

Delta Coal Manning & CVC Collieries

**Lake Macquarie Benthos Survey
Results No. 24**



By Dr Emma Laxton

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**J.H. & E.S. Laxton - Environmental Consultants P/L
Mobile: 0429 855 891 Email: emmalaxton07@gmail.com**

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Summary

J.H. & E.S. Laxton – Environmental Consultants P/L was engaged by Chain Valley Colliery to assess the potential effects of bord and pillar extraction mining beneath Lake Macquarie on benthic fauna.

The benthic survey was conducted on 8th, 13th and 18th March 2024 by Dr Emma Laxton of J.H. & E.S. Laxton – Environmental Consultants P/L. The survey involved the collection of benthos at 24 stations. The stations consisted of seven Control, five Reference and twelve Impact stations.

A total of 1369 benthic marine organisms greater than 1 mm in size were captured in the study area of Lake Macquarie during the survey. These organisms represented sixteen species. The fauna included one nemertean species, seven species of polychaete worm; six species of bivalve; one species of ophuroid; and one crab species. The greatest numbers of organisms were collected at station IM10 (127 organisms), and the least numbers of organisms at station IM4 (14 total). The number of organisms collected ranged from 27 to 117 organisms at control monitoring stations; 29 to 103 organisms at reference stations; and 16 to 127 organisms at the impact monitoring stations.

The bivalve *Theora lubrica* was the most commonly encountered organism. A total of 455 *Theora* were recorded during the survey, representing 33 percent of the organisms collected. The abundance of *T. lubrica* at each station ranged from 0 to 88.

Polychaete worms were also common in the benthos. A total of 497 were recorded, representing 36 percent of the organisms collected. Of the polychaetes, *Sthenelais petitiboneae* was the most represented and widespread.

Other species recorded included the bivalves *Corbula truncata*, *Paphia undulata*, and *Dosinia sculpta*; and the polychaete *Chaetopterus*.

Very few mussels were found alive during the survey. *Trichomya hirsuta* was found alive at IM1, IM11 and IM5 in small abundances only.

Theora lubrica, *Corbula sp*, *Paphia undulata*, *Sthenelais petitiboneae* and the polychaete designated as P2 were found in benthos collected from -4.5m to -6m AHD. *Chaetopterus* and *Dosinia* were found in samples collected from -5.5m AHD and over. Benthos with high portions of silt had benthic communities dominated by polychaete worms and the bivalves *T. lubrica* and *Corbula*. Benthic monitoring stations with sediments predominately comprised of sand had benthic communities dominated by *Dosinia sculta* and *Chaetopterus*.

Species diversity at each station ranged from 4 to 13 species and was comparable with previous years. In March 2024, Control stations had a range of 6 to 9 species; Reference stations had a range of 4 to 9 species; and the Impact stations had a range of 4 to 13 species.

There was variation between the sediments collected at each station within the study area. In March 2024, the sediment in the mud basin of Lake Macquarie off Summerland Point, Chain Valley Bay and Bardens Bay was largely composed of fine grey silt that was mildly plastic in nature (able to be molded into a coherent shape). Small to large shell fragments were also present in the sediment at most of these benthic monitoring stations. Sediment collected at stations C5, C7 and R13 contained a large amount of grey sand. The sediment samples collected at C4, IM5, IM8 and IM11 comprised a high portion of shell.

Rainfall in the months preceding the survey of March 2024 was 37.6 mm and 112.0 mm for January and February 2024 respectively (Cooranbong Lake Macquarie AWS No. 061412). By 18th March a further 17.4 mm had fallen in the catchment.

In March 2024, water temperature, conductivity, salinity and pH were uniform throughout the water column. The concentration of dissolved oxygen declined with water depth at many stations. Testing of the bottom water at each station found dissolved oxygen ranged from 70.4% to 89.9%. Mean dissolved oxygen of bottom waters was 81.89% saturation. Water temperature ranged from 25.18°C to 26.48°C, with a mean water temperature of 25.80°C. Conductivity ranged from 55.17 mS/cm to 55.90 mS/cm. Mean conductivity of bottom water was 55.53 mS/cm. Salinity ranged from 36.55 ppt to 37.10 ppt, with a mean salinity of 36.82 ppt. Turbidity ranged from 0.2 NTU to 17.7 NTU. Mean turbidity was 10.45 NTU. pH ranged from 7.55 to 8.72, average pH was 7.91.

These findings are comparable to previous water quality testing of bottom waters. For instance, in March 2021, March 2022 and March 2023, average dissolved oxygen concentrations of bottom waters were 88.9% saturation, 90.0% saturation and 88.35% saturation respectively. Average water temperature of bottom waters was 24.93°C in March 2021, 26.90°C in March 2022 and 25.80°C in March 2023. Average conductivity of bottom waters was 51.88 mS/cm in March 2021 and 53.77 mS/cm in March 2022, and 57.48 mS/cm in March 2023. Salinity of bottom waters had a mean of 34.1 ppt in March 2021, an average of 35.6 ppt in March 2022, and was 35.28 ppt in March 2023. pH of bottom waters in March 2021, March 2022 and March 2023 averaged 7.98, 8.58 and 7.73 respectively.

1. Introduction

Lake Macquarie is the largest saline lake in New South Wales. It lies on the central coast between Sydney and Newcastle within the local government areas of Central Coast Council and Lake Macquarie Council. Lake Macquarie has a catchment of 700 square kilometers and a water surface area of 110 square kilometers. The average depth of the lake is 8 metres (26 ft), with a maximum depth of 15 metres (49 ft). The lake has a permanent entrance to coastal waters at Swansea, and a shore length of approximately 174 kilometres.

The catchment of Lake Macquarie is largely rural with large areas of bushland and grazing land. The shoreline of Lake Macquarie is heavily urbanized, especially the eastern, western and northern shorelines. The region has a relatively long history of coal mining and power generation, with mining occurring since the late 1800s and the first power station at Lake Macquarie commencing operations in 1958.

Chain Valley Colliery (CVC) is an underground coal mine situated on the southern shores of Lake Macquarie about 1 kilometre south-east of the township of Mannering Park, NSW. It is located approximately 60 kilometres south of Newcastle and 80 kilometres north of Sydney. The mine has been operating since 1963. Mining is continuing within the Chain Valley Coal Lease Area using the miniwall method. Prior to mining, there were three economically viable seams in the lease area, namely the Wallarah seam (not mined since 1997); the Great Northern seam, and the Fassifern seam. In 2018 CVC went into voluntary receivership and was taken over by Great Southern Energy Pty Ltd (trading as Delta Coal) to provide coal for Vales Point Power Station.

Delta Coal is currently mining the Fassifern Seam beneath Lake Macquarie. To protect the lake foreshore, a protection zone has been established as part of the extraction plan. This zone, known as the High Water Mark (HWM) Subsidence Barrier, was calculated using a 35° angle of draw from the depth of mining. The zone is approximately 130 meters wide. J.H. & E.S. Laxton – Environmental Consultants P/L was engaged by Chain Valley Colliery to assess the impact of previous miniwall mining on benthic fauna in Lake Macquarie. The mine is currently undertaking first workings.

In March 2024, the monitoring programme consisted of 24 stations, seven Control, five Reference and twelve Impact stations. Control stations are in areas of lakebed sufficiently remote from previous or proposed mining. Reference stations are located in areas of lakebed above subsidence areas of previous mining. Impact stations are in areas of lakebed where subsidence is expected/ experienced from previous workings or proposed future workings. Two depth zones within the mud basin were sampled, -4.5m AHD and -5.5 to -6.0m AHD.

Over the years, as mining has progressed, reference stations have been reclassified as impact stations. Three more reference stations (R7, R8, R11) were reclassified as impact stations prior to this survey. Due to this reclassification and in preparation for future extraction plans, two reference stations were added to the study (R12 and R13).

This report presents the results of the just completed 24th sampling of stations situated off Summerland Point, in Chain Valley Bay, Bardens Bay and Sugar Bay. These results will be compared with those obtained from the previous surveys (February 2012 to March 2023). The March 2024 benthic survey was conducted on the 8th, 13th and 18th March. Water quality variables were measured on 18th March.

2. Location of sampling stations

Figure 2.1 shows the location of benthic monitoring stations, mine workings, and the SSD-S465 Consent boundary for March 2024. **Table 2.1** provides the exact location of each sampling station by latitude and longitude and by eastings and northings using WGS84 datum. The table also shows the depth of water at each station. **Figure 2.2** shows the development consent areas for Delta Coal.



Figure 2.1 Location of benthic sampling stations and mine workings

Table 2.1 Co-ordinates and water depth at each benthic sampling station

Station	Sample depth m AHD	Latitude	Longitude	MG-56 Easting	MG56 Northing
C1	-4.50	S33° 09' 10.69"	E 151° 32' 50.11"	364519	6330815
C2	-4.50	S33° 08' 02.89"	E 151° 33' 56.65"	366214	6332927
C3	-5.50	S33° 07' 55.78"	E 151° 33' 49.05"	366014	6333144
C4	-6.00	S33° 08' 06.35"	E 151° 32' 41.17"	364260	6332794
C5	-6.00			367701	6334310
C6	-5.50			363988	6332492
C7	-5.50			366276	6334947
R1	-4.50	S33° 08' 47.18"	E 151° 32' 37.31"	364177	6331535
R9	-4.50			365258	6331210
R10	-5.50			365172	6334706
R12	-5.50			365919	6330294
R13	-6.00			366357	6334708
IM1	-4.50	S33° 09' 13.44"	E 151° 32' 58.51"	364738	6330734
IM2	-4.50	S33° 08' 24.67"	E 151° 33' 03.34"	364842	6332237
IM3	-5.50	S33° 08' 29.02"	E 151° 32' 57.52"	364693	6332101
IM4	-6.00	S33° 08' 09.42"	E 151° 32' 57.04"	364873	6332705
IM5 (R3)	-5.50	S33° 08' 00.10"	E 151° 32' 56.72"	364660	6332992
IM6 (R4)	-6.00	S33° 08' 07.58"	E 151° 33' 00.88"	364771	6332763
IM7 (R5)	-5.50	S33° 07' 30.78"	E 151° 32' 40.55"	364229	6333889
IM8 (R6)	-6.00	S33° 07' 22.56"	E 151° 32' 52.42"	364533	6334146
IM9 (R8)	-5.50			364523	6332010

