Monitoring Completed Navigation Projects (MCNP) Program

HQ Navigation Program Monitor
Jeffrey A. McKee, Chief, Navigation Branch

ERDC Technical Director for Navigation
Jeff Lillycrop

Program Manager
Lyn Hales

Funding Sources

O&M	$ 2.3 m
Congressional Add	$ 5.7 m
	$ 8.0 m

Research Area Review Group (RARG) for Navigation
Annual Meeting
8 April 2015
Vicksburg, MS

Purpose of the MCNP Program

The Advancement of Coastal and Hydraulic Engineering Technology with respect to USACE requirements

Determine how well Coastal and Inland Navigation projects are accomplishing their purposes (how well they are resisting attacks by the physical environment)

- Create more accurate and economical engineering solutions
- Strengthen design criteria and methodology
- Improve construction practices and cost effectiveness
- Enhance Operation and Maintenance techniques
- Reduce O&M cost

MCNP program identifies where current technology is inadequate. (Determines where additional research is required)

MCNP Program is Field Driven, addressing real-world problems.

Nominations for New Monitoring Projects are solicited from Divisions and Districts by HQ as funding becomes available, per ER 1110-2-8151.

Nominations are Evaluated and Prioritized by CECW according to criteria of ER 1110-2-8151.

Existing Structures with Unique Features and/or Documented Deficiencies.

Site-specific monitoring is intended to produce Generic results with conclusions applicable on a Regional and/or National basis.

Program functions at the pleasure of Chief, Navigation Branch, CECW.

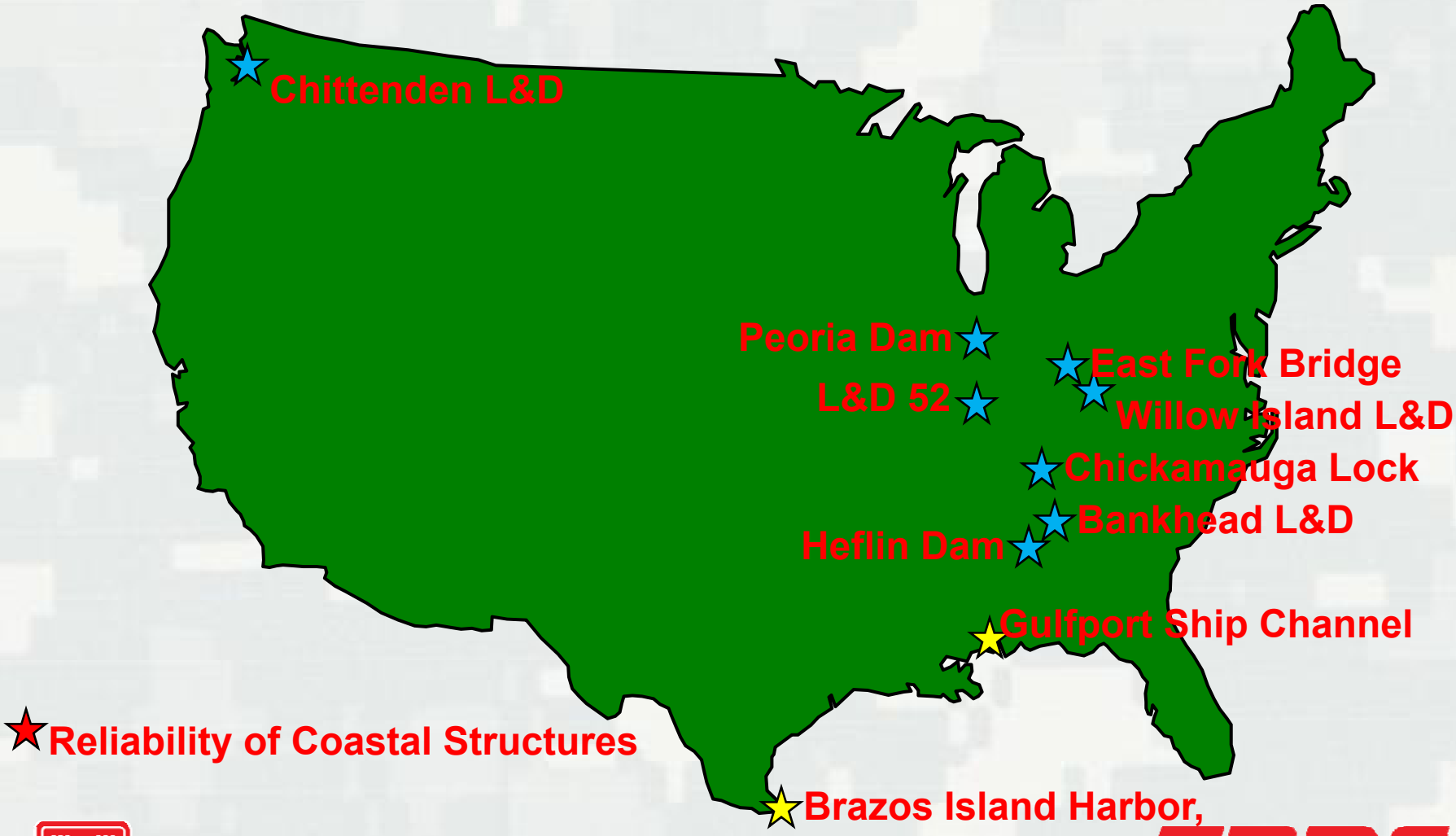
Monitoring Completed Navigation Projects (MCNP)

FY15 Program

4 Focus Areas

1. Monitoring Existing Structures with Unique Features or Documented Deficiencies (O&M)
    a. Channel Fluid Mud/Nautical Depth Concept
    b. Brazos Island Harbor, Texas
    c. Reliability of Coastal Structures
    d. Fiber Reinforced Polymer (FRP) Composites
2. River Information Services (RIS) (O&M)
3. Trunnion Rod Investigations (Add)
4. Advancing USACE Capabilities in Structure Health Monitoring (Add)

Monitoring Existing Structures with Unique Features or Documented Deficiencies



Gulfport and Calcasieu Ship Channels Fluid Mud

Implementation of Nautical Depth

Product Delivery Team

Tim Welp (PI), CHL ERDC
District Team Members: Carl Dyes, SAM; Tracy Falk, MVN, Chris Frabotta, SWG

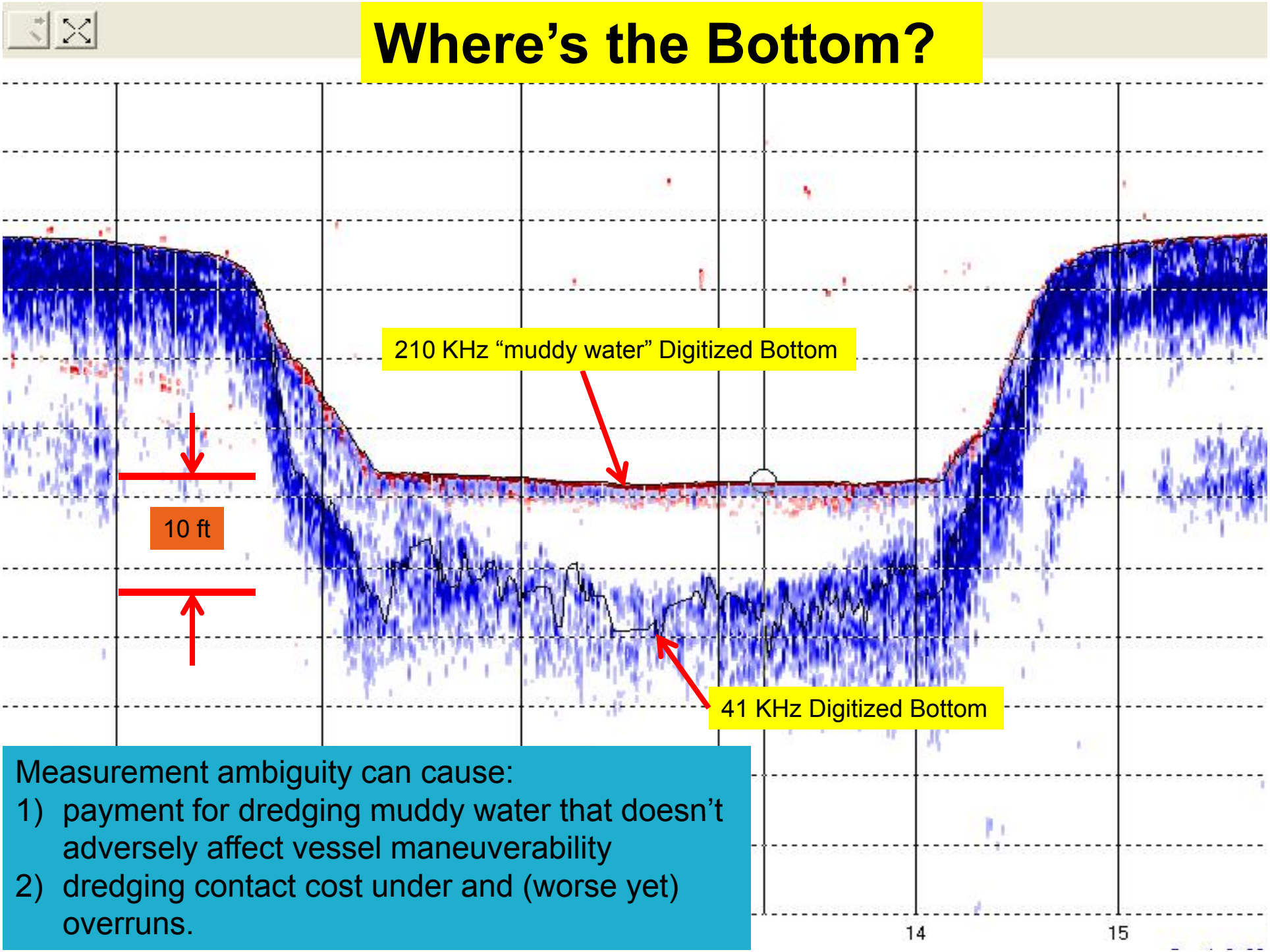
MCNP and DOER Program

Purpose: Implementation of the "Nautical Bottom" or "Navigable Depth" concept to optimize management of Corps of Engineers navigation channels with fluid mud.

