KBMS Casuarina Boat Harbour Phase 1 DSDMP Water Quality Monitoring

3 September 2024

Monitoring Summary Report 1

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Acronyms and Abbreviations

Abbreviation	Definition
BCH	Benthic Communities and Habitats
CBH	Casuarina Boat Harbour
CEMP	Construction Environmental Management Plan
CoC	Chain of Custody
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DDC	Dolphin Discovery Centre
DSDMP	Dredge Spoil Disposal Management Plan
EP Act	Environmental Protection Act 1986
GIS	Geographical Information System
KBMS	Koombana Bay Marine Structures
KBSC	Koombana Bay Sailing Club
LAT	Lowest Astronomical Tide
LoR	Limit of Reporting
MAFRL	Marine and Freshwater Research Laboratory
NATA	National Association of Testing Authorities
Nephelometer	Instrument for measuring turbidity
NTU	Nephelometric Turbidity Units
PAR	Photosynthetically Active Radiation
PSU	Practical salinity unit approximates g/l
QA/QC	Quality Assurance and Quality Control
SDP	Sea Dumping Permit
SI	Surface Irradiance
TSS	Total Suspended Solids – sediment weight/volume in a subsample of water collected
WAL/IS JV	WA Limestone / Italia Stone Joint Venture
ZoI	Zone of Impact
ZoMI	Zone of Medium Impact
ZoHI	Zone of High Impact

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EXECUTIVE SUMMARY

The Koombana Bay Marine Structures (KBMS) is a Strategic Proposal (Ministerial Statement 1226) approved under Part IV of the *Environmental Protection Act 1986* (EP Act) for the construction and operation of small craft marine infrastructure in Koombana Bay, located in Bunbury, Western Australia.

The Casuarina Boat Harbour (CBH) proposal was approved as a Derived Proposal under the Strategic Proposal. The CBH Proposal includes a dredging and dredge spoil disposal component. Construction is proposed to be completed in two phases.

Capital dredging for Phase 1 of the CBH Proposal is being implemented in accordance with an approved Dredge Spoil Disposal Management Plan (DSDMP). The DSDMP includes a water quality monitoring program at near-disposal, far-disposal and reference locations in the vicinity of the dredge spoil disposal site. Triggers for total suspended sediment (TSS) concentrations have been established in the DSDMP to monitor the accuracy of the disposal plume modelling predictions.

A survey was undertaken following the requirements of the DSDMP during a 1015 m^3 spoil disposal event on 22 August 2024. The survey was constrained by weather. Squally conditions commenced mid-morning. Winds turned northerly and increased to 20 – 25 knots. Seas increased to >3 m.

Following prescriptions of the DSDMP, turbidity (NTU) and TSS data were collected and analysed to provide a working TSS-NTU relationship. NTU data was transformed into estimated TSS values using the relationship:

$$TSS = 1.62*NTU$$

The data collected during the disposal monitoring campaign was incomplete to fully test the triggers due to the limited sampling program possible in the weather conditions prevailing at the time. However, the data collected showed Trigger 1 (TSS at a near disposal monitoring site >2 mg/L above the average of the reference site data) and Trigger 2 (TSS at a far disposal monitoring site >2 mg/L above the average of the reference site data) exceedences at one site each.

Other parameters (temperature, conductivity and dissolved oxygen) showed the water column was well mixed, probably due to the energetic system. The pre-disposal data also showed little stratification of the water column, suggesting that wave energy is routinely transferred through the whole water column, even in lower energy.

The high TSS values were investigated in accordance with the prescriptions of the DSDMP. Investigation determined that:

- TSS means were high mostly as a result of a single high sample from the bottom of the water column.
- The high bottom sample most likely occurred by very energetic wave conditions lifting bottom sediments into the sampling zone.
- The high TSS means appeared to occur only in sand bottom areas where no seagrass beds are noted. As reference sites are all on seagrass beds, the lifting of unconsolidated seabed doesn't occur there, thus the exceedence was more likely due to metocean conditions than the disposal plume.

No impact to seagrass quality is predicted as a result of the present sampling data, as such, none of the management actions presented in the DSDMP require implementation.

1 INTRODUCTION

1.1 Project Background

The Koombana Bay Marine Structures (KBMS) is a Strategic Proposal (Ministerial Statement 1226) approved under Part IV of the *Environmental Protection Act 1986* (EP Act) for the construction and operation of small craft marine infrastructure in Koombana Bay, located in Bunbury, Western Australia.

The future proposals identified under the Strategic Proposal include the construction and operation of:

- Casuarina Boat Harbour (CBH);
- Koombana Bay Sailing Club (KBSC) marina; and
- Dolphin Discovery Centre (DDC) finger jetty.

The CBH Proposal was approved as a Derived Proposal under the Strategic Proposal on 23 July 2024. The CBH Proposal includes a dredging and dredge spoil disposal component, a piling component, land reclamation and construction of breakwater and revetment walls. The marine infrastructure includes the construction and operation of a wharf, jetties, boat ramps and boat pens. Construction is proposed to be completed in two phases. The CBH Phase 1 dredge and construction program includes the northern breakwater, associated reclamation area and internal jetties and boat pens.

Capital dredging for Phase 1 of the CBH Proposal will be implemented in accordance with an approved Dredge Spoil Disposal Management Plan (DSDMP) and associated Sea Dumping Permit (SDP) (SD2022/4034) issued under the Commonwealth *Environment Protection (Sea Dumping) Act 1981*, administered by the Department of Climate Change, Energy, the Environment and Water (DCCEEW). Up to 177,000 m^3 of capital dredging material is proposed to be disposed offshore at the approved spoil ground during Phase 1.

The approved DSDMP outlines the management and monitoring actions required to minimise the environmental impact of dredge spoil disposal activities associated with construction of the proposals identified under the KBMS Strategic Proposal (Cardno 2023). This report covers the component of the DSDMP's water quality monitoring program at near-disposal, far-disposal and reference locations in the vicinity of the dredge spoil disposal site.

1.2 DSDMP Water Quality Monitoring Program

1.2.1 Intent

- Demonstrate measured total suspended solids (TSS) concentrations (inferred from turbidity [NTU] data using a TSS~NTU relationship) remain within the expected range predicted by sediment plume dispersion modelling (model validation);
- Measure NTU and additional physical water quality parameters within disposal plumes for comparison against background condition (reference sites);
- Inform ongoing spoil disposal activities and any requirement to manage these; and
- Assess potential impacts to benthic community habitats (BCH e.g. seagrass shading) should measurements be outside of the modelled range (trigger exceedance).

1.2.2 Frequency

Monitoring is to be conducted fortnightly for the duration of dredge spoil disposal activities, including a monitoring campaign prior to the start of dredging and two weeks post- disposal activities.

During dredge spoil disposal activities, data will be collected immediately after an individual disposal action and then at three equally spaced periods as the turbid plume disperses, until just prior to the next disposal action (4 sampling repeats in total).

1.2.3 Monitoring locations

Profiling of the water column will occur at 12 monitoring sites (Figure 1-1):

- Eight sites within the modelled dredge plume extent;
  - Four near-disposal sites (DIS01, DIS02, DIS03 and DIS04).
  - Four far-disposal sites (DIS05, DIS06, DIS07 and DIS08).
- Four sites beyond the modelled dredge plume extent (background, REF01, REF02, REF03 and REF04).

1.2.4 Analysis

Parameters to be measured are those of Section 7.1.2 of the DSDMP. These include:

- Turbidity (NTU);
- Photosynthetically active radiation (PAR);
- Conductivity;
- Temperature;
- Dissolved Oxygen; and
- Depth

In addition, 48 water samples will be collected at a range of locations and water depths alongside a turbidity sensor **during the first monitoring campaign only** and analysed for TSS concentration. The results from this data will be used to establish a NTU~TSS relationship to infer TSS from future NTU profiling.

1.2.5 Test Narrative

Thresholds for elevated TSS concentrations were developed within the Strategic Proposal for the purpose of mapping spatial zones of influence and impact for the project's dredging and disposal action, with respect to BCH. The thresholds/zones were defined as follows:

- Zone of Influence (ZoI): Elevated TSS at least once (i.e. instantaneous duration threshold).
- Zone of Medium Impact (ZoMI): Elevated TSS continually for 18 days.
- Zone of High Impact (ZoHI): Elevated TSS continually for 90 days.

The modelling suggested that ZoMI or ZoHI would not be formed during the disposal actions. Triggers were established to monitor the accuracy of the modelling predictions. Investigations will be triggered should monitoring infer that a ZoMI may exist, in areas where seagrass has been mapped. Triggers and their responses are outlined in Table 1-1.

