Technology for environmental protection

Channel Deepening Project Lyttelton Port, NZ

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Outline

- Brief background on Lyttelton Port and the Channel Deepening Project
- Key challenges and the technology-based solutions
  - Real-time water quality monitoring
  - Turbidity trigger system
  - Real-time data processing and web-based interface
- DUKC and reduction in dredge volumes

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Lyttelton Port

- Bank Peninsula, South Island, NZ
- Connected to Christchurch via road and rail (12km to CBD)
- Volcanic harbor, infilled with soft silts
- Water depths 5-11m
- 2010/2011 earthquakes caused significant damage, rebuild required
- Harbour culturally important to Iwi

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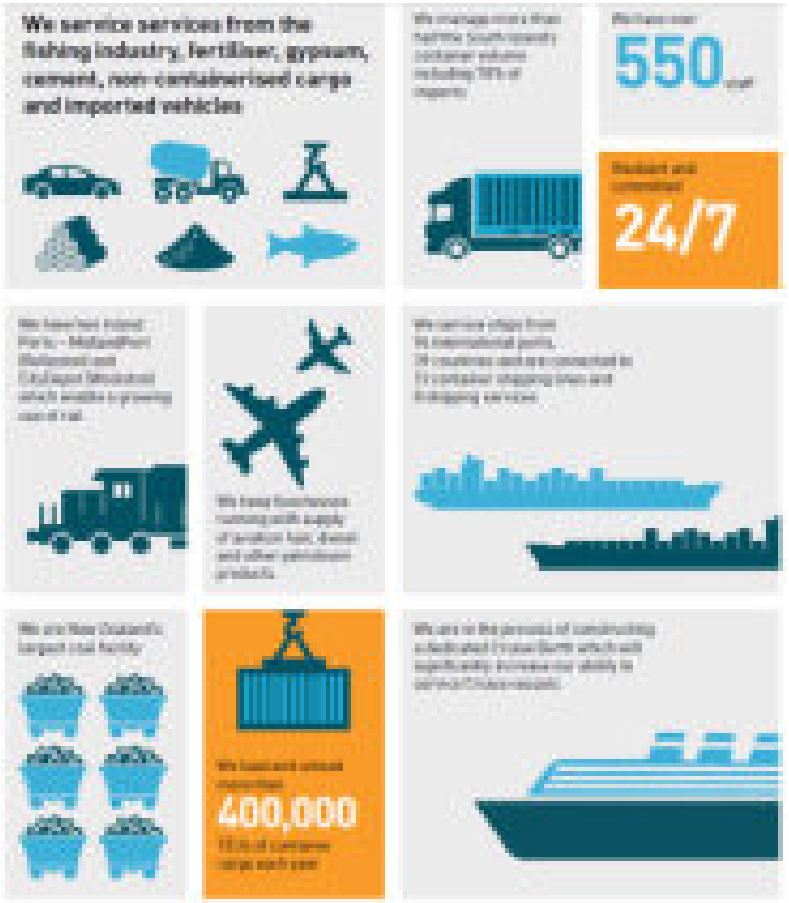
Lyttelton Port operations



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Channel Deepening Project

- Post-quake recovery designed for deep draught capable ships
- Pre-dredge declared depth 11.9m CD – draught 10.5m all tides, 12.4m across high
- Full Channel Deepening Project 14.5m all tides, 1st stage – 12.5m all tides.
- Total volume 18 million m^3, this stage 6 million m^3
- Deepen (~2m), widen by 20m, lengthen by 2.5km and increase size of swing basin

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Key Challenges

- Time constraints
- High ecological values within harbor and offshore
- Protection of deep cultural values
- Keen stakeholder interest
- Easily re-suspended and mobile sediments
- Financial viability

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Solutions

- Invest in robust real-time water quality monitoring
- Involve stakeholders in design and implementation of environmental management systems
- Robust adaptive management and turbidity trigger system
- Web-based data management, processing and display
- No secrets – data available real-time and all reporting
- Reduce dredging volumes (Giles to discuss)

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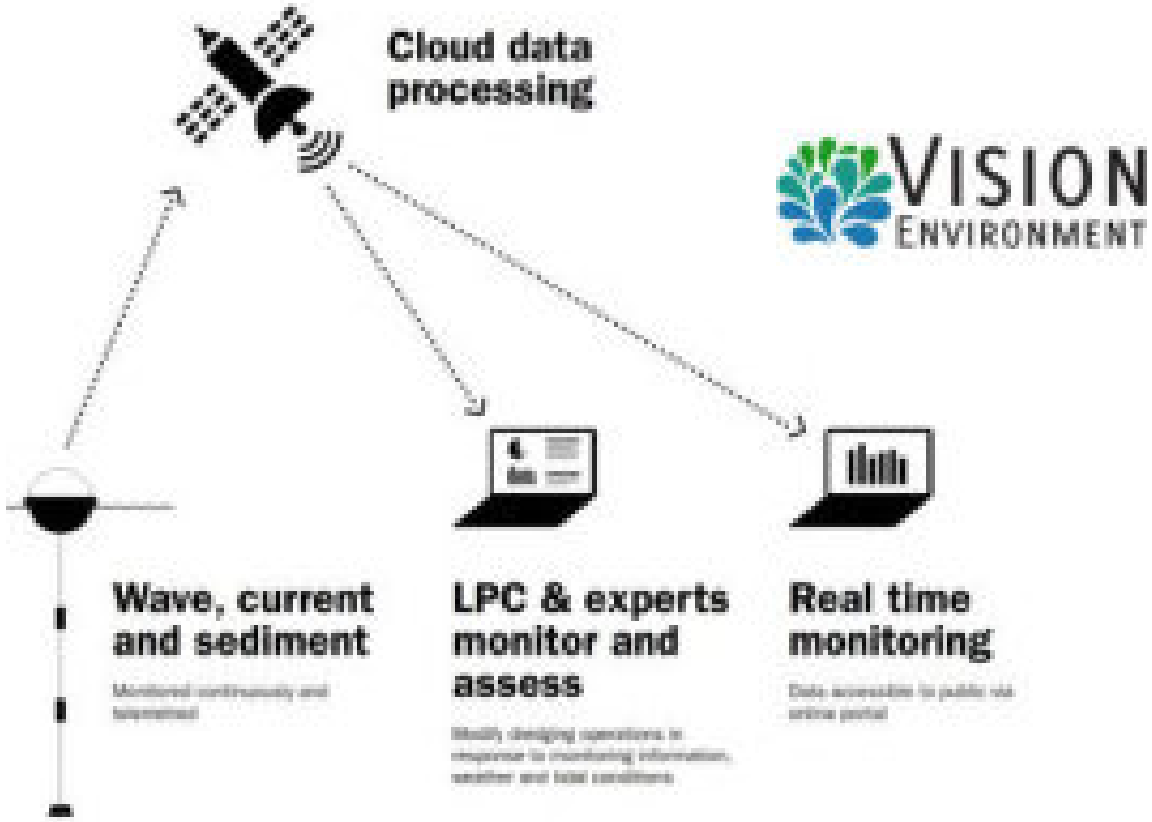
Real-time monitoring



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Turbidity management

- Chose to integrate management of dredging operations and turbidity plumes in real-time, all the time
- Utilise technology to integrate elements and provide interface
  - Complex real-time water quality data
  - Real-time meteorological, wave and current data
  - Dredge location
  - Complex turbidity trigger arrangement
- Fully transparent, key data available to all.

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Turbidity trigger system

- Critical to address stakeholder concerns
- Background + modelled dredge-plume based trigger
- Designed to preserve level and character of existing background conditions
- Three tiers, each with a NTU level and hours per 30 days allowed above that level

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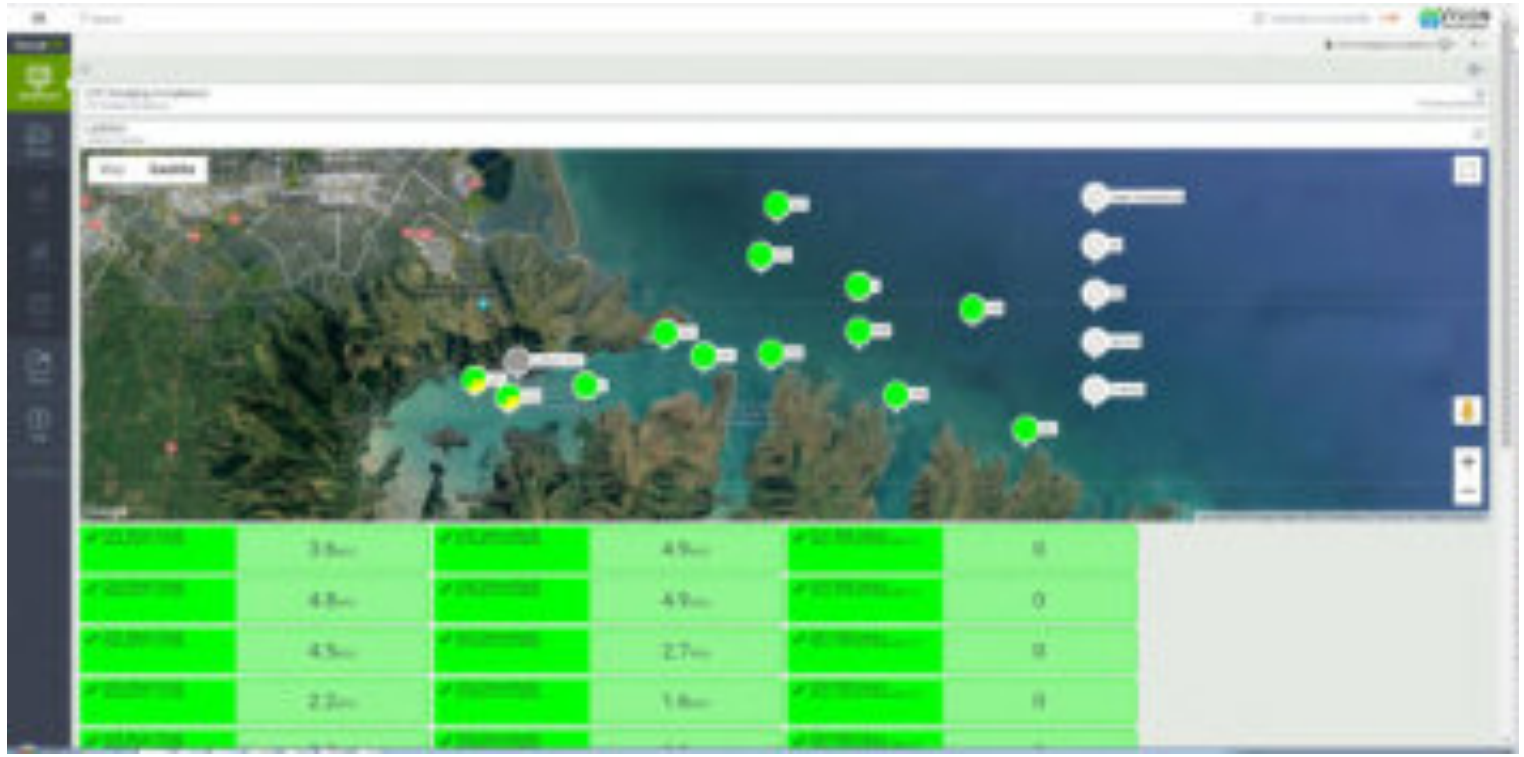
Web based system

- Received data from 16 telemetered buoys and met station
- Ran various algorithms in real-time
- Automated alerts
- Displayed all data
- Simple colour coded dashboard
- Mobile device optimised



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- Simple colour coded dashboard
- Mobile device optimised