PIANC's definition of "Nautical Bottom": "The level where physical characteristics of the fluid mud reach a critical limit beyond which contact with a ship's keel causes damage or unacceptable effects on controllability and maneuverability."

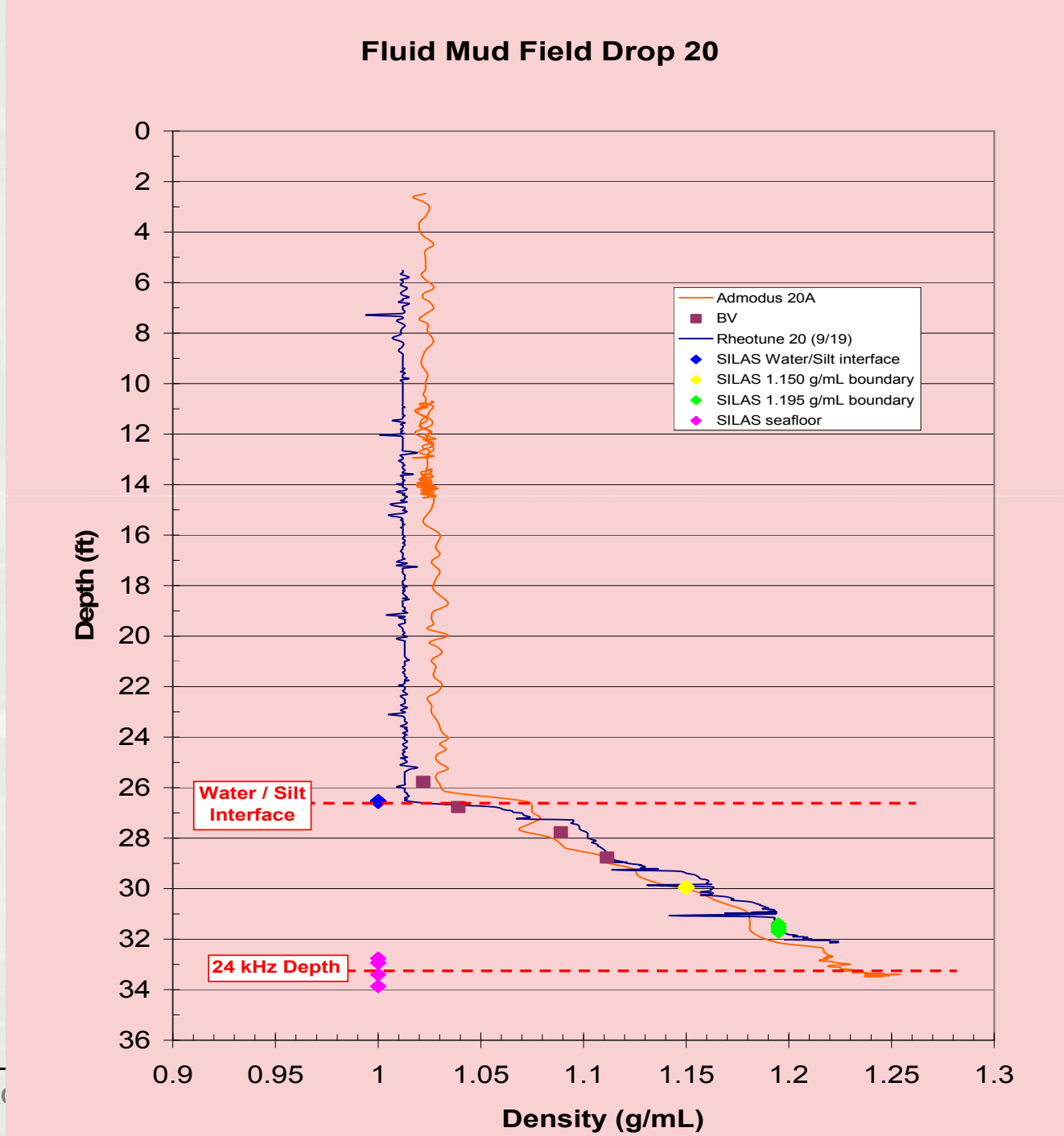
Each navigation channel has an authorized depth to which that channel is maintained (plus overdepth), depending on traffic.

Where's the Bottom?



Measurement ambiguity can cause:

1) payment for dredging muddy water that doesn't adversely affect vessel maneuverability
2) dredging contact cost under and (worse yet) overruns.


Fluid Mud Field Drop 20
Depth (ft)
Density (g/mL)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
0.9
0.95
1
1.05
1.1
1.15
1.2
1.25
1.3
Admodus 20A
BV
Rheotune 20 (9/19)
SILAS Water/Silt interface
SILAS 1.150 g/mL boundary
SILAS 1.195 g/mL boundary
SILAS seafloor
Water / Silt Interface
24 kHz Depth

Requirements for Determining Nautical Depth (PIANC)

- Practical fluid mud European criterion (density of 1.2 grams/cm^3)
- Practical survey method (RheoTune + SILAS)
- Knowledge of vessel behavior in fluid mud

Procedure

SAM and MVN will acquire state-of-art fluid mud surveying equipment and train personnel on its use to determine where nautical bottom is, and integrate private industry accordingly.

Modify CHL ship simulator with most advanced mathematical ship model available to simulate ship maneuvering in fluid mud for Gulfport and Calcasieu Ship Channels.

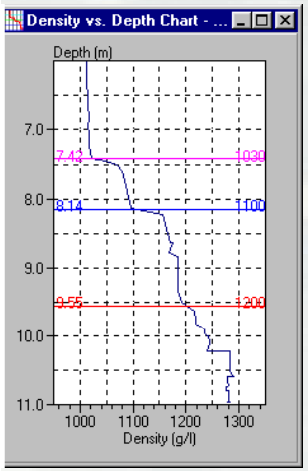
Have Gulfport and Calcasieu Pilots "drive" simulator in different fluid mud scenarios to facilitate acceptance of nautical bottom implementation.

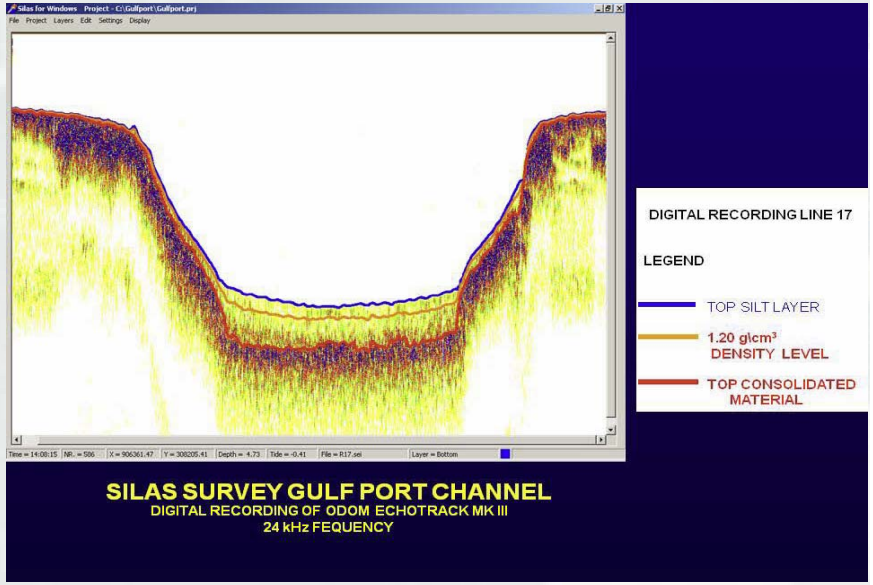
Requirements for Determining Nautical Depth (PIANC)

- Practical fluid mud criterion (density of 1.2 grams/cm^3)
- Practical survey method (RheoTune + SILAS)
- Knowledge of vessel behavior in fluid mud

TECHE (MVN)

IRVINGTON (SAM)





Requirements for Determining Nautical Depth (PIANC)

- Practical fluid mud criterion (density of 1.2 grams/cm^3)
- Practical survey method (RheoTune + SILAS)
- Knowledge of vessel behavior in fluid mud

- Currently working on CHL ship simulator upgrade for Calcasieu fluid mud runs.
- Conducting full-scale ship trails in Atchafalaya Bar Channel and monitoring Calcasieu.