IM10 (R2)	-4.50	S33° 09' 28.23"	E151° 33' 43.87"	365919	6330294
IM11 (R7)	-6.00			366232	6333856
IM12 (R11)	-6.00			367072	6333639

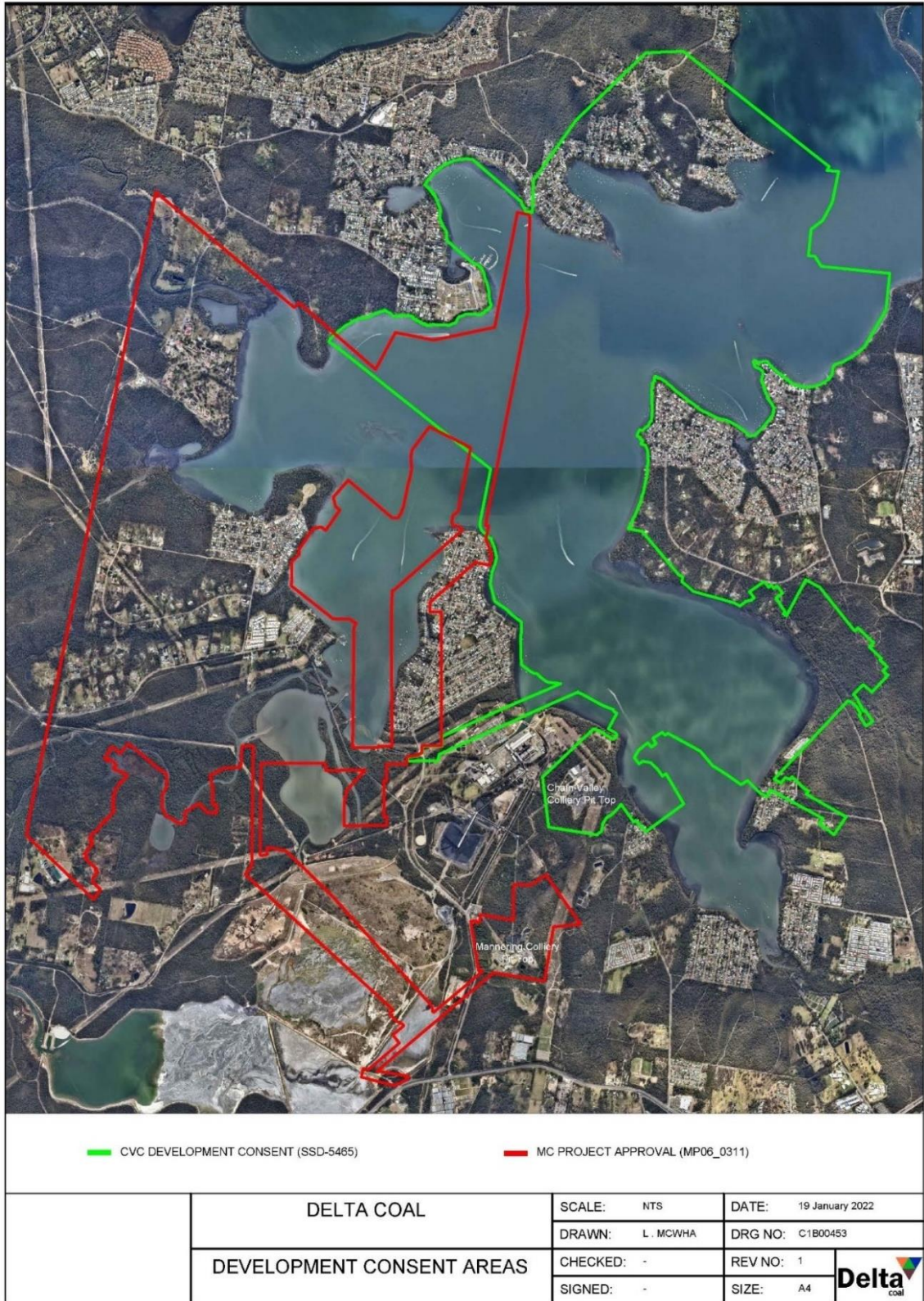


Figure 2.2 Development consent SSD-5465 and MP06_0311 areas

3. Sampling Procedure

Twenty-four stations were sampled in March 2024. At each station the following procedure was carried out:

- A GPS unit was used to locate the sampling station.
- A line with five sieve boxes (five replicates of 200 x 200 x 100 mm collection boxes with 1 mm mesh) and two core samplers (100 x 200 mm cylinders with 1 mm mesh) was cast overboard and secured as the boat drifted into position.
- The sieve boxes were filled using the forward momentum of the work boat.
- The samplers were then hauled to the surface, and the contents of each sampler placed in a clean, labeled zip-lock plastic bag.
- A 250mL jar was filled using the sediment collected from the core samplers.
- Processing of samples occurred in the laboratory.
- A water quality profile from surface to bottom was measured using a calibrated Yeo-Kal 618RU Water Quality Analyser. Water temperature, conductivity, salinity, pH, dissolved oxygen, ORP, turbidity and depth were measured. Each line of data was stored in the memory of the machine.

In the laboratory the marine benthic samples were treated in the following way:

- Each sample was tipped into a 1 mm mesh sieve and washed free of mud.
- The washed material from each sample was then placed into a tray and sorted for animals.
- Organisms and parts of organisms were removed, counted, identified and the results entered into a spread sheet. This process was repeated until the debris of the entire sample had been examined.
- Sorted organisms were preserved in formaldehyde solution.
- All shell remaining in the sample was kept for later examination.

The 250mL samples of whole sediment were treated in the following way:

- Each sample was tipped into a 1L measuring cylinder and the volume made up to 800mL with freshwater.
- The cylinders were stoppered and shaken vigorously to suspend the sediment in the freshwater.

- The cylinders were then placed on the laboratory bench to allow the fractions of the sediment to settle.
- Fractions were decanted into separate measuring cylinders and allowed to settle.
- Once settled the volumes of each fraction (silt, sand, gravel and shell) were calculated and recorded. Results were displayed relative to the final volume of sediment collected.

4. Factors affecting the depth of water in Lake Macquarie

The bathymetric chart (**Figure 4.1**) of Lake Macquarie shows water depths relative to AHD throughout the year 1997. The actual depth of water above the lakebed varied greatly, between 0 and 1.3m above AHD.

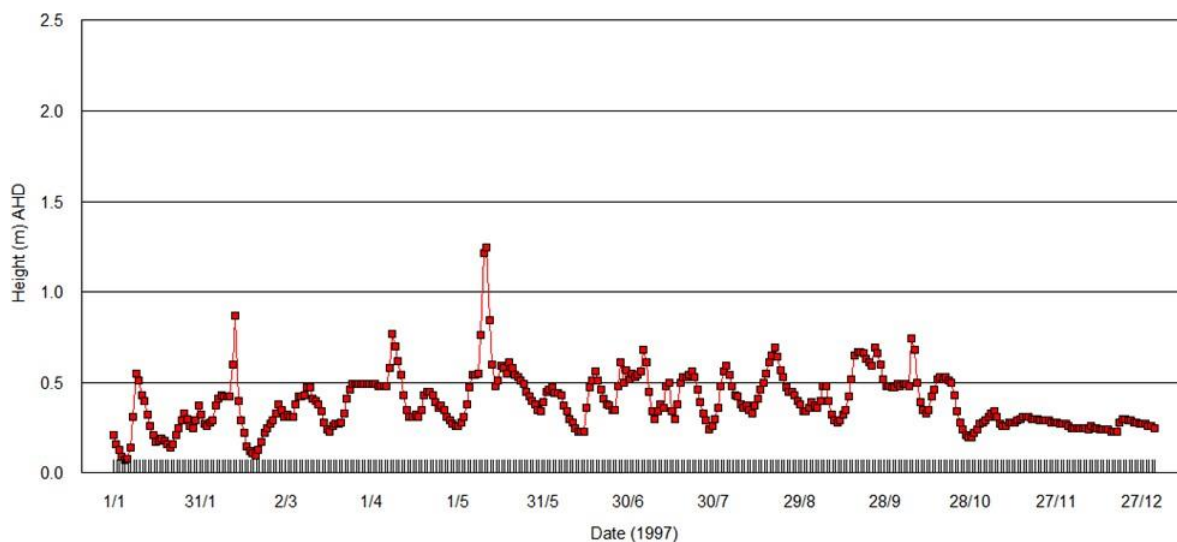


Figure 4.1 Water level changes in a coastal lagoon with an entrance open to coastal waters.

Water depths in coastal saline lakes with an open entrance to coastal waters vary due to combinations of the following factors:

- The body of Lake Macquarie is subject to tidal influence. The height of the tidal prism at Swansea Head may reach almost 2m (during spring tides) but by the time the body of the lake is reached, the tidal prism has been reduced to around 0.05m.

- The height of coastal waters and coastal lakes are influenced by changes in atmospheric pressure. The Tasman Sea acts as a huge barometer. When the atmospheric pressure is high the sea surface is depressed. This causes water to drain from Lake Macquarie causing the depth of water in the body of the lake to decrease. When the atmospheric pressure over the Tasman Sea is low, the surface of the sea bulges upwards. This raising of sea level causes water to flow into Lake Macquarie, increasing the water depth.
- Low pressure systems in the Tasman Sea almost always generate strong winds and coastal rainfall. The strong winds cause large swells to form that impact the coast. Wave setup at the entrance to Lake Macquarie causes the water level in the lake to rise as large volumes of seawater enter the system.
- Rainfall during a period of low atmospheric pressure causes runoff into catchment rivers and streams to increase. When this extra water reaches the body of Lake Macquarie, the water level rises in proportion to the runoff volume. This water is prevented from exiting the lake by wave setup at the entrance and the state of the tide. Under these circumstances, the level of the lake can rise to heights of a meter or more above AHD (**Figure 4.1**).

