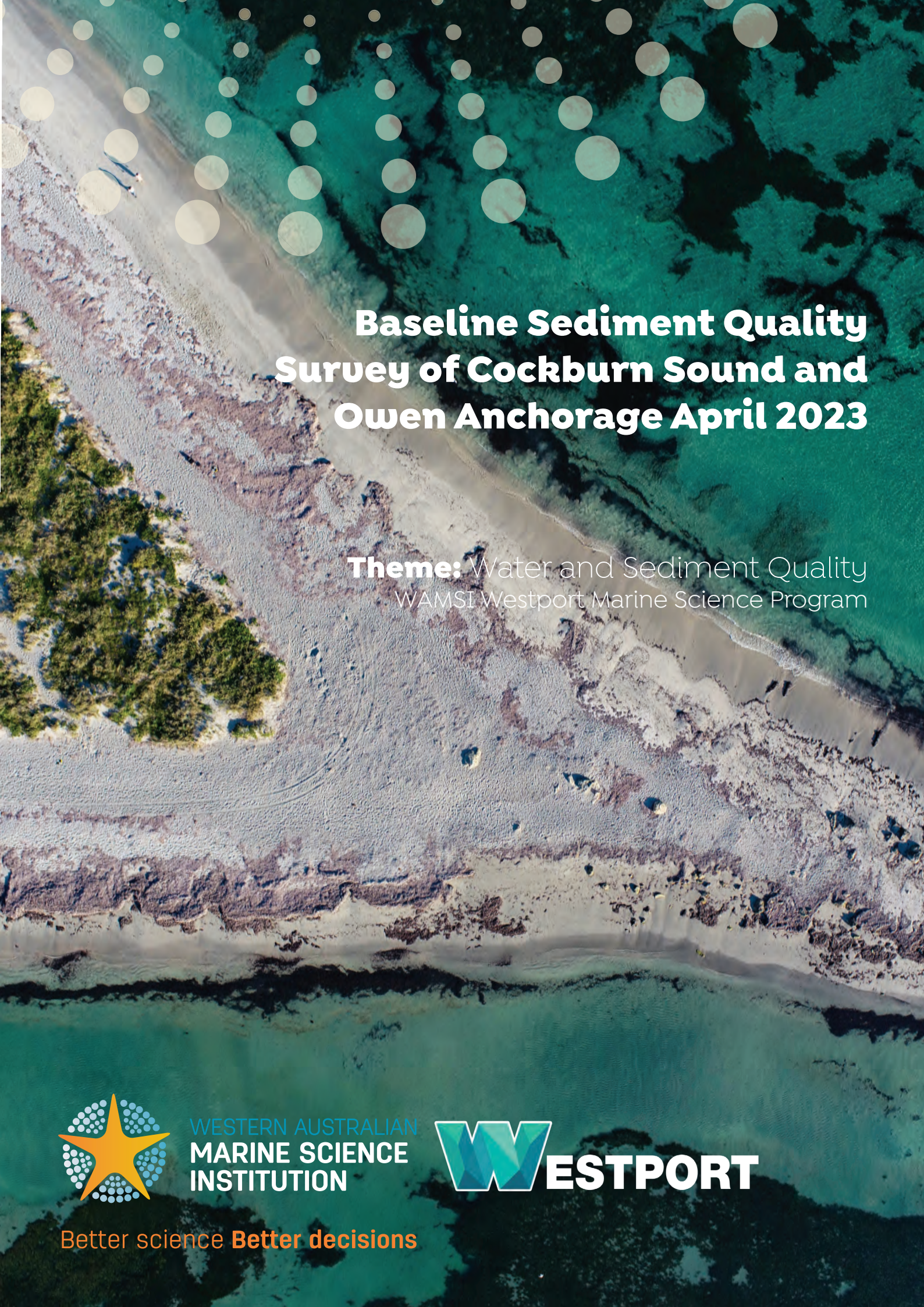

Baseline Sediment Quality Survey of Cockburn Sound and Owen Anchorage April 2023

Theme: Water and Sediment Quality
WAMSI Westport Marine Science Program

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ABOUT THE MARINE SCIENCE PROGRAM

The WAMSI Westport Marine Science Program (WWMSP) is a $13.5 million body of marine research funded by the WA Government. The aims of the WWMSP are to increase knowledge of Cockburn Sound in areas that will inform the environmental impact assessment of the proposed Westport development and help to manage this important and heavily used marine area into the future. Westport is the State Government's program to move container trade from Fremantle to Kwinana, and includes a new container port and associated freight, road and rail, and logistics. The WWMSP comprises more than 30 research projects in the biological, physical and social sciences that are focused on the Cockburn Sound area. They are being delivered by more than 100 scientists from the WAMSI partnership and other organisations.

FUNDING SOURCES
The $13.5 million WAMSI Westport Marine Science Program was funded by the Western Australian Government, Department of Transport. WAMSI partners provided significant in-kind funding to the program to increase the value to >$22 million.

DATA
Finalised datasets will be released as open data, and data and/or metadata will be discoverable through Data WA and the Shared Land Information Platform (SLIP).

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Front cover image: Drone image of Cockburn Sound coastline. Photo courtesy of: Michael Cuttler (The University of Western Australia).

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The WAMSI Westport Marine Science Program is a $13.5 million body of research that is designed to fill knowledge gaps relating to the Cockburn Sound region. It was developed with the objectives of improving the capacity to avoid, mitigate and offset environmental impacts of the proposed Westport container port development and increase the WA Government's ability to manage other pressures acting on Cockburn Sound into the future. Funding for the program has been provided by Westport (through the Department of Transport) and the science projects are being delivered by the Western Australian Marine Science Institution.

1 Baseline Sediment Quality Survey of Cockburn Sound and Owen Anchorage

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Project
Westport Project 3.1: Water and Sediment Quality Monitoring

Date
10 October 2023

Executive Summary

Twenty-two sampling sites were positioned in Owen Anchorage, Cockburn Sound and Warnbro Sound based on the last comprehensive sediment survey conducted in these areas in 2006. Sediment was sampled from these sites over two non-consecutive days on Friday 28 April 2023 and Monday 1 May 2023. The sample collection methods followed the Manual of Standard Operating Procedures for Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (EPA, 2005). Sediment samples were collected for subsequent laboratory analysis of:

- Metals/metalloids (aluminium (Al), antimony (Sb), arsenic (As), boron (B), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), selenium (Se), silver (Ag), vanadium (V) and zinc (Zn))
- Particle size distribution (PSD)
- Total petroleum hydrocarbons (TPHs)
- Polycyclic aromatic hydrocarbons (PAHs)
- Tributyltin (TBT)
- Urea herbicides (diuron)
- Triazine herbicides (Irgarol)
- perfluoroalkyl sulfonic acids (PFAS) – only at sites on the eastern edge of Cockburn Sound (1530, SH, 3210, 4010, KBJ) and inside and outside Careening Bay (C430 and OCB)

Total organic carbon was also analysed to normalise PAH, TBT and herbicide values.

Data was compared against EPA (2017) environmental quality guidelines (EQG). Specifically, the median total concentration of a contaminant in sediment (dry weight) from a single site or a defined sampling area should not exceed the environmental quality guideline value for high, moderate, and low ecological protection areas (test against EQG A). In addition, the total concentration of a contaminant at individual sample sites should not exceed the environmental quality guideline re-sampling trigger (EQG B).

For all protection areas in Cockburn Sound, Owen Anchorage and Warnbro Sound, the median concentration for each contaminant (metals/metalloids, hydrocarbons (TPH and PAH), tributyltin, herbicides (diuron and irgarol) and PFAS) did not exceed the EQG A, and individual sites total contaminant concentrations did not exceed the EQG B. In fact, individual sites concentrations did not exceed the lower EQG A value for any contaminant (where there were EQG values available).

2 Introduction

Cockburn Sound is a semi-enclosed marine embayment located approximately 30 km south of Perth in Western Australia. Industrial development commenced with the establishment of an oil refinery at James Point in 1955 and by 1978, a wide range of industries had been established, among them; blast furnaces, fertiliser manufacturers, iron, steel, alumina and nickel refineries, a grain export terminal, a power station and a number of tanneries. Industrial growth also led to the construction of wharves, breakwaters and the implementation of shipping channel dredging. Between 1973 and 1976, a causeway was erected from the mainland to Garden Island to accommodate a naval base. The Woodman Point Wastewater Treatment Plant was commissioned in the 1960's and between 1966 and 1984, primary treated effluent was discharged into Cockburn Sound through an outlet 1.85 km from the end of Woodman Point.

Increased environmental concerns following nutrient enrichment and a massive dieback of seagrass in Cockburn Sound, led to a number of environmental studies in the 1970's and later during the 1990's. Now there is a summer water quality monitoring program which has continued for over 30 years. During the late 1970's, it was shown that eutrophication within Cockburn Sound was responsible for the large majority of the reduction in seagrass meadows (Chiffings, 1979). At the time, annual nutrient loads from industrial and domestic waste were estimated to be over 2000 tonnes of nitrogen and 1350 tonnes of phosphorus (DEP, 1996). The diversion of the Woodman Point wastewater outfall and improvements in industrial waste treatment resulted in annual discharges falling to 490 tonnes of nitrogen and 55 tonnes of phosphorus by 1994 (DEP, 1996). Two additional sources of nutrients and contaminants have since been studied in Cockburn Sound; contaminated groundwater discharges (Appleyard, 1994) and sediment nutrient release (Bastyan *et al*., 1994). By 2000, annual discharge into the Sound was estimated to be approximately 300 tonnes of nitrogen, the primary sources being groundwater (200 tonnes) and industrial discharge (55 tonnes; DAL, 2001). Since 2000, sub-marine groundwater discharges (SGD) have been further studied with similar estimates (234 ± 88 tonnes) (Smith *et al*., 2003; Loveless and Oldham, 2008). In October 2005, the large fertiliser manufacturer CSBP also diverted their discharge away from Cockburn Sound into the Sepia Depression Ocean Outlet Line (SDOOL). Water quality monitoring has indicated that nutrient concentrations in the Sound have decreased significantly since the late 1970's. There have also been marked improvements in light attenuation and chlorophyll *a* concentrations (Hale *et al*., 1998). Whilst earlier reports into seagrass health and recovery within Cockburn Sound (Kendrick *et al*., 2002) showed no significant improvements, a recent report indicated that the total seagrass cover within Cockburn Sound has increased by 244 ha between 1999 and 2017 (Hovey and Fraser, 2017).

Since 2007, a new range of industries has been established in Cockburn Sound including the Perth Seawater Desalination Plant located north of James Point. There are also approved plans to build a marina with boating facilities as part of the Port Rockingham Marina project at Wanliss Street. In more recent years there has been increased shipping and construction activities around the Australian Marine Complex (AMC) located in the Jervoise Bay area, and particular to this report the proposed Westport Project which seeks to relocate the Port of Fremantle's facilities into Cockburn Sound. Westport is a large-scale project with potential long-term consequences for the water quality and benthic habitat in Cockburn Sound.

The specific objectives of the 2023 sediment quality monitoring program were to:

- Establish a sediment quality baseline dataset.
- Providing updated sediment baseline data useful for understanding the current state of Cockburn Sound.

3 Materials and Methods

3.1 Sediment Sampling Sites

Twenty-two sampling sites were positioned in Owen Anchorage, Cockburn Sound and Warnbro Sound based on the last comprehensive sediment survey conducted in these areas in 2006 (Department of Water, 2006). Six sites were located in Owen Anchorage, with the original site 1310 being moved close to the Old Ammunition Jetty (and renamed AJ) and site OA11 being moved to the northwest to accommodate the Port Coogee development. Fourteen sites were located in Cockburn Sound, the original thirteen sites from 2006 with an additional site (G3) added and two original sites in Warnbro Sound (Figure 1 and Table 1).

3.2 Timing

Sampling was undertaken over two non-consecutive days on Friday 28 April 2023 and Monday 1 May 2023.

3.3 Sample Collection

The sample collection methods outlined in this section follow the Manual of Standard Operating Procedures for Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (EPA, 2005). Surface sediment samples were collected by SCUBA divers using polycarbonate cores (9.4 cm internal diameter x 15 cm depth) situated within a 1 x 1 metre quadrat with the configuration of one core taken in each of the corners and one in the centre of the quadrat (five cores in total). This was repeated for a second quadrat, to enable enough sediment to complete all analyses and processing of organics and metals which require different methods.

3.4 Sample Processing, Preservation and Storage

Upon return to the surface, cores were photographed and the sediment described in terms of colour, size estimation, sorting and presence of flora and/or fauna (see Appendix 2). For metals/metalloids and particle size distribution the top 2 cm of sediment was removed from each core with a plastic spoon and placed in a glass bowl for mixing. Once homogenised, sub-samples were placed in the appropriate containers supplied by the laboratory and placed in Esky's on ice. Once back at the laboratory the containers were frozen until ready for analysis. For metal/metalloid analysis samples were freeze dried, sieved (< 2 mm) and ground to a fine powder before chemical analysis. For the hydrocarbons (total petroleum hydrocarbons and polycyclic aromatic hydrocarbons) the sediment was collected with a stainless-steel spoon and directly placed in the laboratory supplied glass containers. For the remainder of the organics (tributyltin, herbicides/pesticides, total organic carbon and perfluoroalkyl sulfonic acids) the top 2 cm of sediment was removed with a stainless-steel spoon and placed into a glass bowl for homogenization, then sub-sampled into appropriate containers as supplied by laboratories and placed in esky's on ice before delivery to the appropriate laboratories for analysis. Additional handling and processing requirements applied to PFAS were considered (HEPA 2020).

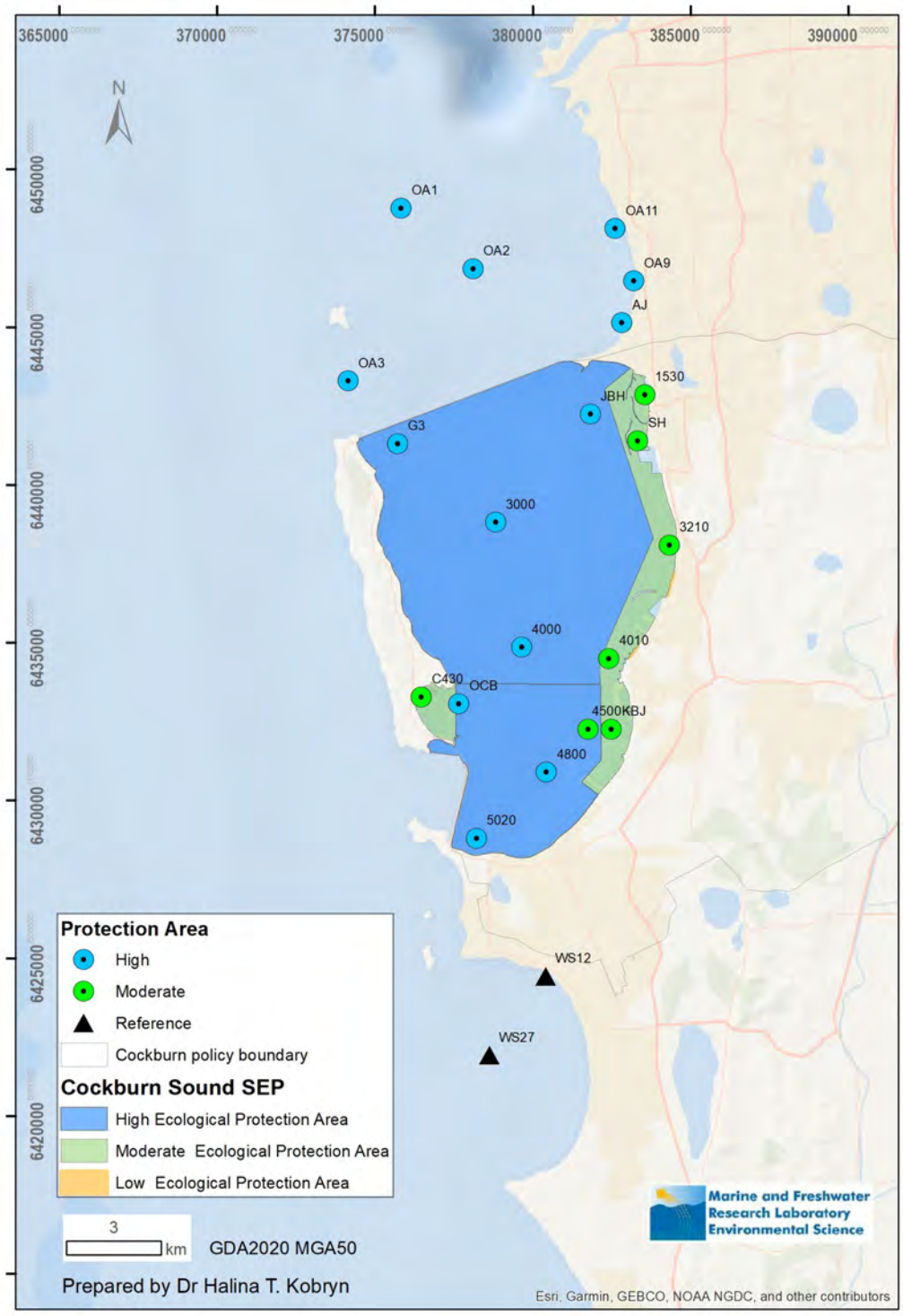

Figure 1. Locations of sediment quality sampling sites in Owen Anchorage, Cockburn and Warnbro Sounds.

Table 1. Sediment quality sites, GPS locations (GDA2020 MGA Zone 50), protection area designation and depth.

Site name	Site location	Protection Area	Depth (m)	Easting	Northing
OA1	Owen Anchorage	High	6.5	375836	6448785
OA2	Owen Anchorage	High	16.6	378117	6446866
OA3	Owen Anchorage	High	11.7	374151	6443307
OA9	Owen Anchorage	High	4.1	383210	6446474
AJ	Owen Anchorage	High	9.0	382832	6445148
OA11	Owen Anchorage	High	6.5	382618	6448135
1530	Jervoise Bay Marina, Cockburn Sound	Moderate	9.4	383556	6442871
SH	Southern Harbour, Cockburn Sound	Moderate	12.9	383334	6441409
JBH	Jervoise Bay, Cockburn Sound	High	10.2	381830	6442256
3000	Cockburn Sound, north basin	High	20.6	378828	6438824
3210	Alcoa Jetty, Cockburn Sound	Moderate	12.0	384334	6438093
4000	Cockburn Sound, central basin	High	21	379655	6434861
4010	James Pt, Cockburn Sound	Moderate	3.6	382420	6434506
4500	Cockburn Sound, off CBH Jetty	Moderate	17.5	381759	6432262
KBJ	Kwinana Bulk Jetty, Cockburn Sound	Moderate	16.4	382495	6432259
4800	Cockburn Sound, southern basin	High	19.9	380440	6430897
5020	Mangles Bay, Cockburn Sound	High	3.3	378226	6428801
C430	Careening Bay, Cockburn Sound	Moderate	10.1	376472	6433284
OCB	Outside Careening Bay, Cockburn Sound	High	17.4	377668	6433067
G3	Garden Is. north	High	13.1	375728	6441317
WS12	Warnbro Sound shallow	Reference	4	380419	6424429
WS27	Warnbro Sound basin	Reference	19.1	378637	6421922

3.5 Chemical Parameters

Sediment samples were collected at the locations described above for subsequent laboratory analysis of:

- Metals/metalloids (aluminium (Al), antimony (Sb), arsenic (As), boron (B), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), selenium (Se), silver (Ag), vanadium (V) and zinc (Zn))
- Particle size distribution (PSD)
- Total petroleum hydrocarbons (TPHs)
- Polycyclic aromatic hydrocarbons (PAHs)
- Tributyltin (TBT)
- Urea herbicides (diuron)
- Triazine herbicides (Irgarol)
- perfluoroalkyl sulfonic acids (PFAS) – only at sites on the eastern edge of Cockburn Sound (1530, SH, 3210, 4010, KBJ) and inside and outside Careening Bay (C430 and OCB)

Total organic carbon was also analysed to normalise PAH, TBT and herbicide values. See Table 2 for chemicals analysed, their holding times and the laboratories that conducted the analyses.

