Fremantle Ports Inner Harbour Maintenance Dredging

Dredging Environmental Management Plan Compliance Report

O2 ENVIRONMENT
An O2Marine company

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Important Note

Acknowledgement Of Country

In the spirit of reconciliation O2 Marine Pty Ltd acknowledge that this project is proposed on the lands of the Whadjuk/Noongar People. We pay our respects to Elders past, present and emerging and recognise their continuing connection to land, sea, culture and community.

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Acronyms and Abbreviations

Term	Full term
BCH	Benthic Communities and Habitat
CASA	Civil Aviation Safety Authority
DEMP	Dredging Environmental Management Plan
DLI	Daily Light Integral
EC	Environmental Criteria
EPA	Environmental Protection Authority
EPO	Environmental Protection Objective
EQG	Environmental Quality Guideline
IMO	In-Situ Marine Optics
LAC	Light Attenuation Coefficient
MAFRL	Marine and Freshwater Research Laboratory
MEQ	Marine Environmental Quality
MT	Management Target
N/A	Not Applicable
O2M	O2 Marine
O2Me	O2 Metocean
QA/QC	Quality Assurance/Quality Control
RIU	Remote Imagery Units
TSS	Total Suspended Sediments
UAV	Unmanned Aerial Vehicle
WA	Western Australia
WAMSI	Western Australian Marine Science Institution
ZoI	Zone of Influence
ZoHI	Zone of High Influence
ZoMI	Zone of Moderate Influence

Executive Summary

Fremantle Ports completed maintenance dredging of the Inner Harbour in April and May 2024, removing ~55,000 m^3 of sediments that had accumulated in the Inner Harbour from the Swan River estuary since capital dredging was undertaken in 2010. Dredged sediments were disposed of at the Gage Roads offshore disposal site in line with a Sea Dumping Permit issued by the Department of Climate Change, Energy, the Environment and Water.

To ensure adequate management of potential environmental risks, Fremantle Ports developed a Dredging Environmental Management Plan (DEMP) (BMT 2024) that required implementation prior, during and post the dredging operation.

Fremantle Ports engaged O2 Marine to implement the DEMP and provide a DEMP compliance report. A 'Traffic Light Assessment' approach, outlined in Table 1 was used to indicate compliance with Environmental Protection Outcomes (EPOs) and Environmental Protection Objectives (EPObs) and associated Environmental Criteria (EC) and Management Targets (MTs), respectively. The results of this 'Traffic Light Assessment' to indicate compliance of the EPO's are presented in Table 1.

Table 1: Traffic light assessment of environmental protection outcomes and objectives in the context of key and other environmental factors specified in the DEMP.

Environmental Factor	Environmental Protection Outcomes & Objectives (EPO)	Monitoring result	EPO Achieved?[1]
Marine Environmental Quality	**Water column turbidity** EPO 1) Maintain water clarity to meet the environmental criteria at the boundary of ZoMI/ZoI to minimise social impacts on aesthetic quality from increased water column turbidity associated with dredging activity	Water column turbidity at Swan River sites was increased due to the dredging activity however returned to baseline levels 11 days after dredging was completed. The EPO to minimise social impacts on aesthetic quality is considered at risk with a moderate level of confidence of being achieved.	
	Sediment contaminants EPO 2) Ensure dredge sediment quality of the Inner Harbour is maintained to prevent the release of potential new contaminants.	Dredge sediment quality of the Inner Harbour was maintained in the 2024 MQMP therefore the EPO to prevent the release of potential new contaminants was achieved.	
	Hydrocarbon spills and waste generation EPOb 1) No hydrocarbon spills or release of waste into the environment from dredging and disposal	No hydrocarbon spills or waste incidents occurred during dredging and disposal activities therefore the associated EPOb was achieved.	
Benthic communities and habitats	**Direct loss** EPOb 2) Ensure no permanent loss of BCH outside of the zone of high impact (ZoHI)	There was no direct loss of BCH outside of the Native Vegetation Clearing Permit area therefore the associated EPOb to ensure no permanent loss of BCH outside of approved areas was achieved.	

[1]*Green ( ) symbols indicate Environmental Protection Outcomes and/or Environmental Protection Objectives were met; amber ( ) symbols represent the Environmental Protection Outcomes are at risk and red ( ) symbols represent a non-achievement of the Environmental Protection Outcome and/or Environmental Protection Objectives.*

Environmental Factor	Environmental Protection Outcomes & Objectives (EPO)	Monitoring result	EPO Achieved?[1]
	Indirect loss EPO 3) Maintain light levels to meet the environmental criteria at the ZoMI/ZoI boundary to avoid indirect loss of seagrass from increased water column turbidity associated with sediment disposal.	Light levels were reduced in the Swan River however all sites met the EC and returned to pre-dredge levels 11 days after dredging was completed. However as two of the eight light attenuation monitoring sites, including a Swan River impact site, were unable to provide sufficient data to calculate light levels, there is only a moderate level of confidence of the EPO being achieved.	
Social Surroundings	**Public and navigational safety** EPOb 3) No public or navigational safety incidents from dredging and disposal.	No public or navigational safety incidents occurred during dredging and disposal activities therefore the associated EPOb was achieved.	
	Visual amenity, odour generation and noise EPOb 4) Minimise social impacts from potential reduced public amenity, odour generation or noise associated with dredging and sediment disposal.	No visual amenity, odour generation and noise complaints occurred during dredging and disposal activities therefore social impacts associated with visual amenity, odour and noise were minimised.	
	Aboriginal Heritage EPOb 5) Aboriginal stakeholder dredge monitoring recommendations are implemented.	Due to the implementation of Aboriginal stakeholder recommendations Aboriginal heritage values were maintained.	
Marine Fauna	**Introduced Marine Species (IMS)** EPOb 6) No introduction of IMS to the Project site from the arrival of the dredge and any associated support vessels.	No Introduced Marine Species were introduced to the Project site from the arrival of the dredge therefore the associated EPOb was achieved.	
	Collision / vessel strike and entrainment EPOb 7) No collision/vessel strike or entrainment with marine fauna from the operation of the dredge.	No marine fauna collision/vessel strike or entrainment incidents occurred during dredging and disposal activities therefore the associated EPOb was achieved.	

[1] *Green (■) symbols indicate Environmental Protection Outcomes and/or Environmental Protection Objectives were met; amber (■) symbols represent the Environmental Protection Outcomes are at risk and red (■) symbols represent a non-achievement of the Environmental Protection Outcome and/or Environmental Protection Objectives.*

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1. Introduction

1.1. Background

As described in Section 1 of the Dredging Environmental Management Plan (DEMP; BMT 2024), Fremantle Ports undertook maintenance dredging to remove sediments that have accumulated in the Inner Harbour from the Swan River estuary since capital dredging was undertaken in 2010. Maintenance dredging aimed to return the Inner Harbour and Entrance Channel to design depth to ensure safe access to the harbour, safe berths and berth capacity is maintained. Fremantle Ports carried out an initial maintenance dredging campaign in April and May 2024 and removed ~55,000 m^3 of sediments. Material from the Inner Harbour was disposed at the historical Gage Roads offshore disposal area utilised in the 2010 capital dredging campaign.

1.2. Dredging Environmental Management Plan

1.2.1. Overview

The DEMP outlines the required monitoring and management of potential environmental impacts associated with the dredging project. The following environmental factors were considered to be at risk from the project (Section 1.5; BMT 2024):

- Marine environmental quality (key environmental factor)
- Benthic communities and habitats (key environmental factor)
- Social surrounds (key environmental factor)
- Marine fauna (other environmental factor)

Key environmental factors were assigned outcome-based provisions (Environment Protection Outcomes; EPO) and associated environmental criteria to monitor and respond to impacts the project may have on the environmental factors at risk.

The DEMP also assigned management-based provisions (Environmental Protection Objectives; EPOb) and associated management targets to manage and monitor the impacts the project may have on the environmental factors.

This report outlines the provisions undertaken to implement EPO 1 (Marine Environmental Quality [MEQ]) and EPO3 (Benthic Communities and Habitat [BCH]). To ensure that the MEQ and BCH were not impacted by dredging and disposal activities, spatial levels of zones of influence (ZoI) were established and EPOs were defined (BMT 2024).

The specific Environmental Protection outcomes and objectives assigned for the protection of environmental factors are presented in Table 7 and Table 8.

1.3. This Compliance Report

The purpose of this report is to present a summary of compliance against all DEMP requirements including the outcome-based and management-based provisions.

The report includes a summary of the findings of marine water quality sampling associated with the implementation of the DEMP and provides an assessment of the results against the defined environmental criteria to ascertain whether the relevant Environmental Protection Outcomes (EPOs) have been achieved.

The following monitoring was implemented to meet the requirements of the DEMP and achieve the EPOs:

- Light attenuation monitoring
- In-water plume monitoring
- Water clarity monitoring, and
- Plume monitoring via drone aerial photography and remote imagery units installed within the Inner Harbour and dredge vessel.

In addition, documentation from the contractor, proponent and environmental consultant was verified to ensure the requirements of the DEMP were met and assess compliance against the management-based provisions.

2. Methods

2.1. Monitoring Locations and Frequency

The section below provides a synopsis of methods used during the DEMP implementation campaign and aligns with Section 2.3 of the DEMP (BMT 2024).

Dredging commenced on 15 April and was planned to be completed on 24 April over a 10-day period however due to operational delays dredging was completed on 3 May 2024 over an 18-day period. Monitoring was planned to be implemented one week prior to dredging, on three occasions during dredging (on days 2, 5 and 10) and one week post dredging. In response to the extended operational period an additional day of sampling was undertaken on Day 15. Due to weather restrictions post-dredge monitoring was undertaken 11 days following the completion of dredging, rather than one week post dredging as planned.

Sampling activities were conducted between 26 March to 14 May 2024, including:

- NTU/TSS relationship on 26 and 28 March 2024;
- Pre-dredge monitoring on 8, 9 and 12 April 2024;
- Dredge monitoring on 16, 19, 24 and 29 April (days 2, 5, 10 and 15, respectively); and
- Post-dredge monitoring on 14 May 2024.

Summarised in Table 2 are the requirements of the sampling program. The locations of the in-water monitoring are outlined in Table 3 and presented in Figure 1 and Figure 2. Field sheets from the sampling efforts are presented in Appendix G.

Table 2: Summary of the 2024 field implementation program

Item	Duration	Sample sites & dates
Light attenuation monitoring	• 1 week prior to dredging • During dredging • 1 week post dredging	Light loggers were deployed at 8 sites on 8 and 9 April and retrieved on 14 May
In-water plume monitoring	NTU/TSS relationship 10 sites sampled in triplicate as follows: • Spring tide incoming • Spring tide outgoing • Neap tide incoming • Neap tide outgoing	10 sites sampled on: • 26 March Spring tide incoming • 26 March Spring tide outgoing • 28 March Neap tide incoming • 28 March Neap tide outgoing
	NTU Profiling • 1 week prior to dredging • During dredging (day 2, 5, 10 and 15) • 1 week post dredging	10 sites sampled during:: • Pre-dredge monitoring on 8 and 9 April 2024 • Dredge monitoring on 16, 19, 24 and 29 April • Post-dredge monitoring on 14 May 2024
Water clarity monitoring	• 1 week prior to dredging • During dredging (day 2, 5, 10 and 15) • 1 week post dredging	13 sites sampled during:: • Pre-dredge monitoring on 8 and 9 April 2024 • Dredge monitoring on 16, 19, 24 and 29 April • Post-dredge monitoring on 14 May 2024
Plume monitoring via remote imagery units (RIU)	• Two RIU to be installed within the Inner Harbour and one RIU to be installed on the dredge vessel • Image capture = every 30 minutes • Daily range = between 0700-1900 hrs	Three RIUs were installed as follows: • At Berth 12 on a navigational aid facing south towards the eastern end of the Inner Harbour • On South Mole lighthouse facing north towards the Inner Harbour Entrance Channel • On the dredge vessel positioned on the bridge facing towards the vessel's stern

		The RIUs installed in the Inner Harbour were in place from 9 April to 7 May, and the RIU installed on the dredge was in place from 15 April to 3 May
Plume monitoring via drone aerial photography	• 1 week prior to dredging • During dredging (day 2, 5, 10 and 15) • 1 week post dredging A series of sample locations to monitor turbid plumes from the entrance channel of the Inner Harbour to field point SR (Figure 1) adjacent to Point Walter.	The survey area was divided in to four zones (Figure 2): • Zone 1 (Entrance Channel of Inner Harbour to Fremantle Traffic Bridge) • Zone 2 (Fremantle Traffic Bridge to Aquarama Marina) • Zone 3 (Aquarama Marina to base of Point Walter sand bar) • Zone 4 (Base of Point Walter sand bar to Attadale Reserve) The surveys were undertaken on: • Pre-dredge monitoring on 12 April 2024; • Dredge monitoring on 16, 19, 24 and 29 April; and • Post-dredge monitoring on 14 May 2024.

Table 3: In-water as-deployed sampling activities and locations (Coordinates are UTM50, GDA94)

Site ID	Easting	Northing	Impact / Reference / Recreational	In Water Monitoring		
				Light attenuation	In-water plume	Water clarity
Disposal Area Sites						
OS	375170.4994	6459810.374	Reference	✓	✓	✓
DI1[1]	374557.898	6453989.735	Impact	✓	✓	✓
DI2	375525.0489	6455931.233	Impact	✓	✓	✓
Down River Sites						
RD	379701.5461	6448172.416	Reference	✓	✓	✓
DR1	379188.6031	6452483.597	Impact	✓	✓	✓
DR2	382137.6848	6454321.013	Impact	-	✓	✓
Swan River Sites						
SR	386126.708	6458010.061	Reference	✓	✓	✓
SI1[1]	383149.433	383149.433	Impact	✓	✓	✓
SI2	382534.649	6455918.438	Impact	✓	✓	✓
SI3	383808.460	6456203.435	Impact	-	✓	✓
Recreational Sites						
SD1[1]	383026.14	6455690.263	Recreational	-	-	✓
SD2[1]	384518.791	6455818.484	Recreational	-	-	✓
SD3	381029.579	6452414.574	Recreational	-	-	✓
			Total site numbers	8	10	13

Notes:

1. *Sites moved from original locations due to proposed site deemed unsuitable for frame deployment or Secchi disc reading. Further discussed in Section 2.2.1 and Section 2.2.3, respectively.*

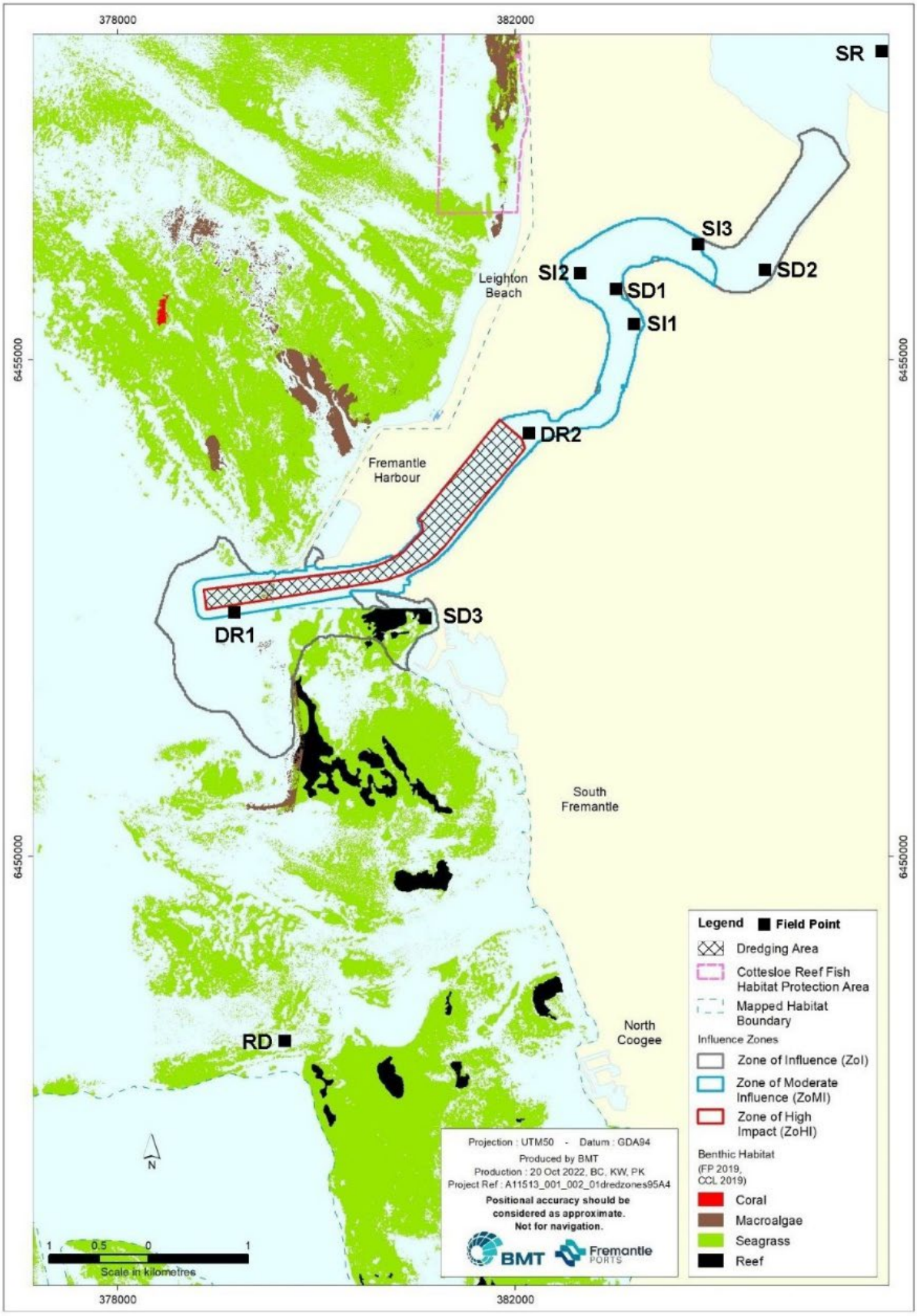

Figure 1: Marine water quality sampling locations – Down River, Swan River and Recreational sites

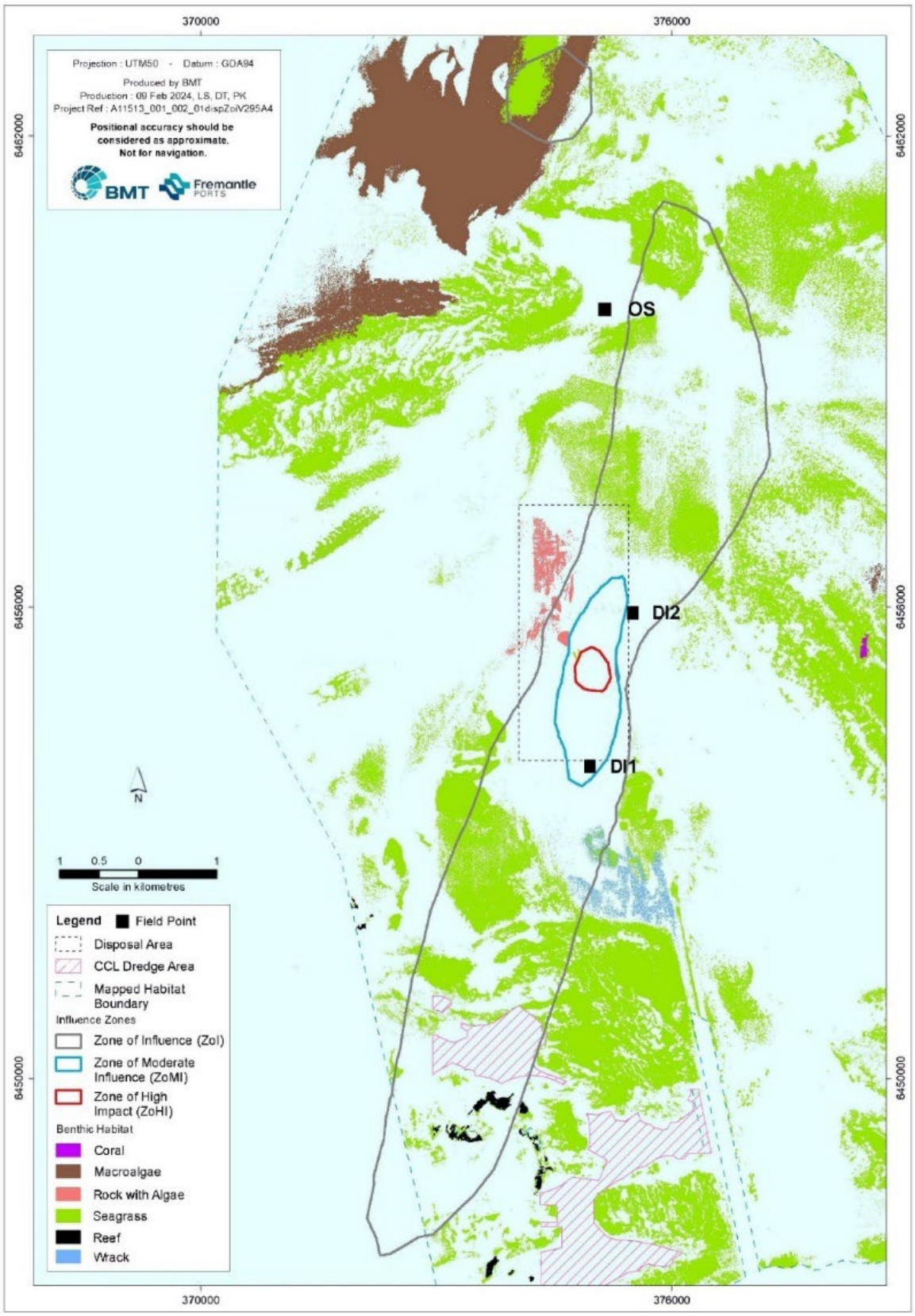

Figure 2: Marine water quality sampling locations – Disposal Area sites

Figure 3: Drone aerial imagery Zones

2.2. Field Methods

2.2.1. Light attenuation monitoring

At each of the eight sample locations, MS9-LPS light logger attached to seabed frames were deployed approximately 0.5 m above the seabed. Loggers were set to record photosynthetic active radiation (PAR) and integrating light count data in 10 bursts every ~15 minutes, between ~2 hours after sunrise to ~2 hours before sunset. Light loggers were deployed one week prior to dredging and retrieved 11 days post dredging. No servicing was required during this sample period.

To allow calculation of LAC, two additional MS9-LPT loggers were installed in Fishing Boat Harbour, in locations which received unimpeded sunlight throughout the day. An ambient logger was placed above water in full sunlight to calculate available light, and a subsurface logger installed just below (~50 cm) the water surface to calculate light reflectance at the surface. The pair of MS9-LPT loggers were in place for 10 days to calculate the relationship, and the ambient logger installed for the duration of the dredging campaign.