5. Benthos of the study area – February 2012 to March 2024

Table 5.1 shows the organisms found in the sediment samples collected off Summerland Point and in Chain Valley Bay between February 2012 and March 2024.

Plates 5.1 to 5.7 provide information about the benthic organisms present in the basin mud of Lake Macquarie, NSW.

Table 5.1 Organisms found in Benthos of Lake Macquarie (2012-2024)

Designated name	Family or Species	Comments
Anemone	Coelenterata	Found associated with mussel shells.
Planaria (Flat worm)	Platyhelminthes	Two specimens found in 2017.
Polychaete thin	<i>Sthenelais pettiboneae</i>	Most common polychaete present.
Polychaete	<i>Gorgonorhynchus repens</i>	Common.
Polychaete (mud tube)	Not yet identified	Present in small numbers.
Polychaete	<i>Chaetopterus sp</i>	Common.
Polychaete	<i>Diopatra sp</i>	Common.
Polychaete	<i>Pectinaria sp</i>	First found in March 2019
Gastropod	<i>Nassarius jonasii</i>	Present in small numbers.
Gastropod	<i>Lepsiella (Bedeva) hanleyi</i>	Present in small numbers.
Gastropod	<i>Philine angasi</i>	First recorded in August 2014.
Bivalve	<i>Corbula truncata</i>	Common as live animals and dead shells.
Bivalve	<i>Theora lubrica</i>	Common
Bivalve	<i>Paphia undulata</i>	Uncommon as live animals. Common as dead shells.
Bivalve	<i>Cyamiomactra mactroides</i>	Uncommon as live animals.
Bivalve	<i>Mactra sp</i>	First collected in December 2022 off Pulbah Island.
Bivalve	<i>Anadara trapezia</i>	Uncommon.
Bivalve	<i>Dosinia sculpta</i>	Found in sandy sediments.
Bivalve	<i>Trichomya hirsuta</i>	Common as dead shells. Found in large clumps.
Bivalve	<i>Saccostrea glomerata</i>	Occasionally found on mussel shells.
Ophuroid	Brittle star	Found amongst mussel clumps and on mud.
Echinoid	Sea urchins	Encountered in sandy sediments.
Echinoid	<i>Echinocardium cordatum</i>	Encountered in sandy sediments.
Sponge	<i>Dysidea sp</i>	Collected occasionally.
Sponge	<i>Tetilla sp</i>	Collected occasionally.
Sponge	Red sponge	Several specimens found in 2019.
Crabs	Small	Captured occasionally.
Prawn	Small	Captured occasionally.

Plate 5.1 Sponge species found on the benthos of Lake Macquarie



Phylum: Porifera
Class: Demospongiae
Subclass: Errantia
Order: Tetractinellida
Family: Tellidae
Species: *Tetilla sp*

Remarks: Tetillids are ovoid to spherical sponges which are found commonly in all marine habitats at all depths. They are especially common in sedimented habitats.



Phylum: Porifera
Class: Demospongiae
Family: Dysideidae
Species: *Dysidea sp*

Remarks: Typically mauve in colour, irregularly shaped with varying numbers of oscula and a coarse, hard and bumpy surface texture.

Plate 5.2 Annelid and Nemertean species found in the benthos of Lake Macquarie



Phylum: Annelida
Class: Polychaeta
Subclass: Errantia
Order: Phyllodocida
Family: Sigalionidae
Species: *Sthenelais petitiboneae*

Remarks: Found in marine environments



Phylum: Annelida
 Class: Polychaeta
 Subclass: Canalipalpata
 Order: Terebellida
 Family: Chaetopteridae
 Genus: *Chaetopterus*

Remarks: *Chaetopterus* or the parchment worm or parchment tube worm is a genus of marine polychaete worm that lives in a tube it constructs in sediments or attaches to a rocky or coral reef substrate. The common name arises from the parchment-like appearance of the tubes that house these worms.



Phylum: Annelida
 Class: Polychaeta
 Subclass: Canalipalpata
 Order: Terebellida
 Family: Pectinariidae

Remarks: Pectinariidae live vertically, head-down in sandy sediments, with the narrow tip of the conical tube at about the sediment surface. They feed on buried organic matter within the sediments. *Pectinaria anitpoda* is one of the most common and widespread of this family. Found in inshore waters and off the continental shelf to a depth of about 90 m.



Phylum: Annelida
 Class: Polychaeta
 Subclass: Errantia
 Order: Eunicida
 Family: Onuphidae
 Genus: *Diopatra*

Remarks: Members of this genus live in thick, parchment-like tubes that project from the sediment on the seabed. The tubes comprise of fragments of shell, algae, fibers and other small objects collected by the worm and stuck in place by mucus.



Phylum: Nemertea
 Class: Anopla
 Order: Heteronemertea
 Family: Gorgonorhynchidae
 Species: *Gorgonorhynchus repens*

Remarks: *G. repens* is orange in colour and grows to an unstretched length of about 50 mm. It is cylindrical in shape with bluntly tapering ends. The proboscis is a densely branching structure giving the impression of a cloud of mucus secretion. Proboscis worms are predatory, snaring or spearing their prey.

Plate 5.3 Gastropod species found in the benthos of Lake Macquarie



Phylum: Mollusca
 Class: Gastropoda
 Superfamily: Buccinoidea
 Family: Nassariidae
 Species: *Nassarius jonassii*

Remarks: Endemic to Australia; Noosa Heads, Qld, to SA. Inhabit sand and mud flats in estuaries and lagoons, intertidal down to 100 m. Most *Nassarius* species are very active scavengers. They often burrow into marine substrates and then wait with only their siphon protruding, until they smell nearby food.



Phylum: Mollusca
Class: Gastropoda
Order: Neogastropoda
Family: Muricidae
Species: *Lepsiella (Bedeva) hanleyi*

Remarks: Common name mussel drill. Shell up to 32 mm, with angulated whorls, a high spire and moderately long anterior canal and with both spiral threads and axial ribs. Endemic to Australia. Found in temperate and southern parts of tropical Australia. Lives mainly on sheltered shores, including estuaries and often in association with mangroves. Feeds by drilling holes in bivalves. Lays lens-shaped capsules and development is direct.



Phylum: Mollusca
Class: Gastropoda
Subclass: Heterobranchia
Family: Philinoidea
Species: *Philine angasi*

Remarks: Species of sea snail, marine opisthobranch gastropod mollusc. Commonly called headshield slugs. The foot of this family has developed into fleshy rounded lobes that surround and obscure the shell.

Plate 5.4 Bivalve species and other molluscs found in the benthos of Lake Macquarie



Phylum: Mollusca
Class: Bivalvia
Order: Myoida
Family: Corbulidae
Species: *Corbula sp*

Remarks: Marine bivalve mollusc.



Phylum: Mollusca
 Class: Bivalvia
 Order: Veneroida
 Family: Semelidae
 Species: *Theora lubrica*

Remarks: Small infaunal bivalve native to the Northwest Pacific. It has been introduced to California, Australia, New Zealand, the Mediterranean Sea, and the Atlantic coast of Spain. It typically occurs in soft, muddy subtidal or lower intertidal sediments, rich in organic matter. It is considered a pollution-indicator species, because of its frequent dominance in highly polluted sediments. No ecological or economic impacts have been reported for this species.



Phylum: Mollusca
 Class: Bivalvia
 Order: Veneroida
 Family: Veneridae
 Species: *Paphia undulata*

Remarks: Saltwater clam, marine bivalve mollusc. Inhabits inshore shallow sandy seabeds.



Phylum: Mollusca
 Class: Bivalvia
 Order: Veneroida
 Family: Veneridae
 Species: *Dosinia sculpta*

Remarks: *Dosinia* is a genus of saltwater clams, marine bivalve molluscs in the family Veneridae, (subfamily Dosiniinae). The shell of *Dosinia* species is disc-like in shape, usually white, and therefore is reminiscent of the shells of Lucinid bivalves.

Typically found in the intertidal zone at the water's edge at a mean distance from sea level of -15 meters (-50 feet).



Phylum: Mollusca
Class: Bivalvia
Order: Veneroidea
Family: Cyamiidae
Species: *Cyamiomactra mactroides*



Phylum: Mollusca
Class: Bivalvia
Order: Veneroidea
Family: Mactridae
Species: *Mactra*

Remarks: Large genus of medium-sized marine bivalve mollusc or clam, commonly known as trough shells or duck clams. The word "trough" refers to the large ligamental pit at the hinge line, which contains a large internal ligament. Most bivalves in other families have an external ligament.



Phylum: Mollusca
Class: Bivalvia
Order: Arcoida
Family: Arcidae
Species: *Anadara trapezia*

Remarks: Sydney cockle, or ark cockle is an estuarine filter-feeding bivalve. Its calcareous, heavily-ribbed, shell can grow to approximately 7 to 8 cm across. Its current range is along the east coast of Australia, from Queensland to Victoria. It has been used as an indicator species to study levels of the metals selenium, copper and cadmium.



Phylum: Mollusca
Class: Bivalvia
Order: Mytiloidea
Family: Mytilidae
Species: *Trichomya hirsuta*

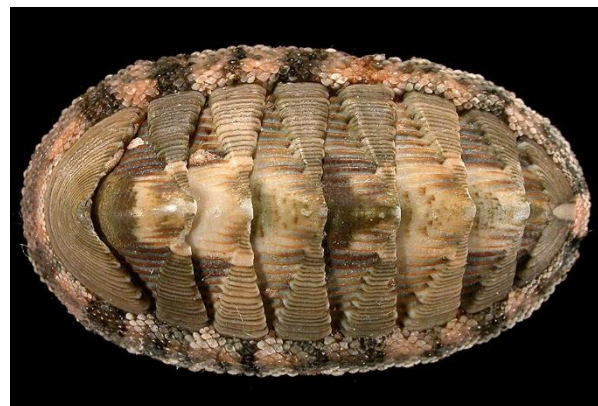
Remarks: The hairy mussel is a major part of the megafauna of Lake Macquarie. It is tolerant of low oxygen levels in the water and its temperature tolerance range has been researched in connection with using the waters of the lake for cooling power stations.