Table 2. Analytical limits of reporting (LOR), guideline values and sample storage, preservation and holding times.

Test parameter	EQG A[1]	EQG B[1]	LOR	Storage container	Preservation	Primary Laboratory	Secondary Laboratory	Holding
Aluminium (mg/kg)	No value	No value	<10	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Antimony (mg/kg)	2	25	<0.2	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Arsenic (mg/kg)	20	70	<0.1	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Boron (mg/kg)	No value	No value	<1	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Cadmium (mg/kg)	1.5	10	<0.02	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Chromium (mg/kg)	80	370	<0.2	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Cobalt (mg/kg)	No value	No value	<0.1	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Copper (mg/kg)	65	270	<0.2	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Lead (mg/kg)	50	220	<0.1	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Manganese (mg/kg)	No value	No value	<0.2	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Mercury (mg/kg)	0.15	1	<0.01	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Molybdenum (mg/kg)	No value	No value	<0.1	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Nickel (mg/kg)	21	52	<0.2	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Selenium (mg/kg)	No value	No value	<0.1	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Silver (mg/kg)	1	3.7	<0.02	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Vanadium (mg/kg)	No value	No value	<0.2	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Zinc (mg/kg)	200	410	<0.5	70 mL PP jar	Freeze	MAFRL	NMI	28 days
Particle size	N/A	N/A	N/A	Ziplock bag	Freeze	MAFRL	-	5 years
TPH (C_6–C_{36}) (mg/kg)[2]	280	550	<3 - 5	Glass jars	Chill	ALS	NMI	14 days
Total PAHs (µg/kg)[3]	4,000	45,000	<4 - 5	Glass jars	Chill	ALS	NMI	14 days
Tributyltin (µgSn/kg)[3]	5	70	<0.5	Glass jars	Chill	ALS	NMI	14 days
Herbicides (mg/kg)[3]	No value	No value	<0.001	Glass jars	Chill	ALS	Envirolab	14 days
PFAS (mg/kg)	No value	No value	<0.0002-0.0005	HDPE jar	Chill	ALS	NMI	6 months
Total organic carbon (%)	N/A	N/A	<0.2	70 mL PP jar	Freeze	MAFRL	NMI	14 days

[1] Environmental quality criteria reference document for Cockburn Sound (EPA 2017)
[2] ANZG (2018) default guideline value
[3] Normalised to 1% organic carbon

3.6 Field Quality Control Procedures

To test for potential sample contamination during collection, storage or transport, and to examine precision of analyses, the following quality control regime was undertaken:

- 2 x triplicates (3 separate samples taken from the same site)
- 2 x laboratory split (one sample split into two)
- 1 x transport blank
- 1 x field blank

The QA/QC measurement performance criteria and the number of QA/QC samples collected during this survey is summarised in Table 3. A summary of the assessment of all field and laboratory data quality procedures and indicators is provided in Section 4.1.

Table 3. Measurement performance criteria and summary of QA/QC samples collected.

Type	Data Quality Indicators	Frequency	Number of samples collected	Performance Criteria
Transport blank	Accuracy Bias Contamination during transport	One transport blank for sediments	One	No analytes detected > ½ limit of reporting (LOR) or > 1/10 sample concentration, whichever is greater
Field blank	Accuracy Bias Contamination during sampling process	One field blank for sediment	One	No analytes detected > ½ limit of reporting (LOR) or > 1/10 sample concentration, whichever is greater
Field triplicate	Variation	One field triplicate for each analysis per 10 sediment sampling locations	Two	Relative standard deviations (RSD) < 50%
Laboratory split	Laboratory precision	One laboratory split for each analysis per 10 sediment sampling locations	Two	Relative percent difference (RPD) < 35%

Procedural and record-keeping quality control measures implemented were:

- GPS waypoints were recorded for all sampling sites.
- Water depths, times, dates, samples collected and in situ observations were also recorded onto field sheets (Appendix 2).
- Photographs were taken of sediment samples collected.
- Appropriate chain of custody forms to accompany samples were completed for each laboratory.
- Any changes to the field procedures were documented.

3.7 Data Analysis

EPA (2017) recommends comparison of data against environmental quality guidelines (EQG). Specifically, the median total concentration of a contaminant in sediment (dry weight) from a single site or a defined sampling area should not exceed the environmental quality guideline value for high, moderate, and low ecological protection areas (test against EQG A). In addition, the total concentration of a contaminant at individual sample sites should not exceed the environmental quality guideline re-sampling trigger (EQG B). For the protection areas, the sites assigned to specific protection areas generally followed the Department of Water (DoW) (2006) report and included:

- Owen Anchorage sites were assigned to a high protection area and included OA1, OA2, OA3, OA9, AJ and OA11.
- Cockburn Sound high protection area separated into northern and southern areas and included sites JBH, 3000, 4000, and G3 in the northern HPA and sites 4800, 5020 and OCB in the southern HPA.
- Cockburn Sound moderate protection area included sites 3210, 4010, C430, KBJ and 4500.
- Marinas and harbours in the Cockburn Sound moderate protection area considered separately and consisted of sites 1530 and SH.
- Warnbro Sound high protection area included sites WS12 and WS27.

Organic contaminants (PAH, TBT herbicides/pesticides) were normalised to 1% organic carbon before being assessed against EQGs, however, for contaminants below the laboratory limit of reporting (LOR) the LOR was used in calculations against the EQG. The median of each contaminant from each of the protection areas defined above were compared to the EQG A and also each contaminant concentration from an individual site was compared against the EQG B.

4 Results

4.1 Quality Control Assessment

The samples reached the laboratories within their required holding times (see Table 2 and Appendix 1). The ALS laboratory recorded spike recoveries slightly less than the lower control limit and data quality objectives for the TPH/BTEX surrogates, therefore the result of this compound may have been measured in slight lower concentrations than were actually present. The quality control undertaken by each laboratory is provided in Appendix 1.

The field and transport blank results showed no contamination due to the sampling process or the transport and storage of samples; all results were below the laboratory limits of reporting or results at least an order of magnitude lower than that analysed in the reference site samples (Appendix 1), the exceptions to this were aluminium, nickel and copper. However, these were contaminants of the acid washed sand already present and not due to the sampling process.

For the triplicates the performance criterion was that the relative standard deviations of the three separate sample results was less than 50%, which was achieved for everything except for PAH for one of the samples, however, the laboratory re-ran the triplicate samples and received the same results, therefor the difference were considered to be field variability (Table 4). For the split between laboratories the performance criterion was that the relative percentage differences were less than 35%, this was achieved for all metal/metalloids except for copper and molybdenum and only for one out of the two splits for both metals. TBT and PAH also exceed the criteria for one of the samples but due to variability of TBT in sediment samples in general and because PAH samples are not homogenised in the field, difference in results between laboratories was not considered to be due to laboratory analytical differences.

The field sheet in Appendix 2 notes field conditions (weather), sampling locations, sampling containers and handling and storage methods, sediment description, date and time of sampling, and identity of samplers.

Table 4. RSD and RPD for between and within laboratory analysis.

QA/QC	Split	Split	Triplicate	Triplicate
Analyte	Site JBH (RPD %)	KBJ (RPD %)	Site G3 (RSD %)	Site AJ (RSD %)
Aluminium	33	21	6	0
Antimony	<LOR	<LOR	<LOR	<LOR
Arsenic	15	14	3	2
Boron	15	0	26	4
Cadmium	<LOR	14	0	0
Chromium	31	19	3	3
Cobalt	<LOR	22	<LOR	0
Copper	13	**56**	7	5
Lead	14	13	8	7
Manganese	21	11	3	0
Mercury	<LOR	<LOR	0	35
Molybdenum	**160**	34	48	0
Nickel	19	12	6	3
Selenium	22	5	0	0
Silver	<LOR	<LOR	<LOR	0
Vanadium	23	16	16	1.5
Zinc	2	0	8	1.6
TPH (C10- C36 sum)	<LOR	<LOR	1.6	8
PAH (sum)	<LOR	**100**	**82**	<LOR
TBT	<LOR	**130**	<LOR	<LOR
Diuron	<LOR	<LOR	<LOR	<LOR
Irgarol	<LOR	<LOR	<LOR	<LOR
PFAS	No sample	<LOR	No sample	No sample

NOTES:
<LOR - indicates concentrations were below the LOR and therefore RPD/RSD was not calculated.
Numbers in bold indicate the RPD was greater than the performance criterion.

4.2 Metals/metalloids

For all protection areas the median concentration for each of the metals and metalloids did not exceed the EQG A and individual sites metal and metalloid concentrations did not exceed the EQG B, in fact individual sites concentrations did not exceed the lower EQG A value either, where there was an EQG value (Table 5, Table 7, Table 9 and Table 11). Metals/metalloids with no EQG values included aluminium, boron, cobalt, manganese, molybdenum, selenium and vanadium.

Aluminium ranged from 220 mg/kg at site OA1 situated in the northern section of Owen Anchorage to 7400 mg/kg at site 4800 the deepest site in the southern section of Cockburn Sound. When examining the particle size distribution, the sites with the highest concentrations of aluminium were generally the deeper Cockburn Sound sites with the highest silt and clay fractions (4000, 4800, 4500, KBJ and OCB, see Figure 2, Figure 3, Figure 4 and Figure 5).

Boron ranged from 21 mg/kg at site 4010 at James Point to 91 mg/kg at site 4800, other sites with higher boron concentrations were C430 in Careening Bay and OCB outside of Careening Bay.

Cobalt was below the laboratory LOR (<0.1 mg/kg) at a number of sites to 1.0 mg/kg at 4800. Similar to aluminium, the sites with the highest cobalt concentrations were 4000, 4800, 4500, KBJ and OCB.

Manganese ranged from 6.9 mg/kg at site OA11 to 22 mg/kg at site SH in the Southern Harbour. Sites 4000, 4500, 4800 and OCB also had higher manganese concentrations.

Molybdenum ranged from 0.1 mg/kg at sites WS12 in Warnbro Sound and OA3 and OA11 in Owen Anchorage to 1.7 mg/kg at site G3.

Selenium ranged from 0.1 mg/kg at the Owen Anchorage sites of OA1, OA3 and OA11, site 4010 at James Point and WS12 in Warnbro Sound to 0.6 mg/kg at sites KBJ, 4800, C430 and OCB.

Vanadium ranged from 1.6 mg/kg at OA11 to 14 mg/kg at site 4800. Other sites with higher vanadium concentrations included 4000, 4500, C430 and OCB in Cockburn Sound and WS27 in Warnbro Sound.

Generally, the lowest concentrations of sediment metals/metalloids occurred at sites OA1, OA3 and OA11, 4010 at James Point, G3 at the top of Garden Island and WS12. These sites had a low percentage of silt and clay (< 6%; Figure 2, Figure 3, Figure 4 and Figure 5). While the sites with the highest concentrations of sediment metals/metalloids occurred at sites 4000, 4800, 4500, and OCB. These sites had the highest percentage of silt and clay (> 70%; Figure 2, Figure 3, Figure 4 and Figure 5). In addition, site C430 in Careening Bay had the highest concentrations of copper (51 mg/kg), lead (18 mg/kg) and mercury (0.1 mg/kg) compared to other sites, while site KBJ had the highest concentration of cadmium (1.1 mg/kg) and zinc (34 mg/kg). The concentrations of metals at KBJ and C430 were similar to the sediment toxicant survey in 2006 (Department of Water, 2006) in which the highest concentration of cadmium and zinc occurred at KBJ and the highest concentrations of copper and lead occurred at C430, the only difference was that mercury exceed the EQG A in the sediments at site KBJ.

4.3 Hydrocarbons

Most sites had total petroleum hydrocarbons (sum C5-C36) below the laboratory LOR and all sites were well below the ANZG (2018) default guideline value of 280 mg/kg (Table 5, Table 7, Table 9 and Table 11). The highest sediment TPH occurred at site WS12 in the Warnbro Sound shallows. The high carbon chain fractions C15-C28 (40 mg/kg) and C29-C23 (15 mg/kg) were detectable.

For all protection areas the median concentration for total polycyclic aromatic hydrocarbons (PAH) did not exceed the EQG A and individual sites total PAH concentrations did not exceed the EQG B, in fact individual sites concentrations did not exceed the lower EQG A value either (Table 5, Table 7, Table 9 and Table 11). In addition, for individual low molecular weight hydrocarbons and high molecular weight hydrocarbons, were below the EQG values (Table 6, Table 8, Table 10 and Table 12). PAHs were detectable at the following sites:

- Low molecular weight phenanthrene at sites AJ, C340 and KBJ.
- Low molecular weight anthracene at sites AJ and C340.
- Low molecular weight acenaphthylene at site AJ.
- Low molecular weight naphthalene at site WS12.
- High molecular weight fluoranthene and pyrene, at sites SH, 4000, 4800, 5020, OCB, 3210, 4500, AJ, C340 and KBJ.
- High molecular weight benzo(a)anthracene, benzo(a)pyrene and chrysene at sites AJ, C430 and KBJ.

4.4 Tributyltin

For all protection areas the median concentration for tributyltin (TBT) did not exceed the EQG A and individual sites TBT concentrations did not exceed the EQG B, in fact individual sites concentrations did not exceed the lower EQG A value either (Table 5, Table 7, Table 9 and Table 11). Detectable TBT in sediments only occurred at sites 1530, SH, KBJ and C430 and ranged from 1.3 µgSn/kg at site SH to 3.4 µgSn/kg at site KBJ after normalisation. In the 2006 survey (Department of Water; 2006), TBT concentrations were detectable at sites 1530 (Northern Harbour), KBJ (Kwinana Bulk Jetty) and C430 (Careening Bay) and TBT in the sediment at C430 exceeded the EQG A and the EQS (% of imposex). Results were not normalised.

4.5 Herbicides

The targeted herbicides, diuron and irgarol, were below the laboratory LOR of <0.001 mg/kg at all sites. There are no EQG values for these herbicides in sediment. These herbicides were not sampled for in the Department of Water (2006) survey but another survey by the Department of Water (2008) examined diuron and irgarol in sediment from sites in northern and southern harbours and Careening Bay amongst others. In the 2008 survey Igarol 1051 and diuron were below the reporting limits (0.005 mg/kg) at Careening Bay and Austal Ship (Northern Harbour) but detectable at Tenix Marine (Southern Harbour) at 0.01 and 0.014 mg/kg for irgarol and 0.0454 and 0.058 for diruon.

4.6 Perfluoroalkyl Sulfonic Acids

Perfluoroalkyl sulphonic acids (PFAS) was measured in the sediments of a selected number of sites on the Cockburn Sound eastern shoreline (1530, SH, 3210, 4010 and KBJ) and OCB and C430 in and around Careening Bay. Sum of PFAS in sediment all sites were below the laboratory LOR of <0.0002 mg/kg. In addition, the sum of PFHxS and PFOS were also below laboratory LORs at all sites. There are no EQG values for PFAS in sediment.

Table 5. Contaminant concentrations in sediments from Owen Anchorage.

Contaminant	Units	Guideline value		Owen Anchorage high protection area						
		EQG A	EQG B	OA1	OA2	OA3	OA9	AJ*	OA11	Median
Aluminium	mg/kg	No value	No value	220	1500	300	650	1500	440	545
Antimony	mg/kg	2	25	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
Arsenic	mg/kg	20	70	3.6	2.5	5.6	1.6	2.4	1.2	2.5
Boron	mg/kg	No value	No value	31	55	27	32	65	27	31.5
Cadmium	mg/kg	1.5	10	0.09	0.06	0.08	0.05	0.06	0.03	0.06
Chromium	mg/kg	80	370	16	14	17	12	16	6.6	15
Cobalt	mg/kg	No value	No value	<0.1	0.2	<0.1	0.1	0.2	<0.1	0.1
Copper	mg/kg	65	270	0.2	1.8	0.3	1.1	3.5	1.2	1.2
Lead	mg/kg	50	220	0.8	3.1	1	2.9	4.4	2.5	2.7
Manganese	mg/kg	No value	No value	17	14	19	11	12	6.9	13
Mercury	mg/kg	0.15	1	<0.01	0.01	<0.01	<0.01	0.02	<0.01	0.01
Molybdenum	mg/kg	No value	No value	0.2	0.4	0.1	0.3	0.6	0.1	0.3
Nickel	mg/kg	21	52	0.5	1.6	0.6	1.5	1.9	0.7	1.1
Selenium	mg/kg	No value	No value	0.1	0.2	0.1	0.2	0.4	0.1	0.15
Silver	mg/kg	1	3.7	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02
Vanadium	mg/kg	No value	No value	3.1	5	7	2.7	8.1	1.6	4.1
Zinc	mg/kg	200	410	0.8	5	1.1	3.4	8.1	3.1	3.3
TPH (sum C6-C36)	mg/kg	280†	550†	<14	<14	<14	<14	17	16	14
Total PAH#	µg/kg	4000	45,000	<83	<83	<83	<83	502	<83	83
TBT#	µgSn/kg	5	70	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Diuron#	mg/kg	No value	No value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Ingarol#	mg/kg	No value	No value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001

* Three separate samples were taken at site AJ, the highest concentration of the three was used in the comparisons

Values were normalized if the value was above the LOR

† ANZG (2018) default guideline value

Table 6. Individual concentrations of polycyclic aromatic hydrocarbons in sediments from Owen Anchorage.

Contaminant	Units	Guideline value		Owen Anchorage high protection area						
		EQG A	EQG B	OA1	OA2	OA3	OA9	AJ*	OA11	Median
Acenaphthene	µg/kg	16	500	<4	<4	<4	<4	<4	<4	4
Acenaphthylene	µg/kg	44	640	<4	<4	<4	<4	6	<4	4
Anthracene	µg/kg	85	1100	<4	<4	<4	<4	16	<4	4
Fluorene	µg/kg	19	540	<4	<4	<4	<4	<4	<4	4
Naphthalene	µg/kg	160	2100	<5	<5	<5	<5	<6	<5	5
Phenanthrene	µg/kg	240	1500	<4	<4	<4	<4	52	<4	4
Low molecular weight PAH	µg/kg	552	3160	<25	<25	<25	<25	88	<25	25
Benzo(a)anthracene	µg/kg	261	1600	<4	<4	<4	<4	31	<4	4
Benzo(a)pyrene	µg/kg	430	1600	<4	<4	<4	<4	32	<4	4
Dibenzo(a,h)anthracene	µg/kg	63	260	<4	<4	<4	<4	<4	<4	4
Chrysene	µg/kg	384	280	<4	<4	<4	<4	39	<4	4
Fluoranthene	µg/kg	600	5100	<4	<4	<4	<4	96	<4	4
Pyrene	µg/kg	665	2600	<4	<4	<4	<4	88	<4	4
High molecular weight PAH	µg/kg	1700	9600	<24	<24	<24	<24	290	<24	24

* Three separate samples were taken at site AJ, the highest concentration of the three was used in the comparisons

Values were normalized if the value was above the LOR

Table 7. Contaminant concentrations in sediments from Cockburn Sound high protection area.