Sites SI1 and DI1 were unable to be deployed within the proposed locations due to positioning within anchorage / mooring areas deeming them unsuitable. The frames were relocated to the closest possible location (as-deployed coordinates supplied in Table 3).

Monitoring sites RD and SI2 were unable to provide sufficient data to calculate the LAC. This outcome is discussed further in Section 6.

2.2.2. In-water plume monitoring

2.2.2.1. NTU/TSS Relationship

Surface and seabed turbidity (NTU) and Total Suspended Sediments (TSS) samples were concurrently collected at 10 representative locations (five in-river and five open ocean sites) using an In-Situ Marine Optics (IMO) NTU logger and water pump, respectively. At each site triplicate samples were collected for both parameters ~ 0.5 m below the water surface and 0.5 m above the seabed.

Samples were stratified by tidal type (spring and neap) and tide height (incoming and outgoing) to ensure suitability of the derive correlation to consider variability, particularly within the river mouth and estuary locations.

2.2.2.2. NTU Profiling

Surface and seabed turbidity (NTU) was measured at all 10 in-water plume monitoring locations. At each of the 10 sample locations, monitoring involved lowering a YSI multiparameter probe at a steady pace through the water column. This was completed three times at each location provided in Table 3.

2.2.3. Water clarity monitoring

At each of the 13 sample locations, monitoring involved lowering the Secchi disc between 1100 hrs and 1300 hrs. The Secchi disc was lowered in accordance with the procedure presented within the DEMP until the black quadrants were no longer visible, with the depth below surface recorded to the nearest 0.1 m. This was completed three times at each location and the median recorded.

Sites SD1 and SD2 were relocated to a more suitable location for Secchi disc reading (as-sampled coordinates supplied in Table 3.

Site SD1 was originally located landside of the river and site SD2 was within a mooring area. Both sites were adjusted accordingly to an area considered appropriate for the purposes of this monitoring program.

2.2.4. Remote imagery units

Two remote imagery units were installed at South Mole and Berth 12, and one at an elevated position on the dredge vessel. Inner Harbour locations were positioned to capture images downstream and upstream of the dredging design. All images were time- and date- stamped and of a minimum resolution of 12 megapixels.

2.2.5. Drone aerial photography

A Civil Aviation Safety Authority (CASA) Pilot and Unmanned Aerial Vehicle (UAV) operator surveyed four zones extending from the Entrance Channel up to Point Walter. A series of images were collected along this extent to allow validation of the visible surface plume. At each site, the drone was flown up and downstream to capture imagery over the full extent of the river.

Where possible images were taken as close to high tide as possible to capture the worst-case plume dispersion.

2.3. Field QA/QC

Quality Assurance/Quality Control (QA/QC) field sampling requirements were conducted in accordance with the DEMP during all sampling activities, in summary:

- All equipment was serviced, calibrated, maintained and pre-deployment inspected by O2 Marine's affiliate company O2M Technautics;
- All equipment was configured to the specifications required for the implementation of the DEMP;
- Competent and trained personnel attended deployment campaigns; and
- Instrument set up following manufacturer's recommendations and project specific requirements.

2.4. Data QA/QC

2.4.1. Light attenuation and In-water plume monitoring

All raw data collected by the MS9-LPT units and the YSI multiparameter probe were subject to the standard O2 Marine data processing QA/QC procedures.

O2 Marine's strict QC procedures are applied to all water quality, oceanographic, and atmospheric data packages. The procedures apply a tiered approach to QC and include:

1. Derivation of data for QC. This step refers to the conversion of a basic signal (e.g. voltage or echo readings) to a meaningful quantity (e.g. current speed, turbidity, etc.), and it is usually done within the instrument using instrument manufacturer's software

2. Removal of irrelevant data from datasets (e.g. data that were not collected at the monitoring site, for example just prior or after instrument deployment or retrieval, respectively, when instruments are on the monitoring vessel).
3. Automatic determination of QC flags such as:
    a. Check clocks for consistency and regularity of sampling;
    b. Run peak over thresholds;
    c. Identify improbable rates of change (spike detection)
4. Manual determination of QC flags by Specialist (visual inspection).

O2Metocean (O2Me) Standard QC closely follows (and often exceeds the requirements of) dredge modelling procedures derived from the Western Australian Marine Science Institution (WAMSI) Dredging Science node (i.e. Jones et al. (2015) and Fisher et al. (2015 and 2017)).

All water quality parameters and the criteria for automatically identifying 'bad' water quality data (step 2 above) is defined and tabulated in Appendix C.

O2Me applies a tiered approach to QC of metocean and water quality datasets, as specified in Appendix C. O2Me's Tier 4 Intermediate QC' has been applied to the packaged dataset.

Please see Appendix C for a technical report on the QC applied to light data.

2.5. Laboratory Analysis

All laboratory analyses were completed at the Marine and Freshwater Research Laboratory (MAFRL) and in accordance with the relevant NATA accreditation (Appendix F).

2.6. Data Analysis

2.6.1. Light Attenuation Monitoring

Quality assurance (QA) and QC'd data were converted as per the formula outlined in Table 6.2 of the Manual of Standard Operating Procedures for Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (EPA 2005). This equation was used to be able to compare data to historic LAC sampling in the Cockburn sound area for future activity.

LAC was calculated to a Log10 basis and is as follows;

$$LAC = [log10(Irradiance\ at\ depth) - log10(Irradiance\ at\ surface)]/Depth\ interval\ (in\ metres)$$

The equation was applied to daily light integrals of PAR as measured with the MS9LPT sensors.

Once evaluated, the median LAC from each impact site was compared to the environmental criteria (EC) as presented in the DEMP and as summarised below:

- Median Light attenuation coefficient (LAC) from any Impact site for the ~3.5 week monitoring period during dredging operations exceeds:
    - >0.1084 above the median of baseline measurements from the same site (LAC equivalent of a TSS concentration of 10 mg/L); and

- >0.1084 above the median of pooled reference site measurements (LAC equivalent of a TSS concentration of 10 mg/L).

2.6.2. In-Water Plume Monitoring

To develop the correlation between NTU and TSS, triplicate TSS and NTU samples were collected from 10 sites (five in-river and five open ocean sites representative of the DEMP monitoring sites) and used to derive the correlation coefficient, further described in Section 3.2.1.

During the NTU profiling sampling program, the median from surface readings and the median from bottom readings was converted from NTU to TSS using the derived correlation. Once converted to TSS the median value will then be compared to the EC as presented in the DEMP and as summarised below:

- Surface or bottom TSS (mg/L) at any individual impact site is 10 mg/L above the reference site data on the dredging activity sampling occasion.

Post dredge monitoring of TSS was compared to background data to determine if plumes were still 'evident' after the completion of dredging. Results were compared directly with the EC as presented in the DEMP, summarised below:

- Post plume monitoring - Plumes are considered 'evident' if TSS has not returned to <80th percentile of background data for the site (or to reference levels).

80th percentiles were calculated by pooling the raw data at each sample site into the pre-determined site groupings (Table 3). From there, the 80th percentile for both surface and bottom samples were calculated.

2.6.3. Water Clarity Monitoring

Secchi disc depths were compared directly with the EC as presented in the DEMP, summarised below:

- Median Secchi depth from Impact sites must not be reduced by 20% (equivalent to the EPA [2017] water clarity Environmental Quality Guideline [EQG] for the maintenance of aesthetic quality) during the sampling occasion; and
- Median Secchi depth from Recreation sites must not be <1.6 m (equivalent to the EPA [2017] water clarity EQG for the maintenance of primary contact recreation).

2.6.4. Remote Imagery Units Monitoring and Drone Aerial Photography

There were no specific requirements for data analysis tied to management actions for these two sampling programs. However, in the event of an exceedance above, they will be used to assist in causal determination of whether the reported exceedances were a result of dredge plume based on the visual assessment. Presentation of selected baseline images of drone aerial imagery and RIU imagery have been provided in Appendix A and Appendix B, respectively.

3. Results

3.1. Light Attenuation Monitoring

The LAC was calculated at Impact sites DI1, DI2, DR1 and SI1, and Reference sites OS and SR. Monitoring sites RD and SI2 were unable to provide sufficient data to calculate the LAC. This outcome is discussed further in Section 6.

Median LAC has been calculated for the pre-dredging period (baseline), the dredging period and additionally for the dredging period to the end of the sample period (Table 4), and each sites respective threshold values (corresponding to the EC values).

LAC results and comparison against the EC are summarised in Table 4 and presented in figures in Appendix D. The figures (Appendix D) present the LAC data across the sampling period, with sections displaying pre-dredging, dredging, and post-dredging periods.

The median LAC from the dredging period at site SI1 (0.1585 m^{-1}) exceeded the median baseline LAC threshold value (0.1390 m^{-1}) however as the median LAC did not exceed the median reference site (site SR) threshold value (0.2639 m^{-1}), the EC has been met. All remaining sites also achieved the EC (Table 7).

3.1.1. Daily Light Integral

Daily Light Integral (DLI) has been calculated from the same sites LAC was calculated and is presented in Appendix E. The highest median was recorded at Impact site SI1 (7.19 mol/m^2/day) and the lowest median at Reference site SR (0.11 mol/m^2/day). There were no major differences in DLI between Reference and Impact sites.

Table 4: LAC results from sites with a comparison against the Environmental Criteria

Site		Median Baseline LAC (4 days in water from 10-14 April)	Site threshold LAC (median baseline site +0.1084)	Median pooled reference site LAC (33 days in water from 10 April to 13 May)	Reference site LAC (median pooled reference site +0.1084)	Median LAC during dredging period (18 days from 15 April to 2 May)	Median LAC during dredging period to end of sampling period (29 days from 15 April to 13 May)
Units							m^{-1}
Environmental Criteria		LAC threshold >0.1084 above the median of baseline measurements from the same site					
		LAC threshold >0.1084 above the median of pooled reference site measurements:					
Disposal Sites	DI1	0.0400	0.1484			0.0471	0.0511
	DI2	0.0410	0.1494			0.0432	0.0453
	OS	0.0394		0.0405	0.1489	0.0391	0.0408
Down River Site	DR1	0.0400	0.1484			0.0482	0.0516
	OS	0.0394		0.0405	0.1489	0.0391	0.0408
Swan River Sites	SI1	0.0306	0.1390			0.1585	0.1192
	SR	0.1478		0.1555	0.2639	0.1582	0.1567

Notes

- *A coloured cell indicates an exceedance of the Environmental Criteria*

3.2. In-Water Plume Monitoring

3.2.1. NTU to TSS correlation

The NTU to TSS correlation equation was deemed sufficient to calculate TSS from NTU and is as follows:

$$y=3.337x,\ r^2=0.77$$

Where y=TSS and x=NTU

3.2.2. TSS

The median TSS value for surface and bottom, at each site, on each day of sampling during the operational period has been compared to the EC and are presented in Table 5. The EC is considered achieved if TSS concentrations at impact sites is 10mg/L above the reference site data on the dredging activity sampling occasion.

Swan River impact sites exceeded thresholds on Day 5, 10 and 15 as summarised below;

Day 5 of active dredging:

- SI1 Surface TSS: 13.68 mg/L

Day 10 of active dredging:

- DR2 Surface TSS: 26.02 mg/L and Bottom TSS: 46.39 mg/L
- SI1 Surface TSS: 16.67 mg/L and Bottom TSS: 28.03 mg/L
- SI2 Surface TSS: 14.35 mg/L

Day 15 of active dredging:

- DR2 Bottom TSS: 19.69 mg/L
- SI3 Surface TSS: 19.36 mg/L and Bottom TSS: 20.69 mg/L

Post dredge monitoring was undertaken after the completion of the dredging operation. The median TSS values for surface and bottom, at each site, 11 days post dredging was compared to the EC and are presented in Table 5. The EC is considered achieved if TSS concentrations at impact sites is <80th percentile of background data for the site (or to reference levels). All impact sites >80th percentile of background data for the site however so were reference sites (Table 5). Impact sites returned to reference levels (Table 5) except for:

- DI1 Surface TSS: 1.77 mg/L (OS Surface TSS 1.70 mg/L)
- DI1 Bottom TSS: 6.01 mg/L (OS Bottom TSS: 2.14 mg/L)
- DI2 Bottom TSS: 2.94 mg/L (OS Bottom TSS: 2.14 mg/L)
- SI1 Surface TSS: 3.84 mg/L (SR Bottom TSS: 3.17 mg/L)
- DR1 Bottom TSS: 3.64 mg/L (RD Bottom TSS 2.50 mg/L)

Table 5: Summary of TSS trigger levels for Impact sites

Site ID	Surface							Bottom						
	Pre dredging	80th percentile	Day 2	Day 5	Day 10	Day 15	Post dredging[1]	Pre dredging	80th percentile	Day 2	Day 5	Day 10	Day 15	Post dredging[1]
Date			16/4	19/4	24/4	29/4	14/5			16/4	19/4	24/4	19/4	14/5
EC: *Surface or bottom TSS (mg/L) at any individual impact site is 10 mg/L above the reference site data on the dredging activity sampling occasion*														
Disposal Area Sites														
Reference site (Threshold = Reference site + 10 mg/L)														
OS	0.18	0.67	2.00	1.66	2.87	2.17	1.70	0.24	1.64	2.33	1.87	2.54	2.34	2.14
Threshold	n/a	n/a	12.00	11.66	12.87	12.17	n/a	n/a	n/a	12.33	11.87	12.54	12.34	n/a
Impact Sites														
DI1	0.76	0.67	1.87	1.84	2.74	2.00	1.77	1.69	1.64	3.17	1.80	2.40	2.17	6.01
DI2	0.18	0.67	1.84	1.84	3.17	2.17	1.67	0.77	1.64	2.50	1.87	3.30	3.67	2.94
Swan River Sites														
Reference site (Threshold = Reference site + 10 mg/L)														
SR	1.78	2.08	3.24	3.00	4.34	4.34	3.17	3.72	3.38	6.44	9.34	5.64	7.68	6.37
Threshold	n/a	n/a	13.24	13.00	14.34	14.34	n/a	n/a	n/a	16.44	19.34	15.64	17.68	n/a
Impact Sites														
DR2	1.11	1.22	5.50	10.01	26.02	3.84	2.04	1.95	2.12	4.00	10.41	46.39	19.69	5.04
SI1	2.24	2.08	5.81	13.68	16.67	10.68	3.84	2.42	3.38	7.04	12.01	28.03	10.35	4.04
SI2	1.84	2.08	3.70	4.00	14.35	10.34	2.37	1.98	3.38	5.47	4.10	9.68	8.34	3.20

SI3	1.97	2.08	5.11	12.85	13.38	19.36	2.37	1.98	3.38	5.11	14.52	14.92	20.69	2.70
Down River Sites														
Reference site (Threshold = Reference site + 10 mg/L)														
RD	0.31	0.56	2.00	1.67	2.54	2.34	2.47	0.30	0.55	2.40	1.97	2.54	2.34	2.50
Threshold	n/a	n/a	12.00	11.67	12.54	12.34	n/a	n/a	n/a	12.40	11.97	12.54	12.34	n/a
Impact Site														
DR1	0.56	0.56	1.83	2.00	3.67	2.84	1.90	0.55	0.55	4.17	2.07	3.67	9.01	3.64

Notes

1. Post dredging exceedances are only determined from an exceedance of the 80th percentile from pre-dredging baseline measurement from the same site

- *'TSS'= Total Suspended Solids, 'EC'= Environmental Criteria*
- *A coloured cell indicates an exceedance of the Environmental Criteria*

3.3. Water Clarity Monitoring

The median Secchi disc data from pre-dredge sampling was used to calculate a 20% reduction threshold value to compare against the EC during the operational period for Impact sites. To achieve the EC, no Secchi disc measurements during the operational sampling period (or post dredging period) for Impact sites could be 20% less than the baseline data from each respective site and no Recreational sites may have a Secchi disc measurement of <1.6 m. Summary data for Impact and Recreational sites are presented in Table 6.

Disposal Area sites water clarity was below thresholds on Day 2, 10 and 15 of active dredging (Table 6) as summarised below;

- Day 2 at DI1 and DI2;
- Day 10 at DI1 and DI2; and
- Day 15 at DI2.

Reference site OS also exceeded thresholds on Day 2, 10 and 15. Post dredging, all sites returned to above thresholds.

Down River site DR1 water clarity exceeded thresholds on Day 2, 10 and 15 of active dredging (Table 6) however had returned to above thresholds post dredging.

Swan River impact sites water clarity was below thresholds on Day 2, 5, 10 and 15 of active dredging (Table 6) as summarised below;

- Day 2 at DR2 and SI1;
- Day 5 at DR2, SI1 and SI3;
- Day 10 at all sites (DR2, SI1, S12 and SI3); and
- Day 15 at all sites (DR2, SI1, S12 and SI3),

Reference site SR also exceeded thresholds on Day 10 and 15. Post dredging, all sites except SI1 had returned to above thresholds.

All recreation sites were above the water clarity EC throughout the dredge operation (Table 6).

Table 6: Secchi disc trigger values for Impact sites

Site ID	Pre dredging	Thresholds: Impact sites: 20% reduction Trigger Value Recreational sites: <1.6m Trigger Value	Median Day 2 16/4	Day 5 19/4	Day 10 24/4	Day 15 29/4	Post dredging 14/5
EC	*Median Secchi depth from Impact sites must not be reduced by 20% during the sampling occasion* *Median Secchi depth from Recreational sites must not be <1.6m*						
Disposal Area Sites							
DI1	7.9	6.3	4.4	9.3	4.5	7.6	15.0
DI2	10.5	8.4	4.7	10.1	4.3	7.5	12.6
OS	10.0	n/a (8.0)	5.4	8.9	4.0	6.6	10.0
Down River Sites							
DR1	9.8	7.8	4.8	8.3	5.0	5.0	12.7
RD	>5.0	n/a (4.0)	5.0	>5.0	4.0	>5.0	5.1
SD3	4.8	3.8	5.5	>4.6	3.5	>4.6	3.6
Swan River Sites							
DR2	6.7	5.4	3.7	2.0	1.0	4.0	8.5
SI1	5.3	4.2	3.9	1.7	1.6	2.3	2.2
SI2	>2.7	2.2	>2.7	>2.4	1.7	1.8	>2.8
SI3	3.5	2.8	3.0	2.7	1.7	1.6	3.8
SR	4.8	n/a (3.8)	4.8	5.7	2.9	3.3	7.0

SD1	4.8	3.8	3.0	1.7	1.9	2.1	5.8
SD2	6.5	5.2	3.8	2.7	1.9	2.6	5.6

Notes

- *A coloured cell indicates an exceedance of the Environmental Criteria*
- *'>'= Secchi disc measurement is the water depth*
- *Reference sites are provided for informative purposes only and not to be used to assess against the EC. Please refer to Section 6.5 for a discussion of Reference Site data*

3.4. Remote Imagery Units and Drone Aerial Photography

Remote imagery units and drone aerial photography was used to informally assess whether the exceedances from the in-water plume and water clarity monitoring were associated with a sediment plume created by dredging activity. To understand the spatial extent of the dredge plume, the drone surveyed four zones, encompassing the Swan River and Down River sites.

Presented in Appendix A are the pre-dredge drone aerial photographs from Zones 1 – 4, provided for a visual assessment of marine environmental quality prior to dredging impact (Appendix A, Figure 5).

Sediment plumes were observed at Swan River sites on Day 2, 5, and 10 extending from the Inner Harbour to Point Walter in line with plume modelling predictions. On Day 15 the sediment plume entered Freshwater Bay extending east past the plume modelling extent.

- On Day 2 a sediment plume was observed east of the Inner Harbour at Stirling Bridge (Appendix A, Figure 6, Zone 2).
- On Day 5 a sediment plume was observed in the Inner Harbour (Appendix A, Figure 7, Zone 1) and west of Point Walter (Appendix A, Figure 7, Zone 4).
- On Day 10 a sediment plume was observed east of Bicton Baths (Appendix A, Figure 8, Zone 3).
- On Day 15 a sediment plume was observed entering Freshwater Bay (Appendix A, Figure 9, Zone 4).
- No sediment plumes were observed in post dredge monitoring on 14 May (Appendix A, Figure 10 all Zones).

No visible plumes were identified at the Inner Harbour's Entrance Channel or west of the Inner Harbour or Disposal sites (Appendix A and Appendix B, Figure 5 - Figure 14, Zone 1).

3.4.1. Imagery evidence for TSS and Secchi disc exceedances

Content was collected and visually analysed from drone aerial photography (Appendix A) and RIUs (Appendix B) and used to represent a snapshot of water quality from each day of operation within each zone.

Upon review of the imagery from the drone and RIUs, it can be surmised that the exceedances for water clarity in the Swan River sites presented in Section 3.2.2 and Section 3.3, respectively, are due to the dredge influence.

Rationale includes:

- Water clarity decline determined from visual analysis from the imagery from the operational period when compared to imagery from the baseline period (Appendix A and Appendix B).
- Visual plume observed in imagery from the operational period (refer section 3.4).

It is important to note that these images are not used to confirm the extent and severity of the plume and are used as an informal assessment and discussion point only.

Visible sediment plumes observed at Swan River sites align with TSS and Secchi disc exceedances:

- On Day 2 a sediment plume was observed east of the Inner Harbour at Stirling Bridge, there were no TSS exceedances at any Swan River site however Secchi disc exceedances occurred at DR2, SI1 and SI3 indicating sediments had begun moving upstream from the Inner Harbour.
- On Day 5 a sediment plume was observed west of Point Walter. TSS exceedances occurred at Swan River impact sites SI1 and SI3 and Secchi disc exceedances occurred at DR2, SI1 and SI3 in line with visible sediment plumes.
- On Day 10 a sediment plume was observed east and west of Bicton Baths. TSS exceedances occurred at Swan River impact sites DR1, SI1, SI2 and SI3 and Secchi disc exceedances occurred at all sites in line with visible sediment plumes.
- On Day 15 a sediment plume was observed entering Freshwater Bay. TSS exceedances occurred at Swan River impact sites DR1 and SI3 and Secchi disc exceedances occurred at all sites in line with visible sediment plumes. Swan River reference site SR water clarity (Secchi Disc) was reduced on Day 10 and 15 therefore may have been impacted by the sediment plume entering Freshwater Bay however no reduction in TSS occurred at this site.
- No sediment plumes were observed in post dredge monitoring on 14 May. Except for S1, there were no Secchi disc exceedances at Swan River impact sites, in line with the absence of visible sediment plumes. TSS exceeded the environmental criteria (<80th percentile) however exceedances were not attributed to sediment plumes from dredging activity (refer section 3.2.2).

No visible plumes were identified at the Inner Harbour's Entrance Channel or west of the Inner Harbour or Disposal sites (Appendix A and Appendix B, Figure 5 - Figure 14, Zone 1).

4. Compliance assessment of Outcome-based provisions

The following table presents an assessment against the outcome-based provisions based on the summary of results (Table 7).