Tech Transfer

- New Nautical Depth EngineeringTechnical Letter
- Updated Hydrographic Surveying EM1110-2-1003 chapter
- Technical Report

Brazos Island Harbor, TX

Product Delivery Team

Tahirih Lackey (PI), David King, and Ernest Smith, CHL ERDC
District Team Member: Robert Thomas, SWG

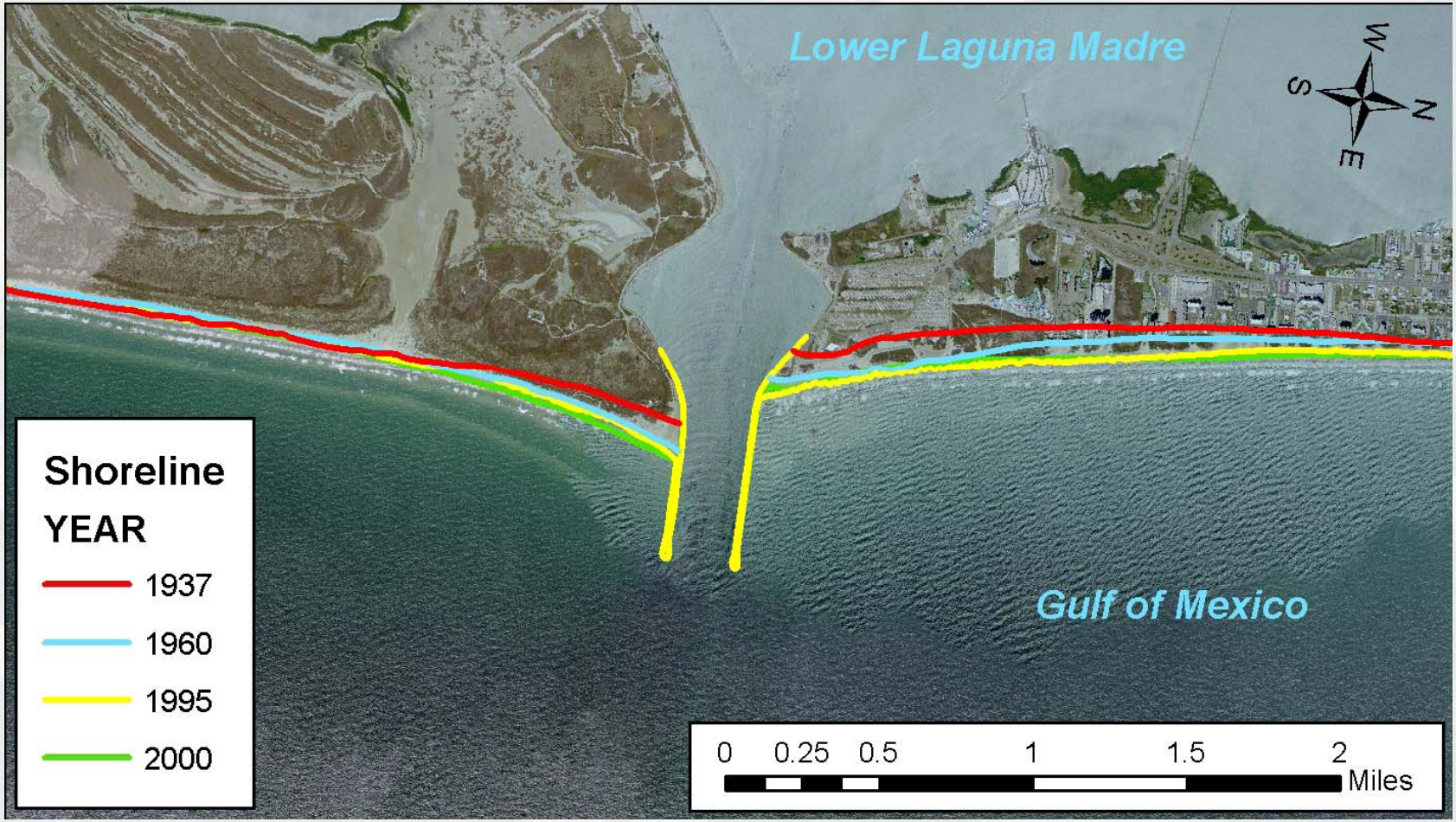
Brazos Island Harbor Project is 42 ft deep-draft navigation channel extending 23 miles from Gulf of Mexico to Brownsville, TX. (authorized to 44 + 2 ft overdepth)

Typically during 2 year dredging cycle, 350,000 cu yd material removed and used to nourish adjacent South Padre Island beaches or placed in berms just off the shoreline.

Over past few years increased shoaling has occurred, resulting in drafts of 35-36 ft being implemented from 9-12 months after dredging. Results in lightering of cargo ships, or diverting to Mexico. Economic loss to Brownsville area about $ 6 million/year at 38 ft draft, and $ 19 million/year at 35 ft draft.

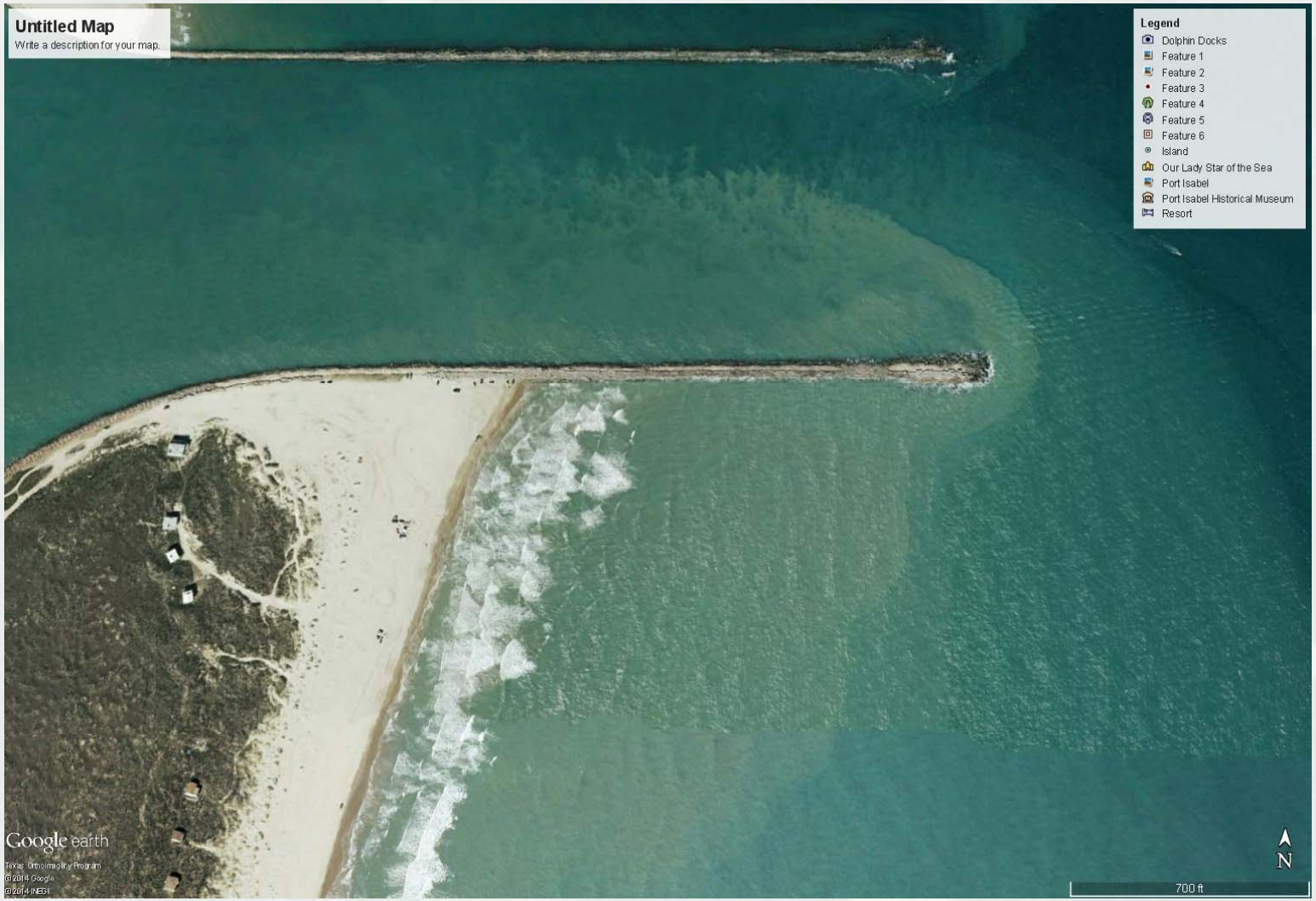
Objectives: Determine the cause of the increased shoaling within the entrance channel using both field data collection efforts and numerical modeling of the system. Develop potential design alternatives that can alleviate the problem.