Hairy mussels have been used as bioindicators to monitor concentrations of heavy metals (namely Pb, Cd, Cu, Zn, Co, Ni, and Ag) in marine environments.



Phylum: Mollusca
Class: Bivalvia
Order: Ostreoida
Family: Pectinidae
Species: *Saccostrea glomerata*

Remarks: Sydney rock oysters are endemic to Australia and New Zealand. In Australia it is found in bays, inlets and sheltered estuaries from Wingan Inlet in eastern Victoria, along the east coast of NSW and up to Hervey Bay QLD, around northern Australia and down the west coast to Shark Bay in WA. Sydney rock oysters are capable of tolerating a wide range of salinities. They are usually found in the intertidal zone to 3 metres below the low water mark.



Phylum: Mollusca
Class: Polyplacophora

Remarks: Chitons have a shell composed of eight separate shell plates or valves. These plates overlap slightly at the front and back edges, enabling articulation. These plates protect the mollusc; and enable the animal to flex upward when manoeuvring over uneven surfaces. It also makes it possible for chitons to curl up into a ball when dislodged from rocks. The shell plates are encircled by a skirt known as a girdle.

Chitons live worldwide, from cold to tropic waters. They live on hard surfaces such as under rocks or in crevices. They are fully marine.

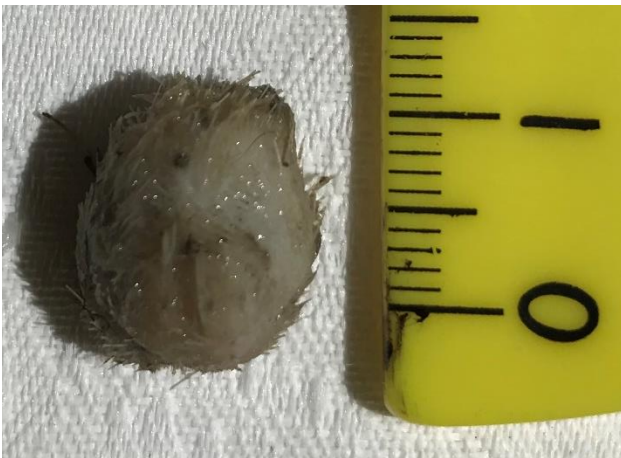
Plate 5.5 Brittle stars found in Lake Macquarie, NSW



Phylum: Echinodermata
Class: Ophiuroidea
Order: Ophiurida
Family: Ophionereididae
Species: *Ophionereis schayeri*

Remarks: Largest and most common brittle star found in Sydney waters. Brittle stars have five long, slender arms which radiate out from a central disc. The mouth is located in the centre of the underside of the disc. There is no anus. Offshore, brittle stars form dense aggregations. In intertidal zones, they are typically found as single individuals in crevices, under stones and amongst seaweed. They feed by raising their arms above the substrate; extending tube-feet; and removing particles from the water. They pass food along the arms to the mouth. They also scavenge on decaying matter.

Plate 5.6 Sea urchins found in Lake Macquarie, NSW



Phylum: Echinodermata
Class: Echinoidea
Order: Spatangoida
Family: Loveniidae
Species: *Echinocardium cordatum*

Remarks: Sand dollars are small in size. They possess a rigid skeleton called a test. The test consists of calcium carbonate plates arranged in a fivefold symmetric pattern.



Phylum: Echinodermata
Class: Echinoidea
Order: Cidaroida

Plate 5.7 Crab species found in Lake Macquarie, NSW



Phylum: Arthropoda
Class: Malacostraca
Order: Decapoda

6. Molluscs found as dead shells

Benthic organism samples collected between February 2012 and March 2024 included a large component of shell. **Plate 6.1** shows the bulk of the shell obtained from the samples of sediment taken in March 2024.



Plate 6.1 Shell removed from samples during sorting process - March 2024 survey.

Similar masses of shell were found in the samples of the February 2012 to March 2023 surveys.

The following organisms were identified amongst the shell:

- | | | | |
|---|-----------------------------|----|--|
| 1 | <i>Paphia undulata</i> | 7 | <i>Chlamys sp.</i> |
| 2 | <i>Anomia sp.</i> | 8 | <i>Saccostrea glomerata</i> |
| 3 | <i>Dosinia sculpta</i> | 9 | <i>Corbula truncata</i> |
| 4 | <i>Trichomya hirsuta</i> | 10 | <i>Batillaria (Velacumantis) australis</i> |
| 5 | <i>Katelysia rhytiphora</i> | 11 | <i>Conuber sp.</i> |
| 6 | <i>Pecten sp.</i> | 12 | <i>Anadara trapezia</i> |

Plates 6.2 and **6.3** provide information about the mollusc and gastropod species found as dead shells in the basin mud of Lake Macquarie, New South Wales during the periods of monitoring.

Plate 6.2 Mollusc species found as dead shells in the benthos of Lake Macquarie, NSW.



Phylum: Mollusca
Class: Bivalvia
Order: Ostreoida
Family: Anomiidae
Genus: *Anomia*

Remarks: Genus of saltwater clam, marine bivalve mollusc. Known as "jingle shells". Common in both tropical and temperate oceans and live primarily attached to rock or other shells via a calcified byssus that extends through the lower valve. *Anomia* shells tend to take on the surface shape of what they are attached to; thus if an *Anomia* is attached to a scallop shell, the shell of the *Anomia* will also show ribbing.



Phylum: Mollusca
Class: Bivalvia
Order: Veneroida
Family: Veneridae
Genus: *Katelaysia*
Species: *Katelaysia rhytiphora*

Remarks: Commonly known as mud cockles, this group of commercially important bivalves often represents a major faunal component of shallow estuarine and marine embayments. *K. rhytiphora* is broadly distributed around Australia's temperate coastline from Augusta, Western Australia to Port Jackson, NSW.



Phylum: Mollusca
Class: Bivalvia
Order: Ostreoida
Family: Pectinidae
Genus: *Pecten*

Remarks: Genus of large saltwater clams or scallops. Marine bivalve mollusc.



Phylum: Mollusca
 Class: Bivalvia
 Order: Ostreoida
 Family: Pectinidae
 Genus: *Chlamys*

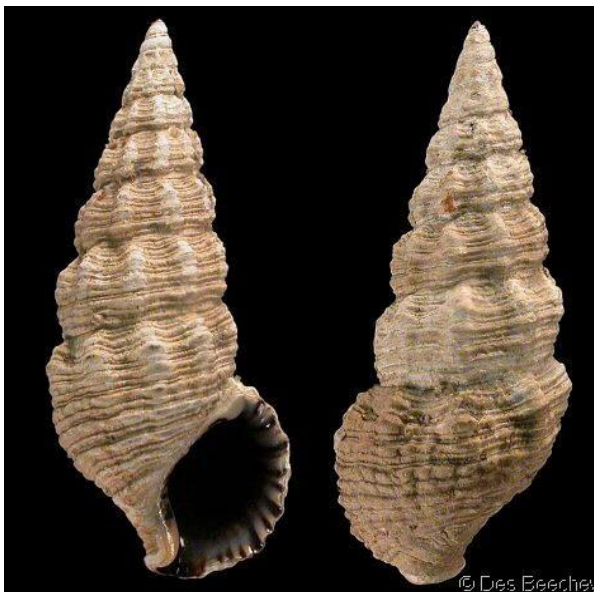
Remarks: Genus of saltwater clams or scallops. Marine bivalve mollusc.

Plate 6.3 Gastropod species found as dead shells in the benthos of Lake Macquarie, NSW.



Phylum: Mollusca
 Class: Gastropoda
 Family: Naticidae
 Genus: *Conuber*
 Species: *Conuber sordidum*

Remarks: Species of predatory sea snail. A marine gastropod mollusc known commonly as the moon snail. Lives on intertidal muddy sand flats near mangroves or sea weed.



Phylum: Mollusca
 Class: Gastropoda
 Family: Batillariidae
 Species: *Batillaria australis*

Remarks: The Australian Mud Whelk is a marine gastropod found on mud flats in estuaries, river mouths and mangrove swamps. The snail has a high resistance to predation and environmental tolerance, which may partially explain its success as an invasive species. This species is one of the hosts for the flatworm parasite *Austrobilharzia*. Larvae of the flatworm are discharged from the snail into the surrounding water. They normally burrow into the legs of wading birds and complete their life cycle, but may burrow through the skin of humans, causing "bathers itch".

7. Benthic organisms in the study area – March 2024

Table 7.1 shows the organisms found at each station sampled off Summerland Point and in Chain Valley Bay and Bardens Bay in March 2024.

A total of 1369 benthic marine organisms greater than 1 mm in size were captured in the study area of Lake Macquarie during the March 2024 survey of 24 stations (**Table 7.1**). Sixteen species of benthic marine organisms were found. The fauna included one nemertean species (**Plate 5.2**), seven species of polychaete worm (**Plate 5.2**); six species of bivalve (**Plate 5.4**); one species of ophuroid (**Plate 5.6**); and one crab species.

In March 2024, the greatest numbers of organisms were collected at stations IM10 (127 organisms), C7 (117 organisms), C1 (105 organisms) and R9 (103 organisms). The stations with the least numbers of organisms were IM4 (14 total), IM6 (16 total), IM3 (20 total), R12 (29 organisms) and C4 (27 organisms). The number of organisms collected ranged from 27 to 117 organisms at control monitoring stations; 29 to 103 organisms at reference stations; and 16 to 127 organisms at the impact monitoring stations (**Table 7.1**).

The bivalve *Theora lubrica* was the most commonly encountered organism with a total of 455 recorded during the survey, representing 33 percent of the organisms collected. The number of *T. lubrica* at each station ranged from 0 to 88 (**Fig 7.2**). Polychaete worms were also common in the benthos (**Table 7.1**). A total of 497 were recorded, representing 36 percent of the organisms collected. Of the polychaetes, *Sthenelais pettiboneae* was the most represented and widespread (**Fig 7.1**). The number of *Corbula sp* collected ranged from 0 to 37 individuals, totaling 238 organisms or 17 percent of the organisms collected. Other species recorded in small numbers only included the bivalves *Dosinia sculpta* and *Paphia undulata*, and the polychaete *Chaetopterus* (**Figures 7.1** and **7.2**). Very few mussels were found alive during the survey. *Trichomya hirsuta* was found at IM1, IM11 and IM5 in small abundances only.