Contaminant	Units	Guideline value		Cockburn Sound high protection area - north					Cockburn Sound high protection area - south			
		EQG A	EQG B	JBH	3000	4000	G3*	Median	4800	5020	OCB	Median
Aluminium	mg/kg	No value	No value	1000	4200	7000	610	2600	7400	720	6400	6400
Antimony	mg/kg	2	25	<0.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	0.2
Arsenic	mg/kg	20	70	1.4	3.2	3.6	2.5	2.85	4.9	4	4.8	4.8
Boron	mg/kg	No value	No value	28	45	59	68	52	91	40	85	85
Cadmium	mg/kg	1.5	10	0.02	0.05	0.07	0.08	0.06	0.16	0.1	0.1	0.1
Chromium	mg/kg	80	370	8.3	23	33	16	19.5	34	15	30	30
Cobalt	mg/kg	No value	No value	0.1	0.5	0.8	<0.1	0.3	1	0.1	0.8	0.8
Copper	mg/kg	65	270	1.6	3.3	5.5	0.7	2.45	7.9	2.6	8.4	7.9
Lead	mg/kg	50	220	2.3	6.3	8.1	1.3	4.3	9.5	2.2	8.2	8.2
Manganese	mg/kg	No value	No value	9.4	17	21	19	18	21	18	20	20
Mercury	mg/kg	0.15	1	0.01	0.03	0.04	<0.01	0.02	0.06	<0.01	0.05	0.05
Molybdenum	mg/kg	No value	No value	0.2	0.3	0.4	1.7	0.35	1	0.6	0.8	0.8
Nickel	mg/kg	21	52	1	3.5	6	0.8	2.25	7.7	1	6.1	6.1
Selenium	mg/kg	No value	No value	0.2	0.3	0.4	0.2	0.25	0.6	0.2	0.6	0.6
Silver	mg/kg	1	3.7	<0.02	<0.02	0.03	<0.02	0.02	0.07	<0.02	0.06	0.06
Vanadium	mg/kg	No value	No value	2.9	7.6	11	3.3	5.45	14	3.6	13	13
Zinc	mg/kg	200	410	5	20	22	2.4	12.5	25	9.1	21	21
TPH (sum C6-C36)	mg/kg	280†	550†	<14	<14	<14	17	14	15	<14	<14	14
Total PAH[#]	µg/kg	4000	45,000	<83	<83	53	<83	83	37	140	40	40
TBT[#]	µgSn/kg	5	70	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	0.5
Diuron[#]	mg/kg	No value	No value	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001
Ingarol[#]	mg/kg	No value	No value	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001

* Three separate samples were taken at site G3, the highest concentration of the three was used in the comparisons

[#] Values were normalized if the value was above the LOR

† ANZG (2018) default guideline value

Table 8. Individual concentrations of polycyclic aromatic hydrocarbons in sediments from Cockburn Sound high protection area.

Contaminant	Units	Guideline value		Cockburn Sound high protection area - north					Cockburn Sound high protection area - south			
		EQG A	EQG B	JBH	3000	4000	G3*	Median	4800	5020	OCB	Median
Acenaphthene	µg/kg	16	500	<4	<4	<4	<4	4	<4	<4	<4	4
Acenaphthylene	µg/kg	44	640	<4	<4	<4	<4	4	<4	<4	<4	4
Anthracene	µg/kg	85	1100	<4	<4	<4	<4	4	<4	<4	<4	4
Fluorene	µg/kg	19	540	<4	<4	<4	<4	4	<4	<4	<4	4
Naphthalene	µg/kg	160	2100	<5	<5	<5	<5	5	<5	<5	<5	5
Phenanthrene	µg/kg	240	1500	<4	<4	<4	<4	4	<4	<4	<4	4
Low molecular weight PAH	µg/kg	552	3160	<25	<25	<25	<25	25	<25	<25	<25	25
Benzo(a)anthracene	µg/kg	261	1600	<4	<4	<4	<4	<4	<4	<4	<4	4
Benzo(a)pyrene	µg/kg	430	1600	<4	<4	<4	<4	<4	<4	<4	<4	4
Dibenzo(a,h)anthracene	µg/kg	63	260	<4	<4	<4	<4	<4	<4	<4	<4	4
Chrysene	µg/kg	384	280	<4	<4	<4	<4	<4	<4	<4	<4	4
Fluoranthene	µg/kg	600	5100	<4	<4	3.2	<4	4	3.2	8.3	1.9	3.2
Pyrene	µg/kg	665	2600	<4	<4	3.2	<4	4	3.2	<4	1.9	3.2
High molecular weight PAH	µg/kg	1700	9600	<24	<24	22	<24	24	22	28	20	22

* Three separate samples were taken at site G3, the highest concentration of the three was used in the comparisons

Values were normalized if the value was above the LOR

Table 9. Contaminant concentrations in sediments from Cockburn Sound moderate protection area.

Contaminant	Units	Guideline value		Cockburn Sound moderate protection area					
		EQG A	EQG B	3210	4010	C430	KBJ	4500	Median
Aluminium	mg/kg	No value	No value	3000	450	4600	6200	6900	4600
Antimony	mg/kg	2	25	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
Arsenic	mg/kg	20	70	2.9	1.3	5.2	3.9	4	3.9
Boron	mg/kg	No value	No value	27	21	82	59	65	59
Cadmium	mg/kg	1.5	10	0.04	0.03	0.1	1.1	0.19	0.1
Chromium	mg/kg	80	370	9	7.2	27	29	33	27
Cobalt	mg/kg	No value	No value	0.2	<0.1	0.6	0.8	0.8	0.6
Copper	mg/kg	65	270	4.1	0.5	51	16	8.4	8.4
Lead	mg/kg	50	220	2.5	1	18	8.8	8.7	8.7
Manganese	mg/kg	No value	No value	11	14	17	19	21	17
Mercury	mg/kg	0.15	1	0.01	<0.01	0.1	0.02	0.09	0.02
Molybdenum	mg/kg	No value	No value	0.5	0.2	0.9	1.2	0.5	0.5
Nickel	mg/kg	21	52	1.8	0.5	4.4	7	7.3	4.4
Selenium	mg/kg	No value	No value	0.2	0.1	0.6	0.6	0.5	0.5
Silver	mg/kg	1	3.7	<0.02	<0.02	0.06	0.16	0.07	0.06
Vanadium	mg/kg	No value	No value	5.8	2.5	11	9.9	11	9.9
Zinc	mg/kg	200	410	11	1.6	31	34	27	27
TPH (sum C6-C36)	mg/kg	280†	550†	14	<14	19	<14	17	14
Total PAH[#]	µg/kg	4000	45,000	174	<83	114	80	45	83
TBT[#]	µgSn/kg	5	70	<0.5	<0.5	1.9	3.4	<0.5	0.5
Diuron[#]	mg/kg	No value	No value	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Ingarol[#]	mg/kg	No value	No value	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Sum of PFAS	mg/kg	No value	No value	<0.0002	<0.0002	<0.0002	<0.0002	-	0.0002
Sum of PFHxS and PFOS	mg/kg	No value	No value	<0.0002	<0.0002	<0.0002	<0.0002	-	0.0002

[#] Values were normalized if the value was above the LOR † ANZG (2018) default guideline value

Table 10. Individual concentrations of polycyclic aromatic hydrocarbons in sediments from Cockburn Sound moderate protection area.

Contaminant	Units	Guideline value		Cockburn Sound moderate protection area					
		EQG A	EQG B	3210	4010	C430	KBJ	4500	Median
Acenaphthene	µg/kg	16	500	<4	<4	<4	<4	<4	4
Acenaphthylene	µg/kg	44	640	<4	<4	<4	<4	<4	4
Anthracene	µg/kg	85	1100	<4	<4	2.1	<4	<4	4
Fluorene	µg/kg	19	540	<4	<4	<4	<4	<4	4
Naphthalene	µg/kg	160	2100	<5	<5	<5	<5	<5	5
Phenanthrene	µg/kg	240	1500	<4	<4	7.9	3.6	<4	4
Low molecular weight PAH	µg/kg	552	3160	<25	<25	27	25	<25	26
Benzo(a)anthracene	µg/kg	261	1600	<4	<4	8	4	<4	4
Benzo(a)pyrene	µg/kg	430	1600	<4	<4	7	3	<4	4
Dibenzo(a,h)anthracene	µg/kg	63	260	<4	<4	<4	<4	<4	4
Chrysene	µg/kg	384	280	<4	<4	9	4	<4	4
Fluoranthene	µg/kg	600	5100	12	<4	19	10	3	10
Pyrene	µg/kg	665	2600	12	<4	15	10	3	10
High molecular weight PAH	µg/kg	1700	9600	40	<24	63	35	21	35

Table 11. Contaminant concentrations in sediments from Cockburn Sound moderate protection area (marinas and harbours) and Warnbro Sound high protection area.

Contaminant	Units	Guideline value		Cockburn Sound moderate protection area			Warnbro Sound high protection area		
		EQG A	EQG B	1530	SH	Median	WS12	WS24	Median
Aluminium	mg/kg	No value	No value	820	4500	2660	240	2300	1270
Antimony	mg/kg	2	25	<0.2	<0.2	0.2	<0.2	0.2	0.2
Arsenic	mg/kg	20	70	2.2	5.1	3.6	1.9	13	7.45
Boron	mg/kg	No value	No value	22	43	32.5	46	29	37.5
Cadmium	mg/kg	1.5	10	0.06	0.06	0.06	0.07	0.03	0.05
Chromium	mg/kg	80	370	11	25	18	12	21	16.5
Cobalt	mg/kg	No value	No value	<0.1	0.5	0.3	<0.1	0.3	0.2
Copper	mg/kg	65	270	4.8	16	10.4	0.3	0.8	0.55
Lead	mg/kg	50	220	1.8	6.9	4.4	0.7	3	1.85
Manganese	mg/kg	No value	No value	14	22	18	17	13	15
Mercury	mg/kg	0.15	1	<0.01	0.03	0.02	<0.01	<0.01	0.01
Molybdenum	mg/kg	No value	No value	0.2	0.5	0.4	0.1	0.3	0.2
Nickel	mg/kg	21	52	0.9	3.9	2.4	0.4	1.9	1.15
Selenium	mg/kg	No value	No value	0.2	0.4	0.3	0.1	0.3	0.2
Silver	mg/kg	1	3.7	<0.02	0.04	0.03	<0.02	<0.02	0.02
Vanadium	mg/kg	No value	No value	3	10	6.5	1.9	13	7.45
Zinc	mg/kg	200	410	8.5	26	17	1.2	6.7	3.95
TPH (sum C6-C36)	mg/kg	280†	550†	<14	<14	14	61	16	39
Total PAH[#]	µg/kg	4000	45,000	<83	76	79	293	<83	188
TBT[#]	µgSn/kg	5	70	2	1.3	1.6	<0.5	<0.5	0.5
Diuron[#]	mg/kg	No value	No value	<0.001	<0.001	0.001	<0.001	<0.001	0.001
Ingarol[#]	mg/kg	No value	No value	<0.001	<0.001	0.001	<0.001	<0.001	0.001
Sum of PFAS	mg/kg	No value	No value	<0.0002	<0.0002	0.0002	-	-	-
Sum of PFHxS and PFOS	mg/kg	No value	No value	<0.0002	<0.0002	0.0002	-	-	-

[#] Values were normalized if the value was above the LOR

† ANZG (2018) default guideline value

Table 12. Individual concentrations of polycyclic aromatic hydrocarbons in sediments from Cockburn Sound moderate protection area (marinas and harbours) and Warnbro Sound high protection area.

Contaminant	Units	Guideline value		Cockburn Sound moderate protection area			Warnbro Sound high protection area		
		EQG A	EQG B	1530	SH	Median	WS12	WS24	Median
Acenaphthene	µg/kg	16	500	<4	<4	4	<4	<4	4
Acenaphthylene	µg/kg	44	640	<4	<4	4	<4	<4	4
Anthracene	µg/kg	85	1100	<4	<4	4	<4	<4	4
Fluorene	µg/kg	19	540	<4	<4	4	<4	<4	4
Naphthalene	µg/kg	160	2100	<5	<5	5	17	<5	11
Phenanthrene	µg/kg	240	1500	<4	<4	4	<4	<4	4
Low molecular weight PAH	µg/kg	552	3160	<25	<25	25	37	<25	30
Benzo(a)anthracene	µg/kg	261	1600	<4	<4	4	<4	<4	4
Benzo(a)pyrene	µg/kg	430	1600	<4	<4	4	<4	<4	4
Dibenzo(a,h)anthracene	µg/kg	63	260	<4	<4	4	<4	<4	4
Chrysene	µg/kg	384	280	<4	<4	4	<4	<4	4
Fluoranthene	µg/kg	600	5100	<4	6.7	5.3	<4	<4	4
Pyrene	µg/kg	665	2600	<4	6.7	5.3	<4	<4	4
High molecular weight PAH	µg/kg	1700	9600	<24	29	27	<24	<24	24

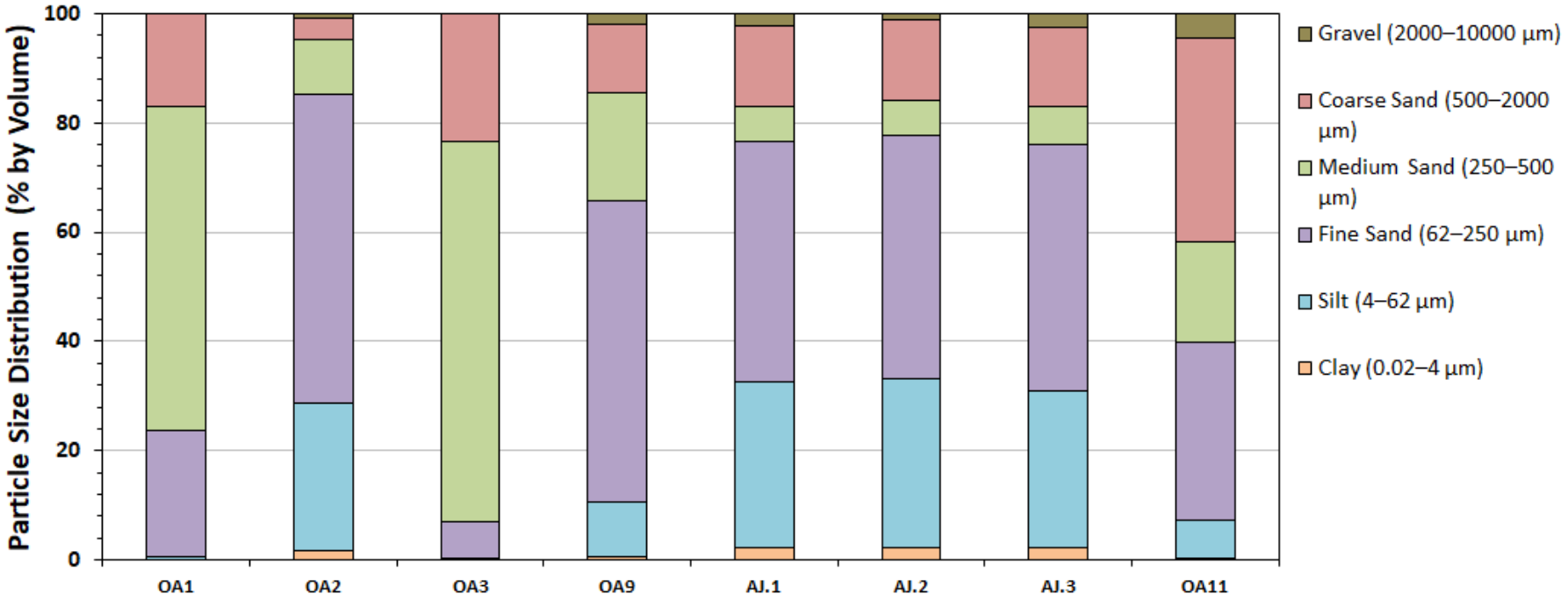

Figure 2. Particle size distribution of sediment from sites in Owen Anchorage.

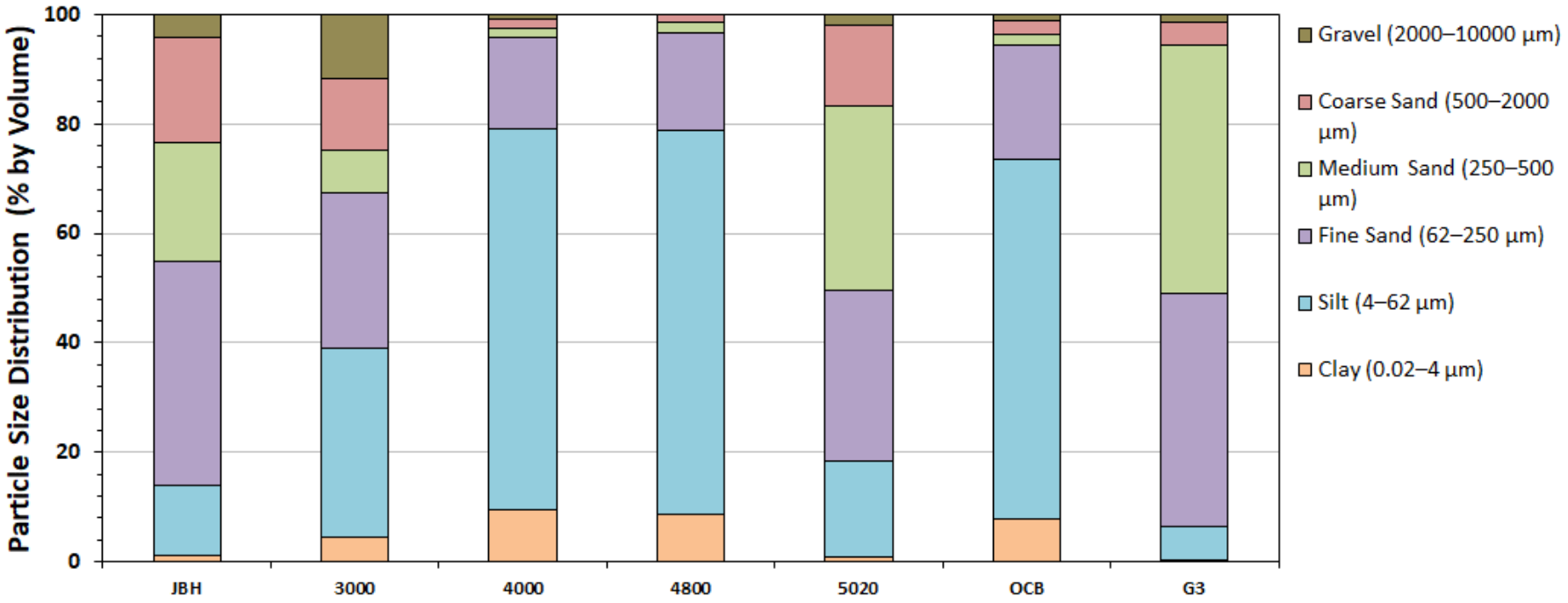

Figure 3. Particle size distribution of sediment from sites in in the high protection area of Cockburn Sound.

