

KBMS Casuarina Boat Harbour Phase 1 DSDMP Water Quality Monitoring



2 October 2024

Monitoring Summary Report 4

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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
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
TSHD	Trailer Suction Hopper Dredge
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.

The trailer suction hopper dredge (TSHD), *Modi R*, suspended operations on 10 September 2024 for and estimated two to three weeks. Dredge operations for the CBH Proposal have continued via an excavator and hopper barge.

A survey was undertaken following the requirements of the DSDMP during a 180 m³ spoil disposal event on 01 October 2024.

NTU data was transformed into estimated TSS values using the relationship:

$$\text{TSS} = 1.62 * \text{NTU}$$

The data collected showed no exceedance of either the Trigger 1 (TSS at a near disposal monitoring site >2 mg/L above the average of the reference site data) or Trigger 2 (TSS at a far disposal monitoring site >2 mg/L above the average of the reference site data) criterion at any site.

Other parameters (temperature, conductivity and dissolved oxygen) showed the water column was well mixed.

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. 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 m³ 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.

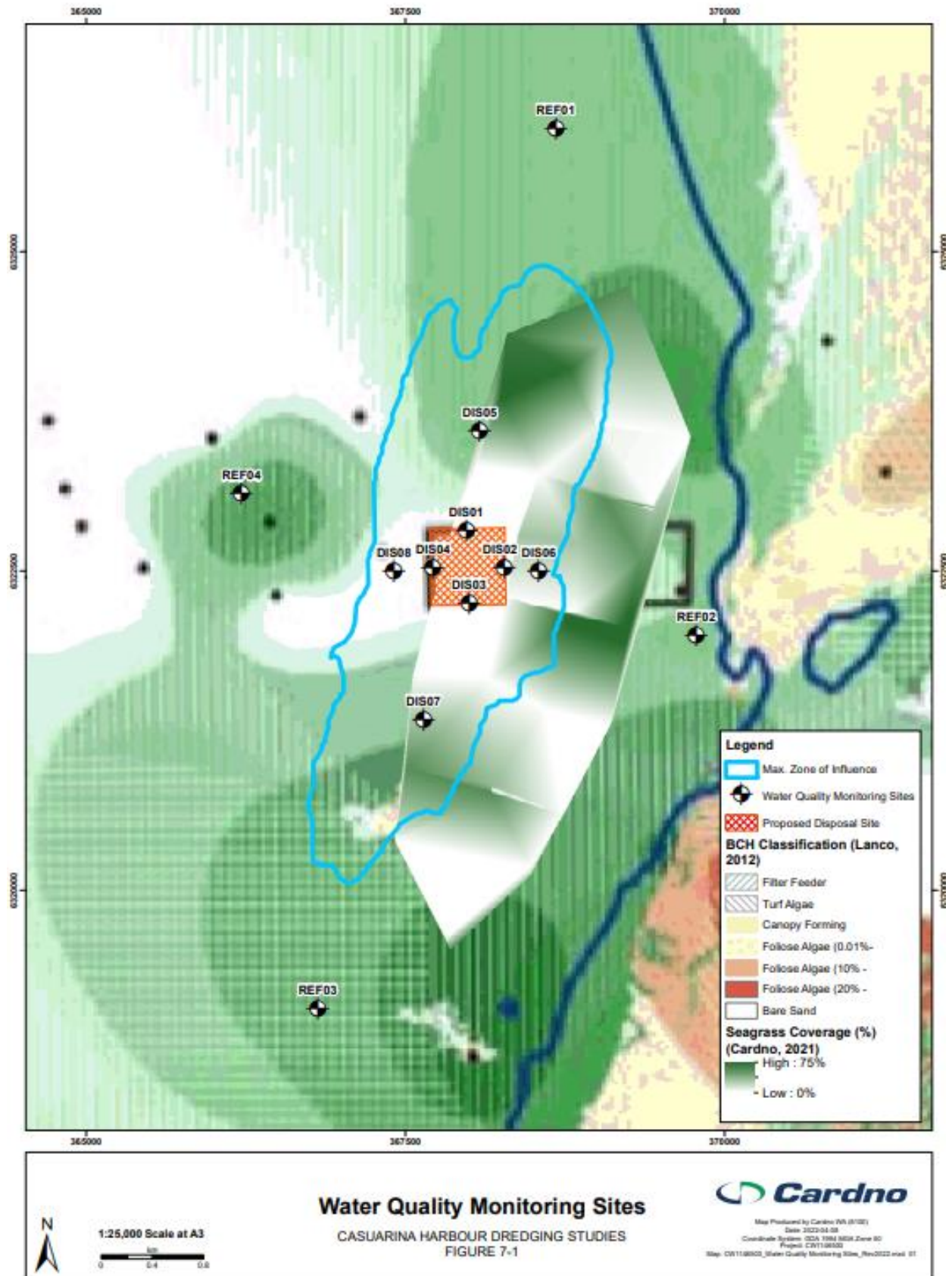


Figure 1-1. DSDMP water quality monitoring locations

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.	<ul style="list-style-type: none"> • 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 <i>Posidonia</i> and <i>Amphibolis</i> 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: <ul style="list-style-type: none"> ○ Dispose in different portion of disposal site; ○ Dispose in certain portions of the site for certain metocean conditions (i.e. 'upstream side'); and ○ Consider additional monitoring campaign to confirm effectiveness of varied placement; and ○ Consider reduction in disposal rate during daylight hours.

1.3 Previous Survey

A summary of the previous disposal monitoring campaign is provided in Table 1-2.

Table 1-2. Previous monitoring campaign summary

Campaign #	Date	Summary
3	20 September 2024	<ul style="list-style-type: none"> No exceedance of TSS triggers.