Theora lubrica, *Corbula sp*, *Paphia undulata*, *Sthenelais pettiboneae* and the polychaete designated as P2 were found in benthos collected from -4.5m to -6m AHD. *Chaetopterus* and *Dosinia* were found in samples collected from -5.5m AHD and over (**Figures 7.1** and **7.2**). In March 2024, benthos with high portions of silt had benthic communities dominated by polychaete worms and the bivalves *T. lubrica* and *Corbula*. Benthic monitoring stations with sediments predominately comprised of sand had benthic communities dominated by *Dosinia sculpta* and *Chaetopterus* (**Figures 7.1** and **7.2**).

Table 7.1 Organisms found at sampling stations during March 2024 survey.

Control Station C1		Depth -4.50m AHD										56 364519	6330815	Sampled 8 - 18 March 2024										
Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophturoid	Crab		
	<i>Gorgonorynchus</i>	<i>Sibirellais</i>	thin	thin	mud	Cirralidae	Cirralidae	Chaetopterus	Omphidae	Pectinidae	Massarus	Belevia	Corbula	Theora	Paphia	Dosinia	Anadara	Cyamonactra	Trichomya					
C1.1	0	4	0	0	0	0	0	0	0	0	0	0	8	13	0	0	0	0	0	0	0	0	0	
C1.2	0	4	0	0	0	0	0	0	0	0	0	0	6	5	0	0	0	0	0	0	0	0	0	
C1.3	0	2	2	0	0	0	0	0	0	0	0	0	6	7	1	0	0	0	0	0	0	0	0	
C1.4	0	3	6	0	0	0	0	0	0	0	0	0	9	4	3	0	0	0	0	0	0	0	0	
C1.5	0	5	1	0	0	0	0	0	0	0	0	0	8	7	0	0	0	0	0	0	0	0	1	
Total	0	18	9	0	0	0	0	0	0	0	0	0	37	36	4	0	0	0	0	0	0	0	1	
Mean/station	0.0	3.6	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4	7.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
no/m2	0	90	45	0	0	0	0	0	0	0	0	0	185	180	20	0	0	0	0	0	0	0	5	
No. species	6																						Total Organisms at Station	105
Control Station C2		Depth -4.50m AHD										56 366214	6332927											
Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophturoid	Crab		
	<i>Gorgonorynchus</i>	<i>Sibirellais</i>	thin	thin	mud	Cirralidae	Cirralidae	Chaetopterus	Omphidae	Pectinidae	Massarus	Belevia	Corbula	Theora	Paphia	Dosinia	Anadara	Cyamonactra	Trichomya					
C2.1	0	2	0	0	0	0	0	0	0	0	0	0	2	7	0	0	0	0	0	0	0	0	0	
C2.2	0	3	0	0	4	0	0	0	0	1	0	0	1	6	0	0	0	0	0	0	0	0	0	
C2.3	0	3	0	0	1	0	0	0	0	0	0	0	3	5	0	0	0	0	0	0	0	0	0	
C2.4	0	1	0	0	2	0	0	0	0	0	0	0	2	5	0	0	0	0	0	0	0	0	0	
C2.5	0	2	0	0	4	0	0	0	0	0	0	0	4	5	0	0	0	0	0	0	0	0	0	
Total	0	11	0	0	11	1	1	0	0	1	0	0	12	28	0	0	0	0	0	0	0	0	0	
Mean/station	0.0	2.2	0.0	0.0	2.2	0.2	0.2	0.0	0.0	0.2	0.0	0.0	2.4	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
no/m2	0	55	0	0	55	5	5	0	0	5	0	0	60	140	0	0	0	0	0	0	0	0	0	
No. species	6																						Total Organisms at Station	64
Control Station C3		Depth -5.50m AHD										56 366014	6333144											
Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophturoid	Crab		
	<i>Gorgonorynchus</i>	<i>Sibirellais</i>	thin	thin	mud	Cirralidae	Cirralidae	Chaetopterus	Omphidae	Pectinidae	Massarus	Belevia	Corbula	Theora	Paphia	Dosinia	Anadara	Cyamonactra	Trichomya					
C3.1	0	7	0	0	1	0	0	0	0	0	0	0	1	3	2	1	0	0	0	0	0	0	0	
C3.2	0	1	0	0	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	0	
C3.3	0	0	0	0	1	0	0	0	0	1	0	0	2	5	0	0	0	0	0	0	0	0	0	
C3.4	0	1	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	
C3.5	0	3	0	0	0	0	0	0	0	0	0	0	1	4	1	0	0	0	0	0	0	0	0	
Total	0	12	0	0	2	0	0	0	0	1	0	0	9	18	4	1	0	0	0	0	0	0	0	
Mean/station	0.0	2.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.2	0.0	0.0	1.8	3.6	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
no/m2	0	60	0	0	10	0	0	0	0	5	0	0	45	90	20	5	0	0	0	0	0	0	0	
No. species	9																						Total Organisms at Station	49

Control Station C4

Depth -5.50m AHD

56 364260 6332794

Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophiroid	Crab
	<i>Gorgonothychus</i>	<i>Sibiriella</i>	thin	mud	Cirratulidae	Chaetopterus	Onuphiidae	Pectinariidae	Nassarius	Bedeva	Corbula	Theora	Paphia	Dosinia	Anadara	Cyamiomacra	Trichomya	Ophiroid	Crab								
C4.1	0	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C4.2	0	0	0	0	1	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C4.3	0	0	0	0	1	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C4.4	0	2	0	0	0	0	0	0	0	0	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
C4.5	0	2	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	7	0	0	3	0	0	0	0	0	10	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Mean/Station	0.0	1.4	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	2.0	1.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
no./m2	0	35	0	0	15	0	0	0	0	0	50	25	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5
No. species	6																										
Total Organisms at Station																											
27																											

Control Station C5

Depth -5.50m AHD

56 367701 6334510

Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophiroid	Crab
	<i>Gorgonothychus</i>	<i>Sibiriella</i>	thin	mud	Cirratulidae	Chaetopterus	Onuphiidae	Pectinariidae	Nassarius	Bedeva	Corbula	Theora	Paphia	Dosinia	Anadara	Cyamiomacra	Trichomya	Ophiroid	Crab								
C5.1	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C5.2	0	4	0	0	5	0	0	0	0	0	0	16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C5.3	0	3	0	0	6	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C5.4	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
C5.5	0	3	0	0	2	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	15	1	0	15	1	0	0	0	0	0	41	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Mean/Station	0.0	3.0	0.2	0.0	3.0	0.2	0.0	0.0	0.0	0.0	0.0	8.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
no./m2	0	75	5	0	75	5	0	0	0	0	0	205	5	5	0	0	0	0	0	0	0	0	0	0	0	5	0
No. species	8																										
Total Organisms at Station																											
76																											

Control Station C6

Depth -5.50m AHD

56 363988 6332492

Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophiroid	Crab
	<i>Gorgonothychus</i>	<i>Sibiriella</i>	thin	mud	Cirratulidae	Chaetopterus	Onuphiidae	Pectinariidae	Nassarius	Bedeva	Corbula	Theora	Paphia	Dosinia	Anadara	Cyamiomacra	Trichomya	Ophiroid	Crab								
C6.1	0	2	0	0	1	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C6.2	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C6.3	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C6.4	0	4	0	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C6.5	0	1	0	0	0	0	0	0	0	0	1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	8	3	0	3	0	0	0	0	0	13	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean/Station	0.0	1.6	0.6	0.0	0.6	0.0	0.0	0.0	0.0	0.0	2.6	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
no./m2	0	40	15	0	15	0	0	0	0	0	65	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. species	6																										
Total Organisms at Station																											
41																											

Station IM1

Depth -4.50m AHD

56 364738 6330734

Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophiroid	Crab
	<i>Gorgonorynchus</i>	<i>Sibonoidis</i>	thin	mud	Cirratulidae	Chaetopterus	Onuphiidae	Pectinariidae	Nassarus	Nassarus	Bedeira	Corbula	Theora	Paphia	Dosinia	Anadara	Cyamonactra	Trichomya				
IM1.1	0	0	1	3	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
IM1.2	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
IM1.3	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
IM1.4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
IM1.5	0	2	4	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Total	1	2	7	5	0	0	0	1	0	0	0	0	3	4	0	0	0	0	0	1	0	0
Meanstation	0.2	0.4	1.4	1.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.6	0.8	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
no./m2	5	10	35	25	0	0	0	5	0	0	0	25	15	20	0	0	0	0	5	0	0	0
No. species	9																					
Total Organisms at Station																						
	29																					

Station IM2

Depth -4.50m AHD

56 364842 6332237

Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophiroid	Crab
	<i>Gorgonorynchus</i>	<i>Sibonoidis</i>	thin	mud	Cirratulidae	Chaetopterus	Onuphiidae	Pectinariidae	Nassarus	Nassarus	Bedeira	Corbula	Theora	Paphia	Dosinia	Anadara	Cyamonactra	Trichomya				
IM2.1	0	0	0	1	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0
IM2.2	0	4	1	1	0	0	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
IM2.3	0	4	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0
IM2.4	0	4	1	1	0	0	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
IM2.5	0	2	3	0	1	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0
Total	0	14	5	3	1	0	4	0	0	0	0	5	9	5	0	0	0	0	0	0	0	0
Meanstation	0.0	2.8	1.0	0.6	0.2	0.0	0.8	0.0	0.0	0.0	0.0	1.0	1.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
no./m2	0	70	25	15	5	0	20	0	0	0	0	25	45	25	0	0	0	0	0	0	0	0
No. species	8																					
Total Organisms at Station																						
	46																					

