Performance of the Newly Installed WAD®s Artificial Reef System at the Sunshine Skyway, Tampa Bay, Florida

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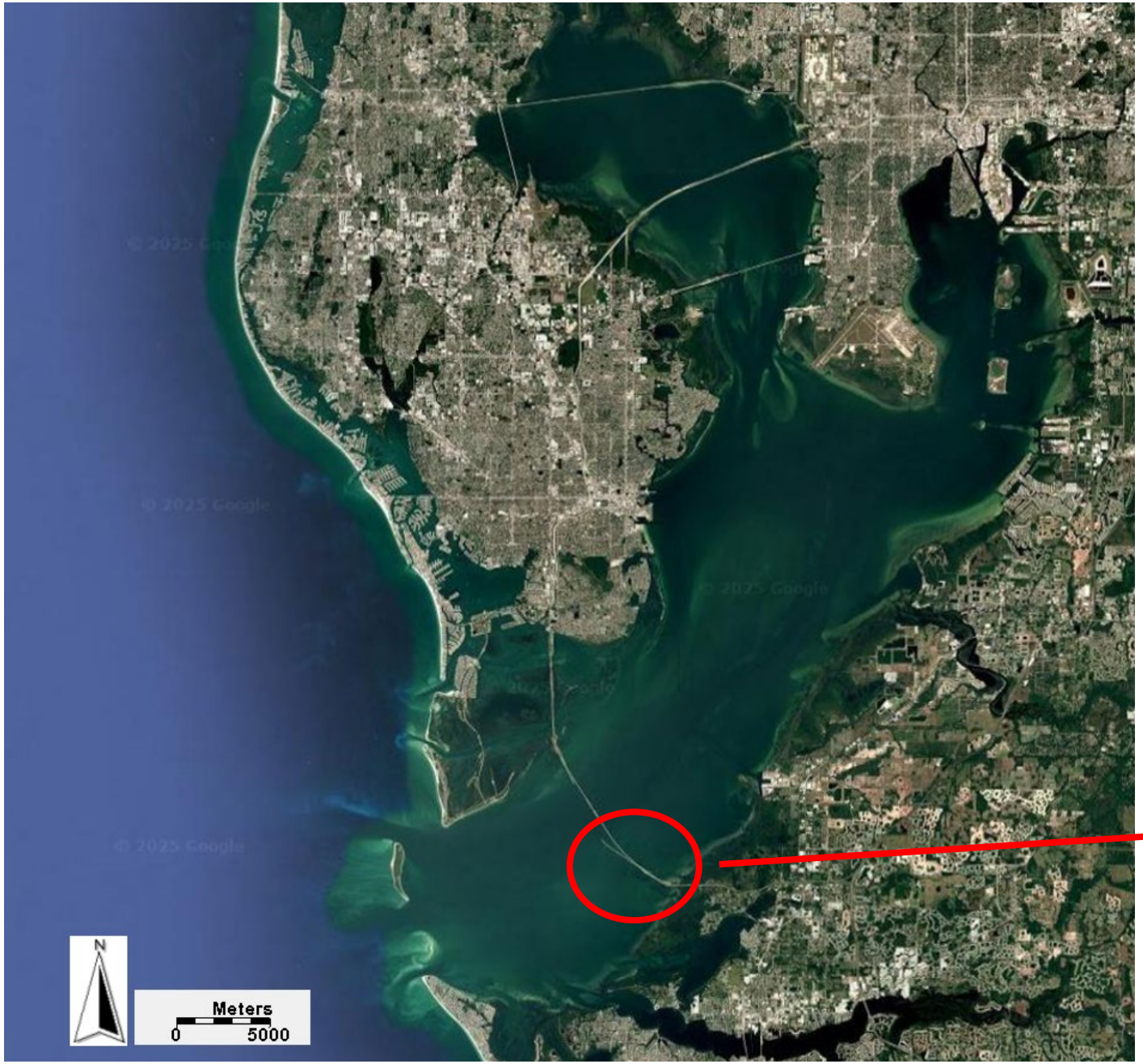
Outline

- Introduction
- Study area
- Design of WAD®s artificial reef system
- Installation of WAD®s artificial reef system
- Monitoring
  - Time-series surveys
- Performance analysis
  - Wave measurement and analysis
- Summary

Study Area



The study area is exposed to both: Waves from the open Gulf of Mexico (GOM)

Wave generated by local wind.

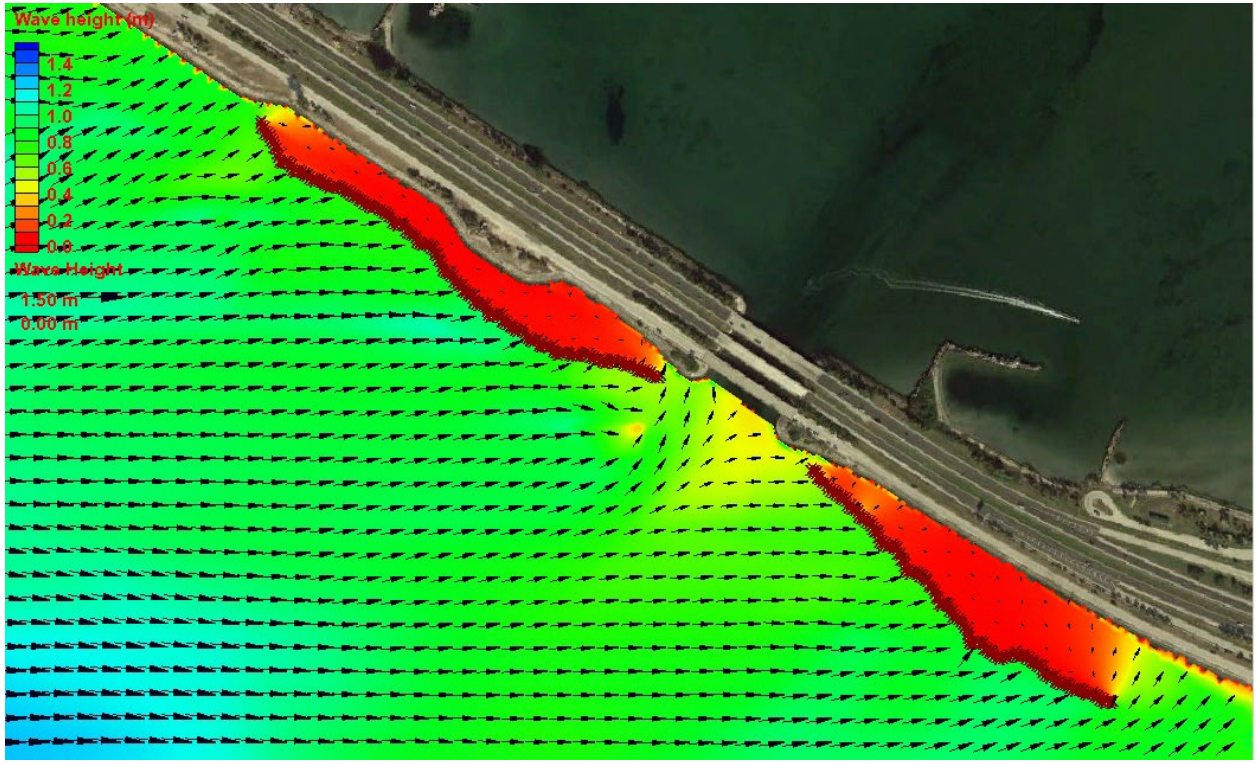
Winds from SSW to NNW (or westerly) have fetches ranging from 10 to 15 km.

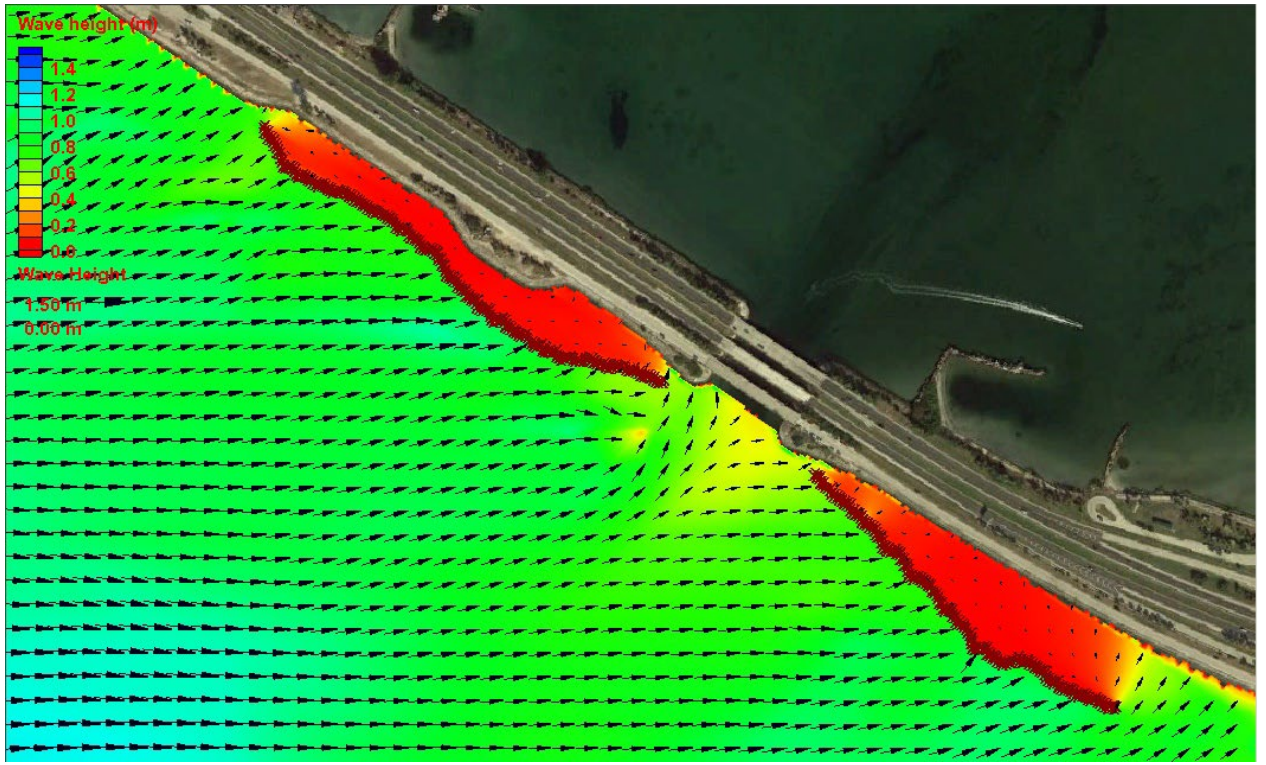
Both GOM and locally generated waves were considered in the design.

Wave impact at Sunshine Skyway project site: currently protected by riprap

Design of WAD®s Artificial Reef System

simulating wave field under modified conditions with WAD®s: examples





Storm waves including wind forcing and 0.5 m surge under Options A and Option B conditions. Left panel: W approaching wave with H_{sig} =1.2 m and T_p = 7.97. Right Panel: WNW approaching wave with H_{sig} =1.1 m and T_p = 6.32.