1.4 Document Purpose

This report provides:

- A summary of the fourth disposal action monitoring campaign data.

In accordance with DSDMP instructions, summary data includes:

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

1.4.1 Structure of this Document

The document lists:

- The background to the Project;
- A summary of the DSDMP;
- The monitoring methodology;
- Summary data for the fourth disposal monitoring campaign; 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, in daylight hours, the hopper barge completed disposal of spoil at 0953 and returned for the next disposal action by 1530. In good weather it takes, on average, 1h30 to complete a full sampling round due to the distance between sites. The five-hour turnaround of the hooper barge returning to the spoil ground (refer to Section 3.1) was such that four sampling rounds could not be completed.

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 with a calibrated YSI ProDSS multiparameter sonde and Licor-192 Underwater Quantum PAR sensor (see Appendix A for YSI calibration sheet).

The water quality monitoring campaign was carried out on 01 October 2024. All parameters were recorded at a surface (0.5 m), mid-water column (total 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 0935, for three complete sampling rounds at all sites.

2.3 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 365TM or Statistica 11 (StatSoft Inc 2011).

NTU data was transformed into estimated TSS values using the relationship:

$$\text{TSS} = 1.62 * \text{NTU}$$

QA/QC of physical water quality profile data included manual checks to remove any erroneous entries. For the current monitoring report, no data was removed.

3 DISPOSAL MONITORING CAMPAIGN DATA SUMMARY

3.1 Dredge Disposal Summary

The trailer suction hopper dredge (TSHD), *Modi R*, suspended operations for the CBH Proposal on 10 September 2024. MScience was advised the TSHD would not be recommencing operations for an estimated two to three weeks. Dredge operations have continued at the Proposal site via an excavator and hopper barge operated by Polaris Marine Group (Polaris).

A summary of the Polaris dredge spoil disposal activities on 01 October 2024 has been provided in Table 3-1. The monitoring campaign commenced immediately after disposal of Load#2 for the day, at 0935hrs.