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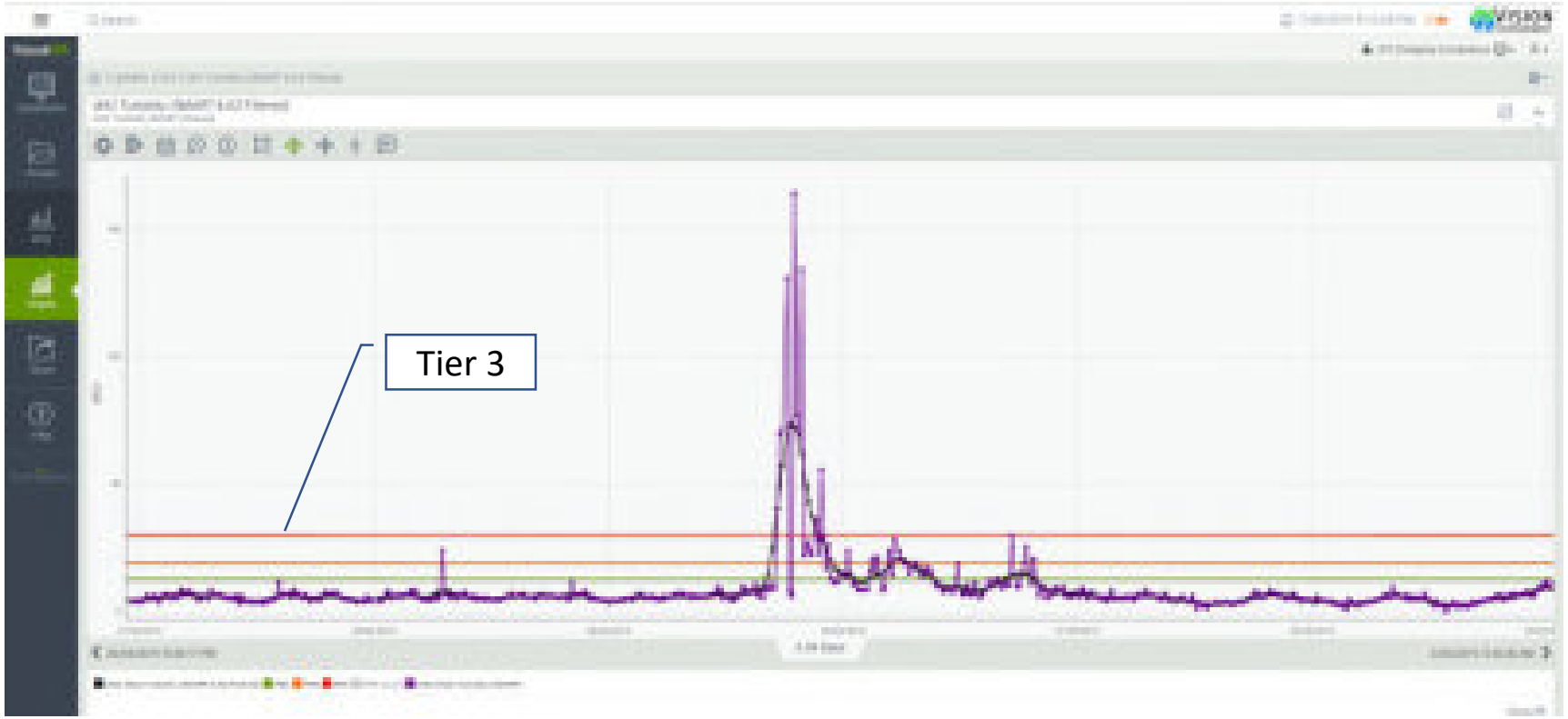
Web based system

- Full interrogation over entire time series
- Key tool in managing dredge
- On-display permanently on bridge of *Fairway*
- Concurrent met, wave and current data



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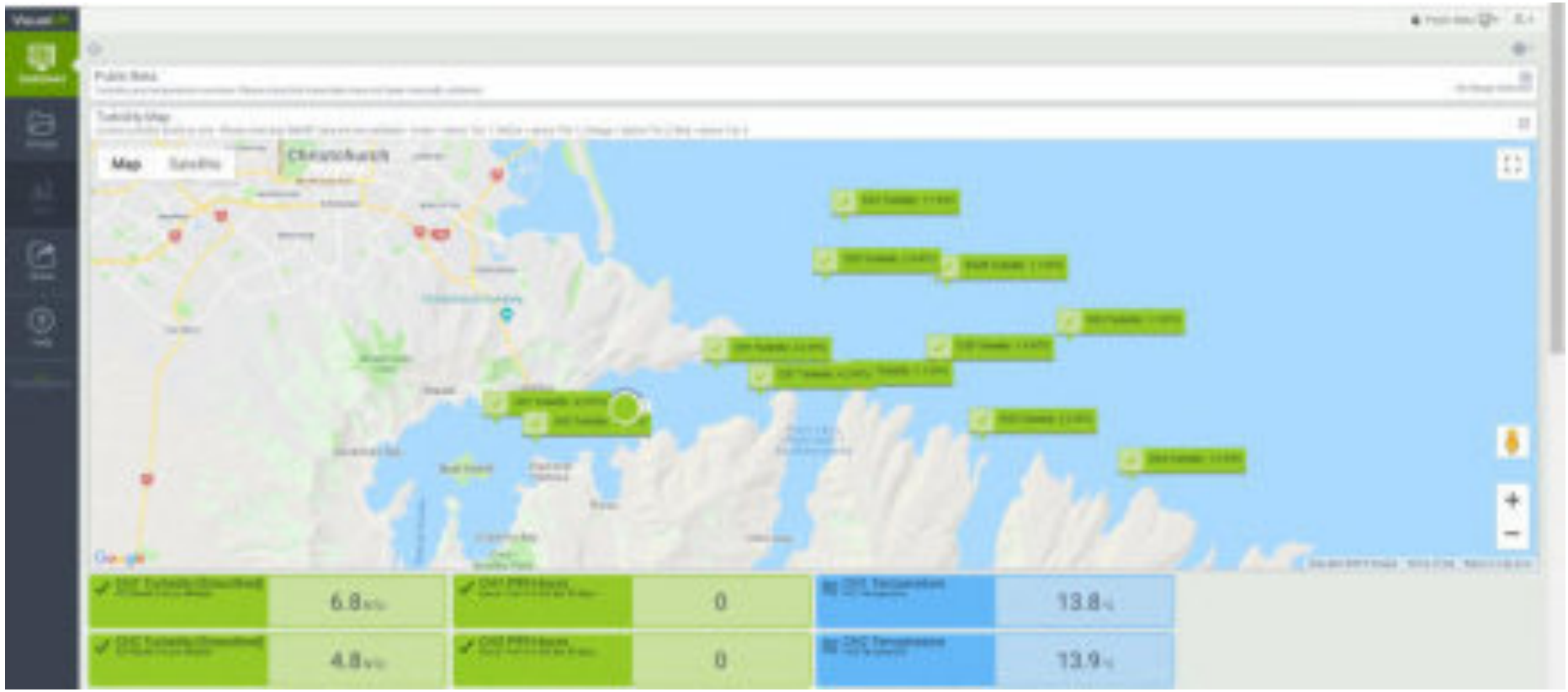
Public website

- Simplified data available to anyone, real-time 24/7



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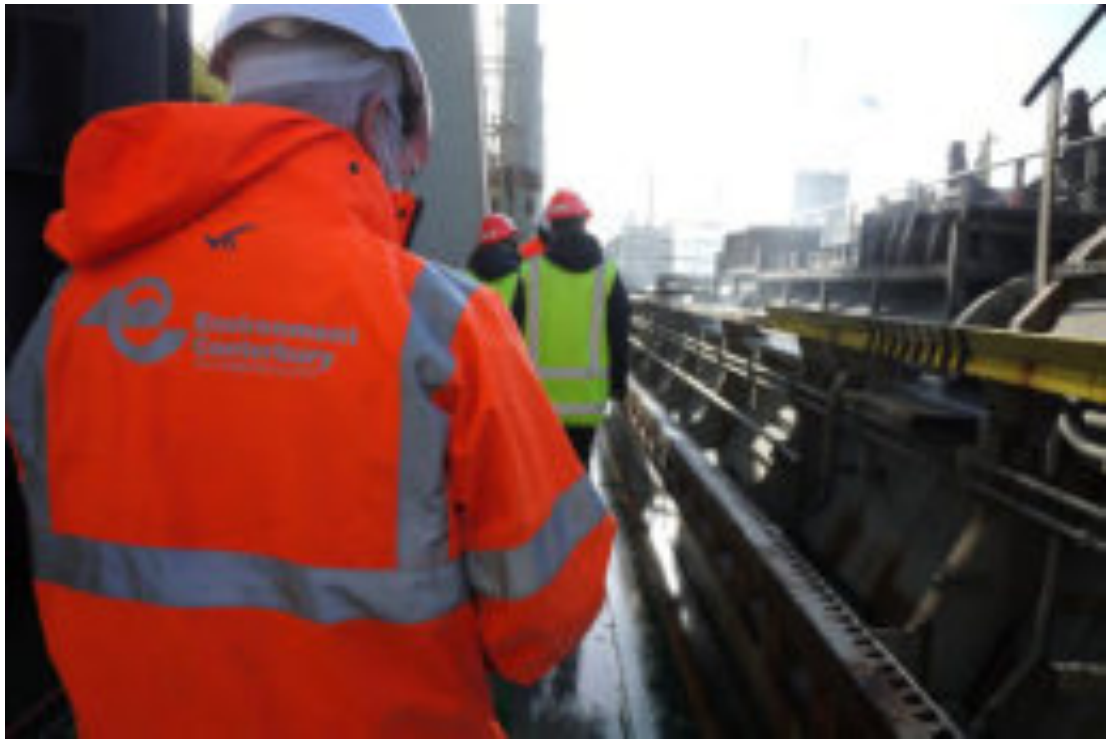
Outcomes

- No dredge caused exceedance of Tier 3 – No delays to project
- System enabled dredge to tune operations to materials and conditions, resulting in efficient dredging
- No public complaints or adverse media
- Met environmental and cultural expectations
- No variations to contract