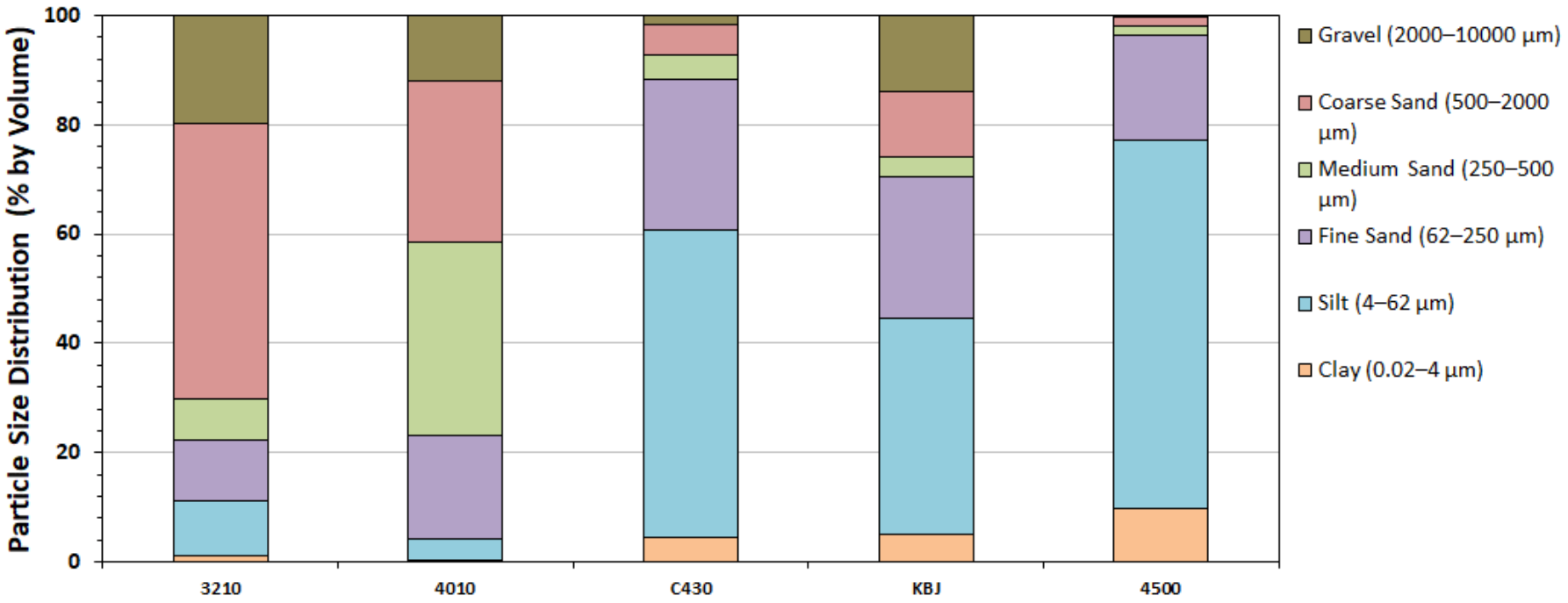

Figure 4. Particle size distribution of sediment from sites in in the moderate protection area of Cockburn Sound.

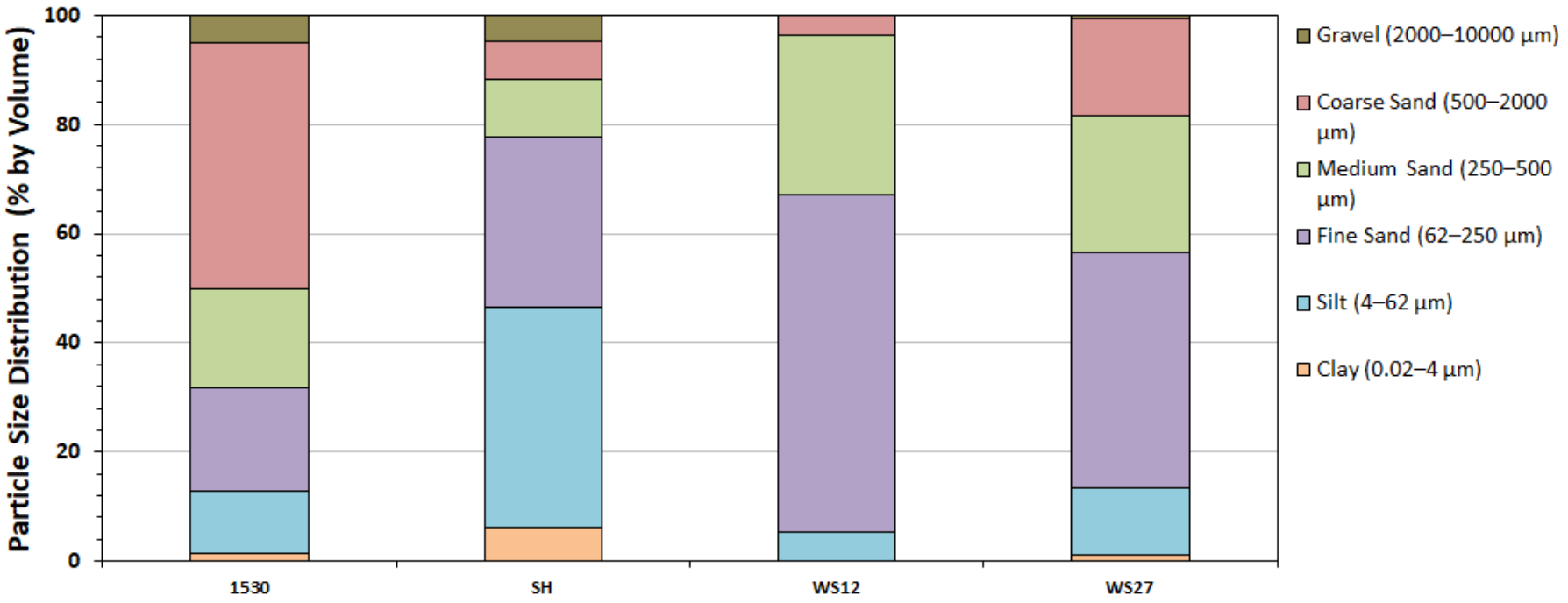

Figure 5. Particle size distribution of sediment from sites in in the moderate protection area of Cockburn Sound (marinas and harbours) and Warnbro Sound (HPA).

5 Discussion

For all protection areas the median concentration for each contaminant (metals/metalloids, hydrocarbons (TPH and PAH), tributyltin, herbicides (diuron and irgarol) and PFAS) did not exceed the EQG A, and individual sites total contaminant concentrations did not exceed the EQG B. In fact, individual sites concentrations did not exceed the lower EQG A value for any contaminant (where there were EQG values available).

The results of this report can be summarized as follows:

Metals and metalloids

- Generally, the lowest concentrations of sediment metals/metalloids occurred at sites OA1, OA3 and OA11, 4010 at James Point, G3 at the top of Garden Island and WS12. These sites had a low percentage of silt and clay (< 6%).
- The sites with the highest concentrations of sediment metals/metalloids occurred at sites 4000, 4800, 4500, and OCB. These sites had the highest percentage of silt and clay (> 70%).
- In addition, site C430 in Careening Bay had the highest concentrations of copper (51 mg/kg), lead (18 mg/kg) and mercury (0.1 mg/kg) compared to other sites, while site KBJ had the highest concentration of cadmium (1.1 mg/kg) and zinc (34 mg/kg).
- The concentrations of metals at KBJ and C430 were similar to the sediment toxicant survey in 2006 (Department of Water, 2006) in which the highest concentration of cadmium and zinc occurred at KBJ and the highest concentrations of copper and lead occurred at C430, the only difference was that mercury exceed the EQG A in the sediments at site KBJ.

Hydrocarbons

- The highest sediment total petroleum hydrocarbons (TPH) occurred at site WS12 in the Warnbro Sound shallows. The high carbon chain fractions C15-C28 (40 mg/kg) and C29-C23 (15 mg/kg) were detectable.
- The low molecular weight polycyclic aromatic hydrocarbons (PAH) phenanthrene was detected in sediments at sites AJ, C340 and KBJ.
- The low molecular weight PAH anthracene was detected in sediments at sites AJ and C340.
- The low molecular weight PAH acenaphthylene was detected in sediments at site AJ.
- The low molecular weight PAH naphthalene was detected in sediments at site WS12.
- The high molecular weight PAH fluoranthene and pyrene were detected in sediments at sites SH, 4000, 4800, 5020, OCB, 3210, 4500, AJ, C340 and KBJ.
- The high molecular weight PAH benzo(a)anthracene, benzo(a)pyrene and chrysene were detected in sediments at sites AJ, C430 and KBJ.
- According to Department of Water (2006) the hydrophobic nature and low solubility of fluoranthene and pyrene means they are resistant to biodegradation and this could be the reason they were found at more sites than the other PAHs albeit in low concentrations.

Tributyltin

- Detectable TBT in sediments only occurred at sites 1530, SH, KBJ and C430 and ranged from 1.3 µgSn/kg at site SH to 3.4 µgSn/kg at site KBJ after normalisation.
- In the 2006 survey (Department of Water; 2006), TBT concentrations were detectable at sites 1530 (Northern Harbour), KBJ (Kwinana Bulk Jetty) and C430 (Careening Bay) and TBT in the sediment at C430 exceeded the EQG A and the EQS (% of imposex). Results were not normalised.

Herbicides

- The targeted herbicides, diuron and irgarol, were below the laboratory LOR of <0.001 mg/kg at all sites. There are no EQG values for these herbicides in sediment.
- These herbicides were not sampled for in the Department of Water (2006) survey but another survey by the Department of Water (2008) examined diuron and irgarol in sediment from sites in northern and southern harbours and Careening Bay amongst others. The survey concluded that Igarol 1051 and diuron were below the reporting limits (0.005 mg/kg) at Careening Bay and Austal Ships (Northern Harbour) but detectable at Tenix Marine (Southern Harbour) at 0.01 and 0.014 mg/kg for irgarol and 0.0454 and 0.058 for diruon.

Perfluoroalkyl sulphonic acids (PFAS)

- PFAS was measured in the sediments of a selected number of sites on the Cockburn Sound eastern shoreline (1530, SH, 3210, 4010 and KBJ) and OCB and C430 in and around Careening Bay. Sum of PFAS in sediment all sites were below the laboratory LOR of <0.0002 mg/kg. There are no EQG values for PFAS in sediment.
- In addition, the sum of PFHxS and PFOS were also below laboratory LORs at all sites.

6 Conclusions/recommendations

The sediment from all protection areas in Cockburn Sound, Owen Anchorage and Warnbro Sound, the median concentration for each contaminant (metals/metalloids, hydrocarbons (TPH and PAH), tributyltin, herbicides (diuron and irgarol) and PFAS) did not exceed the EQG A, and individual sites total contaminant concentrations did not exceed the EQG B. In fact, individual sites concentrations did not exceed the lower EQG A value for any contaminant (where there were EQG values available).

7 References

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8 Appendices

8.1 Laboratory Data

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

SEDIMENT DATA

Contact: Luke Twomey
Customer: Western Australian Marine Science Istitution - M095,
Address: Level 5, Indian Ocean Marine Research Centre (IOMRC) 64 Fairway, Crawley, WA 6009

Date Received: 1/05/2023
Date of Issue: 22/05/2023
Our Reference: WAMS22-3
Your Reference: WCP3.1

METHOD	Sampling	MS002	MS002	MS002	MS002	MS002	MS002	MS002	MS002	MS002
SAMPLE CODE	Date	Total Ext Al mg/kg	Total Ext V mg/kg	Total Ext Cr mg/kg	Total Ext Mn mg/kg	Total Ext Co mg/kg	Total Ext Ni mg/kg	Total Ext Cu mg/kg	Total Ext Zn mg/kg	Total Ext As mg/kg
Reporting Limit		<10	<0.2	<0.2	<0.2	<0.1	<0.2	<0.2	<0.5	<0.1
Analysis Date		10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023
File		23051001	23051001	23051001	23051001	23051001	23051001	23051001	23051001	23051001
OA1	28/04/2023	220	3.1	16	17	<0.1	0.5	0.2	0.8	3.6
OA2	28/04/2023	1500	5.0	14	14	0.2	1.6	1.8	5.0	2.5
OA3	28/04/2023	300	7.0	17	19	<0.1	0.6	0.3	1.1	5.6
OA9	28/04/2023	650	2.7	12	11	0.1	1.5	1.1	3.4	1.6
AJ.1	28/04/2023	1500	5.6	16	12	0.2	1.9	3.2	8.0	2.4
AJ.2	28/04/2023	1500	5.5	15	12	0.2	1.8	3.5	7.8	2.3
AJ.3	28/04/2023	1500	5.4	16	12	0.2	1.9	3.1	8.1	2.4
OA11	28/04/2023	440	1.6	6.6	6.9	<0.1	0.7	1.2	3.1	1.2
1530	1/05/2023	820	3.0	11	14	<0.1	0.9	4.8	8.5	2.2
SH	28/04/2023	4500	10	25	22	0.5	3.9	16	26	5.1
JBH.A	28/04/2023	1000	2.9	8.3	9.4	0.1	1.0	1.6	5.0	1.4
3000	28/04/2023	4200	7.6	23	17	0.5	3.5	3.3	20	3.2
3210	28/04/2023	3000	5.8	9.0	11	0.2	1.8	4.1	11	2.9
4000	1/05/2023	7000	11	33	21	0.8	6.0	5.5	22	3.6
4010	1/05/2023	450	2.5	7.2	14	<0.1	0.5	0.5	1.6	1.3
4500	1/05/2023	6900	11	33	21	0.8	7.3	8.4	27	4.0
KBJ.A	1/05/2023	6200	9.9	29	19	0.8	7.0	16	34	3.9
4800	1/05/2023	7400	14	34	21	1.0	7.7	7.9	25	4.9
5020	1/05/2023	720	3.6	15	18	0.1	1.0	2.6	9.1	4.0

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

Signatory: Lirong Han
Date: 22/05/2023

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

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METHOD	Sampling	MS002	MS002	MS002	MS002	MS002	MS002	MS002	MS002	MS002
SAMPLE CODE	Date	Total Ext Al mg/kg	Total Ext V mg/kg	Total Ext Cr mg/kg	Total Ext Mn mg/kg	Total Ext Co mg/kg	Total Ext Ni mg/kg	Total Ext Cu mg/kg	Total Ext Zn mg/kg	Total Ext As mg/kg
Reporting Limit		<10	<0.2	<0.2	<0.2	<0.1	<0.2	<0.2	<0.5	<0.1
Analysis Date		10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023
File		23051001	23051001	23051001	23051001	23051001	23051001	23051001	23051001	23051001
C430	1/05/2023	4600	11	27	17	0.6	4.4	51	31	5.2
OCB	1/05/2023	6400	13	30	20	0.8	6.1	8.4	21	4.8
G3.1	28/04/2023	530	2.2	16	18	<0.1	0.7	0.6	2.0	2.3
G3.2	28/04/2023	610	3.3	15	18	<0.1	0.8	0.7	2.4	2.4
G3.3	28/04/2023	550	2.8	15	19	<0.1	0.8	0.6	2.1	2.5
WS12	1/05/2023	240	1.9	12	17	<0.1	0.4	0.3	1.2	1.9
WS27	1/05/2023	2300	13	21	13	0.3	1.9	0.8	6.7	13
Field Blank	1/05/2023	820	0.4	1.9	2.3	<0.1	0.2	0.5	<0.5	<0.1
Transport Blank	1/05/2023	840	0.4	2.0	2.7	<0.1	0.2	0.6	<0.5	<0.1

Signatory: Lirong Han
Date: 22/05/2023

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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

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WORLD RECOGNISED ACCREDITATION

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Date Received: 1/05/2023
Date of Issue: 22/05/2023
Our Reference: WAMS22-3
Your Reference: WCP3.1

METHOD	Sampling	MS002	MS002	MS002	MS002	MS002	MS002	ICP002	ICP007	6200
SAMPLE CODE	Date	Total Ext Se	Total Ext Mo	Total Ext Ag	Total Ext Cd	Total Ext Sb	Total Ext Pb	Total Ext B	Total Ext Hg	TOC
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	% C
Reporting Limit		<0.1	<0.1	<0.02	<0.02	<0.2	<0.1	<1	<0.01	<0.1
Analysis Date		10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	11/05/2023	16/05/2023	17-18/05/2023
File		23051001	23051001	23051001	23051001	23051001	23051001	23051101B	23051602	23051701-1801
OA1	28/04/2023	0.1	0.2	<0.02	0.09	<0.2	0.8	31	<0.01	0.2
OA2	28/04/2023	0.2	0.4	<0.02	0.06	<0.2	3.1	55	0.01	0.8
OA3	28/04/2023	0.1	0.1	<0.02	0.08	<0.2	1.0	27	<0.01	0.2
OA9	28/04/2023	0.2	0.3	<0.02	0.05	<0.2	2.9	32	<0.01	0.4
AJ.1	28/04/2023	0.4	0.6	0.02	0.06	<0.2	4.4	65	0.01	1.0
AJ.2	28/04/2023	0.4	0.6	<0.02	0.06	<0.2	3.8	60	0.02	0.9
AJ.3	28/04/2023	0.4	0.6	0.02	0.06	<0.2	3.9	65	0.01	1.0
OA11	28/04/2023	0.1	0.1	<0.02	0.03	<0.2	2.5	27	<0.01	0.4
1530	1/05/2023	0.2	0.2	<0.02	0.06	<0.2	1.8	22	<0.01	0.3
SH	28/04/2023	0.4	0.5	0.04	0.06	<0.2	6.9	43	0.03	1.2
JBH.A	28/04/2023	0.2	0.2	<0.02	0.02	<0.2	2.3	28	0.01	0.4
3000	28/04/2023	0.3	0.3	<0.02	0.05	<0.2	6.3	45	0.03	0.9
3210	28/04/2023	0.2	0.5	<0.02	0.04	<0.2	2.5	27	0.01	0.5
4000	1/05/2023	0.4	0.4	0.03	0.07	<0.2	8.1	59	0.04	1.6
4010	1/05/2023	0.1	0.2	<0.02	0.03	<0.2	1.0	21	<0.01	0.2
4500	1/05/2023	0.5	0.5	0.07	0.19	<0.2	8.7	65	0.09	1.9
KBJ.A	1/05/2023	0.6	1.2	0.16	1.1	<0.2	8.8	59	0.02	1.4
4800	1/05/2023	0.6	1.0	0.07	0.16	<0.2	9.5	91	0.06	2.5
5020	1/05/2023	0.2	0.6	<0.02	0.10	<0.2	2.2	40	<0.01	0.6

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

Signatory: Lirong Han
Date: 22/05/2023

Marine and Freshwater
Research Laboratory
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SEDIMENT DATA

Contact: Luke Twomey
Customer: Western Australian Marine Science Istitution - M095,
Address: Level 5, Indian Ocean Marine Research Centre (IOMRC) 64 Fairway, Crawley, WA 6009

Date Received: 1/05/2023
Date of Issue: 22/05/2023
Our Reference: WAMS22-3
Your Reference: WCP3.1

METHOD	Sampling	MS002	MS002	MS002	MS002	MS002	MS002	ICP002	ICP007	6200
SAMPLE CODE	Date	Total Ext Se	Total Ext Mo	Total Ext Ag	Total Ext Cd	Total Ext Sb	Total Ext Pb	Total Ext B	Total Ext Hg	TOC
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	% C
Reporting Limit		<0.1	<0.1	<0.02	<0.02	<0.2	<0.1	<1	<0.01	<0.1
Analysis Date		10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	10/05/2023	11/05/2023	16/05/2023	17-18/05/2023
File		23051001	23051001	23051001	23051001	23051001	23051001	23051101B	23051602	23051701-1801
C430	1/05/2023	0.6	0.9	0.06	0.10	<0.2	18	82	0.10	1.9
OCB	1/05/2023	0.6	0.8	0.06	0.10	<0.2	8.2	85	0.05	2.1
G3.1	28/04/2023	0.2	0.4	<0.02	0.08	<0.2	1.1	35	<0.01	0.3
G3.2	28/04/2023	0.2	1.7	<0.02	0.08	<0.2	1.3	68	<0.01	0.5
G3.3	28/04/2023	0.2	1.5	<0.02	0.08	<0.2	1.3	55	<0.01	0.4
WS12	1/05/2023	0.1	0.1	<0.02	0.07	<0.2	0.7	46	<0.01	0.3
WS27	1/05/2023	0.3	0.3	<0.02	0.03	0.2	3.0	29	<0.01	0.5
Field Blank	1/05/2023	<0.1	<0.1	<0.02	<0.02	<0.2	1.2	1	<0.01	<0.1
Transport Blank	1/05/2023	<0.1	<0.1	<0.02	<0.02	<0.2	1.3	<1	<0.01	<0.1

Note: Results expressed as dry weight basis.

