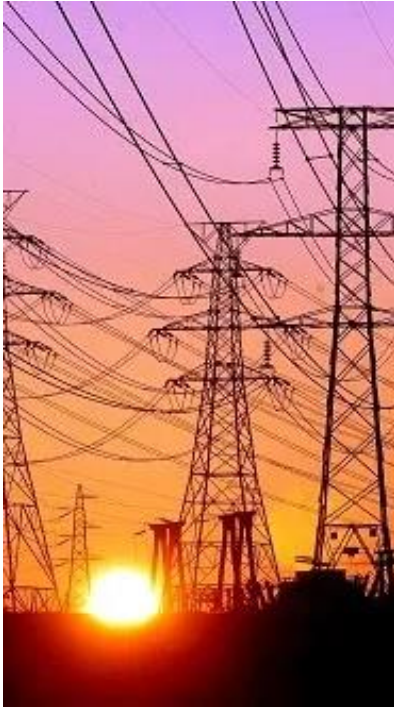




Port Sustainability and Infrastructure Resilience

Konrad Mech, PMP, P.Eng.(non-practicing)
Kongsberg Discovery Canada Ltd.
August 14th, 2024

Critical Civil Infrastructure



Infrastructure is defined as critical if its incapacity or destruction has a significant impact on health, safety, security, economics, and social well-being of a state (Council directive 2008)

Why Should We Care?

High levels of uncertainty

Aging infrastructure/limited investment

Natural and manmade disasters have become more frequent

Infrastructure designed now will last 25-50 years – WILL INEVITABLY be subjected to unknown/unknowable design hazards

Risk vs. Resilience

Resilience & risk are not synonymous but can work together.

Resilience

- Focus is on maintaining performance even as losses occur

Risk

- Focus is on likelihood of experiencing loss (and mitigating the risk)

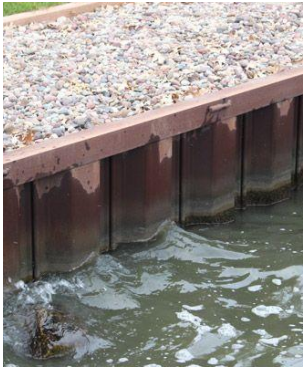
In the news -

The Port of Baltimore shipping channel has fully reopened, 11 weeks after the Francis Scott Key Bridge collapsed when it was struck by a cargo ship.



Coastal Infrastructure

Seawall



Prevents or alleviates overtopping and flooding of the land structures behind due to storm surges and waves

Breakwater



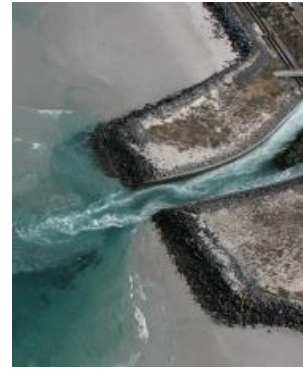
Reduces incoming wave energy, provides a sheltered beach area and shelters vessels from waves and currents

Bridge



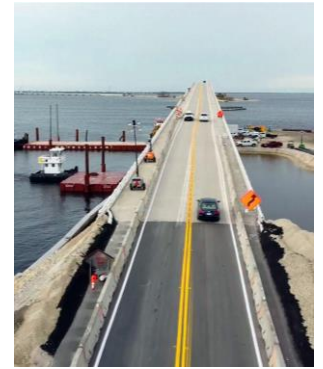
Provides transportation connectivity to safely cross features such as waterways, railways, roadways, and other obstacles

Outfall



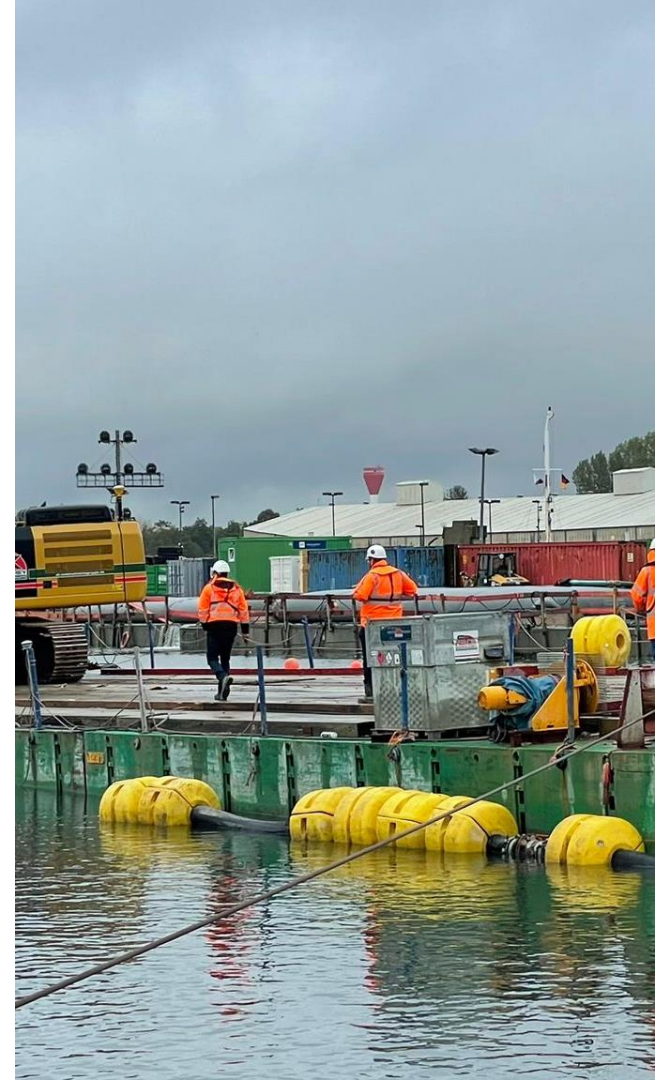
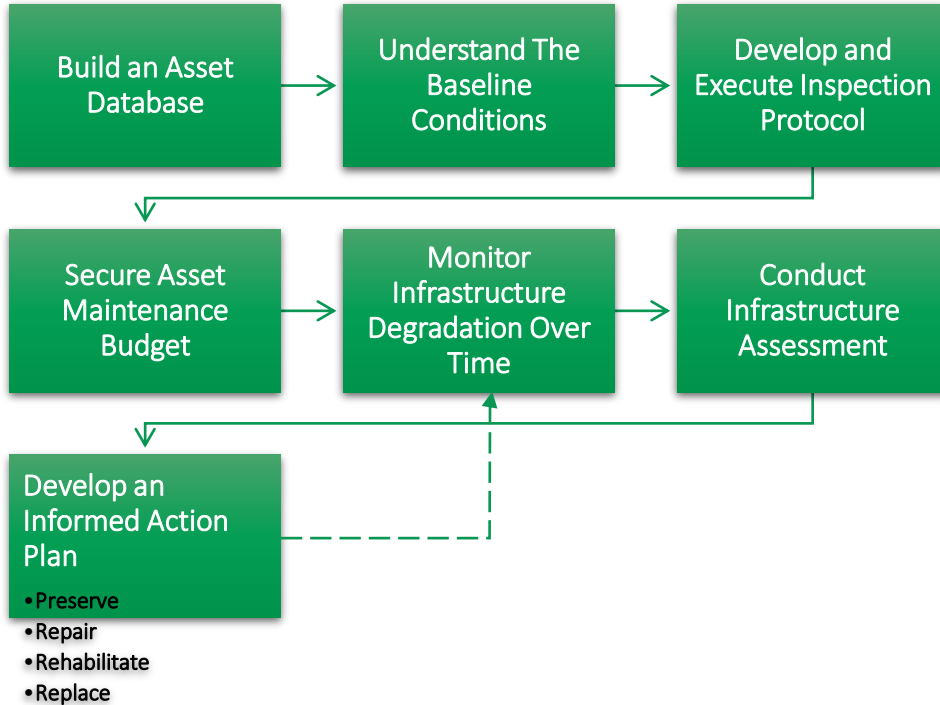
Discharges municipal or industrial wastewater, stormwater, combined sewer overflows (CSOs) into receiving water body

