U.S. Navy's Ambitious Infrastructure Upgrade: Dry Dock 5

Deborah MacPherson

August 28, 2024

moffatt & nichol

Agenda

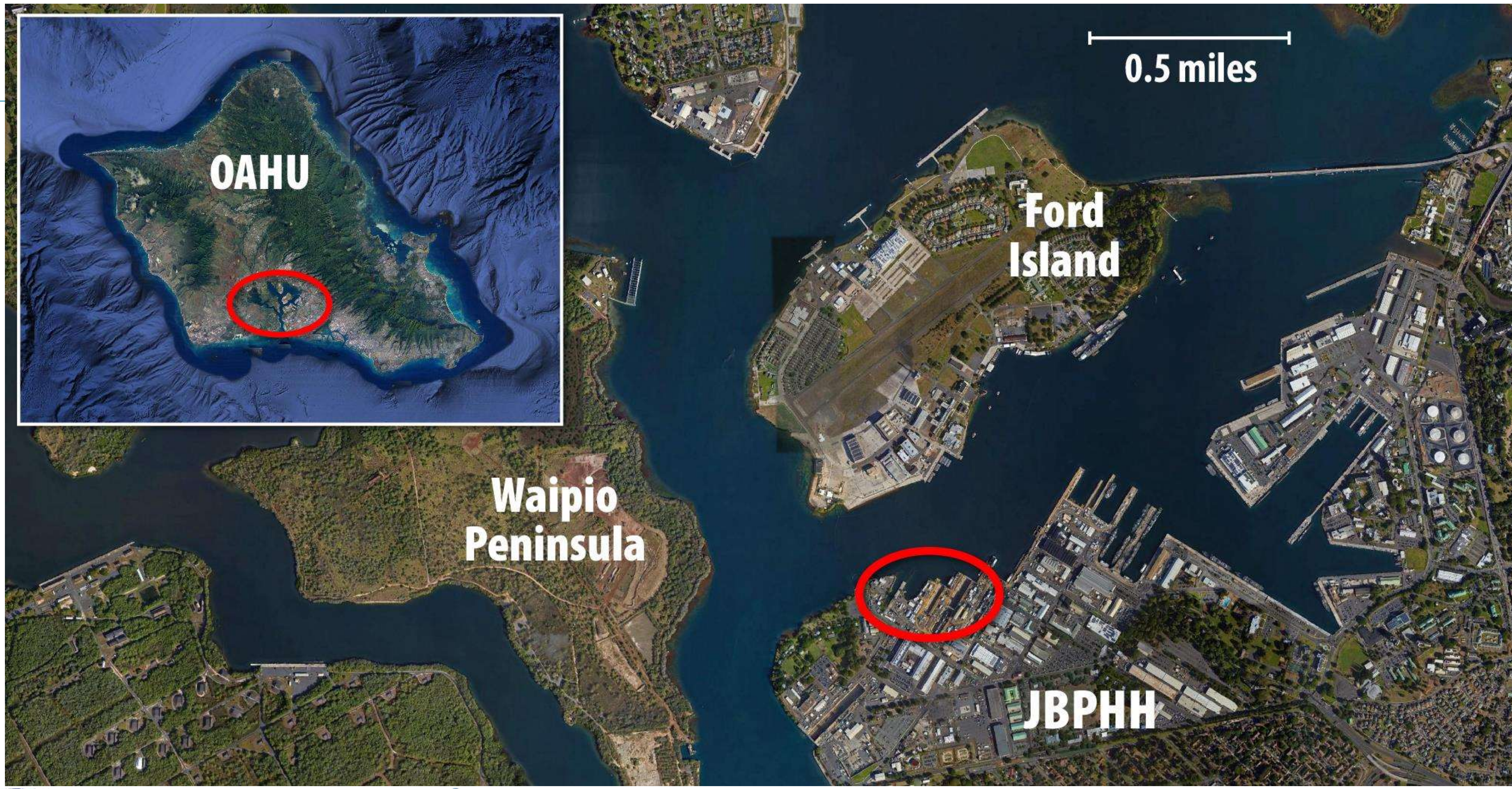
- Introduction
- Design Criteria
- Dry Dock Characteristics
- Focused Areas
  - Coastal and Flooding
  - Seismic
  - Environmental
  - Utilities
  - Sustainable Design/Construction

Introduction

- Project Goal
  - Replace Dry Dock 3
  - Sustainable Design Long term maintenance and efficient operations.
- Background
  - Only two new graving docks constructed in the last 55 years.
  - First New Dry Dock in Pearl Harbor since 1943

Dry Dock No. 3 (1967) - View Facing North
(Historic American Engineering Record HAER HI-67 (Library of Congress)
http://hdl.loc.gov/loc.pnp/pp.print)

Project Site Location



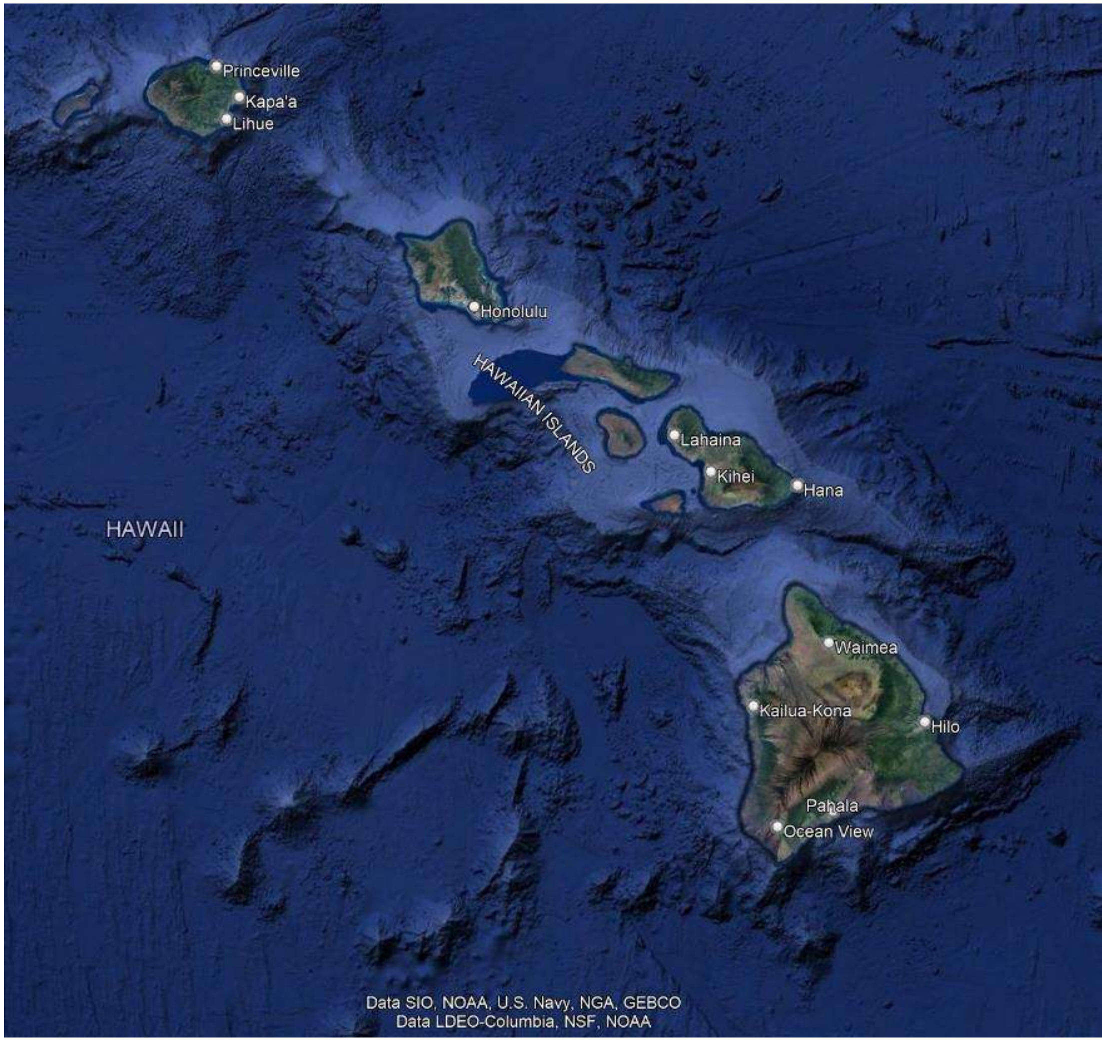

SUBSTATION X AND LPA PLANT
CRANE MAINTENANCE YARD
HP-02
FIRE WATER PUMPHOUSE
EAST SUBSTATION
GAS BOTTLE STORAGE
CHILLER PUMPHOUSE
RESTROOM
S340 REPLACEMENT BUILDING
DRY DOCK #5
WEST SUBSTATION
DEWATERING PUMPHOUSE
BASIN WATER SYSTEM
CAISSON
REVETMENT