DUKC

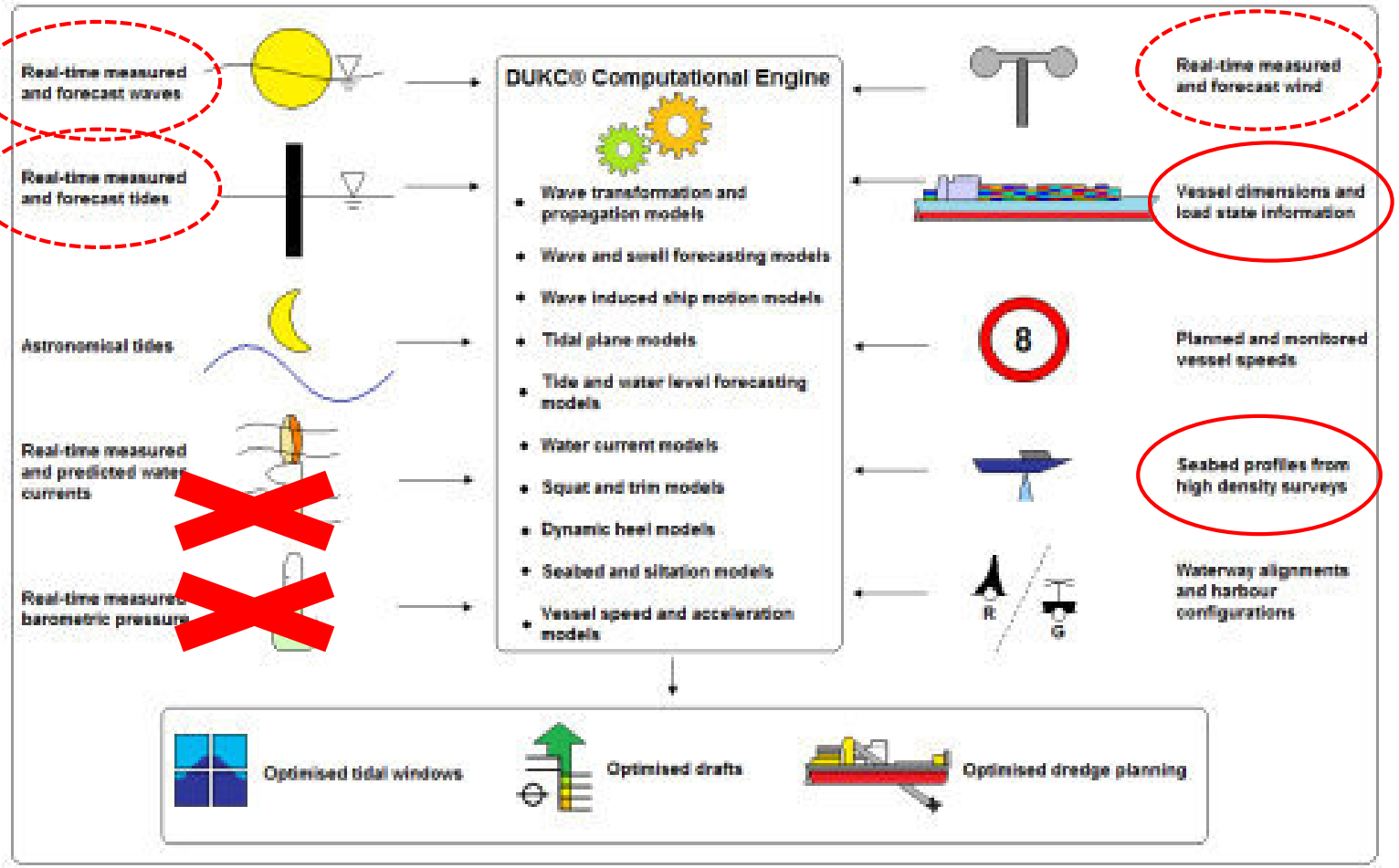
MetOcean

MetOcean

MetService

Data feed

Data feed



✓

Data feed

LPC Pilots

✓

LPC Survey

✓

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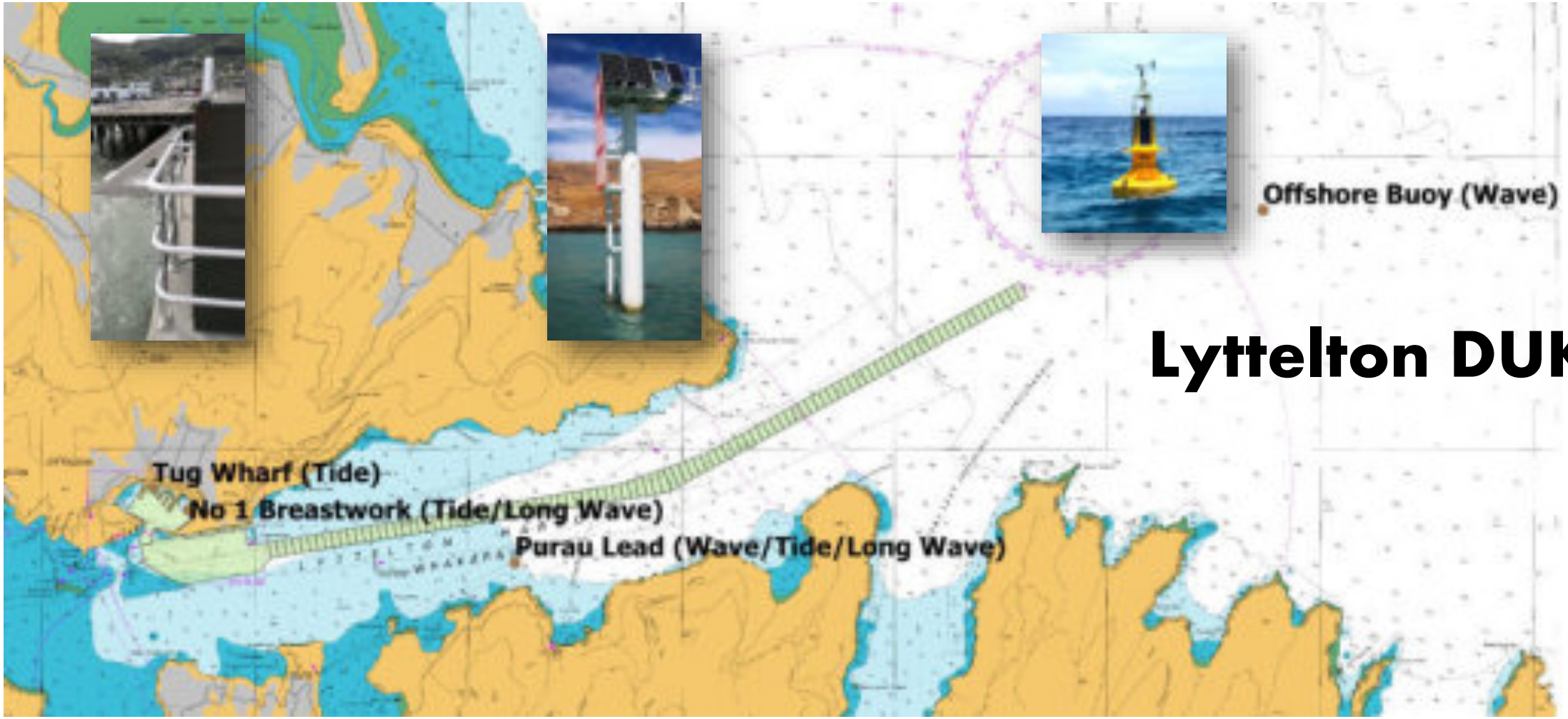
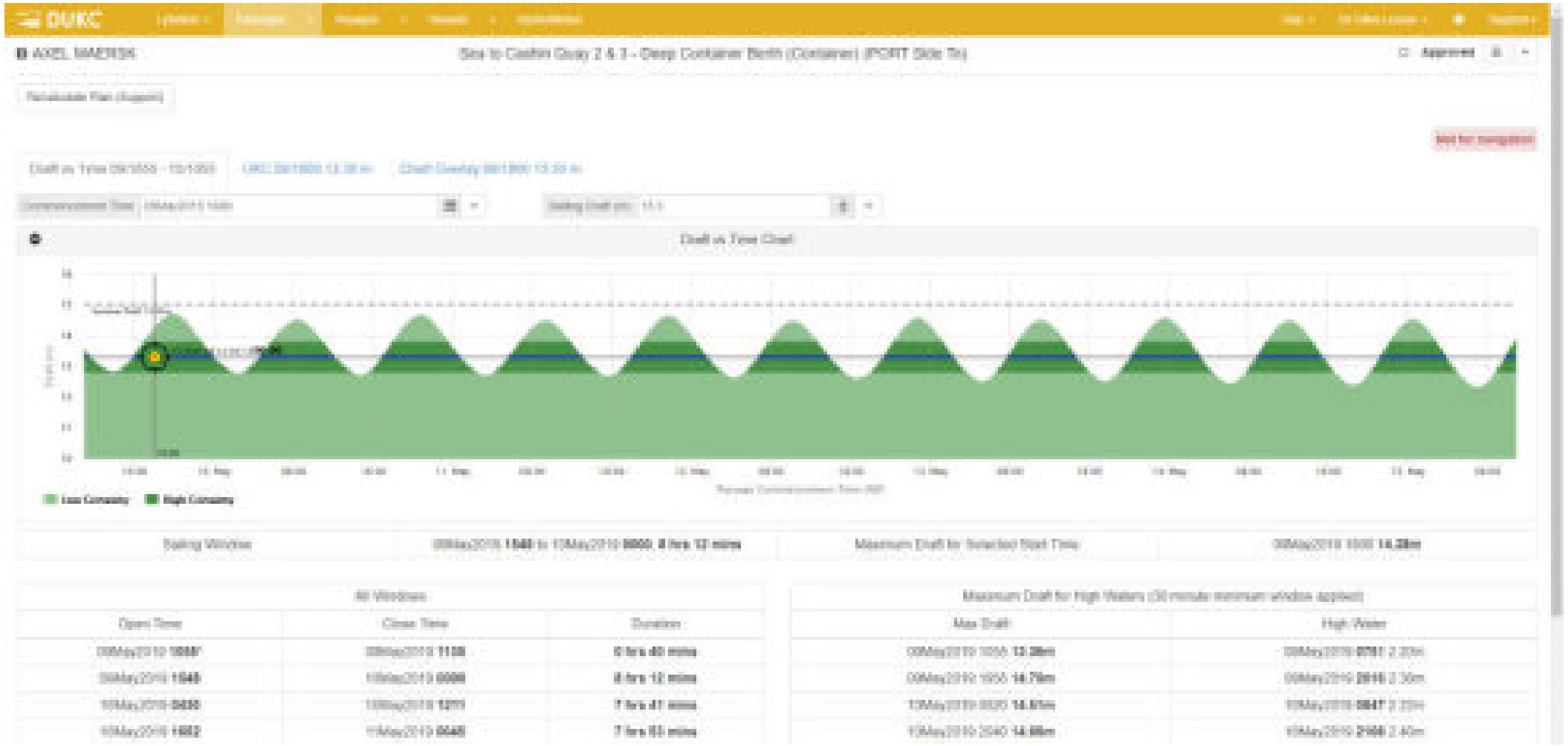
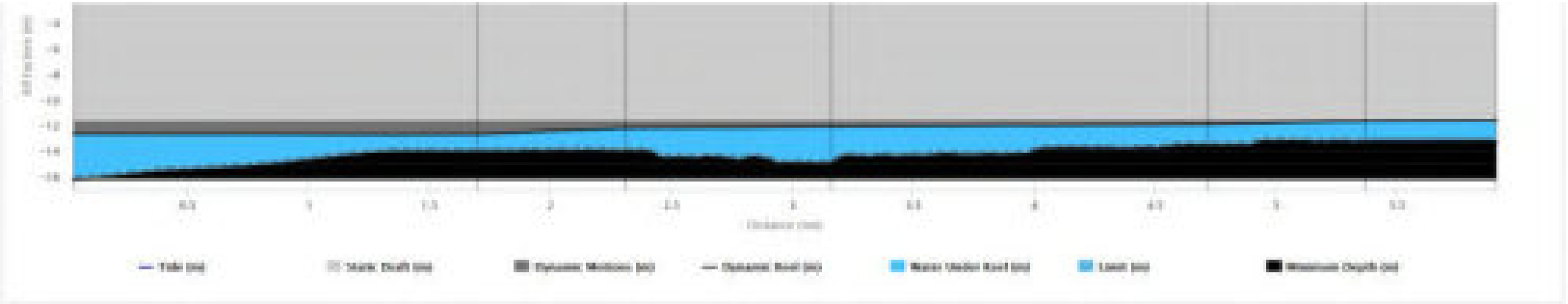


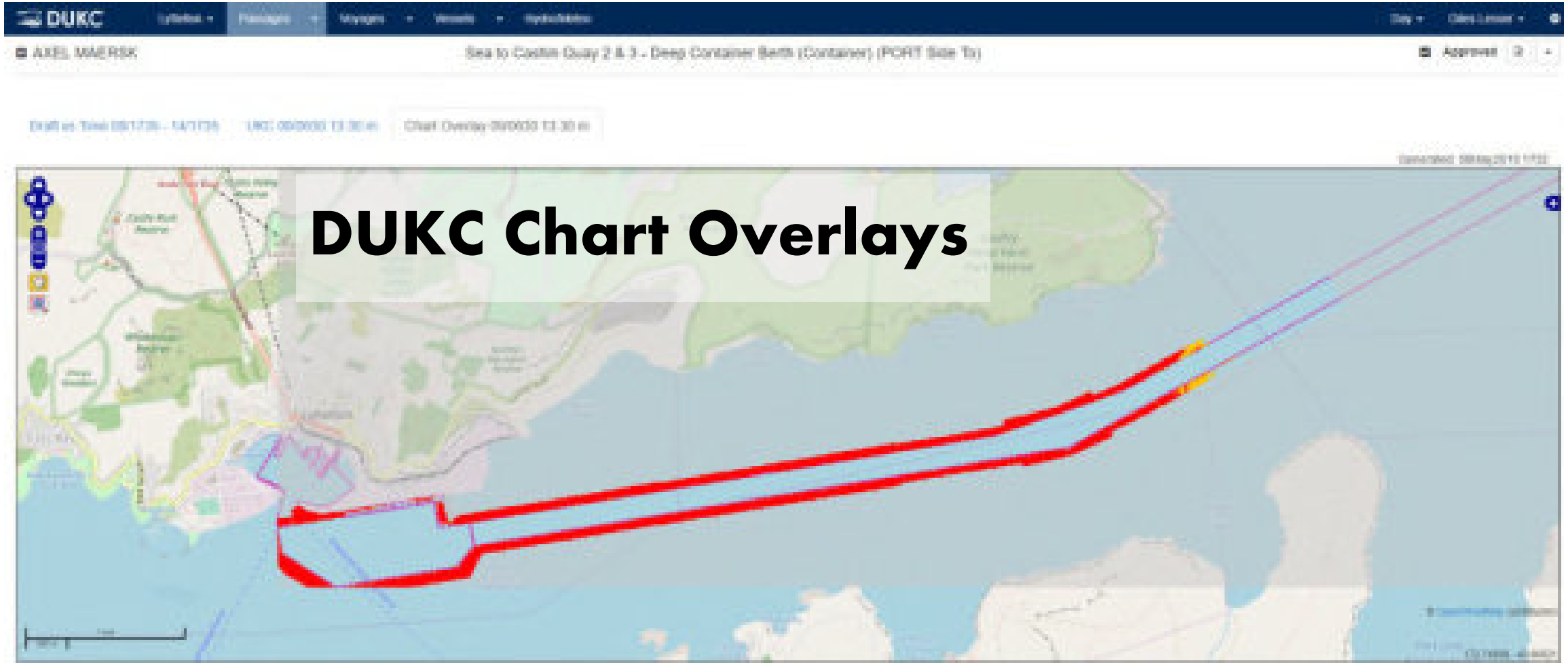
Lyttelton DUKC


DUKC
Sea to Cashin Quay 2 & 3 - Deep Container Berth (Container) (PORT Side To)
Approved
Draft vs Time Chart
Low Certainty
High Certainty
Sailing Window
Maximum Draft for Selected Start Time
All Windows
Open Time
Close Time
Duration
Maximum Draft for High Waters (30 minute minimum window applied)
Max Draft
High Water



