Waterfront Facility Inspection & Rehabilitation Engineering Design

Society of SAME American Military Engineers

NAVFAC Naval Facilities Engineering Systems Command NAVFAC Southwest

moffatt & nichol

bdubbs@moffattnichol.com

What Are Waterfront Facilities?

- Cargo Terminals
- Piers
- Wharves
- Marine Oil Terminals
- Cruise Ship Terminals
- Quay Walls
- Bulkheads
- Graving Docks
- Floating Dry Docks (Moorings)
- Jettys
- Shipyards
- Marinas
- Offshore Wind
- Bridges (kind of…)

What Are Waterfront Facilities?

Cargo Terminals
Containers
Bulk
Liquid Bulk

What Are Waterfront Facilities?

Pier

What Are Waterfront Facilities?

Wharf

What Are Waterfront Facilities?

Yacht Marinas

Captain Laurie Scott

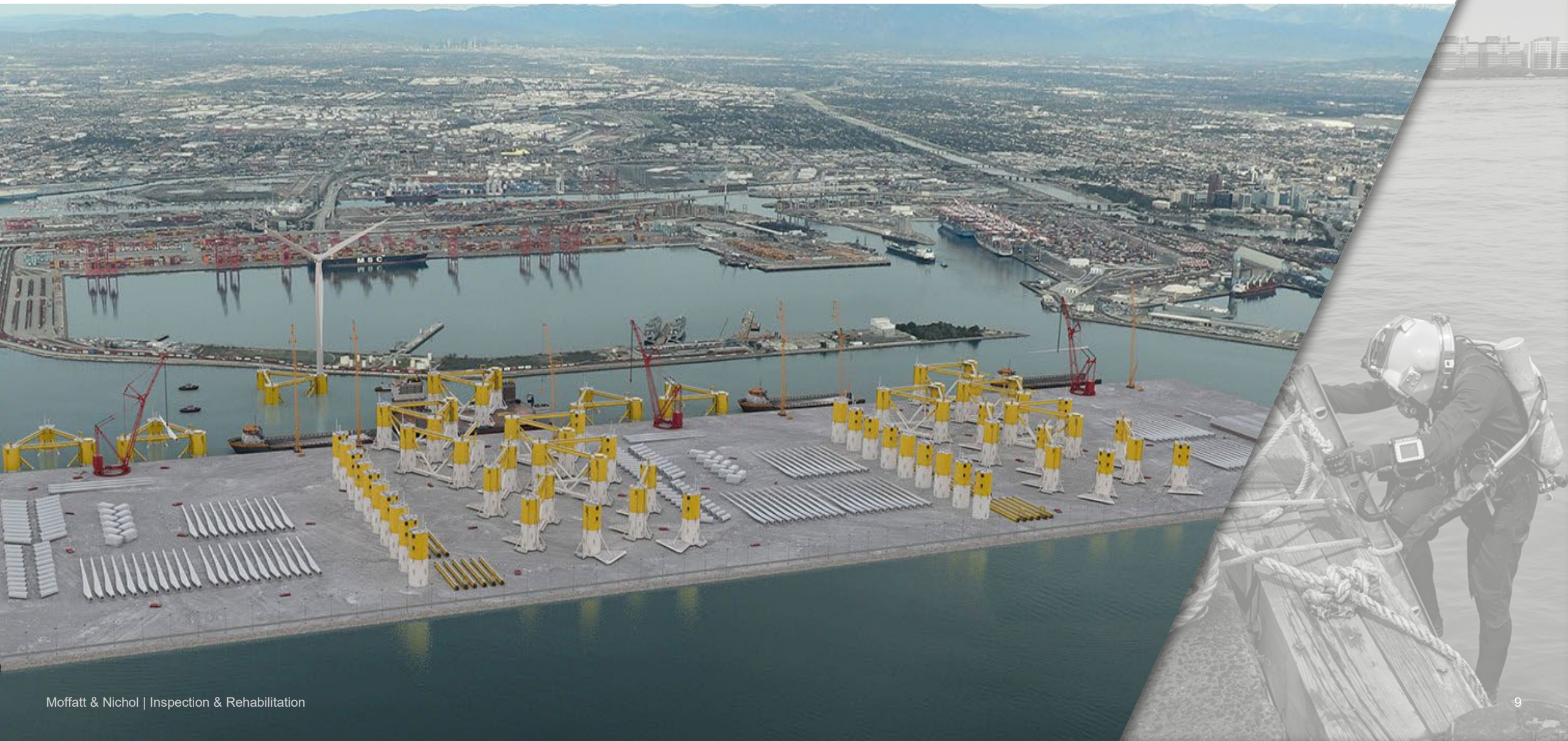
Aboard the S.S. SCOTT FREE

Captain Merrill Stubing

Aboard The Love Boat

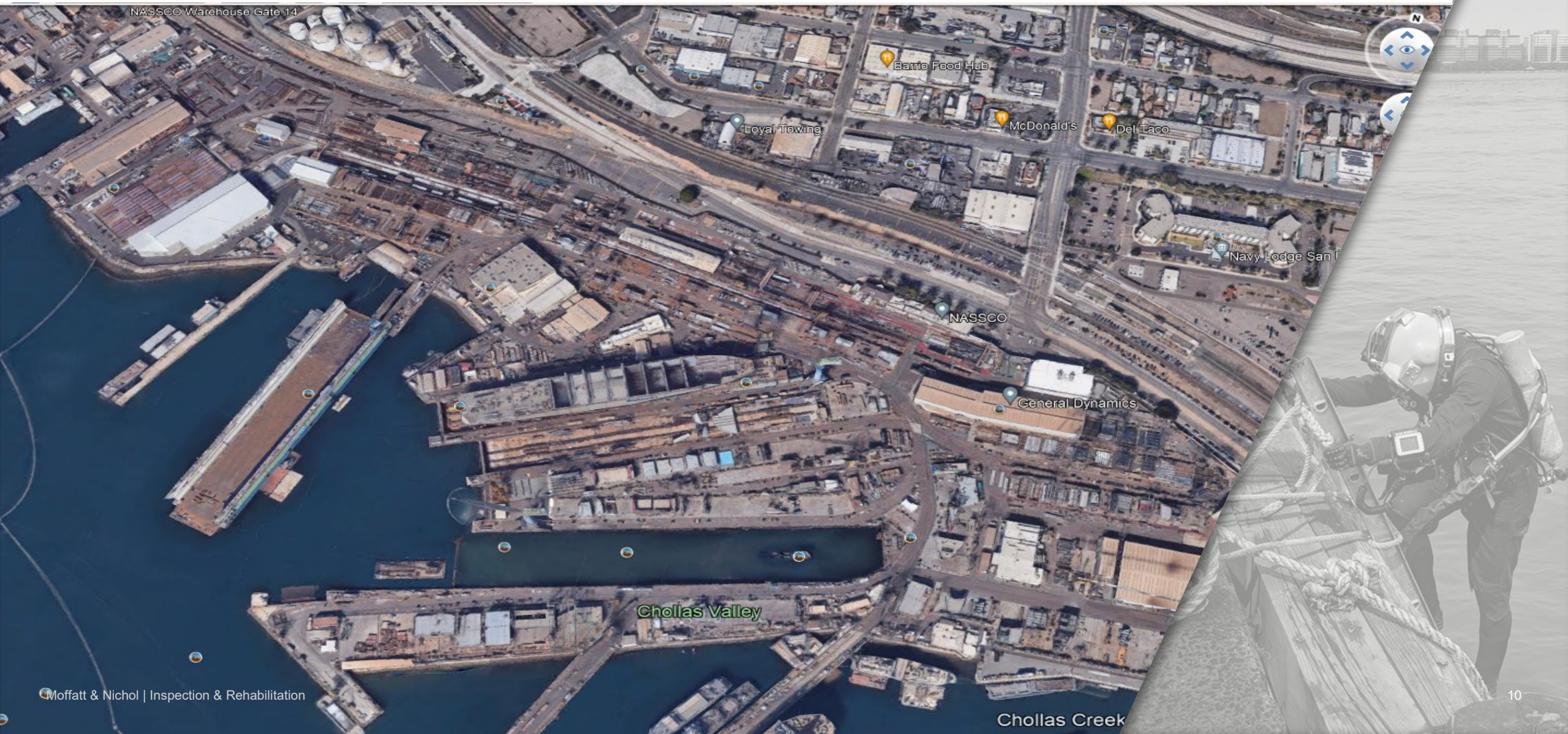
What Are Waterfront Facilities?

POLB - Pier Wind – Offshore Wind Terminal – 400 Acre New Pier



What Are Waterfront Facilities?

NASSCO – San Diego – 80 Acres



What Are Waterfront Facilities?

Quay Walls & Bulkheads

Most Severe Environment

- Salt Water
- Wave Action
- Tides
- Wind
- Heavy Loads
- Constant Use
- Difficult Access for Maintenance
- Sea Level Rise

WWII Infrastructure

NBSD
NBPL
JBPHH
NB KITSAP
Everywhere

WWII Infrastructure

Navy Base Point Loma, San Diego, CA

1913 Fuel Pier

Navy Base Point Loma, San Diego, CA

2018 Fuel Pier

Snapshot of Projects

Hudson River Park Trust, NY

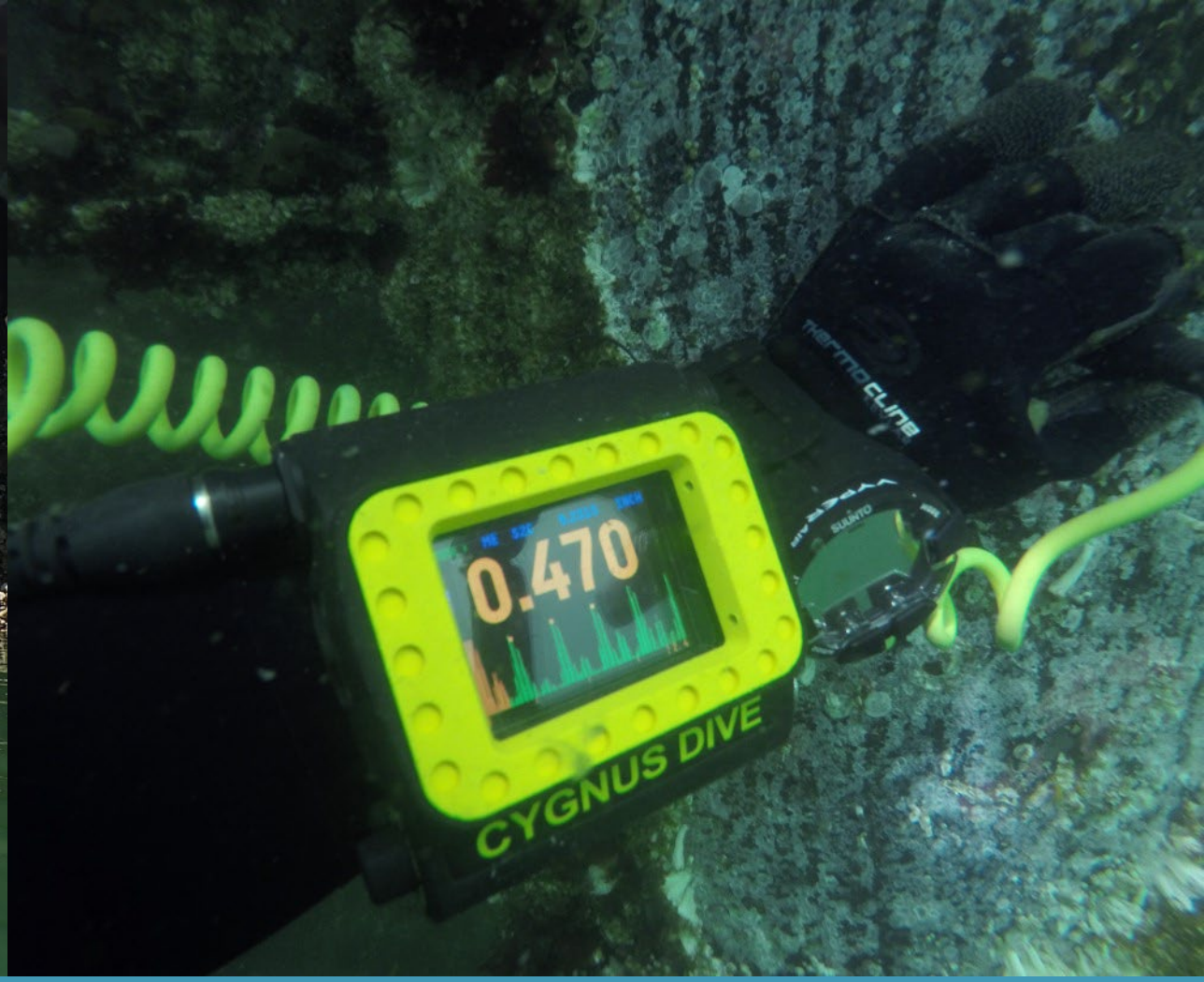
Parkwide Inspections. Construction Support and Oversight