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: Lirong Han
Date: 22/05/2023

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

Marine and Freshwater
Research Laboratory
Environmental Science
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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	WS27
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	9/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**1.29**
Very Fine Silt % (4-8µm)	1.82
Fine Silt % (8-16µm)	2.70
Medium Silt % (16-31µm)	3.57
Course Silt % (31-63µm)	4.05
Total Silt (4-63µm)	**12.14**
Very Fine sand % (63-125µm)	12.24
Fine sand % (125-250µm)	31.01
Medium sand % (250-500µm)	24.90
Coarse sand % (500-1000µm)	15.96
Very Coarse sand % (1000-2000µm)	1.97
Total Sand (63-2000µm)	**86.09**
Total Gravels (>2000µm)	**0.49**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	15.96
1000	1.97
2000	0.34
4000	0.14
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	218.40
Minimum settling velocity of 50% of particles (mm s^1)	39.33
Time for 50% of particles to settle over 1 m (hours)	0.007
D10 (µm)	34.62
Minimum settling velocity of 90% of particles (mm s^1)	0.99
Time for 90% of particles to settle over 1 m (hours)	0.281

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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

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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	WS12
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	9/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.07**
Very Fine Silt % (4-8µm)	0.65
Fine Silt % (8-16µm)	0.80
Medium Silt % (16-31µm)	1.47
Course Silt % (31-63µm)	2.21
Total Silt (4-63µm)	**5.13**
Very Fine sand % (63-125µm)	16.73
Fine sand % (125-250µm)	45.30
Medium sand % (250-500µm)	29.25
Coarse sand % (500-1000µm)	3.09
Very Coarse sand % (1000-2000µm)	0.35
Total Sand (63-2000µm)	**94.72**
Total Gravels (>2000µm)	**0.08**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	3.09
1000	0.35
2000	0.08
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	195.31
Minimum settling velocity of 50% of particles (mm s^1)	31.46
Time for 50% of particles to settle over 1 m (hours)	0.009
D10 (µm)	89.51
Minimum settling velocity of 90% of particles (mm s^1)	6.61
Time for 90% of particles to settle over 1 m (hours)	0.042

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some shell and plant material present.

Signatory: Jamie Woodward
Date: 24/05/2023

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
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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	SH
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	5/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**6.22**
Very Fine Silt % (4-8µm)	6.58
Fine Silt % (8-16µm)	9.98
Medium Silt % (16-31µm)	11.32
Course Silt % (31-63µm)	12.57
Total Silt (4-63µm)	**40.44**
Very Fine sand % (63-125µm)	15.20
Fine sand % (125-250µm)	15.72
Medium sand % (250-500µm)	10.65
Coarse sand % (500-1000µm)	5.30
Very Coarse sand % (1000-2000µm)	1.68
Total Sand (63-2000µm)	**48.55**
Total Gravels (>2000µm)	**4.79**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	5.30
1000	1.68
2000	1.50
4000	3.28
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	74.46
Minimum settling velocity of 50% of particles (mm s^1)	4.57
Time for 50% of particles to settle over 1 m (hours)	0.061
D10 (µm)	6.21
Minimum settling velocity of 90% of particles (mm s^1)	0.03
Time for 90% of particles to settle over 1 m (hours)	8.729

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud, shell and rock present.

Signatory: Jamie Woodward
Date: 24/05/2023

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

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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	OCB
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	9/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**7.81**
Very Fine Silt % (4-8µm)	9.41
Fine Silt % (8-16µm)	14.96
Medium Silt % (16-31µm)	19.33
Course Silt % (31-63µm)	22.12
Total Silt (4-63µm)	**65.82**
Very Fine sand % (63-125µm)	15.02
Fine sand % (125-250µm)	5.84
Medium sand % (250-500µm)	1.83
Coarse sand % (500-1000µm)	1.46
Very Coarse sand % (1000-2000µm)	0.96
Total Sand (63-2000µm)	**25.11**
Total Gravels (>2000µm)	**1.26**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	1.46
1000	0.96
2000	0.77
4000	0.49
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	29.58
Minimum settling velocity of 50% of particles (mm s^1)	0.72
Time for 50% of particles to settle over 1 m (hours)	0.385
D10 (µm)	4.89
Minimum settling velocity of 90% of particles (mm s^1)	0.02
Time for 90% of particles to settle over 1 m (hours)	14.102

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Mud with some sand and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	OA11
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	5/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.40**
Very Fine Silt % (4-8µm)	0.82
Fine Silt % (8-16µm)	1.34
Medium Silt % (16-31µm)	2.05
Course Silt % (31-63µm)	2.74
Total Silt (4-63µm)	**6.95**
Very Fine sand % (63-125µm)	9.63
Fine sand % (125-250µm)	22.95
Medium sand % (250-500µm)	18.25
Coarse sand % (500-1000µm)	28.20
Very Coarse sand % (1000-2000µm)	9.12
Total Sand (63-2000µm)	**88.14**
Total Gravels (>2000µm)	**4.51**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	28.20
1000	9.12
2000	3.35
4000	1.16
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	344.56
Minimum settling velocity of 50% of particles (mm s^1)	97.90
Time for 50% of particles to settle over 1 m (hours)	0.003
D10 (µm)	85.68
Minimum settling velocity of 90% of particles (mm s^1)	6.05
Time for 90% of particles to settle over 1 m (hours)	0.046

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	OA9
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	5/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.60**
Very Fine Silt % (4-8µm)	1.01
Fine Silt % (8-16µm)	1.70
Medium Silt % (16-31µm)	2.53
Course Silt % (31-63µm)	4.73
Total Silt (4-63µm)	**9.98**
Very Fine sand % (63-125µm)	22.04
Fine sand % (125-250µm)	33.22
Medium sand % (250-500µm)	19.76
Coarse sand % (500-1000µm)	9.60
Very Coarse sand % (1000-2000µm)	2.97
Total Sand (63-2000µm)	**87.59**
Total Gravels (>2000µm)	**1.84**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	9.60
1000	2.97
2000	0.48
4000	0.48
8000	0.87
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	176.66
Minimum settling velocity of 50% of particles (mm s^1)	25.74
Time for 50% of particles to settle over 1 m (hours)	0.011
D10 (µm)	60.32
Minimum settling velocity of 90% of particles (mm s^1)	3.00
Time for 90% of particles to settle over 1 m (hours)	0.093

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud, shell, rock and plant material present.

Signatory: Jamie Woodward
Date: 24/05/2023

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Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	OA3
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	4/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.00**
Very Fine Silt % (4-8µm)	0.00
Fine Silt % (8-16µm)	0.00
Medium Silt % (16-31µm)	0.00
Course Silt % (31-63µm)	0.39
Total Silt (4-63µm)	**0.39**
Very Fine sand % (63-125µm)	0.95
Fine sand % (125-250µm)	5.80
Medium sand % (250-500µm)	69.44
Coarse sand % (500-1000µm)	19.83
Very Coarse sand % (1000-2000µm)	3.46
Total Sand (63-2000µm)	**99.47**
Total Gravels (>2000µm)	**0.14**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	19.83
1000	3.46
2000	0.14
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	411.82
Minimum settling velocity of 50% of particles (mm s^1)	139.85
Time for 50% of particles to settle over 1 m (hours)	0.002
D10 (µm)	265.56
Minimum settling velocity of 90% of particles (mm s^1)	58.15
Time for 90% of particles to settle over 1 m (hours)	0.005

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

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Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	OA2
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	4/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**1.77**
Very Fine Silt % (4-8µm)	2.12
Fine Silt % (8-16µm)	3.80
Medium Silt % (16-31µm)	5.44
Course Silt % (31-63µm)	15.45
Total Silt (4-63µm)	**26.81**
Very Fine sand % (63-125µm)	31.57
Fine sand % (125-250µm)	25.16
Medium sand % (250-500µm)	9.88
Coarse sand % (500-1000µm)	3.06
Very Coarse sand % (1000-2000µm)	1.03
Total Sand (63-2000µm)	**70.70**
Total Gravels (>2000µm)	**0.72**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	3.06
1000	1.03
2000	0.66
4000	0.07
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	102.03
Minimum settling velocity of 50% of particles (mm s^1)	8.58
Time for 50% of particles to settle over 1 m (hours)	0.032
D10 (µm)	22.02
Minimum settling velocity of 90% of particles (mm s^1)	0.40
Time for 90% of particles to settle over 1 m (hours)	0.695

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud, shell and plant material present.

Signatory: Jamie Woodward
Date: 24/05/2023

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Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	OA1
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	4/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.00**
Very Fine Silt % (4-8µm)	0.00
Fine Silt % (8-16µm)	0.00
Medium Silt % (16-31µm)	0.00
Course Silt % (31-63µm)	0.65
Total Silt (4-63µm)	**0.65**
Very Fine sand % (63-125µm)	1.31
Fine sand % (125-250µm)	21.63
Medium sand % (250-500µm)	59.46
Coarse sand % (500-1000µm)	16.13
Very Coarse sand % (1000-2000µm)	0.74
Total Sand (63-2000µm)	**99.27**
Total Gravels (>2000µm)	**0.08**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	16.13
1000	0.74
2000	0.08
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	348.43
Minimum settling velocity of 50% of particles (mm s^1)	100.11
Time for 50% of particles to settle over 1 m (hours)	0.003
D10 (µm)	189.59
Minimum settling velocity of 90% of particles (mm s^1)	29.64
Time for 90% of particles to settle over 1 m (hours)	0.009

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

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Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	KBJ.A
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	8/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**5.02**
Very Fine Silt % (4-8µm)	5.68
Fine Silt % (8-16µm)	9.09
Medium Silt % (16-31µm)	11.33
Course Silt % (31-63µm)	13.56
Total Silt (4-63µm)	**39.67**
Very Fine sand % (63-125µm)	15.44
Fine sand % (125-250µm)	10.25
Medium sand % (250-500µm)	3.60
Coarse sand % (500-1000µm)	6.03
Very Coarse sand % (1000-2000µm)	5.95
Total Sand (63-2000µm)	**41.28**
Total Gravels (>2000µm)	**14.03**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	6.03
1000	5.95
2000	7.28
4000	6.75
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	80.19
Minimum settling velocity of 50% of particles (mm s^1)	5.30
Time for 50% of particles to settle over 1 m (hours)	0.052
D10 (µm)	7.47
Minimum settling velocity of 90% of particles (mm s^1)	0.05
Time for 90% of particles to settle over 1 m (hours)	6.033

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Mud with some sand and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	JBH.A
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	8/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**1.06**
Very Fine Silt % (4-8µm)	1.44
Fine Silt % (8-16µm)	2.25
Medium Silt % (16-31µm)	3.06
Course Silt % (31-63µm)	6.02
Total Silt (4-63µm)	**12.78**
Very Fine sand % (63-125µm)	15.73
Fine sand % (125-250µm)	25.39
Medium sand % (250-500µm)	21.73
Coarse sand % (500-1000µm)	14.18
Very Coarse sand % (1000-2000µm)	4.89
Total Sand (63-2000µm)	**81.92**
Total Gravels (>2000µm)	**4.25**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	14.18
1000	4.89
2000	3.05
4000	1.20
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	219.47
Minimum settling velocity of 50% of particles (mm s^1)	39.72
Time for 50% of particles to settle over 1 m (hours)	0.007
D10 (µm)	43.58
Minimum settling velocity of 90% of particles (mm s^1)	1.57
Time for 90% of particles to settle over 1 m (hours)	0.177

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud, shell, coral and plant material present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

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Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	G3.1
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	9/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.30**
Very Fine Silt % (4-8µm)	0.94
Fine Silt % (8-16µm)	1.22
Medium Silt % (16-31µm)	1.63
Course Silt % (31-63µm)	2.29
Total Silt (4-63µm)	**6.08**
Very Fine sand % (63-125µm)	3.76
Fine sand % (125-250µm)	38.96
Medium sand % (250-500µm)	45.21
Coarse sand % (500-1000µm)	2.69
Very Coarse sand % (1000-2000µm)	1.57
Total Sand (63-2000µm)	**92.19**
Total Gravels (>2000µm)	**1.43**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	2.69
1000	1.57
2000	1.18
4000	0.25
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	252.85
Minimum settling velocity of 50% of particles (mm s^1)	52.72
Time for 50% of particles to settle over 1 m (hours)	0.005
D10 (µm)	123.97
Minimum settling velocity of 90% of particles (mm s^1)	12.67
Time for 90% of particles to settle over 1 m (hours)	0.022

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud, shell and plant material present.

Signatory: Jamie Woodward
Date: 24/05/2023

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

Accreditation Number: 10603
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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	C430
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	9/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**4.43**
Very Fine Silt % (4-8µm)	5.94
Fine Silt % (8-16µm)	11.09
Medium Silt % (16-31µm)	17.31
Course Silt % (31-63µm)	21.99
Total Silt (4-63µm)	**56.34**
Very Fine sand % (63-125µm)	17.23
Fine sand % (125-250µm)	10.30
Medium sand % (250-500µm)	4.40
Coarse sand % (500-1000µm)	4.08
Very Coarse sand % (1000-2000µm)	1.48
Total Sand (63-2000µm)	**37.49**
Total Gravels (>2000µm)	**1.75**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	4.08
1000	1.48
2000	1.20
4000	0.55
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	44.39
Minimum settling velocity of 50% of particles (mm s^1)	1.62
Time for 50% of particles to settle over 1 m (hours)	0.171
D10 (µm)	7.75
Minimum settling velocity of 90% of particles (mm s^1)	0.05
Time for 90% of particles to settle over 1 m (hours)	5.611

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Mud with some sand and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	AJ.3
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	5/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**2.25**
Very Fine Silt % (4-8µm)	2.46
Fine Silt % (8-16µm)	4.34
Medium Silt % (16-31µm)	6.46
Course Silt % (31-63µm)	15.54
Total Silt (4-63µm)	**28.81**
Very Fine sand % (63-125µm)	26.70
Fine sand % (125-250µm)	18.28
Medium sand % (250-500µm)	6.88
Coarse sand % (500-1000µm)	9.96
Very Coarse sand % (1000-2000µm)	4.64
Total Sand (63-2000µm)	**66.45**
Total Gravels (>2000µm)	**2.49**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	9.96
1000	4.64
2000	1.46
4000	0.90
8000	0.13
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	103.10
Minimum settling velocity of 50% of particles (mm s^1)	8.77
Time for 50% of particles to settle over 1 m (hours)	0.032
D10 (µm)	18.00
Minimum settling velocity of 90% of particles (mm s^1)	0.27
Time for 90% of particles to settle over 1 m (hours)	1.039

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud, shell and plant material present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
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Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	AJ.2
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	5/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**2.26**
Very Fine Silt % (4-8µm)	2.58
Fine Silt % (8-16µm)	4.63
Medium Silt % (16-31µm)	7.07
Course Silt % (31-63µm)	16.56
Total Silt (4-63µm)	**30.84**
Very Fine sand % (63-125µm)	27.08
Fine sand % (125-250µm)	17.57
Medium sand % (250-500µm)	6.28
Coarse sand % (500-1000µm)	10.05
Very Coarse sand % (1000-2000µm)	4.88
Total Sand (63-2000µm)	**65.86**
Total Gravels (>2000µm)	**1.04**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	10.05
1000	4.88
2000	0.97
4000	0.07
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law

Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	97.18
Minimum settling velocity of 50% of particles (mm s^1)	7.79
Time for 50% of particles to settle over 1 m (hours)	0.036
D10 (µm)	17.02
Minimum settling velocity of 90% of particles (mm s^1)	0.24
Time for 90% of particles to settle over 1 m (hours)	1.162

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud, shell, coral and plant material present.

Signatory: Jamie Woodward
Date: 24/05/2023

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Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	AJ.1
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	5/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**2.23**
Very Fine Silt % (4-8µm)	2.54
Fine Silt % (8-16µm)	4.55
Medium Silt % (16-31µm)	7.00
Course Silt % (31-63µm)	16.29
Total Silt (4-63µm)	**30.38**
Very Fine sand % (63-125µm)	26.51
Fine sand % (125-250µm)	17.48
Medium sand % (250-500µm)	6.51
Coarse sand % (500-1000µm)	10.20
Very Coarse sand % (1000-2000µm)	4.49
Total Sand (63-2000µm)	**65.19**
Total Gravels (>2000µm)	**2.19**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	10.20
1000	4.49
2000	1.64
4000	0.30
8000	0.25
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	99.14
Minimum settling velocity of 50% of particles (mm s^1)	8.10
Time for 50% of particles to settle over 1 m (hours)	0.034
D10 (µm)	17.31
Minimum settling velocity of 90% of particles (mm s^1)	0.25
Time for 90% of particles to settle over 1 m (hours)	1.124

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud, shell, coral and plant material present.

Signatory: Jamie Woodward
Date: 24/05/2023

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Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	5020
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	9/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.81**
Very Fine Silt % (4-8µm)	1.75
Fine Silt % (8-16µm)	3.28
Medium Silt % (16-31µm)	4.86
Course Silt % (31-63µm)	7.73
Total Silt (4-63µm)	**17.62**
Very Fine sand % (63-125µm)	9.59
Fine sand % (125-250µm)	21.45
Medium sand % (250-500µm)	33.80
Coarse sand % (500-1000µm)	11.49
Very Coarse sand % (1000-2000µm)	3.35
Total Sand (63-2000µm)	**79.69**
Total Gravels (>2000µm)	**1.89**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	11.49
1000	3.35
2000	1.49
4000	0.40
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law

Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	252.90
Minimum settling velocity of 50% of particles (mm s^1)	52.74
Time for 50% of particles to settle over 1 m (hours)	0.005
D10 (µm)	28.61
Minimum settling velocity of 90% of particles (mm s^1)	0.67
Time for 90% of particles to settle over 1 m (hours)	0.412

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud, shell, rock and plant material present.

Signatory: Jamie Woodward
Date: 24/05/2023

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Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	4800
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	9/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**8.77**
Very Fine Silt % (4-8µm)	10.54
Fine Silt % (8-16µm)	16.82
Medium Silt % (16-31µm)	20.87
Course Silt % (31-63µm)	21.68
Total Silt (4-63µm)	**69.91**
Very Fine sand % (63-125µm)	13.25
Fine sand % (125-250µm)	4.78
Medium sand % (250-500µm)	1.80
Coarse sand % (500-1000µm)	1.00
Very Coarse sand % (1000-2000µm)	0.32
Total Sand (63-2000µm)	**21.15**
Total Gravels (>2000µm)	**0.17**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	1.00
1000	0.32
2000	0.17
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	25.05
Minimum settling velocity of 50% of particles (mm s^1)	0.52
Time for 50% of particles to settle over 1 m (hours)	0.537
D10 (µm)	4.44
Minimum settling velocity of 90% of particles (mm s^1)	0.02
Time for 90% of particles to settle over 1 m (hours)	17.056

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Mud with some sand and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	4500
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	8/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**9.65**
Very Fine Silt % (4-8µm)	9.98
Fine Silt % (8-16µm)	14.66
Medium Silt % (16-31µm)	18.95
Course Silt % (31-63µm)	23.78
Total Silt (4-63µm)	**67.37**
Very Fine sand % (63-125µm)	15.14
Fine sand % (125-250µm)	4.30
Medium sand % (250-500µm)	1.44
Coarse sand % (500-1000µm)	1.33
Very Coarse sand % (1000-2000µm)	0.51
Total Sand (63-2000µm)	**22.72**
Total Gravels (>2000µm)	**0.27**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	1.33
1000	0.51
2000	0.27
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	28.01
Minimum settling velocity of 50% of particles (mm s^1)	0.65
Time for 50% of particles to settle over 1 m (hours)	0.429
D10 (µm)	4.13
Minimum settling velocity of 90% of particles (mm s^1)	0.01
Time for 90% of particles to settle over 1 m (hours)	19.773

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Mud with some sand and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

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Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	4010
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	8/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.19**
Very Fine Silt % (4-8µm)	0.56
Fine Silt % (8-16µm)	0.83
Medium Silt % (16-31µm)	1.00
Course Silt % (31-63µm)	1.59
Total Silt (4-63µm)	**3.98**
Very Fine sand % (63-125µm)	1.74
Fine sand % (125-250µm)	17.17
Medium sand % (250-500µm)	35.45
Coarse sand % (500-1000µm)	21.25
Very Coarse sand % (1000-2000µm)	8.21
Total Sand (63-2000µm)	**83.81**
Total Gravels (>2000µm)	**12.01**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	21.25
1000	8.21
2000	4.07
4000	2.86
8000	0.00
16000	5.09

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	417.00
Minimum settling velocity of 50% of particles (mm s^1)	143.39
Time for 50% of particles to settle over 1 m (hours)	0.002
D10 (µm)	169.07
Minimum settling velocity of 90% of particles (mm s^1)	23.57
Time for 90% of particles to settle over 1 m (hours)	0.012

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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PARTICLE SIZE ANALYSIS REPORT

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Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	4000
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	8/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**9.56**
Very Fine Silt % (4-8µm)	10.39
Fine Silt % (8-16µm)	15.25
Medium Silt % (16-31µm)	19.68
Course Silt % (31-63µm)	24.26
Total Silt (4-63µm)	**69.57**
Very Fine sand % (63-125µm)	13.46
Fine sand % (125-250µm)	3.13
Medium sand % (250-500µm)	1.63
Coarse sand % (500-1000µm)	1.40
Very Coarse sand % (1000-2000µm)	0.53
Total Sand (63-2000µm)	**20.14**
Total Gravels (>2000µm)	**0.72**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	1.40
1000	0.53
2000	0.72
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	26.77
Minimum settling velocity of 50% of particles (mm s^1)	0.59
Time for 50% of particles to settle over 1 m (hours)	0.470
D10 (µm)	4.16
Minimum settling velocity of 90% of particles (mm s^1)	0.01
Time for 90% of particles to settle over 1 m (hours)	19.510

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Mud with some sand and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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.

PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	3210
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	8/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**1.29**
Very Fine Silt % (4-8µm)	1.38
Fine Silt % (8-16µm)	2.18
Medium Silt % (16-31µm)	2.67
Course Silt % (31-63µm)	3.59
Total Silt (4-63µm)	**9.81**
Very Fine sand % (63-125µm)	5.42
Fine sand % (125-250µm)	5.88
Medium sand % (250-500µm)	7.52
Coarse sand % (500-1000µm)	25.94
Very Coarse sand % (1000-2000µm)	24.24
Total Sand (63-2000µm)	**69.00**
Total Gravels (>2000µm)	**19.89**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	25.94
1000	24.24
2000	14.04
4000	4.98
8000	0.87
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	886.86
Minimum settling velocity of 50% of particles (mm s^1)	648.56
Time for 50% of particles to settle over 1 m (hours)	0.000
D10 (µm)	52.41
Minimum settling velocity of 90% of particles (mm s^1)	2.27
Time for 90% of particles to settle over 1 m (hours)	0.123

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

The results only apply to the sample as received and to the sample tested.
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Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	3000
Sampling Date:	28/04/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	8/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**4.44**
Very Fine Silt % (4-8µm)	4.57
Fine Silt % (8-16µm)	6.58
Medium Silt % (16-31µm)	8.51
Course Silt % (31-63µm)	14.87
Total Silt (4-63µm)	**34.53**
Very Fine sand % (63-125µm)	17.26
Fine sand % (125-250µm)	11.21
Medium sand % (250-500µm)	7.81
Coarse sand % (500-1000µm)	7.68
Very Coarse sand % (1000-2000µm)	5.28
Total Sand (63-2000µm)	**49.24**
Total Gravels (>2000µm)	**11.80**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	7.68
1000	5.28
2000	5.77
4000	6.03
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	96.20
Minimum settling velocity of 50% of particles (mm s^1)	7.63
Time for 50% of particles to settle over 1 m (hours)	0.036
D10 (µm)	9.02
Minimum settling velocity of 90% of particles (mm s^1)	0.07
Time for 90% of particles to settle over 1 m (hours)	4.140

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Mud with some sand and shell present.

Signatory: Jamie Woodward
Date: 24/05/2023

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.
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PARTICLE SIZE ANALYSIS REPORT

Contact: Luke Twomey
Customer: Western Australian Marine Science Institution
Address: Level 5, Indian Ocean Marine Research Centre, 64 Fairway, Crawley WA 6009

Date of Issue: 24/05/2023
Date Received: 1/05/2023
Our Reference: WAMS22-3

Sample Name:	1530
Sampling Date:	1/05/2023
Sample Type:	Sediment
MAFRL Job Code:	WAMS22-3
Client Reference:	WCP3.1
Analysis Date:	5/05/2023
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**1.31**
Very Fine Silt % (4-8µm)	1.76
Fine Silt % (8-16µm)	2.87
Medium Silt % (16-31µm)	3.26
Course Silt % (31-63µm)	3.70
Total Silt (4-63µm)	**11.60**
Very Fine sand % (63-125µm)	6.71
Fine sand % (125-250µm)	12.28
Medium sand % (250-500µm)	18.03
Coarse sand % (500-1000µm)	36.56
Very Coarse sand % (1000-2000µm)	8.40
Total Sand (63-2000µm)	**81.99**
Total Gravels (>2000µm)	**5.10**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	36.56
1000	8.40
2000	3.82
4000	1.28
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	500.91
Minimum settling velocity of 50% of particles (mm s^1)	206.91
Time for 50% of particles to settle over 1 m (hours)	0.001
D10 (µm)	36.62
Minimum settling velocity of 90% of particles (mm s^1)	1.11
Time for 90% of particles to settle over 1 m (hours)	0.251

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some mud, shell, rock and plant material present.

Signatory: Jamie Woodward
Date: 24/05/2023

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.

CERTIFICATE OF ANALYSIS

Work Order	: **EP2305754**	Page	: 1 of 25
Client	: **MARINE AND FRESHWATER RESEARCH LABORATORY**	Laboratory	: Environmental Division Perth
Contact	: KRZYSZTOF WIENCZUGOW	Contact	: Customer Services EP
Address	: C/- MURDOCH UNIVERSITY, SOUTH STREET MURDOCH WA, AUSTRALIA 6150	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: +61 08 93602907	Telephone	: +61-8-9406 1301
Project	: WAMSI22-3	Date Samples Received	: 03-May-2023 13:00
Order number	: ----	Date Analysis Commenced	: 04-May-2023
C-O-C number	: ----	Issue Date	: 15-May-2023 17:08
Sampler	: ----		
Site	: ----		
Quote number	: EP/184/22_V2		
No. of samples received	: 28		
No. of samples analysed	: 28		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alex Rossi	Organic Chemist	Sydney Organics, Smithfield, NSW
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
Matt Frost	Assistant Laboratory Manager	Brisbane Organics, Stafford, QLD
Thomas Donovan	Senior Organic Chemist	Perth Organics, Wangara, WA

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Organotins analysis conducted by ALS Brisbane, NATA Site No. 818.
- Pesticides analysis conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.
- EP080-SD: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- EP080-SD: Poor surrogate recoveries for particular samples sample due to matrix interferences. Confirmed by re-extraction and re-analysis.
- EP234: Poor matrix spike recovery for particular compounds due to matrix interferences and high matrix spike recovery has been noted for particular compounds due to ion enhancement.
- EP132B-SD: High surrogate recovery for sample "EP2305754_025" due to suspected matrix effects and interferences.
- EP132B-SD: Phenanthrene LOR has been raised for samples "EP2305754_019 and 025" due to matrix interferences.
- EP231: Stable isotope enriched internal standards are added to samples prior to extraction. Target compounds have a direct analogous internal standard with the exception of PFPeS, PFHpA, PFDS, PFTrDA and 10:2 FTS. These compounds use an internal standard that is chemically related and has a retention time close to that of the target compound. The DQO for internal standard response is 50-150% of that established at initial calibration. PFOS is quantified using a certified, traceable standard consisting of linear and branched PFOS isomers. These practices are in line with recommendations in the National Environmental Management Plan for PFAS (Australian HEPA) and also conform to QSM 5.3 (US DoD) requirements.

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	OA1	OA2	OA3	OA9	AJ.1
			Sampling date / time	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00
Compound	CAS Number	LOR	Unit	EP2305754-001	EP2305754-002	EP2305754-003	EP2305754-004	EP2305754-005
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**27.8**	**42.4**	**28.1**	**34.0**	**44.1**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	<3	**5**	**3**	<3	**6**
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	<5	<5	<5
>C10 - C40 Fraction (sum)	----	3	mg/kg	<3	**5**	**3**	<3	**6**
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	<3	<3	<3	<3	**4**
C29 - C36 Fraction	----	5	mg/kg	<5	<5	<5	<5	<5
^ C10 - C36 Fraction (sum)	----	3	mg/kg	<3	<3	<3	<3	**4**
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	<5	<5
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	<5
Acenaphthylene	208-96-8	4	µg/kg	<4	<4	<4	<4	<4
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	<4

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	OA1	OA2	OA3	OA9	AJ.1
			Sampling date / time	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00
Compound	CAS Number	LOR	Unit	EP2305754-001	EP2305754-002	EP2305754-003	EP2305754-004	EP2305754-005
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	<4
Phenanthrene	85-01-8	4	µg/kg	<4	<4	<4	<4	<4
Anthracene	120-12-7	4	µg/kg	<4	<4	<4	<4	<4
Fluoranthene	206-44-0	4	µg/kg	<4	<4	<4	<4	<4
Pyrene	129-00-0	4	µg/kg	<4	<4	<4	<4	<4
Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	<4	<4	<4
Chrysene	218-01-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	<4	<4	<4
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	<4	<4
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	<4	<4	<4
Perylene	198-55-0	4	µg/kg	<4	<4	<4	<4	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	<4	<4	<4
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	<4	<4
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	<5
^ Sum of PAHs	----	4	µg/kg	<4	<4	<4	<4	<4
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	<4	<4	<4	<4
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	5	5	5	5	5
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	10	10	10	10	10
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides								
Diuron	330-54-1	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
EP234I: Miscellaneous (ESI Positive Mode) Pesticides								
Irgarol	28159-98-0	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	85.5	78.2	94.0	76.7	81.0
Toluene-D8	2037-26-5	0.2	%	76.6	65.5	78.4	63.0	80.8
4-Bromofluorobenzene	460-00-4	0.2	%	72.0	71.4	71.1	69.3	89.5
EP090S: Organotin Surrogate								
Tripropyltin	----	0.5	%	116	119	110	81.2	113
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	86.6	91.1	87.7	89.3	101
Anthracene-d10	1719-06-8	10	%	121	122	102	127	124
4-Terphenyl-d14	1718-51-0	10	%	98.8	110	103	108	115

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	AJ.2	AJ.3	OA11	1530	SH
			Sampling date / time	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	01-May-2023 00:00	28-Apr-2023 00:00
Compound	CAS Number	LOR	Unit	EP2305754-006	EP2305754-007	EP2305754-008	EP2305754-009	EP2305754-010
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**43.0**	**42.1**	**32.2**	**28.4**	**44.4**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	**10**	**6**	**9**	**5**	**5**
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	<5	<5	<5
>C10 - C40 Fraction (sum)	----	3	mg/kg	**10**	**6**	**9**	**5**	**5**
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	**6**	**4**	**5**	<3	<3
C29 - C36 Fraction	----	5	mg/kg	<5	<5	<5	<5	<5
^ C10 - C36 Fraction (sum)	----	3	mg/kg	**6**	**4**	**5**	<3	<3
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	<0.5	**0.6**	**1.5**
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	<5	<5
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	<5
Acenaphthylene	208-96-8	4	µg/kg	**5**	<4	<4	<4	<4
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	<4

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	AJ.2	AJ.3	OA11	1530	SH
			Sampling date / time	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	01-May-2023 00:00	28-Apr-2023 00:00
Compound	CAS Number	LOR	Unit	EP2305754-006	EP2305754-007	EP2305754-008	EP2305754-009	EP2305754-010
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	<4
Phenanthrene	85-01-8	4	µg/kg	**47**	**4**	<4	<4	<4
Anthracene	120-12-7	4	µg/kg	**14**	<4	<4	<4	<4
Fluoranthene	206-44-0	4	µg/kg	**86**	**9**	<4	<4	**8**
Pyrene	129-00-0	4	µg/kg	**79**	**8**	<4	<4	**8**
Benz(a)anthracene	56-55-3	4	µg/kg	**28**	**4**	<4	<4	<4
Chrysene	218-01-9	4	µg/kg	**35**	**6**	<4	<4	<4
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	**32**	**4**	<4	<4	<4
Benzo(k)fluoranthene	207-08-9	4	µg/kg	**29**	**5**	<4	<4	<4
Benzo(e)pyrene	192-97-2	4	µg/kg	**14**	<4	<4	<4	<4
Benzo(a)pyrene	50-32-8	4	µg/kg	**29**	<4	<4	<4	<4
Perylene	198-55-0	4	µg/kg	**6**	<4	<4	<4	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	**12**	<4	<4	<4	<4
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	**9**	<4	<4	<4	<4
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	<5
^ Sum of PAHs	----	4	µg/kg	**425**	**40**	<4	<4	**16**
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	**39**	<4	<4	<4	<4
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	**41**	**6**	**5**	**5**	**5**
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	**43**	**10**	**10**	**10**	**10**
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	----	----	----	<0.0002	<0.0002
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	----	----	----	<0.0002	<0.0002
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	----	----	----	<0.0002	<0.0002
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	----	----	----	<0.0002	<0.0002
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	----	----	----	<0.0002	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	----	----	----	<0.0002	<0.0002
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	----	----	----	<0.001	<0.001

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	AJ.2	AJ.3	OA11	1530	SH
				Sampling date / time	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	01-May-2023 00:00	28-Apr-2023 00:00
Compound	CAS Number	LOR	Unit		EP2305754-006	EP2305754-007	EP2305754-008	EP2305754-009	EP2305754-010
					Result	Result	Result	Result	Result
EP231B: Perfluoroalkyl Carboxylic Acids - Continued									
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg		----	----	----	<0.0005	<0.0005
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg		----	----	----	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg		----	----	----	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg		----	----	----	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg		----	----	----	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg		----	----	----	<0.0005	<0.0005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg		----	----	----	<0.0005	<0.0005

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	AJ.2	AJ.3	OA11	1530	SH
				Sampling date / time	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	01-May-2023 00:00	28-Apr-2023 00:00
Compound	CAS Number	LOR	Unit		EP2305754-006	EP2305754-007	EP2305754-008	EP2305754-009	EP2305754-010
					Result	Result	Result	Result	Result
EP231D: (n:2) Fluorotelomer Sulfonic Acids - Continued									
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg		----	----	----	<0.0005	<0.0005
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg		----	----	----	<0.0005	<0.0005
EP231P: PFAS Sums									
Sum of PFAS	----	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
Sum of PFAS (WA DER List)	----	0.0002	mg/kg		----	----	----	<0.0002	<0.0002
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides									
Diuron	330-54-1	0.001	mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001
EP234I: Miscellaneous (ESI Positive Mode) Pesticides									
Irgarol	28159-98-0	0.001	mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001
EP080-SD: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**80.7**	**73.1**	**77.3**	**93.9**	**98.7**
Toluene-D8	2037-26-5	0.2	%		**76.8**	**85.5**	**72.8**	**89.1**	**79.3**
4-Bromofluorobenzene	460-00-4	0.2	%		**71.6**	**71.1**	**70.8**	**70.2**	**79.7**
EP090S: Organotin Surrogate									
Tripropyltin	----	0.5	%		**106**	**101**	**108**	**80.6**	**95.8**
EP132T: Base/Neutral Extractable Surrogates									
2-Fluorobiphenyl	321-60-8	10	%		**96.4**	**98.8**	**97.4**	**87.9**	**97.8**
Anthracene-d10	1719-06-8	10	%		**122**	**126**	**117**	**113**	**123**
4-Terphenyl-d14	1718-51-0	10	%		**104**	**108**	**122**	**118**	**113**
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.0002	%		----	----	----	**106**	**110**
13C8-PFOA	----	0.0002	%		----	----	----	**109**	**100**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	JBH.A	3000	3210	4000	4010
			Sampling date / time	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit	EP2305754-011	EP2305754-012	EP2305754-013	EP2305754-014	EP2305754-015
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**36.9**	**40.4**	**40.8**	**48.0**	**27.2**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	**4**	<3	**7**	<3	**6**
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	<5	<5	<5
>C10 - C40 Fraction (sum)	----	3	mg/kg	**4**	<3	**7**	<3	**6**
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C29 - C36 Fraction	----	5	mg/kg	<5	<5	**5**	<5	<5
^ C10 - C36 Fraction (sum)	----	3	mg/kg	<3	<3	**5**	<3	<3
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	<5	<5
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	<5
Acenaphthylene	208-96-8	4	µg/kg	<4	<4	<4	<4	<4
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	<4

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	JBH.A	3000	3210	4000	4010
			Sampling date / time	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit	EP2305754-011	EP2305754-012	EP2305754-013	EP2305754-014	EP2305754-015
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	<4
Phenanthrene	85-01-8	4	µg/kg	<4	<4	<4	<4	<4
Anthracene	120-12-7	4	µg/kg	<4	<4	<4	<4	<4
Fluoranthene	206-44-0	4	µg/kg	<4	<4	6	5	<4
Pyrene	129-00-0	4	µg/kg	<4	<4	6	5	<4
Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	<4	<4	<4
Chrysene	218-01-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	<4	<4	<4
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	<4	<4
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	<4	<4	<4
Perylene	198-55-0	4	µg/kg	<4	<4	<4	<4	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	<4	<4	<4
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	<4	<4
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	<5
^ Sum of PAHs	----	4	µg/kg	<4	<4	12	10	<4
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	<4	<4	<4	<4
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	5	5	5	5	5
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	10	10	10	10	10
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	----	----	<0.0002	----	<0.0002
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	----	----	<0.0002	----	<0.0002
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	----	----	<0.0002	----	<0.0002
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	----	----	<0.0002	----	<0.0002
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	----	----	<0.0002	----	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	----	----	<0.0002	----	<0.0002
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	----	----	<0.001	----	<0.001

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	JBH.A	3000	3210	4000	4010
				Sampling date / time	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit		EP2305754-011	EP2305754-012	EP2305754-013	EP2305754-014	EP2305754-015
					Result	Result	Result	Result	Result
EP231B: Perfluoroalkyl Carboxylic Acids - Continued									
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg		----	----	<0.0005	----	<0.0005
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg		----	----	<0.0005	----	<0.0005
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg		----	----	<0.0005	----	<0.0005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg		----	----	<0.0005	----	<0.0005
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg		----	----	<0.0005	----	<0.0005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg		----	----	<0.0005	----	<0.0005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg		----	----	<0.0005	----	<0.0005

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	JBH.A	3000	3210	4000	4010
				Sampling date / time	28-Apr-2023 00:00	28-Apr-2023 00:00	28-Apr-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit		EP2305754-011	EP2305754-012	EP2305754-013	EP2305754-014	EP2305754-015
					Result	Result	Result	Result	Result
EP231D: (n:2) Fluorotelomer Sulfonic Acids - Continued									
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg		----	----	<0.0005	----	<0.0005
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg		----	----	<0.0005	----	<0.0005
EP231P: PFAS Sums									
Sum of PFAS	----	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
Sum of PFAS (WA DER List)	----	0.0002	mg/kg		----	----	<0.0002	----	<0.0002
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides									
Diuron	330-54-1	0.001	mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001
EP234I: Miscellaneous (ESI Positive Mode) Pesticides									
Irgarol	28159-98-0	0.001	mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001
EP080-SD: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		84.6	89.4	93.2	73.0	84.6
Toluene-D8	2037-26-5	0.2	%		68.4	83.9	73.7	62.3	83.5
4-Bromofluorobenzene	460-00-4	0.2	%		74.6	78.6	88.0	70.9	74.6
EP090S: Organotin Surrogate									
Tripropyltin	----	0.5	%		97.2	81.8	93.6	92.9	110
EP132T: Base/Neutral Extractable Surrogates									
2-Fluorobiphenyl	321-60-8	10	%		91.2	88.9	85.3	86.1	94.8
Anthracene-d10	1719-06-8	10	%		115	127	111	117	119
4-Terphenyl-d14	1718-51-0	10	%		104	97.4	95.6	107	106
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.0002	%		----	----	104	----	108
13C8-PFOA	----	0.0002	%		----	----	100	----	114