Table 3-1. Dredge disposal summary for 01 October 2024

Load# for Project	68	69	70	71
Load# for Day	1	2	3	4
Load start time	00:00	04:42	11:09	17:05
Load stop time	02:15	08:45	14:35	20:40
Discharge start time	03:18	09:35	15:30	21:42
Discharge stop time	03:35	09:53	15:44	21:55
Discharge Location	N 33°13.820	33° 13 .789	33° 13 .650	33° 13 .829
	E 115°35.066	115° 35.100	115° 35.089	115° 35.112
Load Discharge Total (m ³)	180	180	180	180
Daily Discharge Total (m ³)	720			
Project Discharge Total (m ³)	Not Provided			

3.2 Metocean Conditions

Weather conditions on 01 October 2024 were fine and clear. Winds were Easterly at 5 - 10 km/h in the morning, swinging North- North-Westerly and increasing to 10 – 20 km/h in the afternoon (Figure 3-1). Seas were 1 – 1.5 m. The tidal range for the day was 0.29 m, with low tides of 0.33 m in the early afternoon and 0.62 m in the early morning and late evening. There was a 0900hrs high tide of 0.62 m.

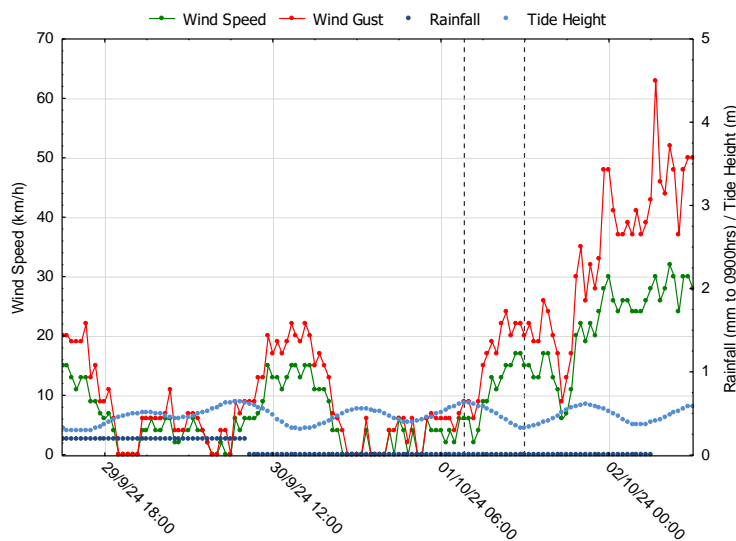


Figure 3-1. Metocean conditions on the day of the disposal monitoring campaign. Vertical dotted lines represent the period when sampling occurred.

3.3 Physical Water Quality

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

3.3.1 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 3-2.

No site reported TSS concentrations >2 mg/L above the average of the reference site data.

Table 3-2. Depth- and time-averaged estimates of TSS (mg/L) for all sites

Near Disposal Sites		Far Disposal Sites		Reference Sites		
Site	TSS (mg/L)	Site	TSS (mg/L)	Site	TSS (mg/L)	Average TSS (mg/L)
DIS-01	1.14	DIS-05	0.22	REF-01	0.33	0.35
DIS-02	0.44	DIS-06	0.49	REF-02	0.49	
DIS-03	0.32	DIS-07	0.22	REF-03	0.31	
DIS-04	0.40	DIS-08	0.25	REF-04	0.28	

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 (Trigger 2).

3.3.2 Turbidity

Mean turbidity was <0.4 NTU at most monitoring sites (Figure 3-2). Site DIS-01 reported the highest mean turbidity at 0.7 NTU. This outcome was a result of a single bottom reading of 3.7 NTU during the first sampling run immediately after the disposal event. Sites DIS-05 and DIS-07 reported the lowest mean turbidity. Most sites showed little variability in NTU through the water column (Appendix C), although turbidity was sometimes slightly higher in bottom samples (generally 0.5 NTU difference between surface and bottom readings).