POLA MOTEMS Audit

Underwater Timber Cores

Bimini Cruise Port

Inspection



Bellingham Shipping Terminal, WA

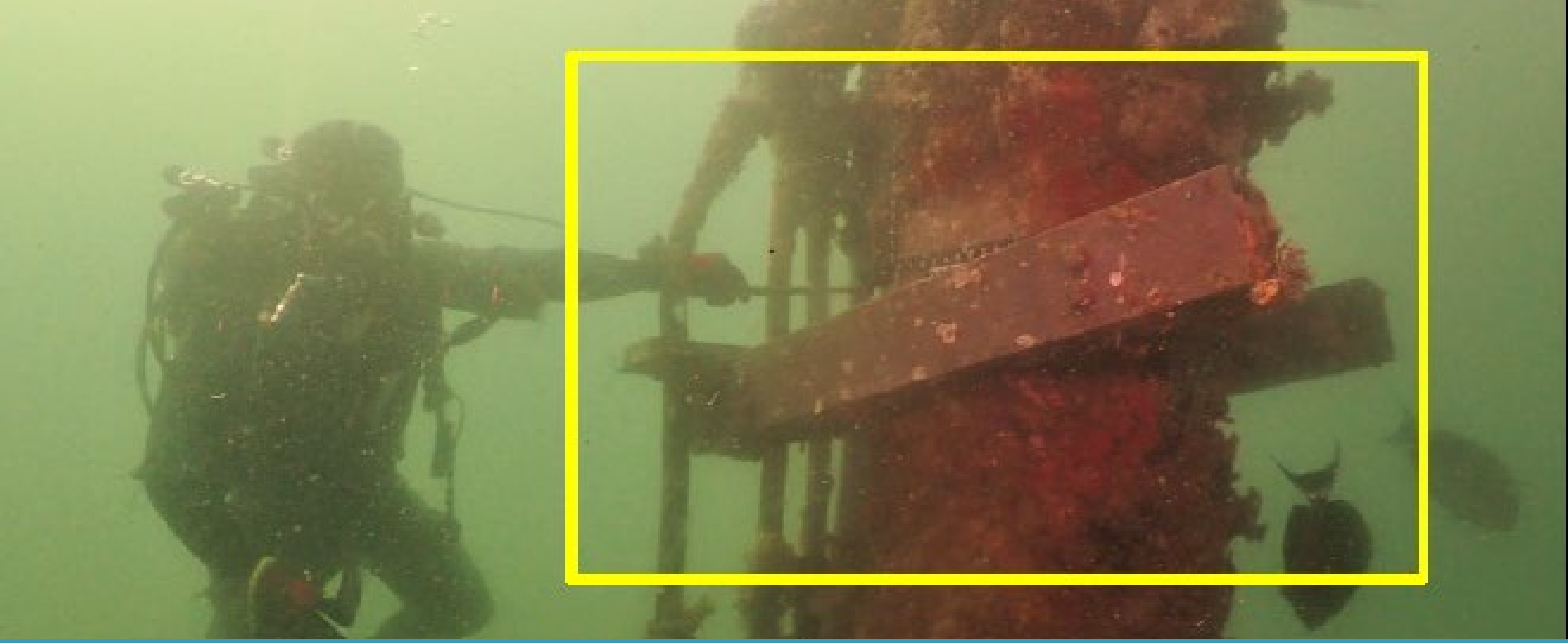
Inspection & Repairs

Port of Lake Charles, LA

Port Wide Inspections. Allision Damage Assessments. Rehabilitation

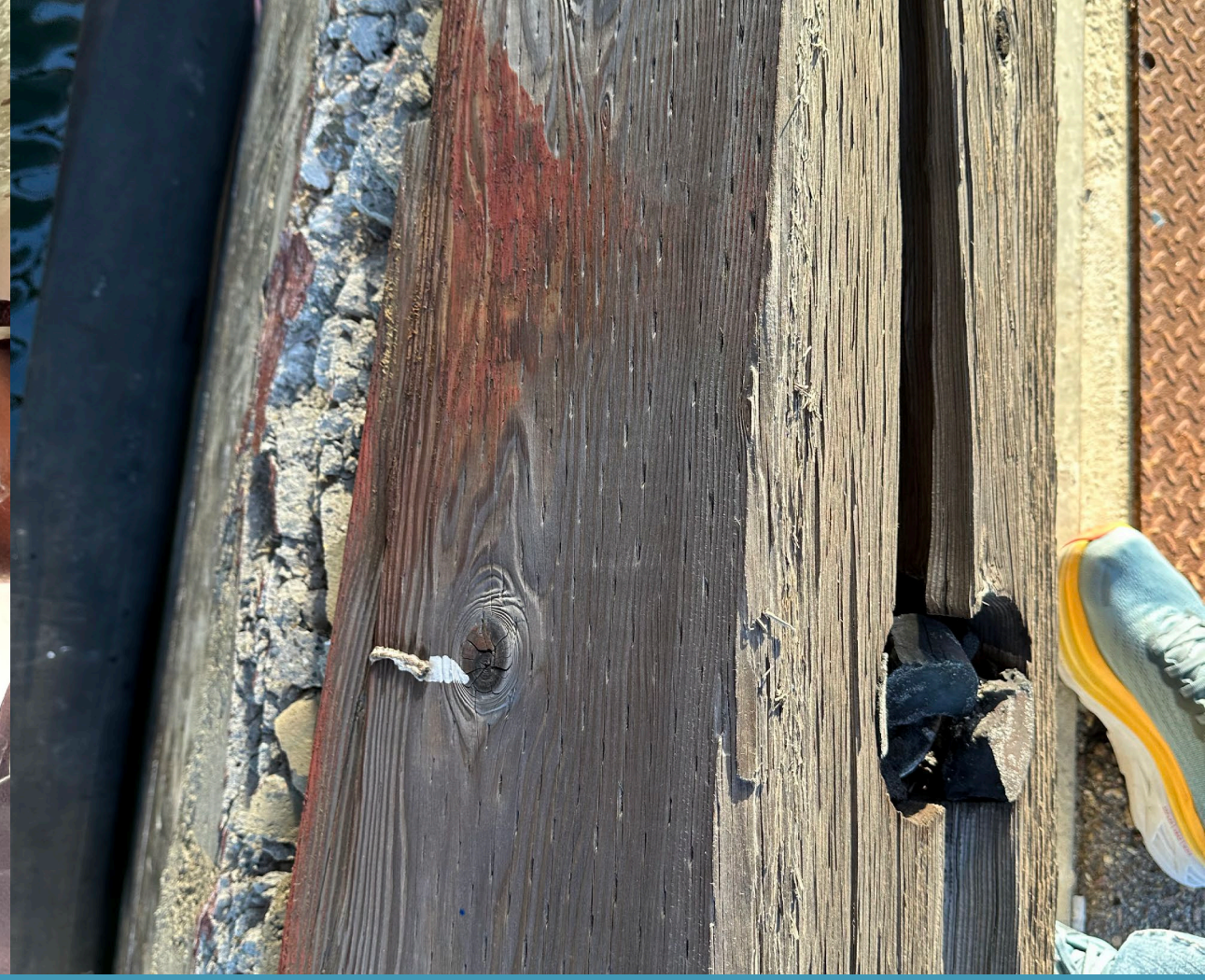
TOTE, Honolulu Harbor

UW/AW Inspection



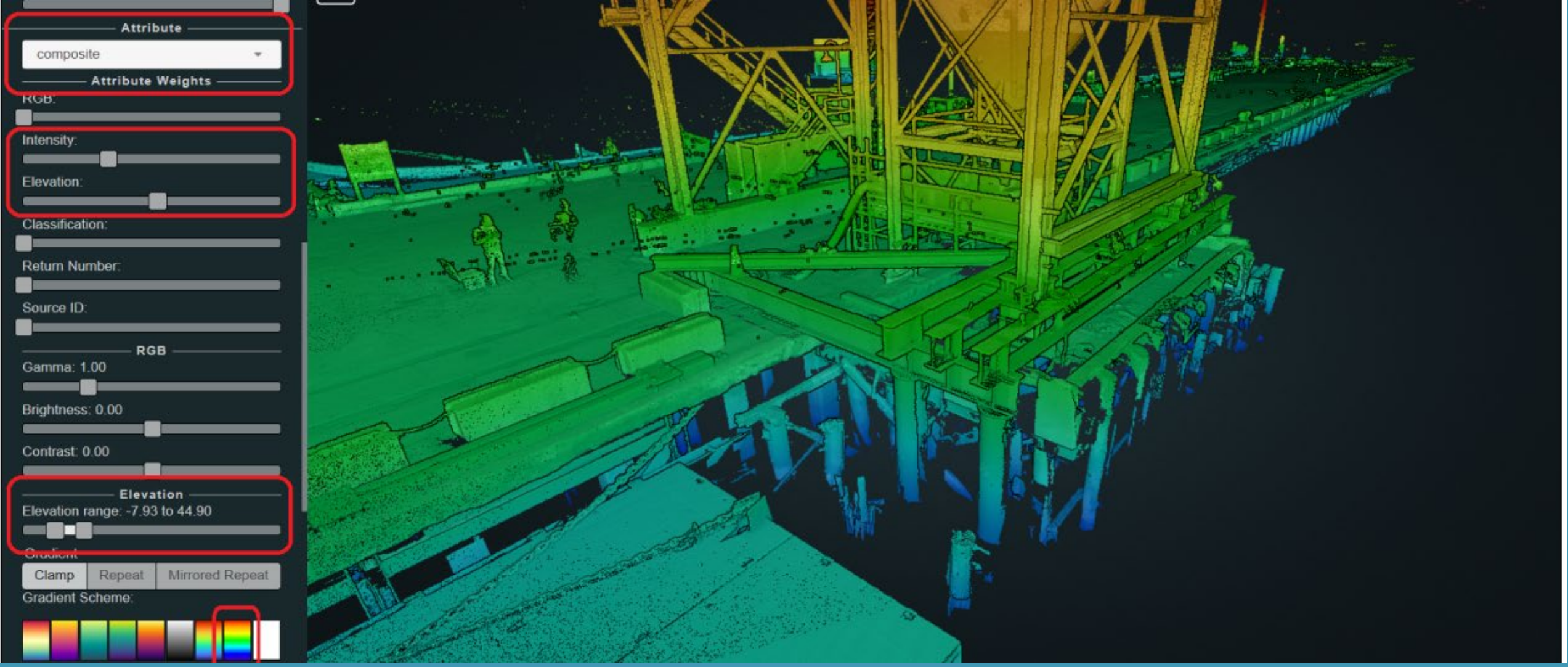
Pearl Harbor Magnetic Silencing Facility, HI