Causeway



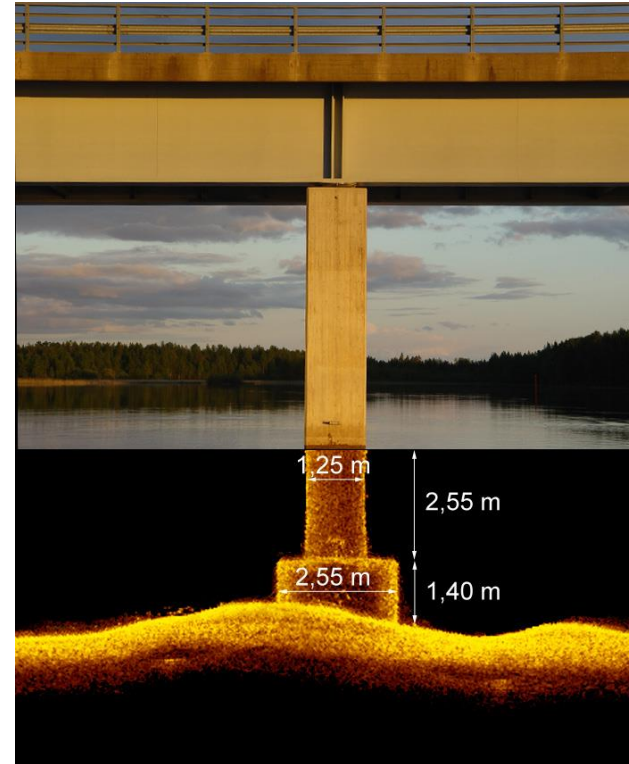
Raises roadway that is often used to cross wetlands or bodies of water

The Needs of Civil Engineering Asset Management



Inspections for underwater structures

- Need for inspection
 - Waterfront structures are ageing
 - Reduce vulnerabilities in critical infrastructure systems
 - Post-damage assessment
- Challenges with traditional / diving inspections
 - High current
 - Low visibility
 - Large areas
 - Accurate reports



The Needs of Civil Engineering Asset Management

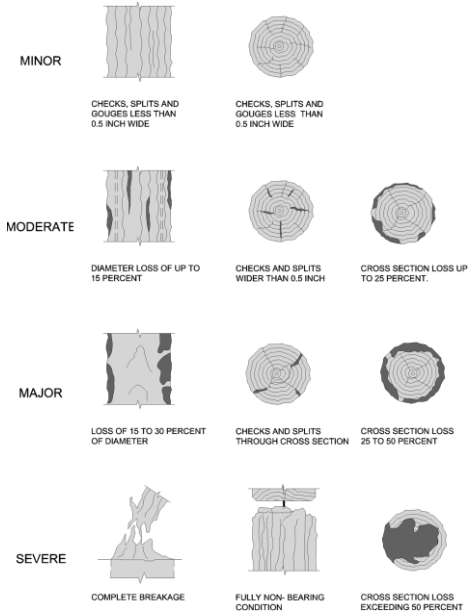


Fig. 2-2. Condition ratings for timber elements
Source: Courtesy of CH2M HILL, Inc. and Ben C. Gerwick, Inc., reproduced with permission.

See Statement of Proprietary information

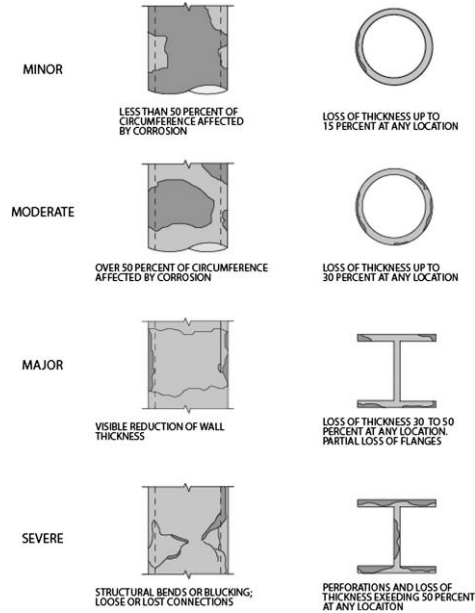


Fig. 2-3. Damage ratings for steel elements
Source: Courtesy of CH2M HILL, Inc. and COWI, Inc., reproduced with permission.

The Needs of Civil Engineering Asset Management

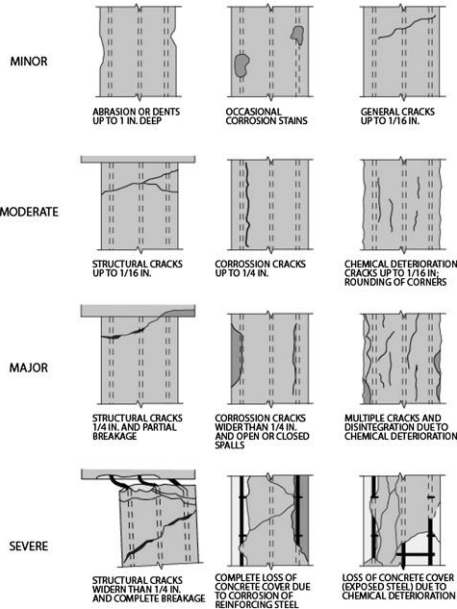


Fig. 2-4. Damage ratings for reinforced concrete elements
Source: Courtesy of CH2M HILL, Inc. and COWI, Inc., reproduced with permission.

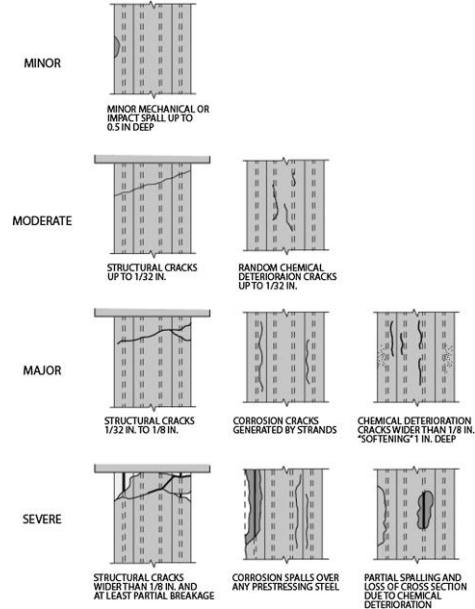


Fig. 2-5. Damage ratings for prestressed concrete elements
Source: Courtesy of CH2M HILL, Inc. and COWI, Inc., reproduced with permission.

The Needs of Civil Engineering Asset Management



Fig. B-9. Reinforced concrete pile with loss of section below the high tide level
Source: Courtesy of Marine Solutions, Inc., reproduced with permission.

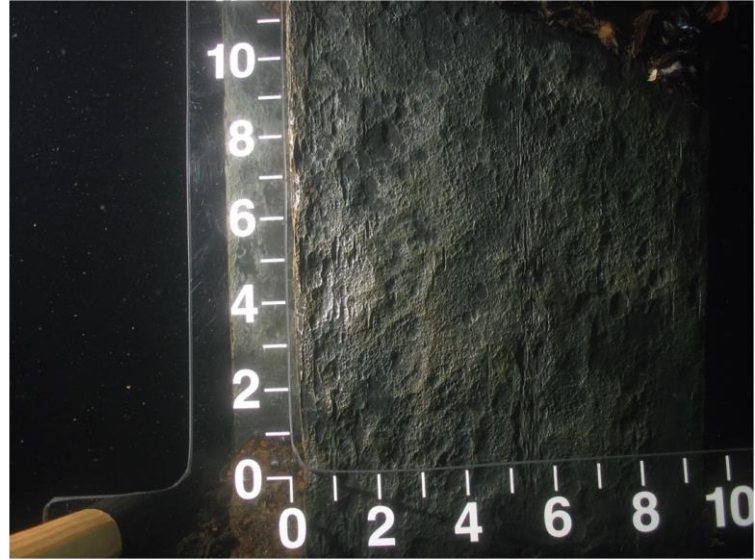


Fig. B-16. Underwater photograph of pitting on a steel pile
Source: Courtesy of Appledore Marine Engineering, Inc., reproduced with permission.