Table 7: Compliance assessment of Outcome-based provisions for the Inner Harbour DEMP

Environmental Factor	Environmental Protection Outcome (EPO)	Environmental Criteria (EC)	Response	Monitoring	Reporting
Marine Environmental Quality (increased water column turbidity)	EPO 1) Maintain water clarity to meet the environmental criteria at the boundary of ZoMI/ZoI to minimise social impacts on aesthetic quality from increased water column turbidity associated with dredging activity	*EC: Surface or bottom TSS (mg/L) at any individual impact site is 10 mg/L above the reference site data on the dredging activity sampling occasion.* The EC was exceeded at Swan River impact sites on Day 5 (SI1 and SI3), Day 10 (DR1, SI1, SI2 and SI3) and Day 15 (DR1 and S13). As a visible sediment plume was observed at the Swan River sites on Days 5, 10 and 15 the TSS exceedances were considered to be attributed to the dredging operation.	Dredging operations were analysed and changed with aim to reduce the intensity/extent of sediment plumes upstream. On day 5 the dredging plan changed from continuously dredging the south east area of the Inner Harbour to alternating with other areas. On day 10 the dredging plan changed to focus on the north and south west area of the Inner Harbour. On day 15 no change to operations was required as the dredge plan was to spot hunt the final areas of the Inner Harbour to be removed.	TSS monitoring occurred prior to, during and post dredging. Water column turbidity at the Swan River sites exceeded plume model predictions however plumes were no longer evident 11 days post dredging..	This report, refer Section 3.2
		EC: Median Secchi depth from Impact sites must not be reduced by 20% during the sampling occasion. The EC was exceeded at Swan River impact sites on Day 2 (DR2, SI1 and SI3), Day 5 (DR2, SI1 and SI3), Day 10 (all sites) and Day 15 (all sites). As a visible sediment plume was observed at the Swan River sites on Days 2, 5, 10 and 15 the Secchi depth exceedances were	Dredging operations were analysed and changed with aim to reduce the intensity/extent of sediment plumes upstream. On day 5 the dredging plan changed from continuously dredging the south east area of the Inner Harbour to alternating with other areas. On day 10 the dredging plan changed to focus on the north and south west area of the Inner Harbour.	Water clarity monitoring occurred prior to, during and post dredging. Remote imagery units were installed at two locations in the Inner Harbour and a third installed on the dredge vessel, site photographs, plume sketches and	This report, refer Section 3.3

		considered to be attributed to the dredging operation. The EC was exceeded at all Disposal Area sites on Days 2, 10 and 15. As reference site (OS) also exceeded thresholds on Days 2, 10 and 15 the Secchi depth exceedances were not considered attributed to the dredging operation. The EC was exceeded at the Down River impact site on Days 2, 10 and 15. As no visible plume was observed in this area it is unclear if exceedances were attributed to the dredging operation.	On day 15 no change to operations was required as the dredge plan was to spot hunt the final areas of the Inner Harbour to be removed.	drone aerial photography was completed to monitor sediment plumes.	
		EC: Median Secchi depth from Recreation sites must not be <1.6 m (equivalent to the EPA [2017] water clarity EQG for the maintenance of primary contact recreation). No exceedances of the EC occurred.	No exceedances of the EC occurred therefore no response was required.	Water clarity monitoring occurred at recreational sites prior to, during and post dredging.	This report, refer Section 3.3
Marine Environmental Quality (increased sediment contaminants)	EPO 2) Ensure dredge sediment quality of the Inner Harbour is maintained to prevent the release of	*EC: Sediments of Inner Harbour sites sampled as part of the annual Marine Quality Monitoring Program (MQMP) are within Environmental Quality Criteria. The sediments are tested for nitrogen, phosphorus, heavy metals, tributyltin, hydrocarbons and organochlorine pesticides. The Environmental Quality*	Sediments were similar to previous years and within the MQMP Environmental Quality Criteria therefore no response was required.	Sediment quality monitoring completed in February 2024 in line with Fremantle Ports 2024 MQMP.	2024 MQMP Report (O2 Marine 2024) Fremantle Ports Record 2042190

	potential new contaminants.	*Criteria adopted for review of the sediment results are the same as implemented for the MQMP.* The EC was met as the sediments were similar to previous years monitoring and within Environmental Quality Criteria.			
Benthic communities and habitats (indirect loss)	EPO 3) Maintain light levels to meet the environmental criteria at the ZoMI/ZoI boundary to avoid indirect loss of seagrass from increased water column turbidity associated with sediment disposal	*EC: Median light attenuation coefficient (LAC) from any Impact site caused by dredging exceeds:* *>0.1084 above the median of baseline measurements from the same site; and* *>0.1084 above the median of pooled reference site measurements.* LAC at Swan River impact site S1 exceeded the median of baseline measurements from the same site however was below the median of pooled reference site measurements. An EC exceedance requires both median baseline and median reference site LAC data to be exceeded and therefore the EC has been met.	No exceedances of the EC occurred therefore no response was required.	Light attenuation monitoring was undertaken for the entire dredging period including pre and post dredging. Two of the eight light loggers installed at Swan River impact site SI2 and Down River reference site RD were unable to provide sufficient data to calculate the LAC.	This report, refer 3.1

5. Compliance assessment of Management-based provisions

The following table presents an assessment against the management-based provisions based on the verification of evidence (Table 8).

Table 8: Compliance assessment of management-based provisions for the Inner Harbour DEMP

Environmental Factor	Environmental Protection Objective (EPOb)	Management Target	Management Action	Monitoring Action	Reporting
Marine Environmental Quality (Hydrocarbon spills and waste generation)	EPOb 1) No hydrocarbon spills or release of waste into the environment from dredging and disposal	*MT: No reported hydrocarbon spills or release of waste into the environment from dredging and disposal* No hydrocarbon spills or waste incidents occurred during dredging and disposal operations.	A clean and tidy work area was observed with all hazardous substances safely stored.	Weekly inspections were completed on Day 5 (19 April 2024) and Day 15 (29 April 2024).	Inspection records verified Fremantle Ports Record 2044001.
			Fuels and oils were stored in contained areas and fuelling occurred within a bunded area.	Weekly inspections were completed on Day 5 (19 April 2024) and Day 15 (29 April 2024).	Inspection records verified Fremantle Ports Record 2044001.
			A mobile spill kit was observed on the dredge with all necessary materials for mitigating an accidental hydrocarbon spill.	Weekly inspections were completed on Day 5 (19 April 2024) and Day 15 (29 April 2024).	Inspection records verified Fremantle Ports Record 2044001.
			The Contractor prepared a Construction Environmental Management Plan (CEMP) that includes oil spill contingency procedures to be implemented in the event of an accidental hydrocarbon spill.	Review of the CEMP provided by the Contractor verified inclusion of oil spill contingency procedures in section 5.3 Hydrocarbon spills and waste generation.	CEMP verified Fremantle Ports Record 2044007.

			All work areas observed were clear of waste/rubbish. On shift change waste bins were situated on the berth to receive waste collected from the dredge operation.	Weekly inspections were completed on Day 5 (19 April 2024) and Day 15 (29 April 2024). Shift change inspection 1 May 2024.	Inspection records verified Fremantle Ports Record 2044001.
			The Trud R dredge vessel obtained a low risk rating from the Department of Primary Industries and Regional Development (DPIRD) risk assessment tool prior to mobilising to site from an interstate or international location. The local support vessel Rind R was taken out of the water and cleaned prior to mobilising to site.	The DPIRD risk assessment tool report was completed on 26 March 2024 prior to the dredge mobilising to site. The local support vessel Rind R was taken out of the water and cleaned from 5 - 14 April 2024 with photo evidence of clean hull provided.	DPIRD low risk rating for Trud R dredge vessel verified Fremantle Ports Records 2044013 & 2044755. Email & photo evidence regarding clean of Rind R Fremantle Ports Record 2044701.
Benthic communities and habitat (direct loss)	EPOb 2) Ensure no permanent loss of BCH outside of the zone of high impact (ZoHI)	*MT: No dredging and sediment disposal outside of the defined areas of the Native Vegetation Clearing Permit (NVCP) and Sea Dumping Permit (SDP) areas.*	The dredge will have an accurate positioning system installed and the position of the dredge will be monitored during dredging operations.	The dredge position data was provided to Fremantle Ports in daily reports. The dredge track logs were provided to Fremantle Ports on	Daily Reports verified Fremantle Ports Records 2044725 to 2044746. Dredge position data (track logs) verified Fremantle Ports Record 2044705.

		No dredging or disposal of sediment occurred outside of the NVCP or SDP therefore the MT was met.		completion of the project.	
			Disposal position logs including details of the timing and position will be maintained.	The disposal position logs including details of the timing and position was provided to Fremantle Ports in daily reports.	Daily Reports verified Fremantle Ports Records 2044725 to 2044746. Disposal position data verified Fremantle Ports Record 2044704 & 2044028.
			The green valve was observed to be fitted to the dredge and in operation during 30-minute overflow periods of dredging.	Weekly inspections were completed on Day 5 (19 April 2024) and Day 15 (29 April 2024).	Inspection records verified Fremantle Ports Record 2044001.
			A targeted disposal area was provided to the Contractor. The targeted disposal area was positioned within the Native Vegetation Clearing Permit (NVCP) and the Sea Dumping Permit (SDP) areas.	The disposal position logs provided by the Contractor were mapped and all logs were within the target disposal area (and therefore within the NVCP and SDP areas).	Disposal position logs map verified Fremantle Ports Record 2044028.
			Dredging of the Inner Harbour was undertaken from 15 April 2024 to 3 May 2024 (18 days) within the dredging window (1 April to 31 August).	Dredging was planned to be undertaken from 15 April 2024 to 24 April 2024 (10 days) however due to dredging operational	Daily Reports verified Fremantle Ports Records 2044725 to 2044746.

				delays was extended until 3 May 2024. Dredging was completed within the dredging window (1 April to 31 August).	
Social surroundings (public and navigational safety)	EPOb 3) No public or navigational safety incidents from dredging and disposal	*MT: Any / all reported community concerns about a potential safety hazard, near miss, or incident as a result of public or navigational safety issues associated with dredging and disposal are addressed in-line with the Communications Plan.* No community concerns were raised during the dredging operation therefore the MT was met.	A public complaints register was developed and maintained during the dredging operation.	No public complaints were received during the dredging operation related to dredging or disposal activities.	Fremantle Ports CGR incident and feedback database records verified.
			A Temporary Notice to Mariners (TNTM) from DoT's Marine Safety Branch was obtained prior to the commencement of works to inform the public of potential navigational hazards associated with dredging and disposal.	Review of the Navigation Warning (i.e. TNTM) published on DoT's website was completed once-off prior to the commencement of dredging operations.	Inner Harbour Maintenance Dredging Communications Plan Fremantle Ports Record 1898201. Navigation Warning Fremantle Ports Record 2044703.
			The dredge and associated support vessels were fitted with the appropriate marine safety equipment, markers and lighting to the satisfaction of Fremantle Ports' Harbour Master.	Weekly inspections were completed on Day 5 (19 April 2024) and Day 15 (29 April 2024).	Inspection records verified Fremantle Ports Record 2044001.

			The Contractor complied with the relevant requirements in Fremantle Ports' Port Information Guide (Fremantle Ports 2018) while operating in Fremantle Ports' limits.	Weekly inspections were completed on Day 5 (19 April 2024) and Day 15 (29 April 2024).	Inspection records verified Fremantle Ports Record 2044001.
Social surroundings (reduced visual amenity, odour generation and noise)	EPOb 4) Minimise social impacts from potential reduced public amenity, odour generation or noise associated with dredging and sediment disposal	*MT: Any / all community concerns raised in relation to reduced public amenity, odour generation or noise associated with dredging and sediment disposal are addressed in-line with the Communications Plan.* No community concerns were raised during the dredging operation therefore the MT was met.	A public complaints register was developed and maintained during the dredging operation.	No public complaints were received during the dredging operation related to dredging or disposal activities.	Fremantle Ports CGR incident and feedback database records verified.
			Change management provisions were not required as there were no public complaints received during the dredging operation.	No public complaints were received during the dredging operation related to dredging or disposal activities.	Fremantle Ports CGR incident and feedback database records verified.
			The Contractor's Construction Environmental Management Plan (CEMP) includes noise management controls.	Review of the CEMP provided by the Contractor verified inclusion of noise management in section 5.8 Reduced Visual Amenity, Odour Generation and Noise.	CEMP verified Fremantle Ports Record 2044007.

			The Contractor's Construction Environmental Management Plan (CEMP) includes noise mitigation measures including maintenance, inspection and operation of the dredge and any associated support vessels and equipment.	Review of the CEMP provided by the Contractor verified inclusion of noise mitigation measures in section 5.8 Reduced Visual Amenity, Odour Generation and Noise.	CEMP verified Fremantle Ports Record 2044007.
			The Contractor's Construction Environmental Management Plan (CEMP) includes plume, odour and noise contingency procedures to be implemented in response to a community complaint to minimise social impacts associated with reduced public amenity.	Review of the CEMP provided by the Contractor verified inclusion of contingency procedures to be implemented for reduced visual amenity, odour generation and noise in section 5.8. No public complaints were received during the dredging operation related to dredging or disposal activities.	CEMP verified Fremantle Ports Record 2044007. Fremantle Ports CGR incident and feedback database records verified.

Social surroundings (disturbance to Aboriginal heritage)	EPOb 5) Aboriginal stakeholder dredge monitoring recommendations are implemented	*MT: Aboriginal representative's dredge monitoring recommendations are implemented in-line with stakeholder consultation as documented in the Communications Plan.* The dredge monitoring recommendations were implemented therefore the MT was met.	A Whadjuk Aboriginal representative undertook a smoking ceremony adjacent to the dredge vessel prior to commencing dredging works.	Whadjuk representative undertook a smoking ceremony prior to commencing dredging works on 15 April 2024.	Smoking ceremony invitation verified Fremantle Ports Record 2044700. Inner Harbour Maintenance Dredging Communications Plan Fremantle Ports Record 1898201.
			A Whadjuk Aboriginal Ranger undertook dredge works monitoring onboard the dredge throughout the operation (during daylight hours).	A Whadjuk Aboriginal Ranger monitored the dredge works during dredging operations (during daylight hours) from 15 April to 2 May (excluding 29 April when the Ranger was unable to attend due to personal leave).	Verified by Whadjuk Ranger Roster and Whadjuk Aboriginal payment forms Fremantle Ports Records 2044758 & 2044756 Inner Harbour Maintenance Dredging Communications Plan Fremantle Ports Record 1898201.
			A Whadjuk Aboriginal Ranger undertook dredge plume monitoring onboard the scientific vessel during in-water monitoring events.	A Whadjuk Aboriginal Ranger monitored the dredge plume during in-water monitoring events on five occasions prior to,	Verified by Whadjuk Ranger Roster and Whadjuk Aboriginal payment forms Fremantle Ports Records 2044758 & 2044756.

				during and after the dredging operations.	
Marine Fauna (Introduced Marine Species (IMS))	EPOb 6) No introduction of IMS to the project site from the arrival of the dredge and any associated support vessels.	*MT: No reported observations of IMS on the dredge and any associated support vessels at the Project site* No IMS were observed on the dredge vessel or support vessels therfore the MT was met.	The Trud R dredge vessel obtained a low risk rating from the Department of Primary Industries and Regional Development (DPIRD) risk assessment tool prior to mobilising to site from an interstate or international location. The local support vessel Rind R was taken out of the water and cleaned prior to mobilising to site.	The DPIRD risk assessment tool report was completed on 26 March 2024 prior to the dredge mobilising to site. The local support vessel Rind R was taken out of the water and cleaned from 5 - 14 April 2024 with photo evidence of clean hull provided.	DPIRD low risk rating for Trud R dredge vessel verified Fremantle Ports Records 2044013 & 2044755. Email & photo evidence regarding clean of Rind R Fremantle Ports Record 2044701.
			The Trud R dredge obtained a low risk rating from the Department of Primary Industries and Regional Development (DPIRD) risk assessment tool prior to mobilising to site from an interstate or international location.	The DPIRD risk assessment tool report was completed on 26 March 2024 prior to the dredge mobilising to site.	DPIRD risk assessment tool report verified Fremantle Ports Record 2044013.
		MT: No new IMS identified at the Project site attributed to the project No new IMS were identified at the Project	No new IMS were identified in the Inner Harbour therefore no management action was required.	The State-Wide Array Surveillance Program (SWASP) was implemented Winter 2023. Targeted	SWASP report and targeted IMS surveys verified Fremantle Ports Record 2044874.

		site that were attributed to the dredging project therefore the MT was met.		surveys for *Didemnum vexillum* (known from AMC) were undertaken in December 2023, February 2024 & April 2024.	
Marine Fauna (marine fauna collision/ vessel strike or entrainment)	EPOb 7) No collision/ vessel strike or entrainment with marine fauna from the operation of the dredge.	*MT: No reported collision/vessel strike or entrainment incidents with marine fauna from the operation of the dredge* No marine fauna collision/vessel strikes or entrainment incidents occurred during the dredging operation therefore the MT was met.	a) Vessel Masters responsible for operating the dredge were suitably trained to understand marine fauna behaviours, actions and reporting requirements in the event of marine fauna injury or mortality and provisions under Environmental Protection and Biodiversity Conservation Regulations Part 8 Division 8.1:Interacting with cetaceans. b) Turtle Exclusion Device (TED) was fitted to the Dredge vessel. c) No marine fauna collision/vessel strike or entrainment incidents occurred in relation to the operation of the dredge.	a) Training was delivered by O2 Marine and was undertaken on 10 April. b) The TED was observed to be fitted to the dredge prior to dredge operations commencing and during operation the TED was observed in weekly inspections completed on Day 5 (19 April 2024) and Day 15 (29 April 2024). c) No marine fauna incidents were recorded during the dredging operation.	a) Marine Species Observer Program 2024 Report (O2 Marine, 2024) Fremantle Ports Record 2042193. b) Inspection records verified Fremantle Ports Record 2044001. c) Fremantle Ports CGR incident and feedback database records verified.

		MT: Monitor fauna behaviour and movement: • *If fauna proceeds towards dredge, cease dredging until fauna is outside of monitoring zone* • *Implement soft-start procedures on recommencement of dredging* Marine fauna behaviour and movement was monitored by a suitably qualified Marine Species Observer and corrective actions were implemented to ensure no marine fauna collision/vessel strikes or entrainment incidents occurred therefore the MT was met.	A dedicated and suitably qualified Marine Species Observer (MSO) was on board the dredge vessel whilst undertaking dredging and disposal activities, and the MSO documented observations and interactions with marine fauna (within a 300m radius from the dredge) and documented the corrective actions taken. Additionally, the Vessel Masters were suitably trained to understand marine fauna behaviours, required actions and reporting requirements and documented the corrective actions taken in daily reports.	The MSO was dedicated observer on the dredge vessel at all times including in low light operations. The Vessel Masters responded to MSO observations and implemented corrective actions. The MSO maintained observation and interaction logs. The Vessel Master documented marine fauna stops or delays in daily reports.	Marine Species Observer Program 2024 Report (O2 Marine, 2024) Fremantle Ports Record 2042193. MSO Interaction and Observation Logs Fremantle Ports Record 2044757. Daily Reports verified Fremantle Ports Records 2044725 to 2044746.
		MT: Monitor fauna behaviour and movement: • *Delay commencement*	A dedicated and suitably qualified Marine Species Observer (MSO) was on board the dredge vessel whilst undertaking dredging and disposal activities, and the MSO	The MSO was dedicated observer on the dredge vessel at	Marine Species Observer Program 2024 Report (O2 Marine, 2024)

		of dredging until fauna is outside of monitoring zone Marine fauna behaviour and movement was monitored by a suitably qualified Marine Species Observer and corrective actions were implemented to ensure no marine fauna collision/vessel strikes or entrainment incidents occurred therefore the MT was met.	documented observations and interactions with marine fauna (within a 300m radius from the dredge) and documented the corrective actions taken. Additionally, the Vessel Masters were suitably trained to understand marine fauna behaviours, required actions and reporting requirements and documented the corrective actions taken in daily reports.	all times including in low light operations. The Vessel Masters responded to MSO observations and implemented corrective actions. The MSO maintained observation and interaction logs. The Vessel Master documented marine fauna stops or delays in daily reports.	Fremantle Ports Record 2042193. MSO Interaction and Observation Logs Fremantle Ports Record 2044757. Daily Reports verified Fremantle Ports Record 2044725 to 2044746.
Marine Environmental Quality (plume management (for four dredging campaigns of 5,000m3 from 2025 to 2029)	EPOb 8) No visible plume caused by dredging or disposal operations during the four subsequent dredge campaigns from 2025 to 2029.	No visible plume occurs outside of the Inner Harbour dredging area and the Gage Roads offshore disposal area during the four subsequent dredge campaigns from 2025 to 2029 that is caused by dredging or disposal operations.	Not applicable to the 2024 dredging campaign	Not applicable to the 2024 dredging campaign.	Not applicable to the 2024 dredging campaign

6. Discussion

6.1. Light Attenuation Monitoring

As identified in Section 4, the EC outlined in the DEMP was achieved across all sites. This suggests that light levels were maintained during the dredging - and post dredging - periods, avoiding indirect stressor effects that could result in loss of seagrass from increased water column turbidity associated with sediment disposal. However as two of the eight light attenuation monitoring sites, including a Swan River impact site, were unable to provide sufficient data to calculate light levels (refer to Section 6.5) there is only a moderate level of confidence of the EPO being achieved.

Within Swan River sites, LAC during the dredging period for site SI1 exceeded the median baseline LAC, however, did not exceed the median LAC from its Reference site (SR). An EC exceedance requires both median baseline and median reference site LAC data to be exceeded and therefore the EC has been met.

Within Down River sites, LAC from site DR1 was compared to the Reference site OS due to data being unavailable from RD reference site (refer to Section 6.5). Reference site OS was considered representative of RD as both are located in open ocean environments. It is important to note that site DR1 is in very close proximity to the zone of high impact and the dredging area, as presented within the modelling report, and therefore expected to have some level of temporary light reduction.

For Disposal Sites, sites DI1 and DI2 both reported no EC exceedances. Results from the predicted ZoMI area aligns well with what is presented in the plume modelling report (BMT 2022).

6.1.1. Daily Light Integral

DLI was calculated and summarised in Section 3.1.1. Reference site data is generally expected to present higher DLI results than Impact sites due reduced dredging impact, however there were no major trends in DLI between all assessed sites. Additionally, site SI1, which presented with the most elevated LAC, reported the highest DLI median out of all sites. This suggests that there may be more light integrating into the water column and less impact on benthic communities than what LAC data presents.

It is generally accepted that as LAC increases, DLI decreases, however this is not supported by these results. This provides further evidence for the consideration of replacing LAC data with DLI as a means of measuring light levels in the water column to understand its effect on benthic communities. This is discussed further in Section 7.1.

6.2. In-water plume monitoring

During the operational period there were nine occasions where TSS concentrations exceeded the EC outlined in the DEMP (refer section 3.2.2 of this report for results). In the context of the EPO however, there were only two exceedances, both at site SI3, where TSS concentrations were more than 10 mg/L than its respective reference site.

