failures, and mud waves

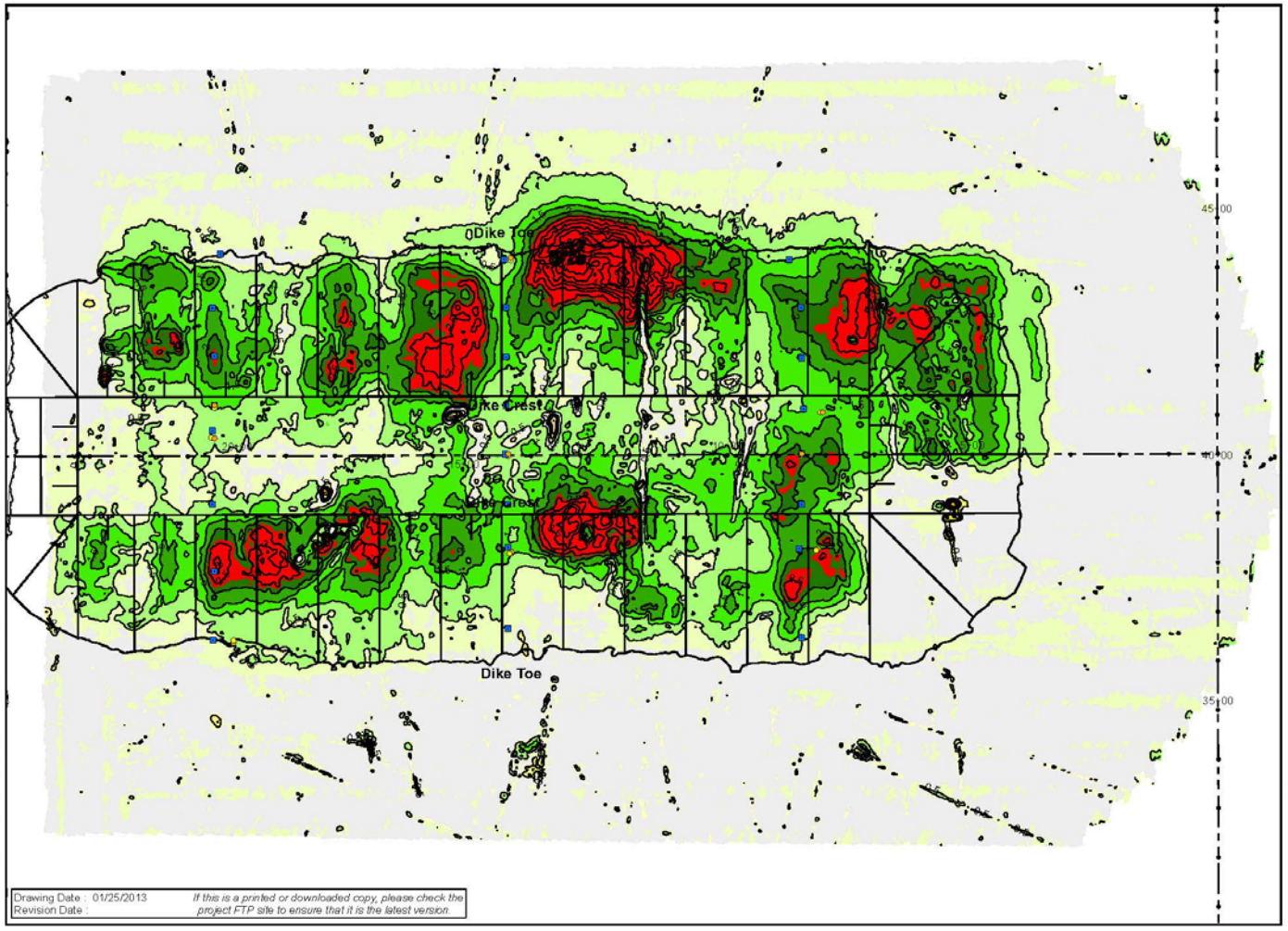




Filling Control

Virginia Port Authority
Project No. 04.81110018

PRELIMINARY



LEGEND
- Settlement Plate
- Piezometer and Extensometer
- Inclinometer
- 10+00 Baseline Stationing

Comparison of Bathymetric Surveys
Difference in Feet
Surveys conducted by Fugro Atlantic

Contour Interval = 0.5 feet
(Zero contour not shown)

Increase in elevation:
- > 2.3 Feet
- 2.0 to 2.3
- 1.5 to 2.0
- 1.0 to 1.5
- 0.5 to 1.0
- 0.2 to 0.5

-0.2 to 0.2 (No Apparent Change)

Decrease in elevation:
- -0.5 to -0.2
- -1.0 to -0.5
- -1.5 to -1.0
- -2.0 to -1.5
- -2.5 to -2.0

N W E S

0 200 400 Feet

Drawing Date : 01/25/2013
Revision Date :
If this is a printed or downloaded copy, please check the project FTP site to ensure that it is the latest version.