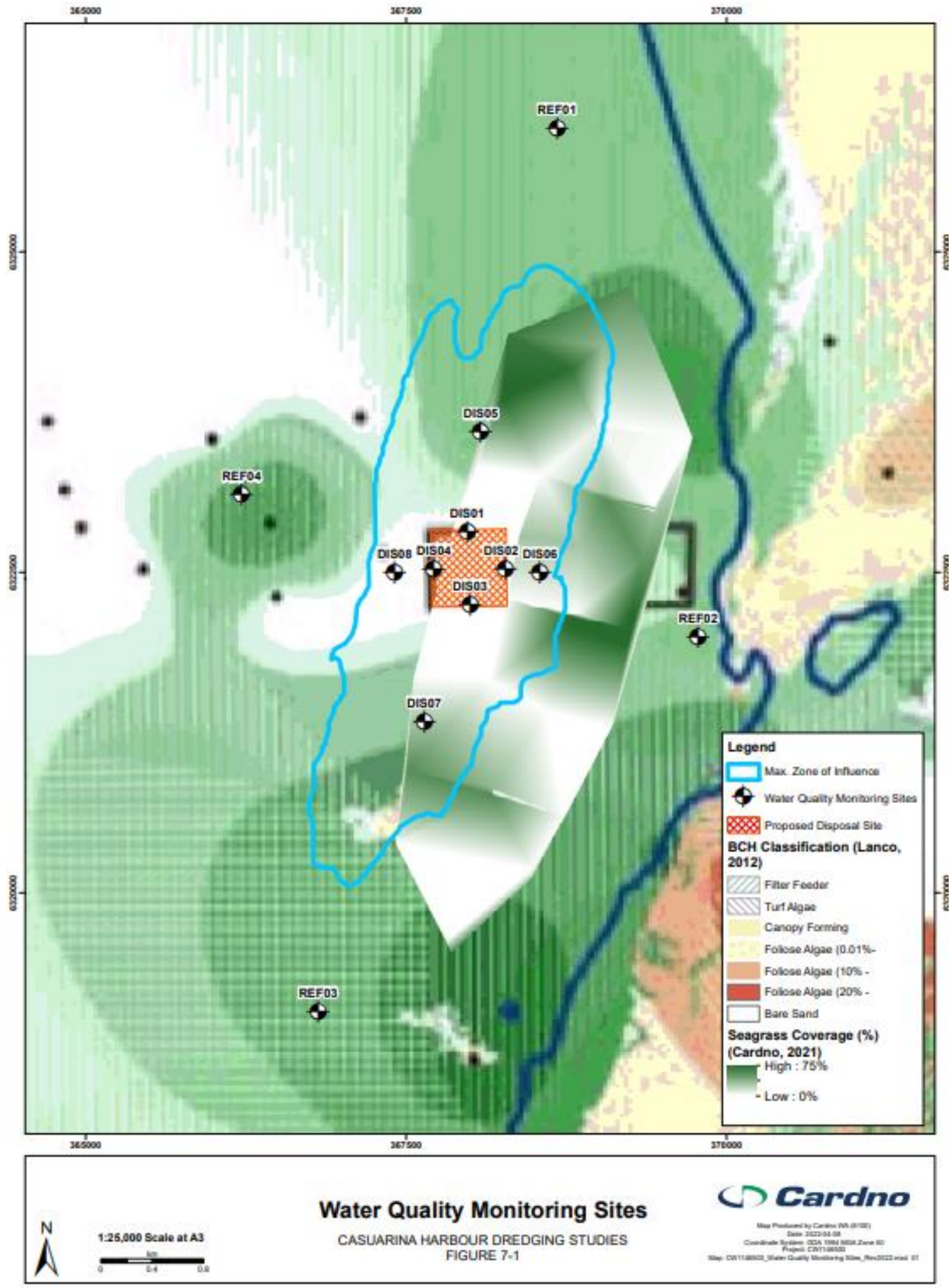


Figure 1-1. DSDMP water quality monitoring locations

Table 1-1. DSDMP triggers, tests and responses

Trigger Level	Test/Threshold	Response
Trigger 1	Depth- and time-averaged (across individual monitoring campaign) TSS concentration (inferred from NTU data) at any of the near disposal monitoring sites (DIS01 to DIS04) is greater than 2 mg/L above average background levels (average of sites REF01-REF04) for a measurement campaign.	Investigate if Trigger 2 has been exceeded for any sites

Trigger 2	Depth- and time-averaged (across individual monitoring campaign) TSS concentration (inferred from NTU data) at any of the far disposal monitoring sites (DIS05 to DIS08) is greater than 2 mg/L above average background levels (average of sites REF01-REF04) for a measurement campaign.	• Assess metocean condition data available from BoM and DoT to determine if the exceedance at the site(s) in question is likely to exist for a continuous period of greater than 18 days (e.g. continuous prevailing winds in one direction);
		• Investigate how the disposal rate during the monitoring campaign compares with historical and planned disposal rates (typical, higher than average, lower than average);
		• Further investigate light attenuation (PAR profile data) associated with site(s) of elevated TSS to determine if stress may be placed on seagrass, with respect to the light attenuation stress thresholds presented in RPS (2023) for *Posidonia* and *Amphibolis* species and PAR at reference sites. This should include temporal assessment of shading across the monitoring campaign, as the plume dissipates (i.e. is the average exceedance prolonged, or due to a short, very high elevation);
		• Provide a statement as to whether, based on the above, seagrass quality in the vicinity of the disposal site is likely to suffer permanent reduction in quality as a result of the ongoing and proposed disposal schedule. If impact to seagrass quality is predicted, the following actions should be undertaken:
		  o Dispose in different portion of disposal site;
		  o Dispose in certain portions of the site for certain metocean conditions (i.e. 'upstream side'); and
		  o Consider additional monitoring campaign to confirm effectiveness of varied placement; and
		  o Consider reduction in disposal rate during daylight hours.

1.3 Document Purpose

This report provides:

- A summary of the pre-disposal monitoring campaign data;
- A summary of the laboratory TSS data and relationship established between TSS and NTU; and
- A summary of the first disposal action monitoring campaign data.

In accordance with DSDMP instructions, summary data includes:

- Plots and statistical summary of vertical profiling data for all parameters and profiles;
- Calculation of depth averaged TSS at each monitoring site;
- Identification of any trigger exceedances;
- Summary of disposal rates associated with the monitoring campaign;
- Assessment of trigger exceedance with respect to potential impacts to seagrass; and
- Recommendation for management should impacts be predicted.

1.3.1 Structure of this Document

The document lists:

- The background to the Project;
- A summary of the DSDMP;
- The monitoring methodology;
- Summary data for the pre-disposal and first disposal monitoring campaigns; and
- Identification of trigger exceedances, assessment of impacts and management recommendations.

The document is current as at the date on the cover page and is referenced as Version 1 (Documents with a lower version number are superseded by this document).

2 METHODOLOGY

2.1 Monitoring Design

The monitoring design implemented was consistent with the prescriptions in Section 7 of the DSDMP (Cardno 2023).

2.1.1 Deviations from the DSDMP

The monitoring design in the DSDMP stipulates water quality profiles should be collected immediately after an individual disposal action, and then spaced equally in time as the plume disperses until just prior to the next disposal action, for 3 repeats (4 sample repeats total).

On the day of sampling, the dredge disposed of spoil at 0828 and wind and wave conditions had increased to 25 knots and >3 m seas by 1300. As such, data could only be collected for one complete sampling round at all sites and four sampling rounds at the near disposal sites (in order to collect the required 48 water samples for TSS analysis) before conditions were unsafe to work in and the vessel had to return to port.

2.1.2 Monitoring locations

During the monitoring campaigns, data was collected from locations as close as possible to the proposed monitoring site coordinates listed in the DSDMP (Cardno 2023), as shown in Figure 1-1.

2.2 Field Procedures

2.2.1 Physical Water Quality

Water quality records (NTU, PAR, conductivity, temperature, dissolved oxygen and depth) were obtained during the pre-disposal and first disposal monitoring campaigns with a calibrated YSI ProDSS multiparameter sonde and Licor-192 Underwater Quantum PAR sensor (see Appendix A for YSI calibration sheet).

The pre-disposal water quality sampling was carried out on the morning of 08 August 2024. All parameters were recorded at a surface (0.5 m), mid-water column (depth/2) and bottom (1 - 2 m off the seabed) depth profile at each monitoring site (Figure 1-1) for one sampling round.

The first disposal water quality monitoring campaign was carried out on 22 August 2024. All parameters were recorded at a surface (0.5 m), mid-water column (depth/2) and bottom (1-2 m off the seabed) depth profile at each monitoring site (Figure 1-1). Data collection occurred first at the near-disposal monitoring sites, then the far-disposal sites and finally the reference sites. Data was collected immediately after an individual disposal event at 0828, for one complete sampling round at all sites. Sea conditions were such that four sampling rounds could be completed only at the near disposal sites (refer to sections 2.1.1 and 3.1).

2.2.2 Water Sampling for TSS

In accordance with prescriptions in Table 7-1 of the DSDMP, TSS samples were obtained during the first disposal monitoring campaign (22 August 2024) at a surface (0.5 m), mid-water column (depth/2) and bottom (1 – 2 m off the seabed) depth profile at four sites (DIS01, DIS02, DIS03 and DIS04). Samples were obtained from these sites immediately after an individual disposal event at 0828hrs, and then spaced in time as the turbid plume dispersed, for three repeats (4 sampling repeats in total) yielding a total of 48 TSS samples.

Turbidity measurements (in NTU) were made using a YSI ProDSS multiparameter sonde. Samples were collected using a SuperTwister submersible pump at the appropriate depth. The sonde and the pump were connected together to ensure water samples were collected at the same depths as NTU measurements. The pump was run at depth for 30 seconds at each site to flush the pump and hose with clean water before collecting samples directly into the laboratory supplied sample containers. A 2 L water sample was collected for analysis of TSS.

2.3 Laboratories

All TSS samples were kept chilled (≤4°C) immediately after collection and delivered to the analytical laboratory the same day. The detection limits and sample requirements for the TSS analyses performed are provided in Table 2-1

Analyses were undertaken by the Marine and Freshwater Research Laboratory (MAFRL) at Murdoch University using methods accredited under the National Association of Testing Authorities (NATA) for the parameter to be measured. Samples were consigned to MAFRL for analysis using a Chain of Custody (CoC)

Table 2-1. Laboratory analysis, limits of reporting and sample requirements

Parameter	Limit of Reporting	Sample Requirements	Storage and Holding Time
Total Suspended Sediment (TSS)	0.5 $mg.L^{-1}$	2L Unfiltered. HDPE bottle	Store cold – 7 days

The known volume of water (2 L) was filtered in the laboratory through a 1– 1.2 µm pore size, 47 mm diameter GF/C filter paper (Whatman – Schleicher & Schuell) using pre-weighed filter papers. Following filtration of the sample, the filter paper was flushed with distilled water to remove contamination by dissolved solids.

TSS was determined gravimetrically and is defined as the dry weight of sediment from a known volume of a subsample of a water sample, as defined by Gray et al. (2000). For this determination, filter papers were first dried at 103-105°C until they reached a constant weight. TSS was then determined as:

$$\mathrm{TSS} = \frac{(\mathrm{Wt(ps)} - \mathrm{Wt(p)})}{\mathrm{Vol}}$$

where: Wt(ps) = dry weight (mg) of filter paper plus filtered sediment

Wt (p) = dry weight (mg) of filter paper (pre-filtration)

Vol = volume (L) of seawater filtered

2.4 Data Analysis and QA/QC

Data analysis was completed as set out within Sections 7.1.3 and 8.1.3 of the DSDMP. Plots and statistical summary (including mean, median, minimum, maximum, 20th percentile, 80th percentile and standard deviation) of profiling data were calculated as recommended by the DSDMP and derived using either Microsoft Excel 365™ or Statistica 11 (StatSoft Inc 2011).

QA/QC of physical water quality profile data included manual checks to remove erroneous entries. For the current monitoring report, this included removal of high surface PAR readings from the first disposal monitoring campaign where the instrument was too shallow to provide a meaningful estimate of light attenuation.

3 PRE-DISPOSAL MONITORING CAMPAIGN DATA SUMMARY

3.1 Metocean Conditions

Weather conditions on 08 August 2024 were overcast with north-west winds reaching 15-20 knots and seas >3 m. The tidal range for the day was 0.36 m, with low tides of 0.63 m in the early morning and 0.52 m in the late afternoon. There was a 1100 high tide of 0.88 m.

3.2 Physical Water Quality

A statistical summary of pre-disposal vertical profiling data for each monitoring site is provided in Appendix B (i). Plots of the vertical profiling data are shown in Appendix C(i) where relevant.

3.2.1 Turbidity

Turbidity was <1 NTU in all samples and showed little variance through the water column at a site, although turbidity was sometimes slightly higher in bottom samples (generally 0.1 NTU difference between surface and bottom readings). Site REF-03 reported the highest turbidity, between 0.8 and 1 NTU (Figure 3-1).