Design Criteria

- UFC 4-213-10 Graving Dry Docks
- UFC 4-152-01 Design: Piers and Wharves
- UFC 3-301-01 Structural Engineering
- UFC 3-201-01 Civil Engineering, with Change 4, 28 Sept 2020
- MIL-STD 1625D(SH) Safety Certification Program for Drydocking Facilities and Shipbuilding Ways
- U.S. Army Corps of Engineers (USACE), Minimum Design Loads for Buildings and Other Structures, ASCE Standard ASCE/SEI 7-16, 2016
- DOD Regional Sea Level (DRSL) database, v3.0, October 2020
- USACE, 2011. Coastal Engineering Manual, EM 1110-2-1100, Change 3, 28 September 2011
- Federal Emergency Management Agency (FEMA), 2014. Flood Insurance Study, City
- County of Honolulu, Hawaii, Revised 05 November 2014

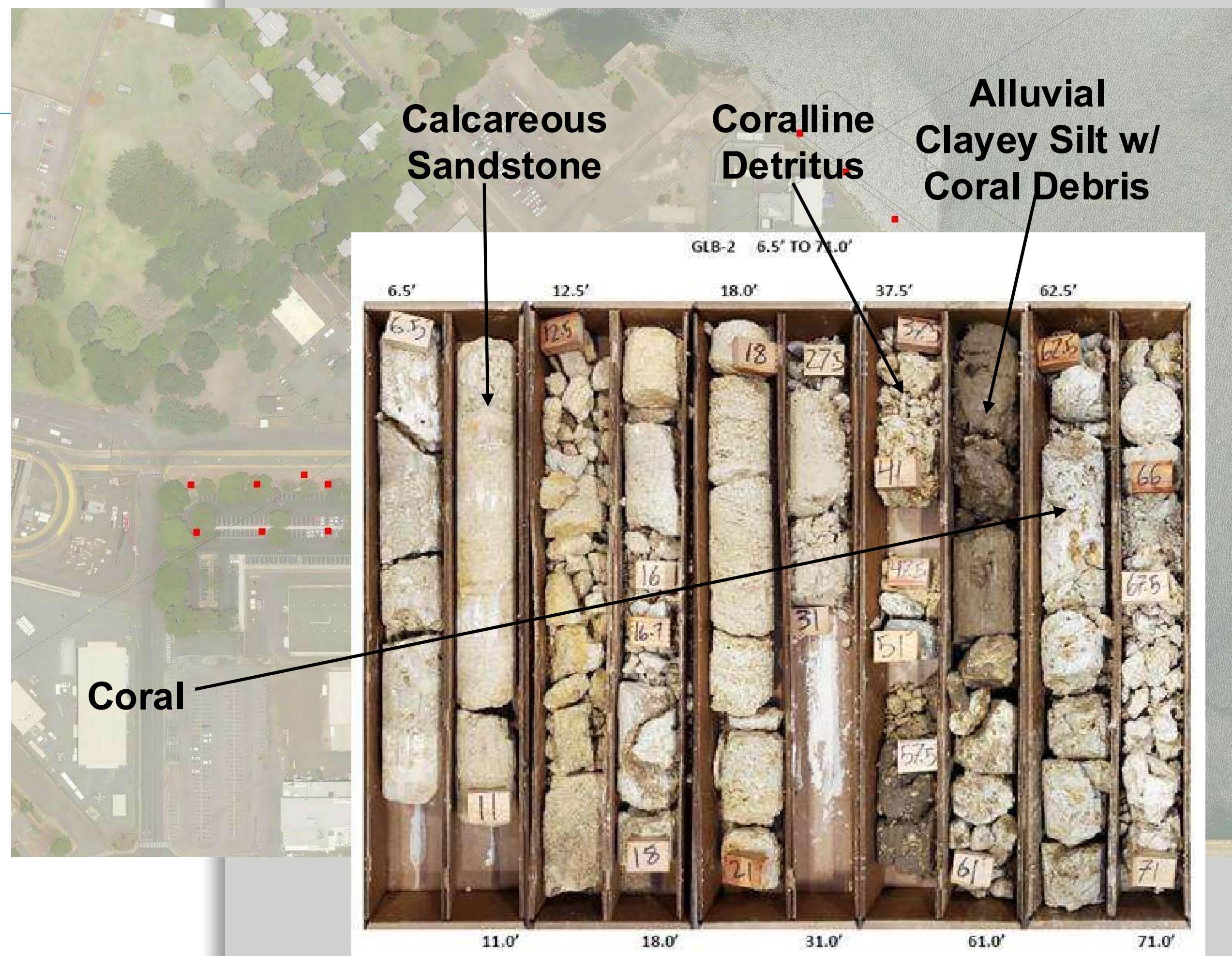
Geotechnical

- Oahu – 5th in Hawaiian archipelago
- Two basaltic shield volcanoes:
  - Ko'olau (to the east) and
  - Wai'anae (to the west)
- Erosion of the volcanos and sea level rise alternating layers of calcareous reef rock, marine deposits, volcanic tuffs, later fill from development.



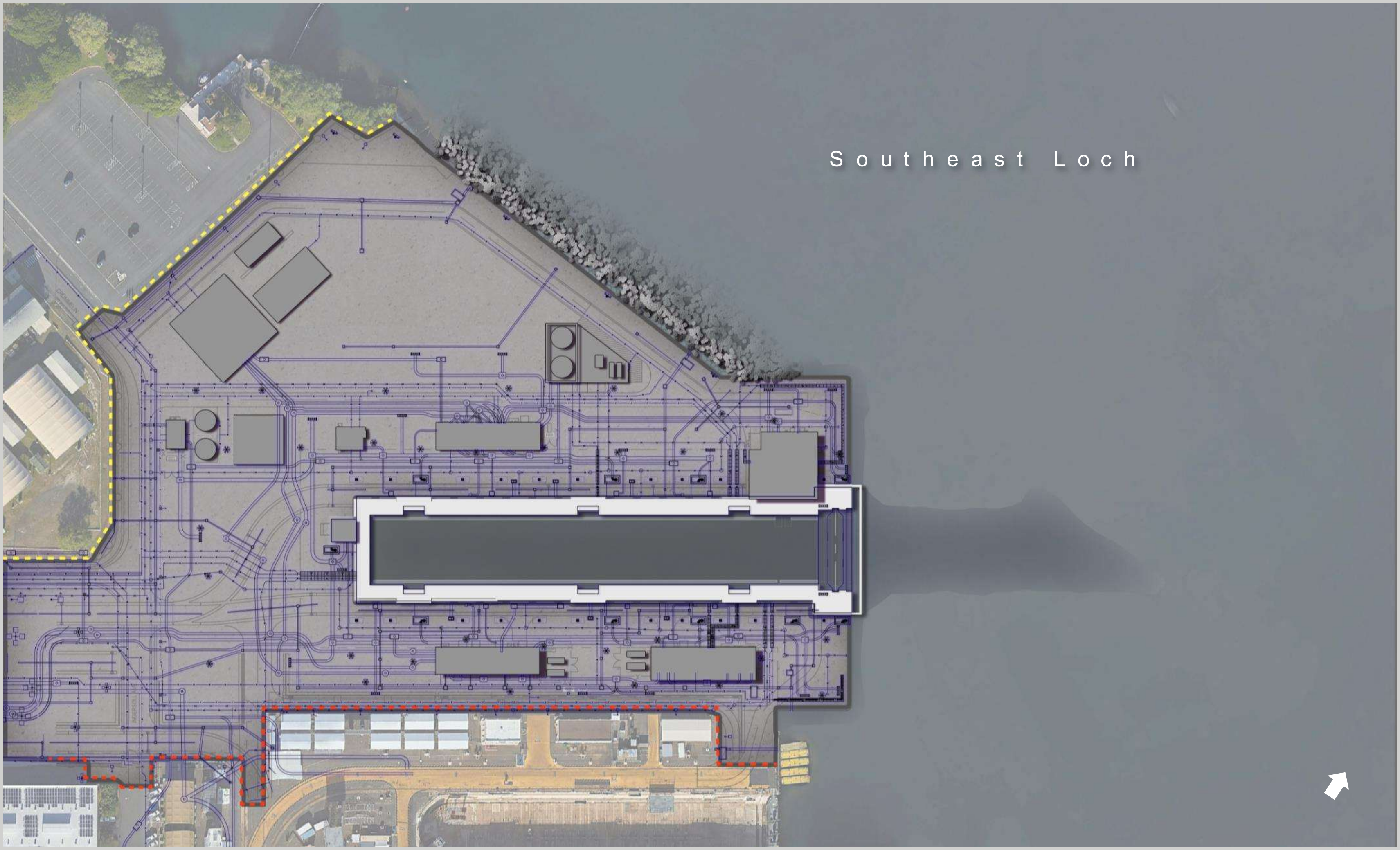
Geotechnical

- Subsurface conditions:
  - Hard layers/zones - coral, sandstone, tuff
  - Coralline detritus - coralline sands and gravels
  - Harbor deposits - very soft clays and silts
  - Alluvium – stiff clays and silts
- ***HIGHLY VARIABLE***