Station IM3

Depth -5.50m AHD

56 364693 6332101

Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophiroid	Crab
	<i>Gorgonorynchus</i>	<i>Sibonoidis</i>	thin	mud	Cirratulidae	Chaetopterus	Onuphiidae	Pectinariidae	Nassarus	Nassarus	Bedeira	Corbula	Theora	Paphia	Dosinia	Anadara	Cyamonactra	Trichomya				
IM3.1	0	2	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0
IM3.2	0	2	1	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
IM3.3	0	0	0	4	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
IM3.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IM3.5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Total	0	4	1	4	0	0	0	0	0	0	0	1	9	1	0	0	0	0	0	0	0	0
Meanstation	0.0	0.8	0.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
no./m2	0	20	5	20	0	0	0	0	0	0	0	5	45	5	0	0	0	0	0	0	0	0
No. species	6																					
Total Organisms at Station																						
	20																					

Station IM4

Depth -6:00m AHD

56 364673 6332705

Replicates	Nemertea <i>Gorgonothychus</i>	Polychaete <i>Sipholis</i>	Polychaete thin	Polychaete mud	Polychaete Cirratulidae	Polychaete <i>Chaetopterus</i>	Polychaete <i>Onuphidae</i>	Polychaete Pectinariidae	Gastropod <i>Nassarius</i>	Gastropod <i>Badava</i>	Bivalve <i>Corbula</i>	Bivalve <i>Theora</i>	Bivalve <i>Paphia</i>	Bivalve <i>Dosinia</i>	Bivalve <i>Anadara</i>	Bivalve <i>Cyammactra</i>	Bivalve <i>Trichomya</i>	Ophiroid	Crab	
IM4.1	0	3	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0	0	0	
IM4.2	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	
IM4.3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
IM4.4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
IM4.5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	7	0	0	0	0	0	0	0	0	4	2	1	0	0	0	0	0	0	
Meanstation no./m2	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	
	0	35	0	0	0	0	0	0	0	0	20	10	5	0	0	0	0	0	0	
No. species	4																			
Total Organisms at Station																				
	14																			

Station IM5 (was R3)

Depth -5:50m AHD

56 364660 6332992

Replicates	Nemertea <i>Gorgonothychus</i>	Polychaete <i>Sipholis</i>	Polychaete thin	Polychaete mud	Polychaete Cirratulidae	Polychaete <i>Chaetopterus</i>	Polychaete <i>Onuphidae</i>	Polychaete Pectinariidae	Gastropod <i>Nassarius</i>	Gastropod <i>Badava</i>	Bivalve <i>Corbula</i>	Bivalve <i>Theora</i>	Bivalve <i>Paphia</i>	Bivalve <i>Dosinia</i>	Bivalve <i>Mactra</i>	Bivalve <i>Cyammactra</i>	Bivalve <i>Trichomya</i>	Ophiroid	Crab	
IM5.1	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	
IM5.2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
IM5.3	0	5	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
IM5.4	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
IM5.5	0	2	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	
Total	0	10	4	1	1	1	0	0	0	0	2	1	0	0	0	0	0	0	4	
Meanstation no./m2	0.0	2.0	0.8	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.8	
	0	50	20	5	5	5	0	0	0	0	10	5	0	0	0	0	0	0	20	
No. species	12																			
Total Organisms at Station																				
	32																			

Station IM6 (was R4)

Depth -6:00m AHD

56 364771 6332763

Replicates	Nemertea <i>Gorgonothychus</i>	Polychaete <i>Sipholis</i>	Polychaete thin	Polychaete mud	Polychaete Cirratulidae	Polychaete <i>Chaetopterus</i>	Polychaete <i>Onuphidae</i>	Polychaete Pectinariidae	Gastropod <i>Nassarius</i>	Gastropod <i>Badava</i>	Bivalve <i>Corbula</i>	Bivalve <i>Theora</i>	Bivalve <i>Paphia</i>	Bivalve <i>Dosinia</i>	Bivalve <i>Anadara</i>	Bivalve <i>Cyammactra</i>	Bivalve <i>Trichomya</i>	Ophiroid	Crab	
IM6.1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
IM6.2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
IM6.3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
IM6.4	0	1	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	
IM6.5	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	
Total	0	9	0	0	0	0	0	0	0	0	0	4	1	2	0	0	0	0	0	
Meanstation no./m2	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.2	0.4	0.0	0.0	0.0	0.0	0.0	
	0	45	0	0	0	0	0	0	0	0	0	20	5	10	0	0	0	0	0	
No. species	4																			
Total Organisms at Station																				
	16																			

Station IM7 (was R5)

Depth -6.00m AHD

56 364229 6333889

Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophiuroid	Crab
	<i>Gorgonothychus</i>	<i>Sibeniels</i>	thin	mud	Cirratulidae	<i>Chaetopleus</i>	<i>Onuphiidae</i>	<i>Pectinariidae</i>	<i>Nassarius</i>	<i>Bedevela</i>	<i>Corbula</i>	<i>Theora</i>	<i>Paphia</i>	<i>Dosinia</i>	<i>Anadara</i>	<i>Cyamonactra</i>	<i>Trichomya</i>					
IM7.1	0	3	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
IM7.2	0	0	0	1	0	0	0	0	0	0	0	10	1	0	0	0	0	0	0	0	0	0
IM7.3	0	1	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0
IM7.4	0	1	0	0	0	0	0	0	0	0	7	9	0	0	0	0	0	0	0	0	0	0
IM7.5	0	1	0	0	0	0	0	0	0	0	3	7	1	0	0	0	0	0	0	0	0	0
Total	0	6	0	1	0	0	0	0	0	0	28	33	2	0	0	0	0	0	0	0	0	0
Mean/station no./m2	0.0	1.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	5.6	6.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	30	0	5	0	0	0	0	0	0	140	165	10	0	0	0	0	0	0	0	0	0
No. species	5																					
Total Organisms at Station																						
	70																					

Station IM8 (was R6)

Depth -6.00m AHD

56 364533 6334146

Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophiuroid	Crab	
	<i>Gorgonothychus</i>	<i>Sibeniels</i>	thin	mud	Cirratulidae	<i>Chaetopleus</i>	<i>Onuphiidae</i>	<i>Pectinariidae</i>	<i>Nassarius</i>	<i>Bedevela</i>	<i>Corbula</i>	<i>Theora</i>	<i>Paphia</i>	<i>Dosinia</i>	<i>Anadara</i>	<i>Cyamonactra</i>	<i>Trichomya</i>					
IM8.1	0	2	0	1	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0
IM8.2	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0
IM8.3	0	2	0	0	0	0	0	0	0	0	7	8	0	0	0	0	0	0	0	0	0	0
IM8.4	0	2	0	1	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0
IM8.5	0	2	0	7	0	0	0	0	0	0	3	8	0	0	0	0	0	0	0	0	0	0
Total	0	8	0	9	0	0	0	0	0	0	18	23	0	0	0	0	0	0	0	0	0	0
Mean/station no./m2	0.0	1.6	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	3.6	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	40	0	45	0	0	0	0	0	0	90	115	0	0	0	0	0	0	0	0	0	0
No. species	4																					
Total Organisms at Station																						
	58																					

Station IM9 (was R8)

Depth -6.00m AHD

56 364323 63322010

Replicates	Nemertea	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Polychaete	Gastropod	Gastropod	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Bivalve	Ophiuroid	Crab	
	<i>Gorgonothychus</i>	<i>Sibeniels</i>	thin	mud	Cirratulidae	<i>Chaetopleus</i>	<i>Onuphiidae</i>	<i>Pectinariidae</i>	<i>Nassarius</i>	<i>Bedevela</i>	<i>Corbula</i>	<i>Theora</i>	<i>Paphia</i>	<i>Dosinia</i>	<i>Anadara</i>	<i>Cyamonactra</i>	<i>Trichomya</i>					
IM9.1	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
IM9.2	0	1	0	0	1	0	0	0	0	0	3	5	0	0	0	0	0	0	0	0	0	0
IM9.3	0	1	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
IM9.4	0	2	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
IM9.5	0	2	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0
Total	0	7	0	0	1	0	0	0	0	0	7	18	0	0	0	0	0	0	0	0	0	0
Mean/station no./m2	0.0	1.4	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	1.4	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	35	0	0	5	0	0	0	0	0	35	90	0	0	0	0	0	0	0	0	0	0
No. species	4																					
Total Organisms at Station																						
	33																					

Station IM10 (was R2)

Depth -4.50m AHD

56 365919 6330294

Replicates	Nemertea	Polychaete Sipholidae	Polychaete thin	Polychaete mud	Polychaete Cirratulidae	Polychaete Chaetopterus	Polychaete Onuphidae	Polychaete Pectinidae	Gastropod Massarius	Gastropod Bederia	Bivalve Corbula	Bivalve Theora	Bivalve Paphia	Bivalve Dostina	Bivalve Anadara	Bivalve Cyanomacra	Bivalve Trichomya	Ophiroid	Crab
IM10.1	0	2	0	0	0	0	0	0	0	0	8	16	0	0	0	0	0	0	0
IM10.2	0	6	0	0	0	0	0	0	0	0	1	7	0	0	0	0	0	0	0
IM10.3	0	2	0	0	0	0	0	0	0	0	3	12	0	0	0	0	0	0	0
IM10.4	0	1	0	0	0	0	0	0	0	0	4	30	0	0	0	0	0	0	0
IM10.5	0	3	0	0	0	0	0	0	0	0	9	23	0	0	0	0	0	0	0
Total	0	14	0	0	0	0	0	0	0	0	25	88	0	0	0	0	0	0	0
Meanstation no./m2	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	17.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
No. species	0	3	0	0	0	0	0	0	0	0	125	440	0	0	0	0	0	0	0
Total Organisms at Station																			
127																			

Station IM11 (was R7)