Brazos Island Harbor, TX



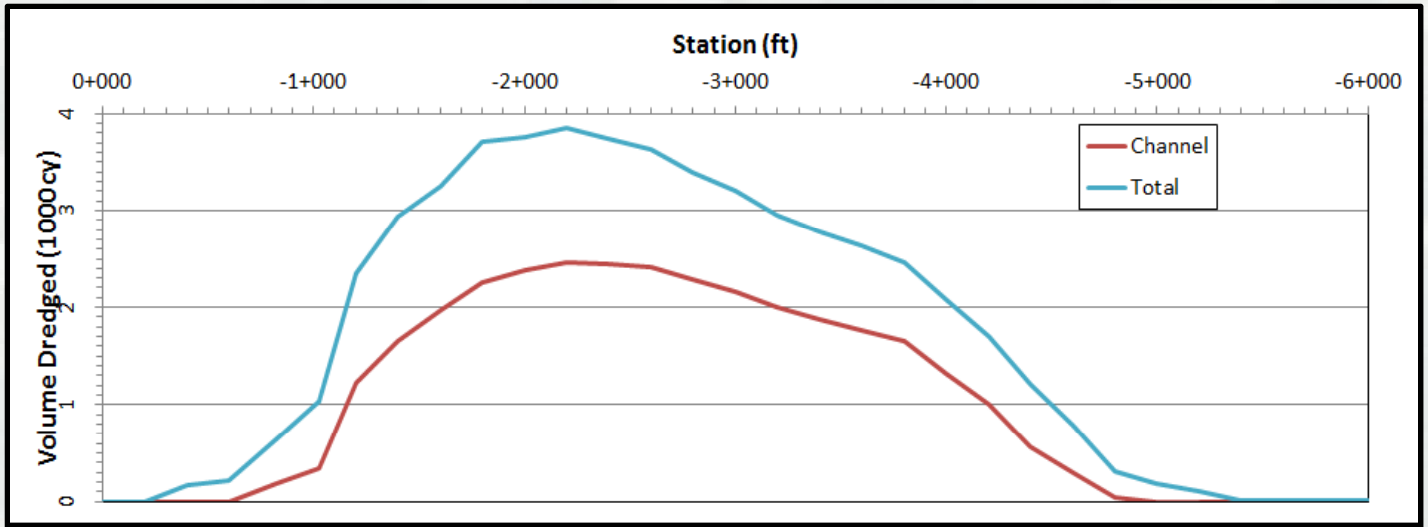
Brazos Island Harbor, TX

Brazos Island Harbor, TX

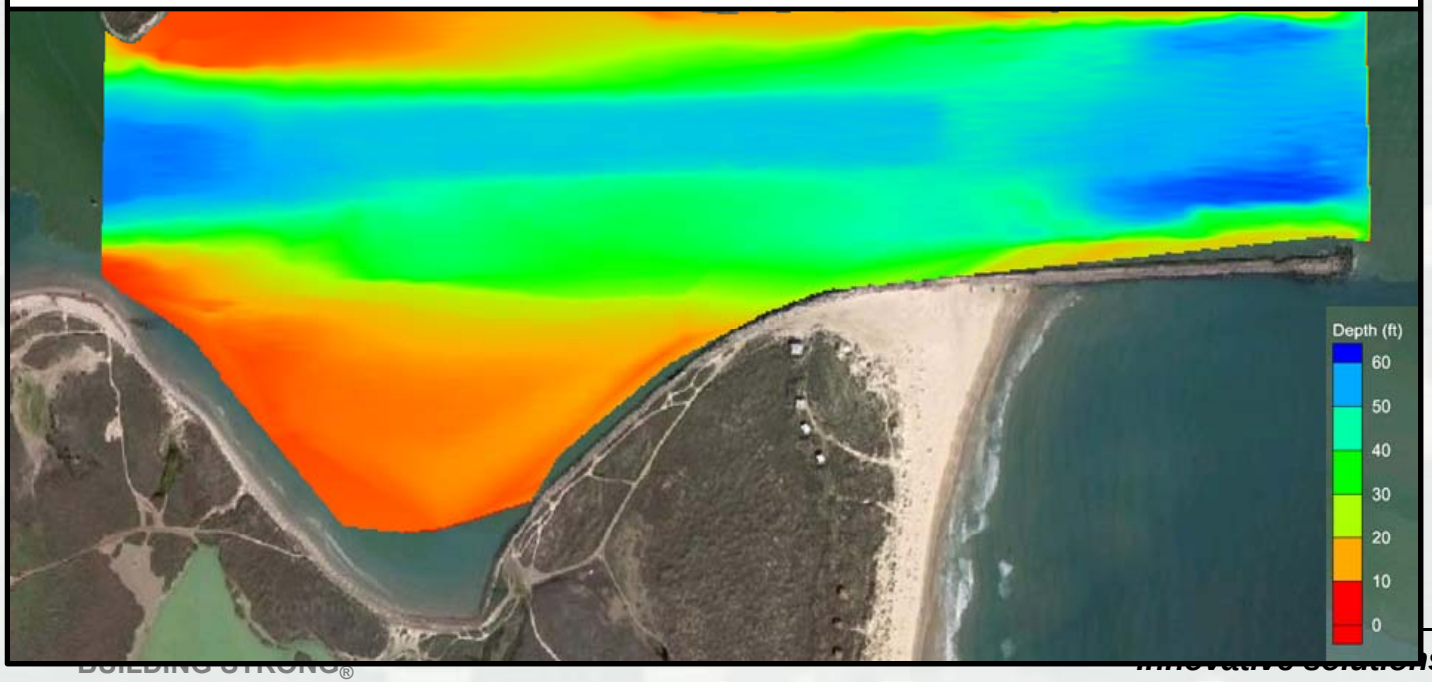


Brazos Island Harbor, TX

Dredging volume along channel plotted with bathymetry survey data

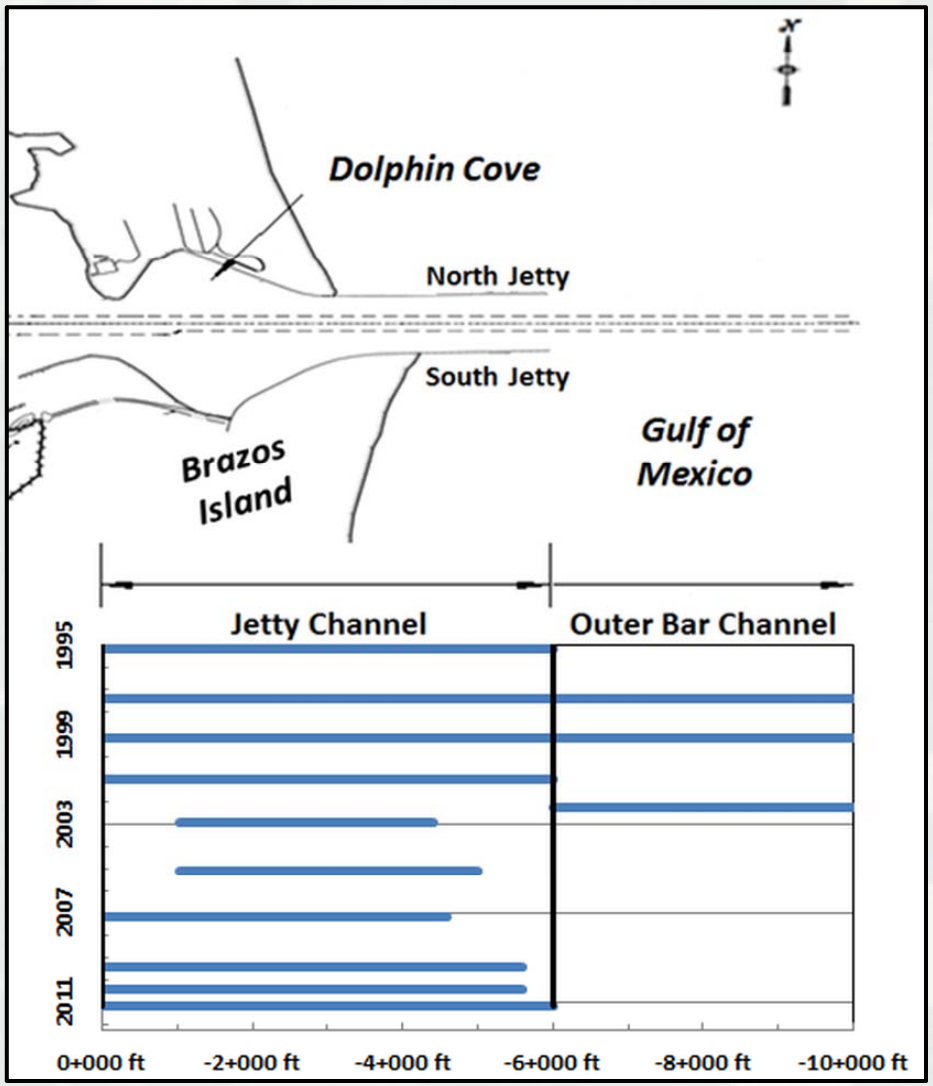


Total volume dredged (blue) and volume dredged in channel only (red) by station in 2014 Emergency maintenance dredging operation.