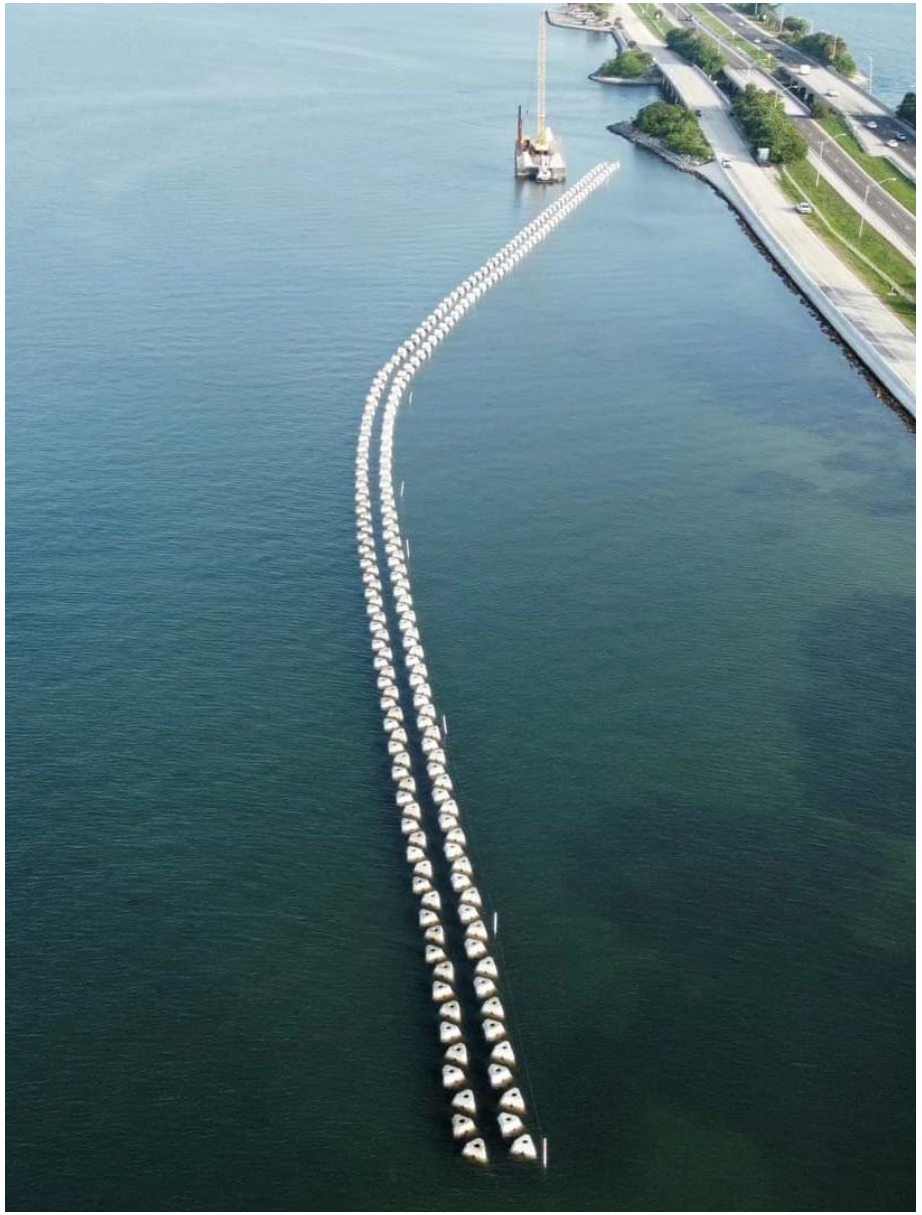
Recommended and Constructed Layout of WAD®s System

Installation of WAD®s Artificial Reef

Two sizes of WAD®s, 8.5 ft and 10.5 ft, were installed.

Installation almost completed: August 2023
Just before Hurricane Idalia

Installation of WAD®s Artificial Reef



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Installation almost completed: August 2023
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WAD®s performance during Hurricane Idalia:

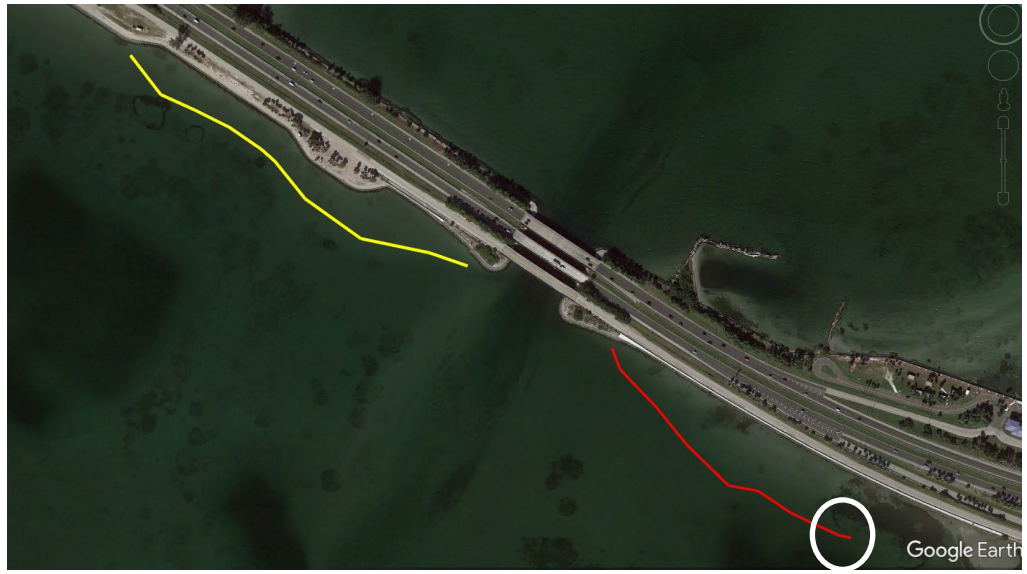
Field data collection:

1) **before and after photos**
2) **underwater photos**
3) **Pre and post-Idalia surveys**

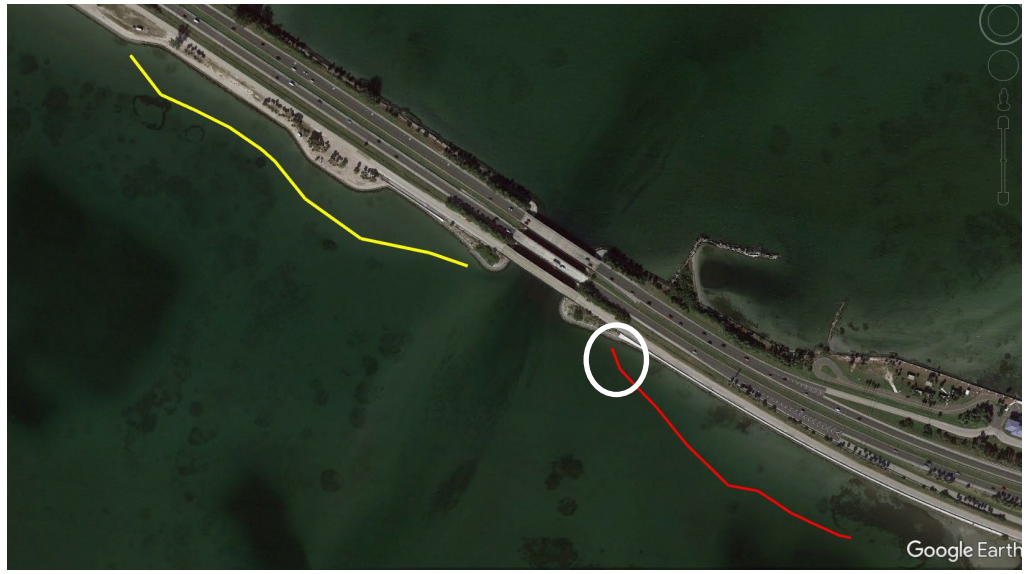
Key issues to address:

1) **scour at the units**
2) **settlement or subsidence**
3) **stability and integrity of the units**

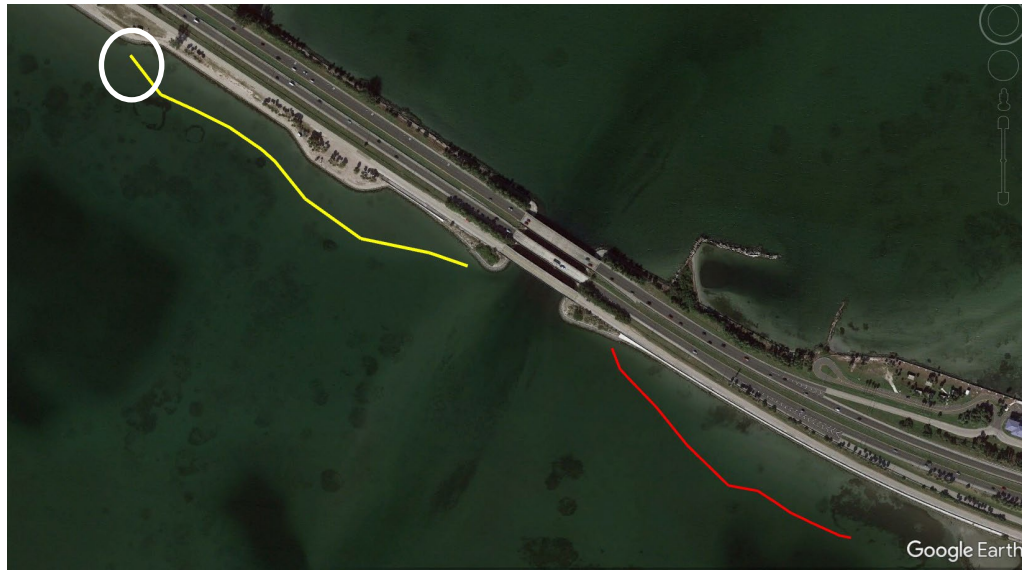
Post-construction monitoring: southeast end



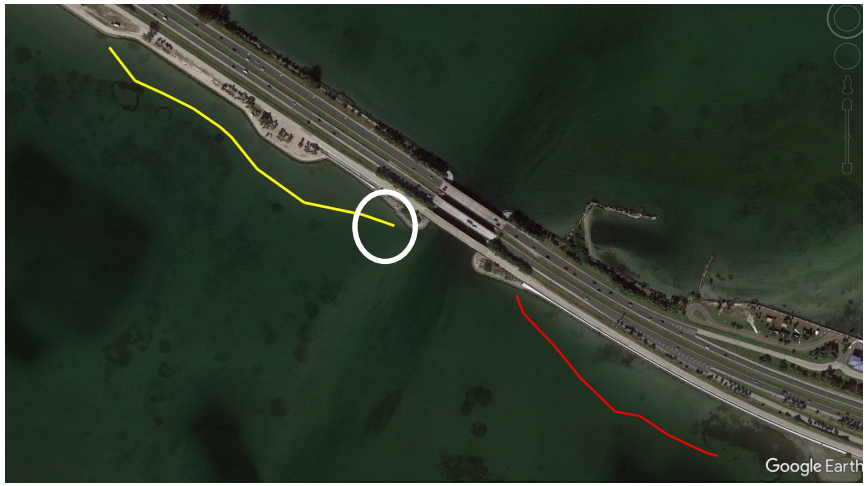
Post-construction monitoring: northwest end of southeast array