Whilst the EPO was not achieved during this program, sites within the ZoMI are expected to have temporarily elevated TSS results, which was reflected within this program. This data suggests that water clarity was moderately maintained to minimise social impacts on aesthetic quality from increased water column turbidity.

The plume was considered to be not evident one week post dredging. The majority of sites, including reference sites, were elevated above the 80th percentile of pre-dredge conditions. This was considered to be representative of the river and nearshore environment during winter conditions. A significant storm system had impacted the area in the week prior, likely resulting in run off and resuspension of sediments. Aerial imagery also confirmed no evident plume visible in the Swan River.

6.3. Water clarity monitoring

As presented in Section 3.3, some Secchi disc measurements from Impact sites exceeded the EC, however, no exceedances were reported for any Recreational site. To constitute an EC exceedance for water clarity, both Impact and Recreational sites must exceed their respective thresholds. The EC, therefore, has been achieved for this program as no Recreational sites reported any exceedances during the sampling period.

In the context of the EPO (i.e. sites SI3 and DR1 on the ZoMI/ZoI boundary for Swan River Sites and sites DI1 and DI2 for Disposal sites), there were six and five exceedances, respectively, across the sampling period, however as no recreational sites exceed the EC, the EPO consequently is maintained.

This data suggests that water clarity was maintained to minimise social impacts on aesthetic quality from increased water column turbidity.

6.4. Remote Imagery Units and Drone Aerial Photography

As discussed in Section 3.4, the imagery from both the RIUs and drone are used to aid in a visual assessment of water clarity. Images from Appendix A and Appendix B portray a visual sediment plume and a decline in water clarity when compared to baseline imagery. Water clarity and the appearance of the visual plume from images during the last drone flight event (14/05/2024) appear to be improved (i.e. better water clarity and sediment plume less evident). Despite this, other events are able to impact both water clarity and the presence of a plume. As the project area encompasses both coastal and riverine systems, tidal influence can relocate suspended sediments from the upper river region down to the river mouth causing the water clarity to decline. Shipping movements (tugboats, commodity vessels, ferries etc) in the operational Port may disturb the seafloor and create a plume like appearance, as observed in Figure 4.

Considering the above, the imagery from both the RIUs and drone provide evidence that the dredge may have caused a decline in water clarity and a visual sediment plume. However, interpretating the causation should be undertaken with a moderate degree of caution as there are other elements that can create the implications described above.

6.5. Limitations of Survey

There were some limitations to the survey which could prevent an accurate understanding of the monitoring presented in the above sections.

The Fremantle Port waters are an active waterway with high commercial and recreational traffic occurring often throughout pre-, during and post- dredging activity. This activity can contribute to suspended sediments in the water column and present similar to a dredging plume, causing a false interpretation of light levels and/or plume and water clarity results. This scenario can be observed in Figure 4.

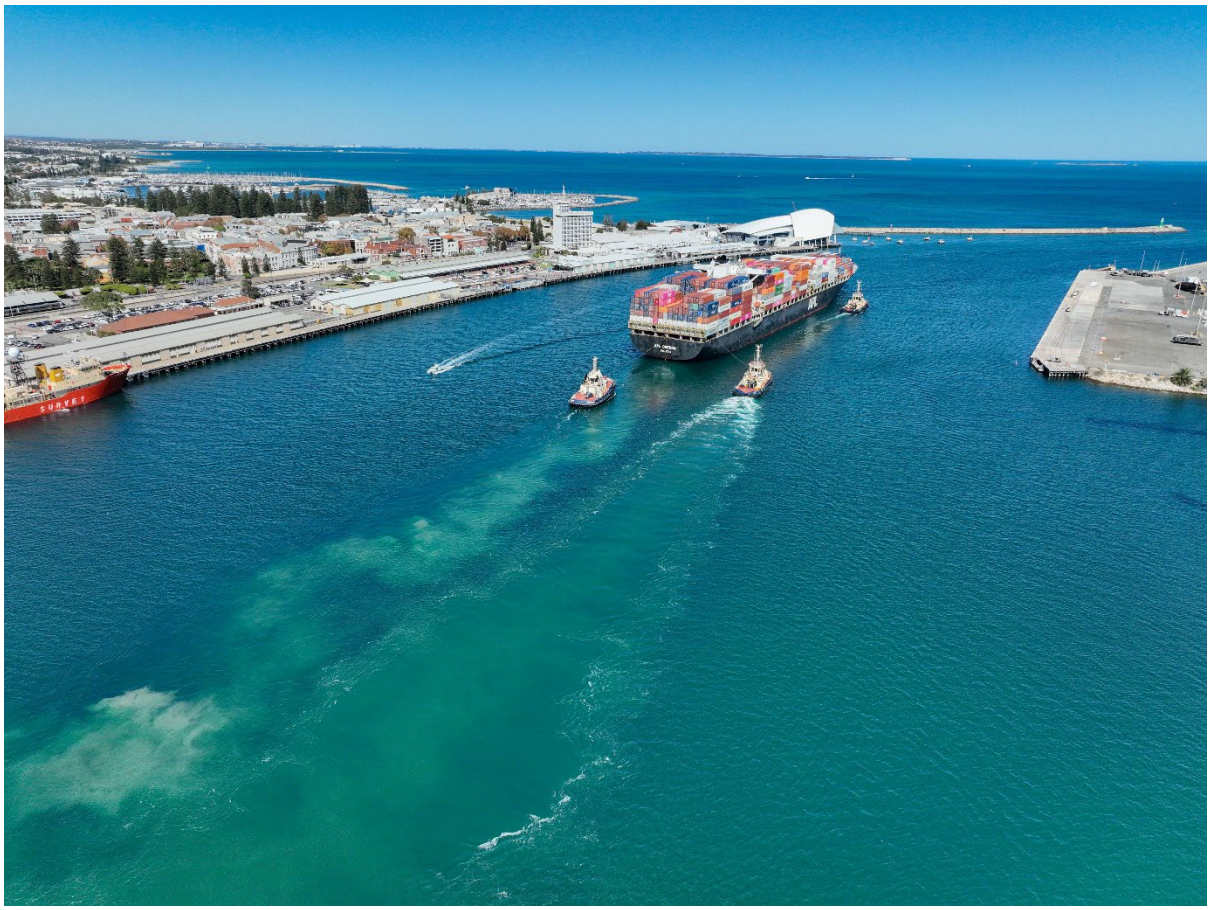

Figure 4: Drone aerial image from Zone 1 on 16/04/2024 showing a visible sediment plume created by a ship exiting the Inner Harbour.

LAC (and DLI) data from Reference site RD and Impact site SI2 was unable to be extracted due to equipment malfunction and therefore unable to interrogate against the thresholds effectively. Internal processes have been reviewed to prevent this incident from occurring in future. Site RD is not an Impact site, and its respective Impact site (DR1) was compared to OS Reference site data, so assessment against the thresholds is of minor consideration.

Site SI2 is an Impact site, however, TSS results suggest there is minimal impact to benthic communities from reduced light levels as surface water TSS at this site only exceeded the EC on one occasion (Day 10) and the bottom water TSS did not exceed the EC. Water column profiles were extracted from Day 10 to assist with this interpretation. Rationale includes;

- Only two of the three water column profiles recorded TSS (NTU converted to TSS) to be above the EC. One of the triplicates reported all TSS results to be below the EC.
- Only a minor fraction of TSS was reported above the EC;
  - 33.33% of data points exceeded the EC from drop one
  - 40% of data points exceeded the EC from drop two
  - No data points exceeded the EC from drop three
- TSS only exceeded the EC in surface waters of two water column profiles, meaning there is less impact arising from a reduction in light attenuation on benthic communities.

See Figure 5 for a summary of TSS data in the water column at site SI2 above the EC.

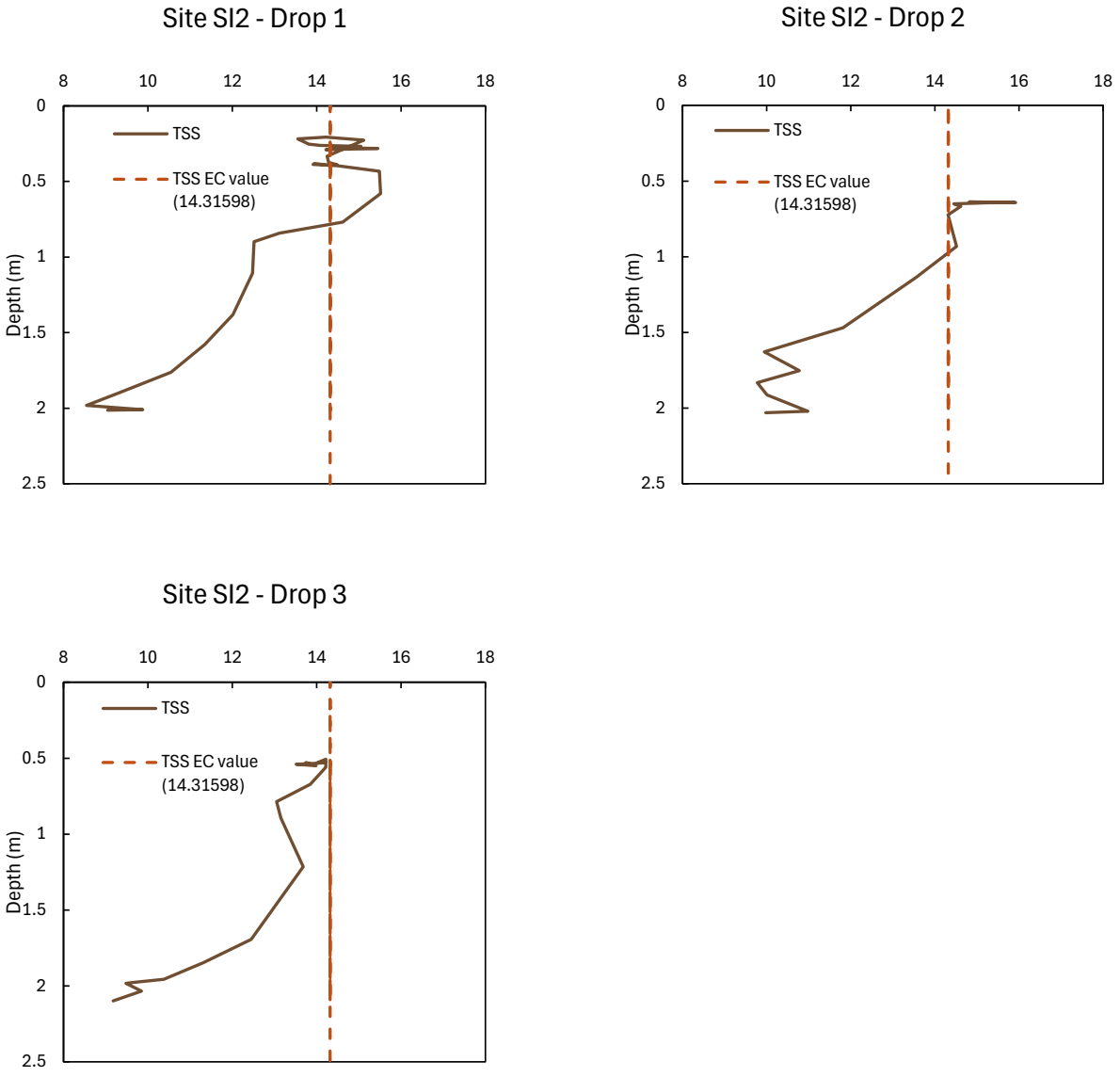

Figure 5: Water column depth profiles and TSS results from each drop at site SI2

7. Future Recommendations

Future dredging campaigns undertaken by Fremantle Ports in the next four years would benefit from alignment with contemporary EPA Technical Guidance: Environmental Impact Assessment of Marine Dredging Proposals (EPA 2021) and use of modern monitoring techniques. Updates to the DEMP are discussed in the following sections.

7.1. Daily Light Integral

The calculation of DLI is considered to provide a more contemporary approach to assessment of shading effects on seagrasses than use of LAC and is recommended to be implemented within future dredging campaigns. DLI monitoring, as opposed to LAC, provides a better understanding of light received at the seabed. As discussed above, the data presents a weak correlation between an increase in LAC and decrease in DLI. Fremantle Ports might consider DLI as the lead indicator of light data for future monitoring practises.

DLI calculation within this document may be used in future dredging campaigns of this size and other activity within Fremantle Ports waters.

7.2. Updates to DEMP

There are components to the DEMP that can be reviewed to allow for better data acquisition and analysis, and to improve the overall robustness of the management plan. Advised updates are summarised below;

- Proposed site locations for sites DI1, SI1, SD1 and SD2 should be changed to the 'as-deployed locations' presented in Table 3 for future dredging campaigns. This will ensure consistency between monitoring campaigns, regardless of parameters surveyed.
- Sites should be re-assessed to enhance the suitability to be assessed against the ECs and EPOs;
  - Impact site DR1 is on the ZoMI/ZoI boundary and thus results are used to assess whether the EPO has or has not been achieved. This site, however, is also in very close proximity to the ZoHI and by default, according to the modelling report, is expected to report elevated results.
  - Results from the Secchi disc measurements at Reference sites (SR and OS) exceeded the EC for water clarity monitoring. If a dredging campaign of this scale is to be undertaken in the future it is recommended that reference sites are re-evaluated to provide a more suitable reference point. Further, it is advised that the modelling report is reviewed to determine if there is a risk of suspended sediments being relocated to these areas.
- Site SI3 was not a part of the suite of sites designated for LAC monitoring. As site SI3 is associated with the EPO it is suggested that it be included for future monitoring if a dredging campaign of this scale is to be undertaken in the future. An additional Swan River site will provide further data and confidence that the EPO is achieved, especially if data from one monitoring site is lost as experienced in this monitoring campaign.
- Field sheets to be updated to those implemented (Appendix G).
- Consideration of all water quality data available for establishing a baseline.
- Refine the monitoring methodology and parameters to better align with the EPA Technical Guidance: Environmental Impact Assessment of Marine Dredging Proposals (as proposed

above), i.e. incorporation of DLI if a dredging operation of this scale is the be undertaken again in the future.

8. References

BMT (2022) Fremantle Ports Inner Harbour Maintenance Dredging – Dredge Plume Modelling. Prepared for Fremantle Ports by BMT Commercial Australia Ltd Pty, Report No. R-11513-4 Perth, Western Australia, September 2022.

BMT (2024) Inner Harbour Maintenance Dredging – Environmental Management Plan. Prepared for Fremantle Ports by BMT Commercial Australia Ltd Pty, Report No. R-11513-6 Perth, Western Australia, March 2024.

EPA (2005) Manual of Standard Operating Procedures for Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria – A Supporting Document to the State Environmental (Cockburn Sound) Policy 2005. Environmental Protection Authority, Perth, Western Australia, January 2005

EPA (2017) Environmental Quality Criteria Reference Document for Cockburn Sound – A Supporting Document to the State Environmental (Cockburn Sound) Policy 2015. Environmental Protection Authority, Perth, Western Australia, April 2017

EPA (2021b) Technical Guidance – Environmental impact assessment of marine dredging proposals, EPA, Western Australia, September 2021

Fisher et al. (2015) Fisher R, Stark, C, Ridd, P and Jones, R, 2015. Spatial Patterns in Water Quality Changes during Dredging in Tropical Environments. PLOS ONE 10(12): e0143309. https://doi.org/10.1371/journal.pone.0143309

Fisher et al. (2017) Fisher, R, Stark, C, Ridd, P, and Jones, R, 2017. Effects of dredging and dredging related activities on water quality: Spatial and temporal patterns, WAMSI Dredge Science Node, Theme 4 Report, Project 4.2, April 2017.

Jones et al. (2015) Jones, R, Fisher, R, Stark, C and Ridd, P, 2015. Temporal Patterns in Seawater Quality from Dredging in Tropical Environments. PLOS ONE 10(10): e0137112. https://doi.org/10.1371/journal.pone.0137112

O2 Marine (2024). Fremantle Ports Marine Quality Monitoring Program. Prepared for Fremantle Ports by O2 Marine, WA Marine Pty Ltd, Report No. 24SCO109. Fremantle, Western Australia, March 2024.

O2 Marine (2024) Fremantle Ports Inner Harbour Dredging Marine Species Observer Program 2024. Prepared for Fremantle Ports by O2 Marine, WA Marine Pty Ltd, Report No. 240079 Fremantle, Western Australia, June 2024.