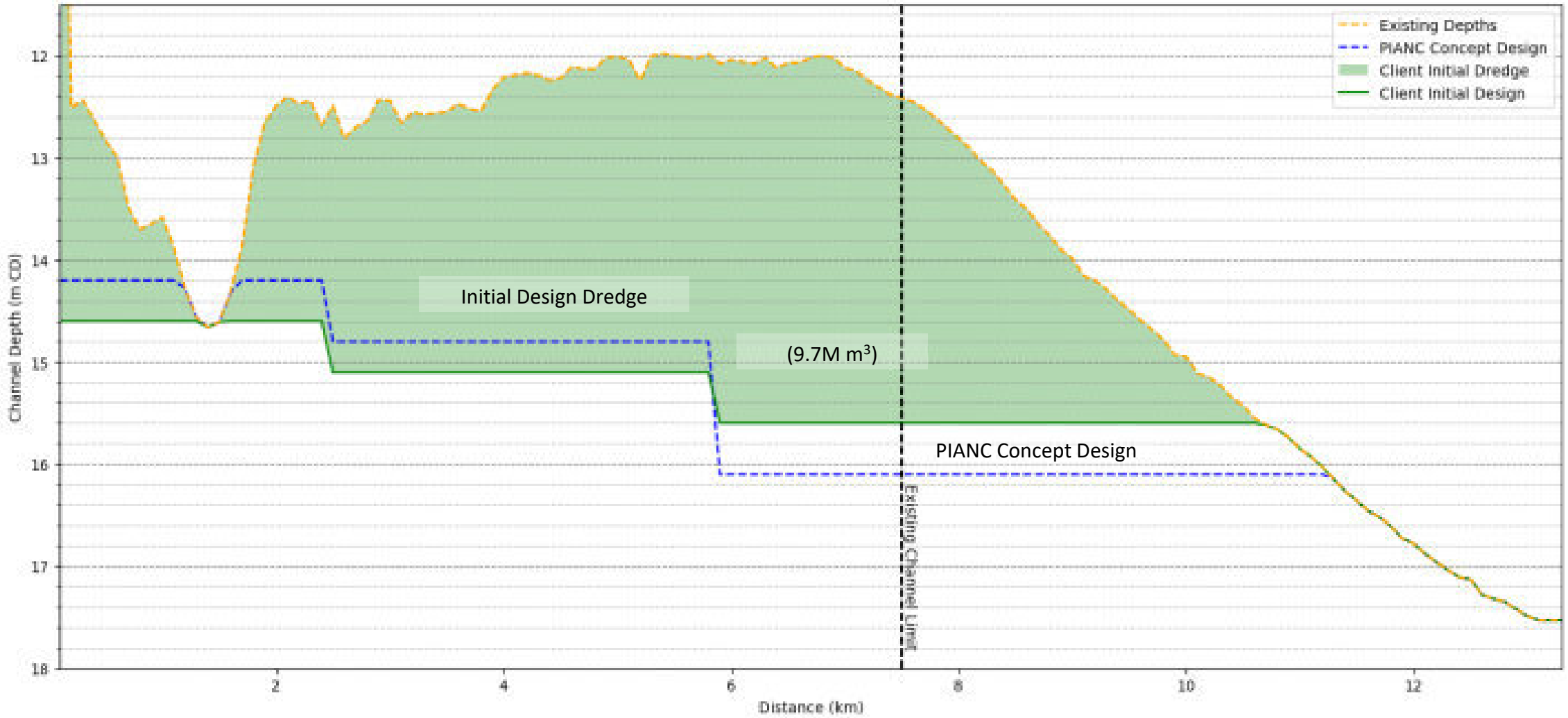
UKC Table

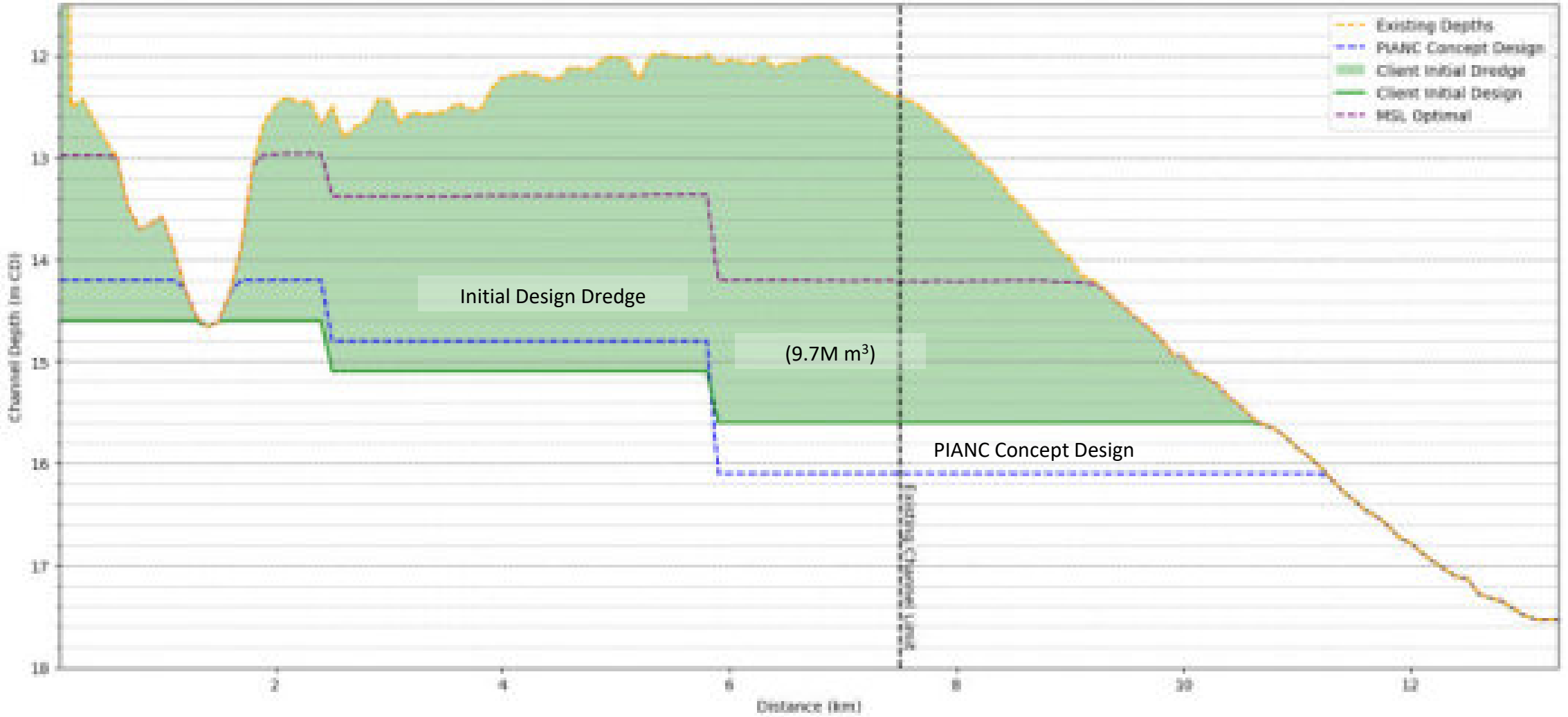
	SOG (kn)	ETA (NZ)	Squat (m)	Heel (m)	Tide (m)	RKR (m)	UKC (m)	UKC-L (m)
PBG	15.0	09/0830	0.72	0.00	1.80	0.30	3.80	3.21
Min UKC (BC)	15.0	09/0836	0.83	0.00	1.82	0.30	1.39	1.10
Min UKC (MB)	15.0	09/0838	0.83	0.00	1.82	0.30	1.83	0.89
Heads	15.0	09/0837	0.82	0.00	1.83	0.30	1.39	1.11
Mechanics Bay	9.0	09/0841	0.35	0.02	1.84	0.33	1.80	1.55
Breeze Bay	9.0	09/0846	0.33	0.00	1.86	0.27	2.87	2.62
Pleiades Rock	9.0	09/0857	0.36	0.00	1.89	0.27	1.88	1.23
Channel Start	5.0	09/0702	0.11	0.00	1.80	0.27	1.69	1.32
Swing Basin	5.0	09/0709	0.11	0.00	1.81	0.33	1.87	1.42