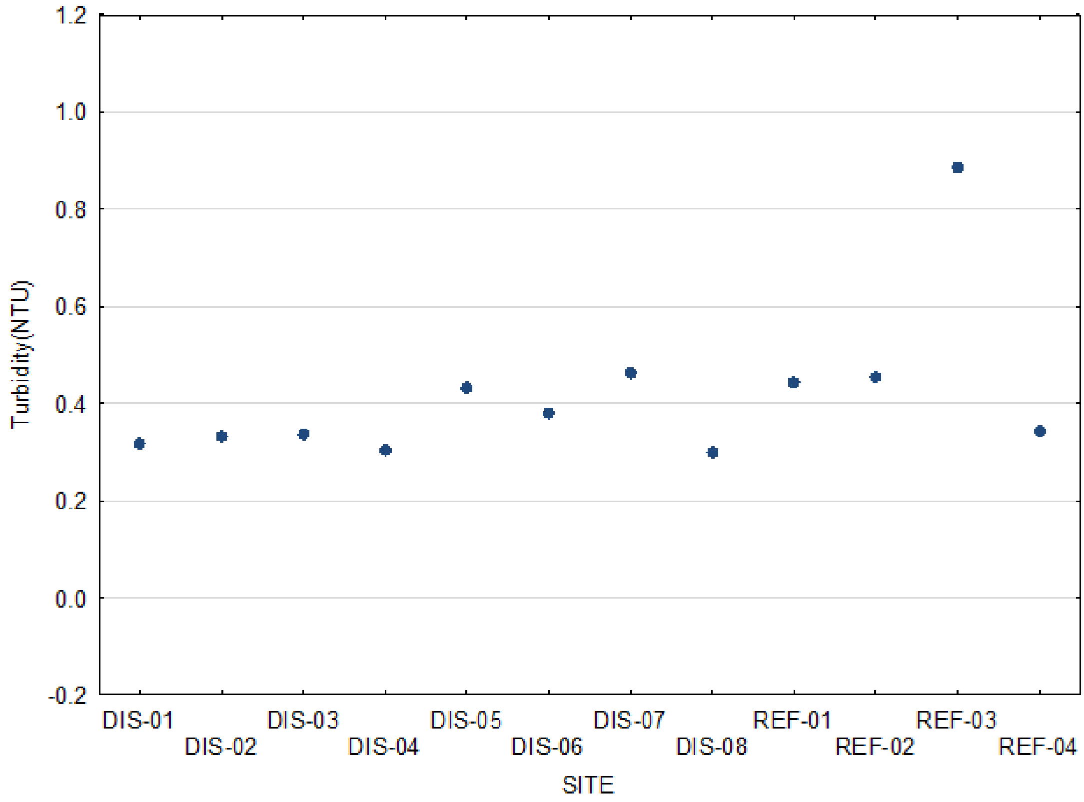


Figure 3-1. Mean NTU by site in the pre-disposal monitoring campaign.

3.2.2 PAR

While light was recorded as PAR, it is best represented as the percentage of surface irradiance (SI(%)) to reflect the strength of the ambient light at the time of measurement. There was considerable variation between mean SI(%) of sites, although without a clear spatial pattern (Figure 3-2). The percentage of surface irradiance recorded dropped sharply with depth and was often close to 0% in the bottom samples (Appendix C(i)).

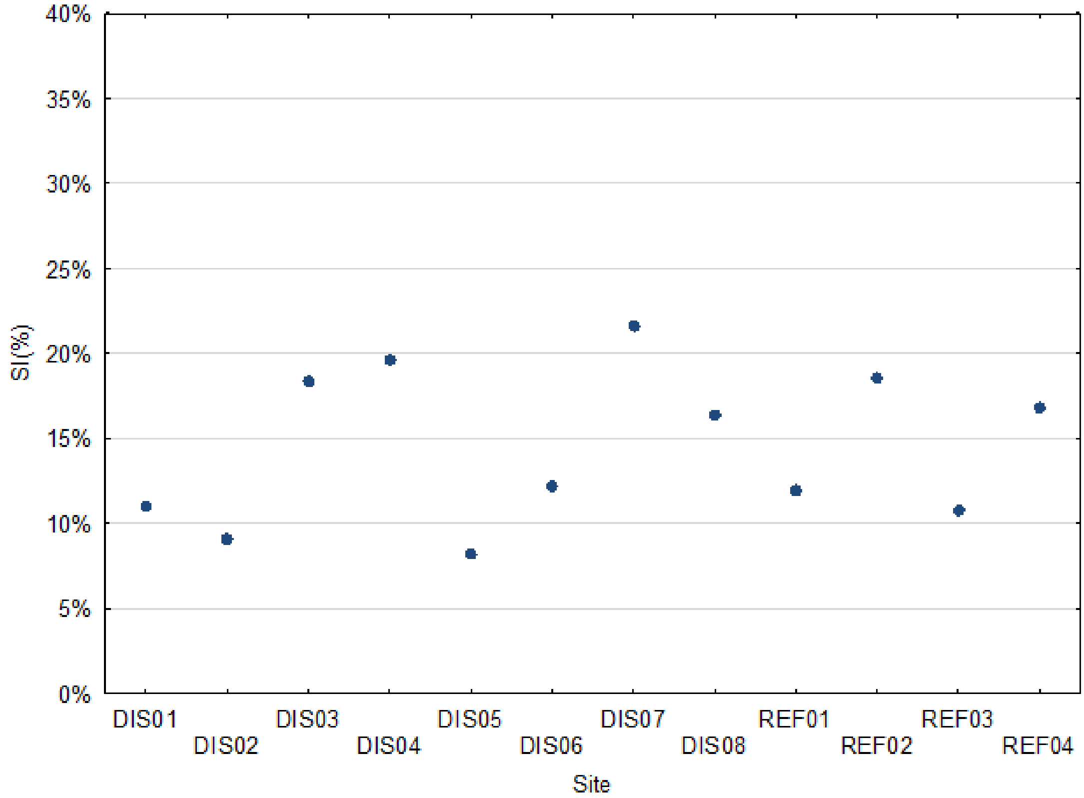


Figure 3-2. Mean precent Surface Irradiance by site in the pre-disposal monitoring campaign.

3.2.3 Temperature, Conductivity, Dissolved Oxygen

Temperature varied by less than 1°C across all sites. Most monitoring sites showed little to no stratification through the water column. Site DIS-07reported the largest temperature difference between the surface and bottom of the water column at 0.3 °C.

Conductivity was in the range expected for marine waters and showed little variation and little stratification at all sites.

Dissolved oxygen levels suggest waters are generally well oxygenated and quite uniform (including across depth profiles) with minimum dissolved oxygen levels over 100% saturation at all sites.

4 DEVELOPMENT OF NTU~TSS RELATIONSHIP

4.1 NTU vs. TSS

TSS refers to the mass of sediment suspended measured in a water sample. Turbidity is an estimate of how much light is absorbed as it passes through the water column. It is often measured in NTU which is an estimate of the amount of light refracted at 90° by a piece of sediment.

The relationship between NTU and TSS is dependent largely on the optical properties of the sediment which is being assessed. Any natural sediment will be composed of a variety of particle sizes. In general, the larger a particle (coarser sediment), the higher the mass per unit of light extinction. Thus, the mass per unit of light extinction will decrease for sediments with higher proportions of fines. As higher water energy is required to suspend coarse particles, the mass per unit of light extinction will increase with the level of water agitation for any sediment.

Not only will the relationship vary with sediment type and wave energy, but it will vary with time since the sediment was suspended. As coarser particles settle more rapidly than finer particles the particle size distribution of suspended sediments will migrate towards 'finer' once the energy event which suspended the particles abates. Thus, the mass per unit of light extinction will be highest immediately after resuspension and decrease with time.

4.2 Laboratory TSS Results

In accordance with the DSDMP, 48 water samples were collected over four sampling runs at different depth profiles (surface, mid and bottom) from sites DIS-01, DIS-02, DIS-03 and DIS-04 and tested for TSS. The results (Appendix D) include the NTU measurements recorded in the field for the site at the time of sample collection.

4.3 NTU~TSS Relationship

TSS-NTU relationships vary based on the particle sizes, colour and reflectivity of the suspended sediments and vary over time since resuspension. A simple linear relationship has been used in this case which assumes that turbidity will be 0 NTU at 0 mg/L.

The slope of the regression line in Figure 4-1 was used to transform the NTU data into estimated TSS values using the relationship:

$$TSS = 1.62*NTU$$

Exponential and logarithmic relationships did not yield a better approximation of TSS when assessed using the variance explained by the line.

Residuals (predicted-actual) of that regression line (Figure 4-2) showed a tendency to underpredict TSS concentrations up to 4 NTU and then overpredict TSS concentrations over 4 NTU.

The variability seen in the present investigation is likely to be driven by the composition (i.e. grain size distribution) of the sediments suspended at each site. NTU is a measure of light backscatter from the sediment suspended in the water column, however, the size; near infrared reflectivity; refractive index; and shape of sediment particles influences the NTU measurement (Chanson et al. 2006). It has been suggested that NTU to TSS relationships are likely to be only valid for specific sites and turbidity meters, and can also depend on water flow, depth and time of year (Chanson et al. 2006). To determine a rigorous NTU to TSS relationship for the DSDMP sites, all the proposed monitoring sites would need to be sampled. At each site, numerous replicate sediment samples would be needed to maximise the distribution of sediment grain sizes which occur at each site are within the sample prior to testing. Ideally, this would be conducted over time to capture any seasonal variability in sediment conditions.

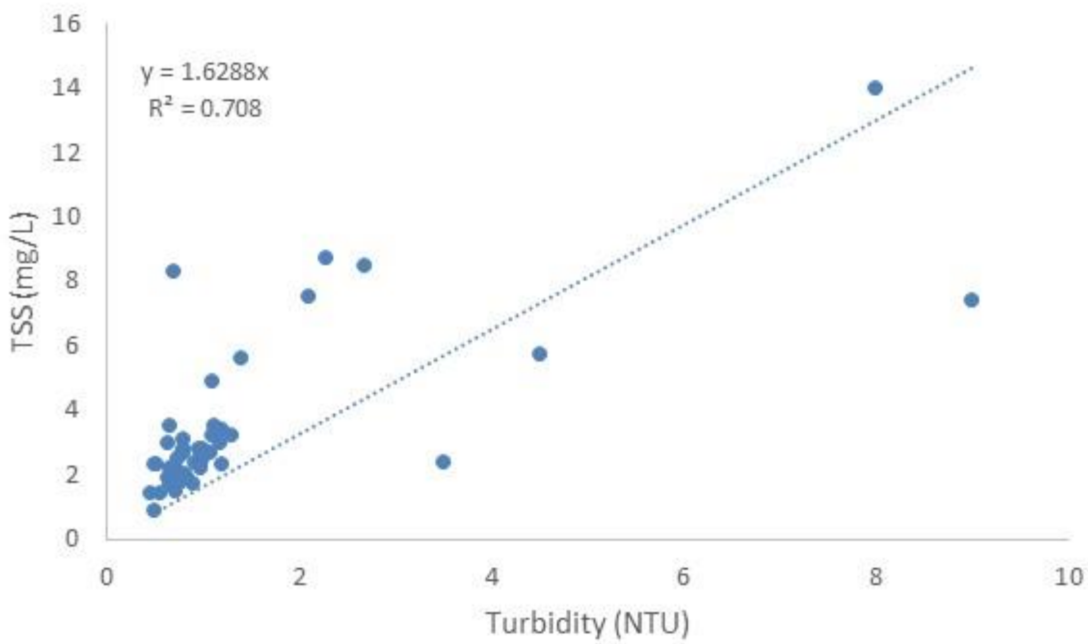


Figure 4-1. Relationship between turbidity (NTU) and TSS (mg/L)