Inspection



SDUPD National City Marine Terminal – 24-2

Allision (aka: Hard-Berthing) Incident

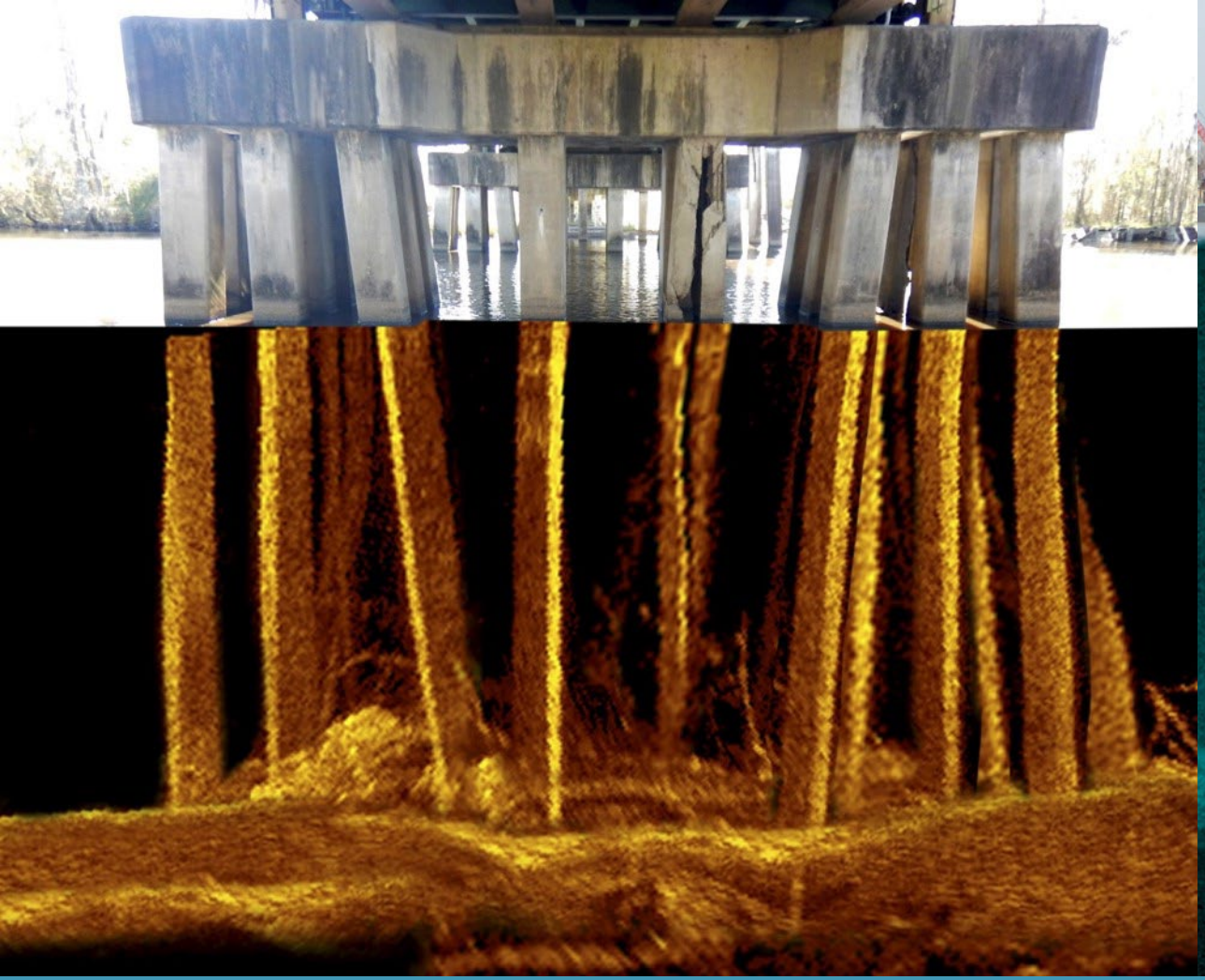


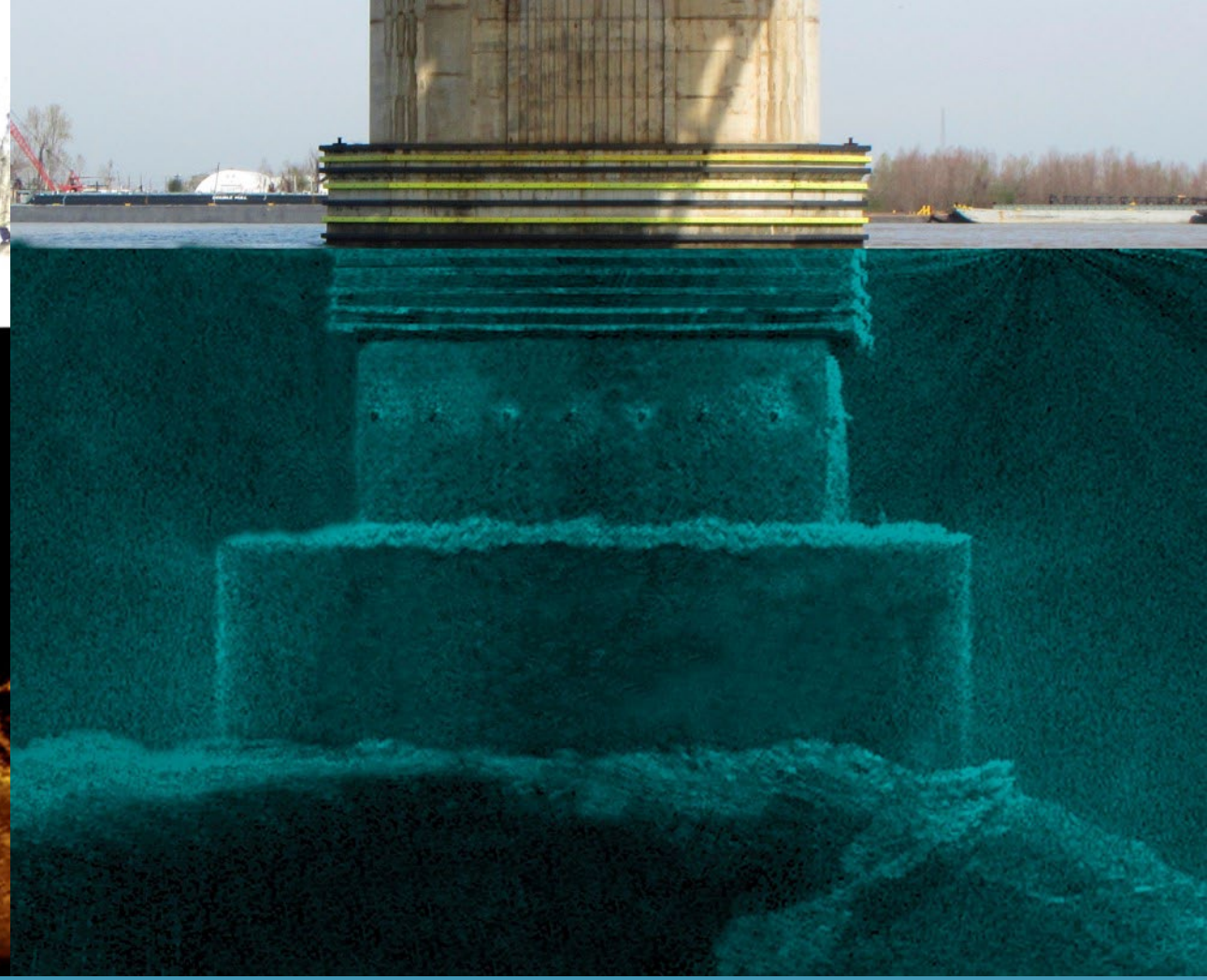
Valero MOT – Post-Fire, Benicia, CA

Inspection – Using LiDAR

LADOTD

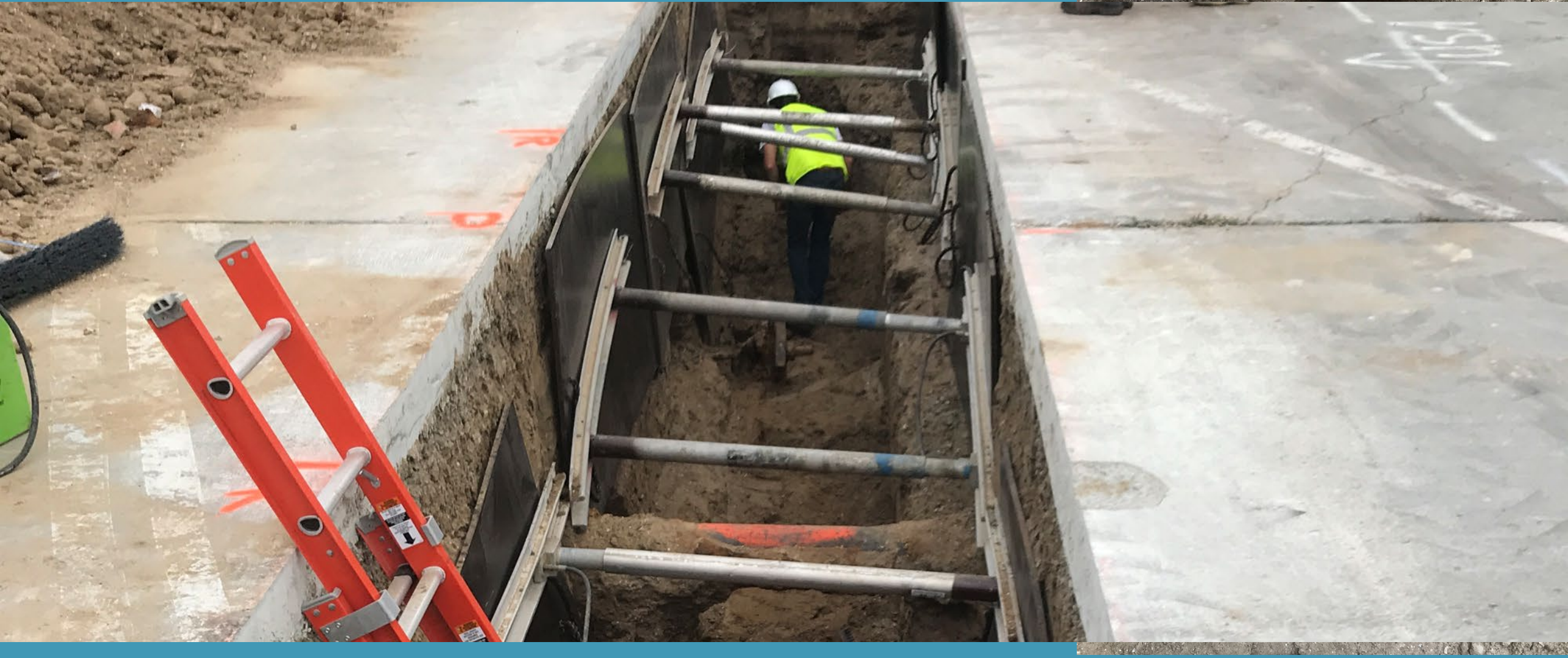
In-Depth Inspection of Complex Bridges





LADOTD

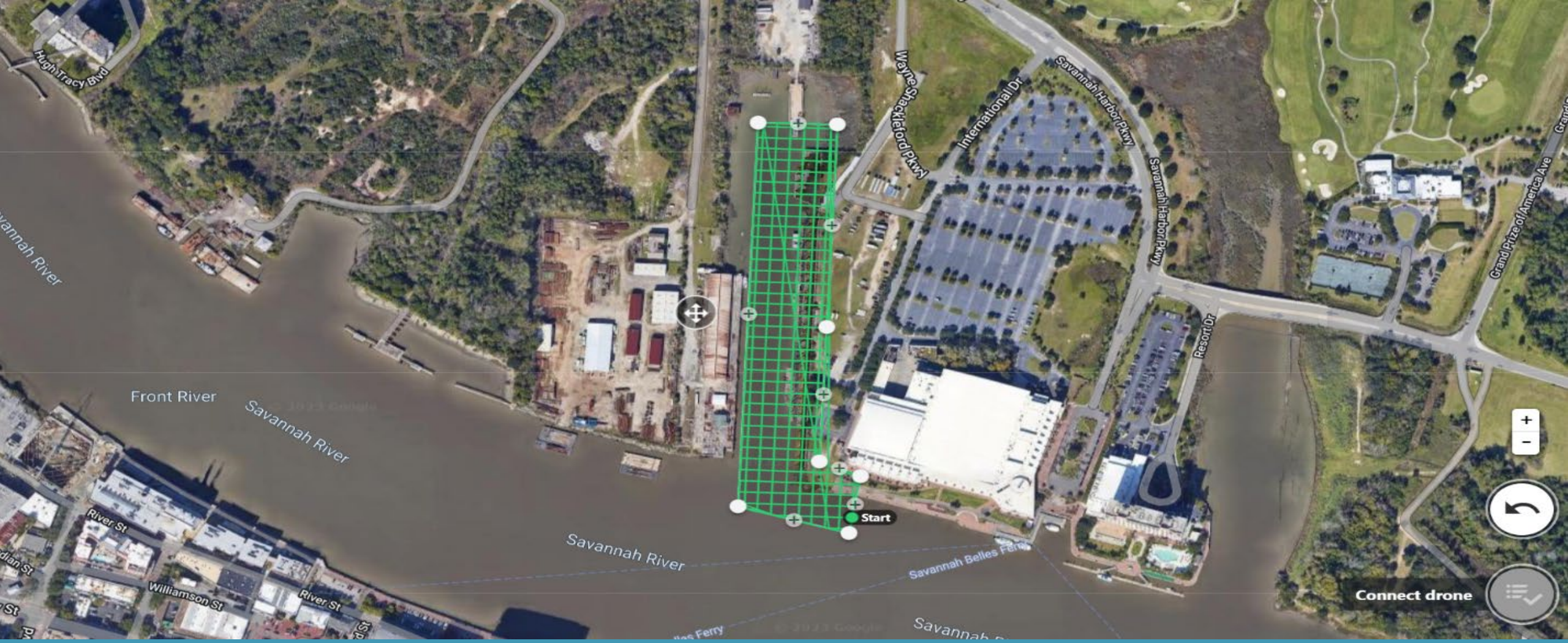
UWI with Acoustic Imaging



SSPBH Tie-Back System Test Pit, B St. Pier, SDUPD