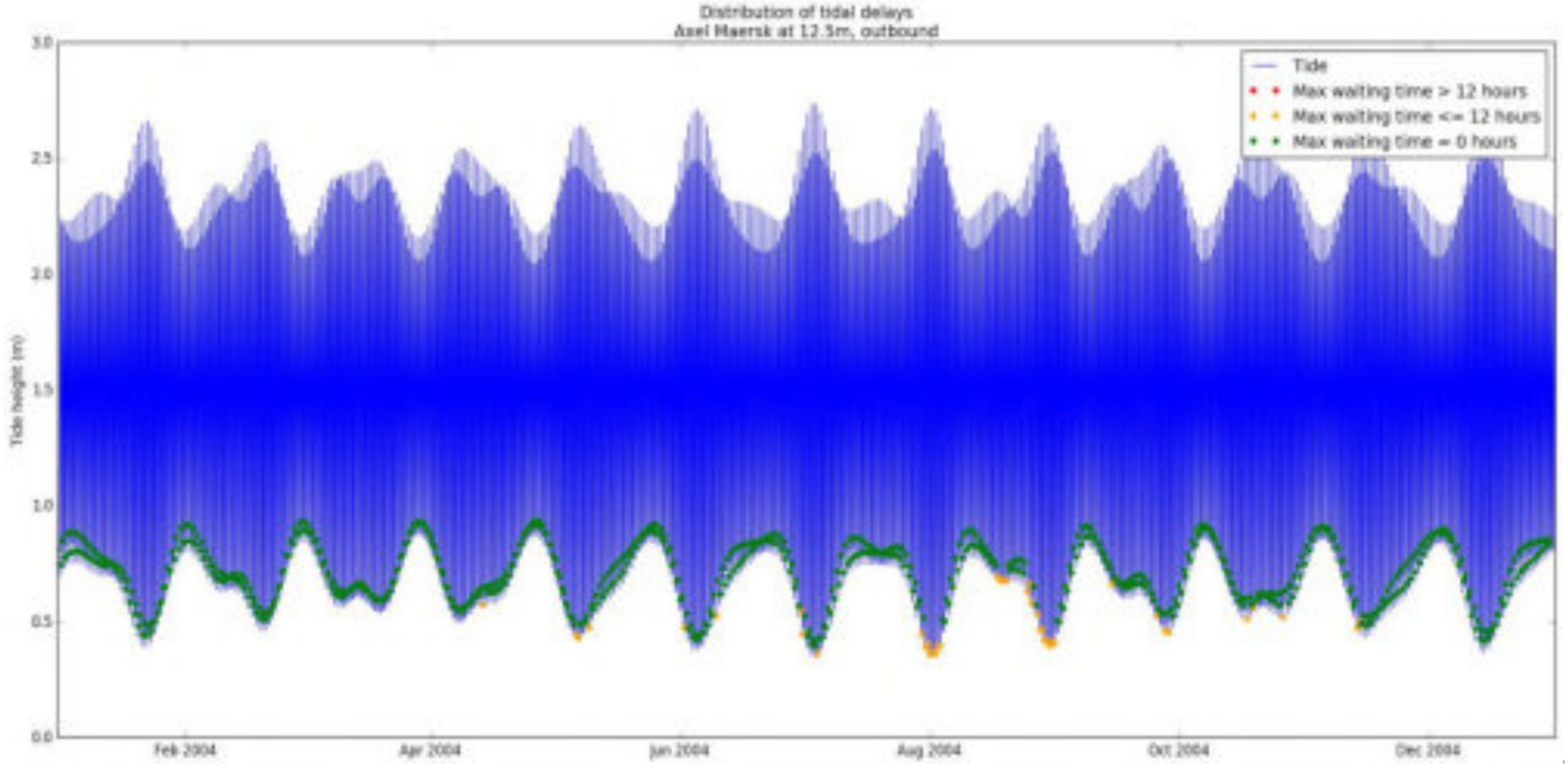

DUKC
DUKC Chart Overlays

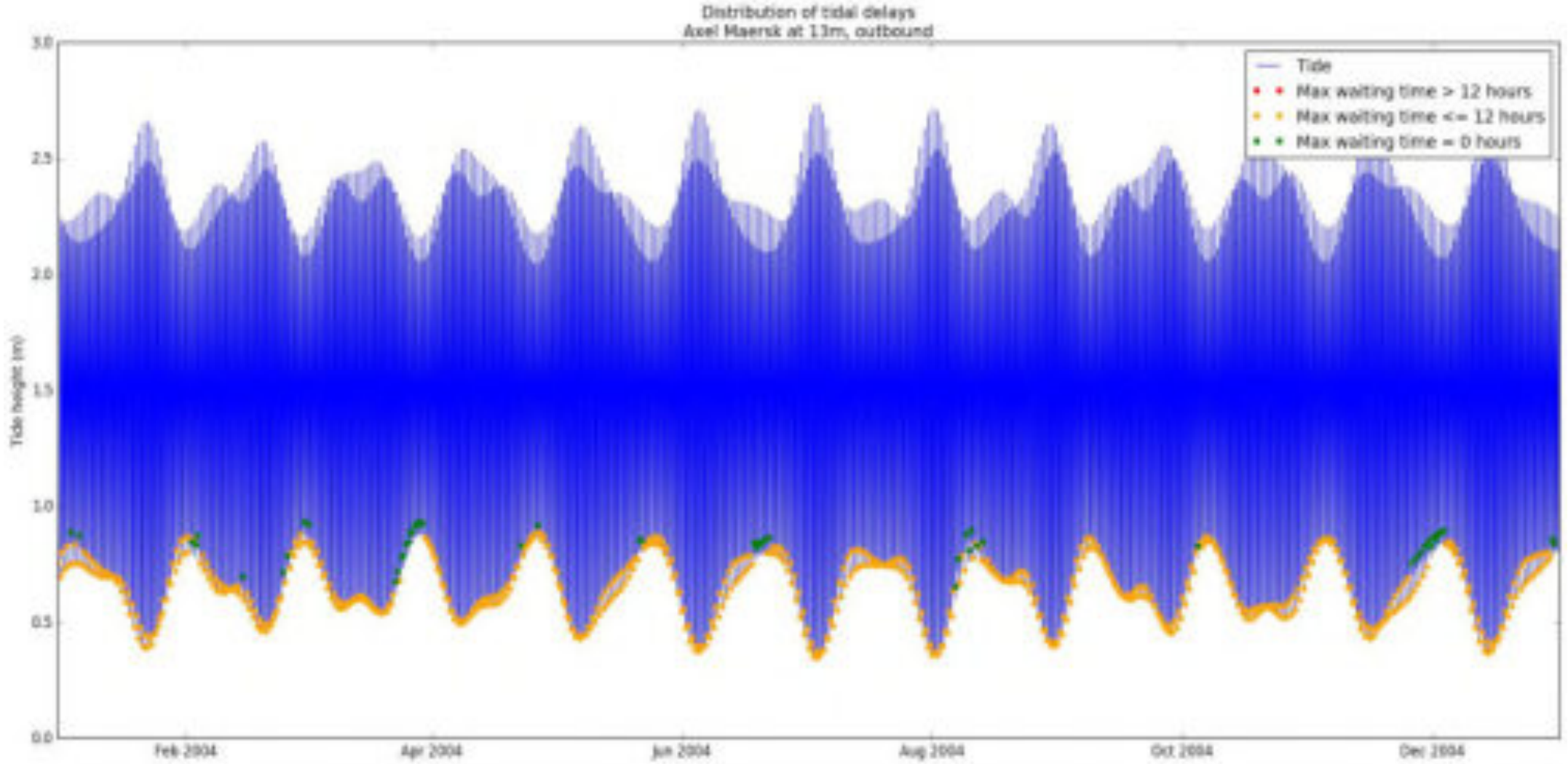
Stage 1 design requirements

- Minimal delays for 12.5m vessels.
- Sailing window “every tide” for ~~13.0m~~ 13.3m vessels.
- 14.5m vessels not a design criterion.

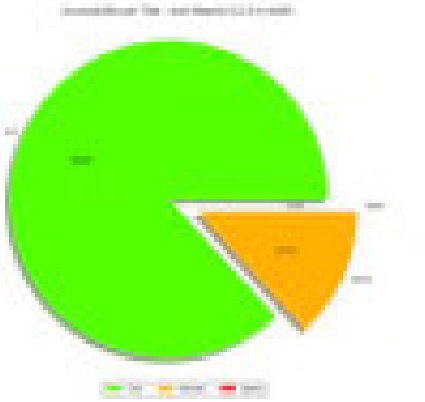

Existing Depths
PIANC Concept Design
Client Initial Dredge
Client Initial Design
Initial Design Dredge
(9.7M m³)
PIANC Concept Design
Existing Channel Limit
Channel Depth (m CD)
Distance (km)
12
13
14
15
16
17
18
2
4
6
8
10
12


Existing Depths
PIANC Concept Design
Client Initial Dredge
Client Initial Design
MSL Optimal
Initial Design Dredge
(9.7M m³)
PIANC Concept Design
Channel Depth (m CD)
Distance (km)
12
13
14
15
16
17
18
2
4
6
8
10
12

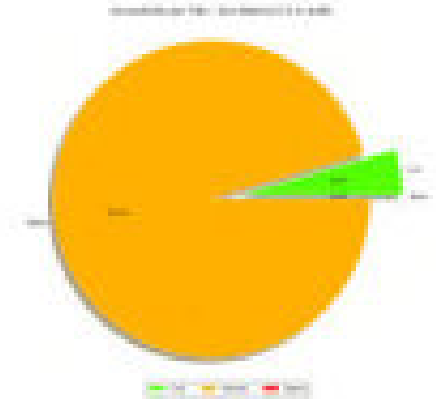

Distribution of tidal delays
Axel Maersk at 12.5m, outbound
Tide
Max waiting time > 12 hours
Max waiting time <= 12 hours
Max waiting time = 0 hours
Tide height (m)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Feb 2004
Apr 2004
Jun 2004
Aug 2004
Oct 2004
Dec 2004


Distribution of tidal delays
Axel Maersk at 13m, outbound
Tide
Max waiting time > 12 hours
Max waiting time <= 12 hours
Max waiting time = 0 hours
Tide height (m)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Feb 2004
Apr 2004
Jun 2004
Aug 2004
Oct 2004
Dec 2004