Post-construction monitoring: northwest end



Post-construction monitoring: southeast end of northwest array



Post-construction monitoring: middle units

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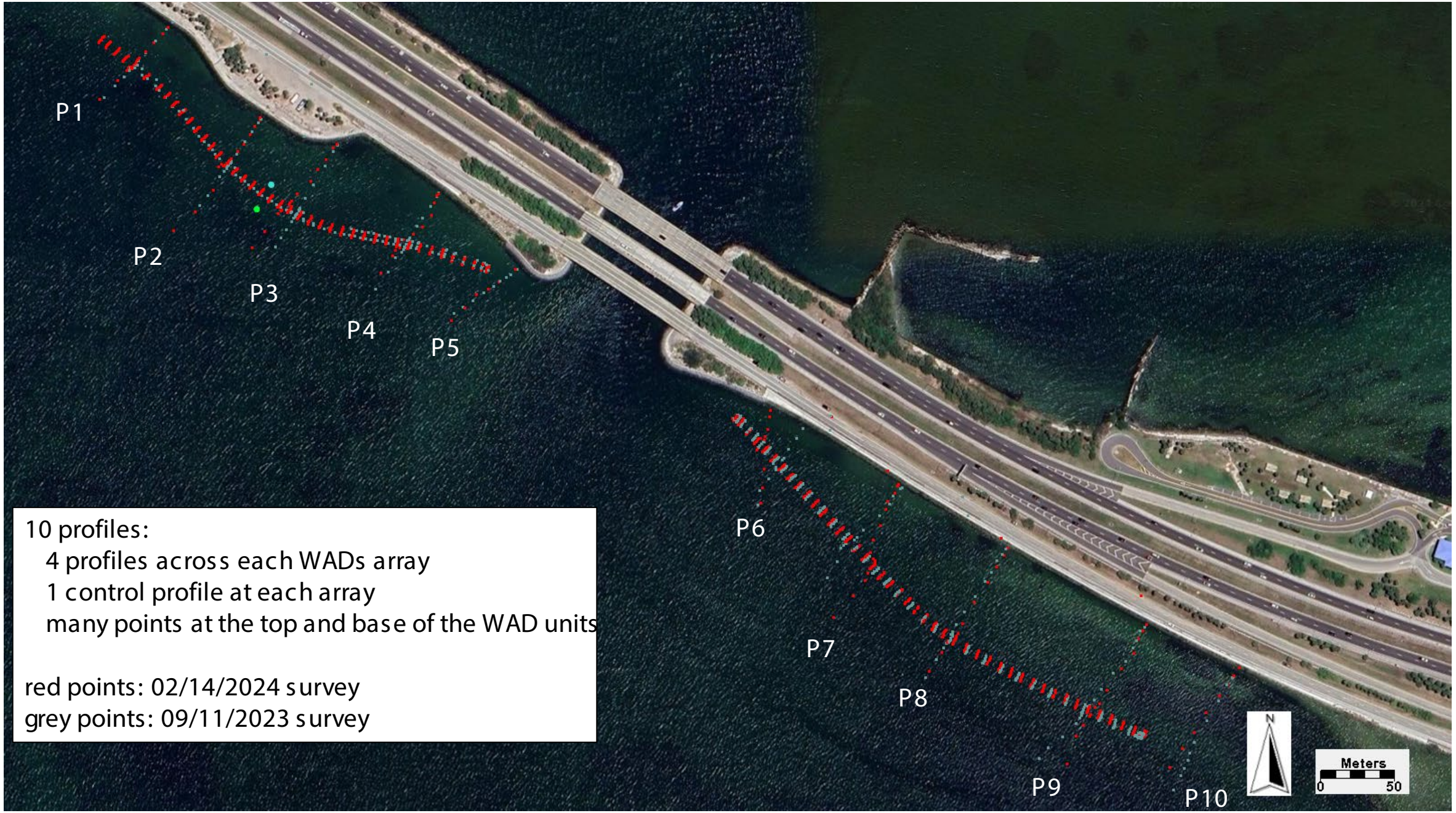
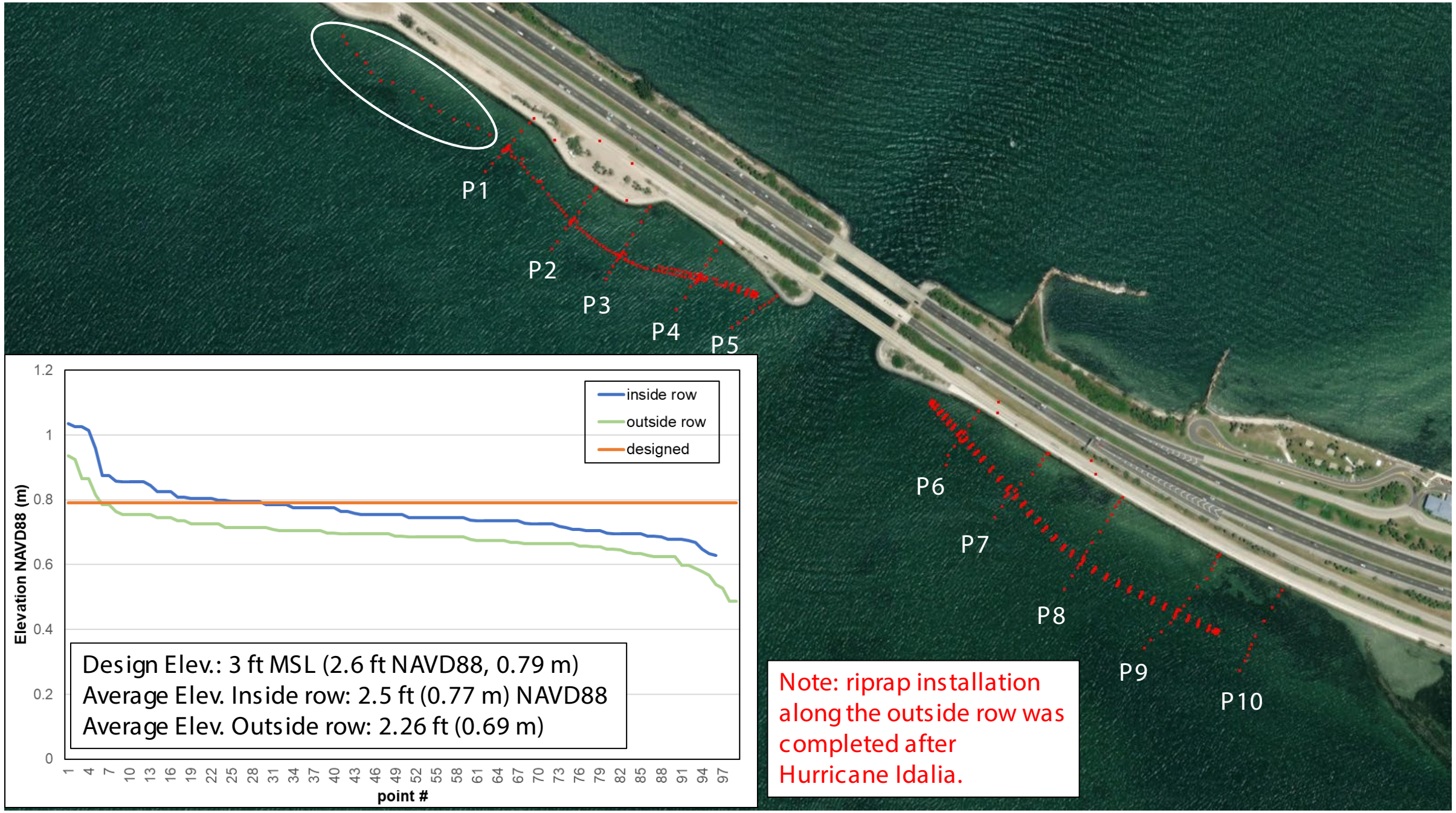
Post-construction monitoring: survey: 09/11/2023 & 02/14/2024

Post-construction monitoring: survey

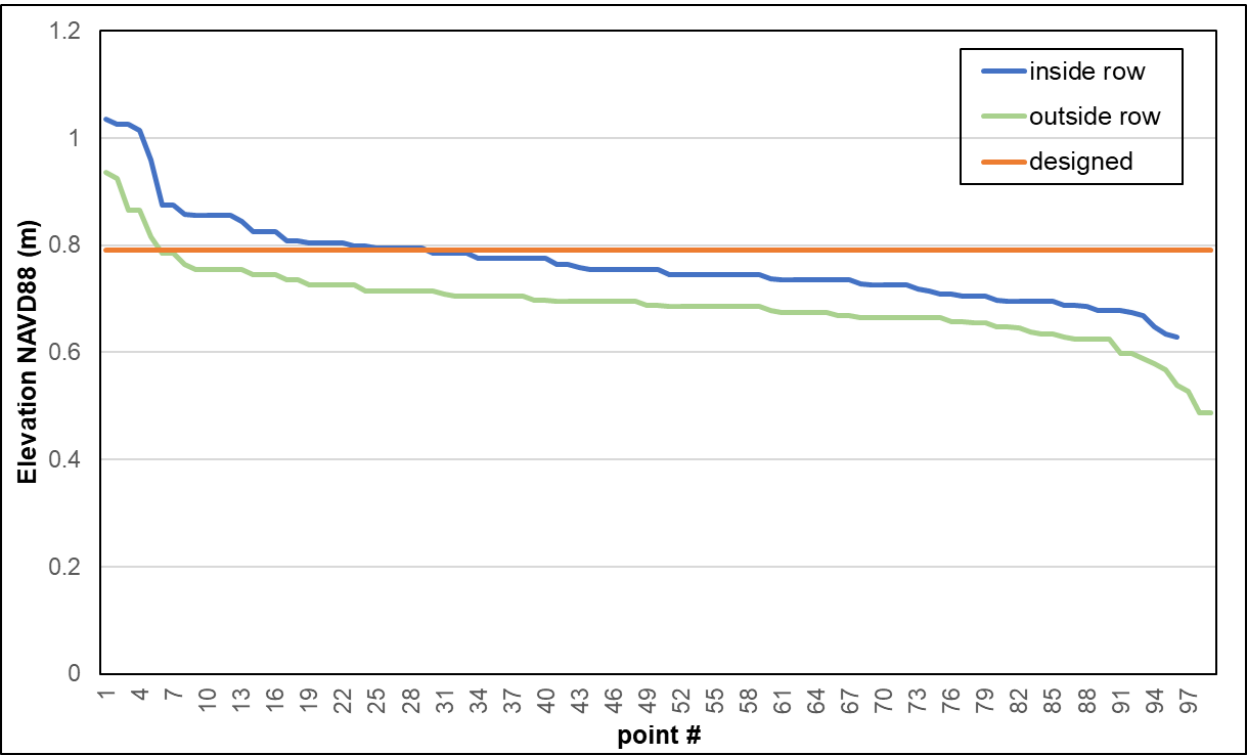


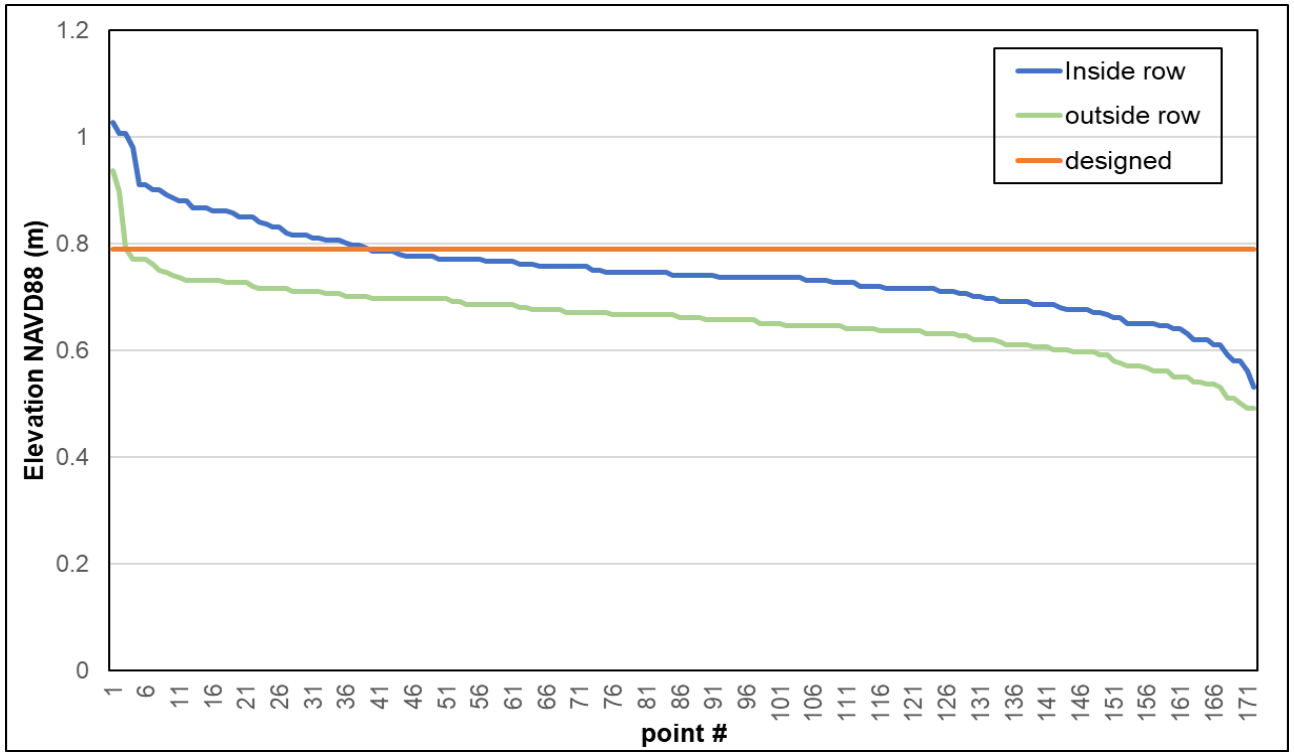
Post-construction monitoring: 09/11/2023 survey