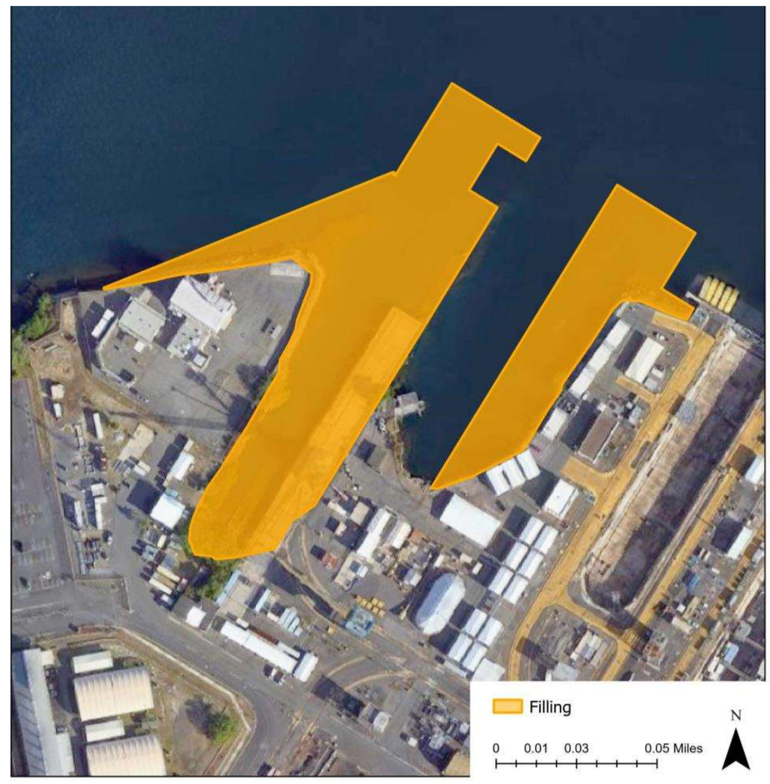


EXISTING SITE CONDITIONS

1. PROPOSED DRY DOCK BASIN
2. MARINE RAILWAY
3. PIER

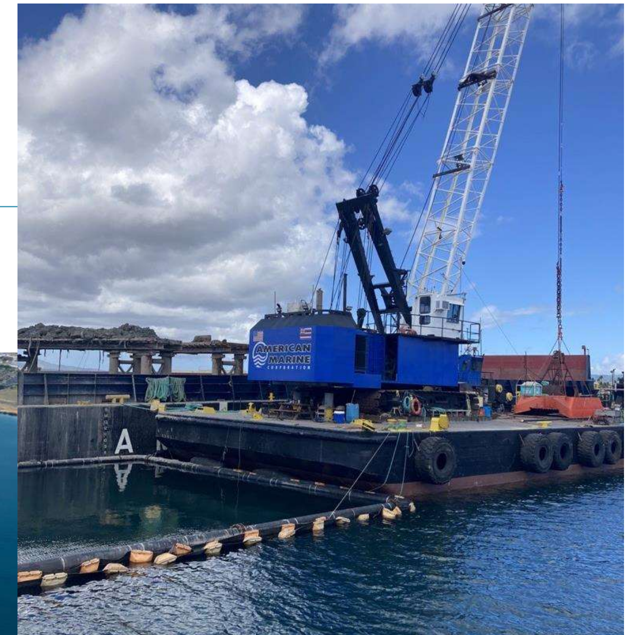

Southeast Loch

Dredging and Reclamation



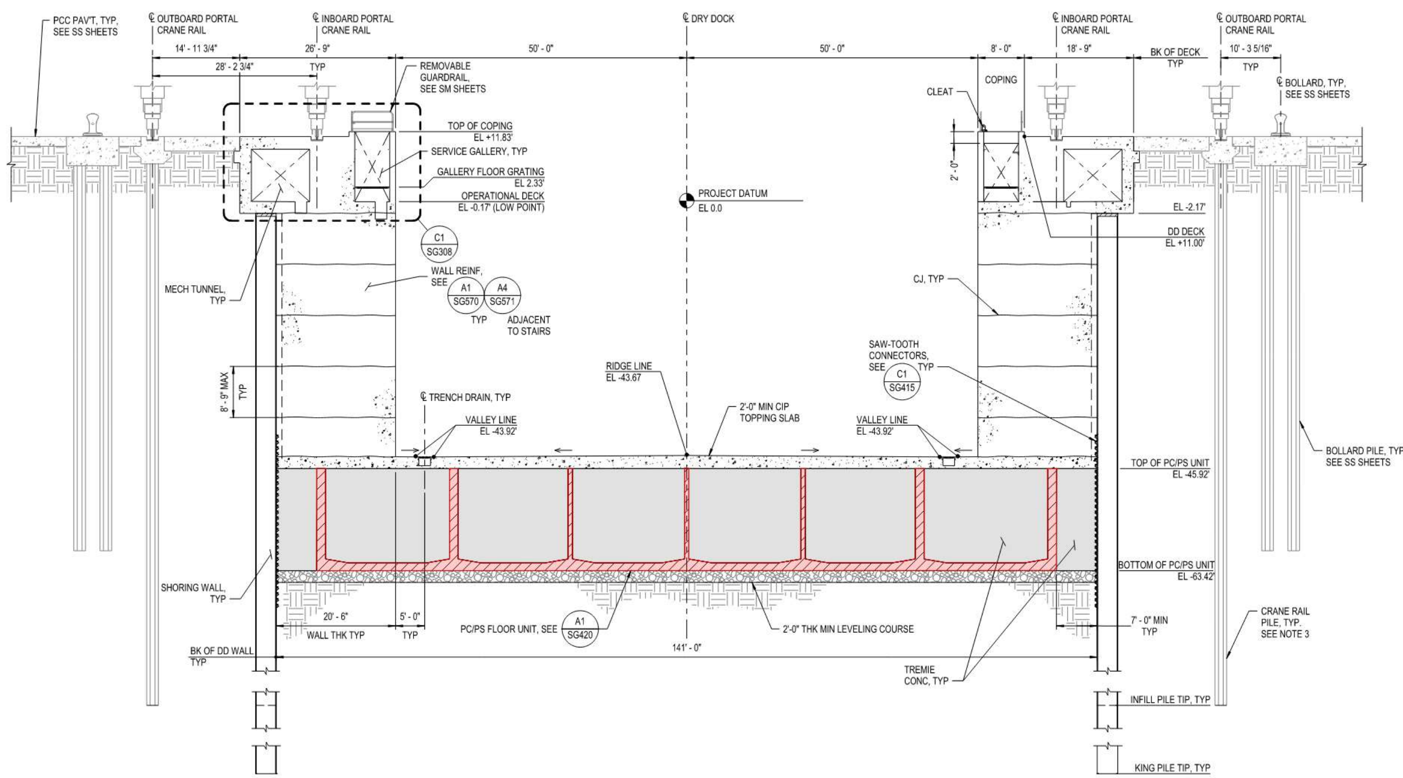
Dredging and Reclamation

- Beneficial reuse within fill areas
- Placement on shore
- Turbidity impacts using silt curtains
- Soil Stabilization – Stone columns



Dry Dock

- 206 m x 30 m x 17 m deep Soil-supported, non-relieving gravity graving dock
- 6 m thick walls and floor
- Portal Crane Track
- Mooring Hardware – Capstans and Bollards
- Mechanical and Electrical Galleries