The Needs of Civil Engineering Asset Management

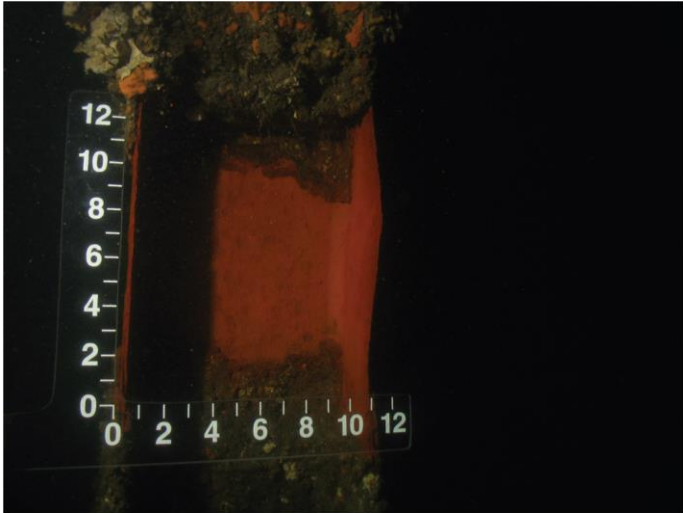
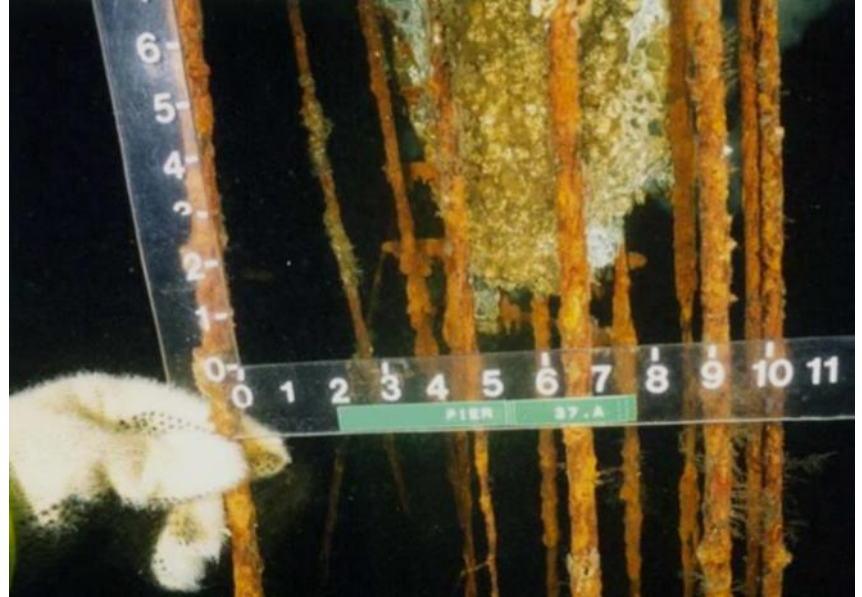


Fig. B-17. Severe corrosion and “knife edging” of a steel H-pile
Source: Courtesy of Appledore Marine Engineering, Inc., reproduced with permission.



Fig. B-20. Underwater photograph showing hollowing of the interior of a timber pile from Teredo
Source: Courtesy of Marine Solutions, Inc., reproduced with permission.

The Needs of Civil Engineering Asset Management

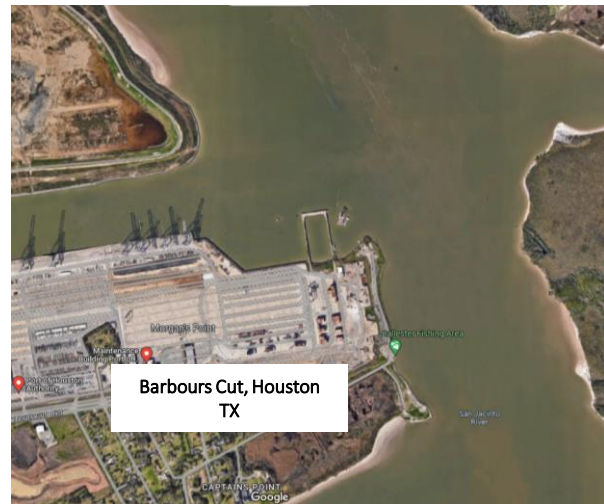


ASCE Port Operations and Maintenance Course – Masonry and Cyclopean Walls

The Needs of Civil Engineering Asset Management

Engineers deliver technical reports with data, for non-engineers to make financial decisions

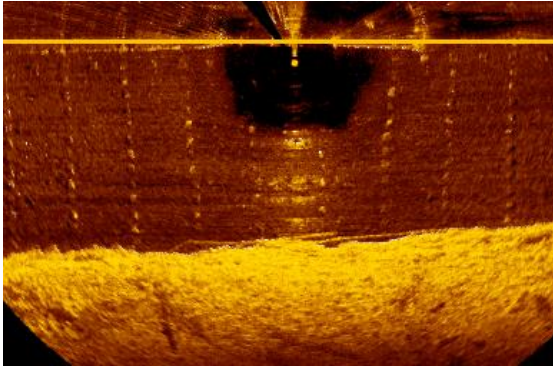




*Single Beam Scanning Sonar Data courtesy of Brian Abbott

Coastal/Underwater Infrastructure Building Materials

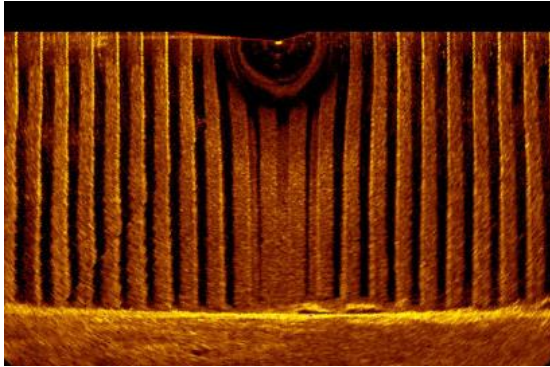
Wood



Wood Timber Wall



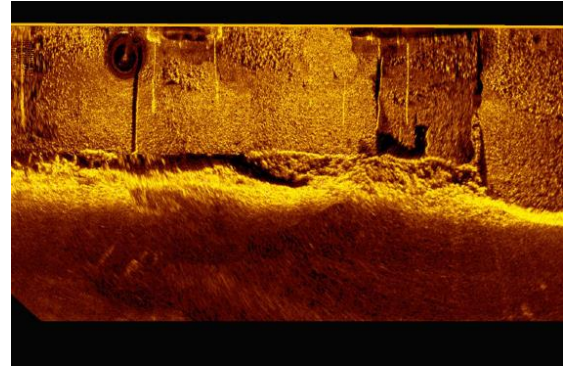
Steel



Sheet Pile Wall



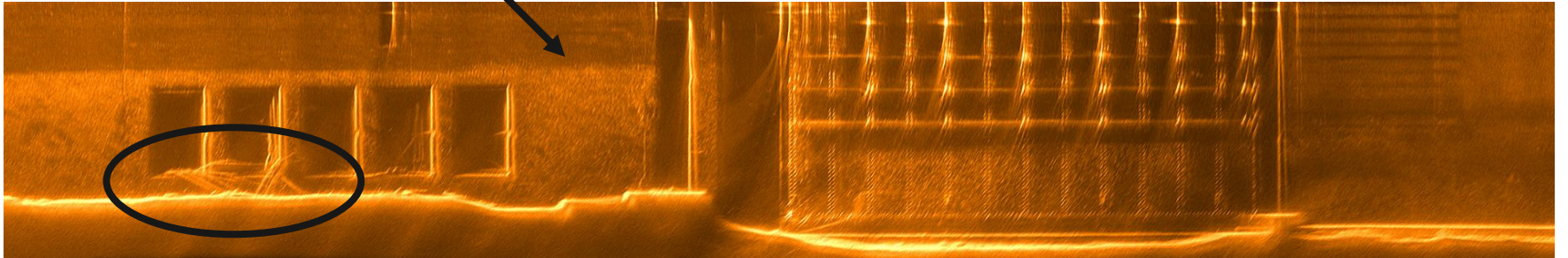
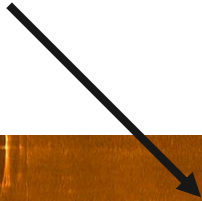
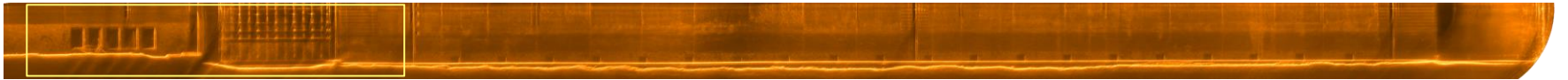
Concrete