Settlement of the WAD® Units

09/11/2023 survey

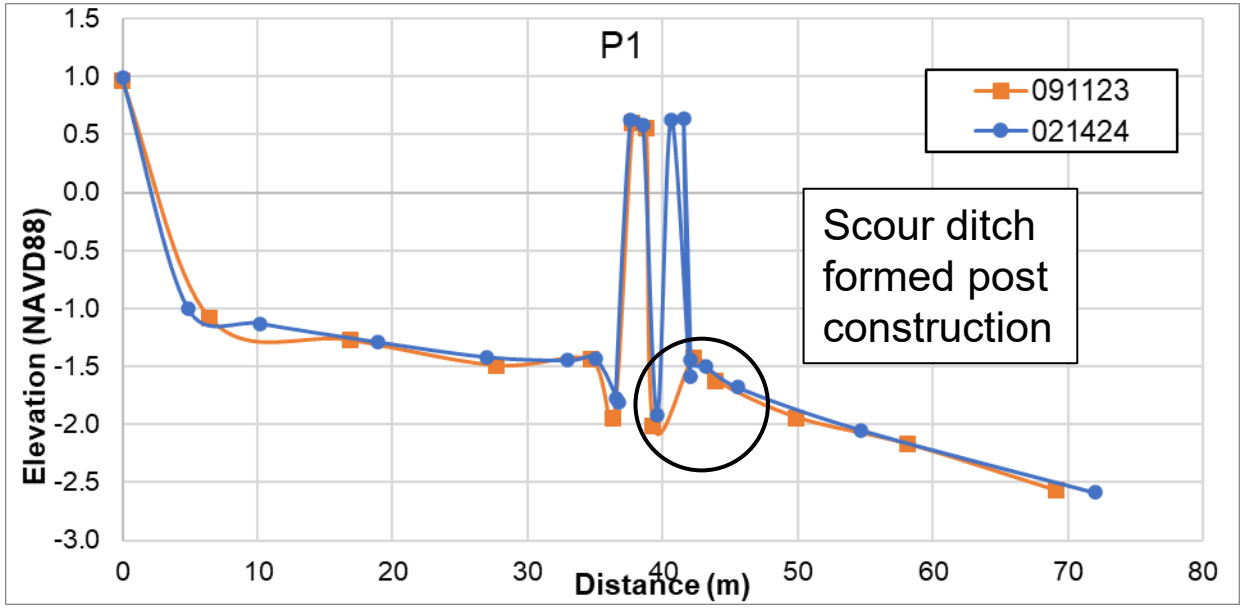


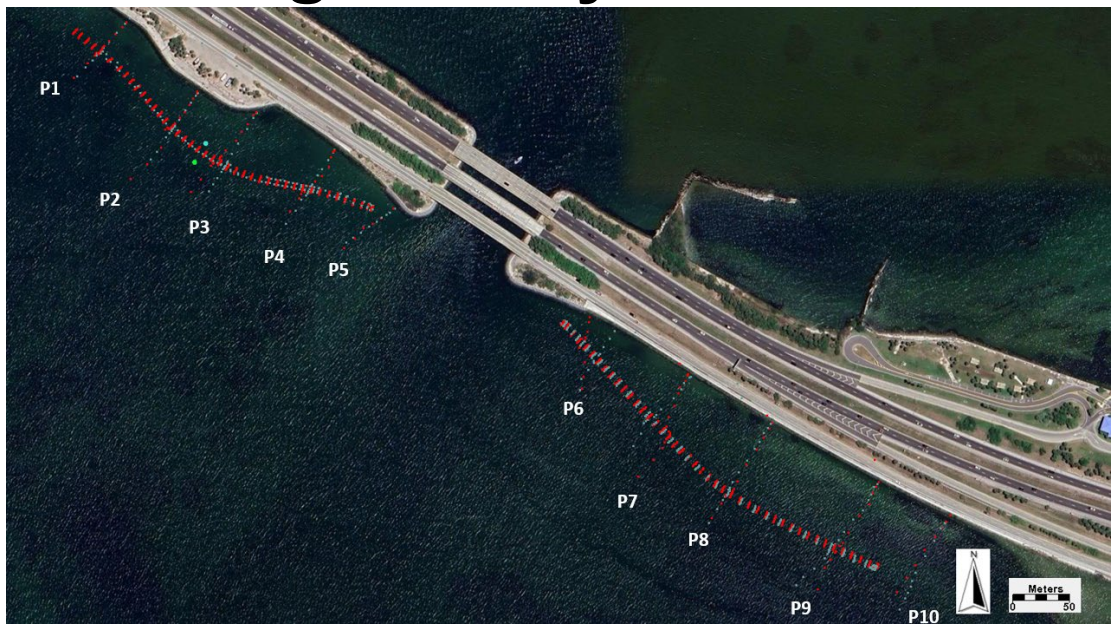


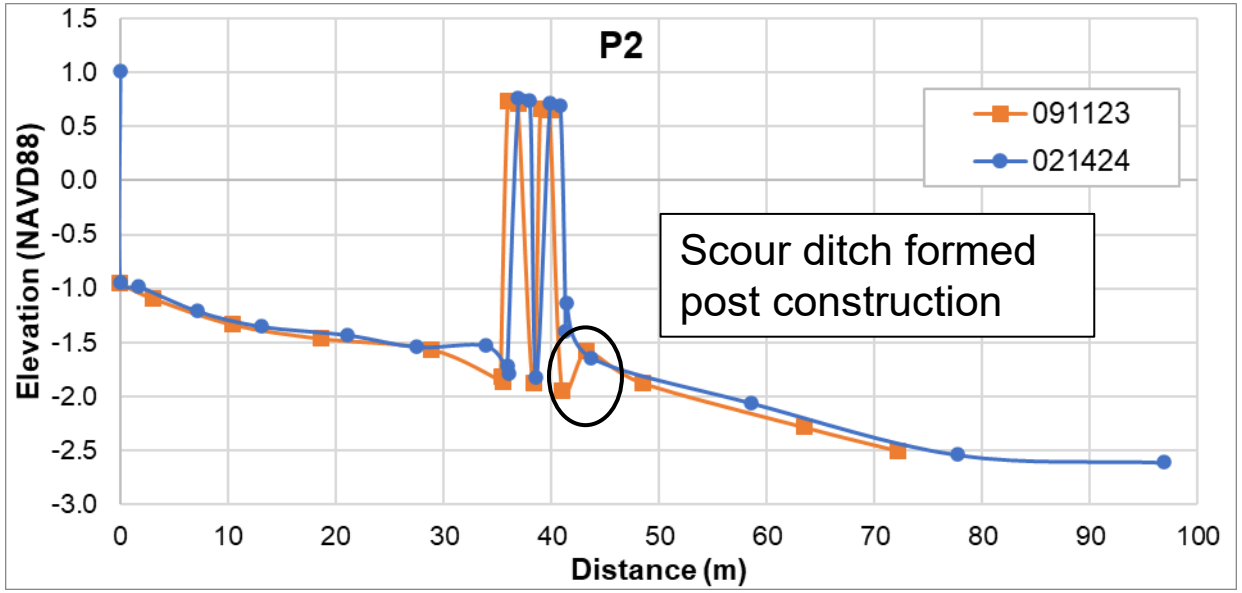
02/14/2024 survey

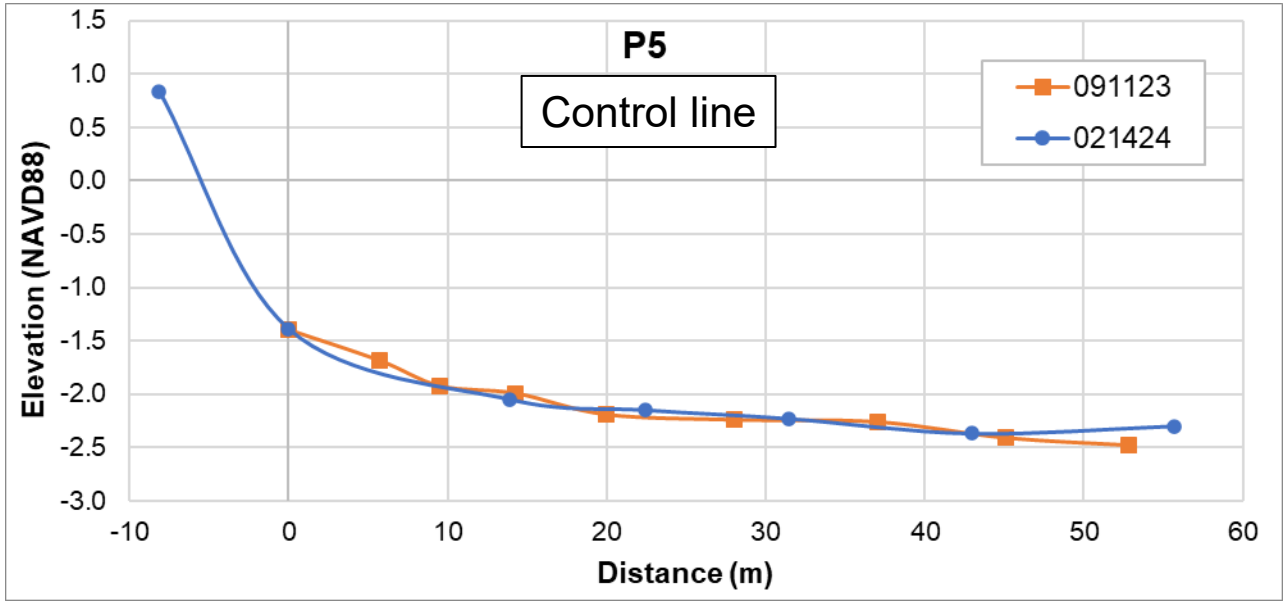
- **Little change between the two surveys**
- **Outside row slightly lower**