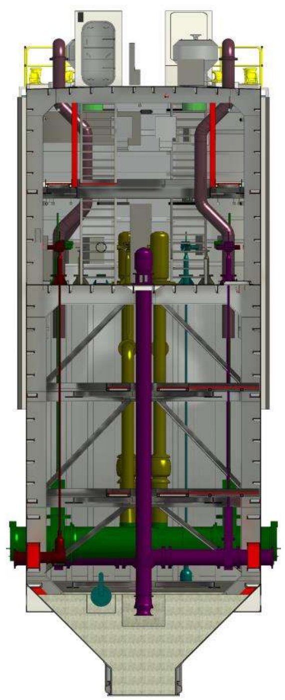
MN DPI

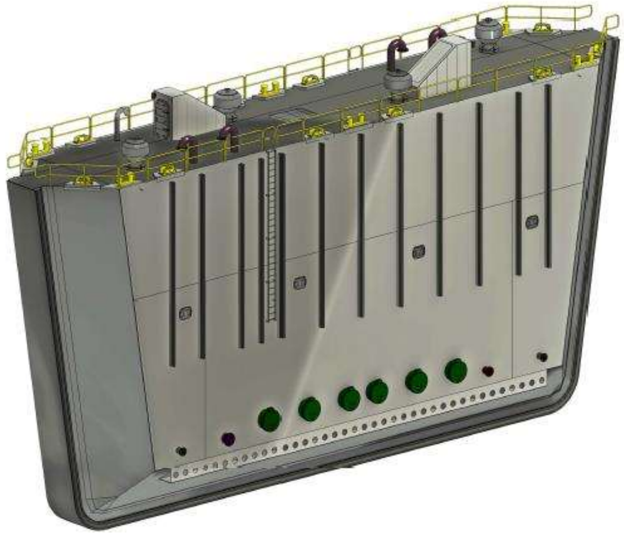
NAVFAC Naval Facilities Engineering Systems Command

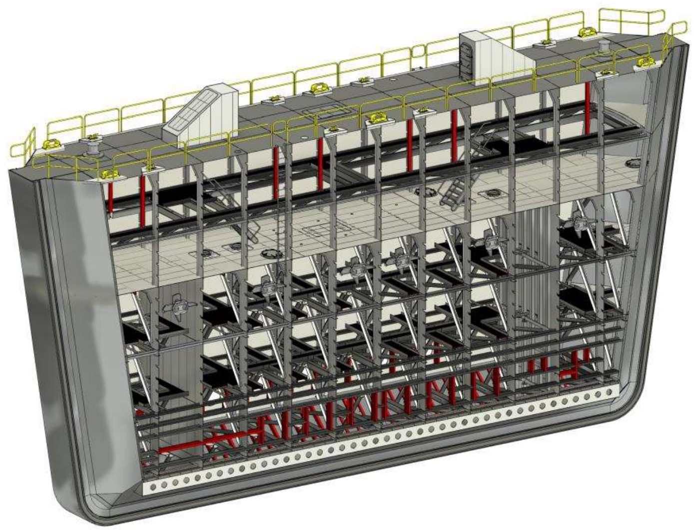
NAVFAC Pacific

Steel Caisson

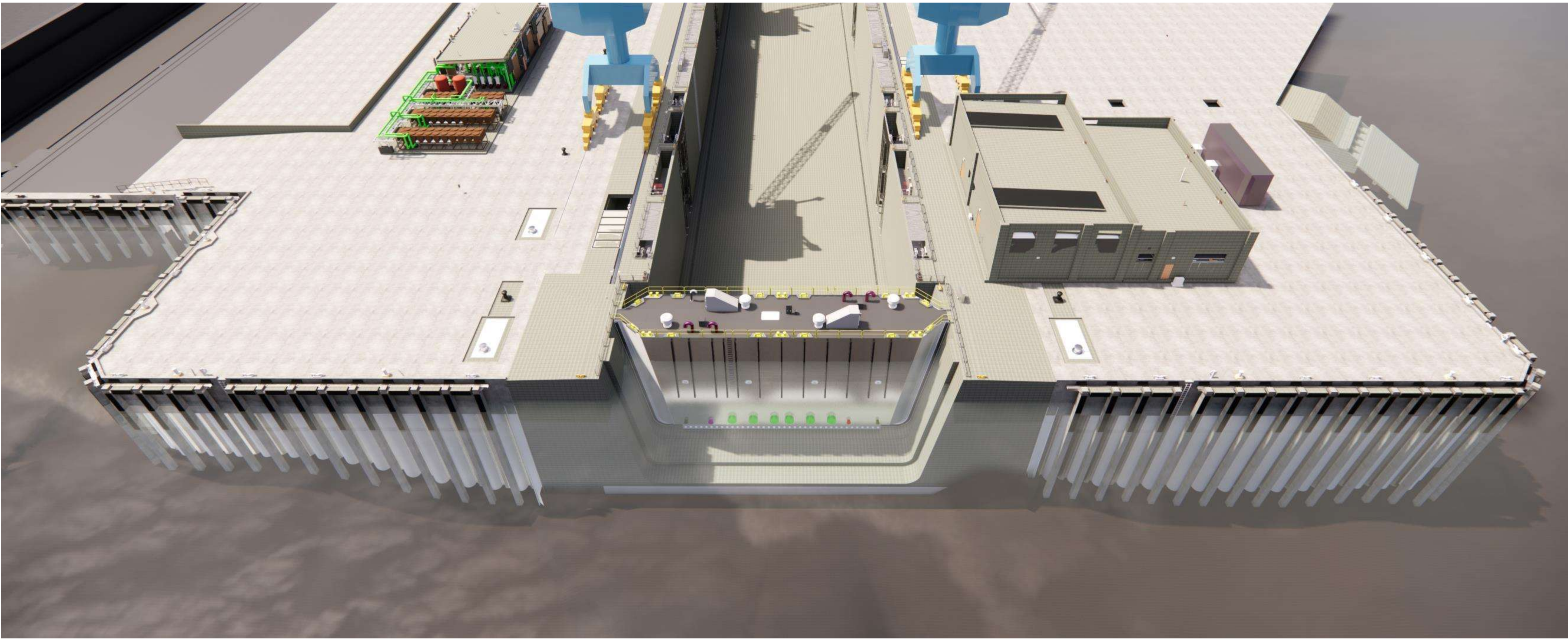
- 36 m x 17.5 m x 6.7 m
- Light Draft < 9 m
- Flood Through Pipes (6 ea.)





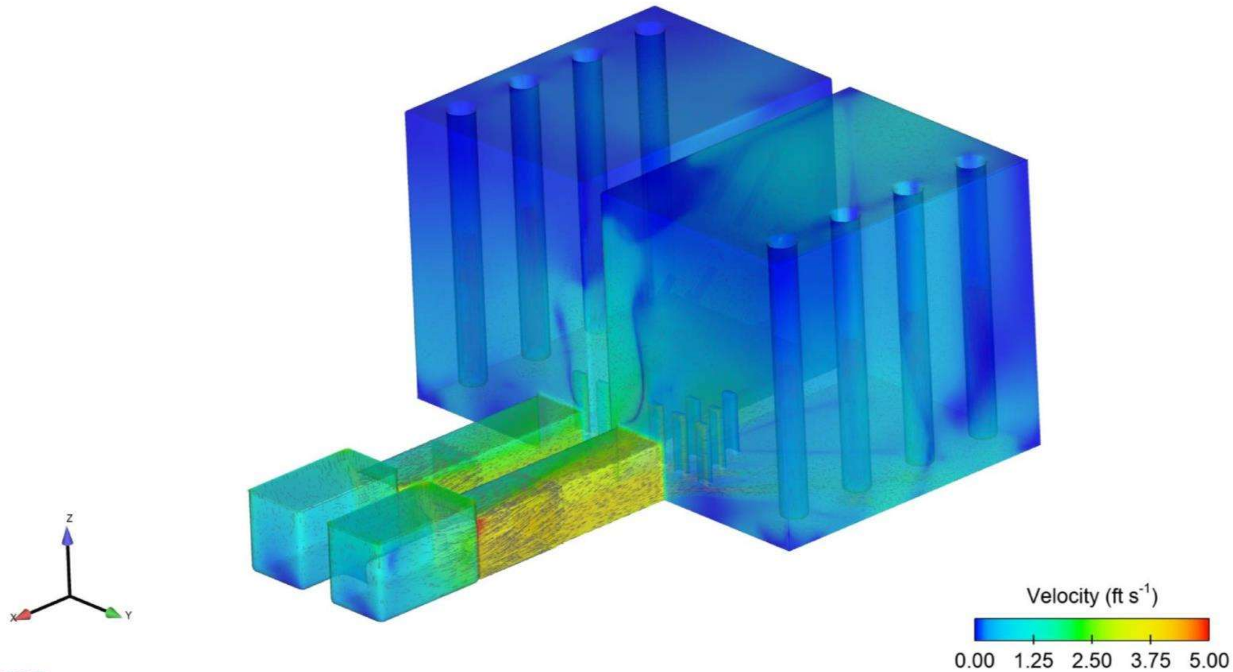


Quaywall



Pumping and Dewatering

- Dual Wet Wells
  - 8 Vertical Turbine Dewatering Pumps (N+1) (Redundancy)
  - 4 Submersible Environmental/Drainage Pumps (N+1) (Redundancy)
  - Dedicated Dewatering Flumes
  - Future maintenance flexibility
  - “Clean” and “Dirty” setup for basin water treatment