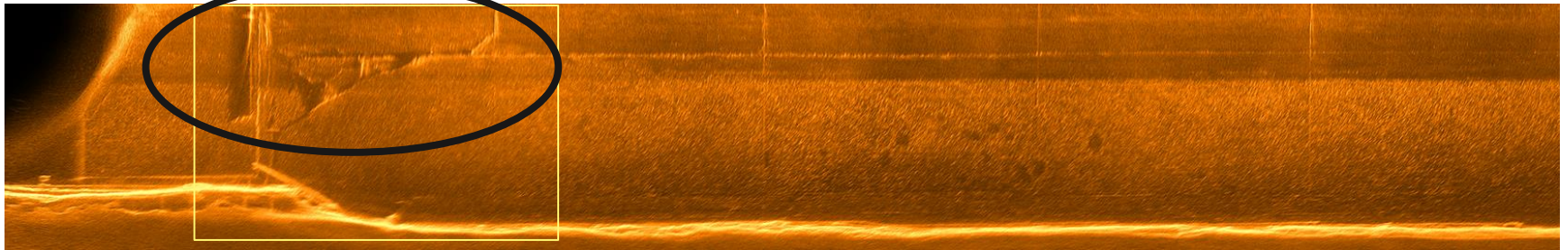
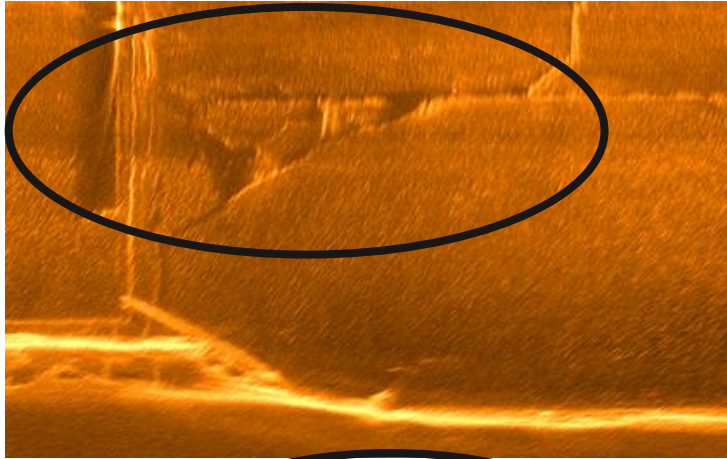
Concrete Wall