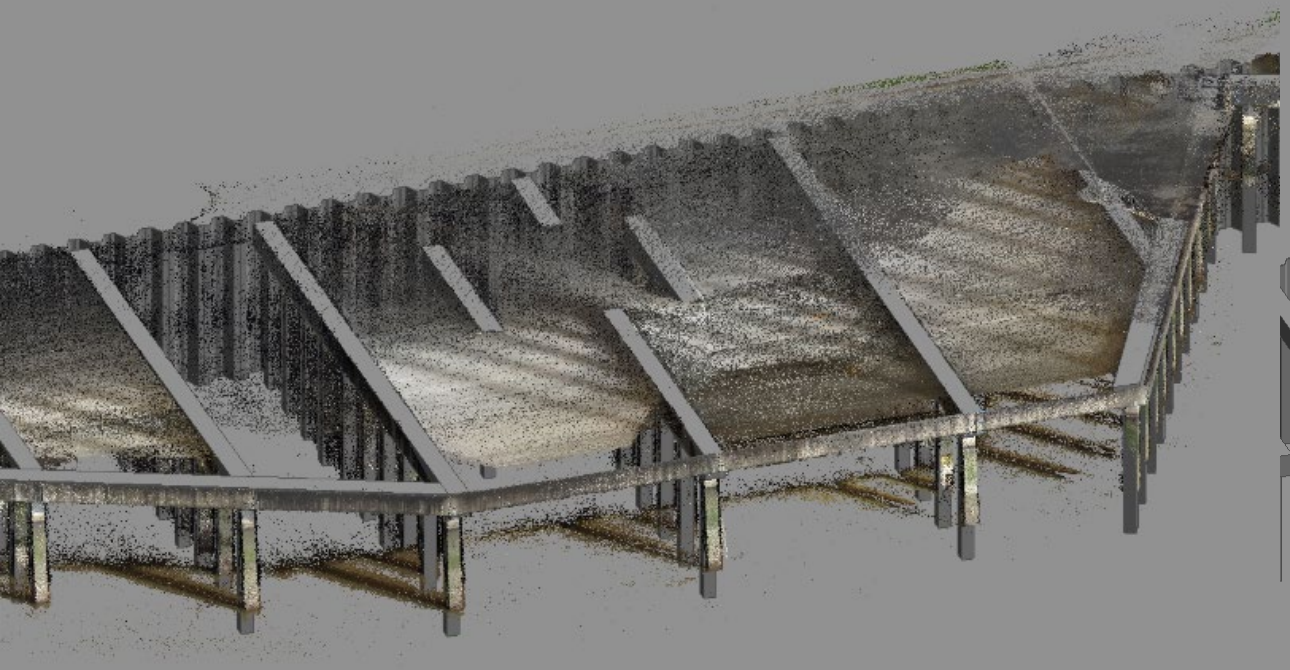
SSPBH Tie-Back System Test Pit, Broadway Pier, SDUPD

Inspection Tools and Tech

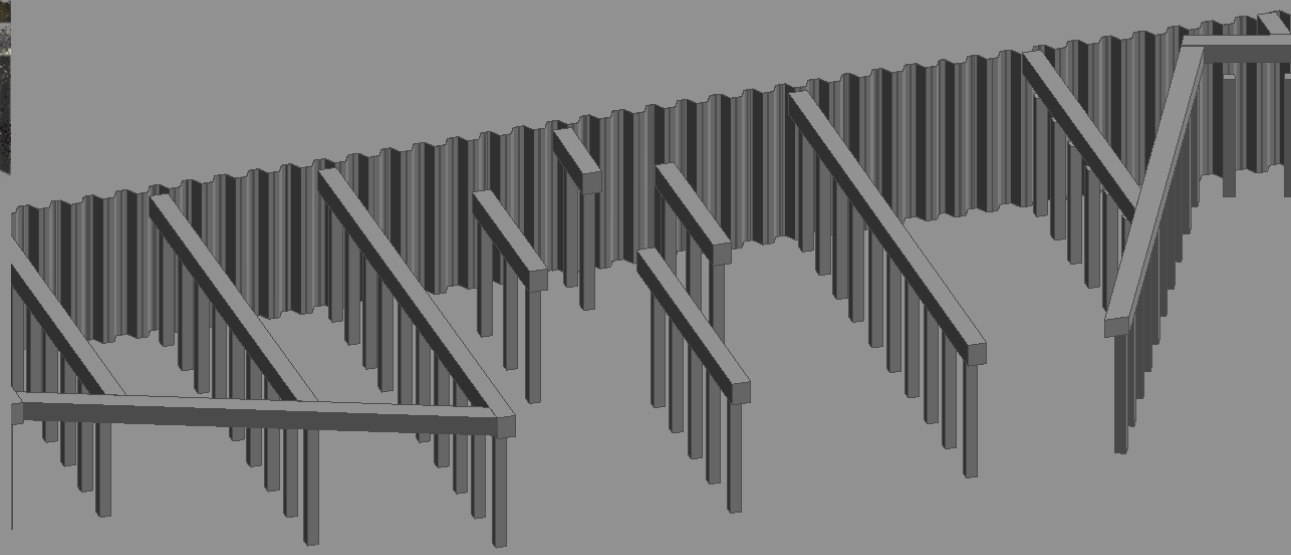


Drone Aerial Photogrammetry

Bulkhead Inspection/Repair Design



Point cloud image from drone.

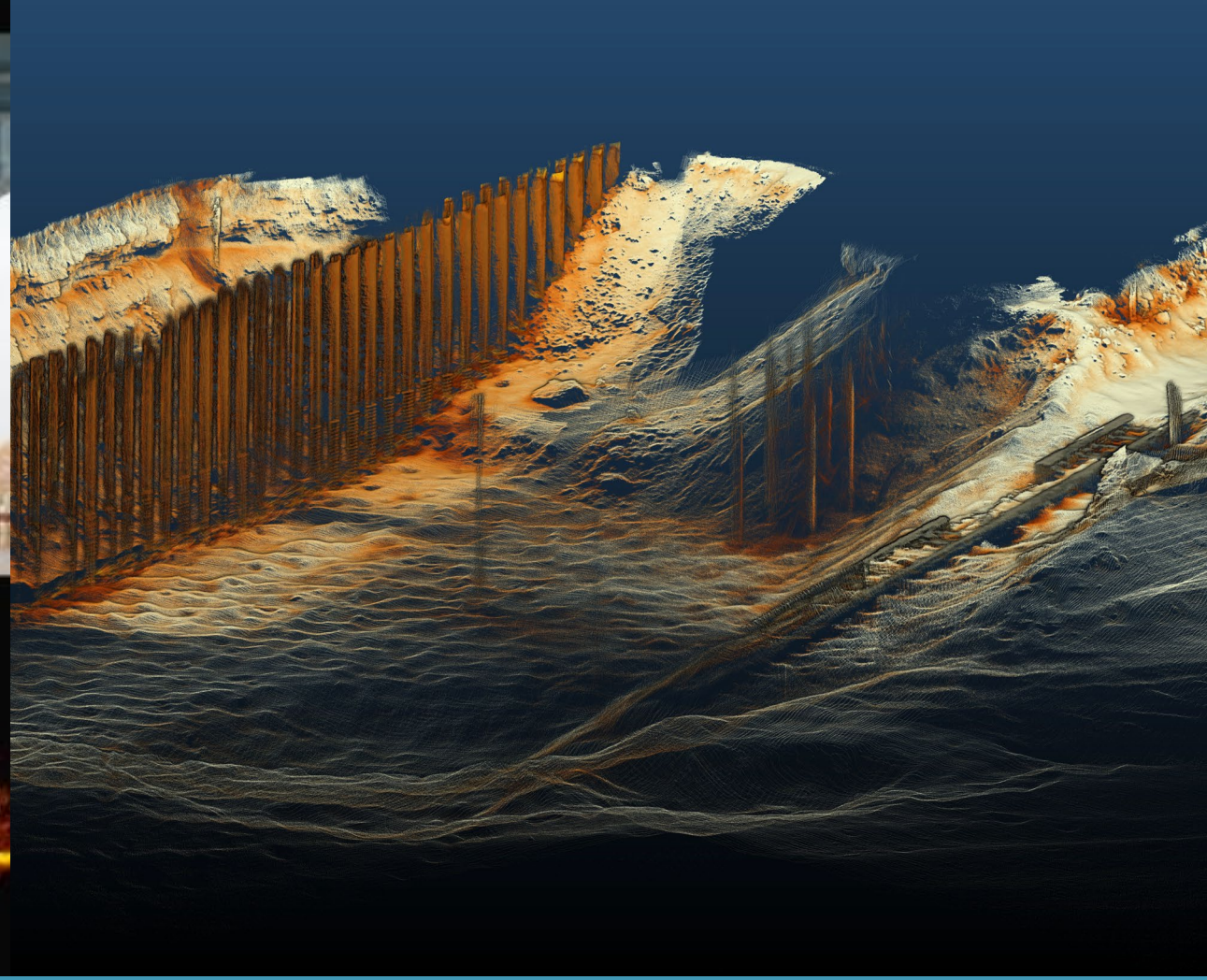


Revit model elements placed by referencing point could. Elevations and dimensions reference mesh and point cloud.