3.3.3 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. Mean percent surface irradiance (Figure 3-3) was generally consistent across sites with most sites showing a depth-time averaged mean of between 20 to 22%. The highest percent surface irradiance (~22 %) was recorded the near disposal site DIS-02 and DIS-08 and the reference sites REF-02 and REF-04.

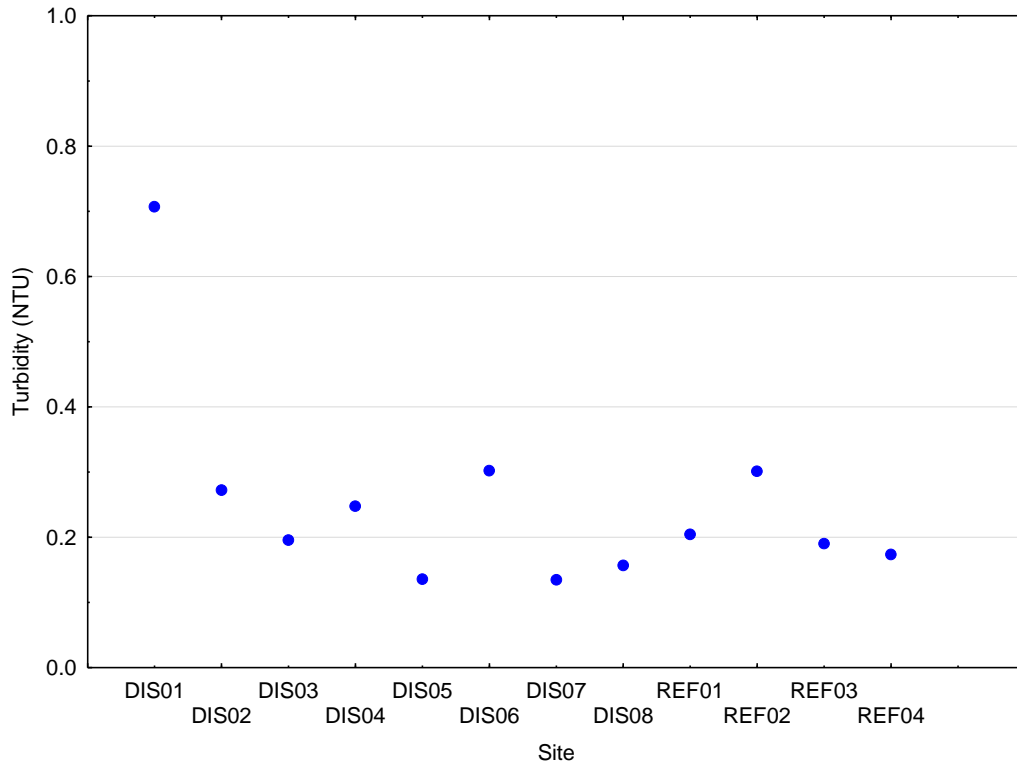


Figure 3-2. Turbidity means (time and depth averaged) at sites in the disposal monitoring campaign.