Depth -6.00m AHD

56 366232 6333856

Replicates	Nemertea	Polychaete Sipholidae	Polychaete thin	Polychaete mud	Polychaete Cirratulidae	Polychaete Chaetopterus	Polychaete Onuphidae	Polychaete Pectinidae	Gastropod Massarius	Gastropod Bederia	Bivalve Corbula	Bivalve Theora	Bivalve Paphia	Bivalve Dostina	Bivalve Anadara	Bivalve Cyanomacra	Bivalve Trichomya	Ophiroid	Crab
IM11.1	0	3	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
IM11.2	0	0	0	1	2	1	0	1	0	0	0	0	1	0	0	0	0	1	1
IM11.3	0	2	0	2	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0
IM11.4	0	1	1	1	1	0	0	0	0	0	1	0	3	0	0	0	0	0	0
IM11.5	0	1	0	0	0	0	0	0	0	0	1	0	1	2	0	2	10	4	0
Total	0	7	2	4	3	1	0	1	0	0	2	0	6	3	0	2	12	5	2
Meanstation no./m2	0.0	1.4	0.4	0.8	0.6	0.2	0.0	0.2	0.0	0.0	0.4	0.0	1.2	0.6	0.0	0.4	2.4	1.0	0.4
No. species	0	35	10	20	15	5	0	5	0	0	10	0	30	15	0	10	60	25	10
Total Organisms at Station																			
50																			

Station IM12 (was R11)

Depth -6.00m AHD

56 367072 6333638

Replicates	Nemertea	Polychaete Sipholidae	Polychaete thin	Polychaete mud	Polychaete Cirratulidae	Polychaete Chaetopterus	Polychaete Onuphidae	Polychaete Pectinidae	Gastropod Massarius	Gastropod Bederia	Bivalve Corbula	Bivalve Theora	Bivalve Paphia	Bivalve Dostina	Bivalve Anadara	Bivalve Cyanomacra	Bivalve Trichomya	Ophiroid	Crab
R11.1	0	8	0	1	0	1	0	0	0	0	1	2	0	0	0	0	0	0	0
R11.2	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.3	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R11.4	0	1	0	1	0	0	0	0	0	0	1	14	0	0	0	0	0	0	0
R11.5	0	6	1	2	0	0	0	0	0	0	0	27	1	0	0	0	0	0	0
Total	0	25	1	6	0	1	0	0	0	0	2	43	1	0	0	0	0	0	0
Meanstation no./m2	0.0	5.0	0.2	1.2	0.0	0.2	0.0	0.0	0.0	0.0	0.4	8.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0
No. species	0	125	5	30	0	5	0	0	0	0	10	215	5	0	0	0	0	0	0
Total Organisms at Station																			
79																			

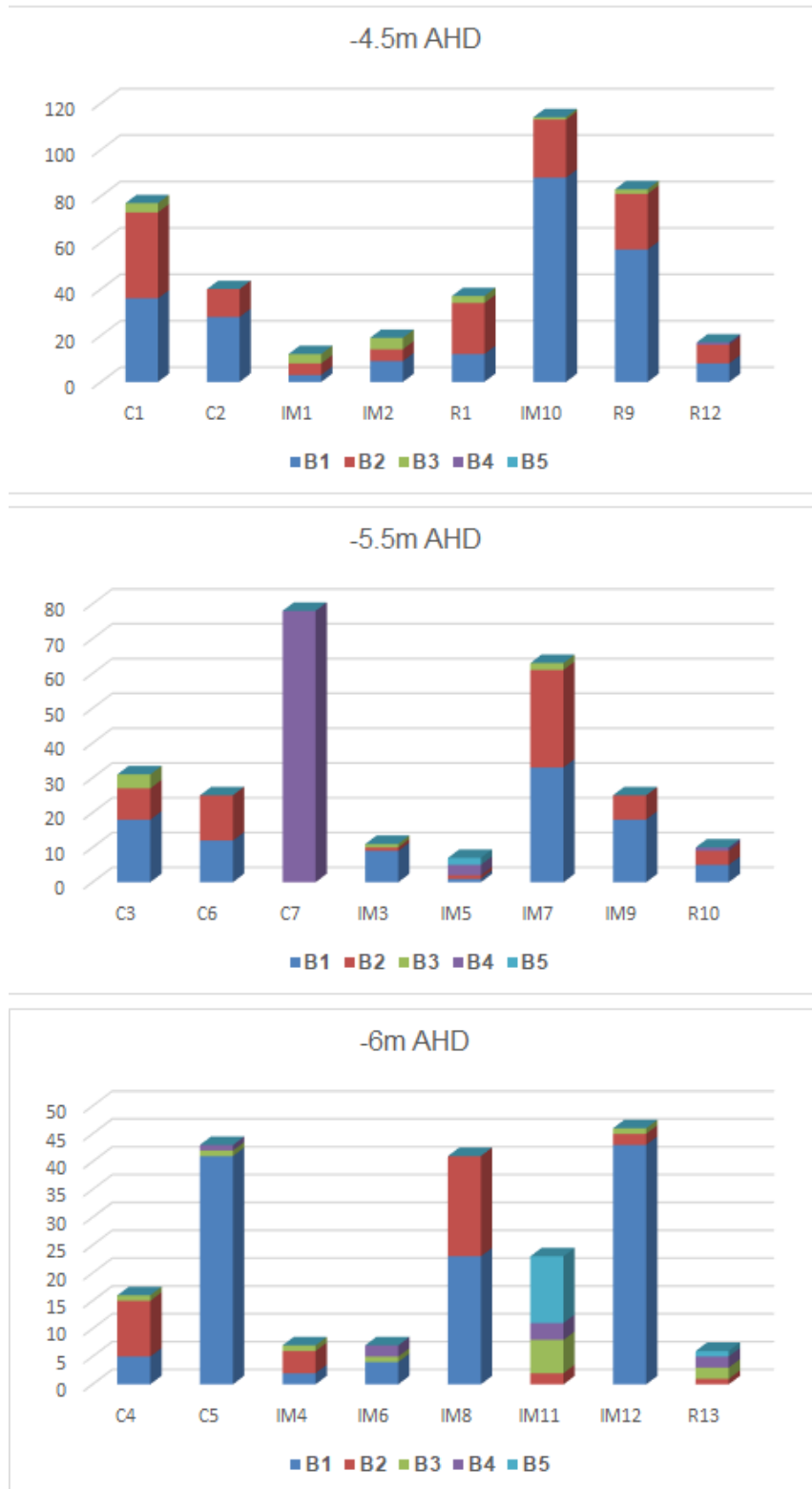
Total Organisms collected **1369**
Total number of species recorded **16**

Figure 7.1 Number of polychaetes found at each Control, reference and Impact Station, March 2024



Key: P1 *Sthenelais pettiboneae* P2 Polychaete mud P3 *Chaetopterus* P4 *Gorgonrhynchus*

Figure 7.2 Number of bivalves found at each control, reference and impact Station, March 2024



Key: B1 *Theora* B2 *Corbula* B3 *Paphia* B4 *Dosinia* B5 *Trichomya*

At the time of survey, species diversity at each station ranged from 4 to 13 species and was comparable to previous years (**Table 7.2**). In March 2024, Control stations had a range of 6 to 9 species; Reference stations had a range of 4 to 9 species; and the Impact stations had a range of 4 to 13 species. There was no significant difference between the average number of species collected and depth.

Table 7.2 Number of species found at each Station from February 2012 to March 2024

Station	C1	C2	C3	C4	C5	C6	C7	R1	R9	R10	R12	R13
Feb 2012	10	5	5	7				8				
Sep 2012	3	6	4	4				6				
Mar 2013	4	5	7	7				6				
Sep 2013	6	6	3	7				5				
Mar 2014	4	3	5	5				6				
Sep 2014	3	4	4	8				6				
Mar 2015	3	3	5	3				5				
Sep 2015	5	4	4	3				5				
Mar 2016	6	4	5	5	5			6				
Sep 2016	7	3	6	5	4	8		8	8			
Mar 2017	2	4	5	3	5	5		4	5			
Sep 2017	4	4	4	4	4	5		4	4			
Mar 2018	4	4	8	4	4	3	5	7	4	4		
Sep 2018	3	4	4	6	5	5	5	4	5	4		
Mar 2019	6	3	4	4	6	5	3	4	4	6		
Sep 2019	5	6	5	5	4	5	6	4	4	4		
Mar 2020	5	6	6	4	7	3	6	6	4	4		
Aug 2020	6	5	4	4	3	5	5	4	5	5		
Mar 2021	5	6	3	4	5	2	2	5	6	5		
Sep 2021	4	4	7	6	7	7	6	5	4	6		
Mar 2022	5	6	4	7	6	7	4	6	5	6		
Sep 2022	5	5	7	7	6	5	6	6	7	6		
Mar 2023	6	6	5	6	6	4	6	6	6	5		
Mar 2024	6	6	9	6	8	6	8	7	4	5	5	9
Mean	4.88	4.67	5.13	5.17	5.31	5.00	5.17	5.54	5.00	5.00		
STD	1.68	1.13	1.54	1.49	1.35	1.60	1.59	1.22	1.25	0.85		
Min	2	3	3	3	3	2	2	4	4	4		
Max	10	6	9	8	8	8	8	8	8	6		