Coastal and Flooding

Coastal Engineering

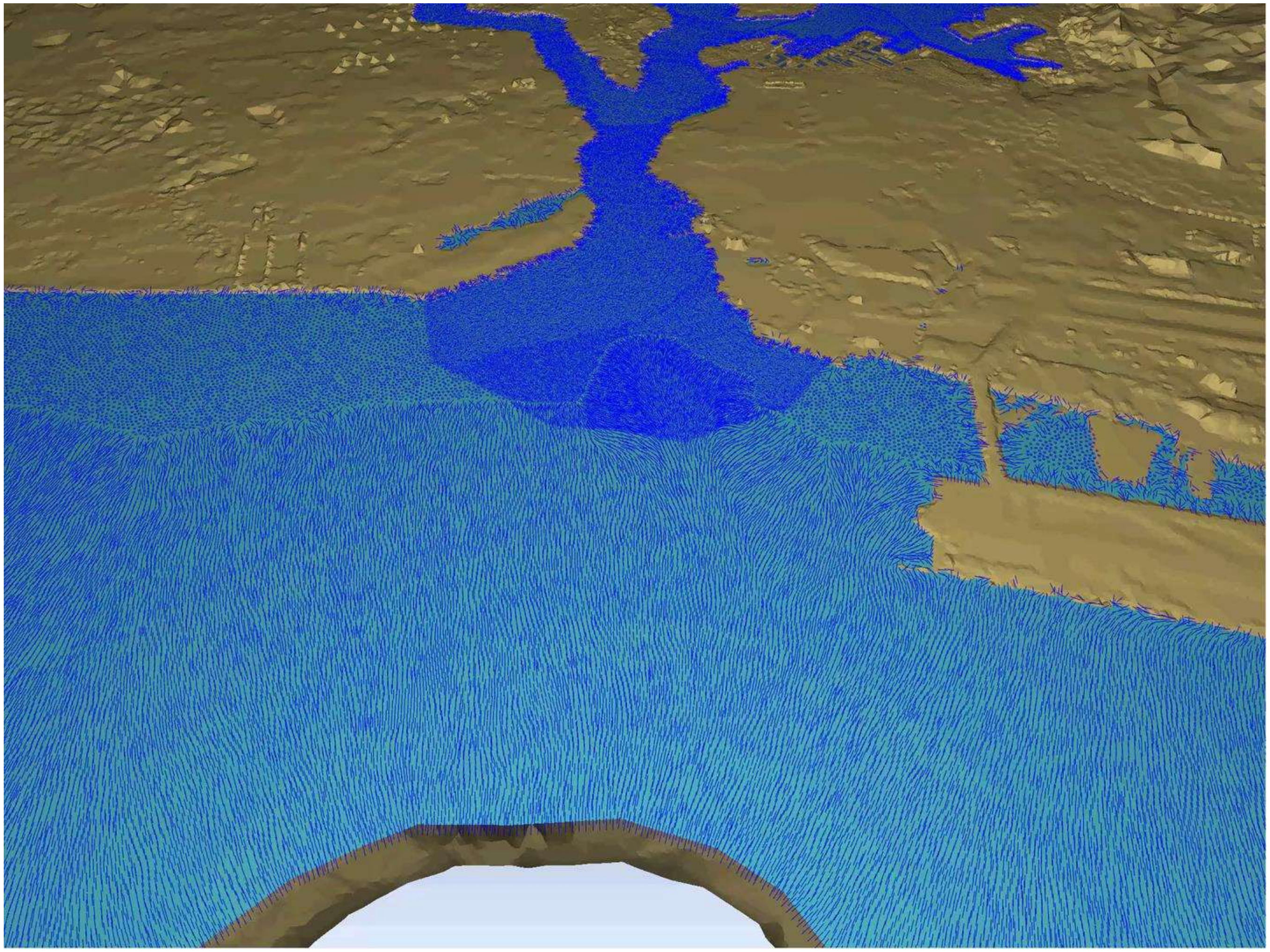
- Water levels
  - Mean Higher High Water (MHHW) = 0.33 m
  - Mean Sea Level (MSL) = 0.0 m
  - Mean Lower Low Water (MLLW) = -0.25 m
- Winds
  - UFC 3-301-01 = 64.8 m/s, 3 sec gust
- Currents
  - 0.5 knots (0.25 m/s)
- Waves (Wind Wave + Swell)
  - 50-yr = 1.25 m; 4.3 sec
  - 100-yr = 1.34 m; 4.4 sec
  - 3000-yr = 1.86 m; 4.9 sec
- Tsunami - ASCE 7-16 for 2% probability in 50-yrs (2475-yr return)
- Sea Level Change
  - Medium Scenario – Year 2100 and 2125

Coastal Engineering

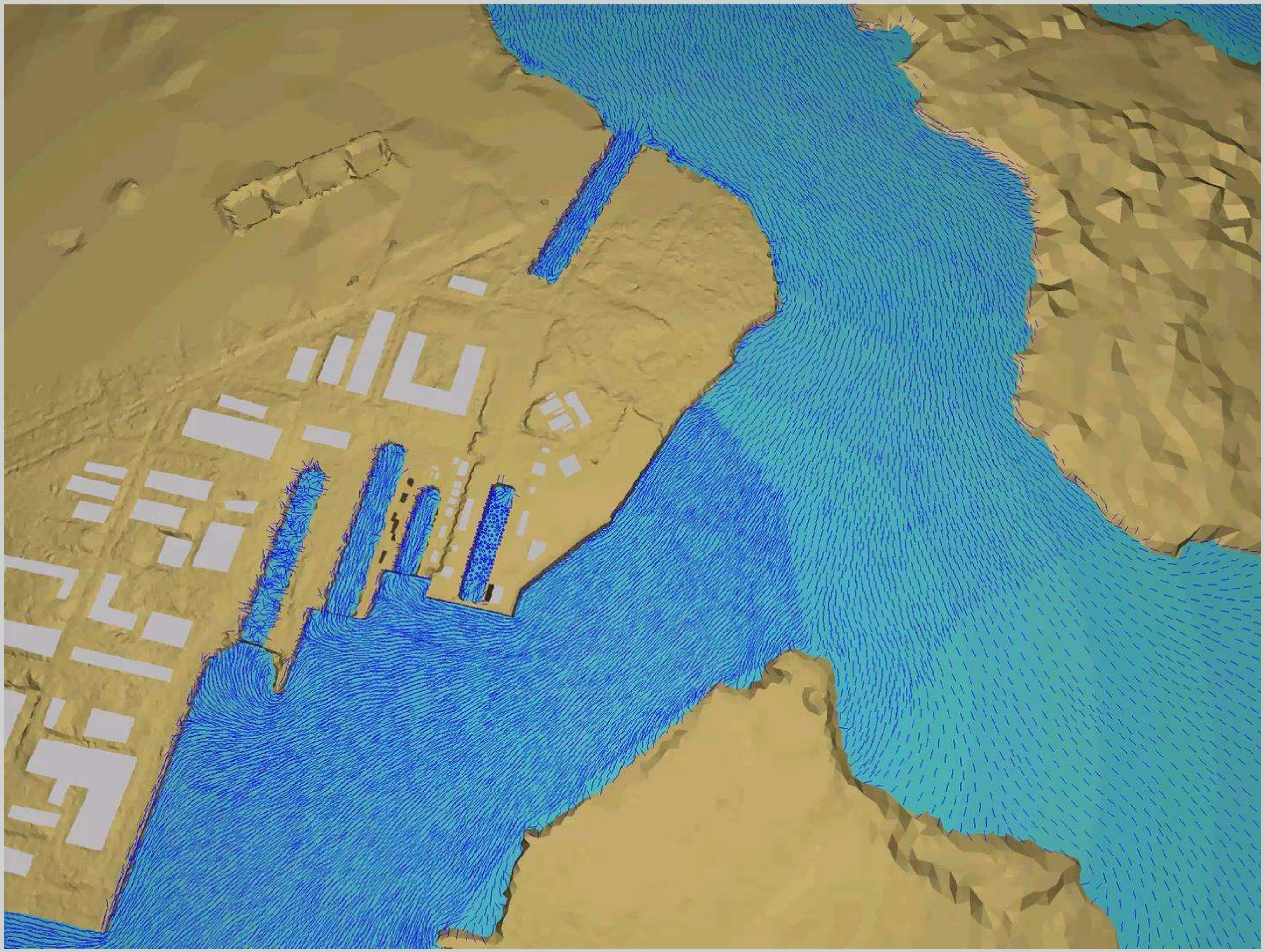
Method	Design Flood Elevation (ft) Terminology	MSL = 0.00 Project Datum	MLW = 100.00	Notes
UFC 3-201-01 Method	Design Flood Elevation	11.00	111.66	FEMA 1% Wave Crest + 3.0-ft freeboard (high risk, essential)
Extreme Event Method	Extreme Flood Elevation	11.10	111.76	FEMA 0.2% Wave Crest + 1.0-ft freeboard
Sea Level Change Approach	Extreme Sea Level Elevation	12.8	113.46	3.6-ft Local Sea Level Change (Medium Scenario, 2100) + MHHW + 1% DRSL Extreme Water Level (Strom Surge) + FEMA 2% Exceedance Wave Runup
		14.5	115.16	5.3-ft Local Sea Level Change (Medium Scenario, 2125) + MHHW + 1% DRSL Extreme Water Level (Storm Surge) + FEMA 2% Exceedance Wave Runup
ASCE 2475-year Tsunami	Max Tsunami Runup Elevation	10.58	111.24	MHW+ 3.6-ft Local Sea Level Change (Medium Scenario, 2100) + MCT Crest Elevation
		12.02	112.68	MHW + 5.3-ft Local Sea Level Change (Medium Scenario, 2125) + MCT Crest Elevation