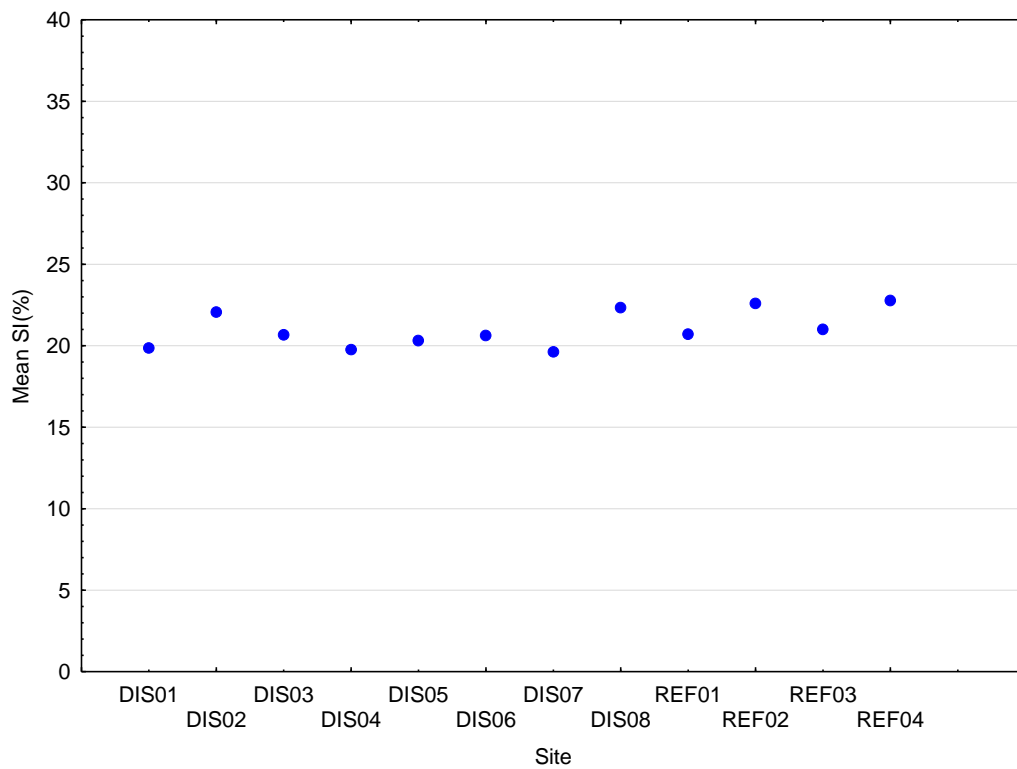


Figure 3-3. Mean percent surface irradiance at sites in the disposal monitoring campaign

3.3.4 Temperature, Conductivity, Dissolved Oxygen

Temperature varied by less than 0.1°C across all sites (Appendix B). Most monitoring sites showed little (0.5°C difference) stratification through the water column (Appendix C). 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, Appendix C) with a negligible difference in dissolved oxygen levels between surface and bottom readings at all sites. Dissolved oxygen saturation was over 100% in all readings.

4 ASSESSMENT OF TRIGGER EXCEEDANCE AND RECOMMENDATIONS

4.1 Exceedance Investigation

Results presented in Section 3.3.1 (Table 3-2) indicate there was no exceedance of the DSDMP Trigger 1 (>2mg/L above reference) at the near disposal monitoring or Trigger 2 (>2mg/L above reference) at the far disposal monitoring sites. As such, no exceedance investigation was required.

4.2 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.

5 REFERENCES

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

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.

6 APPENDIX A – YSI CALIBRATION SHEET

Calibration Report

Multi-Parameter Water Quality Instrument

Customer: M Science

Contact: Matt

Manufacturer: YSI

Instrument: ProDSS

Serial #: 16G103680

Cable length: 30m (16G102376)

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		✓	173.60 mV
pH slope		✓	55 to 60 mV/pH, ideal 59mV 58.7
Response time < 90 seconds		✓	
Calibrated and conforms to manufacturer's specifications		✓	
Conductivity			
Condition		✓	Good, clean
Temperature		✓	°C
Conductivity cell constant 4.5 - 6.5 in GLP file		✓	5.33
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) 0.98
ODO gain in GLP file 100%		✓	(min 0.75 - max 1.50) 0.95
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		Units
						Before	After	
Temperature (23F102023)	Check Temp NATA	Room Temp	17.7	-0.1	°C	NA	17.6	°C
pH (18K105215)	pH 7.00	398528	7.01	-32.50	mV	7.05	7.01	pH
pH (18K105215)	pH 4.00	401033	4.00	141.10	mV	3.87	4.00	pH
Conductivity (23F102023)	2764 µS/cm at 25°C	24/0107	2764	GLP	5.33	2749	2764	µS/cm
Zero Dissolved Oxygen (16G101365)	NaSO3 in distilled water	10175	0.0	0.98	NA	-0.9	0.0	%
100% Dissolved Oxygen (16G101365)	100% Air Saturation	Air	100.0	0.95	uA	104.4	100.0	%
Turbidity (16G103323)	distilled Water	distilled Water	0.00	0	NA	0.15	0.00	NTU
Turbidity (16G103323)	10 NTU	411301	10.00	10	NA	8.69	10.00	NTU
Turbidity (16G103323)	1000 NTU	384011	1000.00	1000	NA	1037	1000.00	NTU