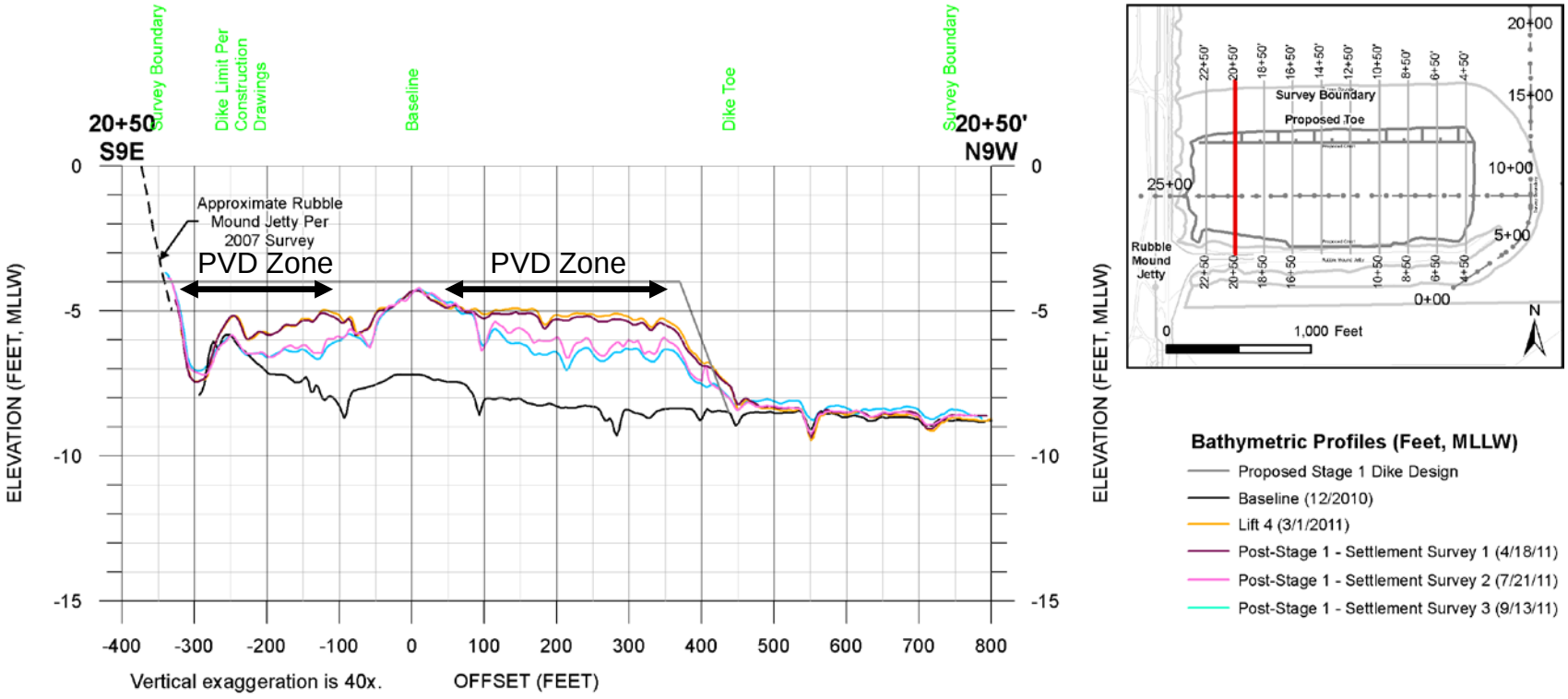
N:\Projects\Craney_Island\04_8111_0018_Stage2_HydroSurvey\Outputs\Stage_2A_Construction\20130121_00_Lift2\mxd\Fig-2_00_Comparison.mxd, 1/25/2013, kspencer

INCREMENTAL SURVEY COMPARISON
Survey 01/08/2013 and 01/21/2013
Stage-2A -Lift 2
Division Cross Dike
Craney Island Eastward Expansion
Portsmouth, Virginia