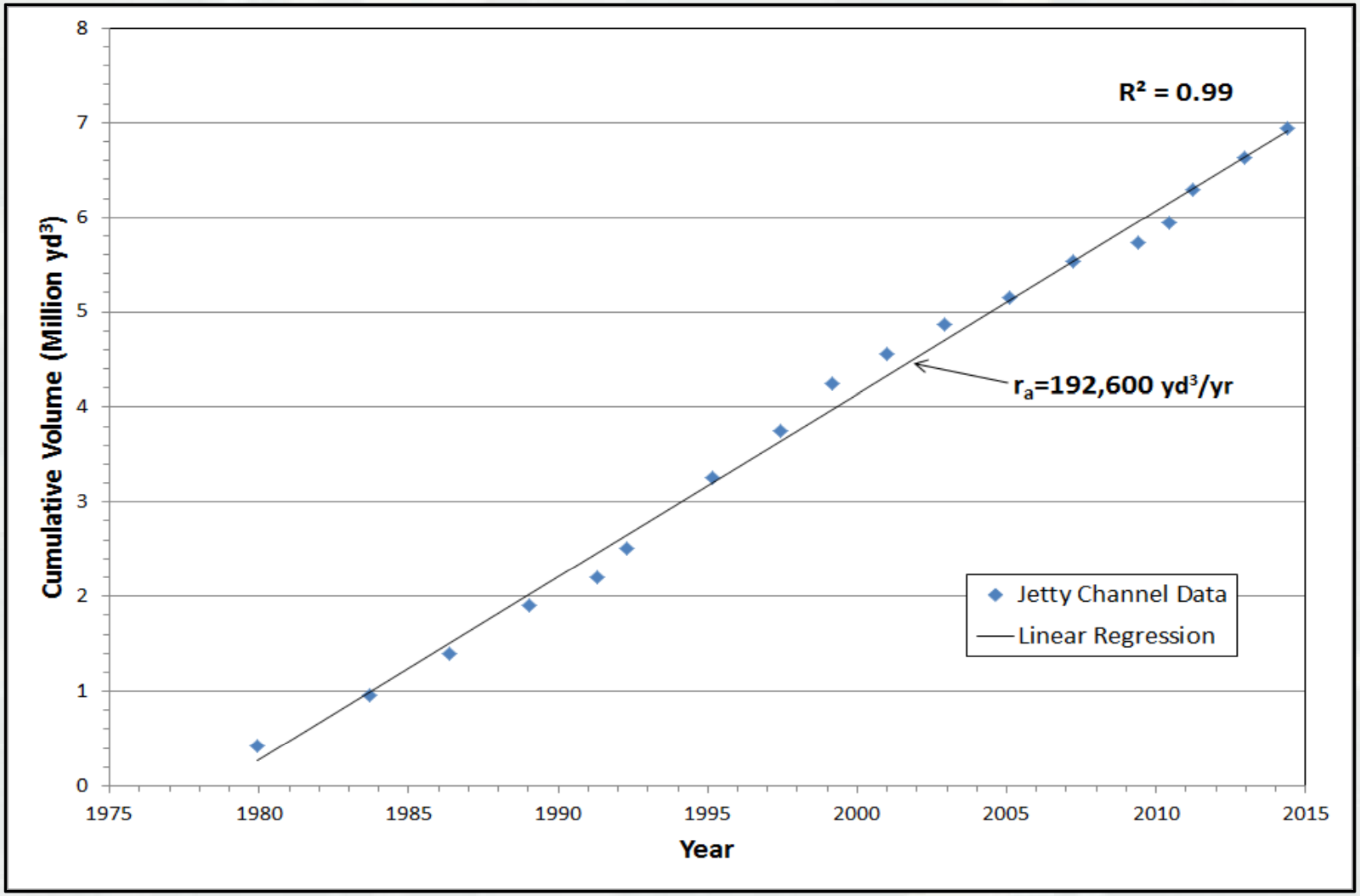


Bathymetry after dredging in 2014

Brazos Island Harbor, TX



Brazos Island Harbor, TX



Brazos Island Harbor, TX
(Preliminary Findings)

The frequent need to dredge is related to small areas of localized channel shoaling that reduce the navigable depth at these locations, and is not necessarily based on the total volume of material infilling the Jetty Channel.

Possible alternatives to reduce the problematic shoaling include:

1. Dredge Outer Bar Channel during dredging of Jetty Channel.
2. Lengthen one or both jetties to reduce sediment entering by longshore transport.
3. Artificial sand bypassing.
4. Narrow the channel at Dolphin Cove to increase current speed.

Brazos Island Harbor, TX
(Project Status)

- ✓ FY14: Project Management Plan Developed
- ✓ FY14/15: NSAT Analysis (Technical Note)
- FY14/15: 1 year of extensive field data collection (bathymetric surveys, ADCP, Tidal gages, etc) – *in progress*
- FY15/16: Numerical modeling using Coastal Modeling System (CMS) flow, waves, and sediment – *in progress*
- FY16: Journal Paper and Technical Report

Reliability Analysis of Rubble Mound Coastal Structures

Product Delivery Team

Glenn Myrick (PI) and Jeff Melby, CHL ERDC; and Monica Chasten, NAP, and District Coastal Engineers from the Coastal Navigation Structures Asset Management (CNSAM) board.

Mission Goals

- Validate updated empirical and numerical methods for computing primary responses such as seaside and leeside armor stability
- Develop generalized partial safety coefficients for the primary failure modes including wave runup, overtopping, seaside stability, leeside stability, and damage progression for rubble mound structures.
- Coastal Structures Operational Conditional Assessment
- Coastal Structures Operational Risk Assessment

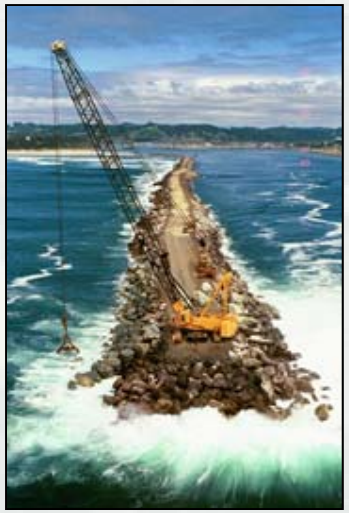
Benefits

Guidance provided will benefit Program Management for Civil Works priority funding toward the >1,000 coastal structures within the USACE portfolio. CEM guidance will aid USACE and the global coastal engineering community.

Updated CEM Guidance

Enhanced mathematical expressions.

Rubble Mound Failures



Yaquina, OR Jetty Damage

Neah Bay, WA
Breakwater Breaches

LALB Breakwater Breach

Redondo Beach, CA Breakwater Breach

Reliability Analysis

Asset Mgt Decisions

Major Rehab, Planning Studies, Feasibility

Risk or Life Cycle Analysis

Consequence Analysis

Reliability Analysis

Structural and Functional Engineering Analysis

Condition Assessment

Annual Condition Evaluation by Project

Periodic Inspections

Maintenance Records

Coastal Structure Inventory
ECID - Enterprise Coastal Inventory Database

Asset Management and Design based on Structure Capacity –
Need Reliability Metric

Quantify Reliability

Collect performance and hazard data

Waves and water levels
Structure damage

Compute Reliability

Example Limit State Equation:
Hudson stability

$$g = \overbrace{\Delta\, D_n\, (K_D \cot\alpha)^{1/3}}^{\text{Resistance}} - \overbrace{\widehat{H_s}}^{\text{Loading}} \quad \begin{cases} < 0 & \text{failure} \\ = 0 & \text{limit state} \\ > 0 & \text{no failure} \end{cases}$$

Probability of Failure $P_f = \text{Prob}\,[\,g \le 0\,]$

Reliability $R_f = 1 - P_f$

Reliability Using Recent Guidance

Understanding the Capacity of the Structure (the ability of the structure to protect itself). Evaluated in a stochastic manner using risk, reliability, probability, and partial safety coefficients determined from historical data (which does not presently exist).

Armor Stability, Seaside Damage, Leeside Damage

Wave Momentum Flux

$$\frac{(M_F)_{\max}}{\rho_w g h^2} = \frac{1}{2}\frac{H}{h}\frac{\tanh kh}{kh} + \frac{1}{8}\left(\frac{H}{h}\right)^2\left[1 + \frac{2kh}{\sinh 2kh}\right]$$

Seaside Armor Size

$$D_{n50} = h a_m \left(\frac{S}{K_s\sqrt{N_z}}\right)^{-1/5}\left(\frac{(M_{\max}/\gamma_w h^2)_{\max}}{\Delta}\right)^{1/2}$$

Leeside Armor Size

$$D_{n50} = a_{ls}\left(\frac{S_{ls}}{K_{ls}\sqrt{N_z}}\right)^{-1/r}\left(\frac{u_{1\%}T_{m-1,0}}{125\sqrt{\Delta}}\right)$$

$$a_{ls} = (\cot\varphi)^{-2.5/r}[1 + 10\cdot\exp(-R_{c-rear}/H_{m0})]^{1/r}$$

Fiber Reinforced Polymer (FRP) Composites

Product Delivery Team

Jeff Ryan (Co-PI) and Richard Lampo (Co-PI), CERL ERDC

District Team Member in every District where Monitoring takes place.