Appendix A. Drone Aerial Imagery

Figure 6: Drone aerial imagery from pre-dredge baseline flight - 12/04/2024

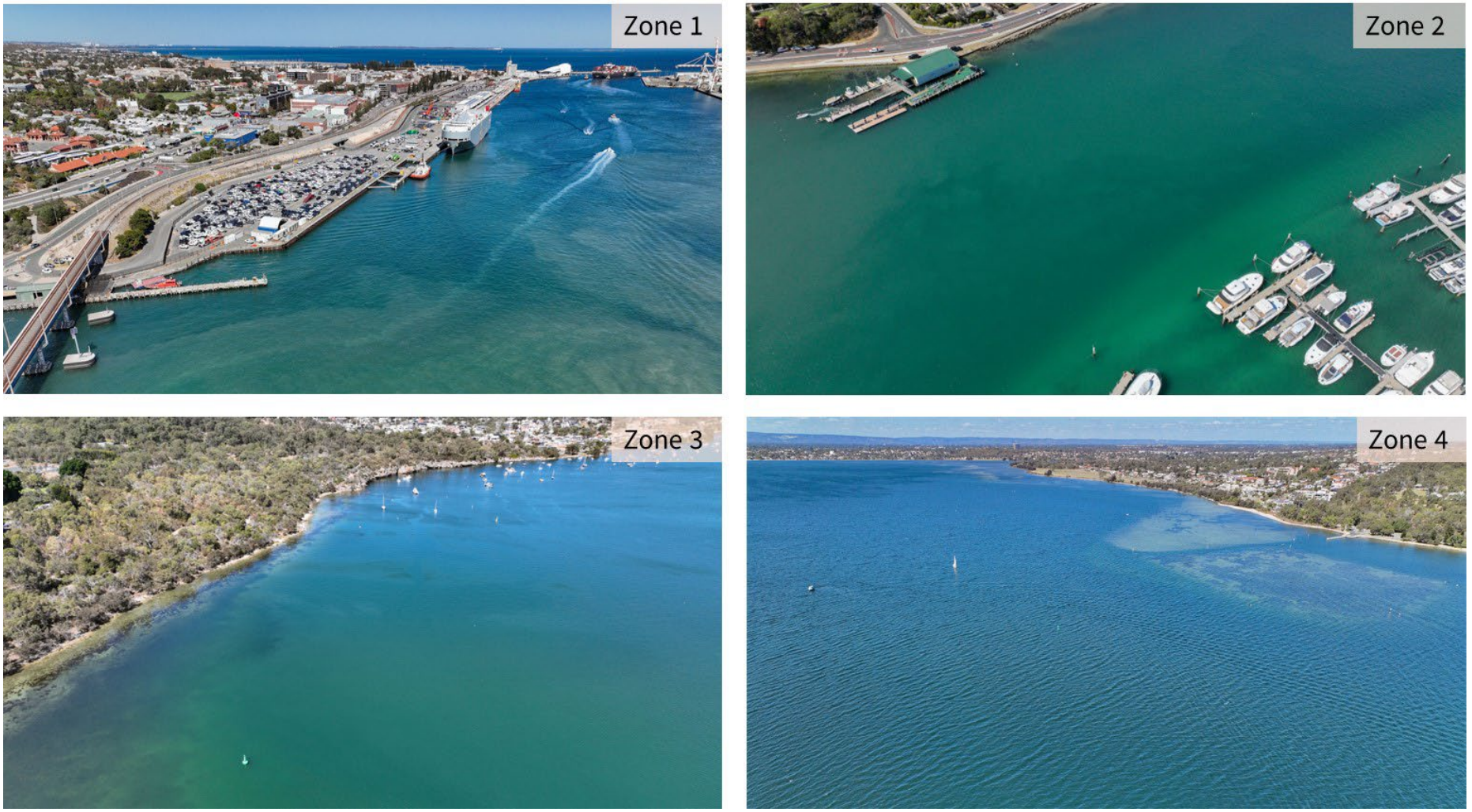

Figure 7: Drone aerial imagery from Day 2 - 16/04/2024

Figure 8: Drone aerial imagery from Day 5 - 19/04/2024

Figure 9: Drone aerial imagery from Day 10 - 24/04/2024

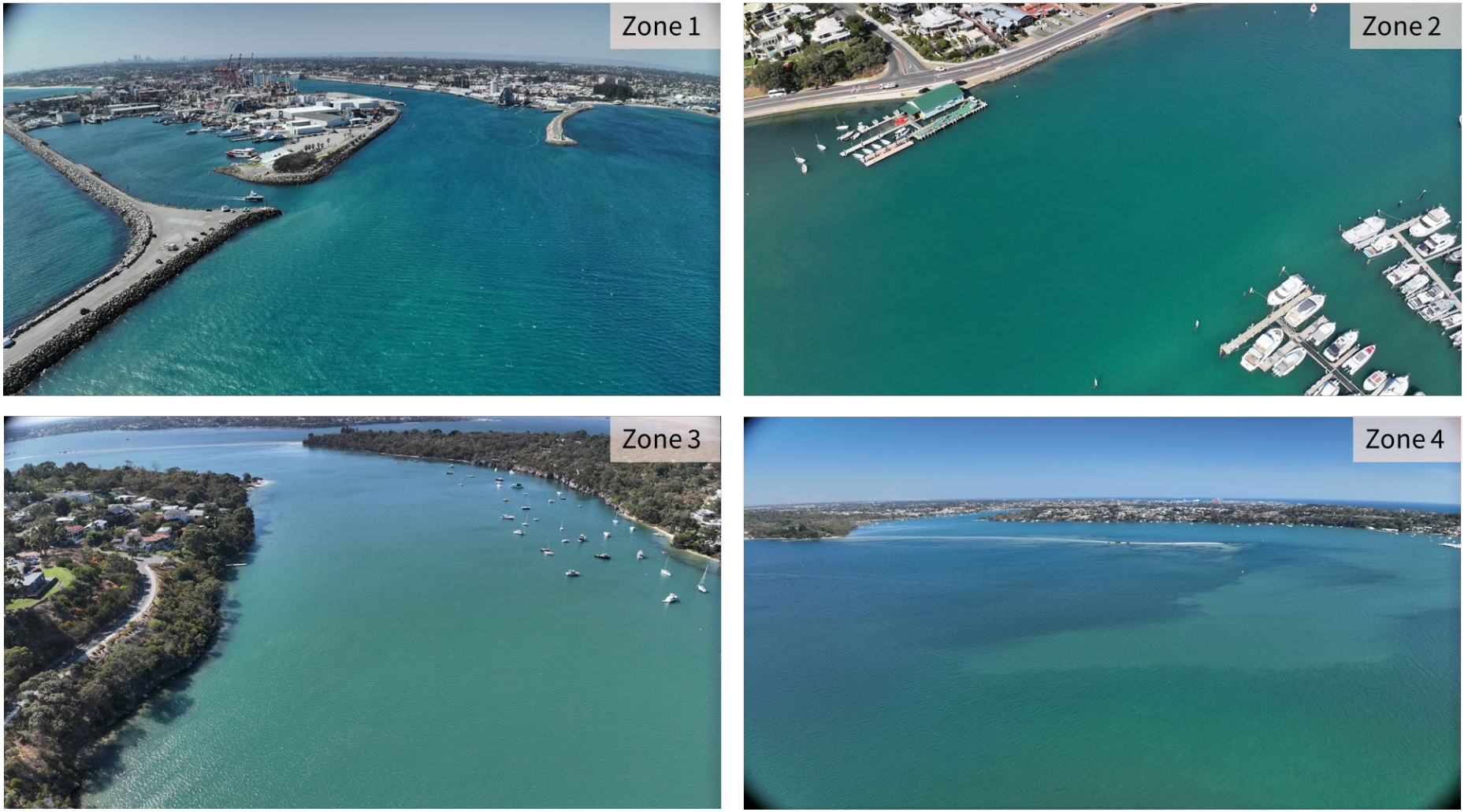

Figure 10: Drone aerial imagery from Day 15 - 29/04/2024

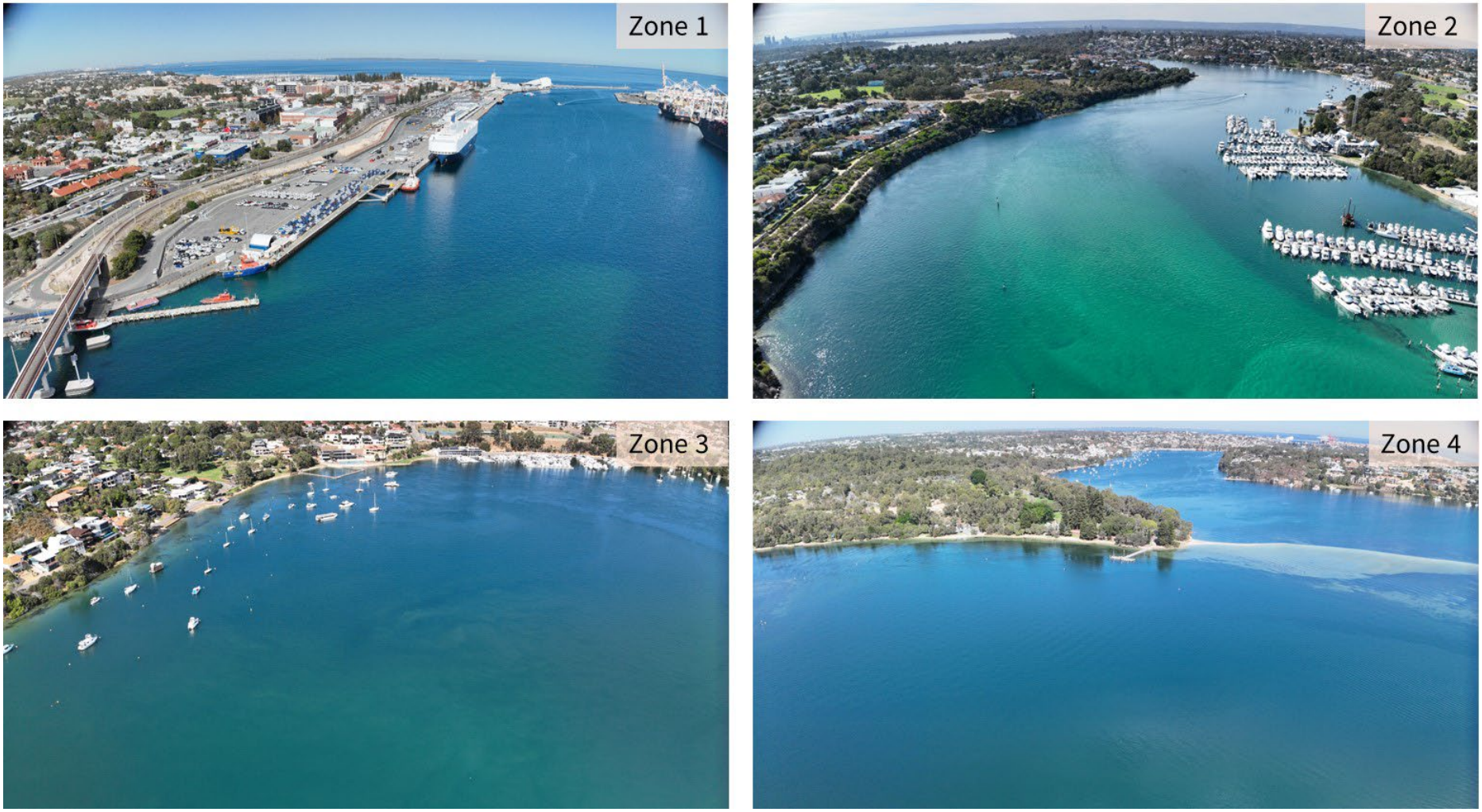

Figure 11: Drone aerial imagery from Post dredging - 14/05/2024

Appendix B. RIU Imagery

Figure 12: RIU images from Berth 12 of the Inner Harbour pre dredging, during dredging (on day 2, 5, 10 and 15) and post dredging

Figure 13: RIU images from dredge (whilst dredging in the Inner Harbour) on day 2, 5, 10 and 15

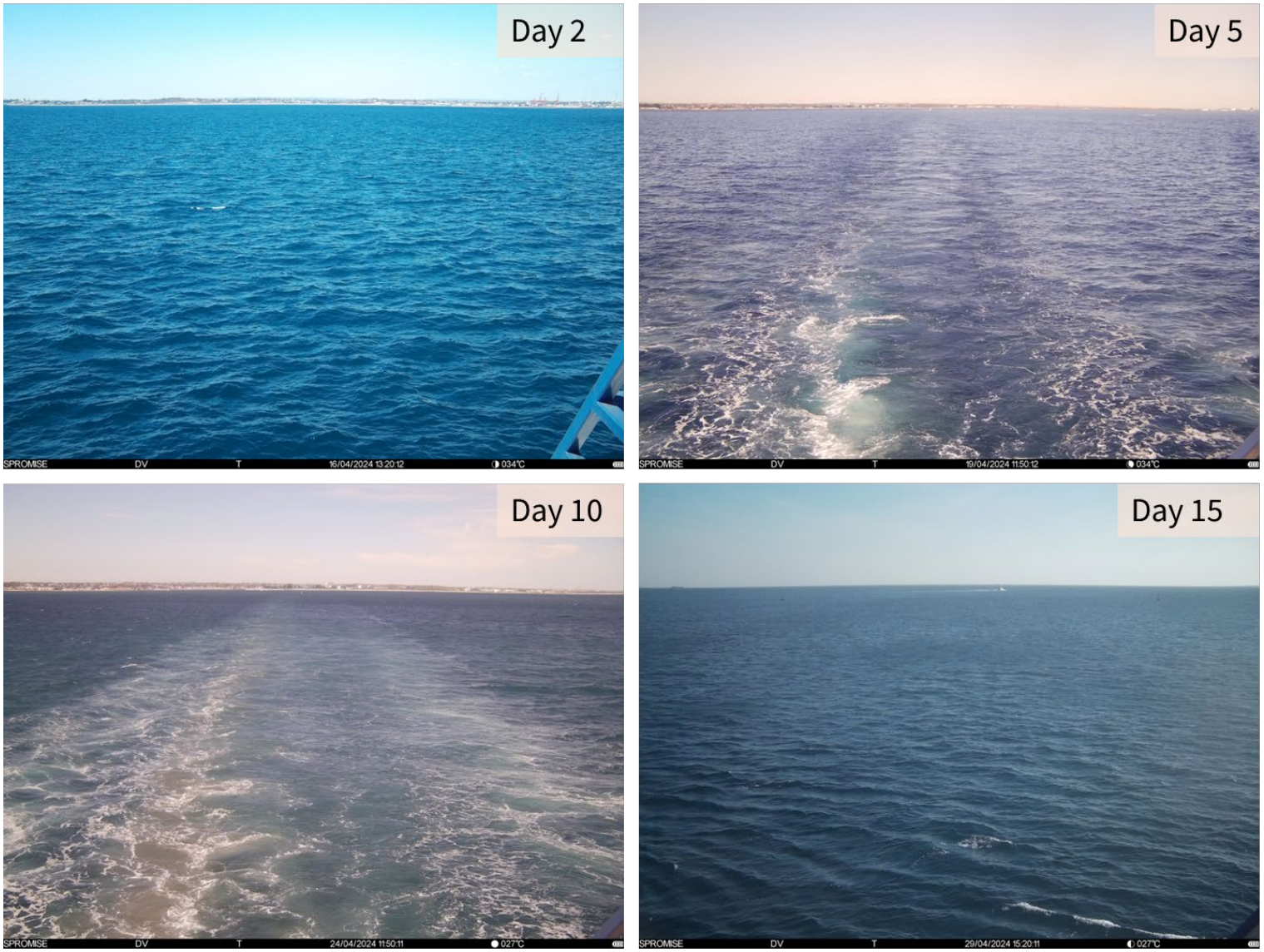

Figure 14: RIU images from dredge (at the disposal site) on day 2, 5, 10 and 15

Figure 15: RIU images from South Mole pre dredging, during dredging (on day 2, 5, 10 and 15) and post dredging

Appendix C. O2 Metocean light data QA/QC application

Date	17/Jun/2024	Reference	24ENV263/T240177 (Rev 0)
To	Rebecca James Melissa Manns	Email	rebecca.james@fremantleports.com.au melissa.manns@fremantleports.com.au
From	James Owen-Conway Sebastian Morillo	Email	james.owenconwa@o2metocean.com.au sebastian.morillo@o2metocean.com.au
Subject	Summary of quality control approach applied to light data collected during Fremantle Ports Inner Harbour Maintenance Dredging program.		

1. Introduction

O2 Metocean (O2Me) were engaged to Quality Control (QC) light data collected by O2 Marine (affiliated company of O2Me) between April 2024 and May 2024 as part of the Fremantle Ports Inner Harbour Maintenance Dredging Project.

This technical note describes the QC implemented.

2. Instrumentation

Data were collected using Insitu Marine Optics (IMO) MS9-LPT loggers (Serial Numbers 112, 114, 115, 117, 118, 119, 135, 142, 143).

3. Quality Control Procedure

QC was undertaken as per O2Me's Quality Control and Conventions document, version 2.3 (O2Me, 2024).

3.1. Quality Control Level

O2Me QC of water quality datasets closely follows (and often exceeds the requirements of) Jones et al. (2015) and Fisher et al. (2015 and 2017).

O2Me applies a tiered approach to QC of metocean and water quality datasets, as specified in Appendix A.

O2Me's Tier 4 has been applied to the packaged dataset provided with this technical note.

3.2. QC Steps

O2Me's Tier 4 'Intermediate QC' involves:

1. Derivation of data for QC. This step refers to the conversion of a basic signal (e.g. voltage or echo readings) to a meaningful quantity (e.g. current speed, turbidity, etc.), and it is usually done within the instrument using instrument manufacturer's software;

2. Removal of irrelevant data from datasets (e.g. data that were not collected at the monitoring site, for example just prior or after instrument deployment or retrieval, respectively, when instruments are on the monitoring vessel).
3. Automatic assignment of QC flags to each data point, including:
    a. Check clocks for consistency and regularity of sampling;
    b. Run peak over thresholds;
    c. Identify improbable rates of change (spike detection);
    d. Etc.

    Automatic QC criteria are defined and tabulated in Appendix B.
4. Visual inspection of the automatically QC'ed data and manual assignment of QC flags and QC comments by an O2Me Specialist.

3.3. Quality Control Flags and Comments

All data points are assigned a QC flag and a QC comment according to Appendix C.

4. Data Provision of Packaged Dataset

4.1. Quality Controlled Data Package

QC'ed data per sampling site are provided in two files:

- A comma separated values file ('CSV' and has file extension of '.csv'); and
- A network common data form files (netCDF and has a file extension of '.nc').

Data files are named as per O2Me's file naming convention. Here, files are named as follows:

- [Project Number]_[Site]_[Instrument Make]-[Instrument Model]_[Serial Number]_[Data Recovered (YYYY-MM-DD)]_[Quality Control Level]

4.2. Notes

Table 1 presents notable observations made by O2Me's Specialist during data QC.

Table 1 Data provision - notable observations and recommendations

Site	Parameter	Period	Description	O2Me recommendation
RD	PAR_raw PAR_QC	08/05/2024 – 14/05/2024	MS9 tilt readings of ~120° relative to the vertical (instrument pointed downwards) over the full	Do not use these readings for data analysis or interpretation.

SI2		(whole period)	deployment period. Light readings are not indicative of the incident light at the site. All PAR readings were flagged 'bad data'.	
SURFACE	All parameters	10/05/2024 – 21/05/2024	Sub-surface logger deployed ~0.5 m below the surface, following the completion of the dredging activity.	Combined with PAR (light) measurements taken in air, this dataset may be used to calculate the attenuation of INCIDENT PAR just below the surface as a result of light entering a different medium (from air to ocean).
AMBIENT DI1 DI2 DR1 OS RD SI1 SI2 SR	ALL	08/05/2024 – 21/05/2024 (whole period)	To align with historical light data collection methodologies in Cockburn Sound (outlined in EPA 2005), loggers were programmed to automatically 'wake up' ~2 hours after sunrise and 'return to stand-by' ~ 2 hours before sunset daily. Approximately 4-hours of light data were missed from all sites.	O2Me deviated from its QC criteria for PAR, which are relevant to calculating Daily Light Integral (DLI), which require PAR readings throughout nearly the entire daylight period (see Appendix B). Instead, the less stringent criterion applied to the dataset for this project is outlined next: *PAR data for DLI analysis is deemed incomplete, and DLI is not calculated, when 1 or more PAR data points corresponding to the instrument measurement period are flagged 'bad data' or 'NaN'.*
AMBIENT	PAR_QC	08/05/2024 – 21/05/2024	Light logger show signs of shading approximately 14:00 – 15:00 each day, confirmed by the comparison of concurrent AMBIENT (above water) and subsea light readings. Partially shaded light data were not reported 'bad data' since light was still recorded during these periods.	Light data gathered after 14:00 daily should be used with extreme caution or discarded.

5. References

Fisher, R, Stark, C, Ridd, P, and Jones, R, 2017. Effects of dredging and dredging related activities on water quality: Spatial and temporal patterns, WAMSI Dredge Science Node, Theme 4 Report, Project 4.2, April 2017.

Fisher, R, Stark, C, Ridd, P and Jones, R, 2015. Spatial Patterns in Water Quality Changes during Dredging in Tropical Environments. PLOS ONE 10(12): e0143309. https://doi.org/10.1371/journal.pone.0143309

Jones, R, Fisher, R, Stark, C and Ridd, P, 2015. Temporal Patterns in Seawater Quality from Dredging in Tropical Environments. PLOS ONE 10(10): e0137112. https://doi.org/10.1371/journal.pone.0137112

O2 Metocean (O2Me) (2024). "O2 Metocean Quality Control & Conventions, Version 2.3", O2 Metocean Document R220029, Fremantle, WA.

Appendix A. Tiered Quality Control Levels

O2 Metocean applies a tiered approach to QC of metocean and water quality datasets. The processing level adopted is agreed with its clients on a case-by-case basis.

QC'ed data files are provided to clients according to the following tiers:

1. Tier 1 'Raw Data':

   Files pre-processed by the instrument manufacturer's proprietary software which have not been curated by O2 Metocean. Data might remain in binary format and may not be ready for use. Examples include the Nortek AWAC '*.WPR' files.

2. Tier 2 'Preliminary QC':

   Raw data are converted into usable parameters (e.g. significant wave heights, current speed, etc) with third-party software. Data are subject to O2 Metocean's automatic QC inhouse scripts for compilation, however they are not prepared for publication and are provided for the purpose of demonstrating QC progress to O2 Metocean's clients. 'QC flags' are automatically generated by computer algorithms though may appear as 'Under Preparation', 'Under Investigation', 'QC Not Performed' or 'Suspect'. These files may include O2 Metocean-derived products (e.g. maximum wave height) and are generally provided in NetCDF format, though CSV files may also be provided at client's request.

3. Tier 3 'Basic QC':

   Basic QC of a dataset involves consideration of the dataset in isolation (e.g. per site). It includes 'QC flags' that are automatically generated by computer algorithms (e.g. removal of peaks over thresholds) or that were assigned by an experienced oceanographer or water quality specialist with basic knowledge of the local environment after running basic checks (e.g. check that the wave direction agrees with expected oceanographic conditions at the site). The files are 'publication ready', include derived products, and are provided in NetCDF format, though CSV files may also be provided at client's request.

4. Tier 4 'Intermediate QC':

   Intermediate QC is O2 Metocean's mid-level of data processing, and the most frequently requested processing level by their clients. It builds on Tier 3 by also considering datasets gathered concurrently at nearby sites for the same project. This level of QC can only be performed by an experienced oceanographer or water quality scientist with a detailed understanding of the local environment and knowledge of gradual spatial variability of the parameters investigated (e.g. turbidity at nearby sites often reveal similar trends, etc.). The files are 'publication ready', include derived products, are provided in NetCDF format, and are (often) accompanied by a stand-alone technical note. CSV files may also be provided at client's request.

5. Tier 5 'Detail QC':

   Detailed QC is O2 Metocean's highest level of data processing. It involves consideration of multiple datasets (proprietary, open source, measured and modelled) and results from the iterative process that occurs hand-in-hand with detailed data interpretation. This level of QC can only be performed by an experienced oceanographer or scientist with a detailed understanding of the local and regional environment. 'QC Codes' are applied by the designated oceanographer or scientist after consideration of the 'QC flags' assigned during the previous tier and his/her knowledge of the local environment through the evaluation of other proprietary and open-source data sets. The files are 'publication ready', include derived products, are provided in NetCDF format, and are accompanied by a stand-alone data appraisal report which includes summary statistics, joint-frequency distributions, etc. useful for engineering design, operability criteria, etc.

Appendix B. Criteria for 'Bad Data': Water Quality Parameters

Table 2: Variables (parameters), automatic QC Criteria for 'Bad Data': Water Quality Parameters, and associated QC variables.

Parameter	Description	Variable (Units)	Automated QC	Associated QC Variables
Pressure	Gauge pressure readings	pressure_raw (dbar)	-	-
Water Depth	Water depth at sensor height, derived from gauge pressure readings. It may be zeroed in air during instrument calibration or derived by subtracting the nominal atmospheric pressure from barometric readings.	depth_raw (m)	• depth_value < 0.5 m ([1])	• depth_QC • qc_flag_depth • comments_qc_flag_depth
Water Temperature	Water temperature	temperature_raw (°C)	• temperature_value < 15°C *[This criterion **does not apply** to 'ambient' above water measurements]* • temperature_value > 35°C *[This criterion **does not apply** to 'ambient' above water measurements]* • temperature_value > [2x preceding temperature_value] • temperature_value < [0.5x following temperature_value]	• temperature_QC • qc_flag_temperature • comments_qc_flag_temperature

[1] Quality controlled carried to temperature, turbidity, and PAR variables.

Parameter	Description	Variable (Units)	Automated QC	Associated QC Variables
Turbidity	Nephelometric turbidity	turbidity_raw (NTU)	• clear water offset applied: where min(turbidity_value) < 0 but > -0.75, the whole turbidity time series is shifted upwards by min(turbidity_value) • inconsistent time intervals removed • turbidity_value <= 0 NTU • turbidity_value > 25 NTU, and preceding and following turbidity_value < [0.5x turbidity _value], or preceding and following turbidity_value > [2.0x turbidity _value]	• turbidity_QC • qc_flag_turbidity • comments_qc_flag_turbidity
Dissolved Oxygen Concentration	DO Readings	DOconc_raw (mg/L)	• DOconc_value < 0 mg/L, • DOconc_value > 20 mg/L	• DOconc_QC • qc_flag_DOconc • comments_qc_flag_DOconc
Dissolved Oxygen Saturation	DO Saturation	DOsat_raw (%)	• DOsat_value < 0 %, • DOsat_value > 150 %	• DOsat_QC • qc_flag_DOsat • comments_qc_flag_DOsat
Conductivity	Conductivity	conductivity_raw (µS/cm)	• conductivity_value < 30,000 µS/cm • conductivity_value > 70,000 µS/cm	• conductivity_QC • qc_flag_conductivitiy

Parameter	Description	Variable (Units)	Automated QC	Associated QC Variables
			• conductivity _value > [1.1x preceding conductivity _value] • conductivity _value < [(1/1.1)x following conductivity _value]	• comments_qc_flag_conductivity
Salinity	Salinity derived from temperature, conductivity and pressure using the UNESCO equation of state (derived within data logger)	salinity_raw (PSU)	• salinity_value > **42** PSU	• salinity_QC • qc_flag_salinity • comments_qc_flag_salinity
pH	pH	pH_raw	• pH_value < **5** • pH _value > **9**	• pH_QC • qc_flag_pH • comments_qc_flag_pH
Light	Photosynthetically Active Radiation	PAR_raw (µmol/m^2/s)	• inconsistent time intervals removed • PAR_value recorded between 20:31 and 03:31 hours. • PAR_value ≤ **0** µmol/m^2/s • PAR_value > **2000** µmol/m^2/s *[This criterium **does not apply** to 'ambient' above water measurements]*	• PAR_QC • qc_flag_PAR • comments_qc_flag_PAR
Light	Daily light integral derived from photosynthetically active	DLI_derived (mol/m^2/day)	• Incomplete dates removed. A day is deemed incomplete when >**5**% ([3]) of	• DLI_QC

[3] Approximately equivalent to the loss of one data point on a half-hourly sampling campaign.

Parameter	Description	Variable (Units)	Automated QC	Associated QC Variables
	radiation (derived externally, not within the logger)[2].		its primary daylight period were flagged 'bad data' or 'NaN'. Primary daylight period is defined as the time spanning from an hour after sunrise to an hour before sunset. • DLI_value > 25 mol/m^2/day *[This criterium **does not apply** to 'ambient' above water measurements]*	• qc_flag_DLI • comments_qc_flag_DLI
Chlorophyll *a*	Chlorophyll *a*	Chla_raw (µg/L)	-	• Chla_QC • qc_flag_Chla • comments_qc_flag_Chla
Crude Oil	Optical fluorescence at the following spectral ranges: • Excitation: 325/120 nm • Emission: 410/600 nm	COil_raw (ppb PTSA (1,3, 6, 8 - Pyrenetetrasulfonic Acid Tetrasodium Salt))	-	• COil _QC • qc_flag_ COil • comments_qc_flag_COil
FDOM	Optical fluorescence at the following spectral ranges: • Excitation: 325/120 nm • Emission: 470/60 nm	fDOM_raw (ppb)	-	• fDOM_QC • qc_flag_fDOM • comments_qc_flag_fDOM

[2] The daily light integral (DLI) is calculated as follows: $DLI = \frac{1}{1 \cdot 10^6} \int_{\text{sunrise}}^{\text{sunset}} PAR\ dt,$ where ***PAR*** is in µmol/m^2/s, and the 10^{-6} is a conversion factor to obtain mol/m^2/day.