FIGURE 2

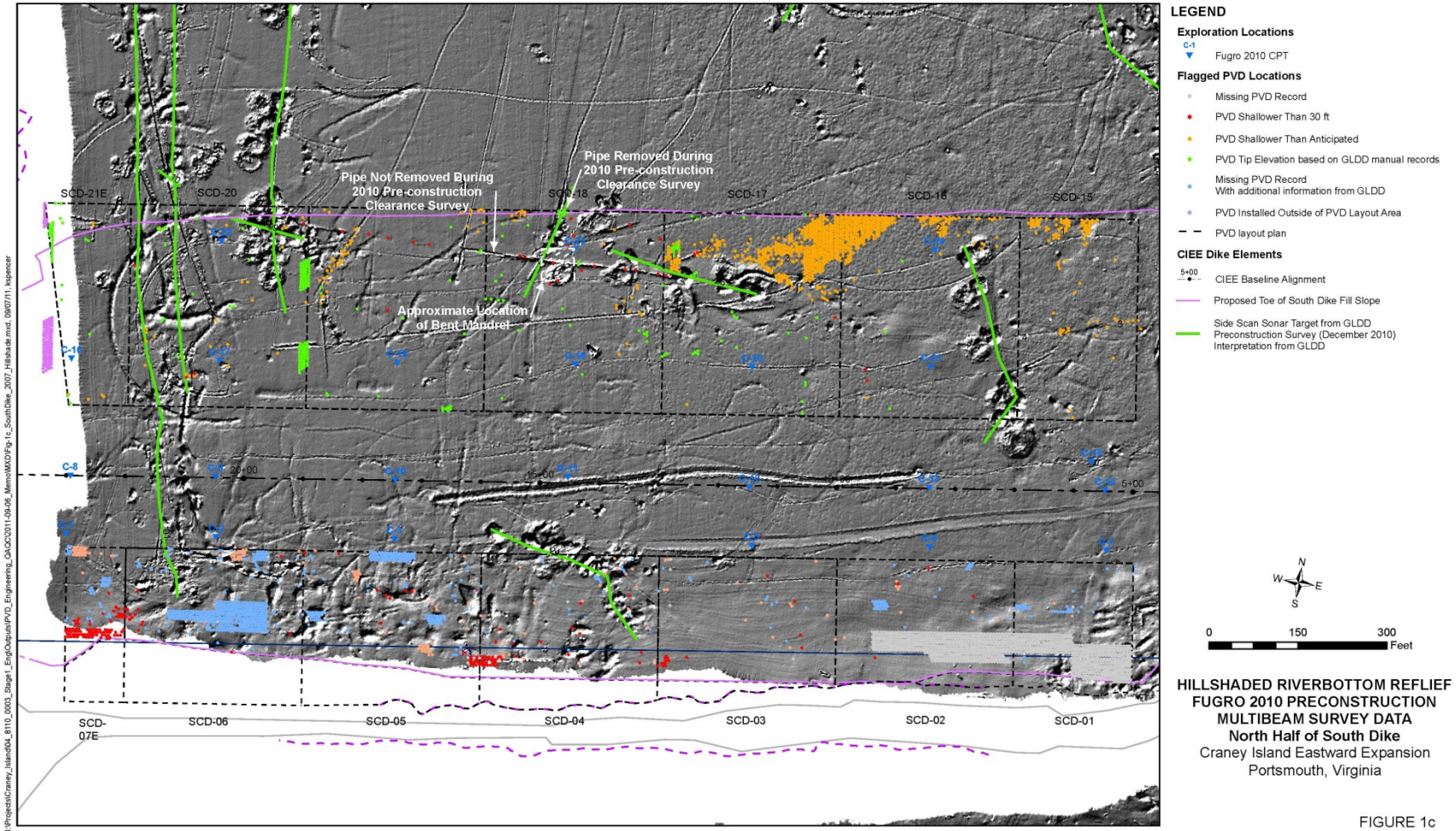
Survey Monitoring During Hold Period

- Multibeam surveys used to monitor settlement during hold period
- Note ~1ft of settlement after PVDs installed between 4/16 & 7/21



Integrating Information

Craney Island Design Partners, LLC
Project No. 04.81100003



HILLSHADED RIVERBOTTOM REFLIEF
FUGRO 2010 PRECONSTRUCTION
MULTIBEAM SURVEY DATA
North Half of South Dike
Craney Island Eastward Expansion
Portsmouth, Virginia

FIGURE 1c

N:\Projects\Craney_Island\04_81100_0003_Stage1_Eng\Outputs\PVD_Engineering_QA\QC\2011-09-06_Memo\MXD\Fig-1c_SouthDike_2007_Hillshade.mxd 09/07/11 kspencer

Thank You

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