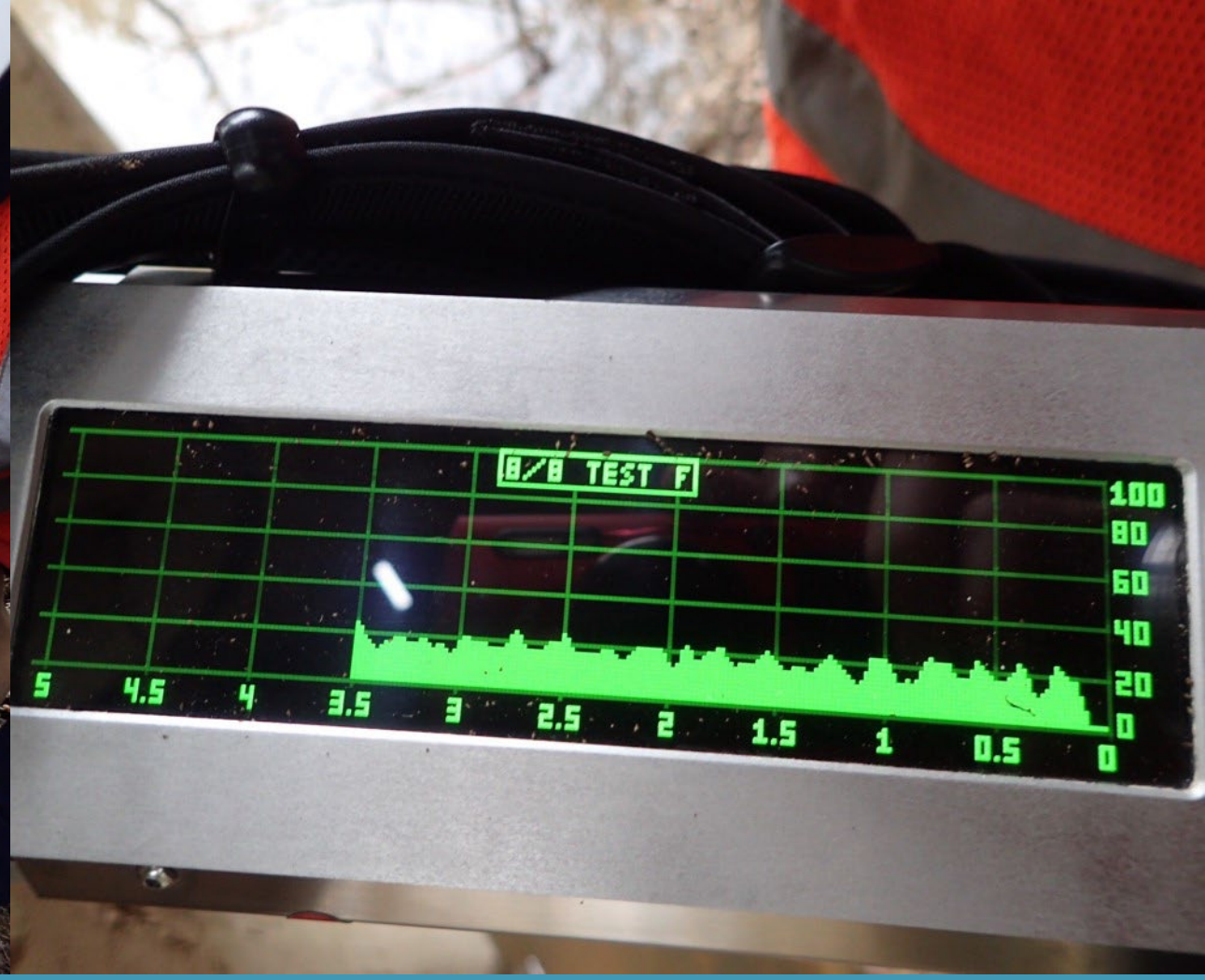
Drone Aerial Photogrammetry

Savannah Convention Center Bulkhead Inspection/Repair Design

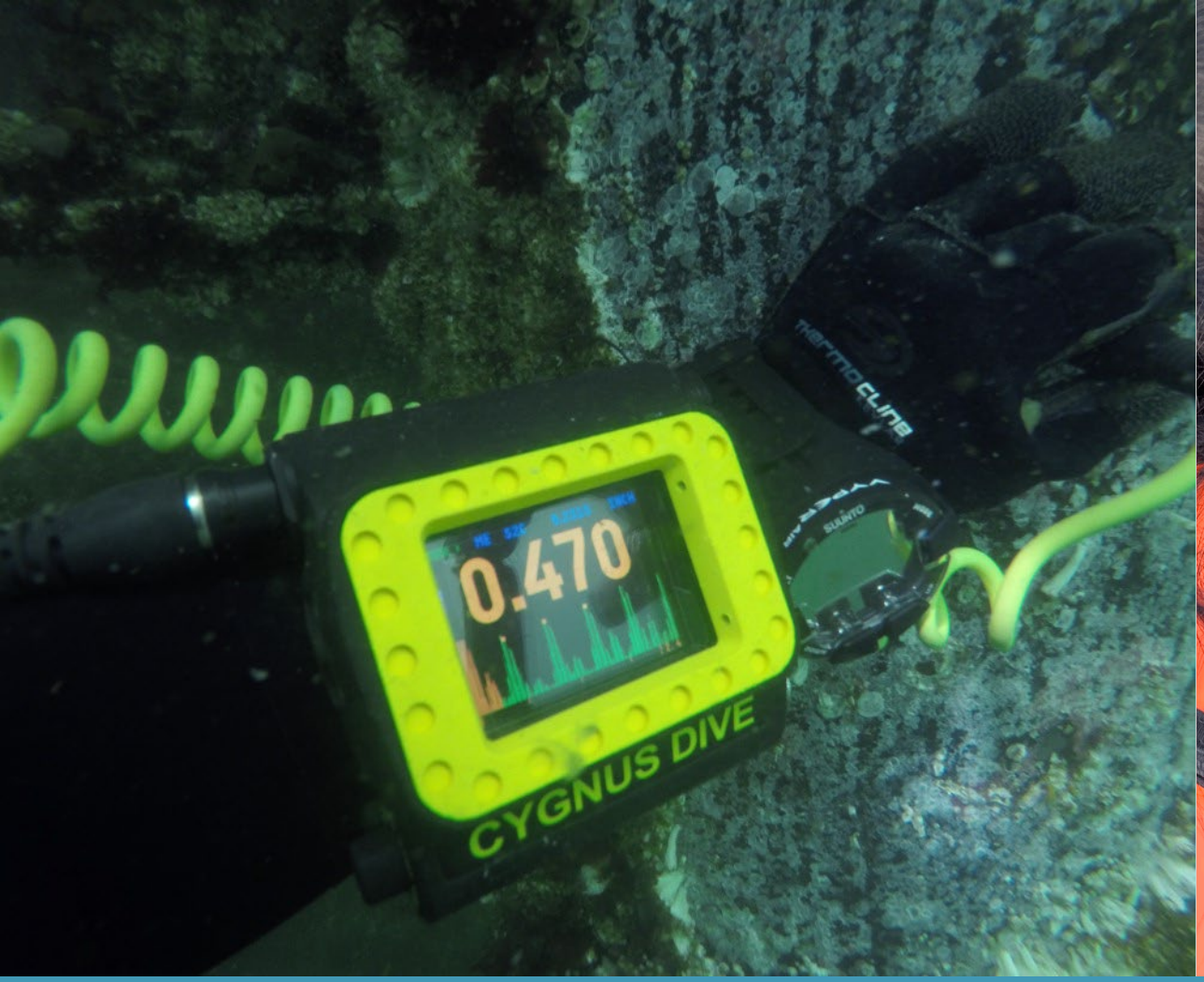
Underwater Acoustic Imaging + LiDAR



Underwater Acoustic Imaging + LiDAR



Timber Resistance Drill

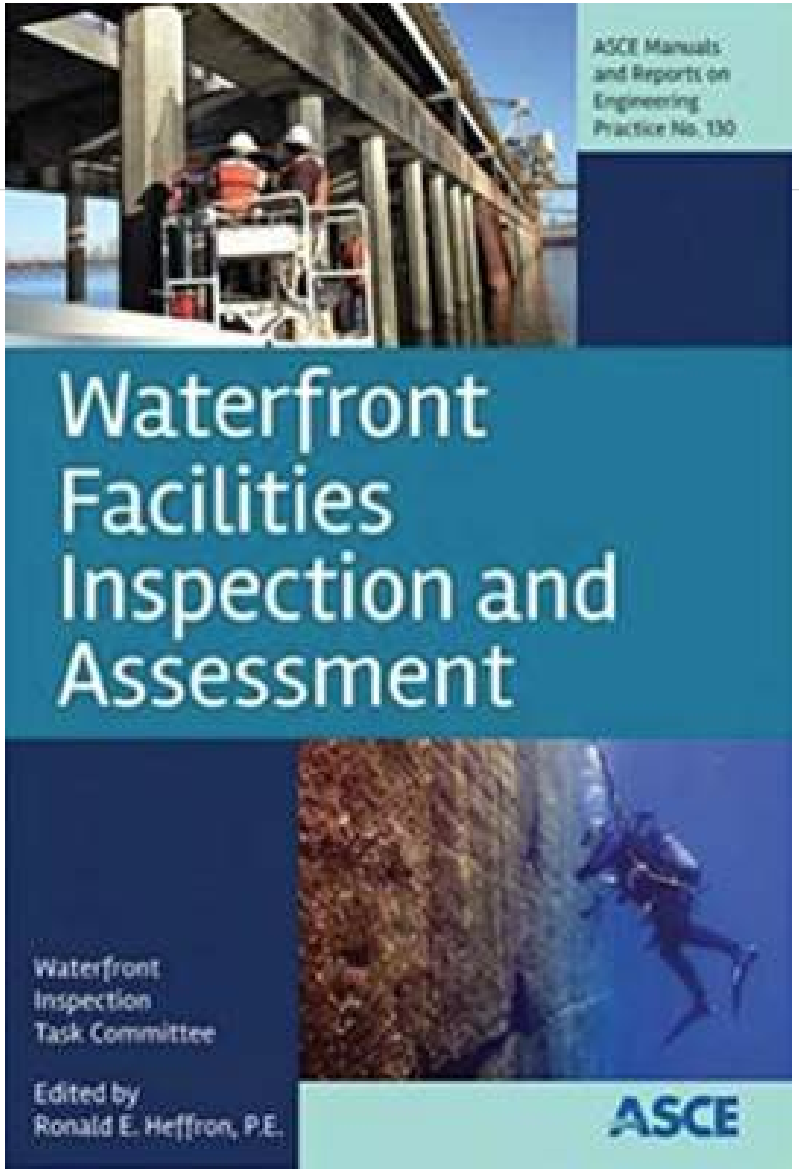


Ultrasonic Thickness Gauge

ASCE Manual 130

New Version Avail. Aug 2025

Co-Authored by Bill Dubbs



PIANC WG-233

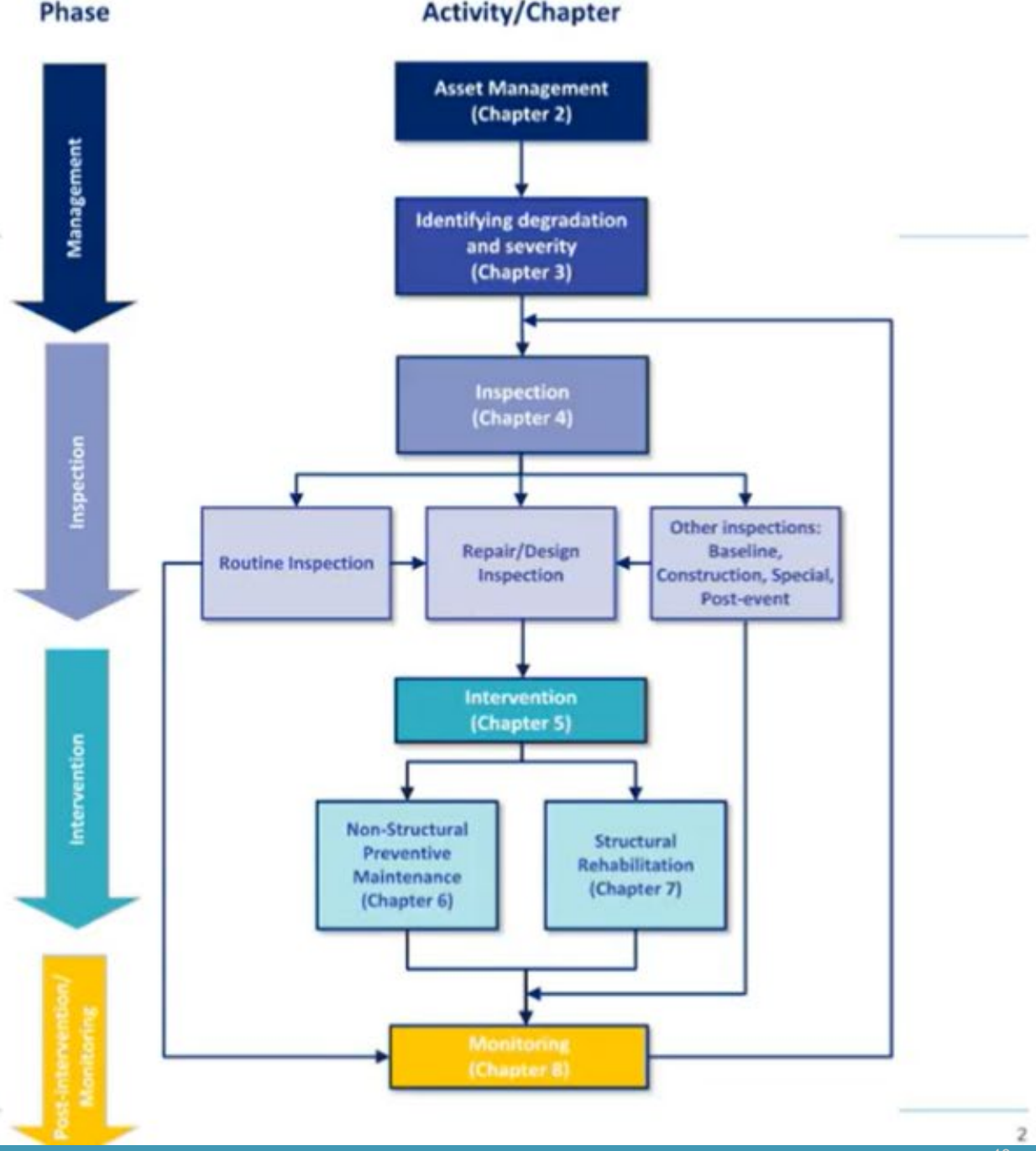
“Inspection, Maintenance & Repair of Waterfront Facilities”