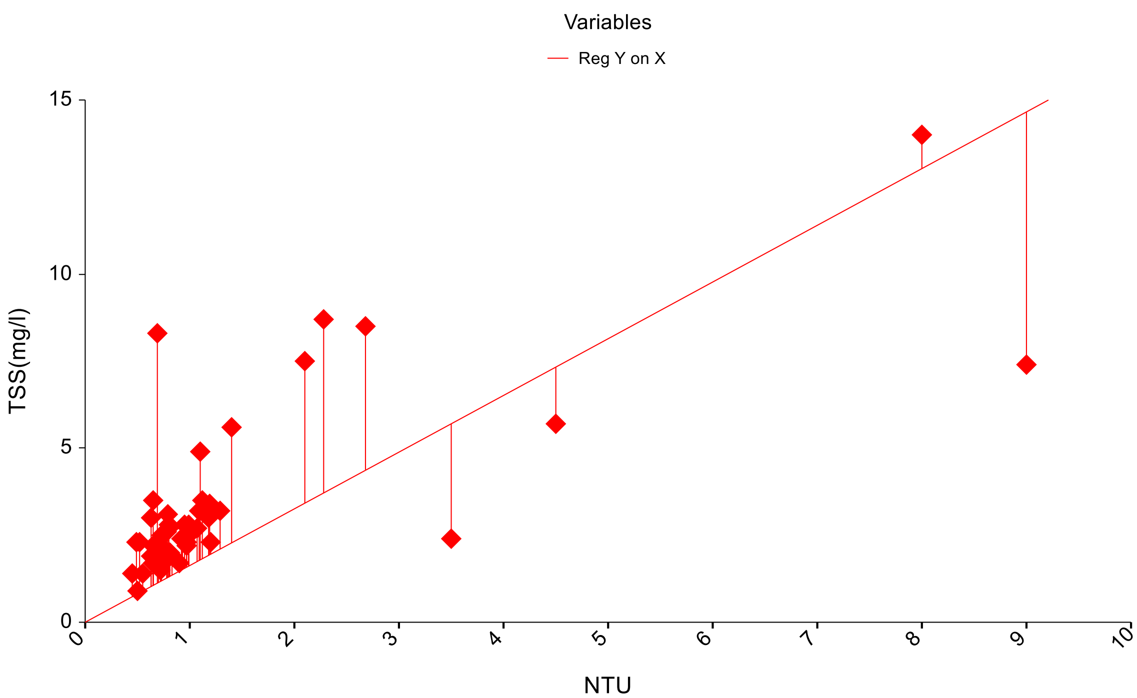


Figure 4-2. Residuals of the linear regression between NTU and TSS

5 FIRST DISPOSAL MONITORING CAMPAIGN DATA SUMMARY

5.1 Dredge Disposal Summary

A summary of the dredge spoil disposal activities on 22 August 2024 has been provided in Table 5-1. The monitoring campaign commenced immediately after disposal of Load#2, at 0828.

Table 5-1. Dredge disposal summary for 22 August 2024

Load# for Project	14	15	16	17
Load# for Day	1	2	3	4
Load start time **Load stop time**	18:17 23:38	1:55 7:00	9:40 15:48	18:37 20:55
Discharge start time **Discharge stop time**	0:56 1:00	8:28 8:34	17:30 17:34	22:20 22:26
Discharge Location **N** **E**	33 13.71 115 35.05	33 13.71 115 35.05	33 13.71 115 35.05	33 13.71 115 35.05
Load Discharge Total (m^3)	1,028	1,015	1,070	1,038
Daily Discharge Total (m^3)	4,151			
Project Discharge Total (m^3)	17,786			

5.2 Metocean Conditions

Weather conditions on 22 August 2024 were overcast in the early morning with easterly winds of 10 to 15 knots. Squally conditions commenced mid-morning, with winds turning northerly and increasing to 20 – 25 knots (Figure 5-1). Seas increased to >3 m. The tidal range for the day was 0.29 m, with low tides of 0.55 m in the early morning and 0.54 m in the late afternoon. There was a 1248 high tide of 0.83 m.

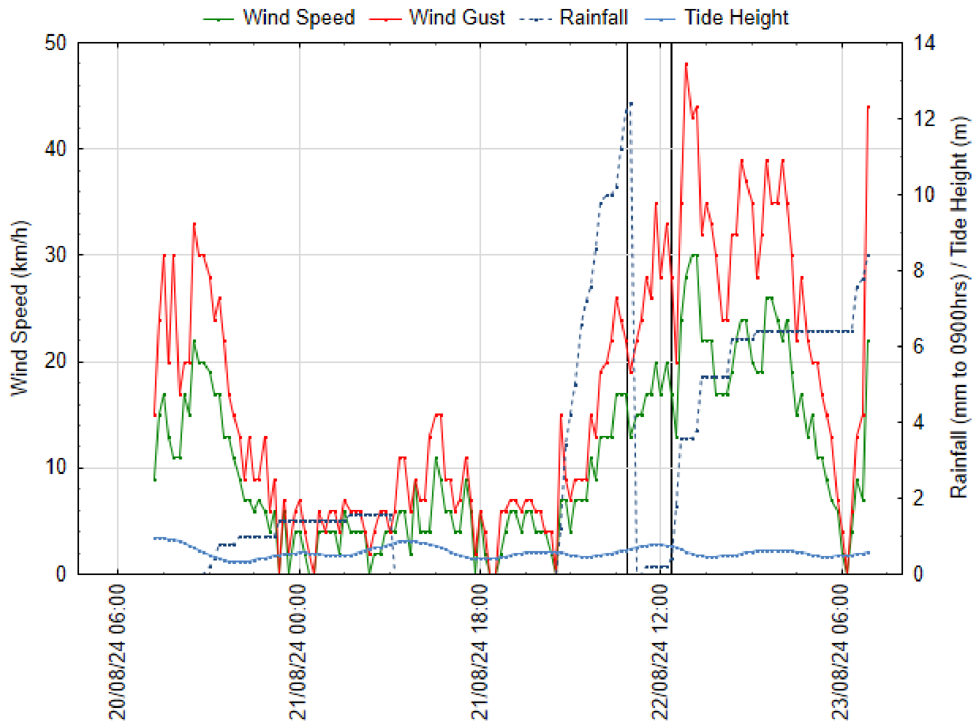


Figure 5-1. Metocean conditions on the day of the disposal monitoring campaign

5.3 Physical Water Quality

A statistical summary of pre-disposal vertical profiling data for each monitoring site is provided in Appendix B(ii). Plots of the vertical profiling data are shown in Appendix C(ii) where relevant. The following results should be taken with caution due to the limited sampling program possible in the weather conditions prevailing at the time.

5.3.1 Total Suspended Sediments

The depth- and time-averaged estimates of TSS for each monitoring site, and the average of the reference site data, during the monitoring campaign are shown in Table 5-2. Site DIS-03 exceeded the Trigger 1 criterion, indicating testing of Trigger 2 at the "Far Disposal" sites. Site DIS-07 reported TSS concentrations >2 mg/L above the average of the reference site data exceeding Trigger 2. As such, an investigation into the cause and impact of the elevated TSS at these sites was warranted. The outcome of the investigation has been provided in Section 6.

Table 5-2. Depth- and time-averaged estimates of TSS (mg/L) for all sites

Near Disposal Sites	
Site	TSS (mg/L)
DIS-01	1.4
DIS-02	2.1
DIS-03	4
DIS-04	1.4

Far Disposal Sites	
Site	TSS (mg/L)
DIS-05	1.7
DIS-06	2.3
DIS-07	4.2
DIS-08	1.7

Reference Sites		
Site	TSS (mg/L)	Average TSS (mg/L)
REF-01	0.9	1.1
REF-02	1.4	
REF-03	1.2	
REF-04	0.9	

Green Cell = TSS threshold concentration (average of REF site data) for the individual monitoring campaign.
Orange Cells indicate TSS at a near disposal site is > 2mg/L above the trigger threshold value (Trigger 1)
Red Cells indicate TSS at a far disposal site is > 2mg/L above the trigger threshold value (Tigger 2).

5.3.2 Turbidity

Mean turbidity was <1.5 NTU at 6 of the 8 disposal monitoring sites and <1 NTU at reference sites (Figure 5-2). Most sites showed little variability in NTU through the water column (Appendix C(ii)) although relatively high turbidity was recorded in bottom samples for some sites. Sites DIS-03 (sample run 1 = 9 NTU, sample run 2 = 8 NTU) and DIS-07 (sample run 1 = 6.7 NTU) reported the highest measurements in bottom readings. Those outlying results led to the high means at those sites, despite median readings remaining low (Appendix B(ii)).

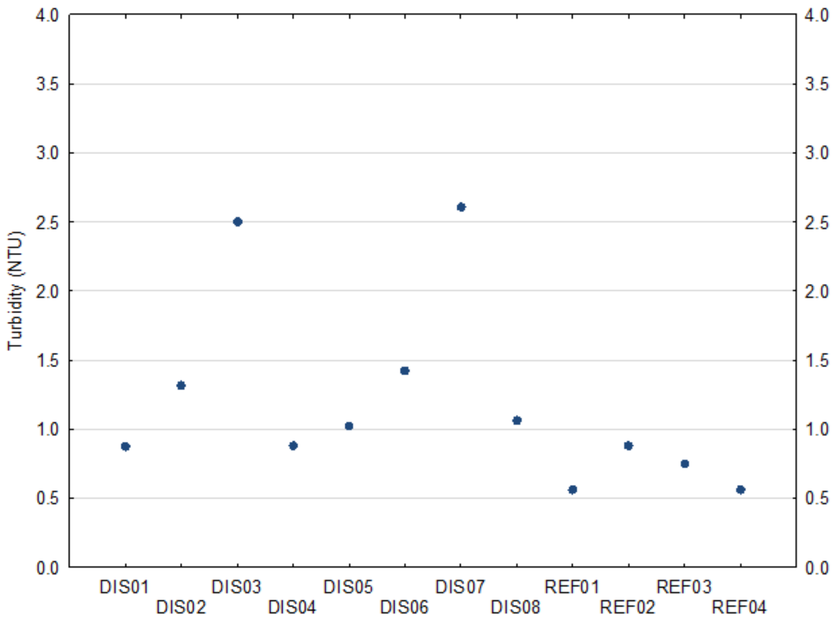


Figure 5-2. Turbidity means (time and depth averaged) at sites in the disposal monitoring campaign.

5.3.3 PAR

Mean percent surface irradiance (Figure 5-3) was generally lower than that seen in the pre-dredging data (Figure 3-2) with some sites showing a depth-time averaged mean of less than 10%. However, percent surface irradiance at the two sites exceeding the TSS trigger criteria remained amongst the highest of all sites and comparable or above that of reference sites.