Lock Infrastructure Inspection

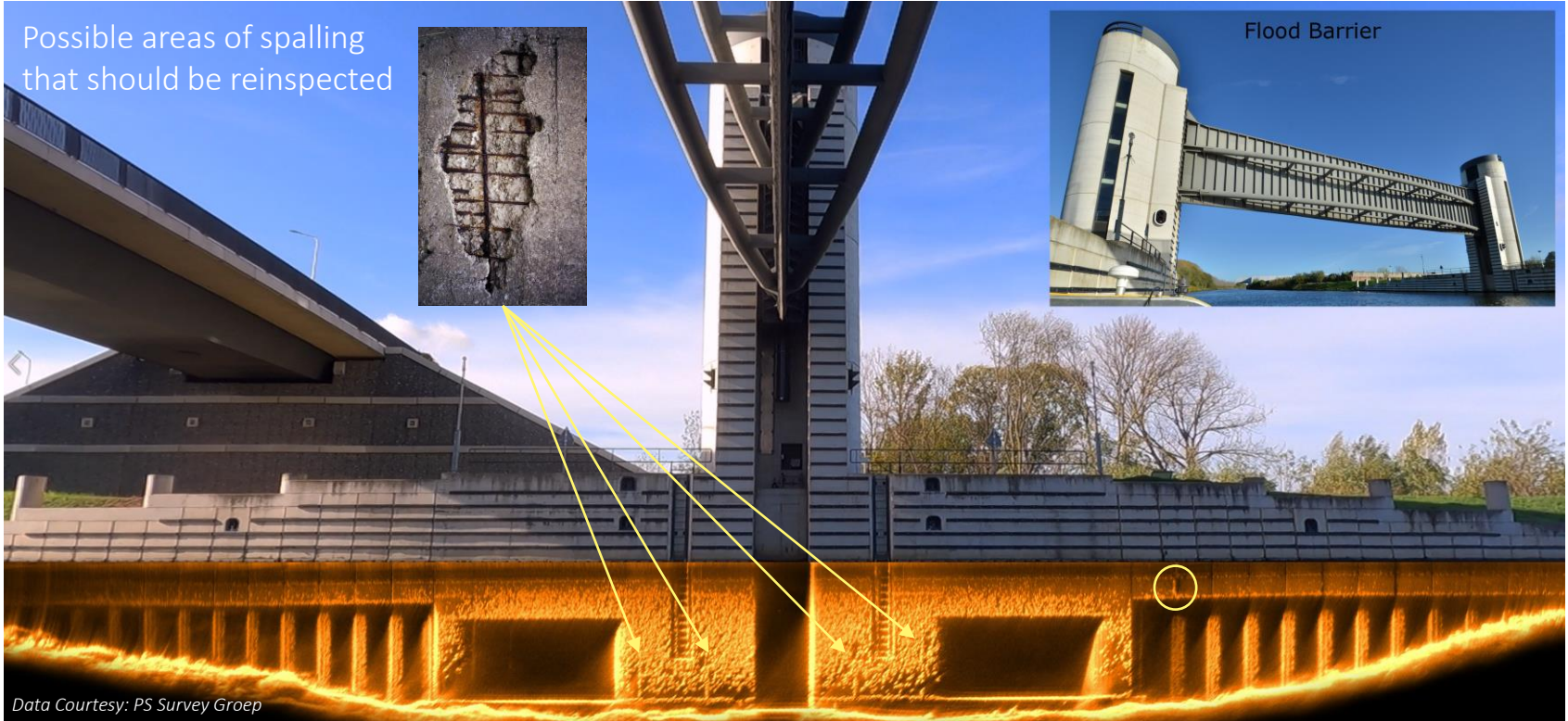


Ship Strike Damage Inspection



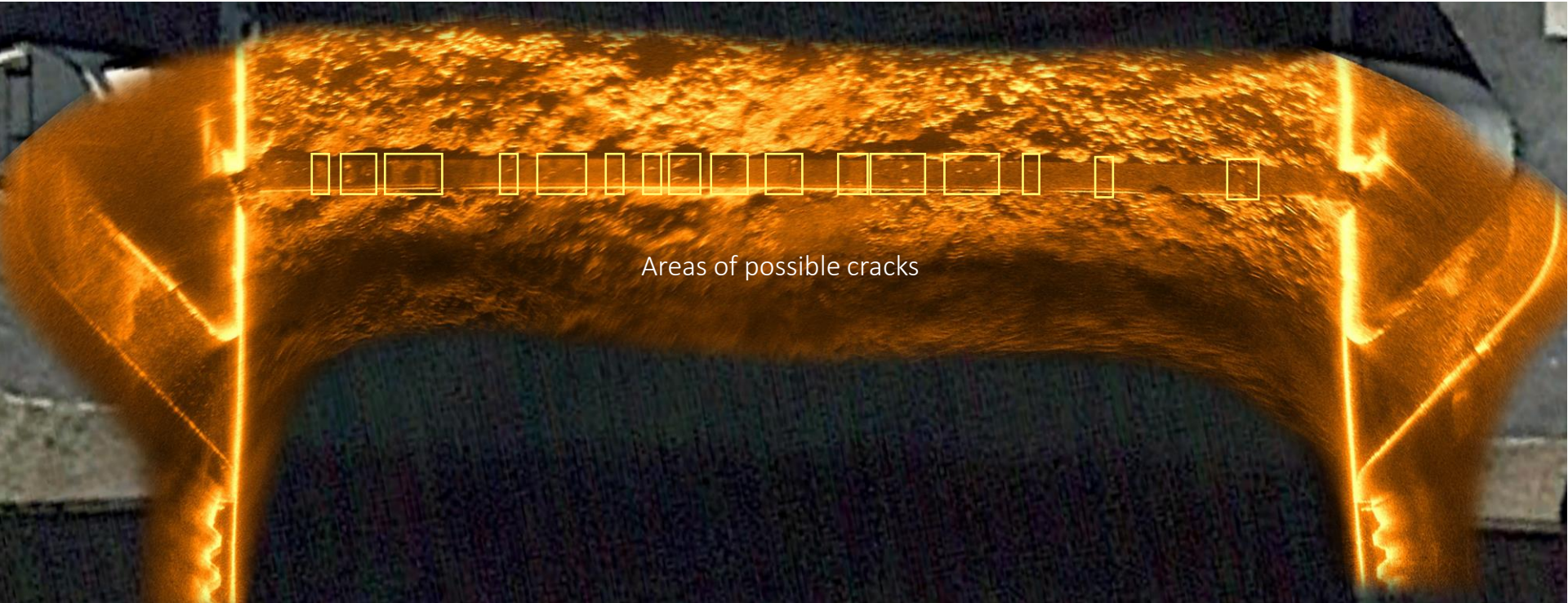
Flood Barrier Inspection

Possible areas of spalling that should be reinspected



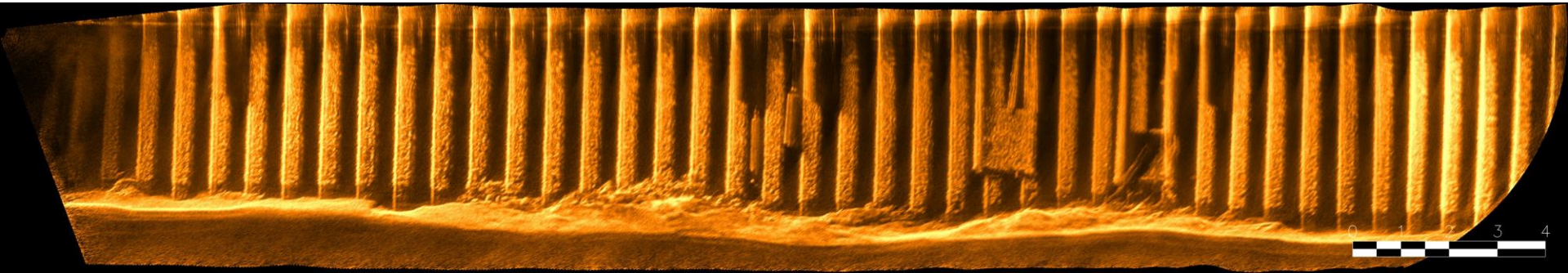
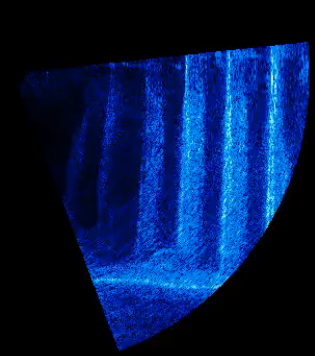
Data Courtesy: PS Survey Groep

Flood Barrier Inspection

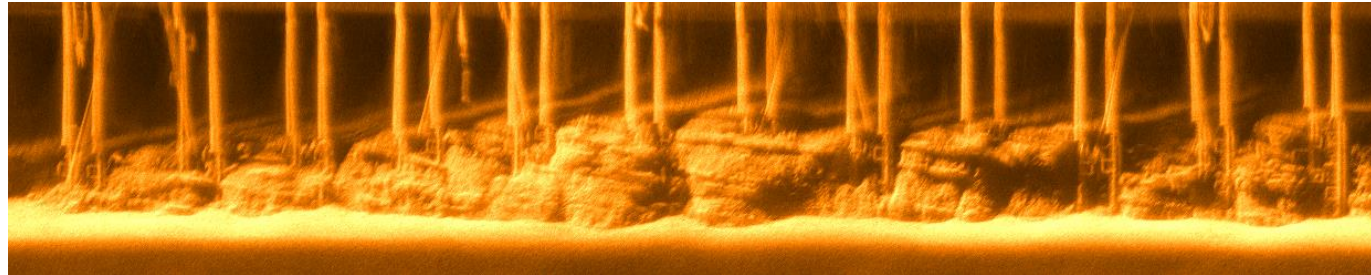
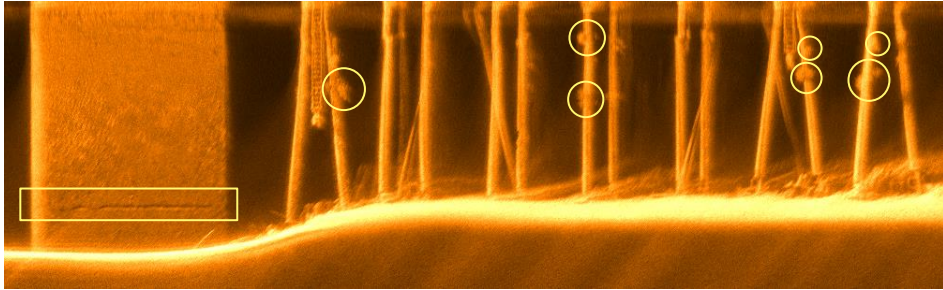
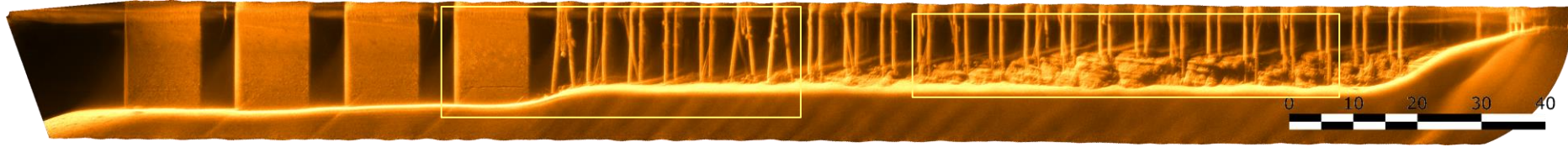


Areas of possible cracks

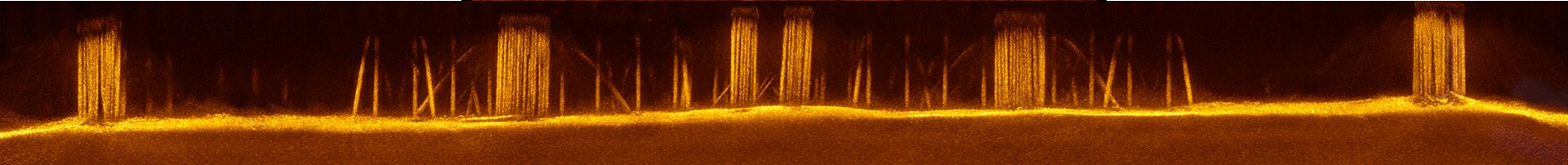
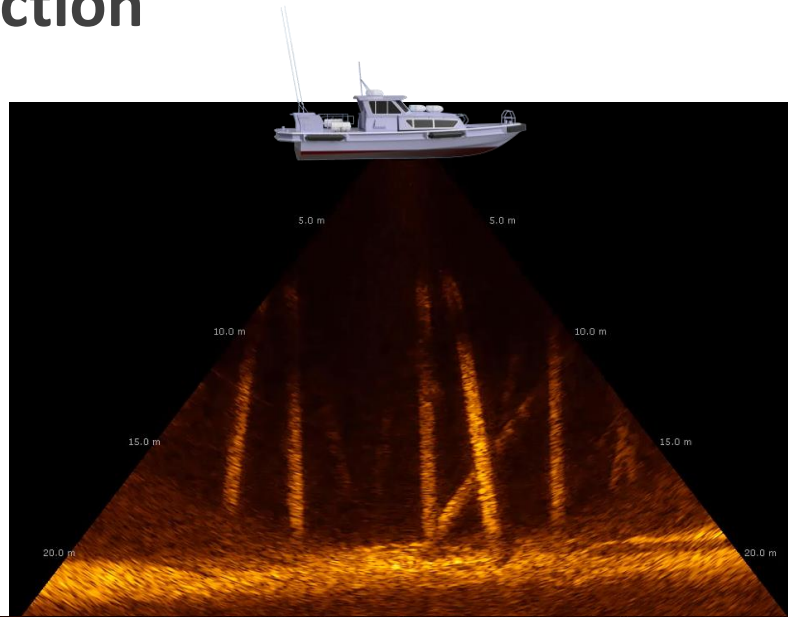
Metal Sheet Pile Wall Inspection