Post-construction monitoring: survey

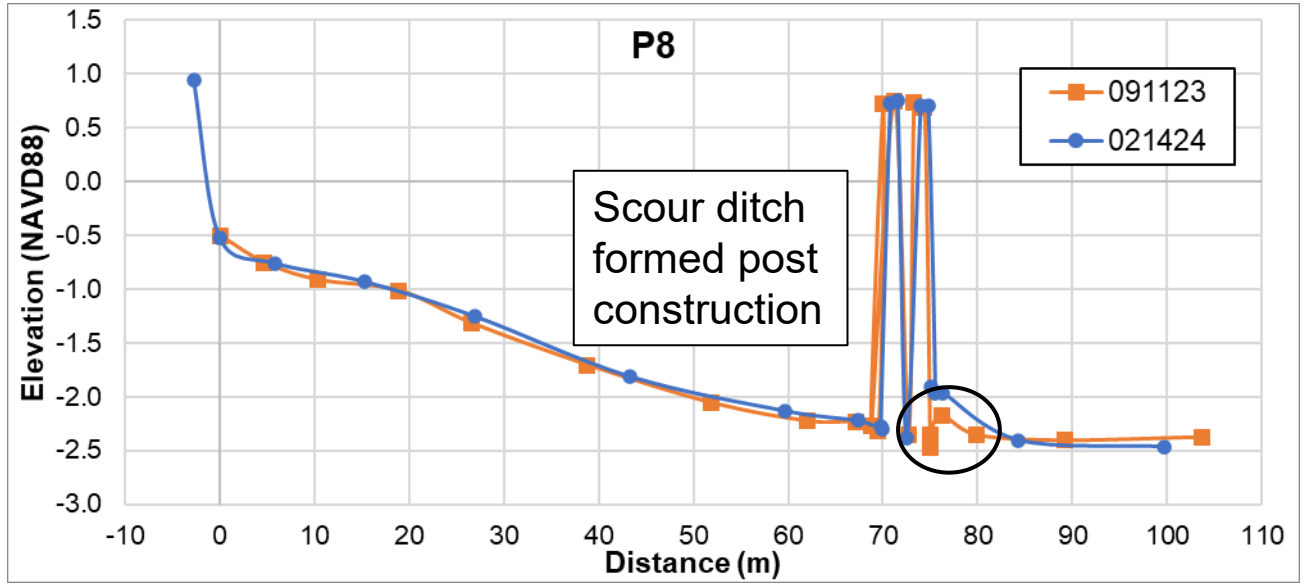


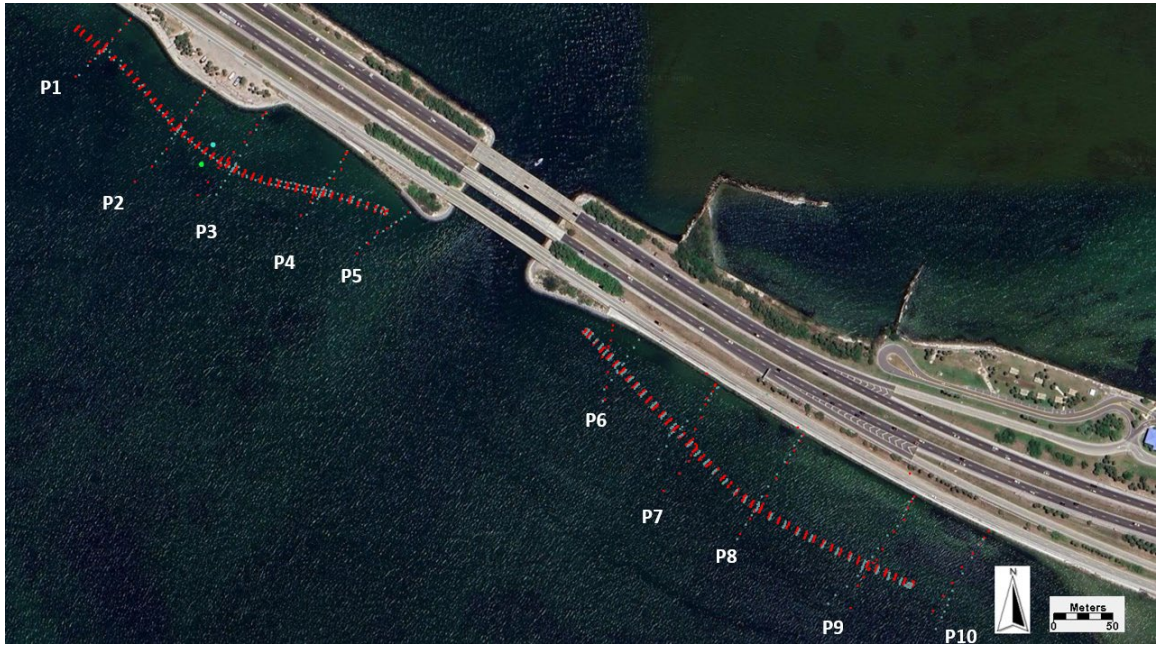


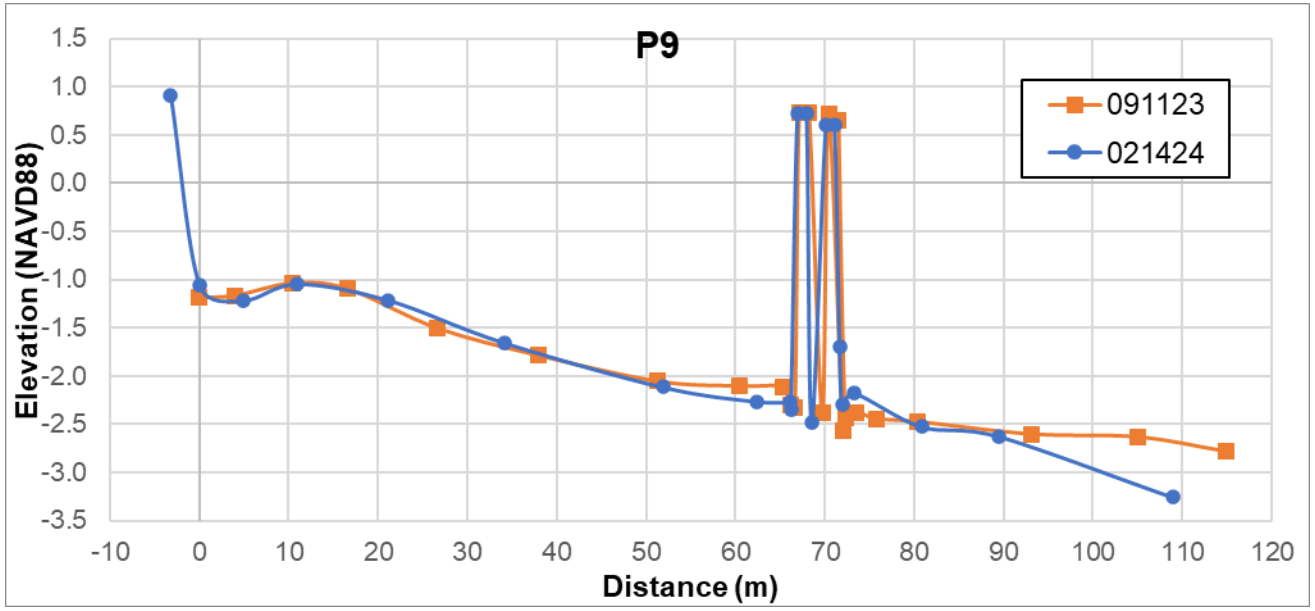


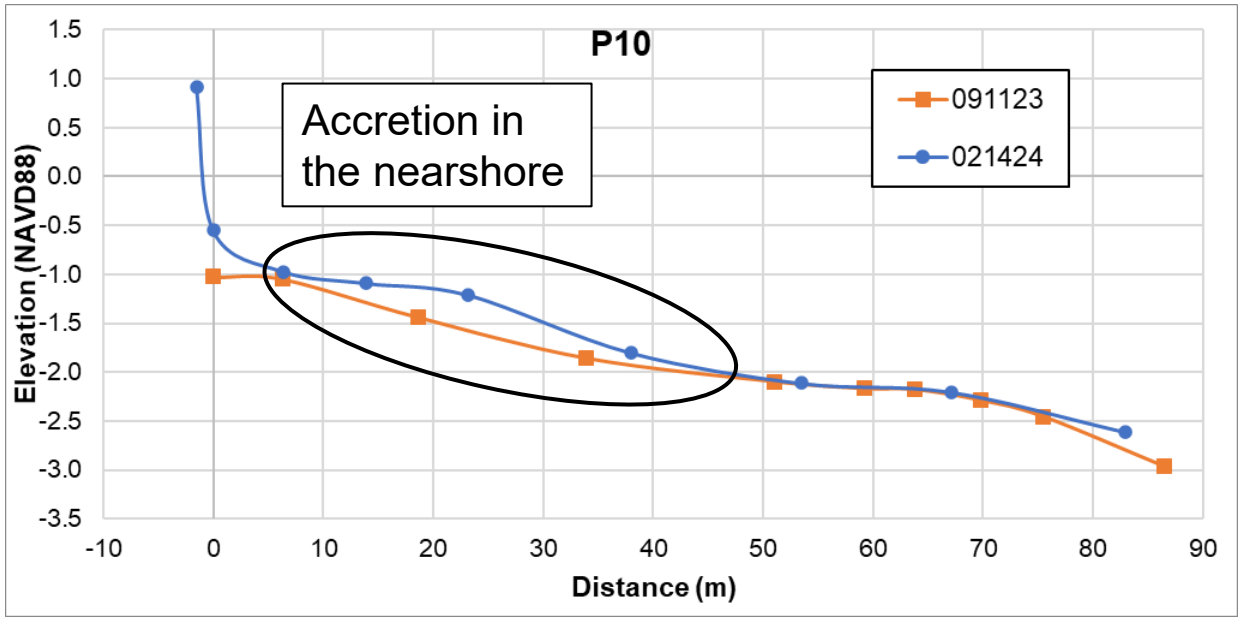


Post-construction monitoring: survey



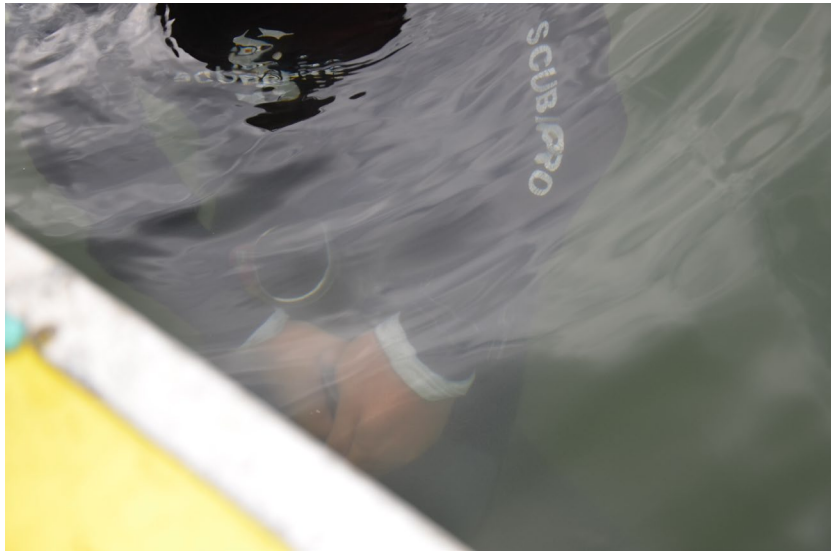