Appendix C. Quality Control Flags and Comments

Appendix C.1. Flags

Every data point is assigned a QC flag, namely:

- [-999] data that had either:
  - not been subject to Basic or Detailed QC (else known as 'under investigation');
  - having been subject to Basic and/or Intermediate (Tier 3 and 4 respectively) QC, are considered 'suspect' and require a Detailed Tier 5 QC assessment to elevate the QC flag to 'bad' or 'good'.
- [-1] data that did not pass Tier 3 or Tier 4 QC (else known as 'bad data');
- [0] data that passed a Tier 3 'Basic QC' and/or Tier 4 'Intermediate QC';
- [+1] data that passed a Tier 5 'Detailed QC' assessment.

A QC flag for a given variable will be defined as the variable name with the prefix 'qc_flag_'.

For the QC approach applied, QC flags assigned to one QC variable are generally not extensible to other variables. The only exception to this, is where depth related QC criteria exceedances occur. In this instance, QC flags extend to all QC variables. For example, should depth data be flagged as 'bad data' due to providing surface readings (suggesting a maintenance trip in progress), all QC variables are flagged as 'bad data'.

Appendix C.2. Comments

Every data point is assigned a QC comment. All QC comments are constructed as follows:

- *[Reference]: [Outcome] ([Type]): Comment [date]*

For example:

A00: Passed (Auto) [2023-02-21]

M90: Suspect (Manual) [2023-02-21]

A12: Rejected (Auto): Temperature Threshold Criterion [2023-02-21]

M00: Passed (Manual) [2023-02-21]

Where the Reference:

- 'A' stands for 'Automatic QC'
- 'M' for 'Manual QC'
- Digits 0-10 denote general comments
- Digits 11-29 are assigned to Threshold Criteria
- Digits 31-49 are assigned to Spike Criteria
- Digits 60-69 correspond to measurements of light (PAR) or its derivative (i.e. Daily Light Integral)
- M50-M59 are reserved to clear, isolated QC issues

- M90 is reserved to a 'suspect' data point which validity shall be assessed during a higher level of QC or data interpretation.

Table 3 defines all QC comments available for application in O2Me's Quality Control and Conventions version 2.3.

Table 3 QC Comment options

Reference	Outcome	Type	Comment ([4])	QC Flag
A00	Passed	Auto	-	0 (if Tier 3 and Tier 4 QC) 1 (if Tier 5 QC)
A99	Not Assessed	Auto	-	-999
A11	Rejected	Auto	Depth Threshold Criterion	-1
A12	Rejected	Auto	Temperature Threshold Criterion	-1
A13	Rejected	Auto	Turbidity Threshold Criterion	-1
A14	Rejected	Auto	Dissolved Oxygen Concentration Threshold Criterion	-1
A15	Rejected	Auto	Dissolved Oxygen Saturation Threshold Criterion	-1
A16	Rejected	Auto	Conductivity Threshold Criterion	-1
A17	Rejected	Auto	Salinity Threshold Criterion	-1
A18	Rejected	Auto	pH Threshold Criterion	-1
A31	Rejected	Auto	Depth Spike Criterion	-1
A32	Rejected	Auto	Temperature Spike Criterion	-1
A33	Rejected	Auto	Turbidity Spike Criterion	-1
A34	Rejected	Auto	Dissolved Oxygen Concentration Spike Criterion	-1
A35	Rejected	Auto	Dissolved Oxygen Saturation Spike Criterion	-1
A36	Rejected	Auto	Conductivity Spike Criterion	-1
A37	Rejected	Auto	Salinity Spike Criterion	-1
A38	Rejected	Auto	pH Spike Criterion	-1
A60	Rejected	Auto	PAR Threshold Criterion	-1
A61	Rejected	Auto	DLI Threshold Criterion	-1
A62	Rejected	Auto	Night Hours	-1
A63	Rejected	Auto	Insufficient Daily PAR Data	-1
A64	Rejected	Auto	Invalid DLI Value	-1

[4] All comments are followed by the date of analysis

A71	Rejected	Auto	Surface Sidelobe Interference	-1
A72	Rejected	Auto	Pitch, Roll and Heading outside recommendation	-1
A73	Rejected	Auto	Unexpected Velocity Reading	-1
A80	Rejected	Manual	Unexpected Rate of Change in Depth	-1
M00	Passed	Manual	-	0 (if Tier 3 and Tier 4 QC) 1 (if Tier 5 QC)
M51	Rejected	Manual	Affected by Bottom Strike	-1
M52	Rejected	Manual	Unexpected Reading	-1
M53	Rejected	Manual	Instrument at Seabed or Maximum Depth Range	-1
M54	Rejected	Manual	Beyond Measurement Window	-1
M55	Rejected	Manual	Beyond Instrument Calibration Range	-1
M56	Rejected	Manual	Potential Third Party Interference	-1
M57	Rejected	Manual	Target Depth Exceeded	-1
M80	Rejected	Manual	Unexpected Rate of Change in Depth	-1
M90	Suspect	Manual	Under Investigation	-999
M91	Suspect	Manual	Suspected Instrument Ceiling Reached	-999

Appendix D. Light Attenuation Monitoring

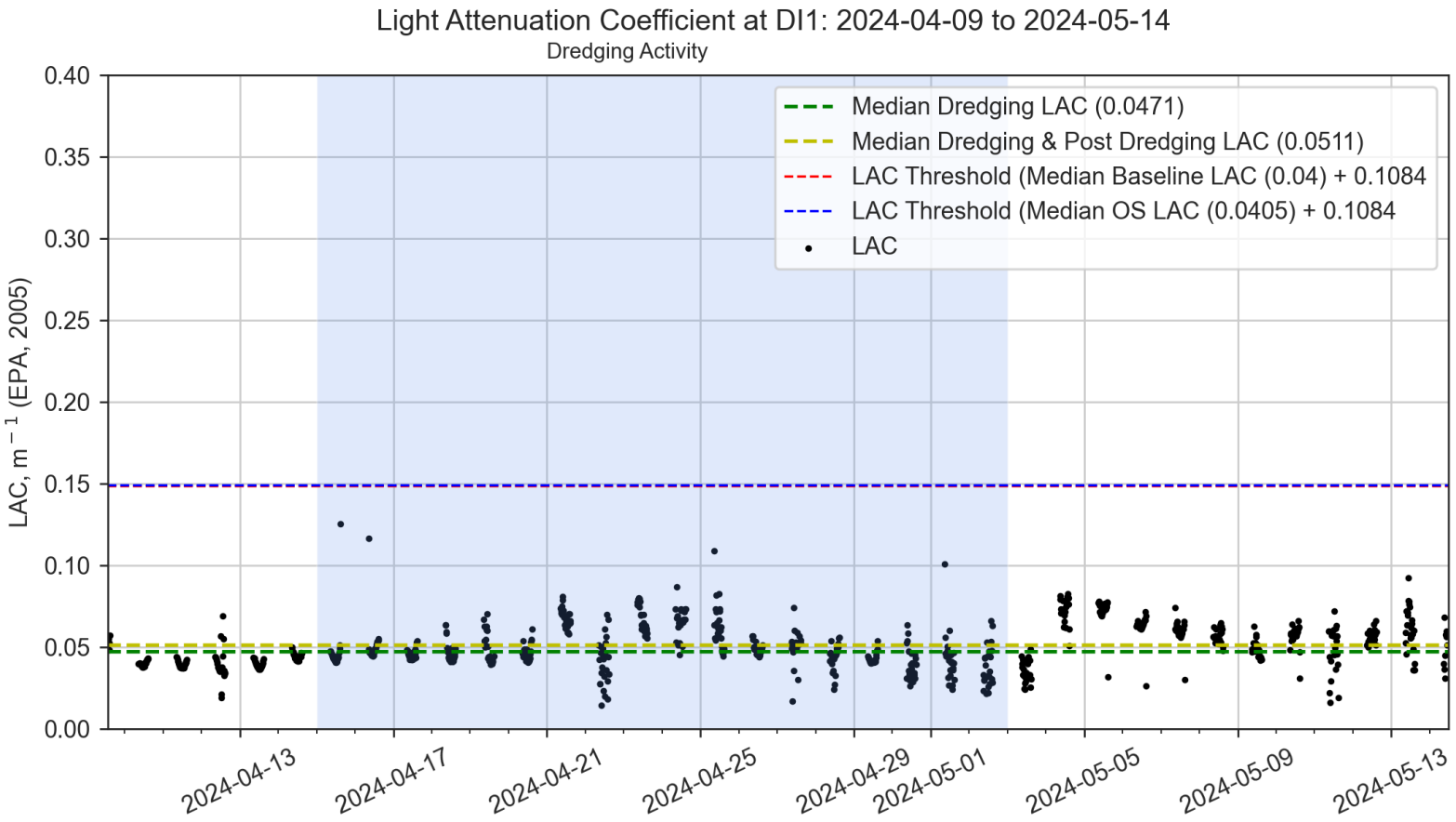

Figure 16: Median LAC threshold at Impact site DI1 during the monitoring period

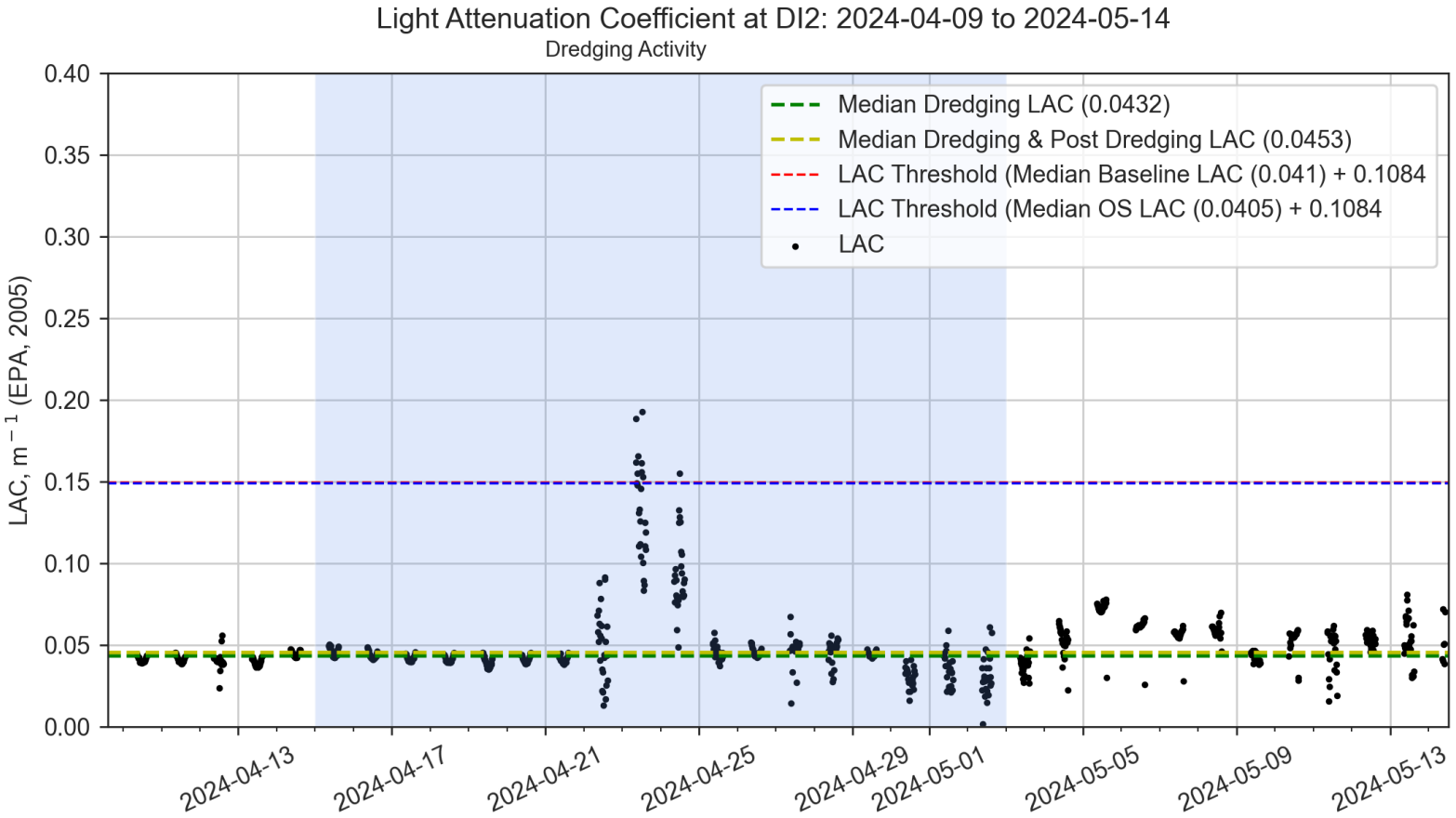

Figure 17: Median LAC threshold at Impact site DI2 during the monitoring period

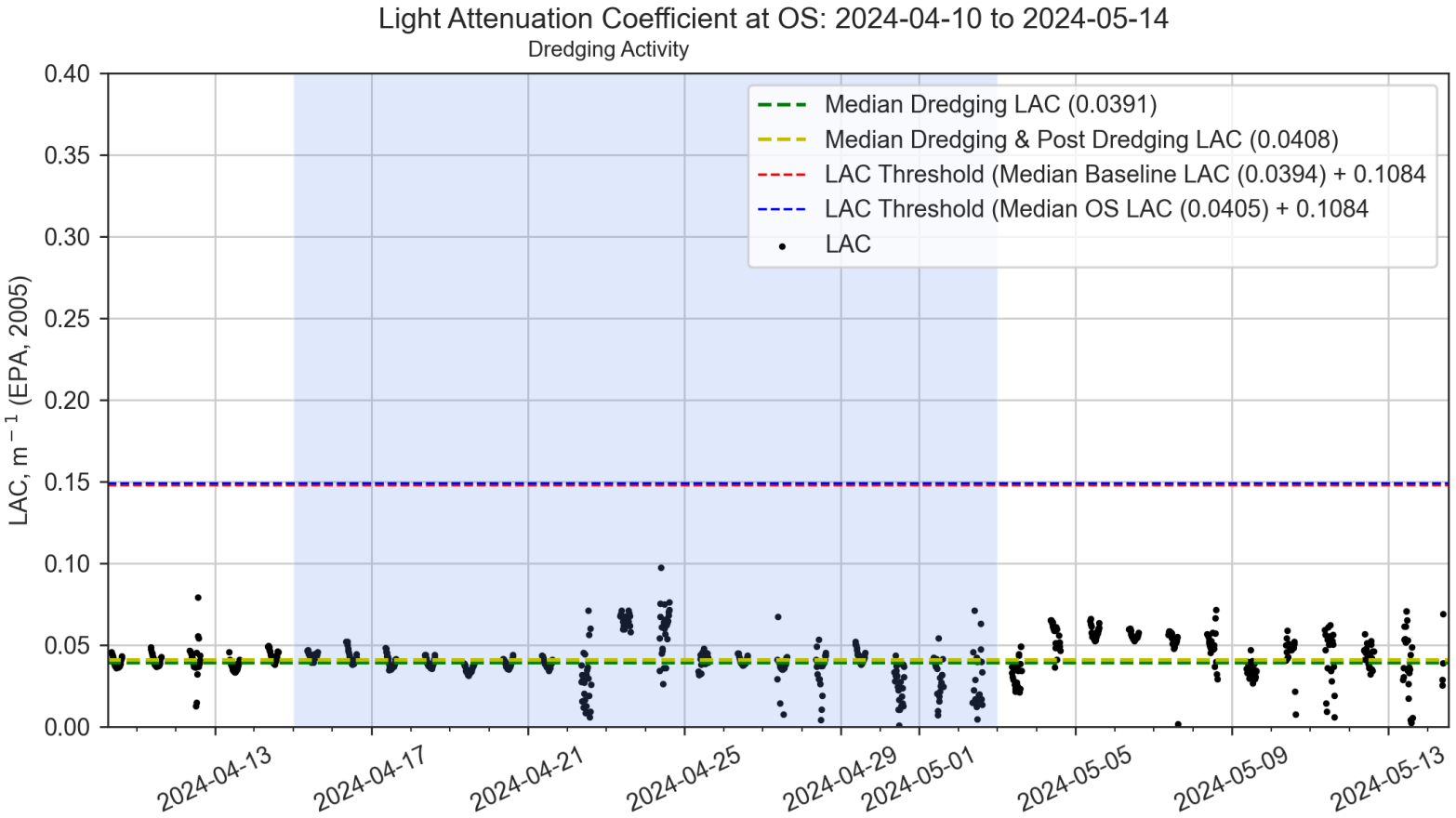

Figure 18: Median LAC threshold at Reference site OS during the monitoring period