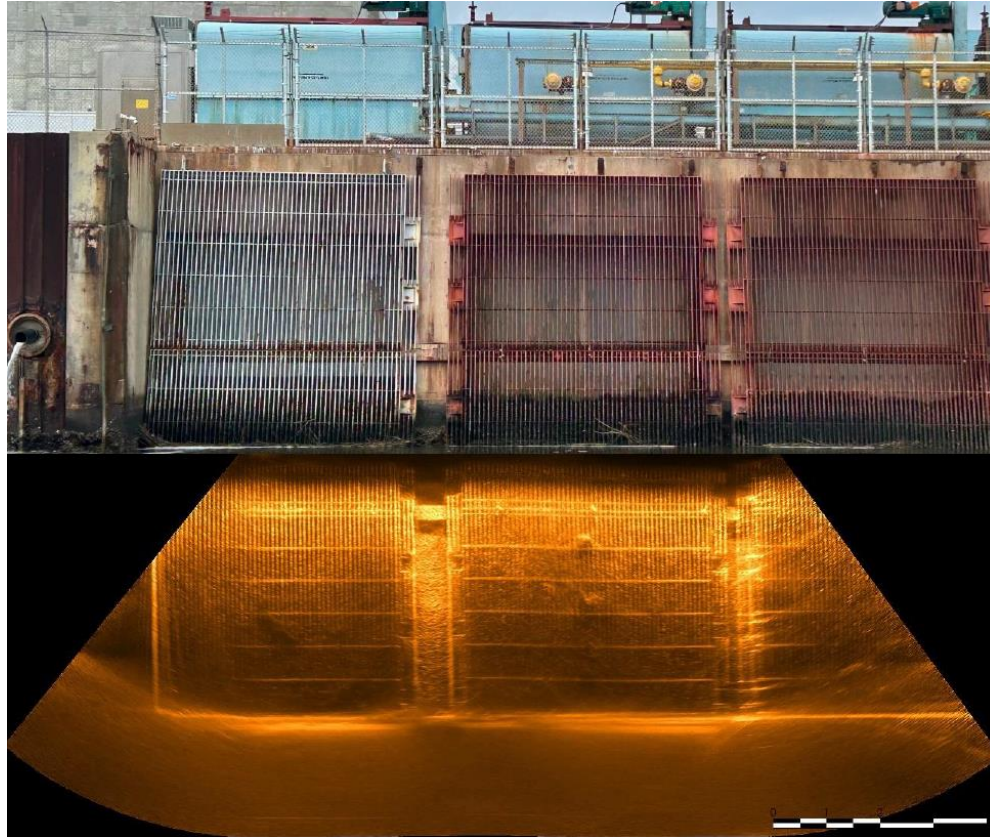
Pier with Concrete and Steel Pilings



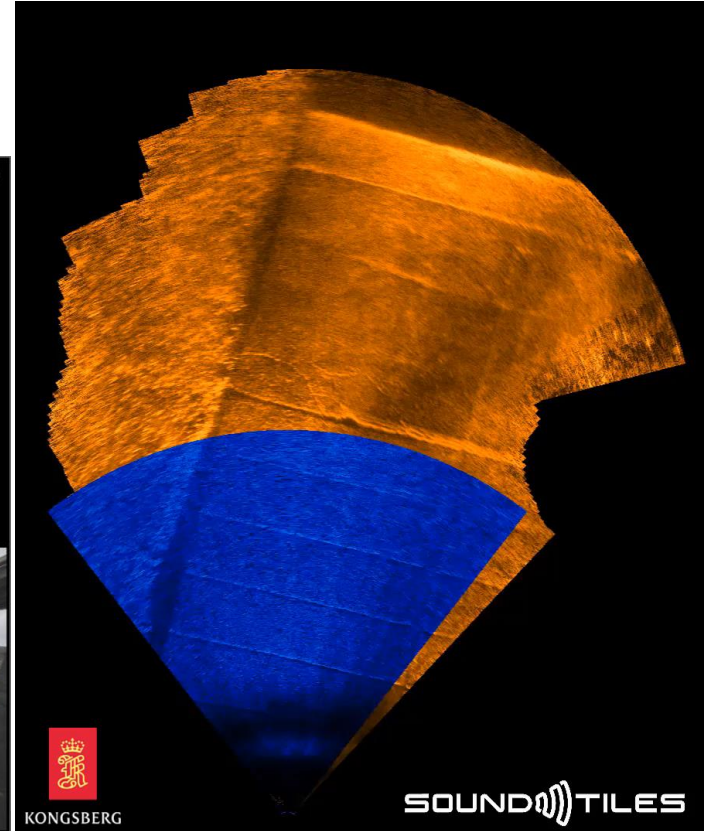
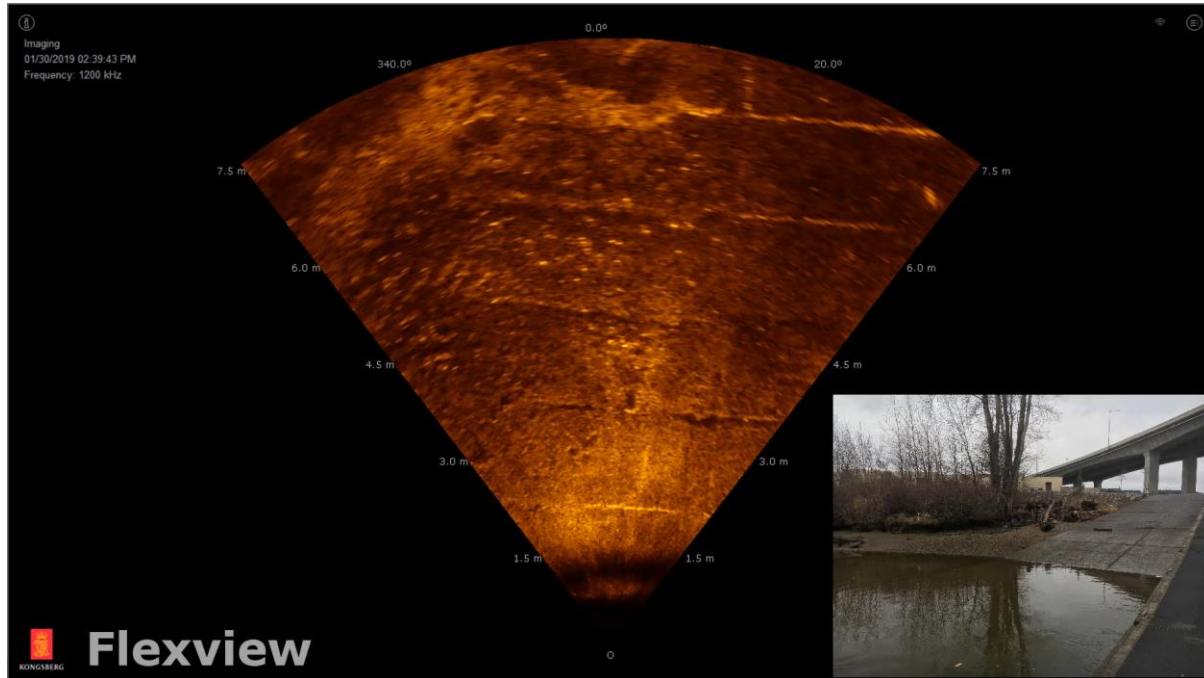
Wood Pile Inspection