Fiber reinforced polymer (FRP) composites are being promoted as the materials of the 21st century because of their superior corrosion resistance, excellent thermo-mechanical properties, and high strength-to-weight ratio.

For over 25 years, the Constructed Facilities Center at West Virginia University (CFC-WVU) has been conducting research on fundamentals of engineering and material sciences, innovation, and development, including field implementation of FRP composite components and systems for infrastructure applications with emphasis on the enhancement of performance, serviceability, and durability over conventional materials.

NavSys and NavStructures Research Programs have installed unique navigation structure repair components at several locations. HQ directed that performance criteria be determined by visual observation, appropriate sensors, and laboratory aging techniques.

Fiber Reinforced Polymer (FRP) Composites

Early Uses:

First application was straw fiber in mud bricks used by Israelites in 800 BC.
Short glass fiber reinforcements used in concrete in US in early 1930s.
Fiber reinforced resin matrix materials (Composites) developed in US in 1940s.
First civil application of Composites was construction of a dome building in Benghazi in 1968.

Advantages of FRP Composites:

Light weight, corrosion resistant, high strength, and shapes are easily formable.

Common Uses:

Bass and ski boats; Automobile bodies; Fishing rods; Tennis rackets; Ski equipment; Golf clubs; Aircraft components; Submarine parts; Plastic timbers for decking; etc.

Fiber Reinforced Polymer (FRP) Composites

FRP Composites consists of:

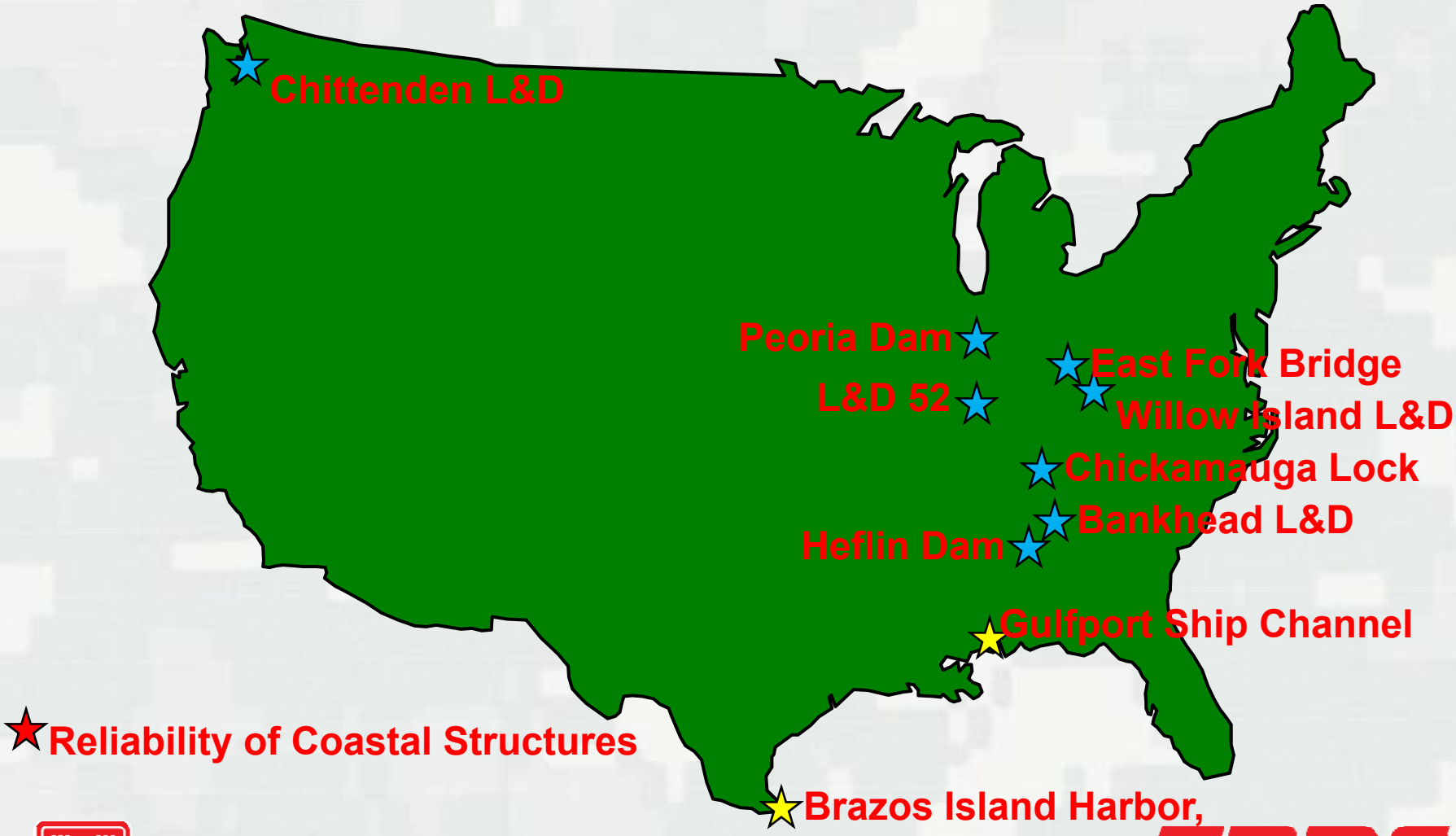
(1) Fiber reinforcements: (a) glass, (b) aramid, and (c) carbon;

(2) Resins: (a) unsaturated polyesters, (b) epoxies, (c) vinyl esters, (d) polyurethanes, and (5) phenolics;

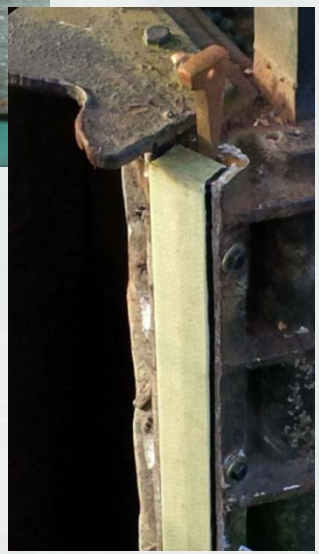
(3) Fillers: (a) calcium carbonate, (b) kaolin, and (c) alumina trihydrate; and

(4) Additives: (a) catalysts and promoters, (b) coloring dyes, and (c) releasing agents.

Monitoring Existing Structures



Fiber Reinforced Polymer (FRP) Composites



FRP Composite Miter Blocks to form Continuous Line of Contact for Watertight Seal when Gates are Closed: Chittenden Locks, Seattle, WA

Hybrid Steel Frame with FRP Composite Recess Filler Panels to Replace Heavy and Hard-to-Handle All-Steel Recess Filler Panels: Willow Island Locks, Newport, OH

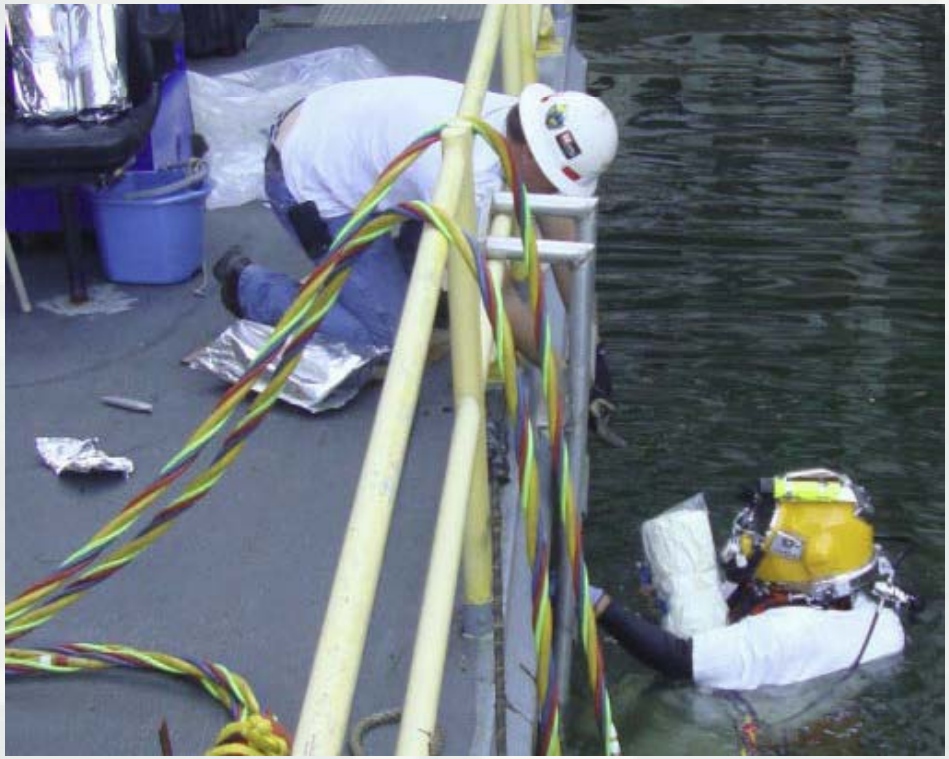
Vertical Lift Gate Rollers

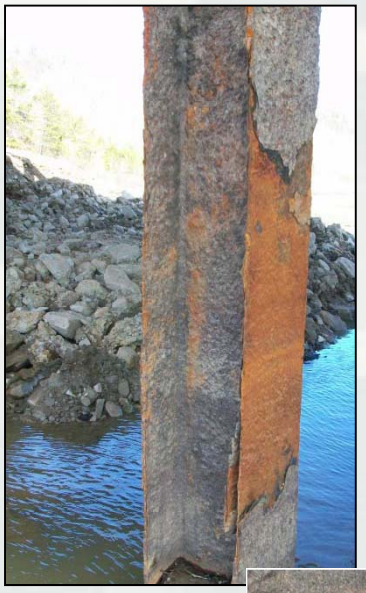
Fiber Reinforced Polymer (FRP) Composites