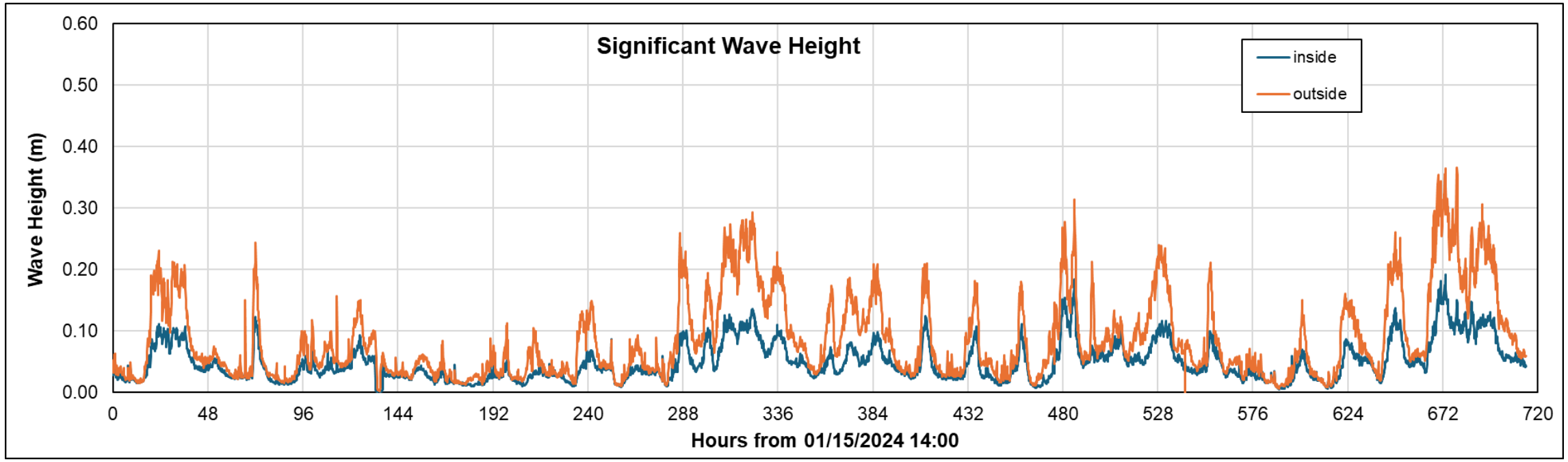


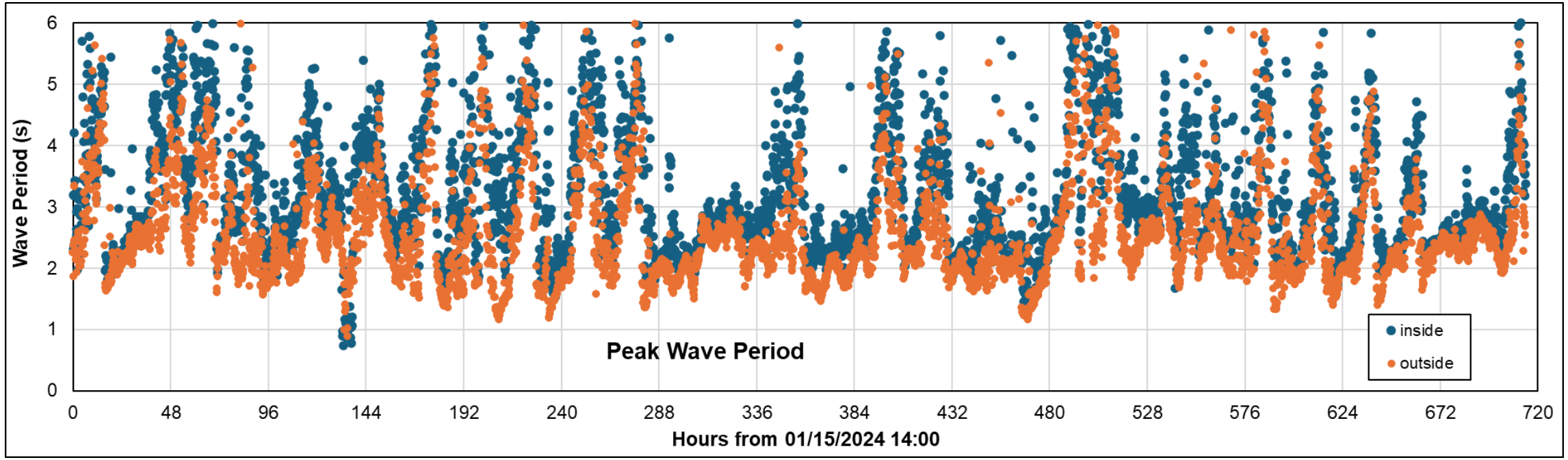
Wave Measurements

Wave Gauge Deployment

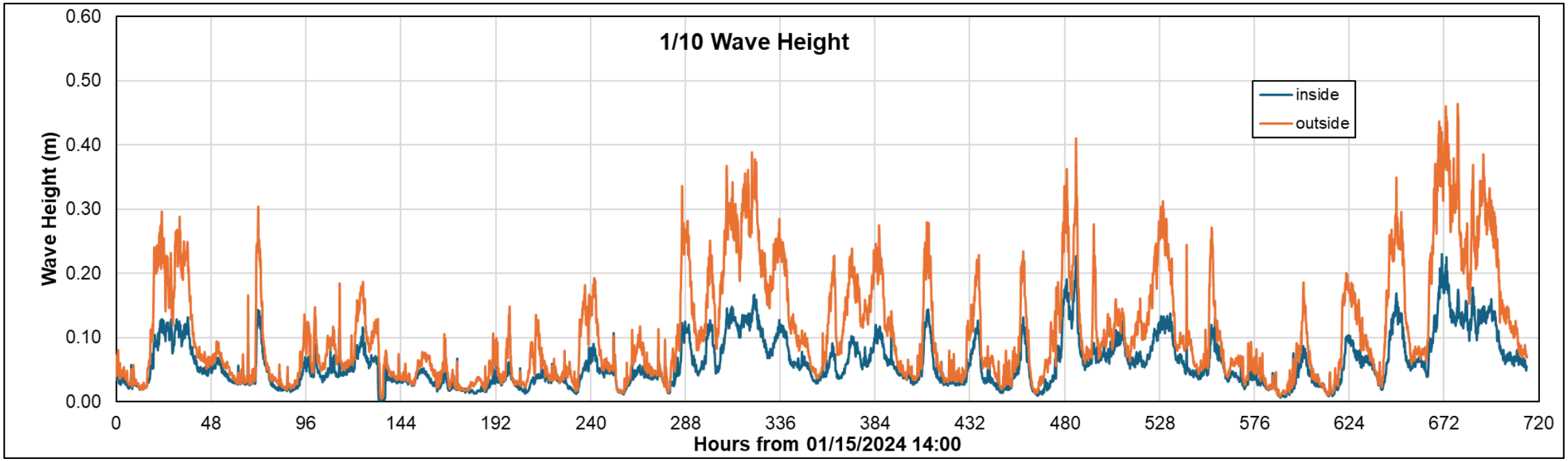


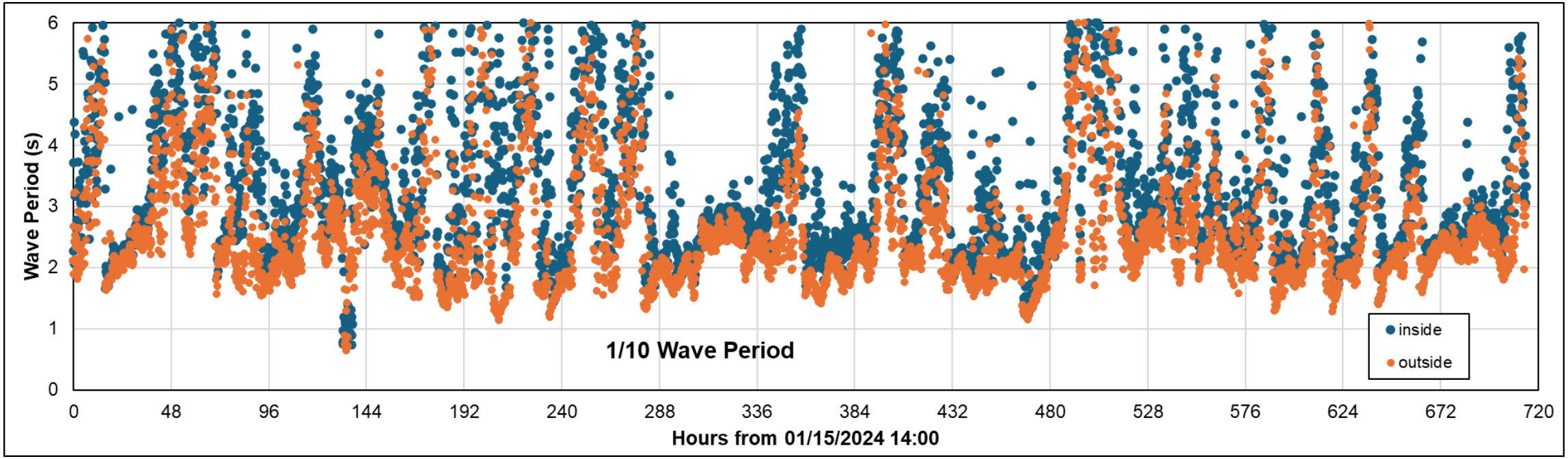
Wave Measurement: Significant Wave Height