Axel Maersk @ 12.5m

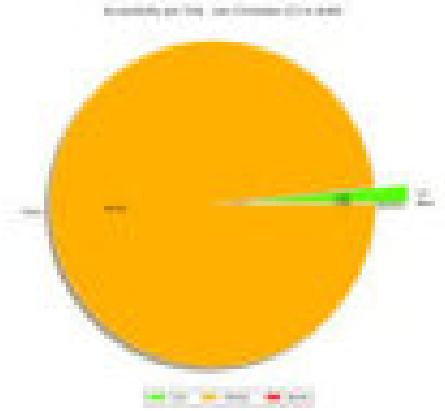


Axel Maersk @ 13.0m

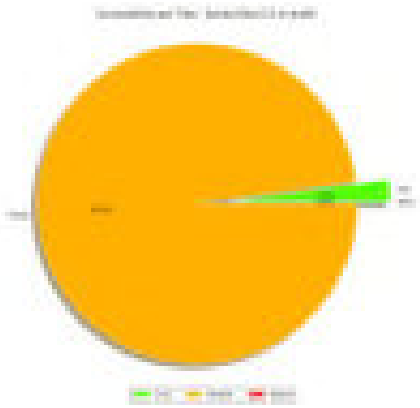


Axel Maersk @ 14.5m

San Christobal @ 13m

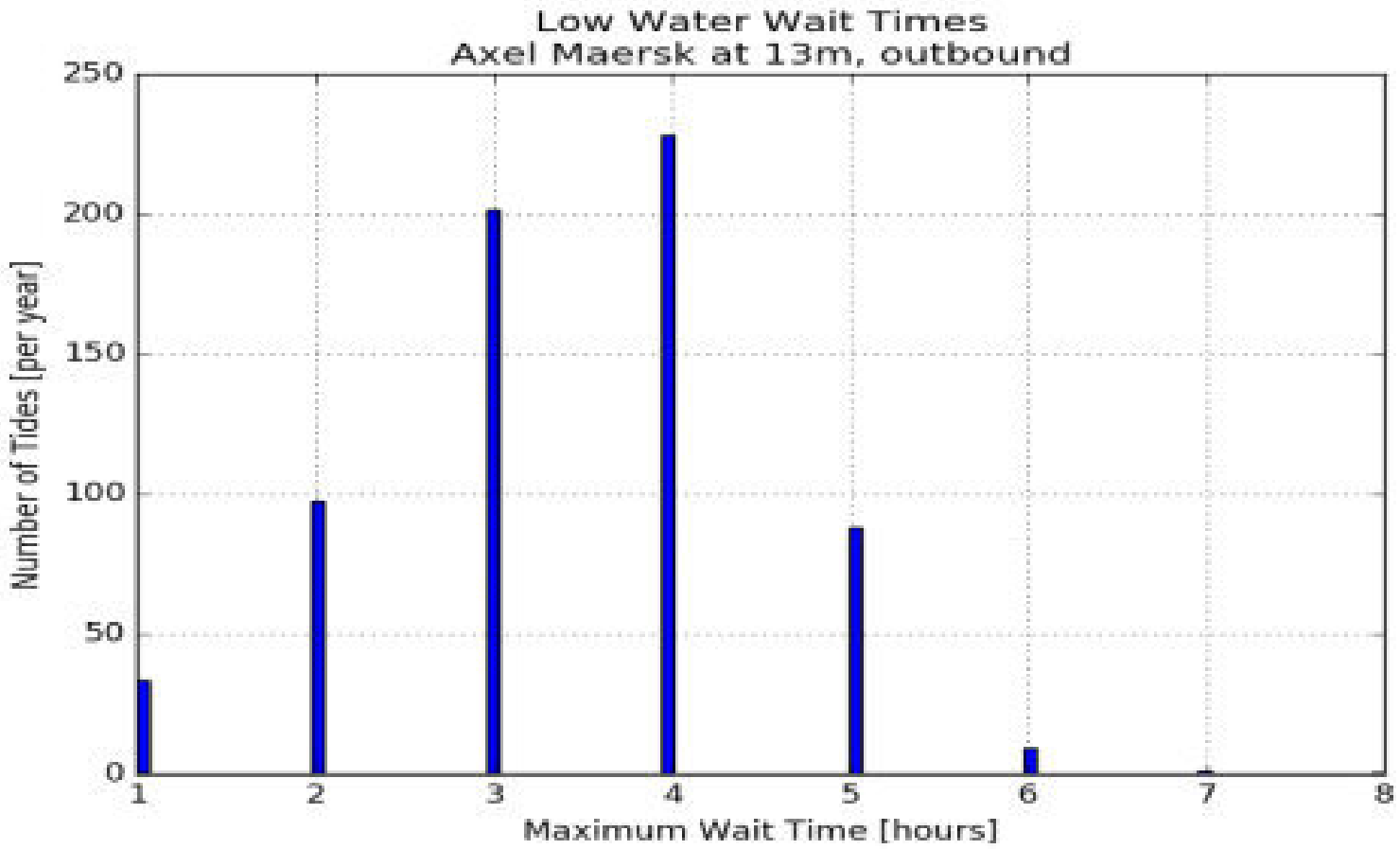


Sanita Rita @ 13.0m

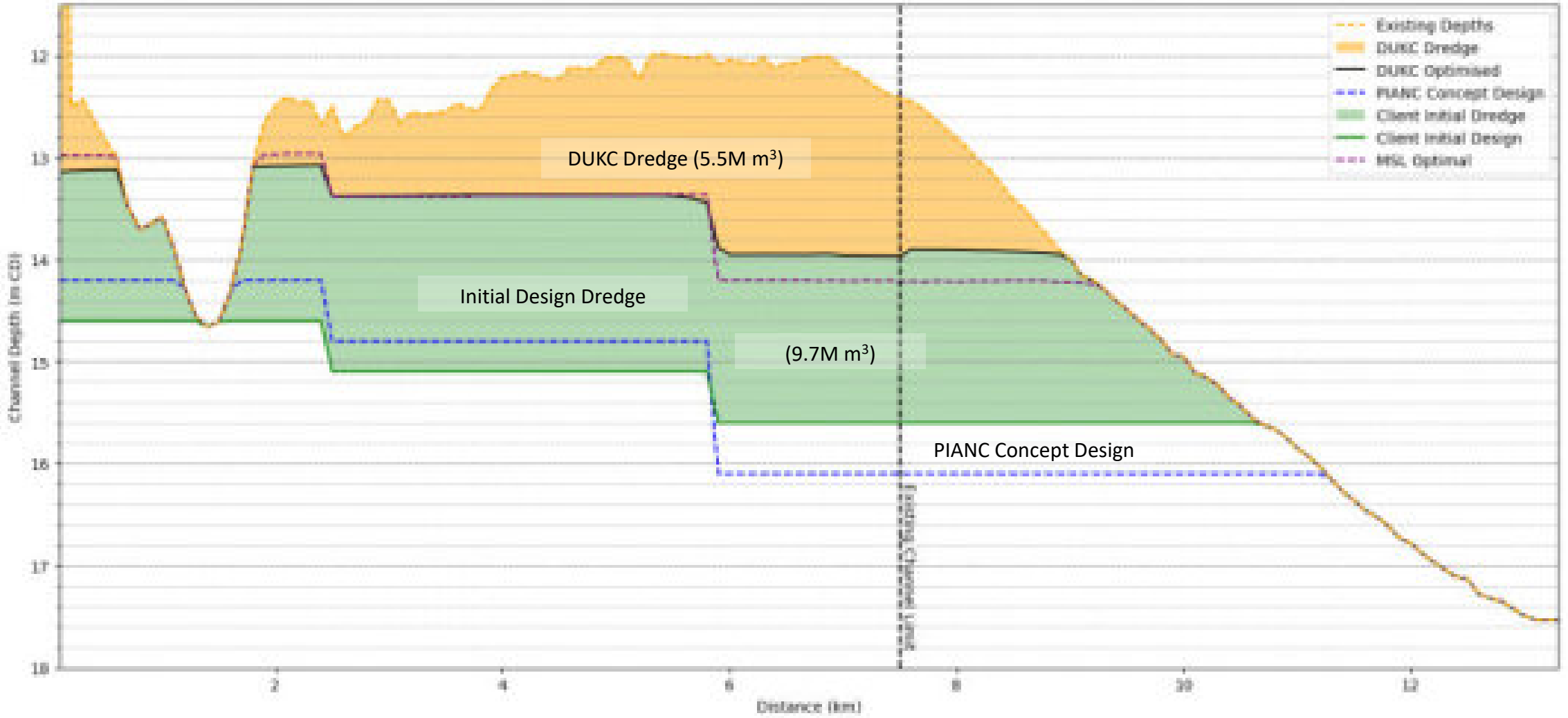


Legend

Sailing window per tide



Annual (non)sailing window statistics for Axel Maersk @ 13.0m


Existing Depths
DUKC Dredge
DUKC Optimised
PIANC Concept Design
Client Initial Dredge
Client Initial Design
MSL Optimal
DUKC Dredge (5.5M m³)
Initial Design Dredge
(9.7M m³)
PIANC Concept Design
Channel Depth (m CD)
Distance (km)
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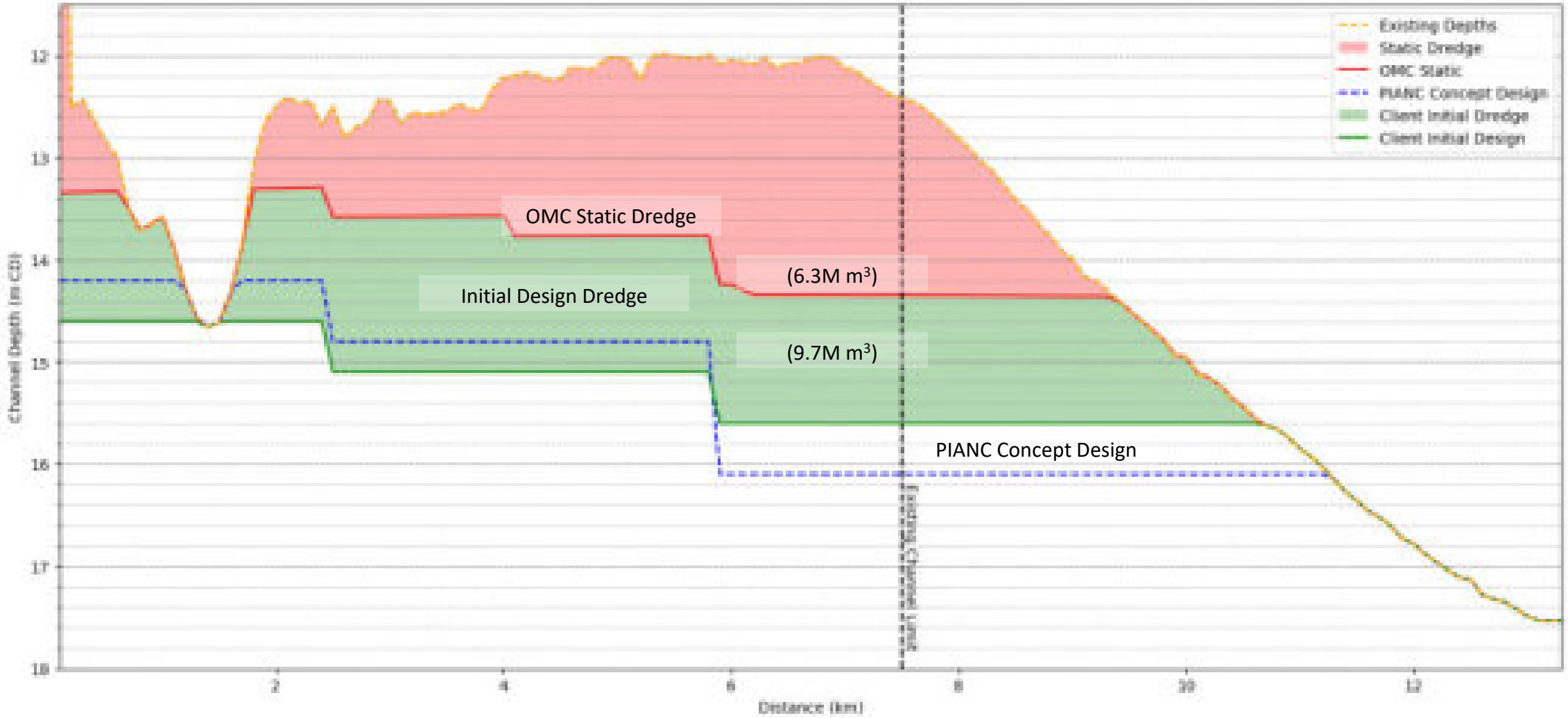
12


Existing Depths
Static Dredge
OMC Static
PIANC Concept Design
Client Initial Dredge
Client Initial Design
OMC Static Dredge
(6.3M m³)
Initial Design Dredge
(9.7M m³)
PIANC Concept Design
Channel Depth (m CD)
Distance (km)
12
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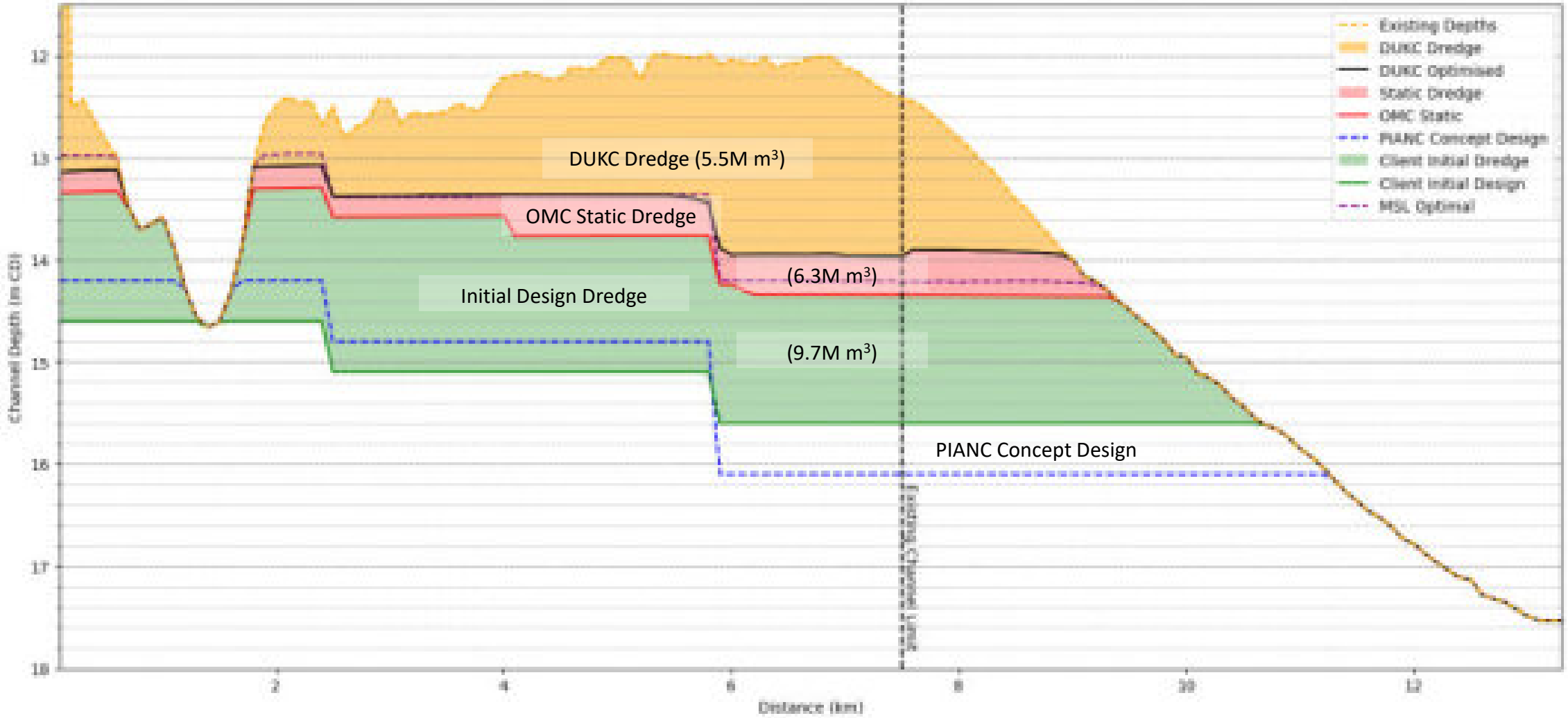
12