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	4500	KBJ.A	4800	5020	C430
			Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit	EP2305754-016	EP2305754-017	EP2305754-018	EP2305754-019	EP2305754-020
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	48.4	46.2	53.8	38.0	47.4
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	7	4	8	4	12
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	<5	<5	<5
>C10 - C40 Fraction (sum)	----	3	mg/kg	7	4	8	4	12
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	6	<3	3	<3	6
C29 - C36 Fraction	----	5	mg/kg	<5	<5	6	<5	7
^ C10 - C36 Fraction (sum)	----	3	mg/kg	6	<3	9	<3	13
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	1.0	<0.5	<0.5	3.6
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	<5	<5
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	<5
Acenaphthylene	208-96-8	4	µg/kg	<4	<4	<4	<4	<4
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	<4

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	4500	KBJ.A	4800	5020	C430
				Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit		EP2305754-016	EP2305754-017	EP2305754-018	EP2305754-019	EP2305754-020
					Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued									
Fluorene	86-73-7	4	µg/kg		<4	<4	<4	<4	<4
Phenanthrene	85-01-8	4	µg/kg		<4	5	<4	<8	15
Anthracene	120-12-7	4	µg/kg		<4	<4	<4	<4	4
Fluoranthene	206-44-0	4	µg/kg		5	14	8	5	37
Pyrene	129-00-0	4	µg/kg		5	14	8	<4	29
Benz(a)anthracene	56-55-3	4	µg/kg		<4	5	<4	<4	16
Chrysene	218-01-9	4	µg/kg		<4	6	<4	<4	17
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg		<4	5	<4	<4	16
Benzo(k)fluoranthene	207-08-9	4	µg/kg		<4	8	5	<4	15
Benzo(e)pyrene	192-97-2	4	µg/kg		<4	<4	<4	<4	8
Benzo(a)pyrene	50-32-8	4	µg/kg		<4	4	<4	<4	13
Perylene	198-55-0	4	µg/kg		<4	<4	<4	<4	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg		<4	<4	<4	<4	8
Dibenz(a.h)anthracene	53-70-3	4	µg/kg		<4	<4	<4	<4	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg		<4	<4	<4	<4	6
Coronene	191-07-1	5	µg/kg		<5	<5	<5	<5	<5
^ Sum of PAHs	----	4	µg/kg		10	61	21	5	184
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg		<4	6	<5	<4	18
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg		5	8	5	5	20
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg		10	10	10	10	22
EP231A: Perfluoroalkyl Sulfonic Acids									
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
EP231B: Perfluoroalkyl Carboxylic Acids									
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg		----	<0.001	----	----	<0.001

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	4500	KBJ.A	4800	5020	C430
				Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit		EP2305754-016	EP2305754-017	EP2305754-018	EP2305754-019	EP2305754-020
					Result	Result	Result	Result	Result
EP231B: Perfluoroalkyl Carboxylic Acids - Continued									
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg		----	<0.0005	----	----	<0.0005
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg		----	<0.0005	----	----	<0.0005
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg		----	<0.0005	----	----	<0.0005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg		----	<0.0005	----	----	<0.0005
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg		----	<0.0005	----	----	<0.0005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg		----	<0.0002	----	----	<0.0002
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg		----	<0.0005	----	----	<0.0005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg		----	<0.0005	----	----	<0.0005

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	4500	KBJ.A	4800	5020	C430
			Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit	EP2305754-016	EP2305754-017	EP2305754-018	EP2305754-019	EP2305754-020
				Result	Result	Result	Result	Result
EP231D: (n:2) Fluorotelomer Sulfonic Acids - Continued								
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	----	<0.0005	----	----	<0.0005
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	----	<0.0005	----	----	<0.0005
EP231P: PFAS Sums								
Sum of PFAS	----	0.0002	mg/kg	----	<0.0002	----	----	<0.0002
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	----	<0.0002	----	----	<0.0002
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	----	<0.0002	----	----	<0.0002
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides								
Diuron	330-54-1	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
EP234I: Miscellaneous (ESI Positive Mode) Pesticides								
Irgarol	28159-98-0	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	**75.5**	**84.0**	**67.6**	**82.5**	**77.5**
Toluene-D8	2037-26-5	0.2	%	**60.4**	**68.0**	**56.2**	**68.8**	**63.3**
4-Bromofluorobenzene	460-00-4	0.2	%	**67.2**	**73.7**	**62.2**	**76.1**	**69.4**
EP090S: Organotin Surrogate								
Tripropyltin	----	0.5	%	**81.4**	**60.4**	**67.2**	**85.4**	**76.3**
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	**102**	**102**	**83.4**	**106**	**94.0**
Anthracene-d10	1719-06-8	10	%	**108**	**103**	**115**	**117**	**112**
4-Terphenyl-d14	1718-51-0	10	%	**123**	**102**	**104**	**110**	**116**
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	----	**112**	----	----	**108**
13C8-PFOA	----	0.0002	%	----	**104**	----	----	**102**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	OCB	G3.1	G3.2	G3.3	WS12
			Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit	EP2305754-021	EP2305754-022	EP2305754-023	EP2305754-024	EP2305754-025
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**49.9**	**31.9**	**30.9**	**30.2**	**39.0**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	**4**
>C16 - C34 Fraction	----	3	mg/kg	**6**	**6**	**9**	**8**	**50**
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	**5**	<5	**10**
>C10 - C40 Fraction (sum)	----	3	mg/kg	**6**	**6**	**14**	**8**	**64**
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	**4**
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	<3	**4**	**6**	**5**	**40**
C29 - C36 Fraction	----	5	mg/kg	<5	<5	**5**	<5	**15**
^ C10 - C36 Fraction (sum)	----	3	mg/kg	<3	**4**	**11**	**5**	**55**
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	<5	**5**
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	**10**
Acenaphthylene	208-96-8	4	µg/kg	<4	<4	<4	<4	<4
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	<4

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	OCB	G3.1	G3.2	G3.3	WS12
			Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit	EP2305754-021	EP2305754-022	EP2305754-023	EP2305754-024	EP2305754-025
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	<4
Phenanthrene	85-01-8	4	µg/kg	<4	<4	<4	<4	<8
Anthracene	120-12-7	4	µg/kg	<4	<4	<4	<4	<4
Fluoranthene	206-44-0	4	µg/kg	4	<4	<4	<4	<4
Pyrene	129-00-0	4	µg/kg	4	<4	<4	<4	<4
Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	<4	<4	<4
Chrysene	218-01-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	<4	<4	<4
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	<4	<4
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	<4	<4	<4
Perylene	198-55-0	4	µg/kg	<4	<4	<4	<4	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	<4	<4	<4
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	<4	<4
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	<5
^ Sum of PAHs	----	4	µg/kg	8	<4	<4	<4	15
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	<4	<4	<4	<4
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	5	5	5	5	5
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	10	10	10	10	10
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	----	----	----	----
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	----	----	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	OCB	G3.1	G3.2	G3.3	WS12
				Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit		EP2305754-021	EP2305754-022	EP2305754-023	EP2305754-024	EP2305754-025
					Result	Result	Result	Result	Result
EP231B: Perfluoroalkyl Carboxylic Acids - Continued									
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg		<0.0002	----	----	----	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg		<0.0002	----	----	----	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg		<0.0002	----	----	----	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg		<0.0002	----	----	----	----
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg		<0.0002	----	----	----	----
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg		<0.0002	----	----	----	----
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg		<0.0002	----	----	----	----
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg		<0.0002	----	----	----	----
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg		<0.0002	----	----	----	----
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg		<0.0005	----	----	----	----
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg		<0.0002	----	----	----	----
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg		<0.0005	----	----	----	----
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg		<0.0005	----	----	----	----
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg		<0.0005	----	----	----	----
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg		<0.0005	----	----	----	----
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg		<0.0002	----	----	----	----
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg		<0.0002	----	----	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg		<0.0005	----	----	----	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg		<0.0005	----	----	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	OCB	G3.1	G3.2	G3.3	WS12
				Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00
Compound	CAS Number	LOR	Unit		EP2305754-021	EP2305754-022	EP2305754-023	EP2305754-024	EP2305754-025
					Result	Result	Result	Result	Result
EP231D: (n:2) Fluorotelomer Sulfonic Acids - Continued									
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg		<0.0005	----	----	----	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg		<0.0005	----	----	----	----
EP231P: PFAS Sums									
Sum of PFAS	----	0.0002	mg/kg		<0.0002	----	----	----	----
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg		<0.0002	----	----	----	----
Sum of PFAS (WA DER List)	----	0.0002	mg/kg		<0.0002	----	----	----	----
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides									
Diuron	330-54-1	0.001	mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001
EP234I: Miscellaneous (ESI Positive Mode) Pesticides									
Irgarol	28159-98-0	0.001	mg/kg		<0.001	<0.001	<0.001	<0.001	<0.001
EP080-SD: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		71.5	72.0	82.8	78.1	68.5
Toluene-D8	2037-26-5	0.2	%		74.2	66.8	79.9	76.6	85.2
4-Bromofluorobenzene	460-00-4	0.2	%		74.8	68.8	79.4	77.8	75.5
EP090S: Organotin Surrogate									
Tripropyltin	----	0.5	%		85.6	56.2	40.2	64.2	64.9
EP132T: Base/Neutral Extractable Surrogates									
2-Fluorobiphenyl	321-60-8	10	%		80.2	97.2	105	102	128
Anthracene-d10	1719-06-8	10	%		85.0	110	112	112	128
4-Terphenyl-d14	1718-51-0	10	%		90.4	108	116	116	200
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.0002	%		102	----	----	----	----
13C8-PFOA	----	0.0002	%		102	----	----	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	WS27	Field Blank	Transport Blank	----	----
			Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	EP2305754-026	EP2305754-027	EP2305754-028	--------	--------
				Result	Result	Result	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**33.1**	<1.0	<1.0	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	----	----
>C16 - C34 Fraction	----	3	mg/kg	**8**	<3	<3	----	----
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	<5	----	----
>C10 - C40 Fraction (sum)	----	3	mg/kg	**8**	<3	<3	----	----
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	----	----
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	----	----
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	----	----
C15 - C28 Fraction	----	3	mg/kg	**4**	<3	<3	----	----
C29 - C36 Fraction	----	5	mg/kg	**6**	<5	<5	----	----
^ C10 - C36 Fraction (sum)	----	3	mg/kg	**10**	<3	<3	----	----
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	----	----
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	----	----
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	----	----
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	----	----
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	----	----
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	----	----
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	----	----
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	----	----
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	----	----	----	----
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	----	----
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	----	----
Acenaphthylene	208-96-8	4	µg/kg	<4	<4	<4	----	----
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	WS27	Field Blank	Transport Blank	----	----
			Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	EP2305754-026	EP2305754-027	EP2305754-028	--------	--------
				Result	Result	Result	----	----
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	----	----
Phenanthrene	85-01-8	4	µg/kg	<4	<4	<4	----	----
Anthracene	120-12-7	4	µg/kg	<4	<4	<4	----	----
Fluoranthene	206-44-0	4	µg/kg	<4	<4	<4	----	----
Pyrene	129-00-0	4	µg/kg	<4	<4	<4	----	----
Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	<4	----	----
Chrysene	218-01-9	4	µg/kg	<4	<4	<4	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	<4	----	----
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	----	----
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	----	----
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	<4	----	----
Perylene	198-55-0	4	µg/kg	<4	<4	<4	----	----
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	<4	----	----
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	----	----
Coronene	191-07-1	5	µg/kg	<5	<5	<5	----	----
^ **Sum of PAHs**	----	4	µg/kg	<4	<4	<4	----	----
^ **Benzo(a)pyrene TEQ (zero)**	----	4	µg/kg	<4	<4	<4	----	----
^ **Benzo(a)pyrene TEQ (half LOR)**	----	4	µg/kg	**5**	**5**	**5**	----	----
^ **Benzo(a)pyrene TEQ (LOR)**	----	4	µg/kg	**10**	**10**	**10**	----	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	----	<0.0002	<0.0002	----	----
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	----	<0.0002	<0.0002	----	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	----	<0.0002	<0.0002	----	----
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	----	<0.0002	<0.0002	----	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	----	<0.0002	<0.0002	----	----
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	----	<0.0002	<0.0002	----	----
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	----	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	WS27	Field Blank	Transport Blank	----	----
				Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	----	----
Compound	CAS Number	LOR	Unit		EP2305754-026	EP2305754-027	EP2305754-028	--------	--------
					Result	Result	Result	----	----
EP231B: Perfluoroalkyl Carboxylic Acids - Continued									
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg		----	<0.0005	<0.0005	----	----
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg		----	<0.0005	<0.0005	----	----
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg		----	<0.0005	<0.0005	----	----
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg		----	<0.0005	<0.0005	----	----
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg		----	<0.0005	<0.0005	----	----
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg		----	<0.0002	<0.0002	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg		----	<0.0005	<0.0005	----	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg		----	<0.0005	<0.0005	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	WS27	Field Blank	Transport Blank	----	----
			Sampling date / time	01-May-2023 00:00	01-May-2023 00:00	01-May-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	EP2305754-026	EP2305754-027	EP2305754-028	--------	--------
				Result	Result	Result	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids - Continued								
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	----	<0.0005	<0.0005	----	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	----	<0.0005	<0.0005	----	----
EP231P: PFAS Sums								
Sum of PFAS	----	0.0002	mg/kg	----	<0.0002	<0.0002	----	----
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	----	<0.0002	<0.0002	----	----
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	----	<0.0002	<0.0002	----	----
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides								
Diuron	330-54-1	0.001	mg/kg	<0.001	<0.001	<0.001	----	----
EP234I: Miscellaneous (ESI Positive Mode) Pesticides								
Irgarol	28159-98-0	0.001	mg/kg	<0.001	<0.001	<0.001	----	----
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	**75.7**	**84.5**	**89.4**	----	----
Toluene-D8	2037-26-5	0.2	%	**96.8**	**82.7**	**90.9**	----	----
4-Bromofluorobenzene	460-00-4	0.2	%	**71.2**	**74.6**	**89.9**	----	----
EP090S: Organotin Surrogate								
Tripropyltin	----	0.5	%	**46.5**	----	----	----	----
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	**115**	**103**	**115**	----	----
Anthracene-d10	1719-06-8	10	%	**118**	**109**	**105**	----	----
4-Terphenyl-d14	1718-51-0	10	%	**123**	**117**	**128**	----	----
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	----	**112**	**97.5**	----	----
13C8-PFOA	----	0.0002	%	----	**98.0**	**100**	----	----

Surrogate Control Limits

Sub-Matrix: SEDIMENT		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP080-SD: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	70	130
Toluene-D8	2037-26-5	70	130
4-Bromofluorobenzene	460-00-4	70	130
EP090S: Organotin Surrogate			
Tripropyltin	----	35	130
EP132T: Base/Neutral Extractable Surrogates			
2-Fluorobiphenyl	321-60-8	70	130
Anthracene-d10	1719-06-8	70	130
4-Terphenyl-d14	1718-51-0	70	130
EP231S: PFAS Surrogate			
13C4-PFOS	----	76	136
13C8-PFOA	----	78	131

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EP090: Organotin Compounds

(SOIL) EP090S: Organotin Surrogate

Analysis conducted by ALS Sydney, NATA accreditation no. 825, site no. 10911 (Chemistry) 14913 (Biology).

(SOIL) EP234I: Miscellaneous (ESI Positive Mode) Pesticides

(SOIL) EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

To: ALS	From: Marine and Freshwater Research Laboratory
Address:	Address: Murdoch University,
	90 South St, Murdoch, 6150
Phone:	Phone: 08 93602907
Email:	Email: k.wienczugow@murdoch.edu.au
Quote Number: EP/184/22	Job Number:WAMSI22-3 PO/ Account #:

Sample Preservation: None / Warm / Cool / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / Marine / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			TBT	irgarol/ diuron	TPH Sed	PAHs	PFAS 28 analytes			
1	OA1	28/4/23	x	x	x	x	x			
2	OA2	28/4/23	x	x	x	x	x			
3	OA3	28/4/23	x	x	x	x	x			
4	OA9	28/4/23	x	x	x	x	x			
5	AJ.1	28/4/23	x	x	x	x	x			
6	AJ.2	28/4/23	x	x	x	x	x			
7	AJ.3	28/4/23	x	x	x	x	x			
8	OA11	28/4/23	x	x	x	x	x			
9	1530	1/5/23	x	x	x	x	x			
10	SH	28/4/23	x	x	x	x	x			
11	JBH.A	28/4/23	x	x	x	x	x			
12	3000	28/4/23	x	x	x	x	x			
13	3210	28/4/23	x	x	x	x	x			
14	4000	1/5/23	x	x	x	x	x			
15	4010	1/5/23	x	x	x	x	x			
16	4500	1/5/23	x	x	x	x	x			
17	KBJ.A	1/5/23	x	x	x	x	x			
18	4800	1/5/23	x	x	x	x	x			
19	5020	1/5/23	x	x	x	x	x			
20	C430	1/5/23	x	x	x	x	x			

Environmental Division Perth
Work Order Reference
EP2305754

Telephone : -- 61-8-9406 1301

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
K.Wienczugow	3/5/23	1100		3/5	1300	
Sample Condition:						

Please acknowledge receipt of samples by signing, stating sample condition, quoting job number and returning to the sender by email.

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

To:	From: Marine and Freshwater Research Laboratory
Address:	Address: Murdoch University,
	90 South St, Murdoch, 6150
Phone:	Phone: 08 93602907
Email:	Email: k.wienczaugow@murdoch.edu.au
Quote Number: EP/184/22	Job Number: WAMSI22-3PO/ Account #:

Sample Preservation: None / Warm / Cool / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / Marine / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			TBTs	irgarol/ diuron	TPH Sed	PAHs	PFAS 28	analytes		
21	OCB	1/5/23	x	x	x	x	x			
22	G3.1	1/5/23	x	x	x	x	x			
23	G3.2	1/5/23	x	x	x	x	x			
24	G3.3	1/5/23	x	x	x	x	x			
25	WS12	1/5/23	x	x	x	x	x			
26	WS27	1/5/23	x	x	x	x	x			
27	Field Blank	1/5/23	x	x	x	x	x			
28	Transport Blank	1/5/23	x	x	x	x	x			
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
K.wienczugow	3/5/23	1100				
Sample Condition:						

Please acknowledge receipt of samples by signing, stating sample condition, quoting job number and returning to the sender by email.