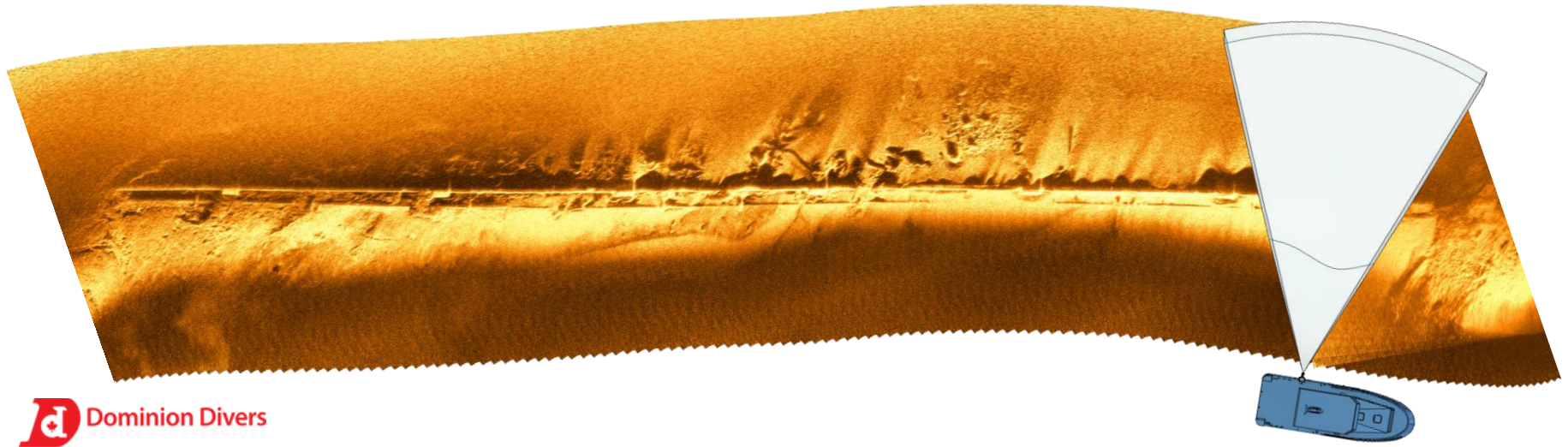
Trash Rack Inspection



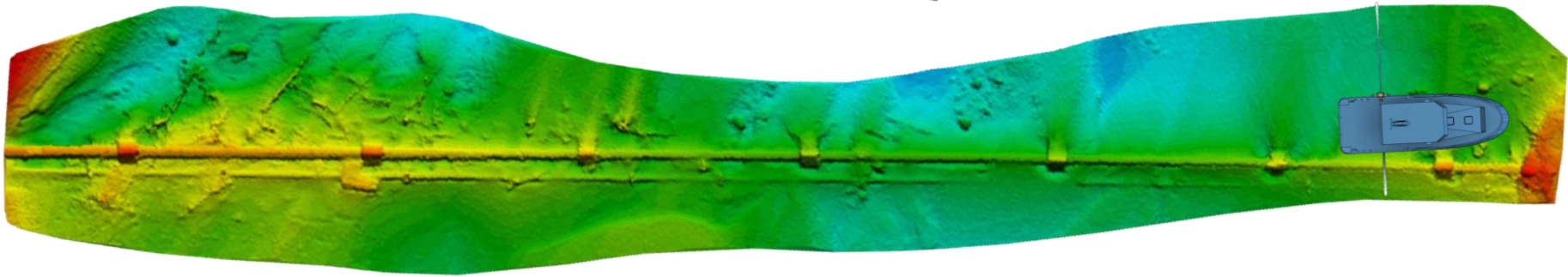
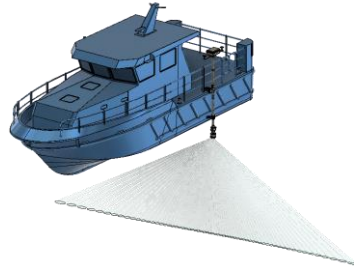
Boat Launch Inspection



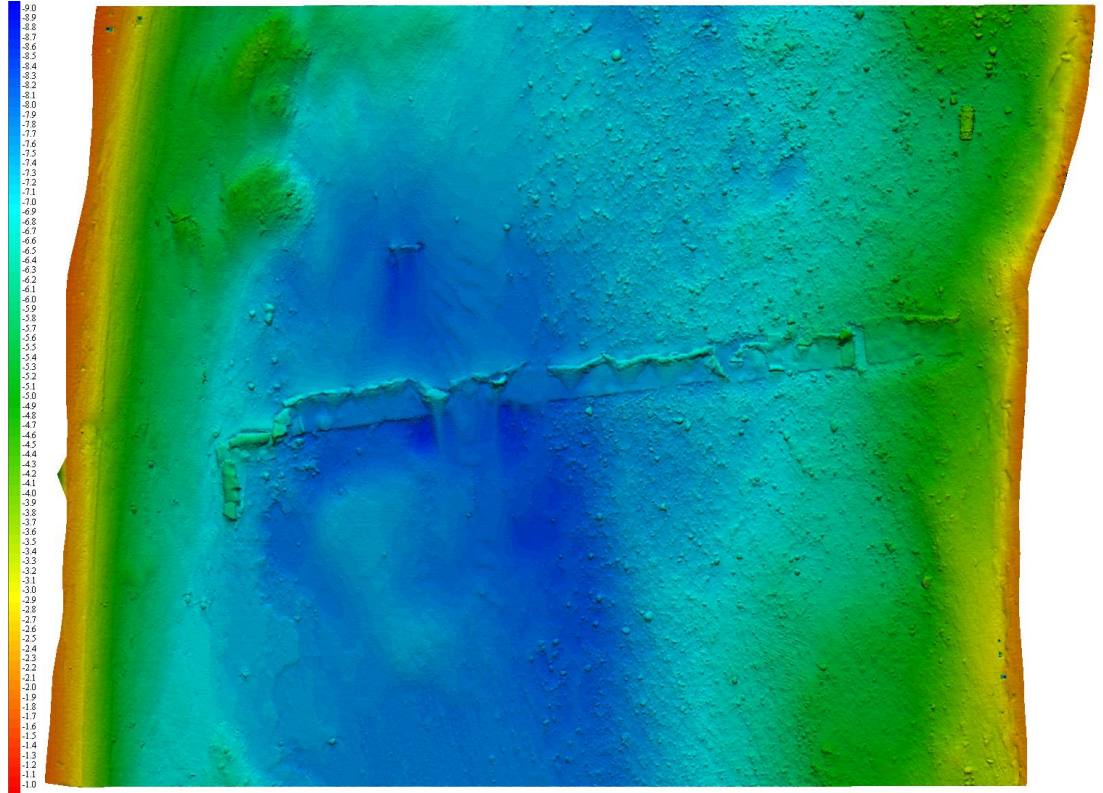
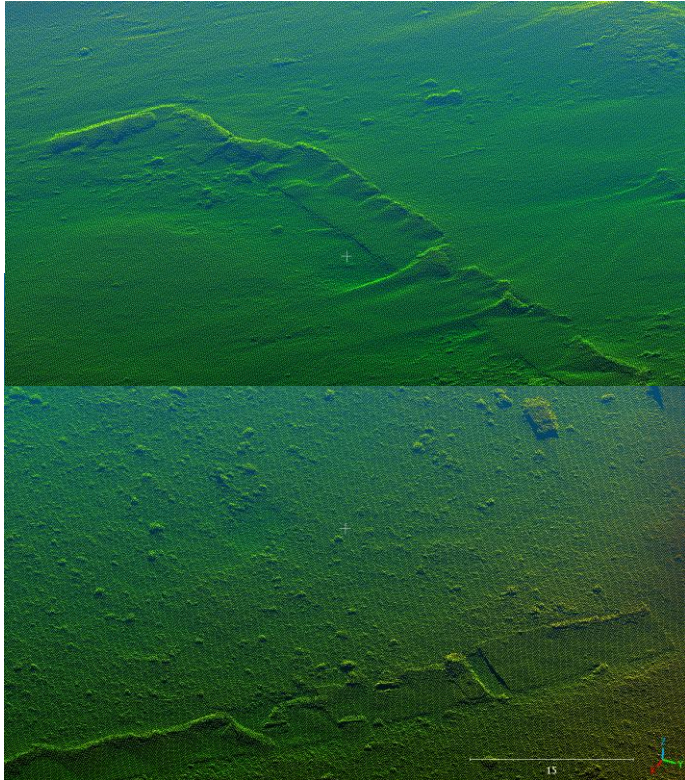
Pipeline 2D Imaging Mosaic