Existing Depths
DUKC Dredge
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OMC Static
PIANC Concept Design
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Client Initial Design
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DUKC Dredge (5.5M m³)
OMC Static Dredge
(6.3M m³)
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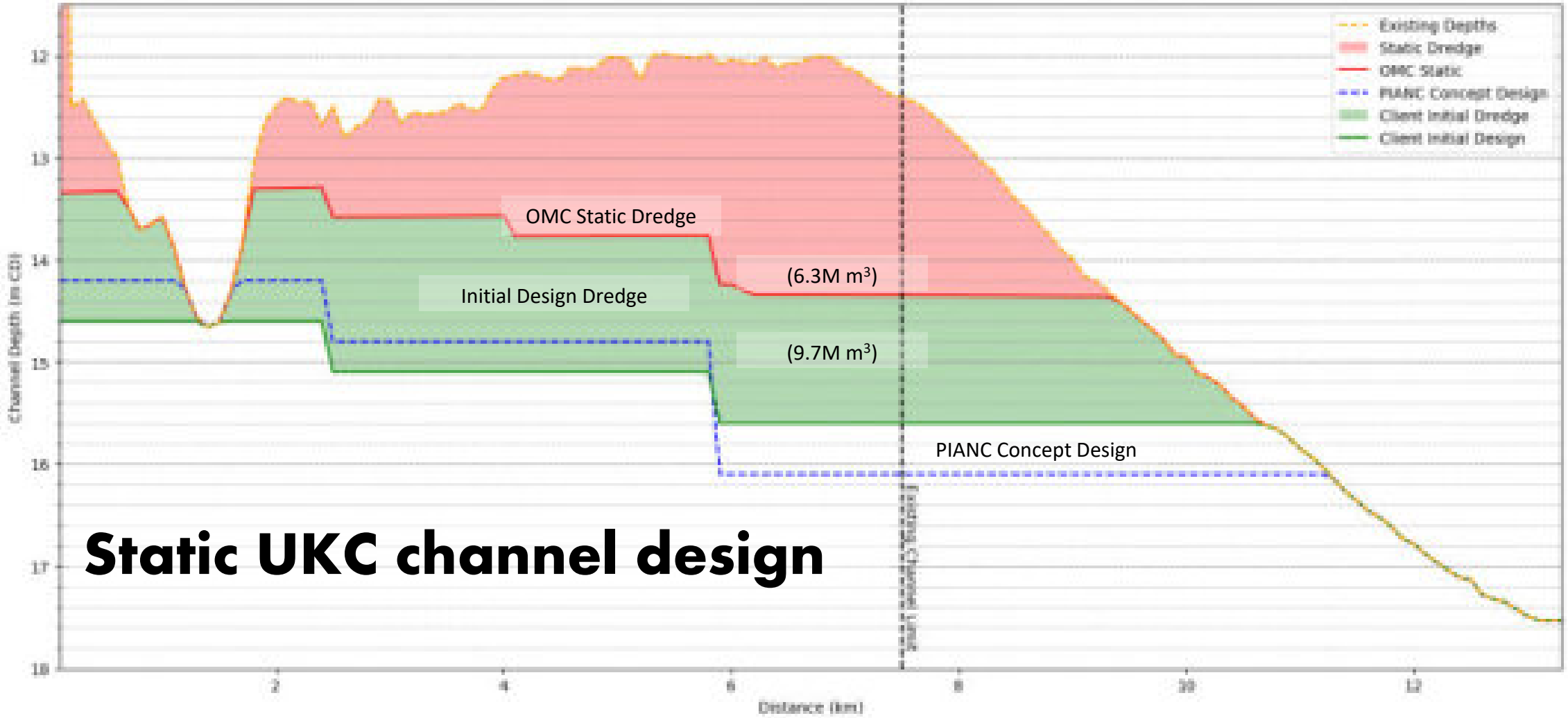
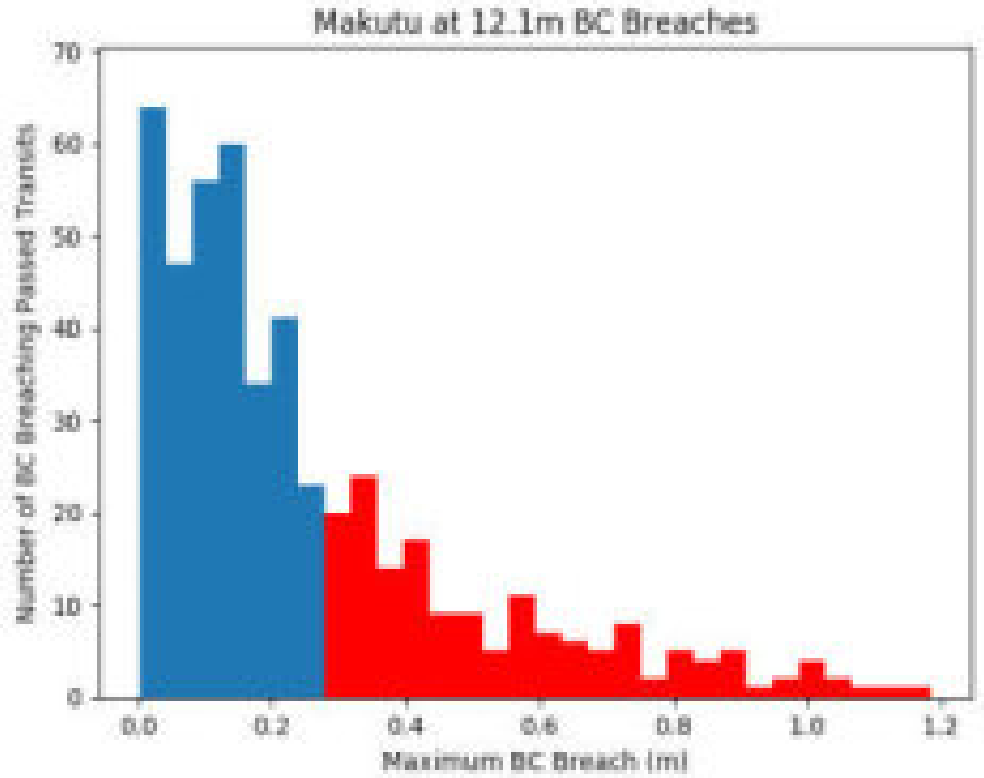
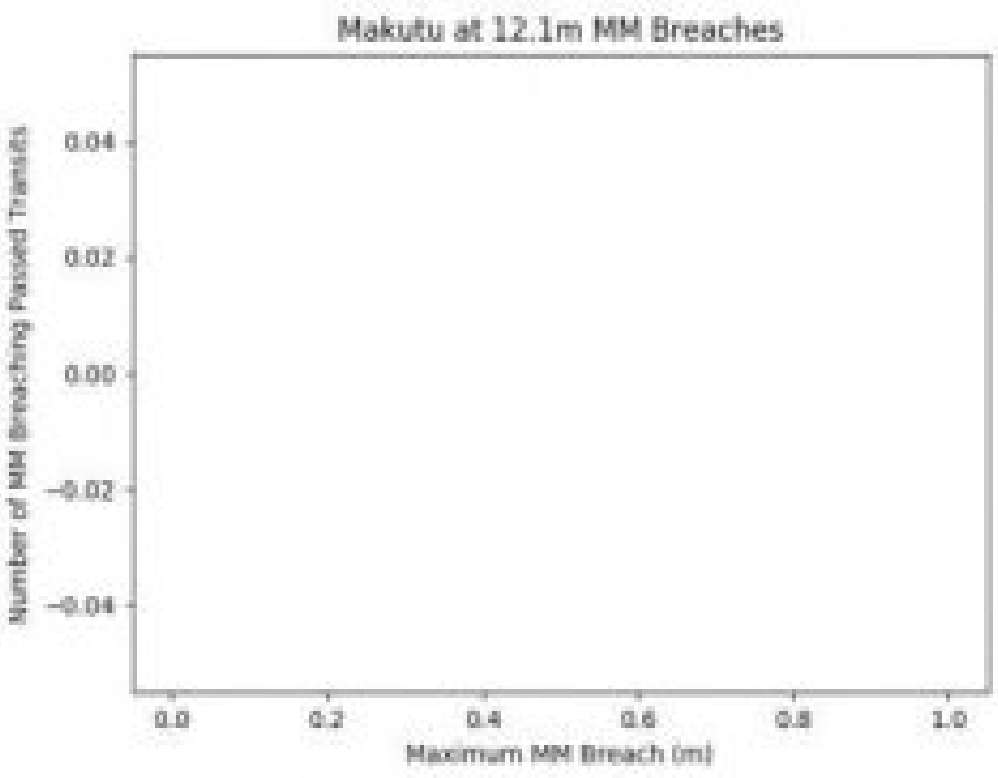
(9.7M m³)
PIANC Concept Design
Channel Depth (m CD)
Distance (km)