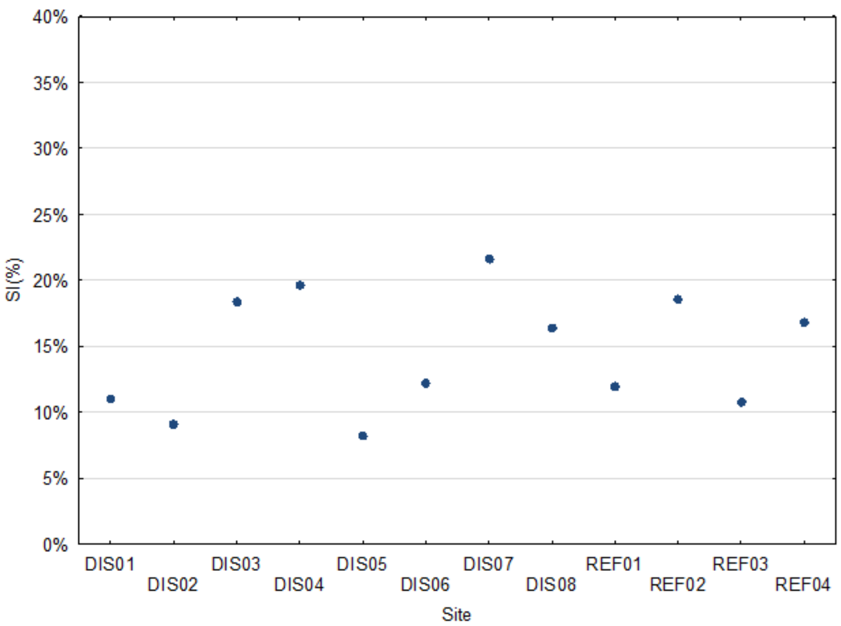


Figure 5-3. Mean percent surface irradiance at sites in the disposal monitoring campaign

5.3.4 Temperature, Conductivity, Dissolved Oxygen

Temperature varied by less than 0.5°C across all sites (Appendix B(ii)). Most monitoring sites showed little (0.1°C difference) to no stratification through the water column (Appendix C(ii)). Variation between readings at the same profile was as large as that between profiles.

Conductivity showed little variation and little stratification at all sites.

Dissolved oxygen levels suggest waters are generally well oxygenated and quite uniform (including across depth profiles) with only a 2 – 3 % difference in dissolved oxygen levels between surface and bottom readings at all sites. Dissolved oxygen saturation was close to 100% in all readings.

6 ASSESSMENT OF TRIGGER EXCEEDANCE AND RECOMMENDATIONS

6.1 Exceedance Investigation

Results presented in Section 5.3.1 (Table 5-2) indicate TSS exceeded the DSDMP Trigger 1 (>2mg/L above reference) at the near disposal monitoring site DIS-03 (4 mg/L) and Trigger 2 at the far disposal monitoring site DIS-07 (4.2 mg/L) when compared to the average of the reference site data (1.1 mg/L) during the current monitoring campaign.

Trigger 1 stipulates that where there has been an exceedance of the trigger threshold at a near disposal site (such as DIS-03), an investigation into whether there has been an exceedance at a far disposal site must be undertaken. Where there has been an exceedance of the trigger threshold at a far disposal site (such as DIS-07), an investigation into the duration and likely impacts of the exceedance is required by addressing the questions outlined in Table 6-1. Further review to determine the cause of the elevated TSS has been provided in Section 6.1.1.

Table 6-1. Trigger 2 response investigation

Questions to be addressed	Answer
Assess the forecast metocean conditions. Is the exceedance at the site(s) in question likely to exist for a continuous period of greater than 18 days (e.g. continuous prevailing winds in one direction)?	No – live weather observations have shown the wind direction changed to westerly on 24 August and has since reduced in strength and alternated coming from the north, west and south-west.
How does the disposal rate during the monitoring campaign compare with historical and planned disposal rates; typical, higher than average, lower than average?	Typical – monitoring commenced immediately after discharge of 1,015 m^3 of spoil material. Typical individual discharge rates are between 1000 to 1050 m^3.
Does the PAR profile data associated with site(s) of elevated TSS indicate stress may be placed on seagrass, with respect to the light attenuation stress thresholds presented in RPS (2023) for *Posidonia* and *Amphibolis* species and PAR at reference sites?	No – PAR profiles at sites DIS-03 and DIS-07 were comparable to the reference sites (see Section 5.3.3). The light attenuation stress thresholds presented in RPS (2023) for *Posidonia* and *Amphibolis* species indicate 3 to 6 months of prolonged shading effects due to continuously elevated TSS (2 mg/L above background) will reduce light intensity below the minimum light requirements for these species. The elevated TSS recorded during the current monitoring campaign was short in duration and likely subsided as wind-wave conditions reduced in strength.
Is seagrass quality in the vicinity of the disposal site likely to suffer permanent reduction in quality as a result of the ongoing and proposed disposal schedule.	No - high TSS values at DIS sites were a result of strong wind-wave conditions and unlikely to be dredge related.

6.1.1 Further Review

The high estimated TSS concentrations at sites DIS-03 and DIS-07 were due to one or two high NTU readings at the bottom of the water column (DIS-03, sample run 1 = 9 NTU, sample run 2 = 8 NTU and DIS-07, sample run 1 = 6.7 NTU). Sandy areas such as these sites carry a “bedload” of high suspended sediment. That sediment is suspended due to natural water movement over an unconsolidated seabed. In high energy conditions such as prevalent on the day of sampling (Strong northly winds 20-25kts and >3 m seas, refer to Section 5.2), this bedload may rise higher in the water column. It is likely that the high turbidity/TSS levels encountered in the Bottom samples of some sites in the monitoring campaign resulted from sampling extending into this bedload.

Benthic habitat mapping provided in the DSDMP shows that REF sites are all in areas of seagrass, whereas most DIS sites are on bare sand. Sites on bare sand will be more prone to bedload effects as seagrass tends to consolidate the bed. Disposal sites DIS-05 and DIS-06 are shown to be in sparse seagrass - neither of those sites showed the extreme NTU readings from bottom samples.

On the basis of the exceedance investigation, any high TSS values at DIS sites would be a result of strong wind-wave conditions and unlikely to be dredge related.

6.2 Response Recommendation

Following the prescriptions of the DSDMP, if impact to seagrass quality is predicted, the following actions should be undertaken:

- Dispose in different portion of disposal site;
- Dispose in certain portions of the site for certain metocean conditions (i.e. ‘upstream side’);
- Consider additional monitoring campaign to confirm effectiveness of varied placement; and
- Consider reduction in disposal rate during daylight hours.

No impact to seagrass quality is predicted as a result of the present sampling data, as such, none of the above actions require implementation.

7 REFERENCES

Cardno (2023) Dredge Spoil Disposal Management Plan. Casuarina Harbour Dredging Studies. Report: CW1146500, Prepared for Department of Transport, West Perth, WA

Chanson H, Takeuchi M, Trevethan M (2006) Using turbidity and acoustic backscatter intensity as surrogate measures of suspended sediment concentration. Application to a subtropical estuary (Eprapah creek). Report: Report CH60/06, Division of Civil Engineering, University of Queensland, Brisbane, QLD

Gray JR, Glysson GD, Turcios LM, Schwarz GE (2000) Comparability of Suspended-sediment Concentration and Total Suspended Solids Data. Report: Report No WRIR 00-4191, U.S. Department of the Interior, U.S. Geological Survey

RPS (2023) Benthic Communities and Habitat Study. Koombana Bay Marine Structures, Bunbury. Report: AU213001693.004, Prepared for South West Development Commission, Subiaco, Western Australia

StatSoft Inc (2011) STATISTICA (data analysis software system), Version 10.

8 APPENDIX A – YSI CALIBRATION SHEET

Calibration Report

Multi-Parameter Water Quality Instrument

Customer:	EnviroPaul/M science	**Manufacturer:**	YSI
Contact:	Matt	**Instrument:**	ProDSS
		Serial #:	22B103407
		Cable length:	30m (21K101124)

Item	Test	Pass	Comments
Battery	Rechargeable Lithium-Ion	✓	Over 90%
	Battery Saver	✓	Automatically turns off after 30 minutes if not used
Connections	Condition	✓	Good, clean
Cable	Condition	✓	Clean, no tears
Display	Operation	✓	
Firmware	Version	✓	1.2.10
Keypad	Operational	✓	
Display	Screen	✓	
Unit	Condition, seals and O-rings	✓	
Monitor housing	Condition	✓	
pH			
Condition		✓	Good, clean
pH millivolts for pH7 calibration range 0 mV ± 50 mV		✓	
pH 4 mV range + 165 to + 180 from 7 buffer mV value		✓	170.40 mV
pH slope		✓	55 to 60 mV/pH, ideal 59mV 57.73
Response time < 90 seconds		✓	
Calibrated and conforms to manufacturer's specifications		✓	
ORP			
Condition		✓	Good, clean
Response time < 90 seconds		✓	
within ± 80mv of reference Zobell Reading		✓	
Calibrated and conforms to manufacturer's specifications		✓	variance range ± 20mV 12 mV
ORP Cal offset in GLP file		✓	(min -100 - max 50) -10.9
Conductivity			
Condition		✓	Good, clean
Temperature		✓	°C
Conductivity cell constant 4.5 - 6.5 in GLP file		✓	5.41
Clean sensor reads less than 1 uS/cm in dry air		✓	
Calibrated and conforms to manufacturer's specifications		✓	
Dissolved Oxygen			
Condition		✓	Good, clean
DO sensor in use		✓	Optical
ODO gain in GLP file 0%		✓	(min 0.75 - max 1.50) 1.12
ODO gain in GLP file 100%		✓	(min 0.75 - max 1.50) 1.11
Calibrated and conforms to manufacturer's specifications		✓	

This is to certify that the above instrument has been calibrated to the following specifications:

Parameter	Standards	Reference	Calibration Point	Span	Units	Instrument Readings Before	After	Units
Temperature (22G104755)	Check Temp NATA	Room Temp	16.9	-0.1	°C	NA	16.8	°C
pH (22C106124)	pH 7.00	398528	7.01	-16.60	mV	7.08	7.01	pH
pH (22C106124)	pH 4.00	401033	4.00	153.80	mV	4.07	4.00	pH
Conductivity (22G104755)	2764 µs/cm at 25°C	24/0602	2764	GLP	5.41	2825	2764	µs/cm
ORP (22C106124)	Zobell A & B	23/3006	247	-10.9	mV	234.2	235	mV
Zero Dissolved Oxygen (22H106196)	NaSO3 in distilled water	10175	0.0	1.12	NA	-0.2	0.0	%
100% Dissolved Oxygen (22H106196)	100% Air Saturation	Air	100.0	1.11	uA	101.6	100.0	%
Turbidity (22D101897)	distilled Water	distilled Water	0.00	0	NA	0.14	0.00	NTU
Turbidity (22D101897)	10 NTU	411301	100.00	10	NA	7.33	10.00	NTU
Turbidity (22D101897)	100 NTU	412931	1000.00	100	NA	102	100.00	NTU