- Final Elevation Determination
  - Dry Dock Deck & Grade Elevation at El. 3.35 m (11.0 ft)
  - Dry Dock Coping at El. 3.60 m
  - Design Flood Elevation = 3.35 m
  - Tsunami Elevation = El. 3.50 m
    - Minimum Facility Floor Elevation for Critical Equipment Protection

Tsunami Inundation Animation



Tsunami Inundation Animation

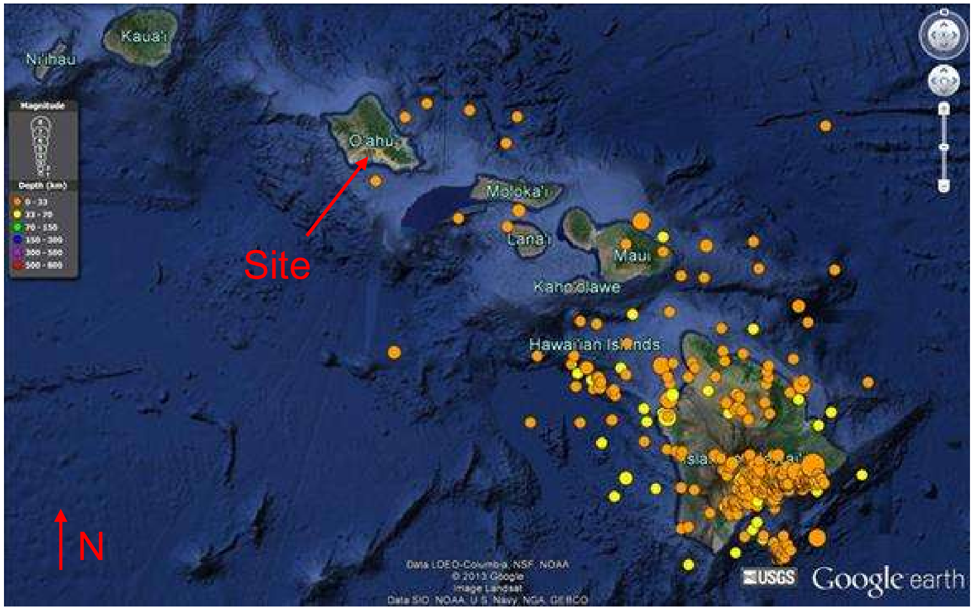


Seismic

Seismic Design & USGS Updates

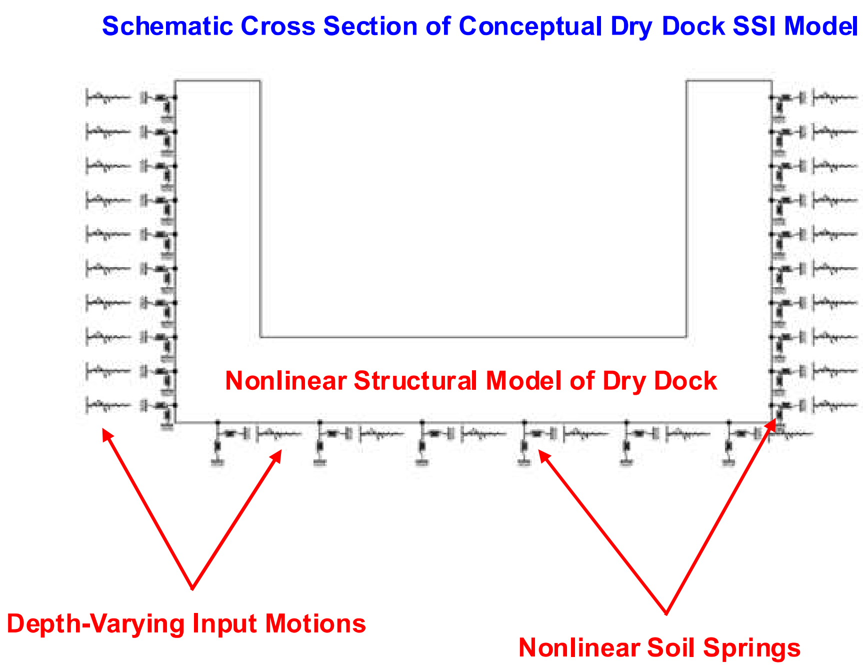
- USGS is updating seismic hazard prediction models for Hawaii
- Design demands may increase
- Coordination with USGS to understand potential changes
- Dry Dock 5 is being designed to resist seismic hazards above current code requirements
- Accounts for possibility future increase due to the USGS updates
- Provides seismic elasticity & protection
- Oahu- Zone 2A

Historical Seismicity in Region (*Source: USGS Database*)
(circles represent earthquakes; larger size for larger magnitude)



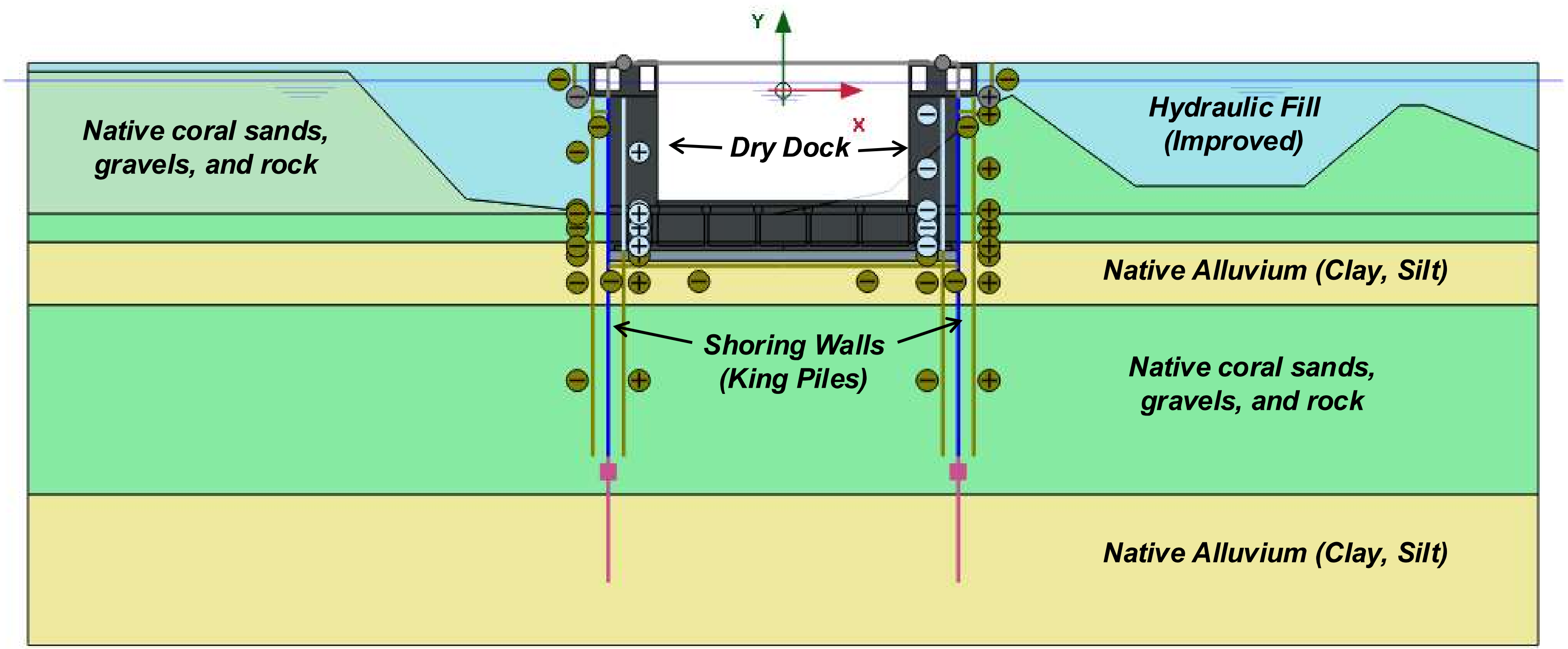
Seismic – Geotechnical
DEPTH-VARYING MOTIONS AND NONLINEAR SOIL SPRINGS