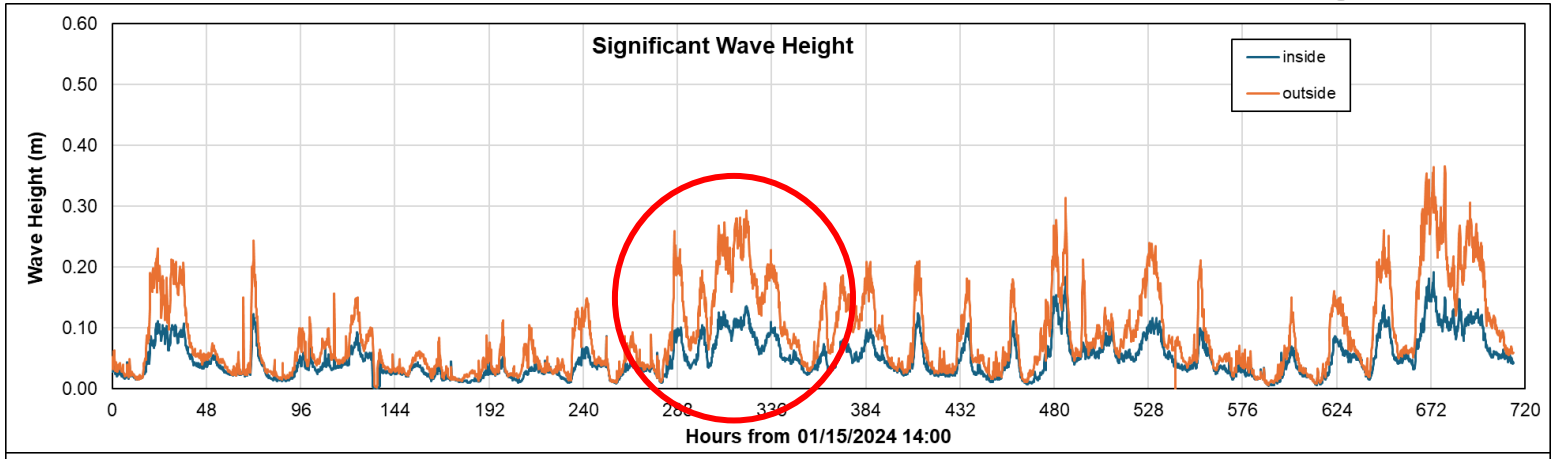


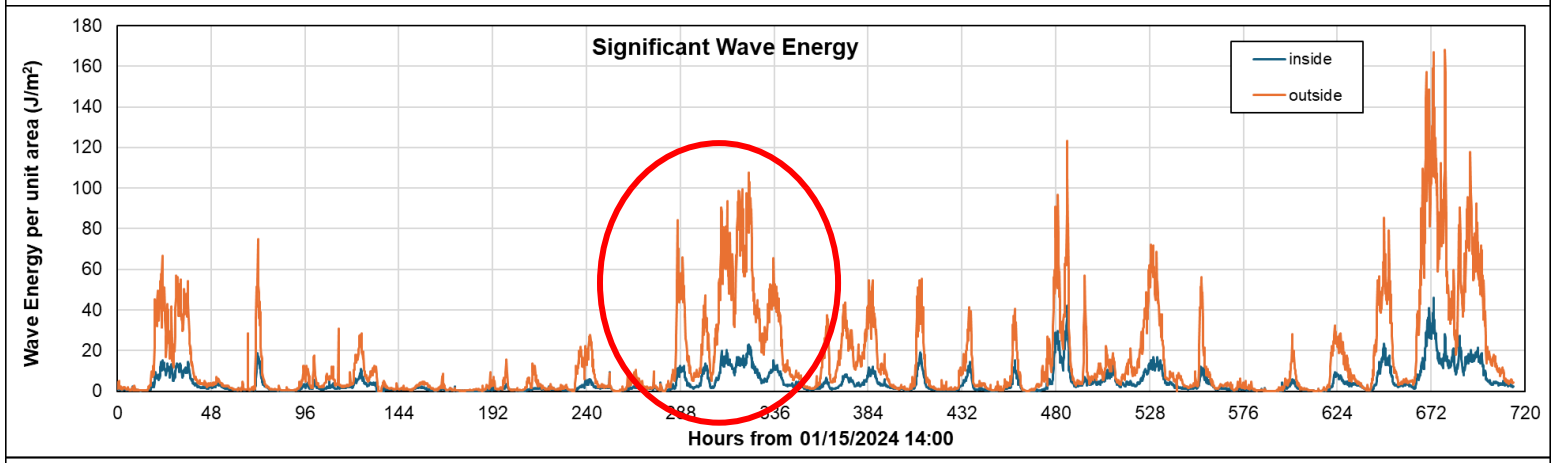
Wave Measurements :1/10 Wave Height

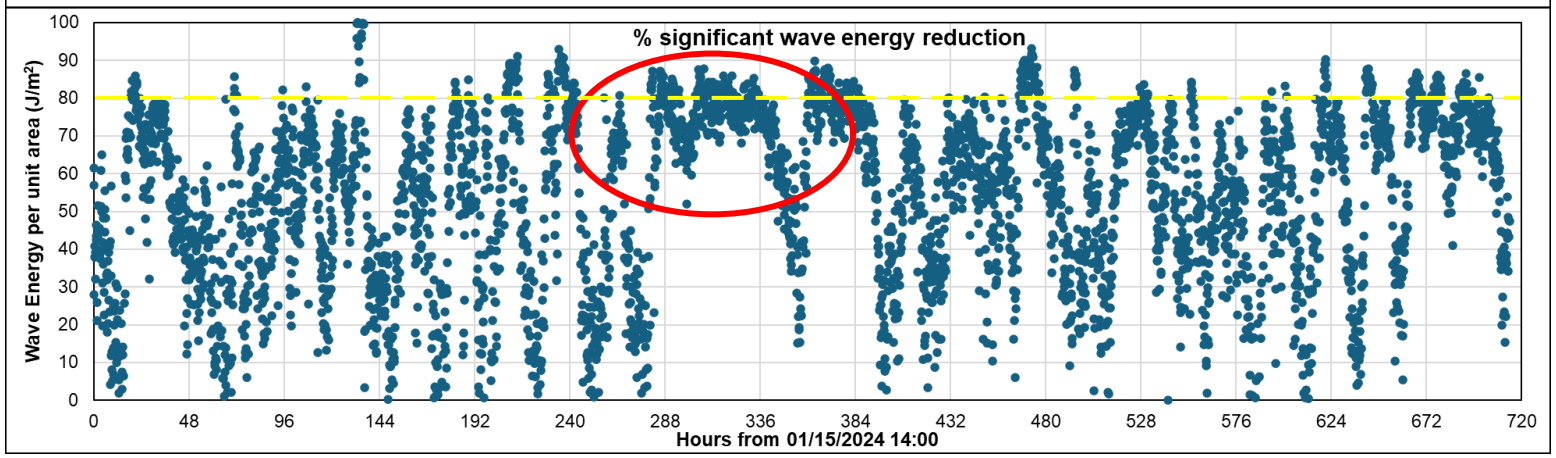




Wave Measurements: Significant Wave Height



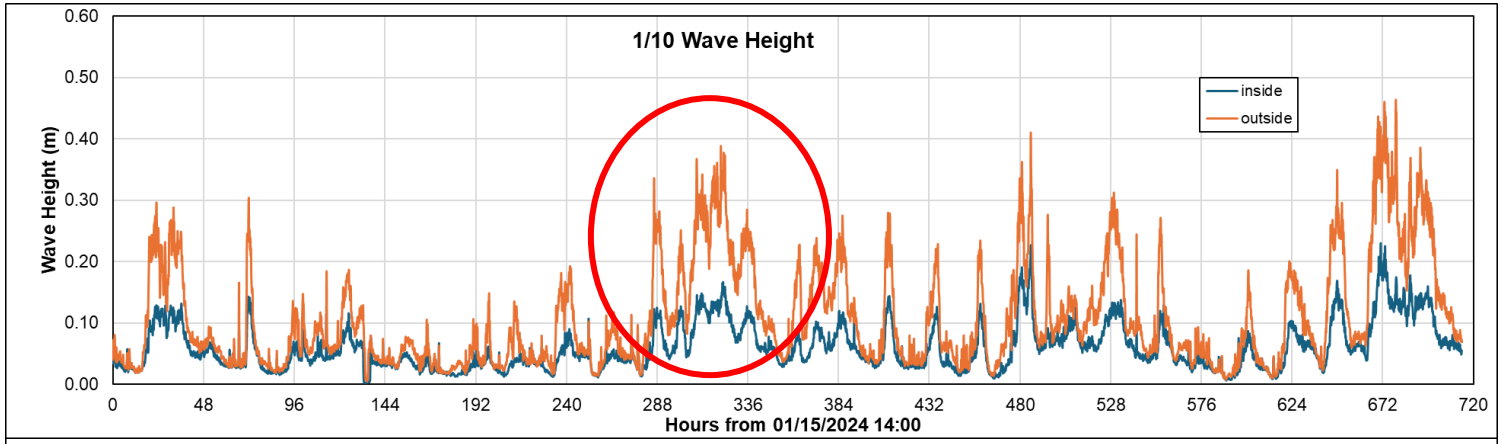


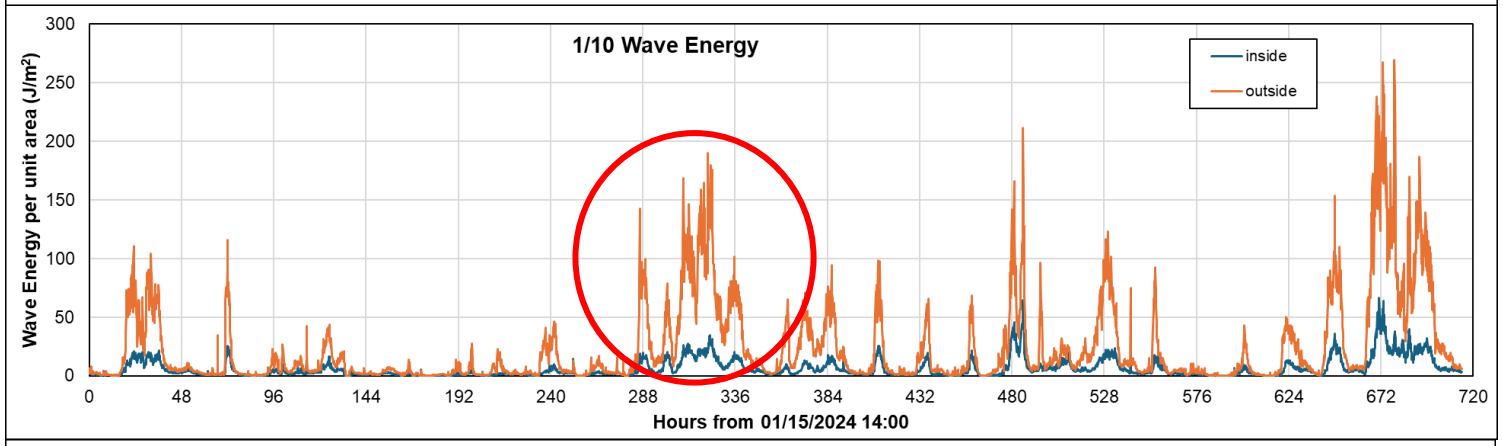


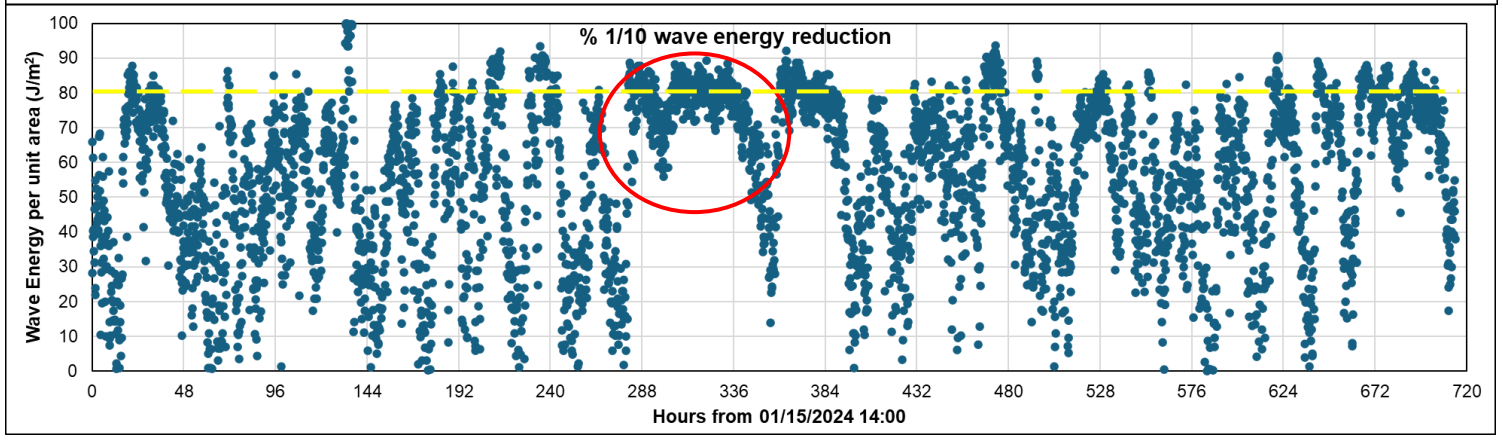
Wave energy per unit area

$$E = \frac{1}{8}\rho g H^2$$

Wave Measurements: 1/10th Wave Height







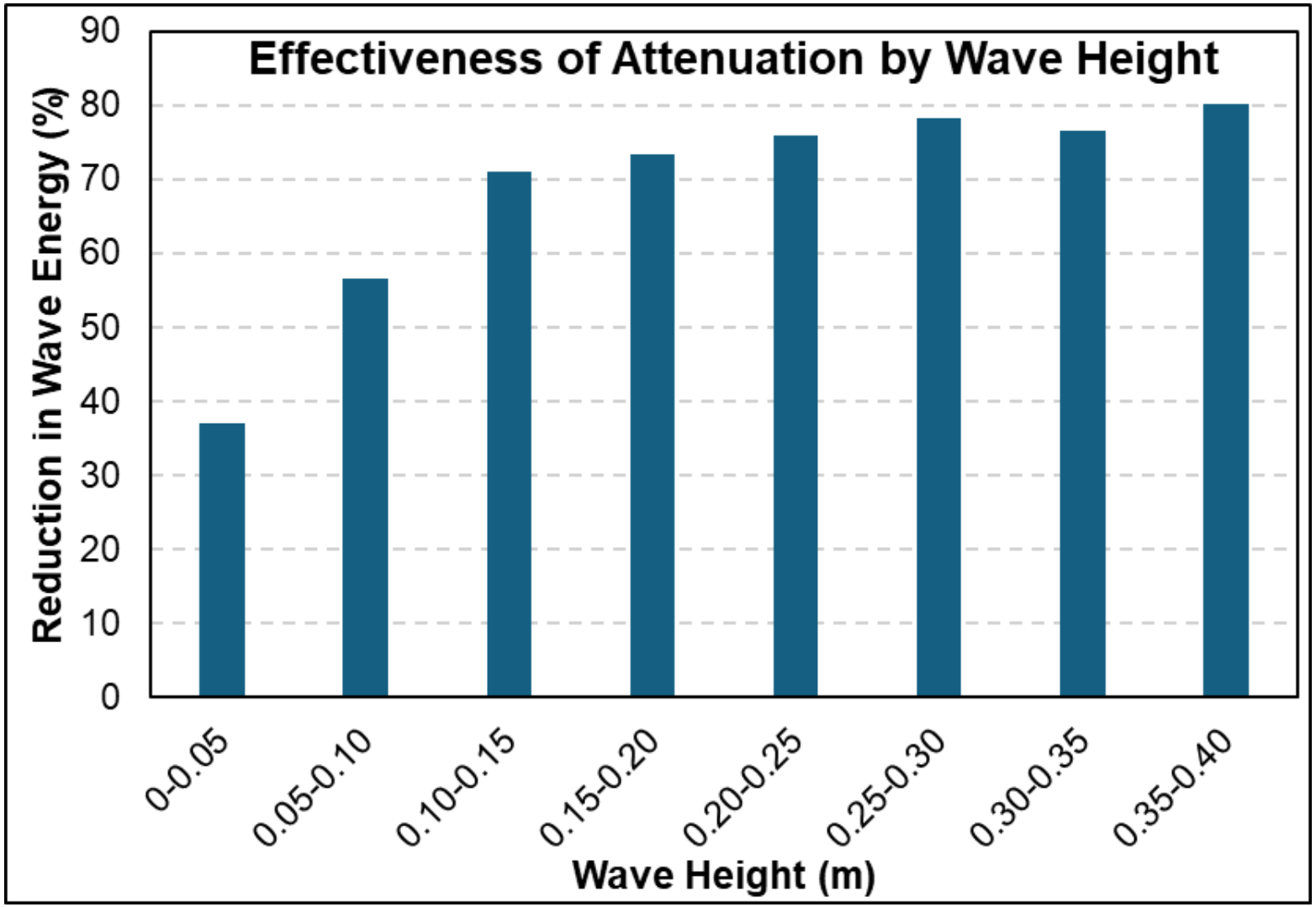
The average height of the highest 10% of the waves (waves that occur 10% of times)

Wave energy per unit area of the 1/10 waves

$$E = \frac{1}{8}\rho g H^2$$

Wave Attenuation Analysis: Significant Wave Height

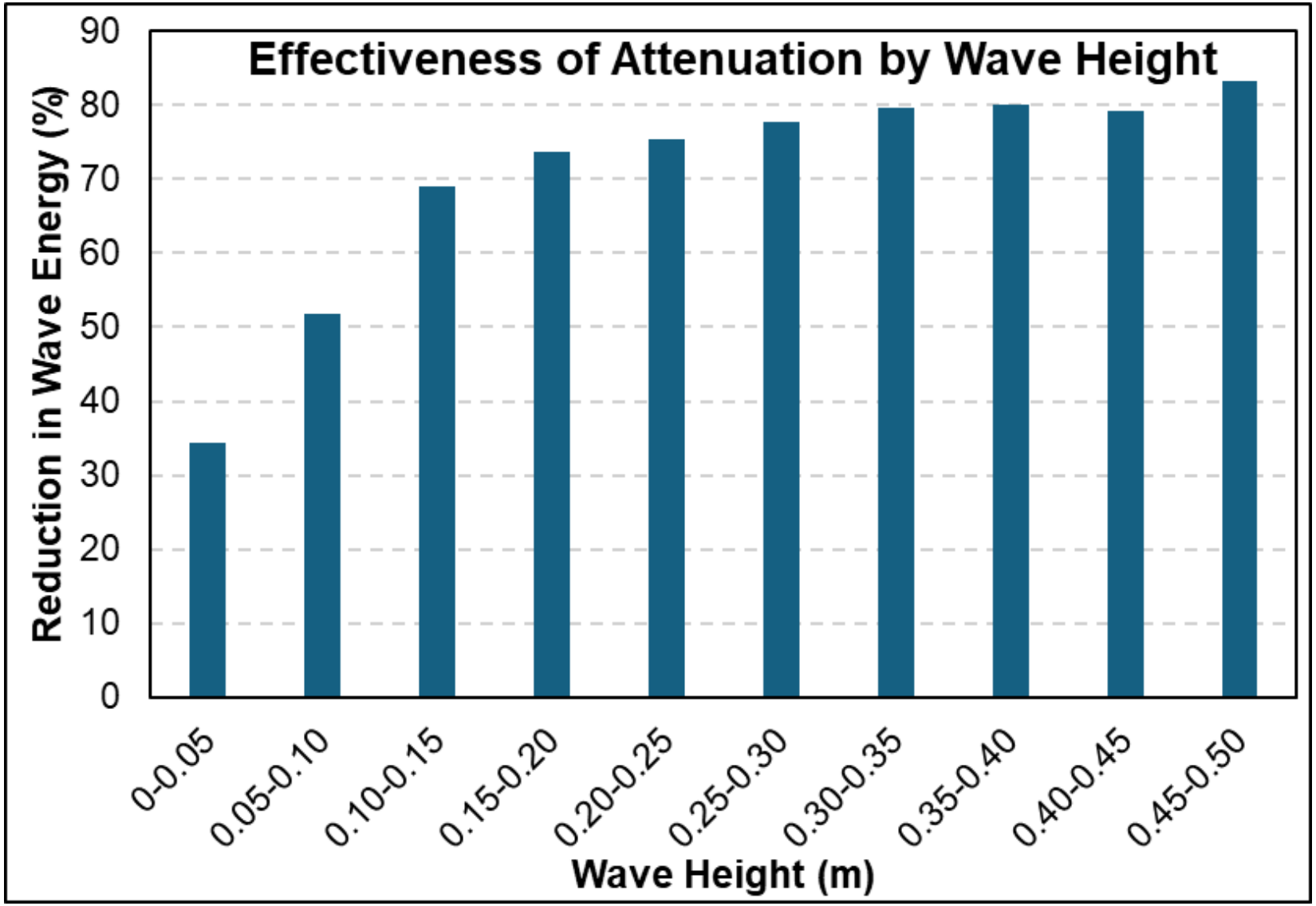
Wave Height (m)	Count	% Reduction
0-0.05	1774	37.07
0.05-0.10	1202	56.49
0.10-0.15	516	71.04
0.15-0.20	417	73.35
0.20-0.25	246	75.86
0.25-0.30	108	78.17
0.30-0.35	16	76.54
0.35-0.40	6	80.09



- **More effective at reducing wave energy with higher waves**

Wave Attenuation Analysis: 1/10th Wave Height

Wave Height (m)	Count	% Reduction
0-0.05	1308	34.38
0.05-0.10	1307	51.70
0.10-0.15	588	68.96
0.15-0.20	364	73.75
0.20-0.25	348	75.38
0.25-0.30	206	77.78
0.30-0.35	114	79.63
0.35-0.40	34	80.03
0.40-0.45	14	79.27
0.45-0.50	2	83.19

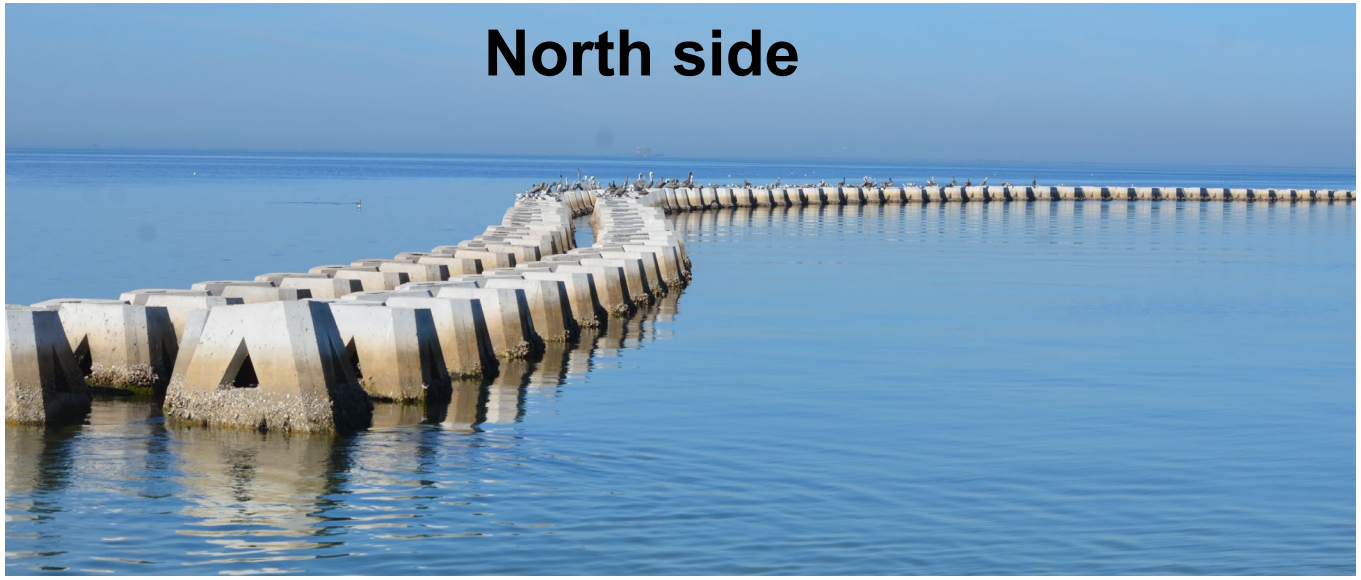


- **More effective at reducing wave energy with higher waves**