Calibrated by: Gaurav Kanwar

Calibration Date: 29-Sep-24

Next Due: 28-Mar-25

7 APPENDIX B – DETAILED WATER QUALITY STATISTICS BY SITE

Site		Turbidity (NTU)	PAR ($\mu\text{Mol}/\text{m}^2/\text{s}$)	Conductivity (μS)	Temperature ($^{\circ}\text{C}$)	Dissolved Oxygen (%)
DIS-01	N	9	9	9	9	6
	Mean	0.7	344.6	46896	17.2	101.6
	Median	0.3	173.0	46863	17.1	101.5
	Minimum	0.1	7.7	46801	17.1	101.1
	Maximum	3.7	886.0	47120	17.4	102.2
	20th %ile	0.2	60.0	46810	17.1	101.1
	80th %ile	0.8	866.0	47037	17.3	102.0
	Std. Dev	1.1259	366.0461	109.9409	0.1093	0.4590
DIS-02	N	9	9	9	9	6
	Mean	0.3	362.1	46886	17.2	101.7
	Median	0.2	154.0	46831	17.1	101.8
	Minimum	0.1	47.0	46801	17.1	101.0
	Maximum	0.5	906.0	47140	17.5	102.4
	20th %ile	0.1	65.5	46813	17.1	101.3
	80th %ile	0.5	869.0	46998	17.3	102.1
	Std. Dev	0.1632	367.6991	113.2723	0.1394	0.5279
DIS-03	N	9	9	9	9	6
	Mean	0.2	356.5	46910	17.2	101.5
	Median	0.2	216.0	46850	17.1	101.5
	Minimum	0.1	67.8	46823	17.1	101.1
	Maximum	0.5	779.0	47142	17.5	102.0
	20th %ile	0.1	77.0	46825	17.1	101.2
	80th %ile	0.3	773.0	47062	17.3	101.9
	Std. Dev	0.1300	315.4611	116.0980	0.1364	0.3656
DIS-04	N	9	9	9	9	6
	Mean	0.2	334.9	46924	17.2	101.6
	Median	0.2	198.0	46863	17.1	101.5

Site		Turbidity (NTU)	PAR ($\mu\text{Mol}/\text{m}^2/\text{s}$)	Conductivity (μS)	Temperature ($^{\circ}\text{C}$)	Dissolved Oxygen (%)
	Minimum	0.1	64.0	46833	17.1	100.9
	Maximum	0.5	851.0	47230	17.4	102.2
	20th %ile	0.2	69.0	46845	17.1	101.3
	80th %ile	0.4	766.0	47048	17.3	101.9
	Std. Dev	0.1196	310.5883	132.0057	0.1093	0.4593
DIS-05	N	9	9	9	9	6
	Mean	0.1	359.9	46826	17.2	101.7
	Median	0.1	214.0	46800	17.1	101.5
	Minimum	0.0	80.0	46738	17.1	101.1
	Maximum	0.5	892.0	46999	17.4	102.6
	20th %ile	0.1	88.0	46758	17.1	101.2
	80th %ile	0.1	794.0	46905	17.3	102.3
	Std. Dev	0.1447	324.3734	83.0376	0.1118	0.6229
DIS-06	N	9	9	9	9	6
	Mean	0.3	359.3	46914	17.2	101.7
	Median	0.1	212.0	46807	17.1	101.7
	Minimum	0.1	61.0	46754	17.0	100.4
	Maximum	1.1	930.0	47704	17.5	102.4
	20th %ile	0.1	70.6	46760	17.1	101.5
	80th %ile	0.7	802.0	46912	17.3	102.2
	Std. Dev	0.3556	336.7760	301.8435	0.1500	0.7036
DIS-07	N	9	9	9	9	6
	Mean	0.1	349.3	46932	17.2	101.6
	Median	0.1	189.0	46879	17.2	101.8
	Minimum	0.1	73.0	46866	17.1	100.8
	Maximum	0.3	840.0	47139	17.5	101.9
	20th %ile	0.1	83.0	46870	17.1	101.7
	80th %ile	0.2	785.0	47020	17.3	101.8
	Std. Dev	0.0868	313.4083	96.5187	0.1302	0.4070