- Site response analysis develops depth-varying motions between the bedrock/firm ground level and the ground surface
- The depth-varying motions are used as inputs into the seismic structural model
  - Nonlinear soil springs represent the ground stiffness around the outside of the dry dock
  - The depth-varying motions applied through the soil springs
- Dynamic soil continuum-structure model simulations (Plaxis) was performed for verification



NAVFAC
Naval Facilities Engineering Systems Command
NAVFAC Pacific

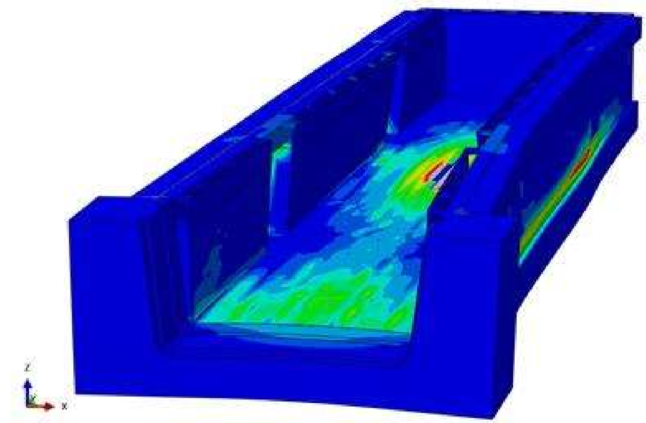
Plaxis Construction Sequence

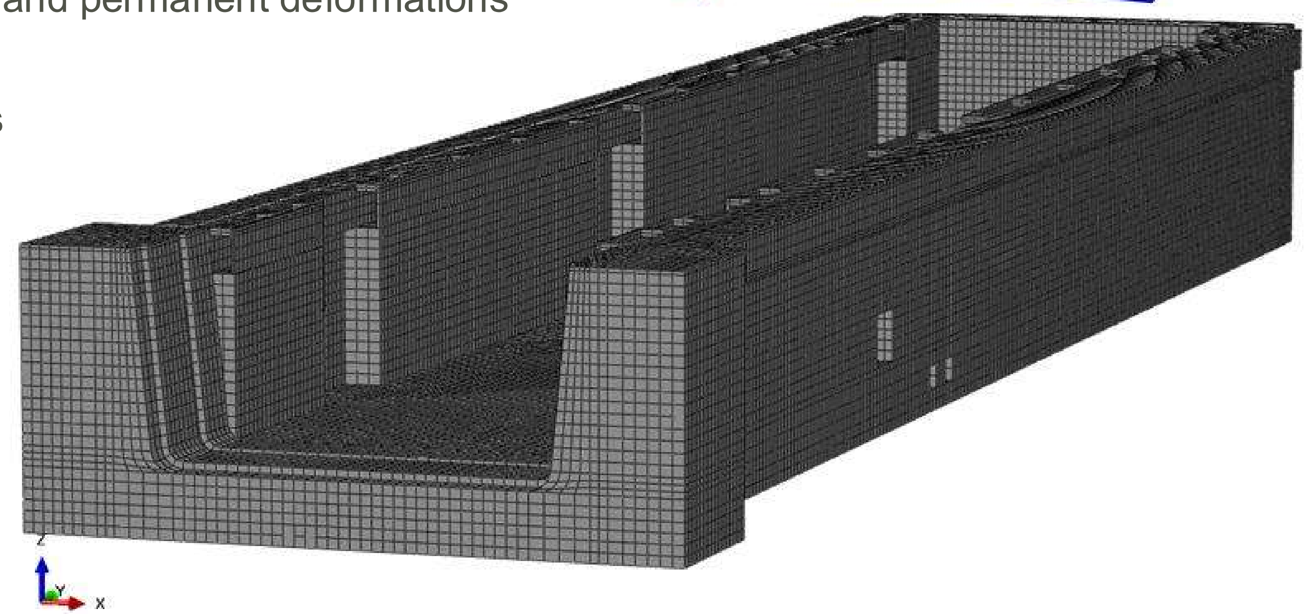


MN DPI
NAVFAC Naval Facilities Engineering Systems Command
NAVFAC Pacific

Dry Dock Seismic

- Detailed FE Analysis with ABAQUS
- Nonlinear Time-History Seismic Analysis
  - 3D soil ground motion time histories input
  - Forces transferred to structure through nonlinear soil springs
  - Accurately predict structural damage and permanent deformations
- SAP2000 Results Validation
  - Limitations from using Shell elements
  - Results comparison
  - Reaction Forces
  - Displacements
  - Stress/Load Paths

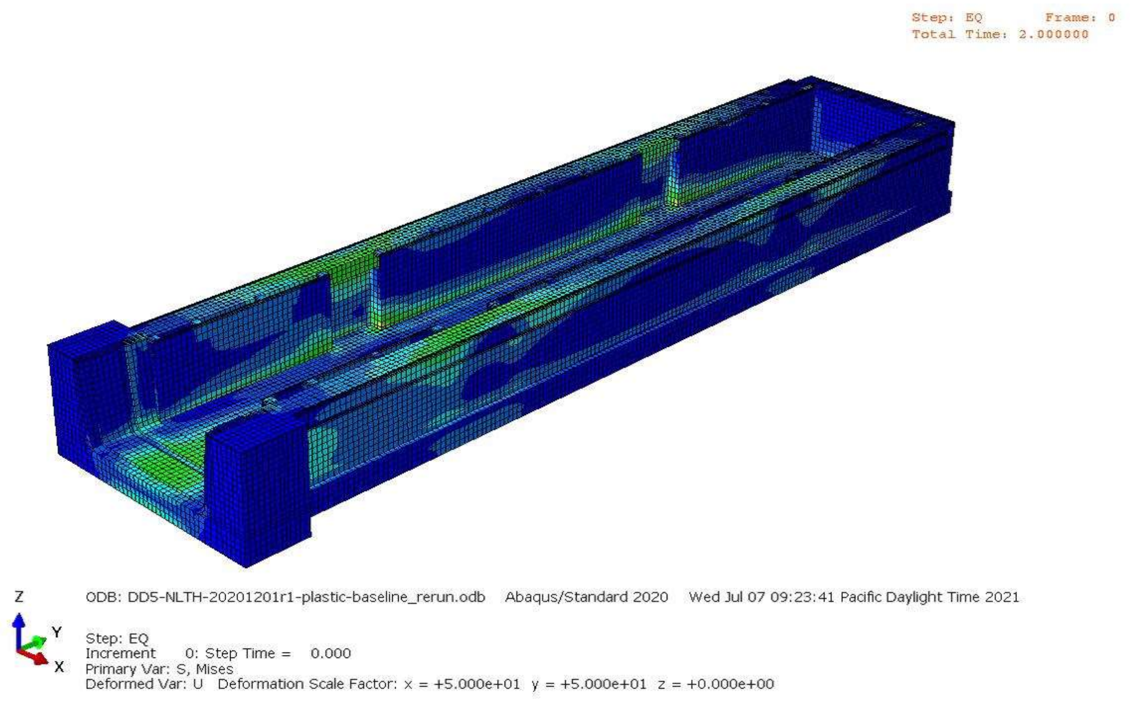




Seismic Performance

SEISMIC RESPONSE - ANIMATION
NOTE - DISPLACEMENTS EXAGGERATED 50 TIMES

- 2,475 Year Return Interval Seismic Event with vessel in dock
- Performance based on actual ground motion records.
- Seismic motions vary with depth and soil properties
- Non-linear soil behavior captured by the model



NAVFAC Naval Facilities Engineering Systems Command NAVFAC Pacific

Environmental

Environmental Impact Statement

- https://www.pearlharbordrydockeis.org/#!/overview
- Completed by NAVFAC PAC with review and input from design team.
- Reviews 4 Main Areas
  - Built Environment
  - Physical Resources
  - Biological resources
  - Social Resources

- **Built Environment**
  - Hazardous Materials & Waste
  - Marine Navigation
  - Traffic
  - Noise
  - Utilities

NAVFAC
Naval Facilities Engineering Systems Command
NAVFAC Pacific

Environmental Impact Statement

- **Physical Resources**
  - Water Resources
  - Geologic Resources
  - Air Quality & Greenhouse Gases
- **Biological Resources**
  - Terrestrial Biological Resources
  - Marine Biological Resources

- **Social Resources**
  - Cultural Resources
  - Land Use
  - Visual Resources
  - Public Health & Safety
  - Socioeconomics
  - Environmental Justice & Protection of Children

MN DPI PACIFIC JV

NAVFAC Naval Facilities Engineering Systems Command NAVFAC Pacific

Marine Resources

- Present ESA-listed species: Hawaiian monk seal and sea turtles, etc.