To be released Q4 2025

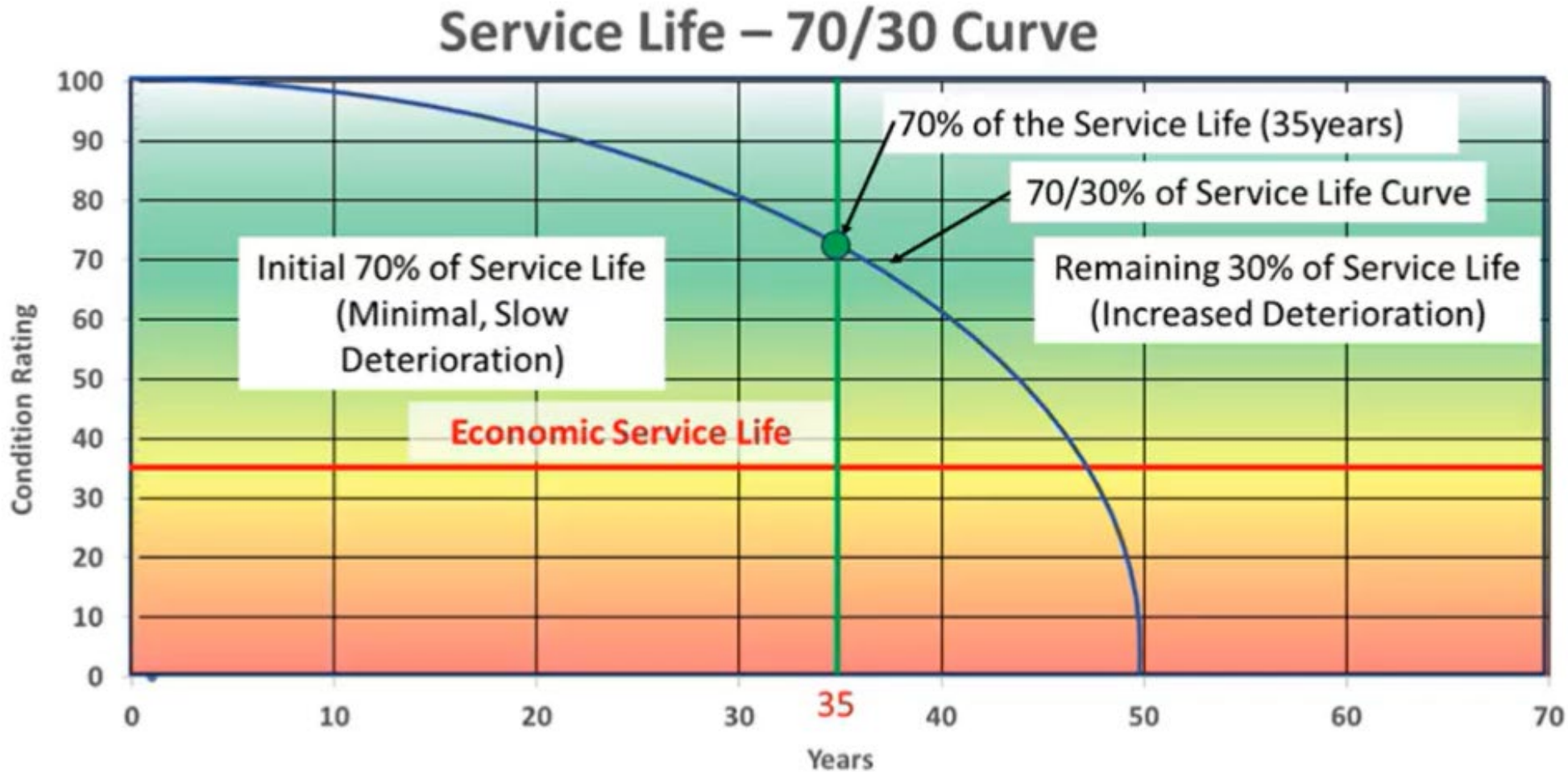
PIANC
The World Association for Waterborne Transport Infrastructure

MANUAL OVERVIEW

- 1 - Scope & Introduction
- 2 - Asset Management
- 3 - Degradation
- 4 - Inspection
- 5 – Intervention
- 6 - Maintenance / Preservation
- 7 - Repair / Rehabilitation
- 8 - Monitoring



SERVICE LIFE



Relationships – Stakeholders & Consultants

“Won’t You Be My Neighbor?”

Inspection & Rehabilitation =

Continuous involvement with engineering teams

Inspection & Rehabilitation =

Relationships built around trust

Port of San Diego, CA – Exemplary Facility Care

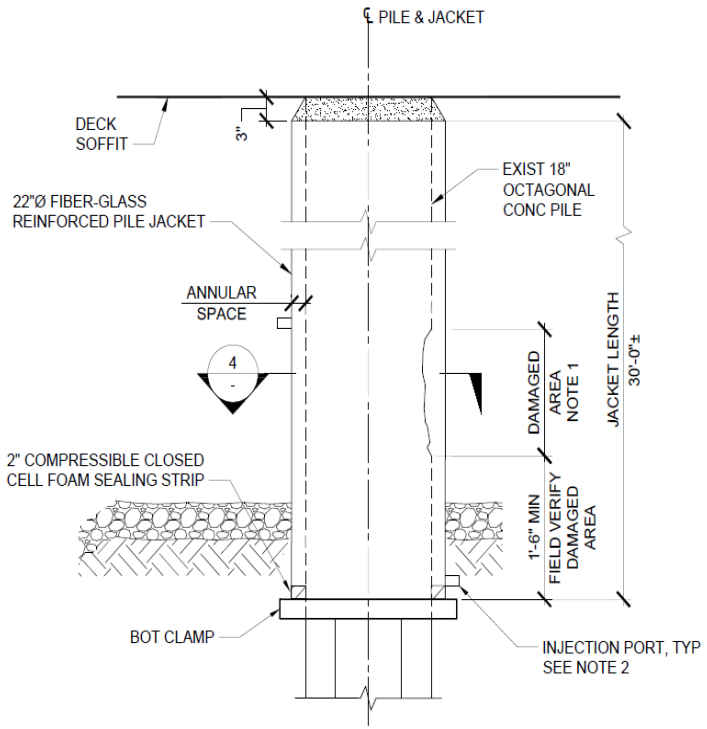
NCMT, Port of San Diego, CA

Berth 24-11 Inspection and Rehabilitation –

2006, 2013, 2018 Marine Terminal Inspections Berth 24-11

NCMT, Port of San Diego, CA

2006, 2013, 2018 Marine Terminal Inspections Berth 24-11



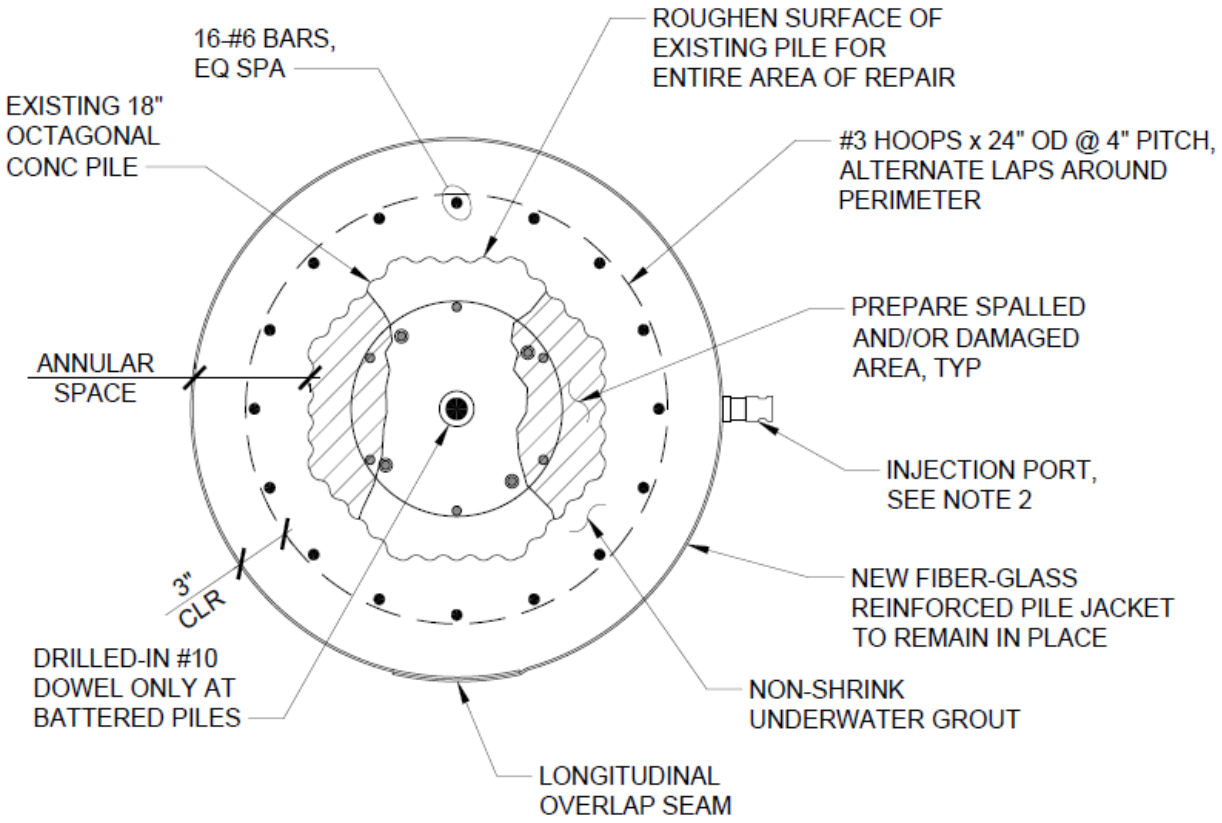
1 / S-2.2 — **DETAIL - DURABILITY JACKET AT PLUMB PILE**

SCALE: 1"=1'-0"

S-2.3

NOTES:

1. DAMAGED AREA HAS A VERTICAL CRACK OR STAIN AND IS ORIENTED AT MORE THAN 60° FROM HORIZONTAL
2. PROVIDE INJECTION PORTS, PER JACKET SYSTEM MANUFACTURER'S RECOMMENDATIONS