Ultra-High Molecular Weight PolyEthylene (UHMWPE) Polymer Slides to Replace Rollers on Hydraulic Vertical Lift Gates and Valves: Bankhead Dam, AL

UHMWPE Plastic Timbers for Miter Gates and Guidewalls to Replace Traditional Wood: Lock & Dam 52, Ohio River

Fiber Reinforced Polymer (FRP) Composites

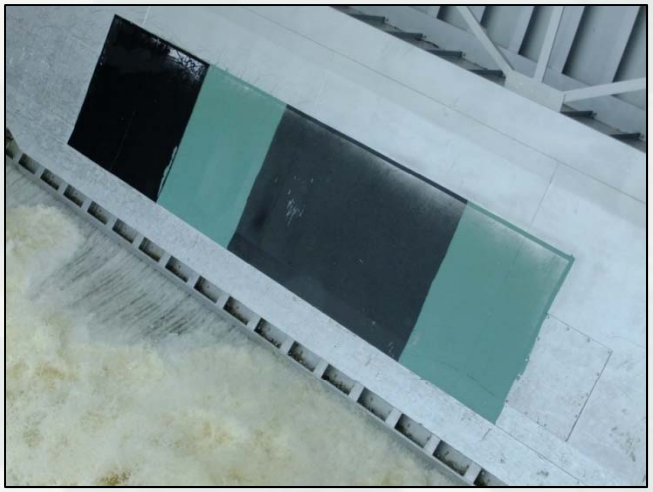


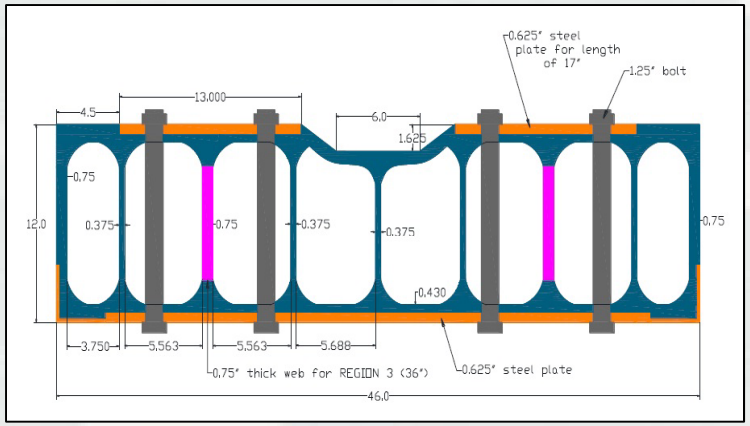


FRP Composite Wrap that Cures Underwater for Concrete Columns and Ports: Chickamauga Lock, Chattanooga, TN

FRP Composite Wrap for Corroded Steel H-Piles: East Fork Bridge, WV

Fiber Reinforced Polymer (FRP) Composites

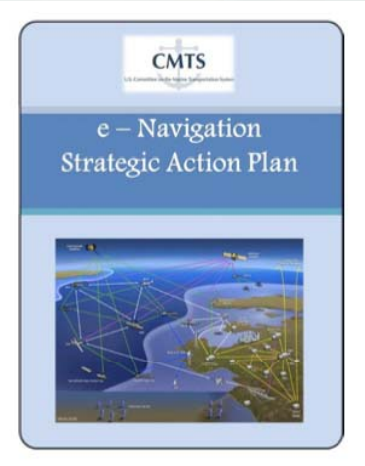




Abrasion-resistant UHMWPE Polymer Composite Overlays and Coatings to Replace Vinyl Coating for Protection of Steel Gates on Navigation Structures from Corrosion: Heflin Dam, Gainesville, AL

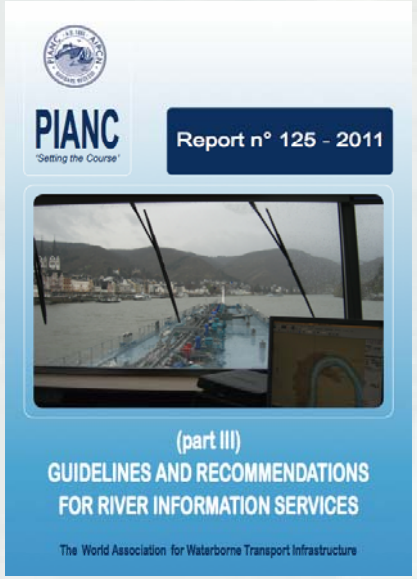
Composite Wicket Gates to Replace Traditional Wooden Wicket Gates: Peoria Dam, Peoria, IL

River Information Services (RIS)



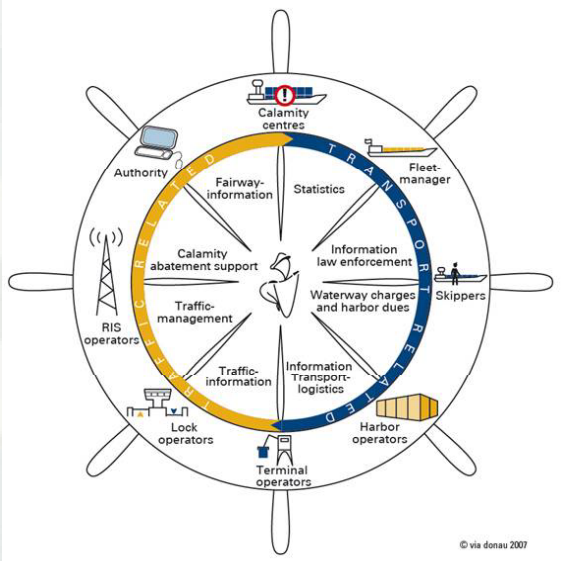
- Implement international RIS and e-Navigation concepts in the US through tangible capabilities.
- Coordinate with other US Federal agencies, the navigation industry, and navigation equipment manufacturers.
- Ensure alignment with national and international technical standards and guidance organizations.

River Information Services



"The harmonised information services to support traffic and transport management in inland navigation, including interfaces to other transport modes. RIS aims at contributing to a safe and efficient transport process and utilising the inland waterways to its fullest extent."

- **RIS services:**
  - **Fairway information services**
  - **Vessel traffic information services**
  - **Traffic management**
  - **Calamity abatement support**
  - **Transport logistics support**
- **RIS key technologies:**
  - **Existing and under development**



RIS Key Technologies
Existing and Under Development

- Inland Electronic Navigation Charts (IENC)
  - Developed and deployed
- Notices to Skippers
  - Existing, but need modernization
- Electronic Reporting
  - Concept stage
- RIS Index
  - Partially existing, needs development
- Inland AIS
  - Existing and developing rapidly

U.S. Department of Homeland Security
United States Coast Guard

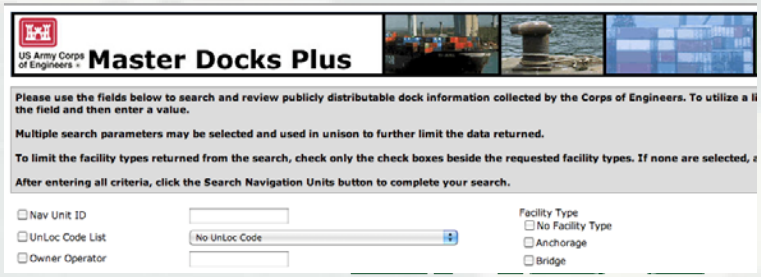
LOCAL NOTICE TO MARINERS
WEEKLY EDITION

District: 17 Week: 01/06

-Navigation Information Service (NIS)-
Watchstander, 24 hours a day at (703) 313-5900
~Navcen Internet Address~
www.navcen.uscg.gov
-Local Notice to Mariners-
www.navcen.uscg.gov/lnm

Issued by: Commander (DPW) Telephone: (907) 463-2269 (0800-1600)
Seventeenth Coast Guard District After Hours: (907) 463-2004 (1600-0800)
PO Box 25517 Facsimile: (907) 463-2273
Juneau, AK 99802-5517

Questions, comments or additional information on this Local Notice to Mariners should be sent to the address above or by E-mail to: D17-PF-D17-LNM@uscg.mil. You can get the U.S. Coast Guard 17th District's Local Notice to Mariners via the Internet directly from the U.S. Coast Guard Navigation Center web site at www.navcen.uscg.gov/lnm/d17.



US Army Corps of Engineers
Master Docks Plus

Please use the fields below to search and review publicly distributable dock information collected by the Corps of Engineers. To utilize a li
the field and then enter a value.