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
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www.mpl.com.au

Certificate of Analysis PEE0276

Client Details

Client	Marine and Freshwater Research Lab
Contact	Krzysztof (Kris) Wienczugow
Address	90 South Street., Murdoch, WA, 6150

Sample Details

Your Reference	WAMSI22-3
Number of Samples	2 Sediment
Date Samples Received	03/05/2023
Date Samples Registered	03/05/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	10/05/2023
Date of Issue	09/05/2023

Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Travis Carey, Organics Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PEE0276

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEE0276-01	JBH.B	Sediment	28/04/2023	03/05/2023
PEE0276-02	KBJ.B	Sediment	01/05/2023	03/05/2023

Triazine Herbicides (Sediment)

Envirolab ID	Units	PQL	PEE0276-01	PEE0276-02
Your Reference			JBH.B	KBJ.B
Date Sampled			28/04/2023	01/05/2023
Simazine	µg/kg	10	<10	<10
Atrazine	µg/kg	10	<10	<10
Propazine	µg/kg	10	<10	<10
Terbuthylazine	µg/kg	10	<10	<10
Metribuzin	µg/kg	50	<50	<50
Ametryn	µg/kg	10	<10	<10
Prometryn	µg/kg	10	<10	<10
Terbutryn	µg/kg	10	<10	<10
Cyanazine	µg/kg	10	<10	<10
Irgarol	µg/kg	10	<10	<10
Hexazinone	µg/kg	10	<10	<10
Surrogate p-Terphenyl-D14	%		*66.7*	*61.9*

Certificate of Analysis PEE0276

Inorganics - Moisture (Sediment)

Envirolab ID	Units	PQL	PEE0276-01	PEE0276-02
Your Reference			JBH.B	KBJ.B
Date Sampled			28/04/2023	01/05/2023
Moisture	%	0.10	32	39

Method Summary

Method ID	Methodology Summary
INORG-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
ORG-025	Determination of semi-volatile organic compounds (SVOCs) by GC-MS-MS. Water samples are extracted by LLE and soils/solids using DCM/Acetone/Methanol.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PEE0276

Client Details

Client	Marine and Freshwater Research Lab
Your Reference	WAMSI22-3
Date Issued	09/05/2023

Recommended Holding Time Compliance

No recommended holding time exceedances

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PEE0276

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
Triazines NAGD | Soil	2	01/05/2023	04/05/2023	05/05/2023	Yes
	1	28/04/2023	04/05/2023	05/05/2023	Yes
Moisture | Soil	2	01/05/2023	04/05/2023	04/05/2023	Yes
	1	28/04/2023	04/05/2023	04/05/2023	Yes

Quality Control PEE0276

ORG-025|Triazine Herbicides (Soil) | Batch BEE0536

Analyte	Units	PQL	Blank	DUP1 PEE0276-01 Samp | QC | RPD %	LCS %	Spike % PEE0276-02
Simazine	µg/kg	10	<10	<10 | <10 | [NA]	[NA]	[NA]
Atrazine	µg/kg	10	<10	<10 | <10 | [NA]	67.7	69.6
Propazine	µg/kg	10	<10	<10 | <10 | [NA]	63.0	60.7
Terbuthylazine	µg/kg	10	<10	<10 | <10 | [NA]	[NA]	[NA]
Metribuzin	µg/kg	50	<50	<50 | <50 | [NA]	[NA]	[NA]
Ametryn	µg/kg	10	<10	<10 | <10 | [NA]	[NA]	[NA]
Prometryn	µg/kg	10	<10	<10 | <10 | [NA]	77.4	71.7
Terbutryn	µg/kg	10	<10	<10 | <10 | [NA]	[NA]	[NA]
Cyanazine	µg/kg	10	<10	<10 | <10 | [NA]	[NA]	[NA]
Irgarol	µg/kg	10	<10	<10 | <10 | [NA]	[NA]	[NA]
Hexazinone	µg/kg	10	<10	<10 | <10 | [NA]	[NA]	[NA]
Surrogate p-Terphenyl-D14	*%*		*97.2*	*66.7 | 85.0*	*90.6*	*61.4*

INORG-008|Inorganics - Moisture (Soil) | Batch BEE0529

Analyte	Units	PQL	Blank	DUP1 BEE0529-DUP1# Samp | QC | RPD %	DUP2 BEE0529-DUP2# Samp | QC | RPD %	LCS %
Moisture	%	0.1		4.39 | 4.44 | 1.13	6.36 | 5.79 | 9.38	[NA]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

To: MPL	From: Marine and Freshwater Research Laboratory
Address:	Address: Murdoch University,
	90 South St, Murdoch, 6150
Phone:	Phone: 08 93602907
Email:	Email: k.wienczugow@murdoch.edu.au
Quote Number: via email Kiara Lockerbie 3/5/23	Job Number: WAMSI22-3 PO/ Account #:

Sample Preservation: None / Warm / Cool / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / Marine / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			Irgarol							
1	JBH.B	28/4/23	x							
2	KBJ.B	1/5/23	x							
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

empl Laboratories ENVIROLAB GROUP
Job No. PEE0216
Date Rec - 3/05/23
Time Rec - 1435
Rec By - SN
TAT Req - SAME 1 / 2 / 3 / STD
Temp - cool / ambient 4
Cooling - Ice / Ice pack / None
Security Seal - Yes / No

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
.Wienczugoiw	3/5/23	1200	SN	3/05/23	1435	
Sample Condition:						

Please acknowledge receipt of samples by signing, stating sample condition, quoting job number and returning to the sender by email.

Australian Government

National Measurement Institute

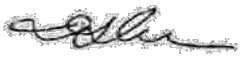
QUALITY ASSURANCE REPORT

Client: MURDOCH UNIVERSITY

NMI QA Report No: MURD03/230504 **Sample Matrix:** Solid

Analyte	Method	LOR	Blank	Sample Duplicates			Recoveries	
				Sample	Duplicate	RPD	LCS	Matrix Spike
		mg/kg	mg/kg	mg/kg	mg/kg	%	%	%
Organics Section								
BTEX								
Benzene	NGCMS_1121	0.5	<0.5	NA	NA	NA	107	NA
Toluene	NGCMS_1121	0.5	<0.5	NA	NA	NA	108	NA
Ethyl Benzene	NGCMS_1121	0.5	<0.5	NA	NA	NA	107	NA
m, p - Xylene	NGCMS_1121	1	<1	NA	NA	NA	103	NA
o-Xylene	NGCMS_1121	0.5	<0.5	NA	NA	NA	105	NA
TRH								
TRH C6-C10	NGCMS_1121	25	<25	NA	NA	NA	106	NA
TRH >C10-C16	NGCMS_1112	50	<50	NA	NA	NA	101	NA
TRH >C16-C34	NGCMS_1112	100	<100	NA	NA	NA	107	NA
TRH >C34-C40	NGCMS_1112	100	<100	NA	NA	NA	-	NA
Surrogate: TOL-D8	NGCMS_1121	-	-	NA	NA	NA	100	NA

Results expressed in percentage (%) or mg/kg wherever appropriate.
Acceptable Spike recovery is 70-130% (BTEX and TRH C6-C10); 50-150% (TRH >C10-C40)
Maximum acceptable RPDs on spikes and duplicates is 40%.
'NA ' = Not Applicable.
RPD= Relative Percentage Difference.

Signed: 

Danny Slee
Organics Manager, NMI-North Ryde

Date: **9/05/2023**

Australian Government

National Measurement Institute

QUALITY ASSURANCE REPORT

Client: MURDOCH UNIVERSITY

NMI QA Report No: MURD03/230504 **Sample Matrix:** Solid

Analyte	Method	LOR	Blank	Sample Duplicates			Recoveries	
				Sample	Duplicate	RPD	LCS	Matrix Spike
		mg/kg	mg/kg	mg/kg	mg/kg	%	%	%
				N23/008625				
PFBA (375-22-4)	NR70	0.0005	<0.0005	<0.0005	<0.0005	-	108	NA
PFPeA (2706-90-3)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	107	NA
PFHxA (307-24-4)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	100	NA
PFHpA (375-85-9)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	102	NA
PFOA (335-67-1)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	104	NA
PFNA (375-95-1)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	107	NA
PFDA (335-76-2)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	99	NA
PFUdA (2058-94-8)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	107	NA
PFDoA (307-55-1)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	106	NA
PFTrDA (72629-94-8)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	112	NA
PFTeDA (376-06-7)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	98	NA
PFHxDA (67905-19-5)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	117	NA
PFODA (16517-11-6)	NR70	0.0005	<0.0005	<0.0005	<0.0005	-	102	NA
FOUEA (70887-84-2)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	108	NA
PFBS (375-73-5)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	99	NA
PFPeS (2706-91-4)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	106	NA
PFHxS (355-46-4)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	100	NA
PFHpS (375-92-8)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	104	NA
PFOS (1763-23-1)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	103	NA
PFNS (68259-12-1)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	102	NA
PFDS (335-77-3)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	98	NA
PFOSA (754-91-6)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	101	NA
N-MeFOSA (31506-32-8)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	79	NA
N-EtFOSA (4151-50-2)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	110	NA
N-MeFOSAA (2355-31-9)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	102	NA
N-EtFOSAA(2991-50-6)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	106	NA
N-MeFOSE (24448-09-7)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	108	NA
N-EtFOSE (1691-99-2)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	109	NA
4:2 FTS (757124-72-4)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	97	NA
6:2 FTS (27619-97-2)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	97	NA
8:2 FTS (39108-34-4)	NR70	0.0001	<0.0001	<0.0001	<0.0001	-	101	NA
10:2 FTS (120226-60-0)	NR70	0.0002	<0.0002	<0.0002	<0.0002	-	100	NA
8:2 diPAP (678-41-1)	NR70	0.0005	<0.0005	<0.0005	<0.0005	-	102	NA

Results expressed in percentage (%) or mg/kg wherever appropriate.
Acceptable Spike recovery is 50-150%.
Maximum acceptable RPDs on spikes and duplicates is 40%.
'NA ' = Not Applicable.
RPD= Relative Percentage Difference.

Signed:

Danny Slee
Organics Manager, NMI-North Ryde

Date: **17/05/2023**

Australian Government
National Measurement Institute

QUALITY ASSURANCE REPORT

Client: MURDOCH UNIVERSITY

NMI QA Report No: MURD03/230504 QA **Sample Matrix:** Sediment

Analyte	Method	LOR	Blank	Duplicates			Recoveries	
				Sample	Duplicate	RPD	Matrix spk	LCS
		mg/kg	mg/kg	mg/kg	mg/kg	%	%	%
Inorganics Section				**N23/008624**			**N23/008624**	
Carbon - Total Organic	NW_S15	200	<200	4000	3900	2.5	NA	99

Filename = N:\North Ryde\Data\Inorganics\WATER SECTION\TOC\TOCS 2023\CSV\

Legend
Acceptable recovery is 80 -120 %.
Acceptable RPDs on duplicates is 40% at > 5 times LOR. Greater RPD may be expected at < 5 LOR.
LOR = Limit Of Reporting
RPD = Relative Percent Difference
LCS = Laboratory Control Sample
ND = Not Determined
NA = Not Applicable

Comments
This report shall not be reproduced except in full.
Results greater than ten times LOR have been rounded to two significant figures.

Signed:

Dr Andrew Evans
Inorganics Manager, NMI-North Ryde
Date: **12/05/2023**

Australian Government
National Measurement Institute

QUALITY ASSURANCE REPORT

Client: BMT

NMI QA Report No: MURD03/230504 T1 **Sample Matrix:** Sediment

Analyte	Method	LOR	Blank	Duplicates			Recoveries	
				Sample	Duplicate	RPD	LCS	Matrix Spike
		mg/kg	mg/kg	mg/kg	mg/kg	%	%	%
Inorganics Section				N23/008624				N23/008624
Aluminium	NT2.49	1	<1	820	730	12	113	104
Antimony	NT2.49	0.5	<0.5	<0.5	<0.5	NA	101	101
Arsenic	NT2.49	0.5	<0.5	1.3	1.2	8	109	105
Cadmium	NT2.49	0.5	<0.5	<0.5	<0.5	NA	92	100
Chromium	NT2.49	0.5	<0.5	6.9	6.5	6	97	104
Copper	NT2.49	0.5	<0.5	1.4	1.4	0	103	98
Iron	NT2.49	1	<1	1060	960	10	96	102
Lead	NT2.49	0.5	<0.5	2.1	1.9	10	98	97
Manganese	NT2.49	0.5	<0.5	8.5	8.3	2	99	102
Mercury	NT2.49	0.5	<0.5	<0.2	<0.2	NA	94	100
Nickel	NT2.49	0.5	<0.5	0.88	0.87	1	96	99
Phosphorus	NT2.49	1	<1	240	220	9	94	101
Silver	NT2.49	0.5	<0.5	<0.5	<0.5	NA	91	98
Zinc	NT2.49	0.5	<0.5	5.0	5.7	13	98	97

Filename = K:\Inorganics\Trace Elements Instrument Data\Processed data\ICPAES\Agilent 5110ICPOES Processed data 2

Legend:
Acceptable recovery is 75-120%.
Acceptable RPDs on duplicates is 44% at concentrations >5 times LOR. Greater RPD may be expected at <5 times LOR.
LOR = Limit Of Reporting ND = Not Determined
RPD = Relative Percent Difference NA = Not Applicable
LCS = Laboratory Control Sample.
#: Spike level is less than 50% of the sample's concentration, hence the recovery data canot be reported.
**: reference value not available
* sample was not spiked for this element
Comments:
Results greater than ten times LOR have been rounded to two significant figures.

Signed:

Dr Andrew Evans
Inorganics Section, NMI-North Ryde
Date: **16/05/2023**

√ 15/5

NMI CHAIN OF CUSTODY (SAMPLE SUBMISSION) FORM

ENVIRONMENTAL SAMPLES to be submitted to:

NMI: 105 Delhi Rd, North Ryde NSW 2113 Ph: 1300 722 845 email: customerservice@measurement.gov.au

SENT FROM:			Internal use only
Company Name:	Murdoch University (Marine and Freshwater Research Laboratory)		**NMI Quote Number:** MURD03B-DS2304N **Valid until:** June 30, 2023
Address:	Murdoch University, 90 South Street, Murdoch, WA 6150	Murdoch University, 90 South Street, Murdoch, WA 6150	**LIMS Reference:** QT-02232 D
Contact:	Krzysztof Wienczugow	**Additional email(s) for report**	**TURN AROUND TIME REQUESTED (Working days):**
Phone:	08 9360 6907 / 0414 352907		24 hrs (100%) / 48 hrs (50%) / 3-4 (25%) / 5-7 Standard / 10 Standard / 20 dioxins / other (please specify)
ABN:	61 616 369 313	**Email for invoice (if required):**	*Fast TATs are not available for all tests and MUST be agreed to prior to sample submission
Contact email:	k.wienczugow@murdoch.edu.au	k.wienczugow@murdoch.edu.au	

If a PO number is required on your invoice, it must be provided at sample submission. PO's received after sample submisison will not appear on final invoice **Purchase order required: Y / N** **PO Number:**

MURD03/2305 04 WW

NMI LRN (NMI USE ONLY - please do not write in this column)	SAMPLE REFERENCE (Sample ID / Description / Number)	DATE & TIME SAMPLED	SAMPLE MATRIX (water / soil / biota)	Trace elements - Al, Sb, As, B, Cd, Co, Cu, Cr, Pb, Mn, Mo, Ni, Se, Ag, V, Zn	Mercury (Hg) - low level	Solids - Total (required for reporting on a dry weight basis) *	BTEX & Naphthalene	TPH C6-C9 / TPH C10-C40	PFAS - LOW LEVEL SUITE	Organotins - Monobutyltin, Dibutyltin, Tributyltin	Carbon - Total Organic (TOC)	NR47 - Full Suite	NR47 - Herbicides only	LCMS Pesticides screen - NRS1 - Incl. Diuron				COMMENTS
N23/008624	JBH-B	28/04/23	sediment	X	X	X	X	X		X	X		X					
N23/008625	KBJ.B	1/05/23	sediment	X	X	X	X	X	X	X	X		X					
DO NOT FILL NMI USE ONLY																		

RECEIVED
04 MAY 2023
BY: MZ 9.00 C

Relinquished by: K. Wienczugow
Print Name:
Date & Time: 3/5/23 / 13:00 hrs
Signature:

Received at NMI laboratory by:
Print Name:
Date & Time: / / : hrs
Signature:

PAGE No: of **PAGES**

If multiple pages, ensure ALL pages are stapled together

8.2 Field Sheets

WAMSI WESTPORT MONITORING

Marine and Freshwater Research Laboratory Environmental Science
MURDOCH UNIVERSITY

MAFRL JOB CODE: WAMS23-3 | DATE: 1/5/2023

LOCATION: Cockburn Sound and Warnbro Sound
FIELD OPERATORS: Kris Wieczygow Heather Denham Ben Carter-Pesci Celeste Wilson

SITE	TIME	Depth	2 x 70mL PP and a ziplock	3 x 150 mL glass	PFAS 200 mL HDPE	WEATHER CONDITIONS (wind direction/strength, % cloud cover)	Sediment description (colour, size estimation, sorting etc)
4000	9:30	21.1	✓✓✓	✓✓✓		SE 2-5knts 2% CC	14, v.fine, well sorted, no smell
4500	10:10	18.1	✓✓✓	✓✓✓		" "	14, very fine, well sorted, no smell
KBJ (AB)	1050	16.7	✓✓✓x2	✓✓✓x2	✓x2	" 5% CC	15, fine, mod sort, no smell
4010	10:24	3.6	✓✓✓	✓✓✓	✓	" 5% CC	14, medium, mod sort, slight smell
4800	11:11	20.2	✓✓✓	✓✓✓		" "	15 very fine, well sorted, no smell
5020	1413	3.3	✓✓✓	✓✓✓		SSW 7-9knt 10% CC	19 med, " " no smell
C430	12:04	10.3	✓✓✓	✓✓✓	✓	SE 2-5knts 5% CC	14, fine, well sorted, no smell
OCB	11:39	16.7	✓✓✓	✓✓✓	✓	SE 2-5 knts 5% CC	15 v.fine, well sorted no smell
WS27	1253	19.2	✓✓✓	✓✓✓		SW 7-9knts 10% CC	15, medium, sorted, no smell,
WS12	1315	2.4	✓✓✓	✓✓✓		" "	14, medium, well sorted, no smell
Field Blank	1513	—	✓✓	✓✓	✓		
Transport Blank	9:00	—	✓✓	✓✓	✓		

Important Information: 1,2,3 triplicates (3 separate samples); A, B splits (1 sample split into 2)

Relinquished by:	Date:	Time:	Received by:	Date:	Time:	Sample Condition:
K. Wieczygow	1/5/2023	1700	J Woodward	1/5/23	1700	0-6°C

WAMSI WESTPORT MONITORING

Marine and Freshwater Research Laboratory Environmental Science
MURDOCH UNIVERSITY

MAFRL JOB CODE: WAMS23-22-3 | DATE: 28/4/2023

LOCATION: Owen Anchorage and North Cockburn Sound
FIELD OPERATORS: Kris Wienczugow, Heather Denham, Ben Cramer-Pesci, Celeste Wilson

SITE	TIME	Depth	2 x 70mL PP and a ziplock	3 x 150 mL glass	PFAS 200 mL HDPE	WEATHER CONDITIONS (wind direction/strength, % cloud cover)	Sediment description (colour, size estimation, sorting etc)
OA2	10:06	16.0	√√ √	√√√		SE 2-5knts; 2% cloud cover	14, Fine, well sorted, no smell
OA3	1100	10.9	√√ √	√√ √		" "	9, Coarse, well sorted, No Smell
G3(123)	1135	15.0	√√√ x3	√√√ x3		" "	14, Fine, well sorted/organic, smell
OA1	1551	6.3	√√√	√√√			14, Medium, well sorted, no smell
OA11	1525	6.3	√√√	√√√			14, medium, mod sort, no smell
OA9	1455	7.0	√√√	√√√			14, fine, well sorted, no smell
AJ (123)	1423	9.4	√√3	√√3			14, fine, well sorted, no smell, tiny green filaments also present
1530	1455	5.8	√√√	√√√	√	SW 14-16knts 15% CC	10 medium mod sorted, no smell
SH	~~13:35~~ 13:35	~~12.4~~ 12.1	√√√	√√√	√	" " "	14, Fine well sorted, silt + fine sand, no smell
JBH (AB)	1356	10.1	√√√	√√√			18, medium, well sorted, no smell
3000	12:33	19.5	√√ √	√√ √		SSE 2-5kts 55% CC	14, v. Fine, well sorted, no smell
3210	1310	11.9	√√ √	√√ √	√	" "	14, coarse, shell + shellgrit poorly sorted

Important Information: 1,2,3 triplicates (3 separate samples); A, B splits (1 sample split into 2)

Relinquished by:	Date:	Time:	Received by:	Date:	Time:	Sample Condition:
K. Wienczugow	28/4/2023	1700	J Woodman	1/5/23	1700	0-6°C

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