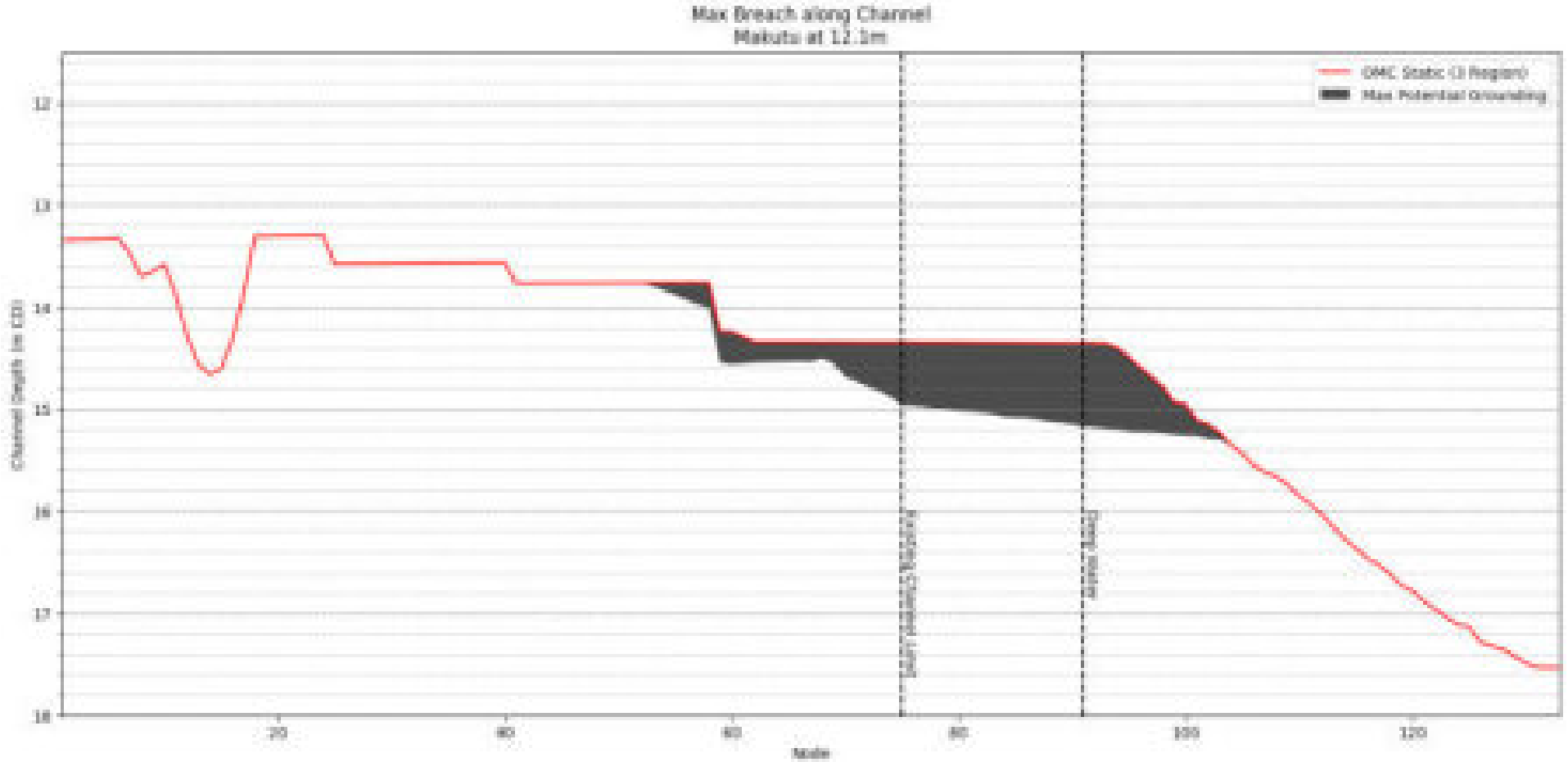
Static UKC channel design

Grounding risk under suggested static UKC rule

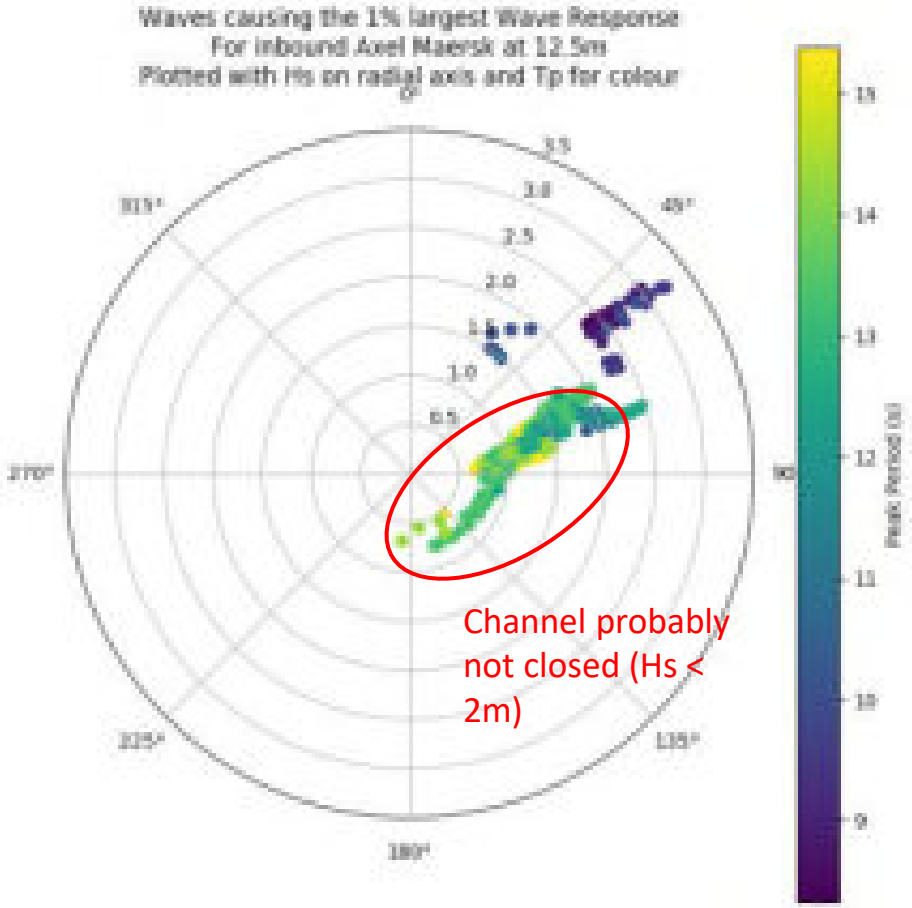




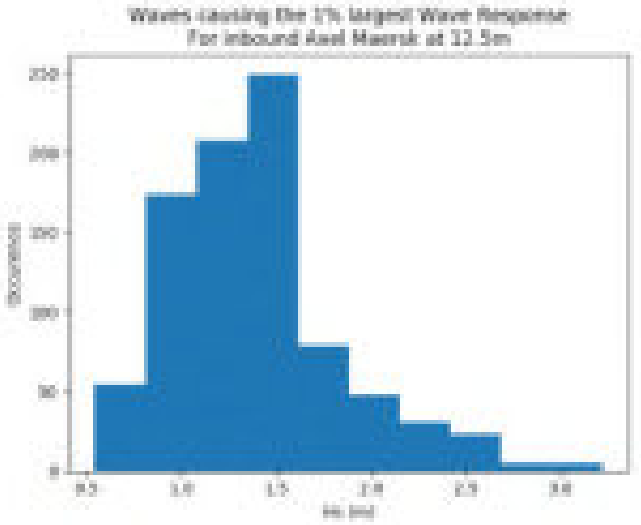
Grounding risk under suggested static UKC rule



Waves responsible for grounding under static rule



Wave height distribution



Outcome

- LPC selected optimised channel design and operational DUKC system.
- Saving in capital dredging estimated at 4.2M m^3 (approx. 40%) or approximately $40M compared with the initial channel design.
- Saving in capital dredging of 0.8M m^3 (approx. 13%) or approx. $8M relative to OMC static channel design.
- Additional operational DUKC benefits:
  - Maximise port accessibility (benefit from over dredge)
  - Management of sedimentation
  - Risk management

Thankyou

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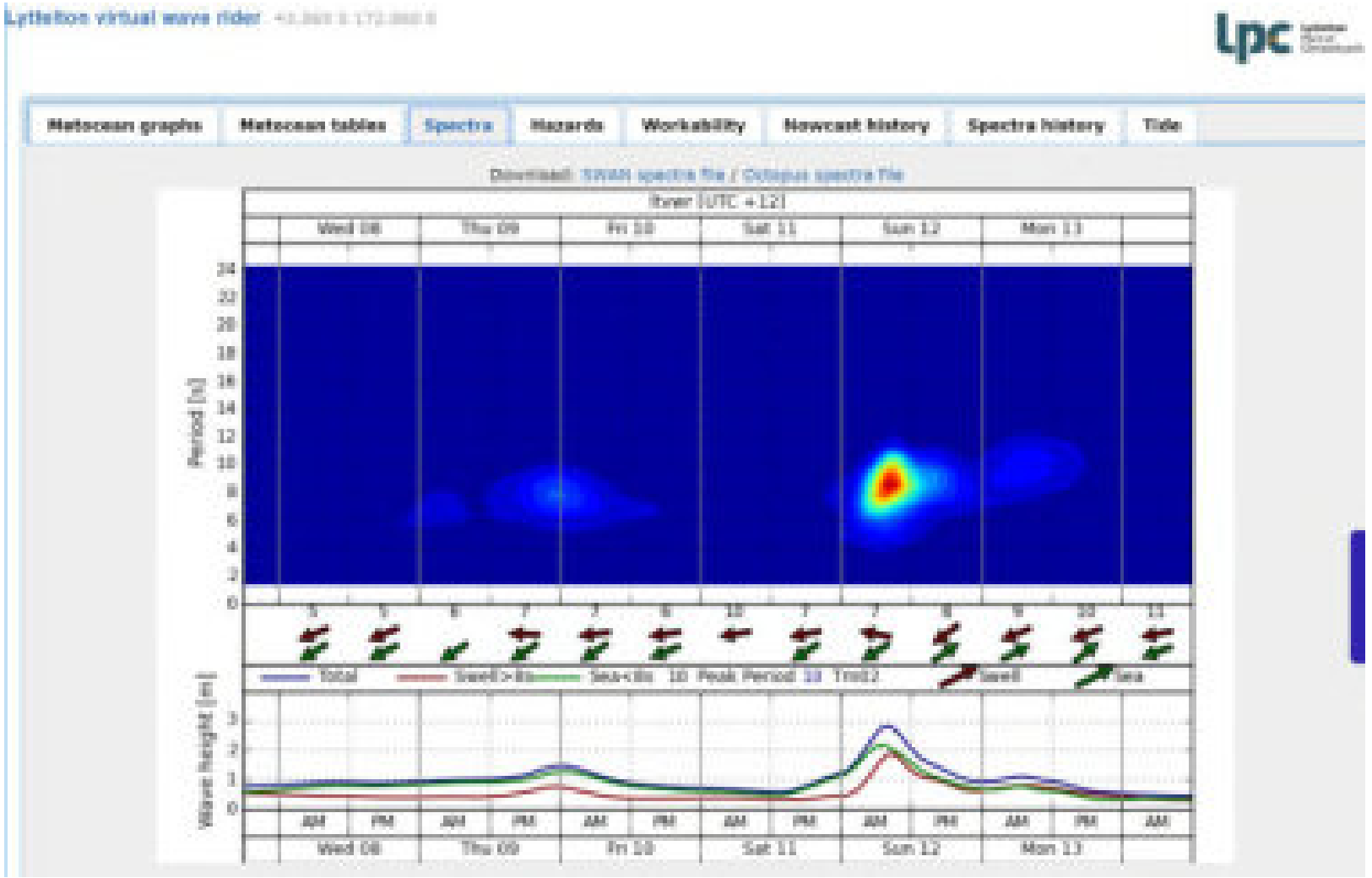
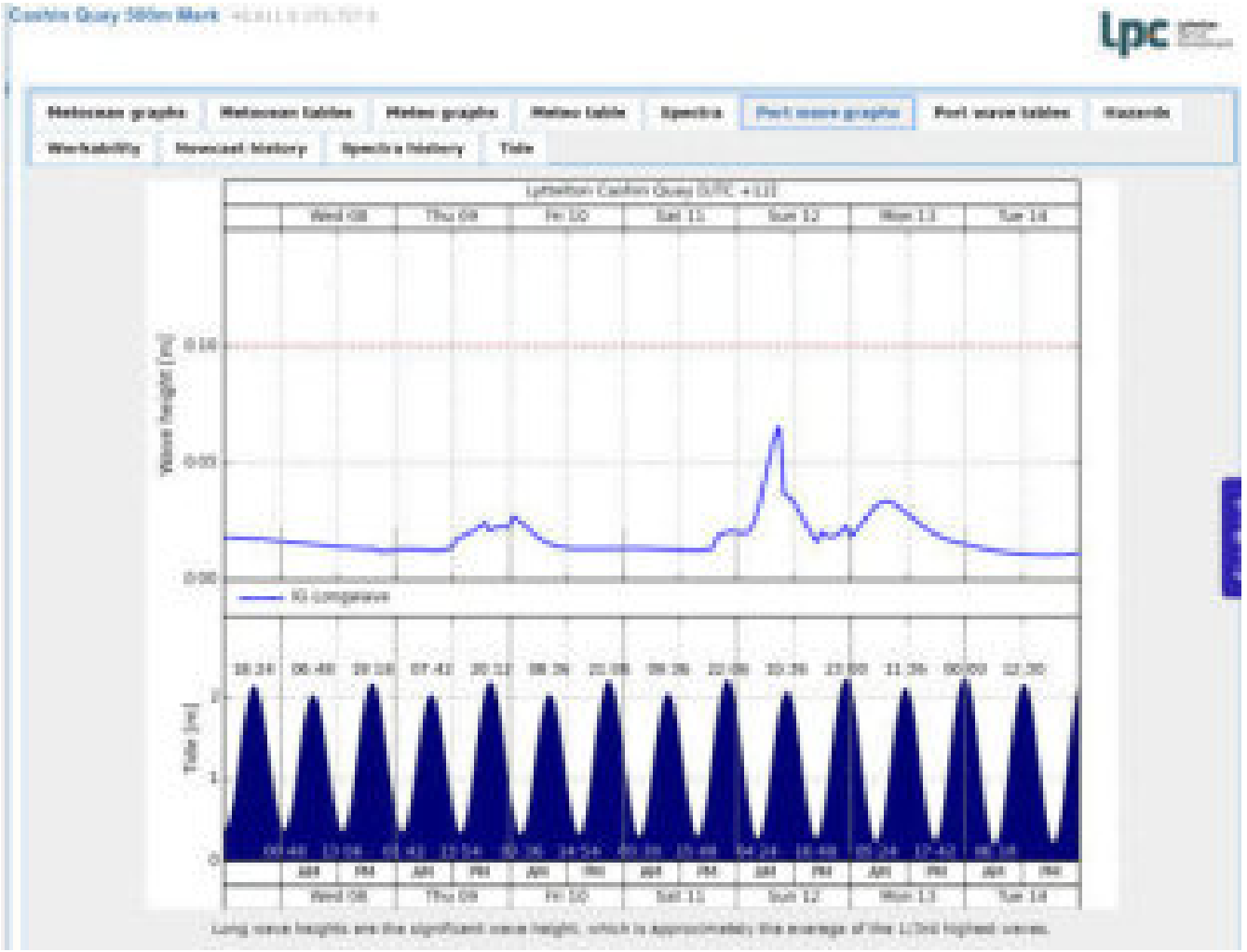

Lyttelton virtual wave rider
Meteocean graphs
Meteocean tables
Spectra
Hazards
Workability
Nowcast history
Spectra history
Tide
Period [s]
Wave height [m]
Wed 08
Thu 09
Fri 10
Sat 11
Sun 12
Mon 13


Lyttelton Cashin Quay 586m Mark
lpc
Wave height [m]
Tide [m]