Hawaiian Monk Seal

Source of Photo: NOAA Fisheries

Green Sea Turtle

(Source of Photo: https://www.wildhawaii.org/wildlife/hawaiian-green-sea-turtle/)

NAVFAC Naval Facilities Engineering Systems Command NAVFAC Pacific

Terrestrial Resources

- There are protected/endangered bats and bird species.

Photo credit USGS, Frank Bonaccorso

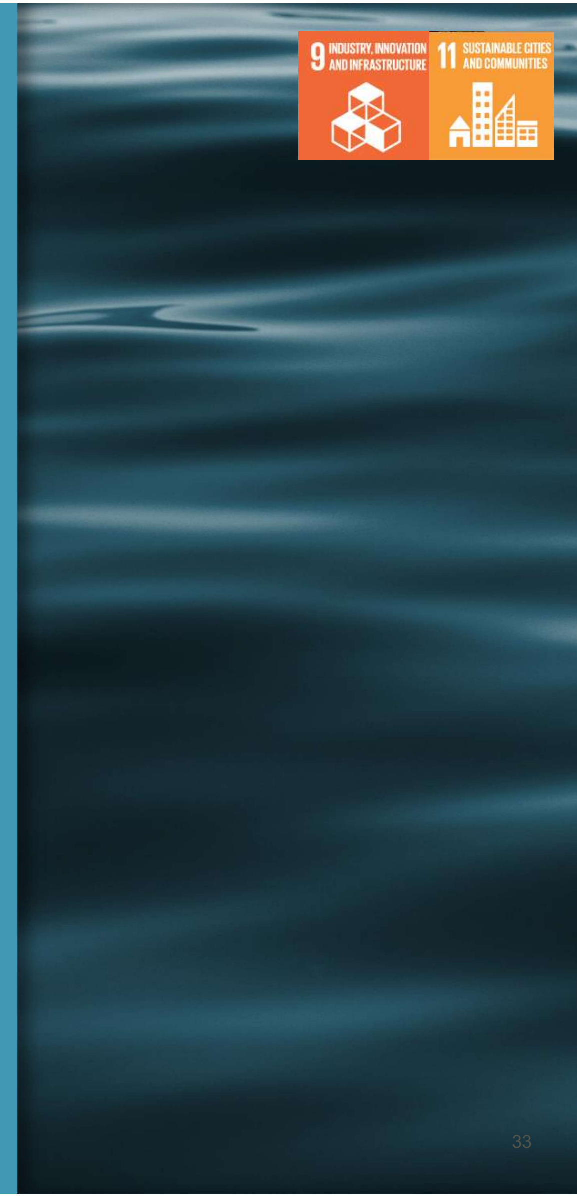
Hawaiian Hoary (Endangered Species)

Refer to Federally-Protected Wedge-Tailed Shearwater (Seabird)

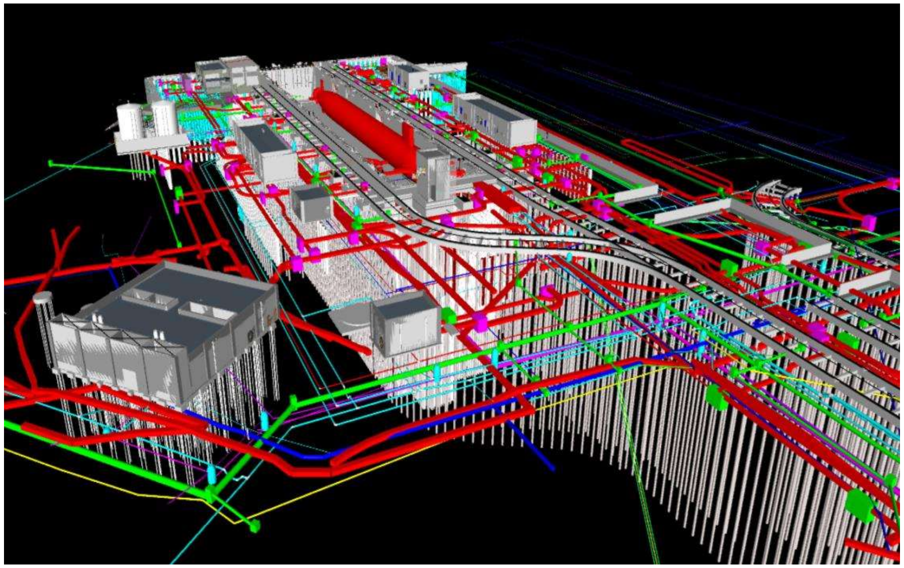
White Tern (Source of Photo: https://web.archive.org/web/20110923164301/http://www.botany.hawaii.edu/biology101/birds/white_tern.htm) Migratory Birds Treaty Act (MBTA)

Pueo (Hawaiian Short-Eared Owl) (Source of Photohttps://www.pueoproject.com/get-to-know-the-pueo)

Sustainable Construction



Utilities



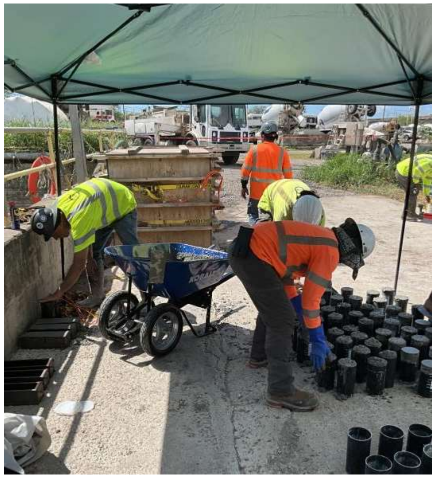
- Improving reliability and safety of utilities
- Investing in infrastructure upgrades
- Improving grid resilience
  - Generators
  - Additional Electrical Power Source
- Critical equipment is elevated to protect from flooding and other natural hazards
- Efficient sanitary sewer pumping station system,
- New potable and fire water systems,
- Stormwater capture system meeting low-impact development requirements

MN DPI PACIFIC JV

NAVFAC Naval Facilities Engineering Systems Command NAVFAC Pacific

Sustainable Concrete

- **100-year design life**
- Service life modeling – Stadium
  - Fly Ash to partially substitute cement.
  - Concrete temperatures controlled:
    - Prevent delayed ettringite formation
    - Minimize shrinkage and thermal cracking.
- Reinforcing steel selected - corrosion performance
- Min Concrete cover for dry dock faces = 150 mm




P-209 DD3 Replacement
July 22, 2021 DRAFT

Questions

moffatt & nichol

Thank you

Deborah MacPherson
Moffatt & Nichol

moffatt & nichol

News Articles

› https://www.hawaiipublicradio.org/the-conversation/2024-02-26/navy-pearl-harbor-shipyard-construction-project-dry-dock

›

› https://seapowermagazine.org/new-dry-dock-project-at-pearl-harbor-naval-shipyard-reaches-early-milestone/

›

› https://www.stripes.com/branches/navy/2024-02-16/navy-new-dry-dock-hawaii-13030318.html

›

› https://www.staradvertiser.com/2024/02/17/hawaii-news/work-begins-on-3-4-billion-pearl-harbor-shipyard-dry-dock/ (Click here in the event you don't have a subscription)

›

› https://www.sofx.com/navy-initiates-construction-of-historic-3-4-billion-dry-dock-in-hawaii/

›

› https://bnnbreaking.com/conflict-defence/military/us-navy-embarks-on-historic-34-billion-dry-dock-construction-at-pearl-harbor

›