Calibrated by: Gaurav Kanwar **Calibration Date:** 03-Aug-24

Next Due: 30-Jan-25

9 APPENDIX B – DETAILED WATER QUALITY STATISTICS BY SITE

(i) PRE-DISPOSAL STATISTICS							
Site		Turbidity (NTU)	PAR (μMol/m²/s)	Conductivity (μS)	Temperature (°C)	Dissolved Oxygen (%)
DIS-01	N	3	3	3	3	3
	Mean	0.32	192	46826	17.2	101.8
	Median	0.32	88	46833	17.2	101.8
	Minimum	0.30	48	46808	17.2	101.5
	Maximum	0.33	440	46836	17.2	102.1
	20th %ile	0.30	48	46808	17.2	101.5
	80th %ile	0.33	440	46836	17.2	102.1
	Std. Dev.	0.02	215.70	15.37	0.00	0.30
DIS-02	N	3	3	3	3	3
	Mean	0.33	216	46757	17.2	101.8
	Median	0.33	141	46758	17.2	101.7
	Minimum	0.32	81	46743	17.2	101.5
	Maximum	0.35	425	46769	17.2	102.1
	20th %ile	0.32	81	46743	17.2	101.5
	80th %ile	0.35	425	46769	17.2	102.1
	Std. Dev.	0.02	183.75	13.05	0.00	0.31
DIS-03	N	3	3	3	3	3
	Mean	0.34	197	46638	17.1	102.0
	Median	0.34	156	46640	17.1	101.9
	Minimum	0.33	84	46626	17.0	101.7
	Maximum	0.34	351	46647	17.1	102.3
	20th %ile	0.33	84	46626	17.0	101.7
	80th %ile	0.34	351	46647	17.1	102.3
	Std. Dev.	0.01	138.14	10.69	0.06	0.31
DIS-04	N	3	3	3	3	3
	Mean	0.30	119	46782	17.2	101.8

(i) PRE-DISPOSAL STATISTICS							
Site		Turbidity (NTU)	PAR (μMol/m²/s)	Conductivity (μS)	Temperature (°C)	Dissolved Oxygen (%)
	Median	0.30	85	46780	17.2	101.8
	Minimum	0.29	80	46760	17.2	101.5
	Maximum	0.32	193	46806	17.2	102.1
	20th %ile	0.29	80	46760	17.2	101.5
	80th %ile	0.32	193	46806	17.2	102.1
	Std. Dev.	0.02	63.85	23.07	0.00	0.30
DIS-05	N	3	3	3	3	3
	Mean	0.43	91	46867	17.3	101.3
	Median	0.44	68	46874	17.3	101.3
	Minimum	0.41	25	46846	17.2	100.9
	Maximum	0.45	180	46881	17.3	101.7
	20th %ile	0.41	25	46846	17.2	100.9
	80th %ile	0.45	180	46881	17.3	101.7
	Std. Dev.	0.02	80.02	18.52	0.06	0.40
DIS-06	N	3	3	3	3	3
	Mean	0.38	230	46761	17.2	101.7
	Median	0.38	163	46760	17.2	101.6
	Minimum	0.35	89	46753	17.2	101.4
	Maximum	0.41	438	46769	17.2	102.2
	20th %ile	0.35	89	46753	17.2	101.4
	80th %ile	0.41	438	46769	17.2	102.2
	Std. Dev.	0.03	183.89	8.02	0.00	0.42
DIS-07	N	3	3	3	3	3
	Mean	0.46	85	46369	16.8	102.0
	Median	0.46	67	46342	16.8	101.9
	Minimum	0.42	38	46202	16.7	101.8
	Maximum	0.51	151	46563	17.0	102.4
	20th %ile	0.42	38	46202	16.7	101.8

(i) PRE-DISPOSAL STATISTICS						
Site		Turbidity (NTU)	PAR (μMol/m²/s)	Conductivity (μS)	Temperature (°C)	Dissolved Oxygen (%)
	80th %ile	0.51	151	46563	17.0	102.4
	Std. Dev.	0.05	58.69	182.01	0.15	0.32
DIS-08	N	3	3	3	3	3
	Mean	0.30	157	46803	17.2	101.9
	Median	0.31	130	46803	17.2	101.8
	Minimum	0.27	63	46775	17.2	101.8
	Maximum	0.32	279	46832	17.2	102.2
	20th %ile	0.27	63	46775	17.2	101.8
	80th %ile	0.32	279	46832	17.2	102.2
	Std. Dev.	0.03	110.56	28.50	0.00	0.23
REF-01	N	3	3	3	3	3
	Mean	0.44	67	47089	17.4	102.2
	Median	0.34	30	47090	17.4	102.1
	Minimum	0.33	25	47081	17.4	102.1
	Maximum	0.66	145	47096	17.4	102.3
	20th %ile	0.33	25	47081	17.4	102.1
	80th %ile	0.66	145	47096	17.4	102.3
	Std. Dev.	0.19	67.74	7.55	0.00	0.12
REF-02	N	3	3	3	3	3
	Mean	0.45	257	46634	17.1	101.3
	Median	0.43	193	46627	17.1	101.2
	Minimum	0.42	62	46604	17.1	101.0
	Maximum	0.51	516	46671	17.1	101.7
	20th %ile	0.42	62	46604	17.1	101.0
	80th %ile	0.51	516	46671	17.1	101.7
	Std. Dev.	0.05	233.67	34.04	0.00	0.36
REF-03	N	3	3	3	3	3
	Mean	0.89	276	46687	17.1	101.1

(i) PRE-DISPOSAL STATISTICS						
Site		Turbidity (NTU)	PAR (μMol/m²/s)	Conductivity (μS)	Temperature (°C)	Dissolved Oxygen (%)
	Median	0.90	236	46687	17.1	101.1
	Minimum	0.81	92	46683	17.1	100.9
	Maximum	0.95	501	46690	17.1	101.3
	20th %ile	0.81	92	46683	17.1	100.9
	80th %ile	0.95	501	46690	17.1	101.3
	Std. Dev.	0.07	207.46	3.51	0.00	0.20
REF-04	N	3	3	3	3	3
	Mean	0.34	90	47110	17.4	102.2
	Median	0.37	104	47113	17.4	102.2
	Minimum	0.28	37	47095	17.4	101.9
	Maximum	0.38	129	47121	17.4	102.4
	20th %ile	0.28	37	47095	17.4	101.9
	80th %ile	0.38	129	47121	17.4	102.4
	Std. Dev.	0.06	47.79	13.32	0.00	0.25

(ii) STATISTICS FROM FIRST MONITORING DURING DISPOSAL						
Site		Turbidity (NTU)	PAR ($\mu Mol/m^2/s$)	Conductivity (µS)	Temperature (°C)	Dissolved Oxygen (%)
DIS-01	N	12	12	12	12	12
	Mean	0.9	46.0	46068	16.6	99.6
	Median	0.8	36.0	46050	16.5	99.8
	Minimum	0.6	0.9	45983	16.4	98.2
	Maximum	1.3	215.0	46178	16.7	101.3
	20th %ile	0.7	6.5	45990	16.5	98.4
	80th %ile	1.2	67.0	46155	16.7	100.2
	Std. Dev	0.3	59.2	75	0.1	1.0
DIS-02	N	12	12	12	12	12
	Mean	1.3	51.3	46058	16.6	99.4
	Median	0.9	23.3	46033	16.5	99.8
	Minimum	0.5	0.3	45919	16.4	98.0
	Maximum	4.5	209.0	46188	16.7	100.7
	20th %ile	0.5	2.8	45980	16.5	98.2
	80th %ile	2.1	80.0	46177	16.7	100.2
	Std. Dev	1.2	69.6	96	0.1	0.9
DIS-03	N	12	12	12	12	12
	Mean	2.5	61.0	46028	16.5	99.3
	Median	1.0	25.0	46000	16.5	99.4
	Minimum	0.7	0.1	45959	16.4	97.9
	Maximum	9.0	308.0	46154	16.6	100.9
	20th %ile	0.8	0.3	45975	16.4	98.4
	80th %ile	3.5	104.0	46093	16.6	100.1
	Std. Dev	2.9	92.9	69	0.1	0.9
DIS-04	N	12	12	12	12	12
	Mean	0.9	76.3	46048	16.5	99.3
	Median	0.8	27.5	46063	16.5	99.5
	Minimum	0.6	1.6	45913	16.4	98.4

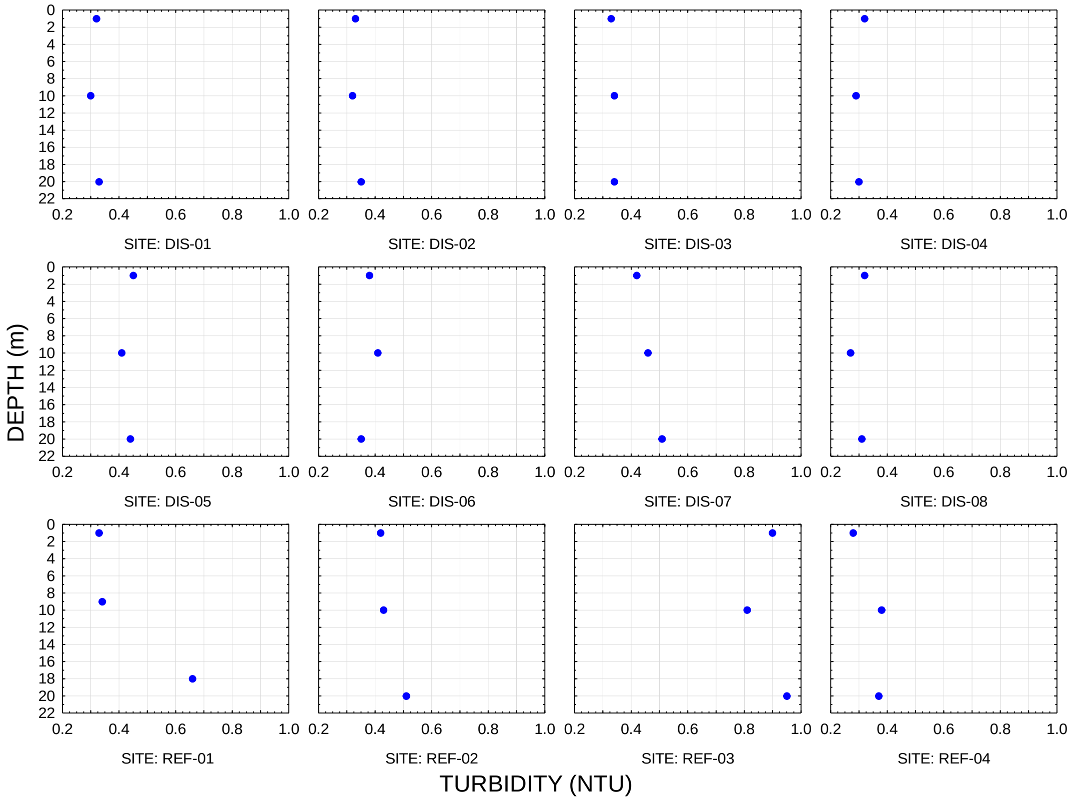
(ii) STATISTICS FROM FIRST MONITORING DURING DISPOSAL						
Site		Turbidity (NTU)	PAR (μMol/m²/s)	Conductivity (μS)	Temperature (°C)	Dissolved Oxygen (%)
	Maximum	1.4	301.0	46106	16.6	100.3
	20th %ile	0.7	4.0	46009	16.5	98.8
	80th %ile	1.1	148.0	46104	16.6	99.8
	Std. Dev	0.2	99.1	58	0.1	0.5
DIS-05	N	3	3	3	3	3
	Mean	1.0	23.6	46012	16.5	98.9
	Median	0.9	12.5	46015	16.5	99.0
	Minimum	0.9	1.2	46003	16.5	98.2
	Maximum	1.3	57.0	46017	16.5	99.6
	20th %ile	0.9	1.2	46003	16.5	98.2
	80th %ile	1.3	57.0	46017	16.5	99.6
	Std. Dev	0.2	29.5	8	0.0	0.7
DIS-06	N	3	3	3	3	3
	Mean	1.4	25.3	45869	16.4	99.2
	Median	0.8	13.2	45857	16.4	99.1
	Minimum	0.8	0.7	45843	16.4	98.3
	Maximum	2.8	62.0	45908	16.4	100.3
	20th %ile	0.8	0.7	45843	16.4	98.3
	80th %ile	2.8	62.0	45908	16.4	100.3
	Std. Dev	1.1	32.4	34	0.0	1.0
DIS-07	N	3	3	3	3	3
	Mean	2.6	32.2	46025	16.5	99.5
	Median	0.6	15.4	46021	16.5	99.9
	Minimum	0.5	0.3	46012	16.5	97.8
	Maximum	6.7	81.0	46043	16.5	100.7
	20th %ile	0.5	0.3	46012	16.5	97.8
	80th %ile	6.7	81.0	46043	16.5	100.7
	Std. Dev	3.6	42.9	16	0.0	1.5