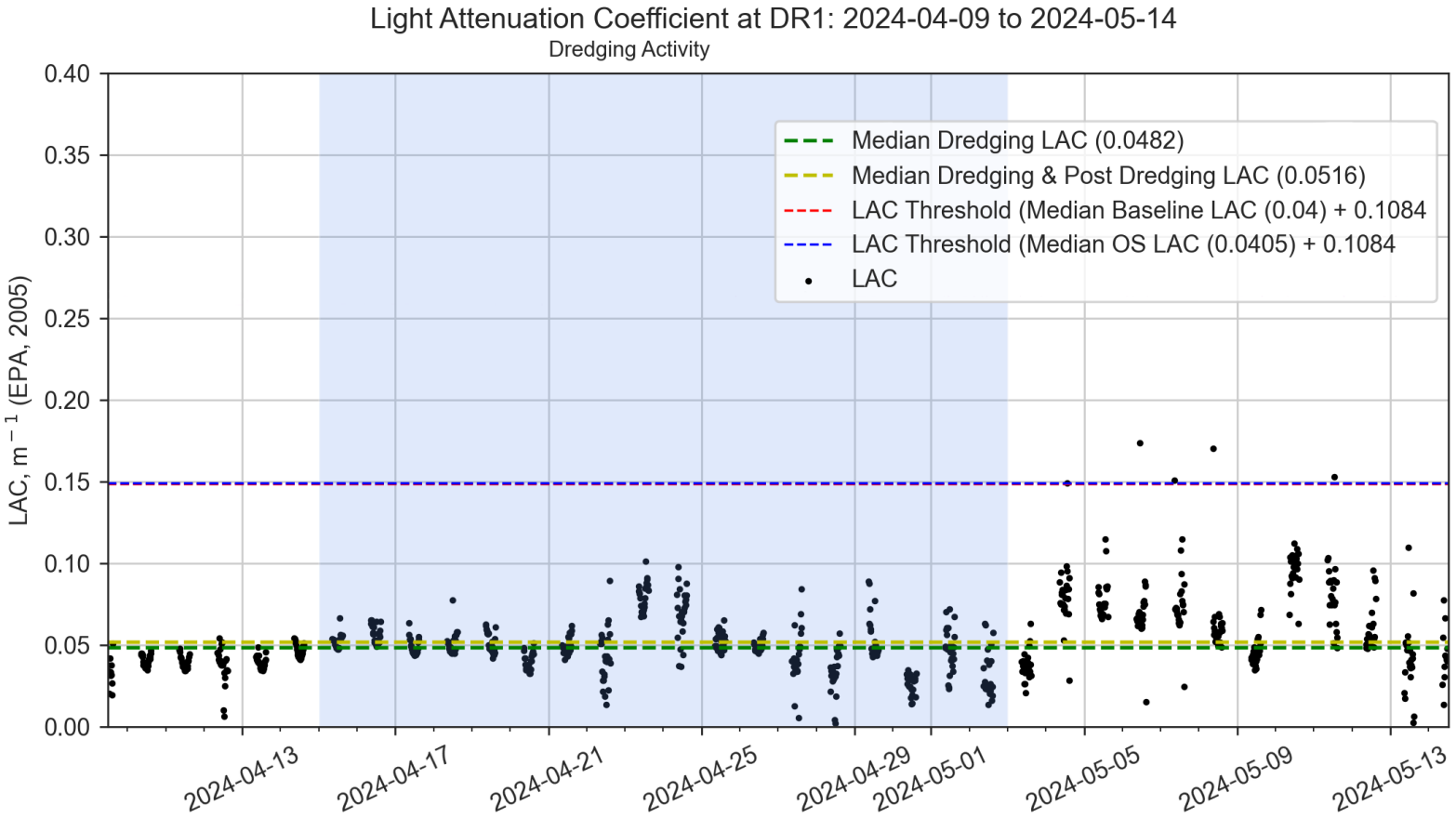

Figure 19: Median LAC threshold at Impact site DR1 during the monitoring period

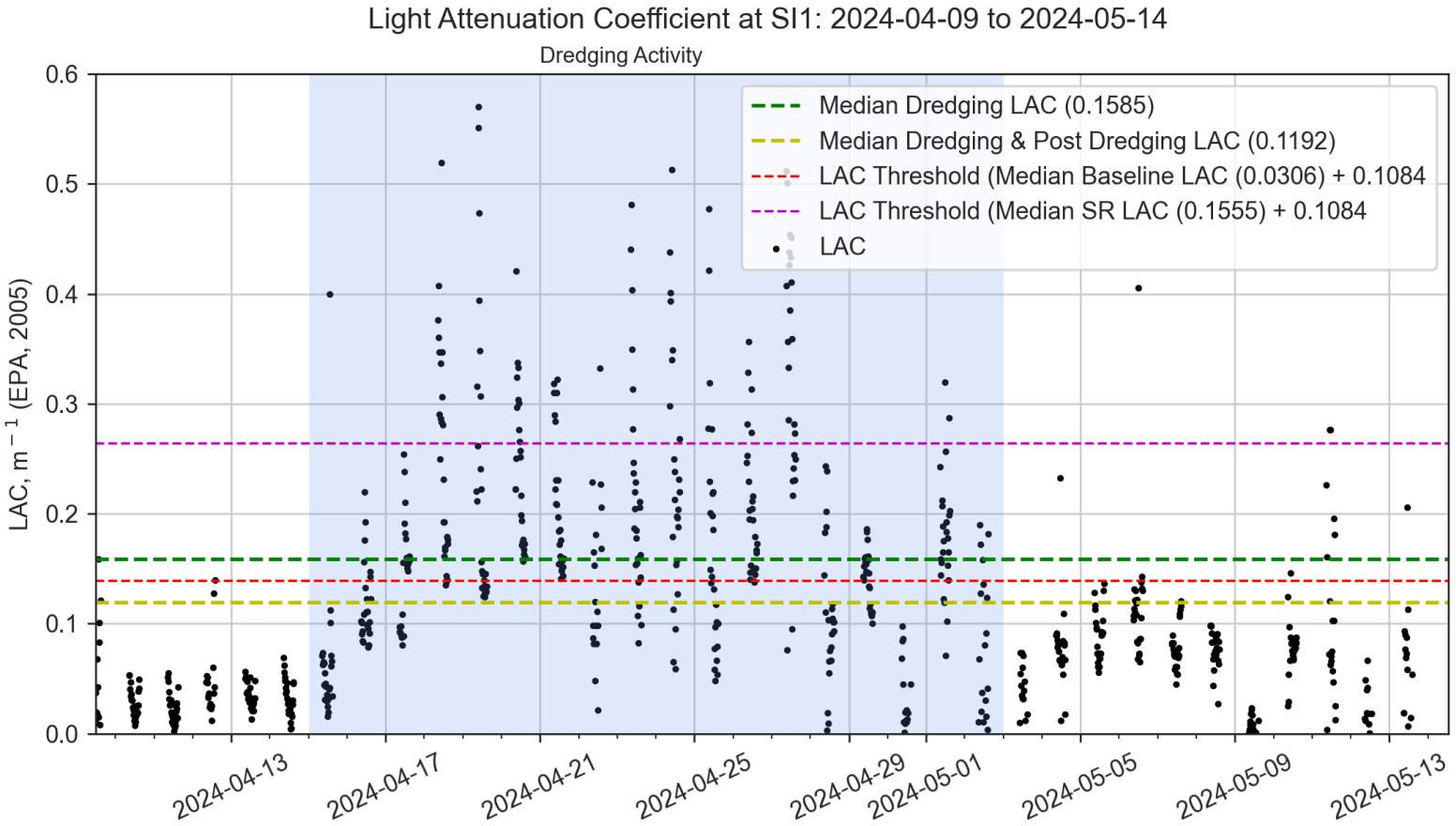

Figure 20: Median LAC threshold at Impact site SI1 during the monitoring period

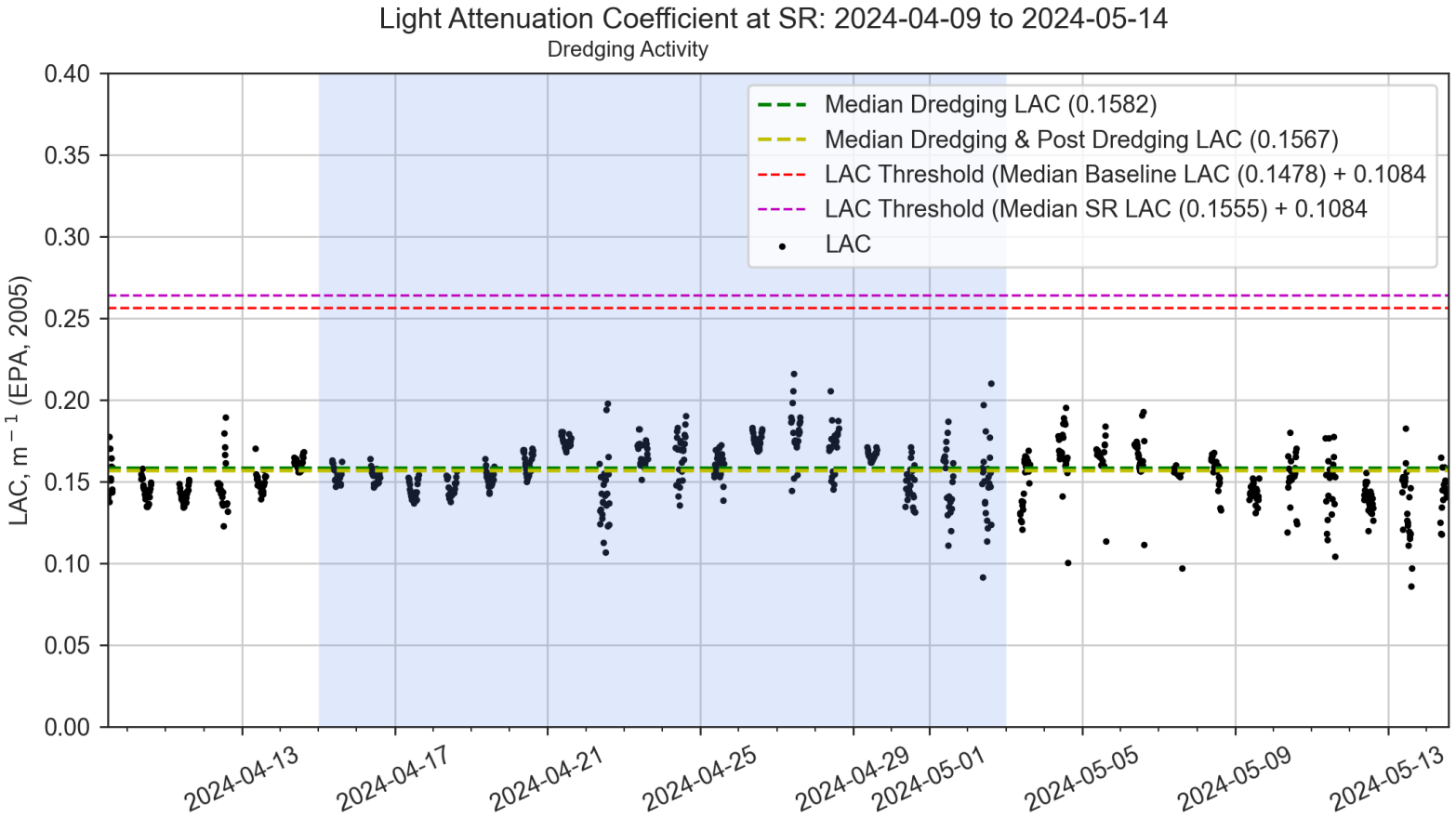

Figure 21: Median LAC threshold at Reference site SR during the monitoring period

Appendix E. DLI calculations

Table 9: Daily Light Integral calculations from 10/04/2024 to 13/05/2024

Date	Impact Sites				Reference Sites	
	DI1	DI2	DR1	SI1	OS	SR
Units	mol/m2/day					
10/04/2024	2.72	2.56	5.67	15.72	5.07	0.28
11/04/2024	2.80	2.51	5.84	16.01	4.87	0.28
12/04/2024	2.12	1.89	4.53	11.75	3.64	0.18
13/04/2024	2.69	2.63	5.64	14.42	5.16	0.22
14/04/2024	2.13	2.03	4.55	14.95	4.28	0.15
15/04/2024	2.02	2.02	3.94	13.48	4.43	0.20
16/04/2024	1.64	2.20	3.43	10.18	4.48	0.21
17/04/2024	2.06	2.37	4.39	8.86	4.99	0.28
18/04/2024	2.10	2.47	4.14	6.37	4.97	0.26
19/04/2024	1.98	2.76	4.16	7.33	5.63	0.21
20/04/2024	1.92	2.44	5.66	6.36	5.00	0.17
21/04/2024	0.80	2.39	4.12	7.04	5.00	0.11
21/04/202	1.00	0.93	1.97	5.70	2.74	0.11
22/04/2024	0.66	0.07	1.50	6.02	1.74	0.12
23/04/2024	0.61	0.21	1.84	5.17	1.93	0.10

24/04/2024	0.47	0.84	1.46	3.60	1.80	0.06
25/04/2024	1.61	1.83	3.73	5.94	4.27	0.09
26/04/2024	1.28	1.50	4.32	2.85	4.43	0.07
27/04/2024	1.58	1.39	4.75	8.55	3.98	0.08
28/04/2024	1.90	1.73	3.43	7.40	3.67	0.12
29/04/2024	0.45	0.62	1.12	2.68	1.24	0.03
30/04/2024	1.01	1.31	1.94	3.16	2.80	0.09
01/05/2024	1.02	1.41	2.74	5.33	2.89	0.08
02/05/2024	1.12	0.99	2.14	6.02	2.19	0.07
03/05/2024	0.42	1.09	1.29	9.76	2.37	0.10
04/05/2024	0.45	0.44	1.57	9.48	2.27	0.11
06/05/2024	0.69	0.72	1.86	8.33	2.37	0.11
07/05/2024	0.79	0.91	1.60	9.35	2.49	0.15
08/05/2024	0.86	0.75	2.18	8.36	2.38	0.12
09/05/2024	0.38	0.49	0.97	3.74	1.18	0.05
10/05/2024	0.72	0.83	0.66	8.06	2.45	0.11
11/05/2024	0.77	0.86	0.92	6.53	2.15	0.10
12/05/2024	0.35	0.40	0.94	5.04	1.19	0.08
13/05/2024	0.37	0.49	1.99	6.60	1.90	0.13
Mean	1.28	1.41	2.97	7.95	3.29	0.14

Median	1.01	1.35	2.46	7.19	2.85	0.11
Std. Deviation	0.76	0.82	1.62	3.65	1.38	0.07

Appendix F. Marine and Freshwater Research Laboratory Total Suspended Sediments Results

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations and/or measurements included is this document are traceable to Australian/national standards.

Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Sophie Preston
Customer: O2 Marine
Address: 20 Mews Rd, Fremantle, WA, 6160

Date of Issue: 10/04/2024
Date Received: 27/03/2024
Our Reference: O2M24-7
Your Reference: 24ENV263

METHOD SAMPLE CODE	Sampling Date	2540D TSS mg/L
Reporting Limit		**<0.5**
Analysis Date		**27/03/2024**
File		**240327**
FLO_IH1_B	26/03/2024	2.7
FLO_IH1_M	26/03/2024	1.8
FLO_IH1_T	26/03/2024	1.8
FLO_IH2_B	26/03/2024	2.6
FLO_IH2_M	26/03/2024	2.0
FLO_IH2_T	26/03/2024	1.5
FLO_IH3_B	26/03/2024	2.0
FLO_IH3_M	26/03/2024	2.3
FLO_IH3_T	26/03/2024	2.0
FLO_IH4_B	26/03/2024	2.2
FLO_IH4_M	26/03/2024	1.4
FLO_IH4_T	26/03/2024	1.6
FLO_IH5_B	26/03/2024	1.1
FLO_IH5_M	26/03/2024	1.9
FLO_IH5_T	26/03/2024	1.0
FLO_OH1_B	26/03/2024	0.8
FLO_OH1_M	26/03/2024	0.9
FLO_OH1_T	26/03/2024	0.8
FLO_OH2_B	26/03/2024	2.2

Signatory: Vaughan Gregory
Date: 10/04/2024

The results only apply to the sample as received and to the sample tested.
Spare test items will be held for two months unless otherwise requested.

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Your Reference: 24ENV263

METHOD SAMPLE CODE	Sampling Date	2540D TSS mg/L
Reporting Limit		**<0.5**
Analysis Date		**27/03/2024**
File		**240327**
FLO_OH2_M	26/03/2024	0.9
FLO_OH2_T	26/03/2024	1.7
FLO_OH3_B	26/03/2024	1.5
FLO_OH3_M	26/03/2024	2.0
FLO_OH3_T	26/03/2024	1.0
FLO_OH4_B	26/03/2024	2.2
FLO_OH4_M	26/03/2024	1.0
FLO_OH4_T	26/03/2024	1.8
FLO_OH5_B	26/03/2024	1.1
FLO_OH5_M	26/03/2024	1.0
FLO_OH5_T	26/03/2024	1.0
EBB_OH1_B	26/03/2024	0.8
EBB_OH1_M	26/03/2024	0.6
EBB_OH1_T	26/03/2024	0.7
EBB_OH2_B	26/03/2024	1.1
EBB_OH2_M	26/03/2024	0.7
EBB_OH2_T	26/03/2024	0.5
EBB_OH3_B	26/03/2024	1.0
EBB_OH3_M	26/03/2024	0.9

Signatory: Vaughan Gregory
Date: 10/04/2024

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Reporting Limit		**<0.5**
Analysis Date		**27/03/2024**
File		**240327**
EBB_OH3_T	26/03/2024	0.8
EBB_OH4_B	26/03/2024	0.9
EBB_OH4_M	26/03/2024	0.7
EBB_OH4_T	26/03/2024	1.3
EBB_OH5_B	26/03/2024	1.9
EBB_OH5_M	26/03/2024	1.0
EBB_OH5_T	26/03/2024	1.0
EBB_IH1_B	26/03/2024	4.3
EBB_IH1_M	26/03/2024	2.5
EBB_IH1_T	26/03/2024	2.6
EBB_IH2_B	26/03/2024	3.6
EBB_IH2_M	26/03/2024	2.0
EBB_IH2_T	26/03/2024	2.8
EBB_IH3_B	26/03/2024	3.0
EBB_IH3_M	26/03/2024	3.7
EBB_IH3_T	26/03/2024	2.7
EBB_IH4_B	26/03/2024	1.9
EBB_IH4_M	26/03/2024	2.1
EBB_IH4_T	26/03/2024	2.5

Signatory: Vaughan Gregory
Date: 10/04/2024

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METHOD SAMPLE CODE	Sampling Date	2540D TSS mg/L
Reporting Limit		**<0.5**
Analysis Date		**27/03/2024**
File		**240327**
EBB_IH5_B	26/03/2024	2.4
EBB_IH5_M	26/03/2024	2.7
EBB_IH5_T	26/03/2024	2.7

Note: For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
Tables for measurement uncertainity are available online at www.mafrl.murdoch.edu.au

Signatory: Vaughan Gregory
Date: 10/04/2024

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Address: 20 Mews Rd, Fremantle, WA, 6160

Date of Issue: 10/04/2024
Date Received: 28/03/2024
Our Reference: O2M24-8
Your Reference: 24ENV263

METHOD SAMPLE CODE	Sampling Date	2540D TSS mg/L
Reporting Limit		**<0.5**
Analysis Date		**3/04/2024**
File		**24040301-02**
FLO_IH1_B	28/03/2024	1.8
FLO_IH1_M	28/03/2024	1.7
FLO_IH1_T	28/03/2024	1.7
FLO_IH2_B	28/03/2024	2.4
FLO_IH2_M	28/03/2024	2.1
FLO_IH2_T	28/03/2024	2.1
FLO_IH3_B	28/03/2024	1.6
FLO_IH3_M	28/03/2024	1.8
FLO_IH3_T	28/03/2024	1.6
FLO_IH4_B	28/03/2024	1.6
FLO_IH4_M	28/03/2024	2.5
FLO_IH4_T	28/03/2024	1.3
FLO_IH5_B	28/03/2024	1.1
FLO_IH5_M	28/03/2024	1.4
FLO_IH5_T	28/03/2024	0.7
FLO_OH1_B	28/03/2024	0.5
FLO_OH1_M	28/03/2024	0.7
FLO_OH1_T	28/03/2024	<0.5
FLO_OH2_B	28/03/2024	0.8

Signatory: Vaughan Gregory
Date: 10/04/2024

The results only apply to the sample as received and to the sample tested.
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Environmental Science
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Date of Issue: 10/04/2024
Date Received: 28/03/2024
Our Reference: O2M24-8
Your Reference: 24ENV263

METHOD SAMPLE CODE	Sampling Date	2540D TSS mg/L
Reporting Limit		**<0.5**
Analysis Date		**3/04/2024**
File		**24040301-02**
FLO_OH2_M	28/03/2024	0.8
FLO_OH2_T	28/03/2024	0.7
FLO_OH3_B	28/03/2024	0.7
FLO_OH3_M	28/03/2024	0.6
FLO_OH3_T	28/03/2024	<0.5
FLO_OH4_B	28/03/2024	0.7
FLO_OH4_M	28/03/2024	<0.5
FLO_OH4_T	28/03/2024	<0.5
FLO_OH5_B	28/03/2024	0.7
FLO_OH5_M	28/03/2024	0.9
FLO_OH5_T	28/03/2024	<0.5
EBB_OH1_B	28/03/2024	<0.5
EBB_OH1_M	28/03/2024	<0.5
EBB_OH1_T	28/03/2024	<0.5
EBB_OH2_B	28/03/2024	0.7
EBB_OH2_M	28/03/2024	<0.5
EBB_OH2_T	28/03/2024	0.6
EBB_OH3_B	28/03/2024	2.1
EBB_OH3_M	28/03/2024	0.8

Signatory: Vaughan Gregory
Date: 10/04/2024

The results only apply to the sample as received and to the sample tested.
Spare test items will be held for two months unless otherwise requested.

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations and/or measurements included is this document are traceable to Australian/national standards.

Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Sophie Preston
Customer: O2 Marine
Address: 20 Mews Rd, Fremantle, WA, 6160

Date of Issue: 10/04/2024
Date Received: 28/03/2024
Our Reference: O2M24-8
Your Reference: 24ENV263

METHOD SAMPLE CODE	Sampling Date	2540D TSS mg/L
Reporting Limit		**<0.5**
Analysis Date		**3/04/2024**
File		**24040301-02**
EBB_OH3_T	28/03/2024	<0.5
EBB_OH4_B	28/03/2024	1.0
EBB_OH4_M	28/03/2024	0.7
EBB_OH4_T	28/03/2024	<0.5
EBB_OH5_B	28/03/2024	0.5
EBB_OH5_M	28/03/2024	<0.5
EBB_OH5_T	28/03/2024	<0.5
EBB_IH1_B	28/03/2024	3.3
EBB_IH1_M	28/03/2024	1.8
EBB_IH1_T	28/03/2024	1.9
EBB_IH2_B	28/03/2024	2.3
EBB_IH2_M	28/03/2024	1.2
EBB_IH2_T	28/03/2024	1.6
EBB_IH3_B	28/03/2024	1.7
EBB_IH3_M	28/03/2024	1.8
EBB_IH3_T	28/03/2024	2.2
EBB_IH4_B	28/03/2024	2.1
EBB_IH4_M	28/03/2024	2.1
EBB_IH4_T	28/03/2024	1.2

Signatory: Vaughan Gregory
Date: 10/04/2024

The results only apply to the sample as received and to the sample tested.
Spare test items will be held for two months unless otherwise requested.

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WATER QUALITY DATA

Contact: Sophie Preston
Customer: O2 Marine
Address: 20 Mews Rd, Fremantle, WA, 6160

Date of Issue: 10/04/2024
Date Received: 28/03/2024
Our Reference: O2M24-8
Your Reference: 24ENV263

METHOD SAMPLE CODE	Sampling Date	2540D TSS mg/L
Reporting Limit		**<0.5**
Analysis Date		**3/04/2024**
File		**24040301-02**
EBB_IH5_B	28/03/2024	2.1
EBB_IH5_M	28/03/2024	1.1
EBB_IH5_T	28/03/2024	1.2

Note: For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
Tables for measurement uncertainity are available online at www.mafrl.murdoch.edu.au

Signatory: Vaughan Gregory
Date: 10/04/2024

The results only apply to the sample as received and to the sample tested.
Spare test items will be held for two months unless otherwise requested.

Appendix G. Field Sheets

Client: Free Ports

Project: 24ENV263

Date: 26/3/24

Tide:

Conditions: GLAMOROUS

Vessel Plated	GPS	Location	Depth	Time Surface (TOP)	Time Mid	Time Bottom
1H2	045	FLO_1H2_	12.5	0828	0831	0836
1H2	046	FLO_1H2	9.3	0853	0856	0900
1H3	047	FLO_1H3	6.8	0914	0920	0925
1H4	048	FLO_1H4	5.8	0938	0941	0944 ~~0947~~ redo 0947
1H5	049	FLO_1H5	11.5	1012	1015	1017
OH1	050	FLO_OH1	12.4	1031	1034	1037
OH2	051	FLO_OH2	16.0	1048	1050	1054
OH3	052	FLO_OH3	17.0	1106	1108	1110
OH4	053	FLO_OH4	12.5	1122	1124	~~1128~~ redo 1131
OH5	054	FLO_OH5	6.8	1143	1147	1150

GPS	Location	Depth	Time Surface	Time Mid	Time Bottom
055	EBB_OH5	6.5	1243	1247	1251
—	EBB_OH4	12.4	1303	1306	1308
056	EBB_OH3	16.7	1321	1323	1326
057	EBB_OH2	15.8	1339	1341	1345
058	EBB_OH1	12.4	1357	1359	1402
059	EBB_1H5	14.7	1420	1423	1425
060	EBB_1H4	5.2	1456	1458	1500
061	EBB_1H1	13.0	1612	1619	1621
062	EBB_1H2	7.6	1638	1640	1642
063	EBB_1H3	5.1	~~13~~ 1657	1659	~~1701~~ 1704

Client: Freo ports **Project:** 24 ENV 263

Date: 28/3/24 **Tide:** EBB

Conditions: Calm Team – DT + NA

Vessel Platter	GPS	Location	Depth	Time Top ~~Surface~~	Time Mid	Time Bottom
IH1	45	EBL_IH1	12,5	1344	1345	1348
IH2	46	EBL_IH2	9.3	1327	1329	1331
IH3	47	EBL_IH3	6.8	1309	1312	1314
IH4	48	EBL_IH4	5.8	1257	1258	1300
IH5	49	EBL_IH5	11.5	1229	1230	1234
OH1	50	EBL_OH1	12.4	1202	1203	1206
OH2	51	EBL_OH2	16.0	1141	1143	1147
OH3	52	EBL_OH3	17.0	1123	1124	1127
OH4	53	EBL_OH4	12.5	1108	1108	1111
OH5	4	EBL_OH5	6.8	1051	1053	1155

28/3

24 ENV 263

Flow

Vessel number	GPS	Location	Depth	~~Surface~~ DO	Time Mid	Bottom
OH5	55	Flo [illegible]_OH[illegible]1	6.5	714	720	722
OH4		Flo [illegible]_OH[illegible]2	12.5	735	736	738
OH3	56	Flo [illegible]_OH[illegible]3	17	752	753	755
OH2	57	Flo [illegible]_OH[illegible]4	15.5	805	806	808
OH1	58	Flo [illegible]_OH[illegible]5	12.5	829	830	833
IH5	59	Flo [illegible]_IH5	14.4	958	959	1001
IH4	60	Flo [illegible]_IH4	5.3	940	942	945
IH3	61	Flo [illegible]_IH3	13.2	925	927	929
IH2	62	Flo [illegible]_IH2	7.6	910	911	914
IH1	63	Flo [illegible]_IH1	5.1	848	852	857

O2 MARINE

MS9 LOGGER DEPLOYMENT

Site	Logger #	Photos	GPS - Anchor	GPS - Frame	Comments
SI1	118	Pycan	279	280	moved spot 3.0m - 400m South
PR1	142		281	282	8:30 with 12m water
RD	143		283	284	5m deep
SI2	0115	Yes	289	290	2.5m
SR	114	Y	293	294	12m
DI1	117		296	298.	19.5m - moved site due to anchorage area
DI2	119		299	300	19.5
OS	135		302	303	13.5

O2 MARINE

NTU FIELD SHEET

PROJECT	FPA DEMP	CLIENT	
FIELD CREW	DT DA JC	DATE	8/4/24
VESSEL	Freedom	LOCATION	

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	DR1		282	12	8:40		
2							
3					843		
1	RD		284	4.8	9:27		
2							
3							
1	DR2		286	13	10:24		
2							
3					10:27		
1	S11		285		10:44		
2					10:46		