Site		Turbidity (NTU)	PAR ($\mu\text{Mol}/\text{m}^2/\text{s}$)	Conductivity (μS)	Temperature ($^{\circ}\text{C}$)	Dissolved Oxygen (%)
DIS-08	N	9	9	9	9	6
	Mean	0.2	380.0	46999	17.2	101.8
	Median	0.1	235.0	46928	17.2	101.7
	Minimum	0.1	76.0	46877	17.1	100.9
	Maximum	0.2	937.0	47510	17.6	102.5
	20th %ile	0.1	105.0	46882	17.1	101.6
	80th %ile	0.2	787.0	47043	17.3	102.2
	Std. Dev	0.0585	342.6423	198.9573	0.1509	0.5541
REF-01	N	9	9	9	9	6
	Mean	0.2	371.0	46810	17.1	101.7
	Median	0.2	212.0	46781	17.1	101.5
	Minimum	0.0	85.0	46648	17.0	100.5
	Maximum	0.5	882.0	47320	17.3	103.4
	20th %ile	0.1	87.0	46665	17.0	101.0
	80th %ile	0.3	817.0	46877	17.2	102.2
	Std. Dev	0.1515	332.0264	204.9049	0.1000	1.0424
REF-02	N	9	9	9	9	6
	Mean	0.3	397.6	46811	17.1	101.4
	Median	0.1	213.0	46720	17.1	101.3
	Minimum	0.0	51.0	46639	17.0	100.1
	Maximum	1.4	946.0	47427	17.3	102.9
	20th %ile	0.0	76.0	46665	17.0	100.8
	80th %ile	0.7	882.0	46885	17.2	101.9
	Std. Dev	0.4669	381.9919	245.3758	0.1000	0.9579
REF-03	N	9	9	9	9	6
	Mean	0.2	383.3	46997	17.2	102.1
	Median	0.2	226.0	46888	17.2	102.0
	Minimum	0.1	49.0	46809	17.1	100.8
	Maximum	0.5	935.0	47660	17.5	103.6

Site		Turbidity (NTU)	PAR ($\mu\text{Mol}/\text{m}^2/\text{s}$)	Conductivity (μS)	Temperature ($^{\circ}\text{C}$)	Dissolved Oxygen (%)
	20th %ile	0.1	94.0	46817	17.1	101.7
	80th %ile	0.3	798.0	47140	17.4	102.6
	Std. Dev	0.1279	348.4674	276.5216	0.1481	0.9538
REF-04	N	9	9	9	9	6
	Mean	0.2	380.3	47122	17.3	101.8
	Median	0.2	279.0	47040	17.3	101.9
	Minimum	0.1	110.0	46975	17.2	100.8
	Maximum	0.3	951.0	47734	17.5	102.8
	20th %ile	0.1	111.0	46984	17.2	101.4
	80th %ile	0.3	754.0	47191	17.4	102.2
	Std. Dev	0.1001	301.4482	240.1160	0.1054	0.6882

8 APPENDIX C – VERTICAL PROFILES