Multiple search parameters may be selected and used in unison to further limit the data returned.

To limit the facility types returned from the search, check only the check boxes beside the requested facility types. If none are selected, a

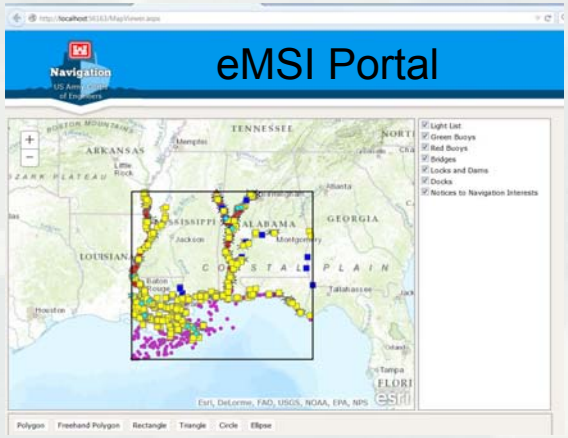
After entering all criteria, click the Search Navigation Units button to complete your search.

Nav Unit ID
UnLoc Code List — No UnLoc Code
Owner Operator

Facility Type
No Facility Type
Anchorage
Bridge

FY15 RIS Activities

- Expanded RIS implementation
  - Enhanced Marine Safety Information (eMSI)
  - Lock Operations Management Application (LOMA)
  - ➔Demonstrations for RARG
- National outreach and coordination
  - US Committee on the Marine Transportation System (CMTS)
  - USCG-USACE Joint Capabilities Test Bed (JCTD)
- International coordination:
  - PIANC e-Nav working group
  - Development of VHF Data Exchange System – "next generation AIS"
  - Coordination of various e-Nav-related standards



Trunnion Rod Investigations (Add)

Product Delivery Team

Lyn Hales and Eddie Wiggins (CHL); FDH Engineering;
District Team Member in each District where Tests are Conducted

MCNP and NavSys Programs

Many Corps dams with trunnion-anchored tainter gates use post-tensioned anchor rods, which was the standard design for many years. The anchor ends are embedded within the concrete pier, making inspection and replacement almost impossible. Across the Corps, there is a growing number of sites where these rods are breaking. This places an unacceptable amount of stress on the remaining rods, which can lead to their failure and ultimately the failure of the dam.

The Corps needs a non-destructive test (NDT) method to measure tension and condition of trunnion rods prior to failure.

Trunnion Rods

Trunnion Rods

John T. Myers Trunnion Rods

John T. Myers Trunnion Rods

Two Methods Under Development for Determining

(1) Tension, and (2) Condition

Non-Destructive Testing

1. Tension--Dispersive Bending Wave (DBW) Method by FDH Engineering Company (with Mobile District)

2. Condition--Non-Linear Acoustics by ERDC-ITL

Laboratory Test Facility at ERDC CHL

Laboratory Test Facility at ERDC CHL

Laboratory Test Facility at ERDC CHL

FDH Dispersive Bending Wave (DBW) Test

FDH – Corps of Engineers Connection

FDH has been using the DBW method since 1993 to determine the in-situ lengths and qualitative condition of structural piling made of concrete, steel, or timber. The methodology involves striking a piling (or trunnion rod) on its side transversely to its longitudinal axis, to create flexural stress waves that travel up and down the pile's length.

In October 2008, FDH was approached by the HQ USACE to consider using the DBW testing to evaluate existing tension in trunnion rods. A team from Mobile District, FDH, Dorsey & Dorsey, Geosystems, Thompson Engineering, and DYWIDAG Systems Int. was formed to research, calibrate, validate, and apply this technology to trunnion rods.

FDH – ERDC Connection

FDH method has been demonstrated at West Point, R. F. Henry, and Greenup dams.

HQ expressed the desire that the state of all trunnion rods at all USACE sites where such rods are utilized be assessed.

HQ directed ERDC to participate with FDH by selecting 4-8 additional dams where ERDC added-value would contribute to verification and validation of the FDH method, as well as the other method currently being developed by ERDC.

Performing rod evaluations at John T. Myers satisfies the HQ directive to ERDC to participate with FDH, and will be baseline data for subsequent monitoring by MCNP program.

The 4-8 additional dams will be investigated by Congressional Add funds.

Advancing USACE Capabilities in Structural Health Monitoring (SHM) (Add)

This project is the result of an opportunity created by a Congressional Add focused on improved technology to assess and extend the life of our civil works infrastructure.

The Bottom Line Need

Low Cost

High Reliability

Low Maintenance

Low Power

Objectives

- Target specific applications where SHM needs are hindered by the cost or availability hardware.
  - Reduce deployment costs.
  - Reduce recurring costs.
  - Lower power requirements.
  - Use modern wireless communication
- Fill gaps in existing research projects with SHM requirements.
  - Focus on immediate needs.
  - Low cost – high benefits.
  - Provide baseline data for current and future R&D.
- Exploit opportunities were the engineering, modeling, and analysis is complete or readily done.
- Investigate long-term viable solution for large scale deployment opportunities.

Investigate Technical Requirements in 4 Key Monitoring Applications

1. Excessive Friction at Tainter Gate Trunnion Bearings
2. Automated System to Monitor Water Release at Navigation Dams
3. Vibration in Lock Culvert Tainter Valves
4. Levee I-wall Stability.

JT Myers Gate Trunnion

Old London Avenue Canal Wall, New Orleans

1. Monitoring for Excessive Friction in Trunnion Bearings

Structural analysis predicts that trunnion friction can be quantified with 5 strain gages at the critical section location.

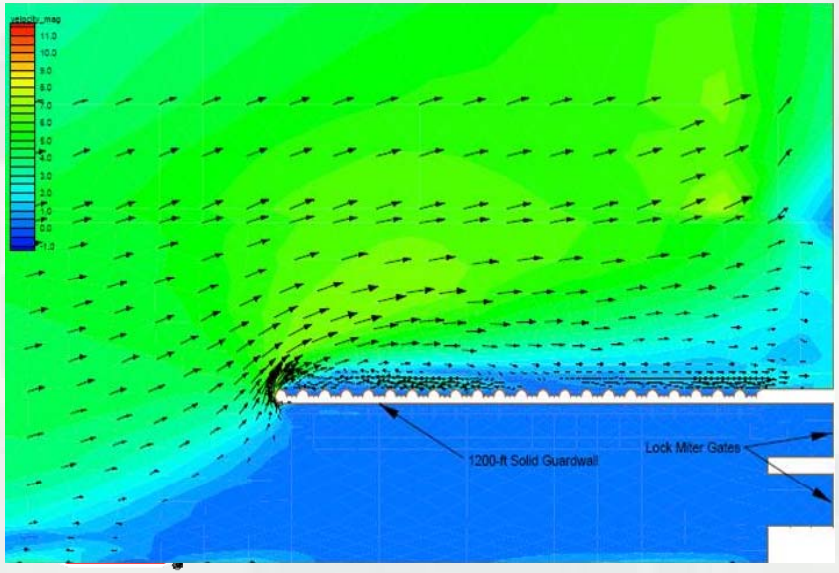
Efforts will involve:

- **Numerical modeling (FEM) of gate forces.**
- **Construction of a physical 1/5 scale experimental model.**
- **A series of experiments to document forces acting on a frozen trunnion.**
- **A TR documenting the results.**

Old London Avenue Canal Wall, New Orleans

2. Real-Time Monitoring of Water Release at Navigation Dams

- **Dangerous outflow currents remain an serious threat to navigation at many USACE locks and dams.**



- **Logs gate positon 24-7.**
- **Transmit data via SMART Gate portal or LOMA:**
  - **Boundary conditions for real-time flow modeling**
  - **Automated reporting of water release.**

3. Lock Culvert Tainter Valve Instrumentation

Culvert tainter valve in lock filling and emptying systems are high maintenance items. New designs under consideration need field investigation of vibration and structural loads.

Note: This effort is subject to time and funding constraints.

4. I-Wall Monitoring

Instrumentation suites to monitor I-wall stability are complex and prohibitively expensive, making large scale deployment impractical with current technology. This research will focus on a simplified approach.

Note: This efforts is subject to time and funding constraints.

Products

- Demonstration Project
- Technical Report

Product Delivery Team

PDT Member	Org. Code or Agency	Project Role
Bruce Barker (ITL)	CEERD-IE	Lead PI; project management
Matthew Smith, PhD, PE	CEERD-IE-S	Co-PI; System design and development
Quincy Alexander (ITL)	CEERD-IE-S	Member; Engineering and Modeling
Chris Lunderman	CEERD-IE-S	Member; Data acquisition and field deployment
Allen Hammack	CEERD-HN-NL	Collaborator, (culvert valves)
Brian Tetreault	CEERD-HN-N	Collaborator , (LOMA)
Keith Martin	CEERD-HF-EL	Collaborator , (lock flow modeling)
Maureen Corcoran, PhD	CEERD-HV-T	Collaborator, (I-wall instrumentation)
Anthony Perkins	CENAO-WR-ON-S	Collaborator, (culvert valves)
Waylon Humphrey	CELRL-OP-LM	Collaborator, (Markland Dam Gates)