MARINE

NTU FIELD SHEET

PROJECT	DFMP.	CLIENT	FPA
FIELD CREW	DT + NA	DATE	8-9/4/24
VESSEL	Freedom	LOCATION	Freo

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU Surface	NTU Bottom
3	SI2		290	2.5	11.20 -	1122	
1	SI3		291	3.5	1136	1139	
2	SR		295	13.5	12:34	1238	
3	DI1		298	20m	1:48	153	
1	DI2		300	20m	2:52	256	
2	OS		303	13.5	3:33	3:37	
3							
1							
2							
3							
1							

9/4/24

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, NA, JADE	DATE	16-04-24
VESSEL	FREEDOM	LOCATION	

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	DR2	DEMP_DR2	063	14.4	0813	1.35	1.20
2	DR2	DEMP_DR2	063	14.4	0817	1.70	2.30
3	DR2	DEMP_DR2	063	14.8	0820	1.65	1.05
1	DR1	DEMP_DR1	064	14.4	0844	0.60	1.60
2	DR1	DEMP_DR1	064	14.3	0847	0.55	0.80
3	DR1	DEMP_DR1	064	14.1	0850	0.55	1.25
1	~~DR1~~ OS	DEMP_~~DR1~~ OS	~~065~~ 065	13.8	0936	0.60	0.68
2	OS	DEMP_OS	065	13.6	0934	0.60	0.70
3	OS	DEMP_OS	~~065~~ 065	13.8	0936	055 *0.50	0.75 *0.70
1	D12	DEMP_D12	066	20.6	0959	~~0.60~~ 0.60	0.75
2	D12	DEMP_D12	066	21.0	1004	0.54	0.90
3	D12	DEMP_D12	066	21.0	1007	0.55	0.90

* Redo 3rd drop

*OS_3 redone as logging was ~~split~~ stopped @bottom

MARINE

NTU FIELD SHEET

PROJECT	24 ENV 263	CLIENT	
FIELD CREW	BJ, NA, JADE	DATE	16-04-24
VESSEL	FREEDOM	LOCATION	

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	DI1	DEMP_DI1	067	19.7	1026	0.56	1.53
2	DI1	DEMP_DI1	067	19.1	1030	0.50	0.95
3	DI1	DEMP_DI1	067	19.3	1033	0.62	0.93
1	RD	DEMP_RD	068	5.1	1102	0.61	0.62
2	RD	DEMP_RD	068	5.0	1105	0.60	0.72
3	RD	DEMP_RD	068	5.0	1106	0.51	0.75
1	SR	DEMP_SR	072	12.3	1232	0.97	1.88
2	SR	DEMP_SR	072	12.1	1235	0.99	2.2
3	SR	DEMP_SR	072	12.1	1237	0.95	1.93
1	S13	DEMP_S13	073	2.8	1300	1.44	1.63
2	S13	DEMP_S13	073	2.6	1301	1.53	1.53
3	S13	DEMP_S13	073	2.7	1302	1.56	1.45
	S12	DEMP_S12	074	2.3	1313	1.11	1.39
	S12	DEMP_S12	074	2.4	1315	1.14	1.64
	S12	DEMP_S12	074	2.4	1316	0.95	1.72
	S11	DEMP_S11	075	5.0	1325	1.81	2.10

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, NA, Jade	DATE	16-04-24
VESSEL	FREEDOM	LOCATION	

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	S12	DEMP_S12	074	2.3	1313	1.11	1.39
2	S12	"	"	2.4	1315	1.14	1.64
3	S12	"	"	2.4	1316	0.95	1.72
1	S11	DEMP_S11	075	5.0	1325	1.81	2.10
2	S11	"	"	5.4	1326	1.72	2.11
3	S12	"	"	5.5	1328	1.74	2.15
1							
2							
3							
1							
2							
3							

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, NA, JBC	DATE	19-04-24
VESSEL	FREEDOM	LOCATION	INNER HARBOUR

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	S12	DEMP* S12	076	2.1	0749	1.2	1.15
2	S12	"	"	2.2	0750	1.15	1.23
3	S12	"	"	2.2	0751	1.2	1.26
1	S11	DEMP* S12	077	5.4	0806	4.1	4.5
2	S11	"	"	5.4	0808	3.9	3.6
3	S11	"	"	5.5	0809	4.1	3.5
1	DR2	DEMP* DR2	078	4.5	0821	3.3	2.7
2	DR2	"	"	4.7	0823	3.0	3.12
3	DR2	"	"	4.6	0824	2.8	3.16
1	DR1	DEMP* DR1	079	13.8	0855	0.6	0.67
2	DR1	"	"	14.0	0857	0.55	0.62
3	DR1	"	"	14.0	0858	0.72	0.59

O2 MARINE

NTU FIELD SHEET

PROJECT	24 ENV 263	CLIENT	FREO PORTS
FIELD CREW	BJ, NA, JBC	DATE	19-04-24
VESSEL	FREEDOM	LOCATION	INNER HARBOUR

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU Surface	NTU Bottom	
1	OS	DEMP* OS	080	13.2	0930	~~0.50~~ 0.53	0.44	- 1st lo reder
2	OS	"	"	13.4	0932	0.45	0.56	
3	OS	"	"	13.4	0933	0.53	0.56	
1	D12	DEMP* D12	081	19.9	0954	0.5	0.56	
2	D12	"	"	20.0	0956	0.59	0.6	
3	D12	"	"	19.9	0957	0.55	0.46	
1	D11	DEMP* D11	082	19.6	1015	0.63	0.5	
2	D11	"	"	19.6	1017	0.55	0.54	
3	D11	"	"	19.6	1018	0.55	0.68	
1	RD	DEMP* RD	083	5.0	1043	0.5	0.5	
2	RD	"	"	5.0	1043	0.6	0.6	
3	RD	"	"	5.0	1044	0.46	0.59	

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, NA, JBC	DATE	19-04-24
VESSEL	FREEDOM	LOCATION	INNER HARBOUR

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	SR	BEMP* SR	087	12.2	1152	0.8	1.53
2	SR	"	"	12.2	1154	0.9	3.2
3	SR	"	"	12.2	1157	0.9	2.8
1	S13	DEMP* S13	0.88	5.8	1220	3.85	5.2
2	S13	"	"	5.9	1222	3.75	4.2
3	S13	"	"	5.2	1223	4.0	4.35
1							& Vessel wake swing boat to shallow water
2							
3							
1							
2							
3							

* VESSEL DUMPING MOORING? WORKS ~200M UPCURRENT (DOWNSTREAM) AT TIME OF SI1 UNKNOWN IF IMPACTING NTU RESULTS. WATER VERY TURBID.

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, NA, JBC	DATE	24-04-2024
VESSEL	FREEDOM	LOCATION	I.H.

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	SI2	DEMP* SI2	089	2.0	0808	4.3	2.9
2	"	"	"	2.0	0809	4.6	2.8
3	"	"	"	2.0	0809	4.3	2.9
1	SI1	DEMP* SI1	090	5.3	0818	4.9	7.6
2	"	"	"	5.4	0820	7.2	8.8
3	"	"	"	5.3	0822	5.0	8.4
4	"	"	"	5.3	0824	13.0	12.1
1	DR2	DEMP* DR2	091	13.2	0837	6.3	11.1
2	"	"	"	13.2	0839	7.8	14.3
3	"	"	"	13.2	0841	7.9	13.9
1	DR1	DEMP* DR1	092	12.3	0900	0.85	1.1
2	"	"	"	12.3	0902	0.8	0.95
3	"	"	"	12.3	0903	0.85	1.1

O2 MARINE

NTU FIELD SHEET

PROJECT	23ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, NA, JBL	DATE	24-04-24
VESSEL	FREEDOM	LOCATION	I.M.

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	OS	DEMP* OS	093	13.1	0934	0.9	0.85
2	"	"	"	13.2	0935	0.75	0.73
3	"	"	"	13.2	0937	0.86	0.76
1	D12	DEMP* D12	094	19.5	1009	0.96	1.12
2	"	"	"	19.2	1012	0.94	0.99
3	"	"	"	19.2	1013	0.95	0.94
1	D11	DEMP* D11	095	19.4	1037	0.85	0.72
2	"	"	"	19.4	1039	0.79	0.6
3	"	"	"	19.4	1041	0.82	0.75
1	RD	DEMP* RD	096	4.7	1116	0.75	0.76
2	"	"	"	4.7	1117	0.76	0.85
3	"	"	"	4.7	1118	0.79	0.72

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV263	CLIENT	FRED PORTS
FIELD CREW	BJ, NA, JBC	DATE	24-04-24
VESSEL	FREEDOM	LOCATION	I.H.

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	SR	DEMP*SR	100	12.0	1232	1.3	1.7
2	〃	〃	〃	12.0	1234	1.2	1.69
3	〃	〃	〃	12.0	1235	1.38	1.6
1	S13	DEMP*S13	101	8.0	1256	4.01	5.68
2	〃	〃	〃	7.5	1257	3.94	3.96
3	〃	〃	〃	8.1	1258	4.45	4.47
1							
2							
3							
1							
2							
3							

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, DT, JBC	DATE	29-04-24
VESSEL	FREEDOM	LOCATION	I.H.

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	S12	DEMP*S12	102	2.5	0727	3.1	2.8
2	〃	〃	〃	2.5	0728	3.2	2.3
3	〃	〃	〃	2.5	0730	2.9	2.5
1	S13	DEMP*S13	103	5.0	0745	5.4	6.5
2	〃	〃	〃	4.4	0747	6.0	6.2
3	〃	〃	〃	5.0	0748	5.8	5.5
1	S11	DEMP*S11	104	3.7	0813	2.8	3.8
2	〃	〃	〃	3.6	0814	3.2	3.1
3	〃	〃	〃	3.7	0815	3.3	3.1
1	DR2	DEMP*DR2	105	9.2	0829	1.1	6.5
2	〃	〃	〃	9.2	0830	1.15	5.7
3	〃	〃	〃	11.5	0831	1.15	5.9

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV263	CLIENT	FREEPORT
FIELD CREW	BJ, DT, JBC	DATE	29-04-24
VESSEL	FREEDOM	LOCATION	1.4

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	DR1	DEMP* DR1	106	14.0	0859	0.9	2.7
2	"	"	"	13.8	0901	0.8	2.9
3	"	"	"	14.0	0902	0.85	2.2
1	OS	DEMP* OS	107	13.8	0931	0.75	0.7
2	"	"	"	13.8	0932	0.65	0.55
3	"	"	"	13.8	0933	0.6	0.75
1	D12	DEMP* D12	108	20.7	1004	0.6	1.1
2	"	"	"	20.6	1005	0.7	0.7
3	"	"	"	20.7	1007	0.65	1.2
1	D11	DEMP* D11	109	20.5	1028	0.6	1.0
2	"	"	"	20.4	1030	0.65	0.6
3	"	"	"	20.4	1032	0.6	0.65

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, DT, JBC	DATE	29-4-24
VESSEL	FREEDOM	LOCATION	1.H

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
1	RD	DEMP RD	110	4.4	1102	0.7	0.7
2	〃	〃	〃	4.8	1103	0.75	0.7
3	〃	〃	〃	5.0	1104	0.6	0.7
1	SR	DEMP SR	114	11.6	1229	1.3	2.1
2	〃	〃	〃	11.8	1231	1.2	2.3
3	〃	〃	〃	11.9	1232	1.3	2.6
1							
2							
3							
1							
2							
3							

Recorded @ as is

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV263	CLIENT	Free Ports
FIELD CREW	Ben, Nic, Jade	DATE	14-05-24
VESSEL	Freedom 2	LOCATION	I.H.

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU	
						Surface	Bottom
* 1	S11	DEMP* S11	115	2.2	0743	1.2	1.07
2	"	"	"	2.2	0744	1.08	1.23
3	"	"	"	2.2	0745	1.15	1.21
1	DR2	DEMP* DR2	116	13.1	0832	0.56	1.51
2	"	"	"	13.4	0836	0.62	1.60
3	"	"	"	13.3	0837	0.65	1.49
1	OS	DEMP* OS	117	13.3	0915	0.51	0.64
2	"	"	"	13.4	0917	0.55	0.64
3	"	"	"	13.4	0919	0.45	0.68
1	D12	DEMP* D12	118	19.5	0953	0.51	0.96
2	"	"	"	19.5	0957	0.50	0.88
3	"	"	"	19.5	0959	0.49	0.86

O2 MARINE

NTU FIELD SHEET

PROJECT	24ENV236	CLIENT	Freo Ports
FIELD CREW	BJ, NM JC	DATE	14-5-24
VESSEL	Freedom	LOCATION	1.1H

REP	SITE	YSI LOG NAME	GPS	DEPTH (m)	TIME	NTU Surface	NTU Bottom
1	D12	DEMP* D12	119	19.5	1035	0.52	1.85
2	"	"	"	19.5	1039	0.50	1.6
3	"	"	"	19.5	1041	0.55	1.8
1	RD	DEMP* RD	120	5.2	1123	0.74	0.75
2	"	"	"	5.2	1124	0.78	0.73
3	"	"	"	5.1	1126	0.72	0.78
1	~~DR7 SD7~~	~~DEMP* DR7~~	~~121~~ 122	12.10	1201	0.55	1.33
2	"	"	"	12.10	1203	0.57	1.09
3	"	"	"	~~12.10~~ 12.0	1206	0.58	0.84
1	~~SD~~SR	DEMP* ~~SD~~SR	~~123~~ 125	12.6	1310	1.03	1.95
2	"	"	"	12.6	1313	0.91	1.81
3	"	"	"	12.6	1315	0.91	1.91
S13		DEMP* S13	126	3.4	1415	0.69	0.73
"		"	"	3.4	1417	0.71	0.81
"		"	"	3.4	1419	0.73	0.86
S12		DEMP* S12	127	2.5	1432	0.71	0.96
"		"	"	2.6	1433	0.74	0.90

O2 MARINE

SECCHI DISK FIELD SHEET

PROJECT	FPA DENIP	CLIENT	
FIELD CREW		DATE	8/4/24
VESSEL		LOCATION	

SITE	TIME	GPS	DISTANCE EYE – WATER (m)	WATER DEPTH (m)	BEAUFORT	SECCHI DISK DEPTH (0.1 m) D1	D2	D3	COMMENTS
DP1	830	282	1.4	12	4	10.1	9.8	9.7	
R1	925	284	11	4.8-5.0	4-5	5.0	5.0	5.0	Wind ↑
SD3	958	285	1.4	4.5/4.8	3	4.8	4.8	4.8	H.L Bottom
DR		286	1.4	13		6.7	6.8	6.3	
SI1		287	1.4	5.	1	5.3	5.3	5.4	
SD1		288	1.4	5.5	1	4.8	4.8	4.9	Hard to moor SITE - Tide ripping
SI2		290	1.4	2.1	1	2.6	2.7	2.7	
SI3		291	1.4	3.5	1	3.8	5.2	5.2	-Prop off 3.9-6m
SD2	11:54	292	1.4	6.5-7.1	1	5.7	6.5	6.5	50m off due to moorings
SR	12:35	295	1.4	13.5	2	4.8	4.8	4.8	
DI1	14:00	298	1.4	19.3	2	8	7.9	7.9	
DI2	15:00	300	1.4	19.5	2	9.9	11.7	10.5	
OS	15:35	303	1.4	13.5	1	10	10	10	

O2 MARINE

SECCHI DISK FIELD SHEET

PROJECT	24ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, NA, Jade	DATE	16-04-2024
VESSEL	Freedom	LOCATION	Inner Harbour

SITE	TIME	GPS	DISTANCE EYE – WATER (m)	WATER DEPTH (m)	BEAUFORT	SECCHI DISK DEPTH (0.1 m) D1	D2	D3	COMMENTS
DR2	0810	063	1.80	14.4	2	3.7	3.54	3.7	
DR1	0844	064	1.80	14.4	3	11.93	7.8	4.8	4.8 | vessel swinging = wind
OS	0930	065	1.80	13.1	4	5.4	4.4	8.0	vessel swinging = wind
DI2	1000	066	1.80	19.9	4	5.9	3.7	4.7	vessel swinging = wind
DI1	1026	067	1.80	19.6	4	3	4.4	4.5	vessel swinging = wind
RO	1102	068	1.80	5.1	3	5.1	5.0	5.0	
SD3	1122	069	1.80	5.5	1	5.5	5.5	5.5	
SD1	1150	070	1.80	5.5	1	2.8	3.0	3.0	
SP2	1208	071	1.80	10.2	1	3.8	4.0	3.6	
SR	1232	072	1.80	12	1	4.0	4.8	4.8	vessel swing = wind
S13	1300	073	1.80	3.64	1	3.0	3.64	3.0	varying depth, site on drop off
S12	1313	074	1.8	2.8	1	2.7	2.6	2.8	
S11	1325	075	1.8	5.5	1	3.85	3.9	4.7	

O2 MARINE

SECCHI DISK FIELD SHEET

PROJECT	24ENV263	CLIENT	FREEPORTS
FIELD CREW	BJ, NA, JBC	DATE	19-04-24
VESSEL	FREEDOM	LOCATION	INNER HARBOUR

SITE	TIME	GPS	DISTANCE EYE – WATER (m)	WATER DEPTH (m)	BEAUFORT	SECCHI DISK DEPTH (0.1 m) D1	D2	D3	COMMENTS
S12	0752	076	2.1	2.4	2	>2.4	>2.4	>2.4	ON BOTTOM
S11	0808	077	2.1	5.8	2	1.8	1.7	1.7	PLUMING
DR2	0821	078	2.1	4.8	2	1.9	2.0	2.0	
DR1	0855	079	1.9	14.0	3	8.3	8.8	8.0	* Boat movement from wakes / wind swinging away from sun
OS	0930	080	1.9	13.5	4	8.0	9.8	8.9	
D12	0955	081	1.9	19.7	3	10.1	9.9	11.4	Rocking & swinging
D11	1015	082	1.9	19.6	3	9.0	9.8	9.3	
RD	1045	083	1.9	5.0	3	>5.0	>5.0	>5.0	Clear. Visible on bottom
SD3	1058	084	2.1	4.6	2	>4.6	>4.6	>4.6	~~Very~~ clear. Visible on bottom
SD1	1120	085	2.1	5.8	1	2.0	1.7	1.7	$\bar{x}$ = 1.8
SD2	1131	086	2.1	5.8	1	2.3	2.4	2.4	$\bar{x}$ = 2.37
SR	1152	087	1.9	12.4	1	5.6	5.9	5.7	
S13	1220	088	1.9	6.0	1	2.4	2.9	2.7	

O2 MARINE

SECCHI DISK FIELD SHEET

PROJECT	24ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, NA, JBC	DATE	24-04-2024
VESSEL	FREEDOM	LOCATION	I.H.

SITE	TIME	GPS	DISTANCE EYE – WATER (m)	WATER DEPTH (m)	BEAUFORT	SECCHI DISK DEPTH (0.1 m) D1	D2	D3	COMMENTS
SI2	0807	089	1.9	2.2	2	1.73	1.54	1.7	WIND PUSHING INTO ROCKY BAY
SI1	0818	090	1.9	5.4	2	1.62	1.40	1.6	
DR2	0838	091	1.9	13.4	2	1.0	1.0	1.0	TRUD R JUST FINISH DREDGING
DR1	0900	092	1.9	12.6	4	5.0	5.2	4.6	
OS	0935	093	1.9	13.3	6	4.0	4.8	4.0	
DI2	1010	094	1.9	19.7	6	3.9	4.4	4.3	ANCHOR STRUGGLE TO HOLD
DI1	1040	095	1.9	19.5	6	4.5	4.7	3.6	
RD	1120	096	1.9	4.7	4	>~~4.7~~	3.9	4.0	
SD3	1135	097	1.9	4.2	~~2~~ 2	3.5	>4.2	>4.2	~~(4.0)~~
SD1	1158	098	1.9	5.2	~~2~~ 2	1.9	1.9	1.8	(1.87)
SD2	1212	099	1.9	9.1	2	1.9	1.91	1.52	(1.78)
SR	1231	100	1.9	12.0	3	2.9	2.9	2.8	
SI3	1255	101	1.9	7.8	2	1.9	1.73	1.7	

O2 MARINE

SECCHI DISK FIELD SHEET

PROJECT	24ENV263	CLIENT	FREO PORTS
FIELD CREW	BJ, DT, JBC	DATE	29-04-24
VESSEL	FREEDOM	LOCATION	I.H.

SITE	TIME	GPS	DISTANCE EYE – WATER (m)	WATER DEPTH (m)	BEAUFORT	SECCHI DISK DEPTH (0.1 m) D1	D2	D3	COMMENTS
S12	0730	102	2.1	2.5	3	1.8	1.7	1.9	
S13	0745	103	2.0	6.1	3	1.6	1.5	1.55	WATER DEPTH ~ 4.4m - 6.1m
S11	0815	104	1.9	3.9	3	2.0	2.3	2.3	
DR2	0830	105	1.9	9.8	3	4.9	4.0	4.0	
DR1	0900	106	1.9	13.6	5	4.0	5.0	5.3	
OS	0935	107	1.9	13.8	6	6.45	7.8	6.6	
D12	1005	108	1.9	20.0	6	9.0	7.5	6.7	
D11	1030	109	1.9	20.5	6	9.0	7.6	7.0	
RD	1105	110	1.9	4.8	5	>5.4	>5.4	>5.5	
SD3	1125	111	1.9	4.6	3	>5.0	>4.9	>4.9	ON BOTTOM
SD1	1155	112	1.9	5.9	1	2.1	2.1	2.2	STRONG UPSTREAM CURRENT (2.
SD2	1210	113	1.9	7.0	1	2.~~5~~	2.6	2.4	X=2.53
SR	1230	114	1.9	12.2	2	3.7	3.1	3.3	

O2 MARINE

SECCHI DISK FIELD SHEET

PROJECT: 24ENV263
FIELD CREW: Ben, Nic, Jade
VESSEL: Freedom 2
CLIENT: Freeports
DATE: 14-05-24
LOCATION: I.H.

SITE	TIME	GPS	DISTANCE EYE – WATER (m)	WATER DEPTH (m)	BEAUFORT	SECCHI DISK DEPTH (0.1 m) D1	D2	D3	COMMENTS
S11	0741	115	2.1	2.2	0	>2.2	>2.2	>2.2	
DR2	0835	116	2.1	13.1	0	7.9	9.38	8.50	
OS	0915	117	2.1	10	3	10	9.5	10	
D12	0953	118	2.1	13.5	2	13.1	11.8	12.25	
D13	1036	119	2.1	19.7	1	14.3	16	15	
RD	1123	120	2.1	5.1	0	>5.1	>5.1	>5.1	
SD3	1150	121	2.1	3.6	1	3.6	3.6	3.6	
DR1	1201	122	2.1	12.67	1	12.67	12.70	12.7	
SD4	1238	123	2.1	5.8	0	>5.8	>5.8	>5.8	
SD2	1251	124	2.1	5.60	0	5.60	5.6	5.6	
SR	1310	125	2.1	12.8	0	7.0	7.16	7.0	
S13	1417	126	2.1	3.8	0	3.8	3.8	3.8	
S12	1430	127	2.1	2.8	0	>2.8	>2.8	>2.8	