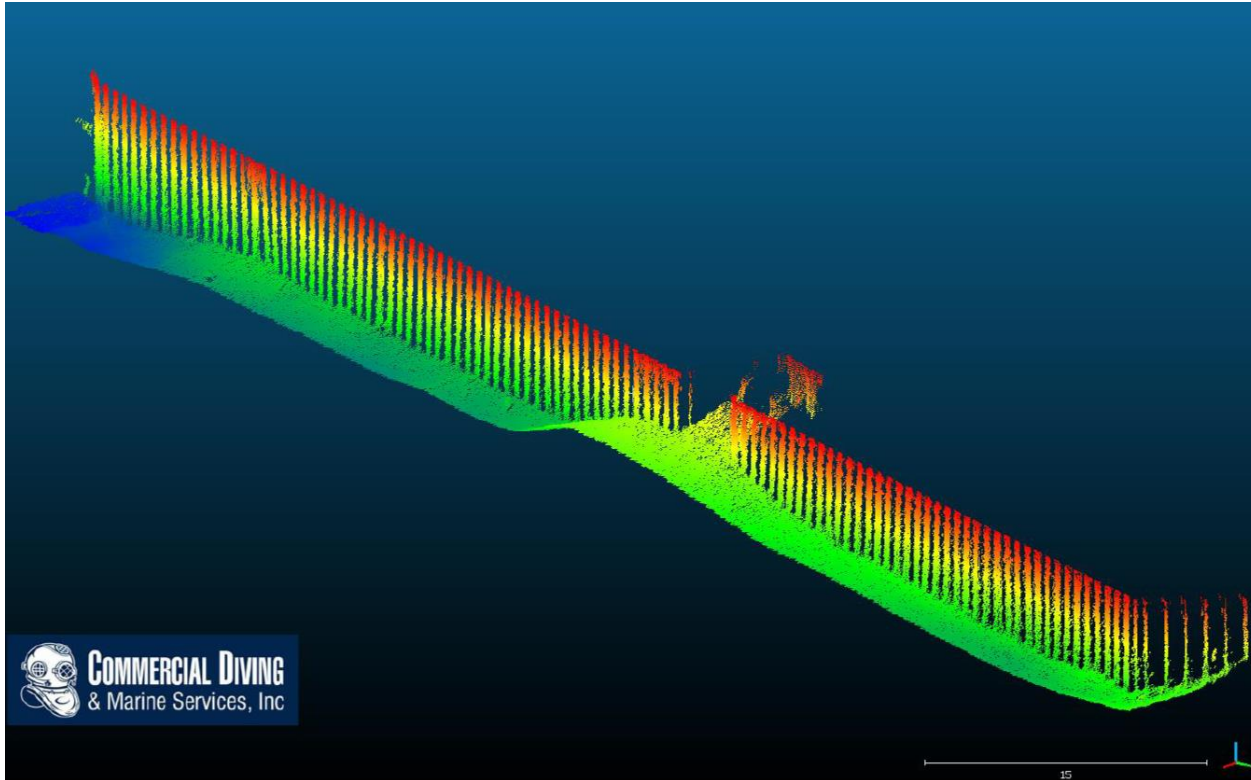
Pipeline 3D Bathymetry



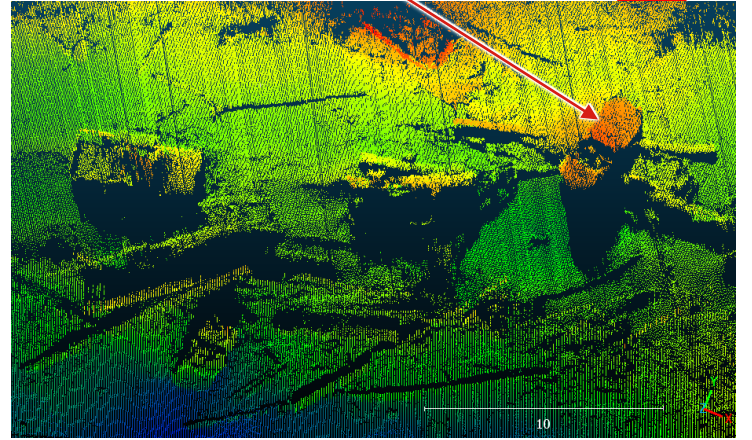
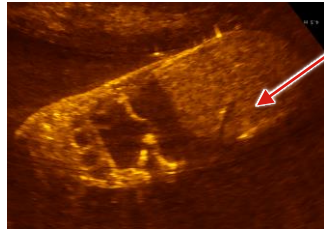
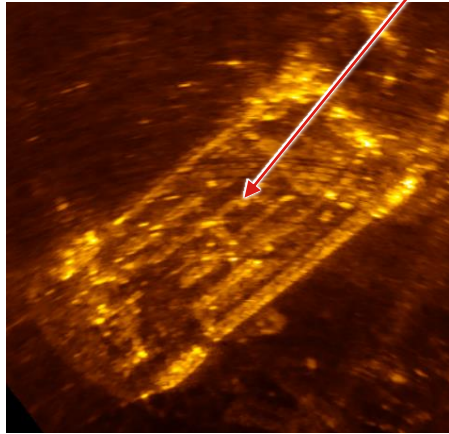
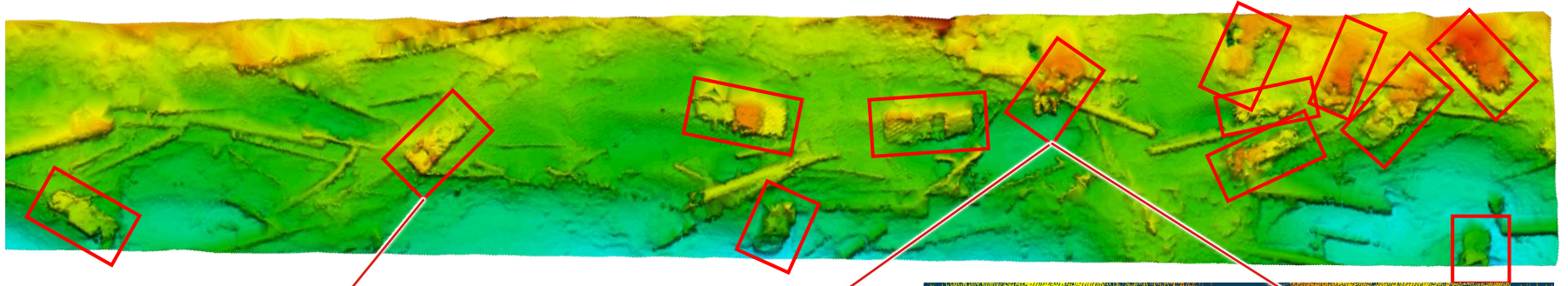
Erosion control mats



Metal Sheet Pile Wall Inspection



Abandoned Car Search



Port Sustainability and Infrastructure Resilience

What Can We Do?

- For High levels of uncertainty:
Conduct Risk Assessment
- For Aging infrastructure:
Conduct Asset Condition Inspection above, below waterline
- Since Natural and manmade disasters have become more frequent:
Develop a budget for ongoing rehabilitation and preservation
- Infrastructure designed now WILL INEVITABLY be subjected to unknown/unknowable design hazards



Resources for Maritime Civil Engineers

- ASCE Manual of Practice MOP 130 – Waterfront Facilities Inspection and Assessment
 - [Link](#)
- ASCE Manual of Practice MOP 156 – Navigation Channel Sedimentation Solutions
 - [Link](#)
- ASCE Port Operations and Maintenance (ODG1623) – on demand course
 - [Link](#)
- Ports Australia Wharf Structures Condition Assessment Manual
 - [Link](#)





KONGSBERG

**Thank you for your
time!**

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