Post Helene and Milton

- Units appear to have held up well with little movement

Oyster growth on units



Summary

1) The Sunshine Skyway WAD®s project is composed of two long segments, ~480 m (1580 ft) and ~375 m (1230 ft) long, respectively, with no gap within each segment.
2) The WAD®s were designed to extend 0.91 m (3.0 ft) above MSL, or about 0.79 m (2.6 ft) above NAVD88, or 0.61 m (2.0 ft) above MHHW.
3) The integrity of WAD®s held well during Hurricane Idalia, with minor tilting. A scour ditch of up to 0.5 m (1.6 ft) deep (including scour at the base of the units and deposition directly seaward) was measured along the seaward edge of the array. This ditch was filled by riprap after H. Idalia. The units appeared to also hold up well after Hurricanes Helene and Milton.
4) On average, the top elevation of the WAD®s units is 0.71 m NAVD88 (2.3 ft), or ~0.3 ft lower than the designed elevation of 0.79 m NAVD88 (2.6 ft). The top elevation of the landward row is 0.77 m NAVD88 (2.5 ft). The top elevation of the seaward row is 0.69 m NAVD88 (2.26 ft).
5) The permeable WAD®s array allowed a modest amount of wave energy to transmit through, avoiding stagnant conditions landward of the artificial reef.
6) The WAD®s array is more effective in blocking higher waves, reducing wave energy by more than 80% for waves higher than 0.30 m.