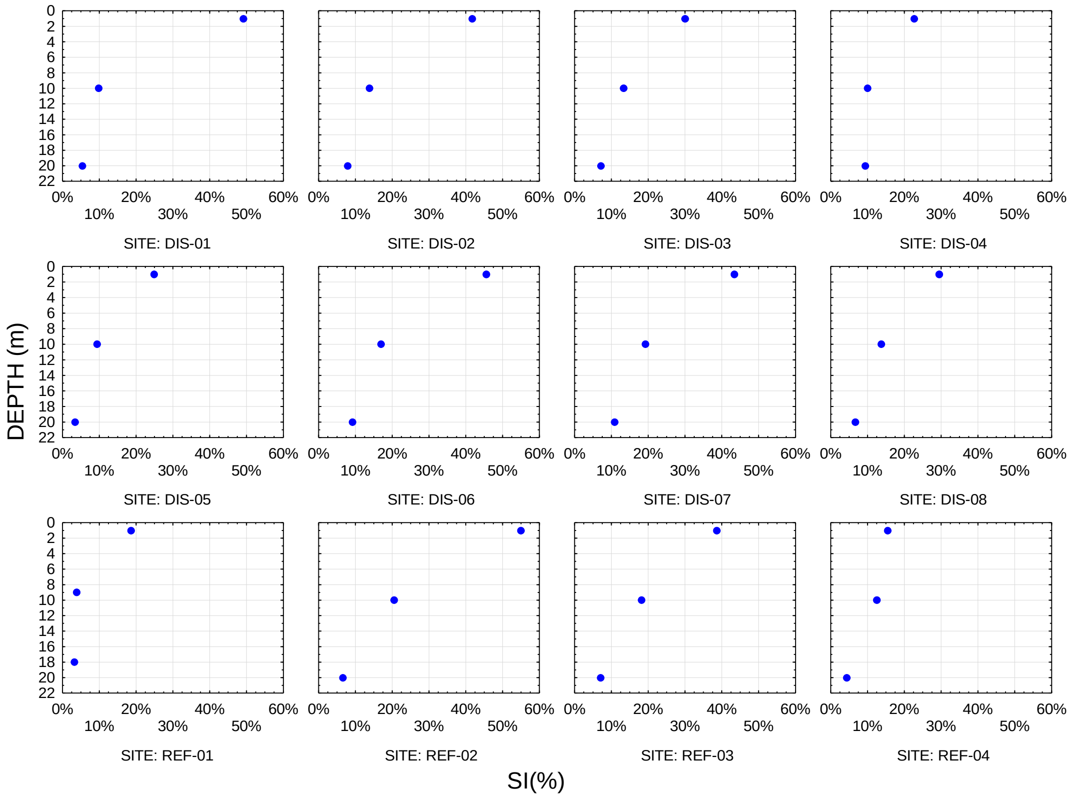
(ii) STATISTICS FROM FIRST MONITORING DURING DISPOSAL						
Site		Turbidity (NTU)	PAR (μMol/m²/s)	Conductivity (μS)	Temperature (°C)	Dissolved Oxygen (%)
DIS-08	N	3	3	3	3	3
	Mean	1.1	32.7	46084	16.5	99.7
	Median	0.6	11.2	46089	16.5	99.8
	Minimum	0.5	1.5	46063	16.5	98.7
	Maximum	2.1	85.5	46100	16.5	100.5
	20th %ile	0.5	1.5	46063	16.5	98.7
	80th %ile	2.1	85.5	46100	16.5	100.5
	Std. Dev	0.9	46.0	19	0.0	0.9
REF-01	N	3	3	3	3	3
	Mean	0.6	45.3	46302	16.7	100.2
	Median	0.4	35.0	46322	16.7	100.4
	Minimum	0.3	5.8	46253	16.6	99.0
	Maximum	1.0	95.0	46332	16.7	101.2
	20th %ile	0.3	5.8	46253	16.6	99.0
	80th %ile	1.0	95.0	46332	16.7	101.2
	Std. Dev	0.4	45.5	43	0.1	1.1
REF-02	N	3	3	3	3	3
	Mean	0.9	38.9	45643	16.3	98.8
	Median	0.7	12.3	45690	16.3	98.8
	Minimum	0.6	3.5	45538	16.3	97.9
	Maximum	1.3	101.0	45700	16.3	99.7
	20th %ile	0.6	3.5	45538	16.3	97.9
	80th %ile	1.3	101.0	45700	16.3	99.7
	Std. Dev	0.4	53.9	91	0.0	0.9
REF-03	N	3	3	3	3	3
	Mean	0.7	32.4	46045	16.5	99.5
	Median	0.6	19.5	46050	16.5	99.6
	Minimum	0.5	8.5	46033	16.5	98.5

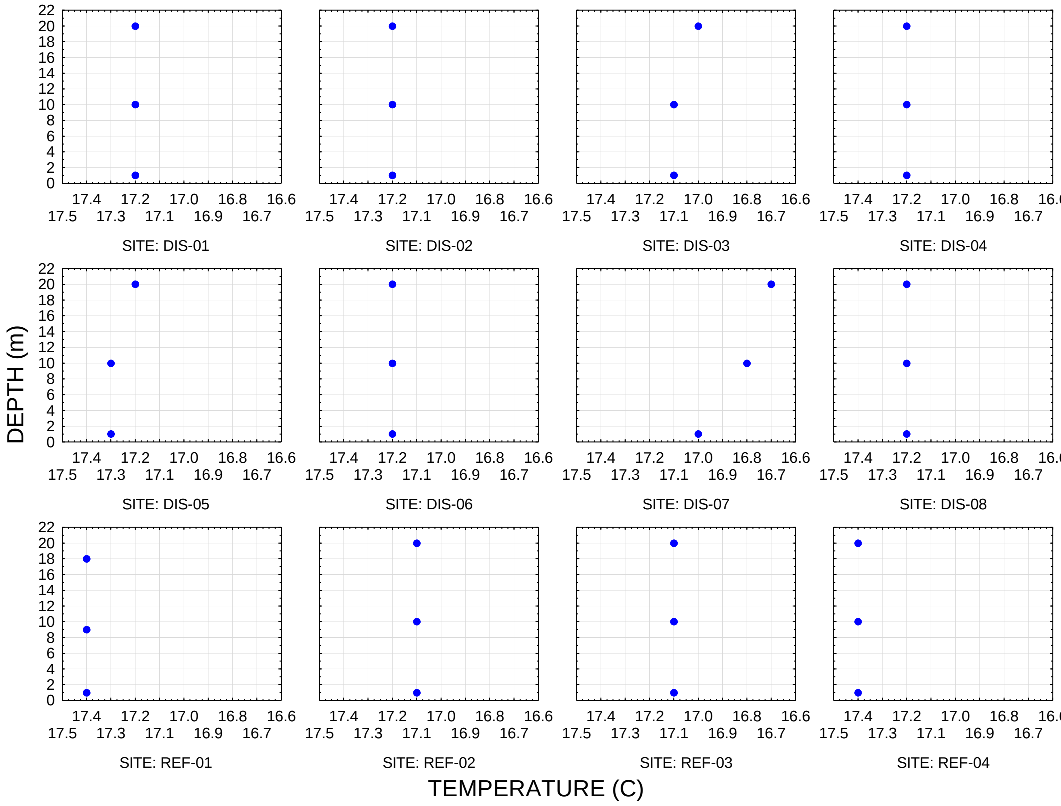
(ii) STATISTICS FROM FIRST MONITORING DURING DISPOSAL						
Site		**Turbidity (NTU)**	**PAR (μMol/m²/s)**	**Conductivity (μS)**	**Temperature (°C)**	**Dissolved Oxygen (%)**
	Maximum	1.2	69.1	46053	16.5	100.3
	20th %ile	0.5	8.5	46033	16.5	98.5
	80th %ile	1.2	69.1	46053	16.5	100.3
	Std. Dev	0.4	32.3	11	0.0	0.9
REF-04	N	3	3	3	3	3
	Mean	0.6	54.2	46242	16.6	99.3
	Median	0.5	25.9	46249	16.6	99.4
	Minimum	0.4	4.7	46225	16.6	98.6
	Maximum	0.8	132.0	46251	16.6	100.0
	20th %ile	0.4	4.7	46225	16.6	98.6
	80th %ile	0.8	132.0	46251	16.6	100.0
	Std. Dev	0.2	68.2	14	0.0	0.7