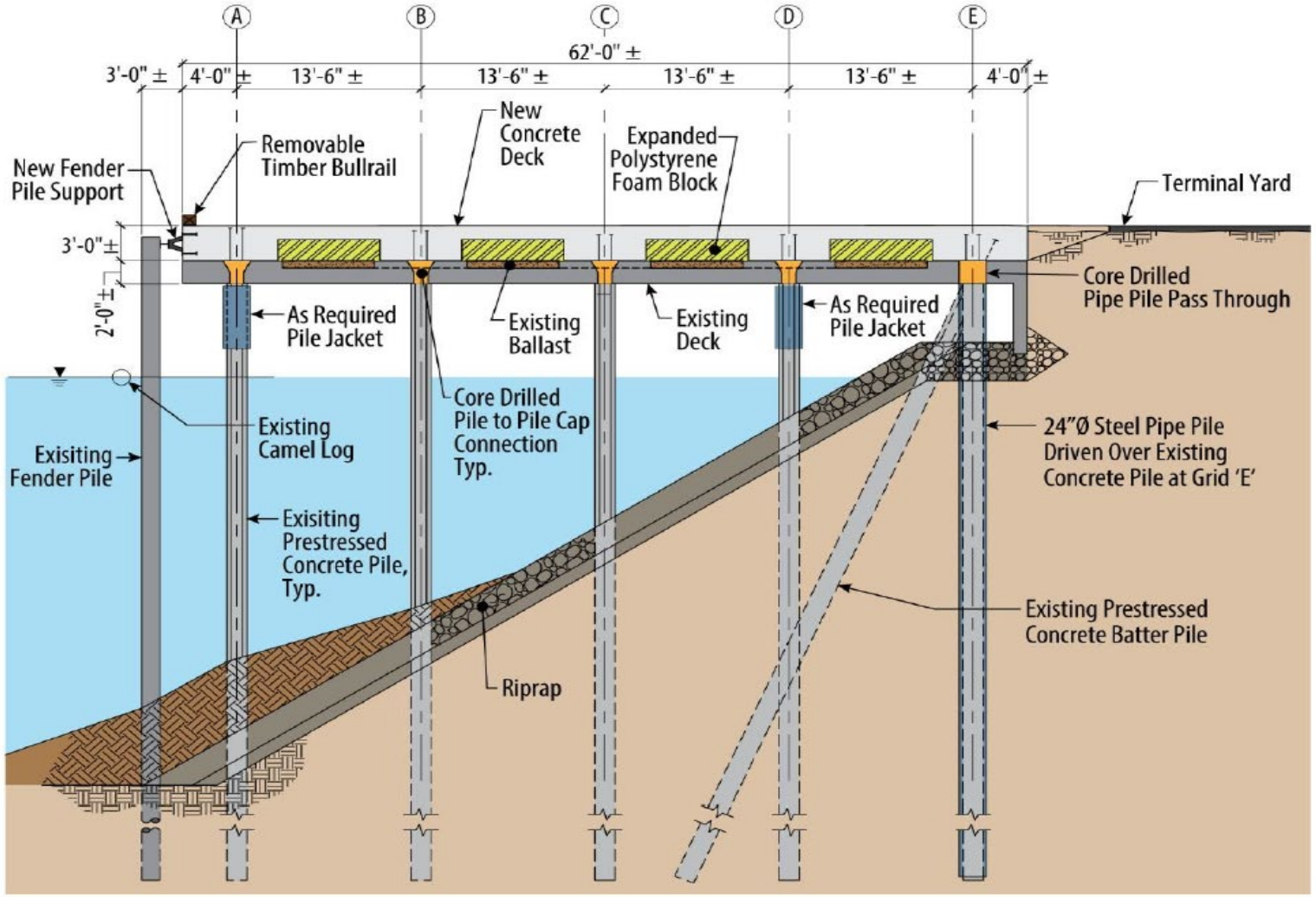


5 / - — **SECTION - STRUCTURAL JACKET**

SCALE: 1 1/2" = 1'-0"

NCMT, Port of San Diego, CA

Berth 24-11 – Pile repairs – preservation vs. structural rehabilitation



NCMT, Port of San Diego, CA

Berth 24-11 – New Deck on top of Old Deck

NCMT, Port of San Diego, CA

Berth 24-10 -> 24-11

- Retrofitting/Strengthening as follows:
  - Repairs aim to rectify the observed damage and restore the structure's capacity to its pre-damage strength.
  - Rehabilitation is the term used when the structure's capacity is increased up to its original design strength. We also want to mitigate any introduced degradation mechanisms. Repair with service life.
  - Retrofitting / Strengthening refers to enhancing the structure's strength to the present code level or for adaptation to new uses.

Repair vs. Rehabilitation

Engineering the Decision for Rehabilitation
25 More Years, Please

- Design Level Inspections
- Options – Decision Tree
- Cost/Benefit Matrix
- Special Inspections (Material Testing)
- Design of Repairs

25 Yr Service Life Extension				
Action Option	Cost Year One	Life Cycle Cost	Service Life (Yrs)	Notes
Do Nothing	0	0	7	Load restrictions
As-Needed Repairs	3M	11M	25	Possible capacity reduction
Coatings	2M	9M	25	Load restrictions
Cathodic Protection	3M	7M	25	Load restrictions
Rehabilitation	9M	12M	25	Restore design capacity
Replacement	34M	45M	100	Any capacity

Rehabilitation – Step 1

- Existing Record Drawings?
  - If no, may call for LiDAR mated with Multi-Beam for digital twin 3D model
- Design-Level Inspections
  - Verify existing drawings or twinned model
  - Needed field information, dependent upon selected course of action
- Berth depth vs. draft requirements
  - Dredging required?
- Identify operational requirements
  - Current and/or future tenant purpose

Rehabilitation – Step 2

- Special Inspections (Material Testing)
  - Why special inspections? Know where we're coming from.
    - Establish environmental factors
      - Salinity, Ice, Temp, Erosion, etc.
    - Identify construction particulars
      - Aggregate sources, local construction practices, curing conditions, etc.
  - Sampling
    - Engineer an appropriate sampling program
      - sample sizes, sample locations
  - Testing
    - Mate the testing with the sampling
      - number of tests
      - types of tests
        - Petrographic
        - Chloride ion profiles

Guam

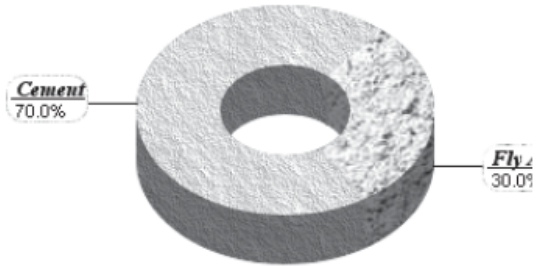
Concrete Cores for Laboratory Testing

Cope Wall - 4x8 Mix C_9-27-12 Pour_(AF @ .25)

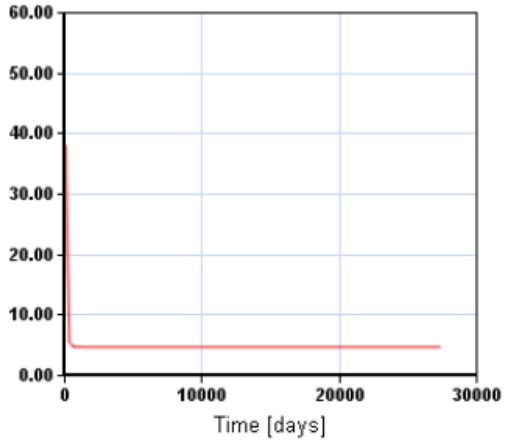
Structure Type: Marine
Structural Element Type: [Cope Wall]
Material Name:
[Modified Material - for Cope Wall - 4x8 Mix C_9-27-12 Pour_(AF @ .25)]

Cement Type	TYPE I/II
Water/Binder Ratio	0.32
Cement Content: (lb/yd³)	536
SCM #1: Fly Ash F (lb/yd³)	229
SCM #2: None (lb/yd³)	0
SCM #3: None (lb/yd³)	0
Fine Aggregates: (lb/yd³)	1340
Coarse Aggregates: (lb/yd³)	1495
Water: (lb/yd³)	245
Air: [%]	5.0
Material Density: (lb/ft³)	142
Mixture Volume: (ft³)	26.803
Paste Volume: [%]	29.89

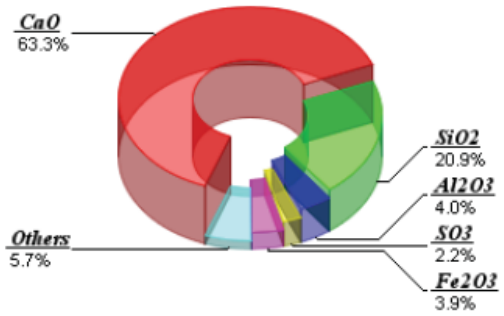
Binder Composition



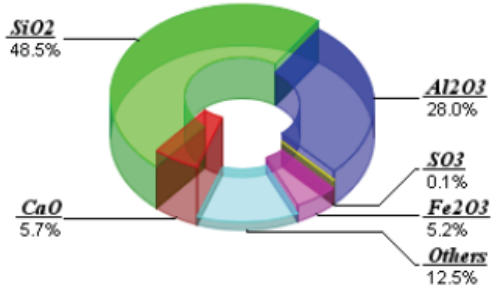
Diffusion Coefficient (e-11 m²/s)- a=.25 - alpha=5.70E



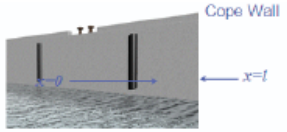
Cement Composition



Fly Ash F Composition



Data for project: Guam-UT Wharf 75-1008T - Structural element [Cope Wall - 4x8 Mix C_9-27-12 Pour_(AF @ .25)]