10 APPENDIX C – VERTICAL PROFILES

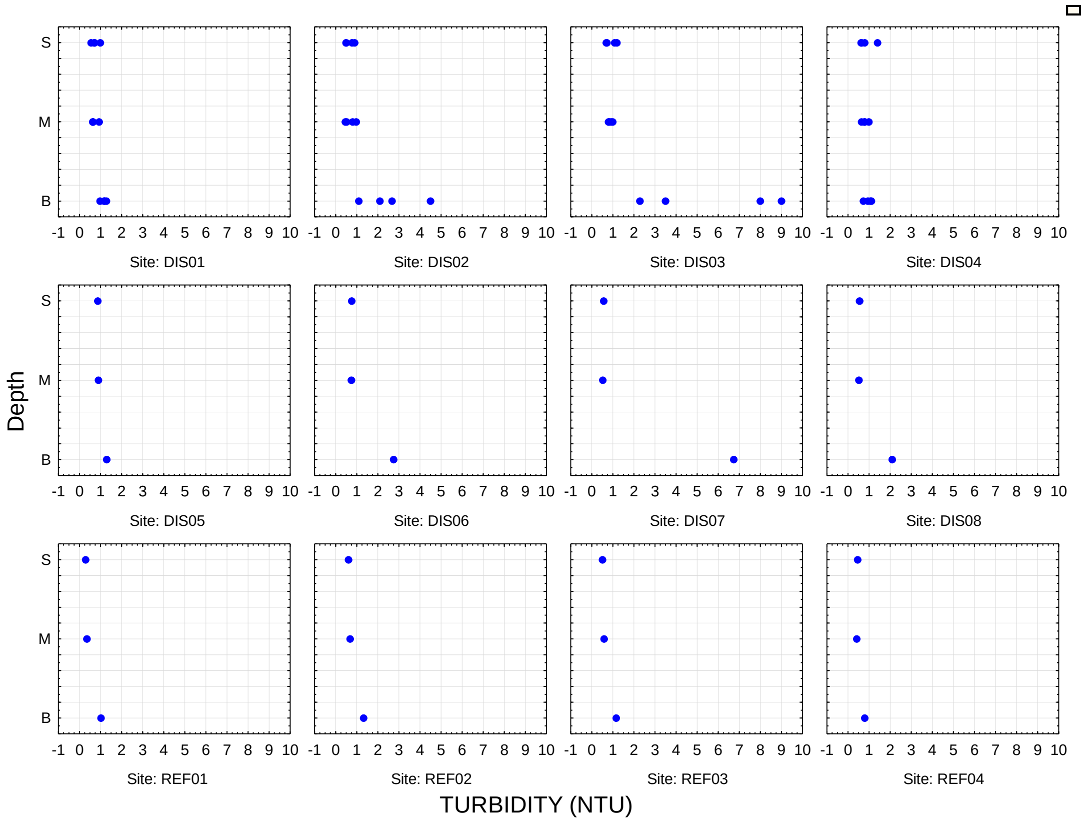
(i) PRE-DISPOSAL MONITORING CAMPAIGN

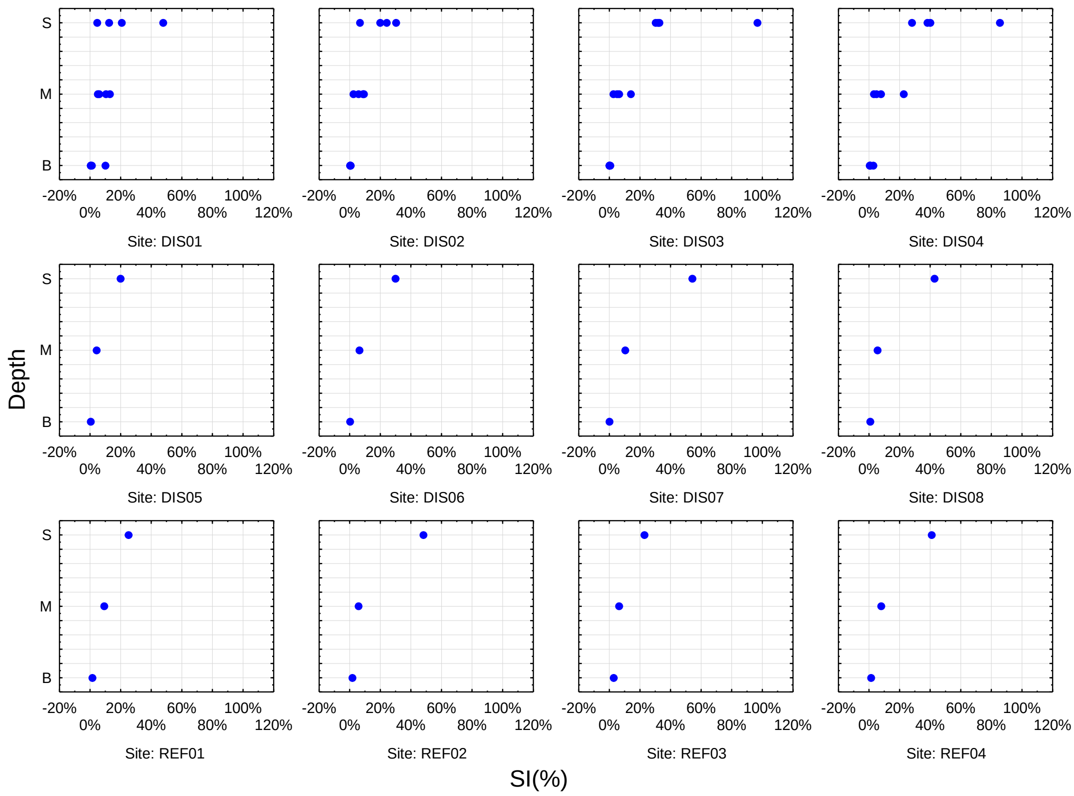


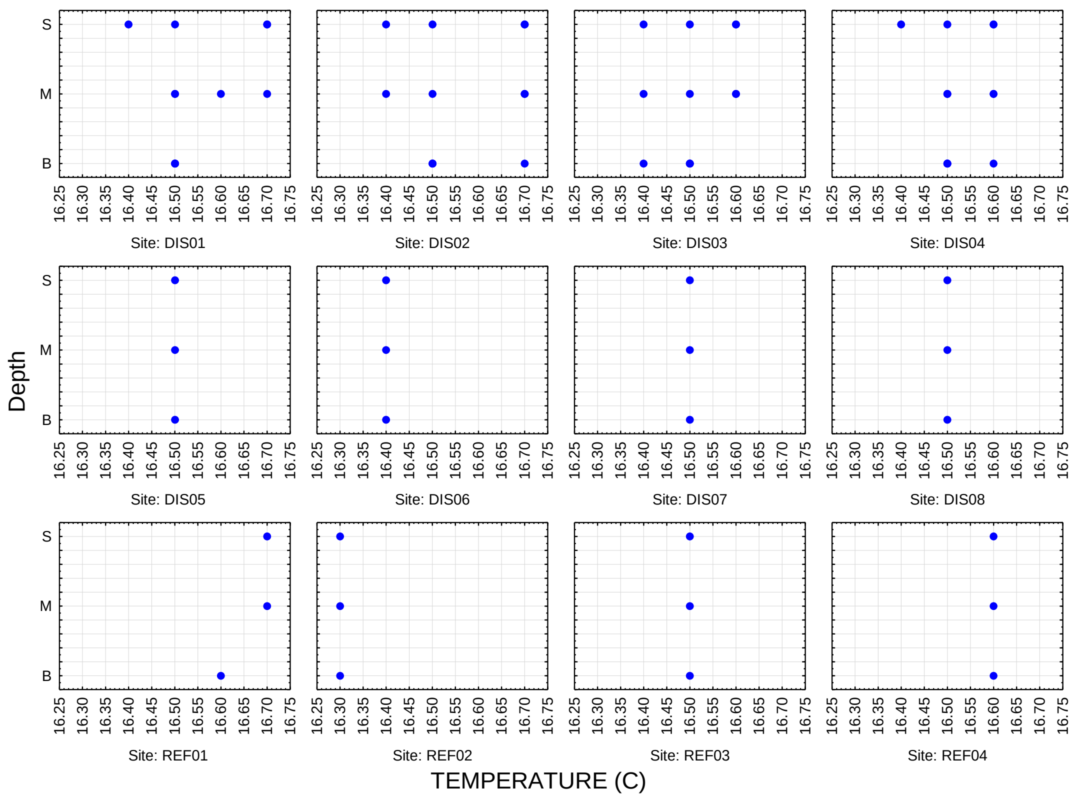




(ii) FIRST DISPOSAL MONITORING CAMPAIGN




Depth
S
M
B
-20%
0%
20%
40%
60%
80%
100%
120%
Site: DIS01
Site: DIS02
Site: DIS03
Site: DIS04
Site: DIS05
Site: DIS06
Site: DIS07
Site: DIS08
Site: REF01
Site: REF02
Site: REF03
Site: REF04
SI(%)


Depth
S
M
B
16.25
16.30
16.35
16.40
16.45
16.50
16.55
16.60
16.65
16.70
16.75
Site: DIS01
Site: DIS02
Site: DIS03
Site: DIS04
Site: DIS05
Site: DIS06
Site: DIS07
Site: DIS08
Site: REF01
Site: REF02
Site: REF03
Site: REF04
TEMPERATURE (C)

11 APPENDIX D – TSS-NTU DATA

Sample ID	Depth Profile	TSS (mg/L)	Turbidity (NTU)
DIS01-S (1)	Surface	1.5	0.72
DIS01-M (1)	Mid	1.7	0.65
DIS01-B (1)	Bottom	2.3	0.97
DIS02-S (1)	Surface	1.8	0.78
DIS02-M (1)	Mid	2.2	0.97
DIS02-B (1)	Bottom	4.9	1.1
DIS03-S (1)	Surface	2.2	0.72
DIS03-M (1)	Mid	1.9	0.83
DIS03-B (1)	Bottom	7.4	9
DIS04-S (1)	Surface	1.9	0.63
DIS04-M (1)	Mid	1.7	0.65
DIS04-B (1)	Bottom	2.8	0.95
DIS01-S (2)	Surface	2.5	0.99
DIS01-M (2)	Mid	2.4	0.93
DIS01-B (2)	Bottom	3.2	1.29
DIS02-S (2)	Surface	1.7	0.9
DIS02-M (2)	Mid	2	0.81
DIS02-B (2)	Bottom	8.5	2.68
DIS03-S (2)	Surface	3.2	1.09
DIS03-M (2)	Mid	2.8	0.99
DIS03-B (2)	Bottom	14	8
DIS04-S (2)	Surface	5.6	1.4
DIS04-M (2)	Mid	2.6	0.99
DIS04-B (2)	Bottom	3.5	1.12
DIS01-S (3)	Surface	1.4	0.55
DIS01-M (3)	Mid	3	0.63
DIS01-B (3)	Bottom	3	1.18

Sample ID	Depth Profile	TSS (mg/L)	Turbidity (NTU)
DIS02-S (3)	Surface	2.3	0.49
DIS02-M (3)	Mid	1.4	0.45
DIS02-B (3)	Bottom	5.7	4.5
DIS03-S (3)	Surface	8.3	0.69
DIS03-M (3)	Mid	2.8	0.8
DIS03-B (3)	Bottom	2.4	3.5
DIS04-S (3)	Surface	2.7	0.8
DIS04-M (3)	Mid	2.6	0.78
DIS04-B (3)	Bottom	2.5	0.73
DIS01-S (4)	Surface	1.9	0.7
DIS01-M (4)	Mid	2.2	0.65
DIS01-B (4)	Bottom	3.4	1.19
DIS02-S (4)	Surface	0.9	0.5
DIS02-M (4)	Mid	2.3	0.52
DIS02-B (4)	Bottom	7.5	2.1
DIS03-S (4)	Surface	2.3	1.2
DIS03-M (4)	Mid	2.4	0.92
DIS03-B (4)	Bottom	8.7	2.28
DIS04-S (4)	Surface	3.5	0.65
DIS04-M (4)	Mid	3.1	0.79
DIS04-B (4)	Bottom	2.7	1.07