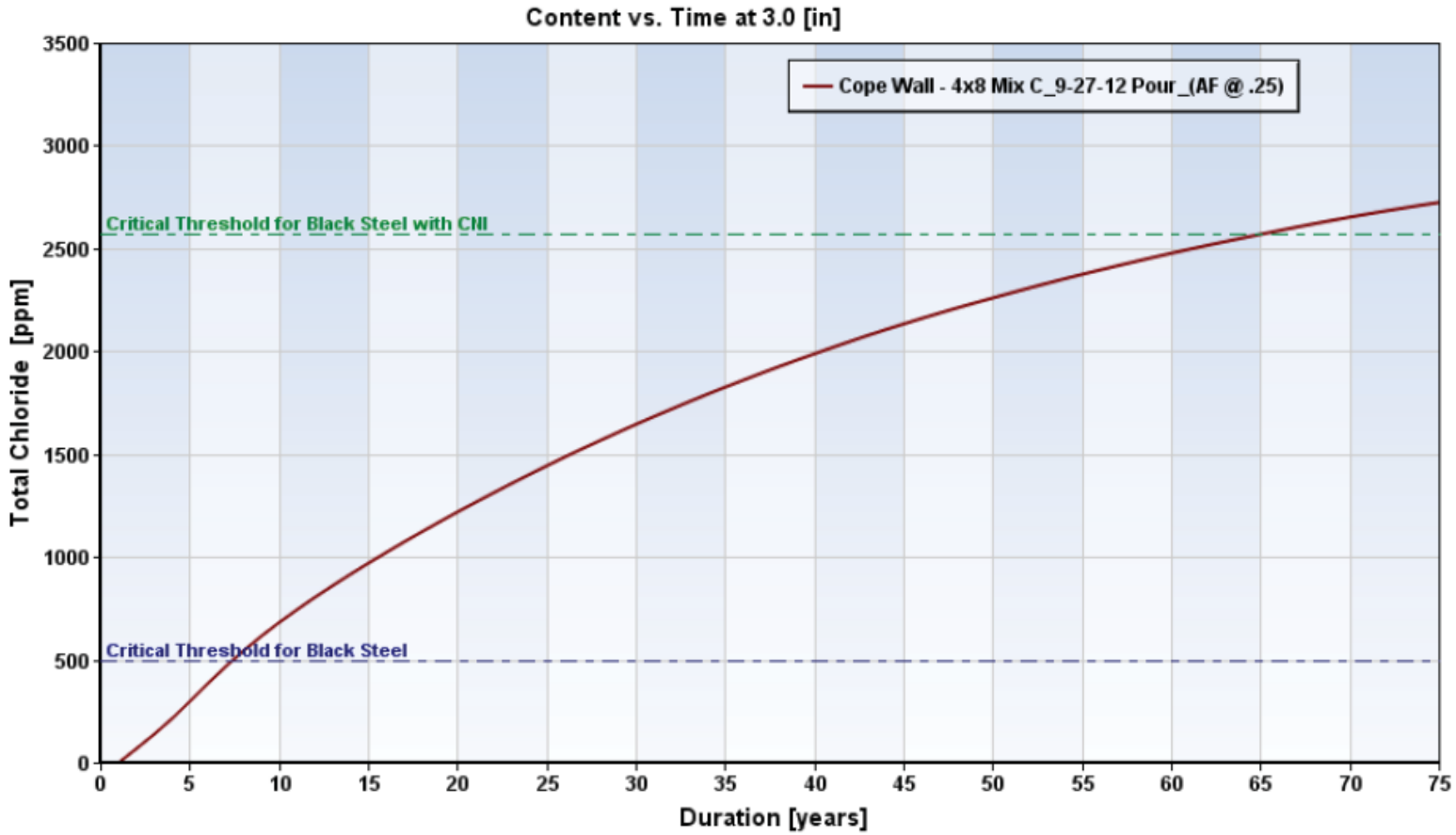


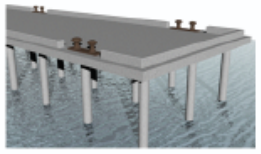
Dimension (in) = 8.
Scenario Duration (years) = 75
Temperature (°F) = 73.4
Water/Binder Ratio = 0.32
Binder Content (lb/yd³) = 765
Total Aggregates (lb/yd³) = 2835
Binder Density (lb/yd³) = 4981
Porosity = 0.135
Cement Type = TYPE I/II

OH- Diffusion Coeff. (e-11 m²/s)= 18.30
Saturation at 50% R.H.= 0.58
Age of First Exposure (days)= 28
Age at Lab Testing (days)= 28
Hydration Param. - a = 0.25
Hydration Param. - alpha (1/s) = 5.700E-03
Thermal Conductivity (W/m.K) = 2.000E+00
Specific Heat (J/kg/K) = 1.000E+03

STADIUM® VERSION 2.997

Material Science – STADIUM Modeling





Marine - Data for Project : Guam-UT Wharf 75-1008T
Compared Simulations for:

Cope Wall - 4x8 Mix A	Cope Wall - 4x8 Mix C_9-27-12 Pour_(AF @ .25)
Cope Wall - Wall Mix A	Cope Wall - 4x8 Mix C_10-6-12 Pour_(AF @ .25)
Cope Wall - Slab Mix A	Cope Wall - 4x8 Mix A_7-19-12 Pour_10 (a @ .25)
Cope Wall - 4x8 Mix A_7-19-12 Pour_(AF @ .27)	Cope Wall - 4x8 Mix C_9-27-12 Pour_(AF @ .27)
Cope Wall - 4x8 Mix A (0.1 AF Fe Cl)	Cope Wall - 4x8 Mix C_10-6-12 Pour_(AF @ .27)
Cope Wall - 4x8 Mix A_7-19-12 Pour_10 (a @ .25)	Cope Wall - 4x8 Mix A_7-19-12 Pour_10 (a @ .25)

STADIUM®

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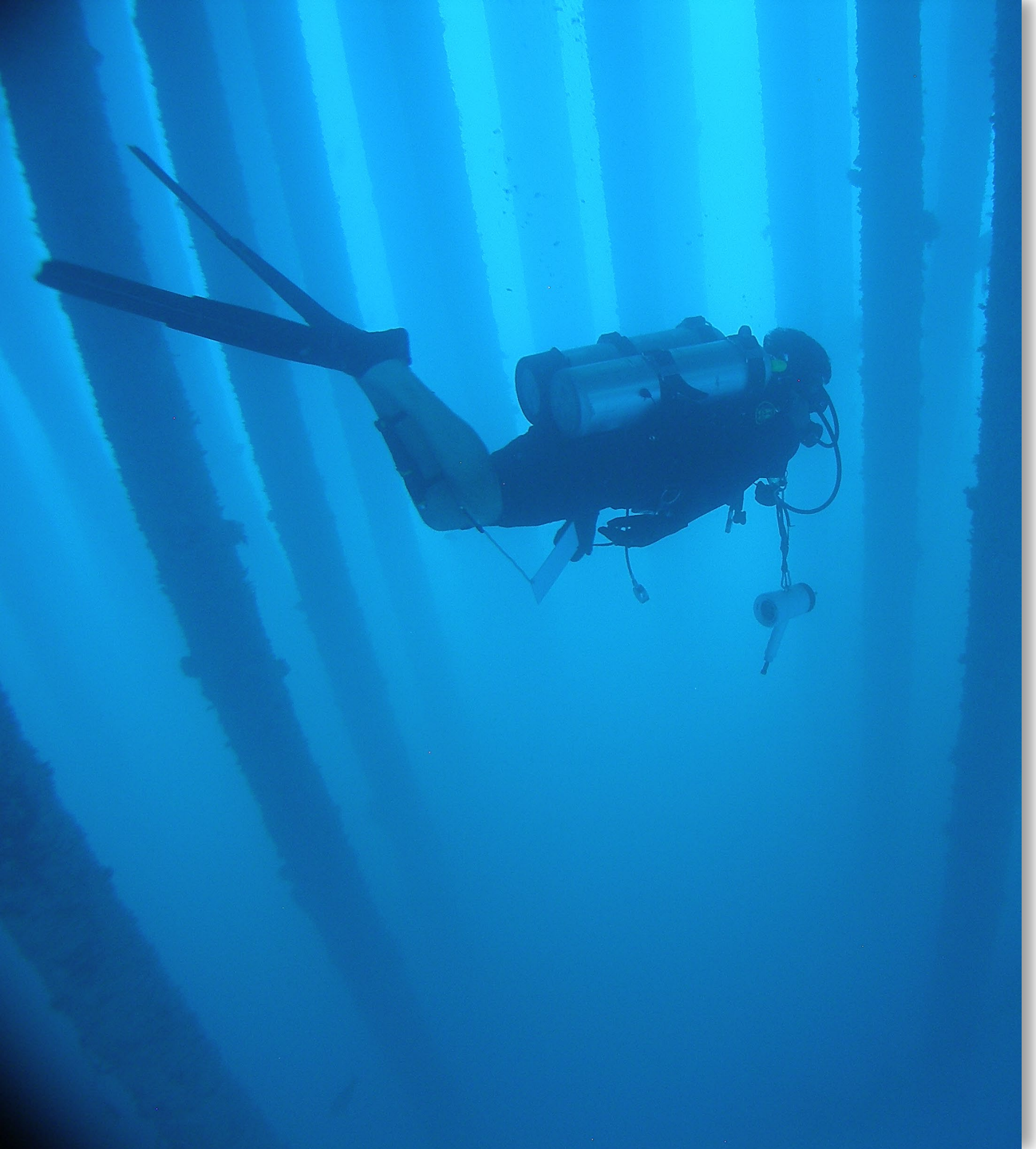
Material Science – STADIUM Modeling

Rehabilitation – Or Preservation?

- Design
  - Preservation – As-Is…As Needed
    - Coatings
    - Sealers
    - Barriers
      - Wraps
      - Encasements
      - Non-structural jackets
    - Cathodic protection systems
  - Rehabilitation - Restore
    - Patch and repair
    - Structural jackets
    - Strengthening
    - Replacement

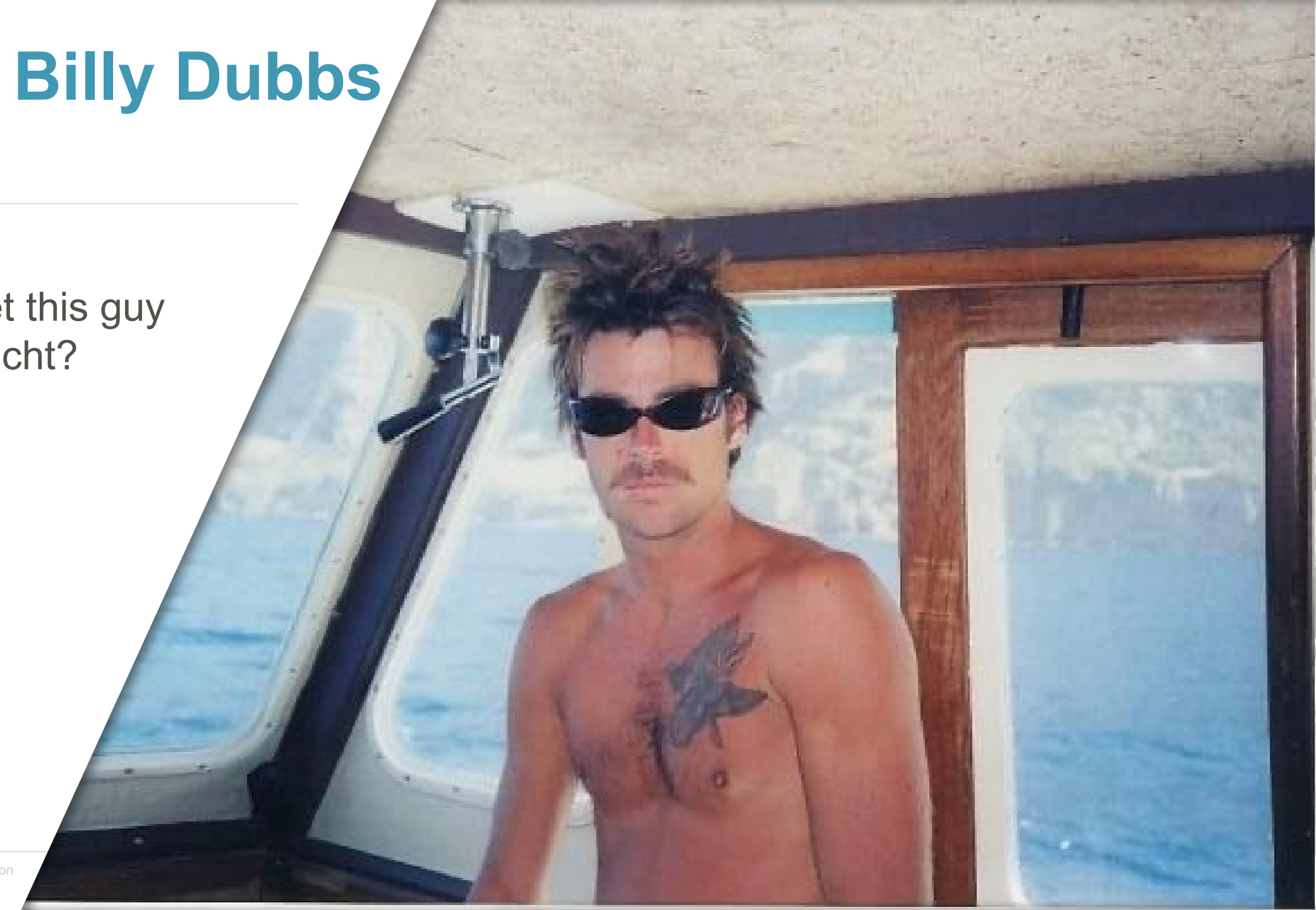


Take Aways

- Benefits of Inspection & Rehabilitation Expertise
- Incorporating Inspection Data into Strategic Asset Management Plans
- Understanding Service Life vs. CapEx Budgets
- Maximizing ROI on Existing Infrastructure
- What should you do? Who should you call?

Captain Billy Dubbs

- Circa 1995
- Would you let this guy drive your yacht?



Questions?

Contact:
Bill Dubbs, PE
bdubbs@moffattnichol.com

moffatt & nichol