Station	IM1	IM2	IM3	IM4	IM5 (R3)	IM6 (R4)	IM7 (R5)	IM8 (R6)	IM9 (R8)	IM10 (R2)	IM11 (R7)	IM12 (R11)
Feb 2012	7	4	4	5	5	5				8		
Sep 2012	4	4	3	5	4	5				3		
Mar 2013	7	5	5	5	6	5				5		
Sep 2013	4	3	4	5	5	4				6		
Mar 2014	5	9	4	5	5	3	4	3		4		
Sep 2014	5	6	3	6	6	6	3	3		5		
Mar 2015	5	4	4	5	6	5	3	3		3		
Sep 2015	5	5	4	4	4	6	5	4		3		
Mar 2016	6	6	3	4	6	4	4	4		5	8	
Sep 2016	6	4	6	3	5	6	6	7	5	4	7	
Mar 2017	3	4	3	4	4	5	4	4	3	5	4	
Sep 2017	5	5	5	5	6	5	4	4	5	3	4	
Mar 2018	5	7	3	4	5	4	6	3	3	8	4	4
Sep 2018	4	8	4	4	5	5	5	4	4	4	6	4
Mar 2019	5	5	2	4	7	3	5	4	4	5	4	6
Sep 2019	6	5	7	5	7	4	4	4	4	3	5	3
Mar 2020	7	7	4	4	7	4	4	4	3	6	8	4
Aug 2020	5	6	4	6	7	4	7	5	4	5	8	4
Mar 2021	7	7	5	7	7	4	5	5	4	4	5	8
Sep 2021	3	7	4	4	8	3	4	4	3	4	7	7
Mar 2022	5	6	5	6	9	7	4	4	3	4	8	6
Sep 2022	6	8	6	3	7	6	5	4	6	5	4	5
Mar 2023	8	9	4	7	4	4	4	5	6	4	5	4
Mar 2024	9	8	6	4	12	4	5	4	4	3	13	7
Mean	5.50	5.92	4.25	4.75	6.13	4.63	4.55	4.10	4.07	4.54	6.25	5.17
STD	1.47	1.72	1.19	1.07	1.83	1.06	1.00	0.91	1.03	1.41	2.44	1.59
Min	3	3	2	3	4	3	3	3	3	3	4	3
Max	9	9	7	7	12	7	7	7	6	8	13	8

8. Sediment Analysis

In March 2024, the sediment in the mud basin of Lake Macquarie off Summerland Point, Chain Valley Bay and Bardens Bay was largely composed of fine grey silt that was mildly plastic in nature (able to be molded into a coherent shape). Small to large shell fragments were also present in the sediment at most of these benthic monitoring stations (**Table 8.1**). For example, stations C1, C2 and C4 had 5%, 10% and 34% shell making up the sediment sample respectively. Sediment collected at stations C5, C7 and R13 contained a large amount of grey sand (**Table 8.2**). The sediment samples collected at C4, IM5, IM8 and IM11 comprised a high portion of shell (**Table 8.2**).

Table 8.1 Description of sediment collected from sampling stations in March 2024.

Station	Description
C1	Dark grey silt with some small sized shell fragments.
C2	Dark grey silt with some small sized shell fragments.
C3	Dark grey silt with some small to medium sized shell fragments.
C4	Dark grey silt with some small to large sized shell fragments.
C5	Dark grey silt with some coarse grey sand and shell fragments.
C6	Dark grey silt with some small to large shell fragments. Mud plastic in nature.
C7	Coarse grey sand and dark grey silt.
R1	Dark grey silt with fine grey sand. No shell fragments or gravel.
R9	Dark grey silt with some shell fragments.
R10	Dark grey silt with some small shell fragments. Some sand.
R12	Dark grey silt with some small shell fragments. Some sand.
R13	Fine grained dark grey sand and dark grey silt.
IM1	Dark grey silt with medium to large shell fragments and some coarse sand.
IM2	Dark grey silt with large shell fragments.
IM3	Dark grey silt with small to large sized shell fragments.
IM4	Dark grey silt with some small sized shell fragments.
IM5 (was R3)	Dark grey silt and large shell fragments.
IM6 (was R4)	Dark grey silt with some shell fragments.
IM7 (was R5)	Dark grey silt with some shell fragments.
IM8 (was R6)	Small to large shell fragments.
IM9 (was R8)	Dark grey silt with some small sized shell fragments.
IM10 (was R2)	Dark grey silt with some small to large sized shell fragments.
IM11 (was R7)	Small to large shell fragments.
IM12 (was R11)	Dark grey silt with some sand and small sized shell fragments.

Table 8.2 Percentage of silt, sand, gravel and shell for control, reference and impact stations

	% Silt	% Sand	% Gravel	% Shell
C1	95	0	0	5
C2	90	0	0	10
C3	95	0	0	5
C4	65	0	0	35
C5	53	44	0	3
C6	90	0	0	10
C7	36	64	0	0
R1	95	5	0	0
R9	94	0	0	6
R10	94	1	0	5
R12	95	1	0	4
R13	26	74	0	0
IM1	91	1	0	8
IM2	96	1	0	4
IM3	95	1	0	5
IM4	98	0	0	2
IM5 (was R3)	50	0	0	50
IM6 (was R4)	95	0	0	5
IM7 (was R5)	99	0	0	1
IM8 (was R6)	5	0	0	95
IM9 (was R8)	99	0	0	1
IM10 (was R2)	80	0	0	20
IM11 (was R7)	2	0	0	98
IM12 (was R11)	95	3	0	2

March 2024

9. Physical characteristics of water in Lake Macquarie – March 2024

At each station, a water quality profile was taken using a calibrated Yeo-Kal 618RU Analyser. The physical characteristics were measured on 18th March 2024. Units of measurement were temperature - degrees Celsius, conductivity - mS/cm; salinity - parts per thousand, pH, ORP –

mV, dissolved oxygen - % saturation and mg/L, and turbidity - NTU.

The water quality profile for each station is presented in **Appendix 1**. At the time of sampling, the water profile had the following characteristics:

Water temperature was high and uniform throughout the water column and throughout the study area. For instance:

- C6, water temperature ranged from 26.83°C at the surface to 25.74°C at -5.5m AHD.
- R3 (now IM5), water temperature ranged from 26.71°C at the surface to 25.89°C at -7.5m AHD.
- R4 (now IM6), water temperature ranged from 26.72°C at the surface to 26.16°C at -4.5m AHD.
- R9, water temperature ranged from 25.96°C at the surface to 25.38°C at -3.8m AHD.

Conductivity was uniform throughout the water column and the study area. For instance:

- C1, conductivity ranged from 55.75 mS/cm at the surface to 55.73 mS /cm at -4.8m AHD.
- C2, conductivity ranged from 55.41 mS /cm at the surface to 55.36 mS at -4.5m AHD.
- IM1, conductivity ranged from 55.73 mS /cm at the surface to 55.69 mS /cm at -4.2m AHD.
- IM2, conductivity ranged from 55.57 mS /cm at the surface to 55.44 mS /cm at -4.8m AHD.
- R1, conductivity ranged from 55.76 mS /cm at the surface to 55.73 mS /cm at -4.5m AHD.

Salinity was uniform throughout the water column and the study area. For instance:

- C3, salinity ranged from 36.78 ppt at the surface to 36.72 ppt at -6.0m AHD.
- IM3, salinity ranged from 36.87 ppt at the surface to 36.76 ppt at -5.5m AHD.
- R2 (now IM10), salinity ranged from 37.01 ppt at the surface to 36.88 ppt at -5.5m AHD.
- R7 (now IM11), salinity ranged from 36.77 ppt at the surface to 36.86 ppt at -7.2m AHD.

pH was relatively uniform throughout the water column and the study area. For instance:

- C4, pH ranged from 8.82 at the surface to 8.04 at -6.7m AHD.
- C5, pH ranged from 8.44 at the surface to 8.10 at -6.7m AHD.
- IM4, pH ranged from 8.01 at the surface to 7.81 at -7.0m AHD.
- R8 (now IM9), pH ranged from 7.84 at the surface to 7.76 at -5.7m AHD.

ORP was relatively uniform throughout the water column and the study area. For instance:

- R12, ORP ranged from 346 mV at the surface to 321 mV at -5.5m AHD.
- R13, ORP ranged from 345 mV at the surface to 321 mV at -6.7m AHD
- IM1, ORP ranged from 272 mV at the surface to 262 mV at -4.2m AHD.
- C6, ORP ranged from 551 mV at the surface to 496 mV at -5.5m AHD.

Dissolved oxygen decreased with depth or was uniform throughout the water column and the study area. For instance:

- C7, dissolved oxygen decreased from 83.3% saturation at the surface to 79.8% saturation at --6.0m AHD.
- IM6, dissolved oxygen decreased from 92.5% saturation at the surface to 89.9 % saturation at -4.5m AHD.
- R6 (now IM8), dissolved oxygen decreased from 87.7% saturation at the surface to 86.8% saturation at -3.1m AHD.
- R10, dissolved oxygen decreased from 85.1% saturation at the surface to 70.4 % saturation at -5.5m AHD (**Appendix 1**).

The physical characteristics of the bottom waters of Lake Macquarie in March 2024 were as follows:

- Water Temperature ranged from 25.18°C to 26.48°C. Mean water temperature was 25.80°C.
- Conductivity ranged from 55.17 mS/cm to 55.90 mS/cm. Mean conductivity was 55.53 mS/cm.
- Salinity ranged from 36.55 ppt to 37.10 ppt. Mean salinity was 36.82 ppt.
- Turbidity ranged from 0.2 NTU to 17.7 NTU. Mean turbidity was 10.45 NTU.
- pH ranged from 7.55 to 8.72. Mean pH was 7.91.
- ORP ranged from 257 mV to 496 mV. Mean ORP was 309 mV.
- Dissolved oxygen (% saturation) ranged from 70.4% to 89.9%. Mean dissolved oxygen was 81.89% saturation.
- Dissolved oxygen (mg/L) ranged from 4.67 mg/L to 5.90 mg/L. Mean dissolved oxygen was 5.41 mg/L (**Table 9.1**).

Rainfall in the months preceding the survey of March 2024 was 37.6 mm and 112.0 mm for January and February 2024 respectively (Cooranbong Lake Macquarie AWS No. 061412). By 18th March a further 17.4 mm had fallen in the catchment.

Table 9.1 Physical characteristics of the bottom water – March 2024

Station	Depth m	Temperature °C	Conductivity mS/cm	Salinity ppt	pH	ORP mV	Turbidity NTU	DO % sat	DO mg/L
Control Stations									
C1	4.8	25.44	55.73	36.97	7.55	262	14.80	75.20	5.00
C2	4.5	25.64	55.36	36.70	7.82	270	17.70	85.20	5.65
C3	6.0	25.66	55.39	36.72	7.83	273	16.40	77.20	5.12
C4	6.7	26.20	55.55	36.84	8.04	417	8.40	84.70	5.56
C5	6.7	25.79	55.17	36.55	8.10	309	11.80	80.80	5.34
C6	5.5	25.74	55.54	36.83	8.72	496	10.10	72.20	4.77
C7	6.0	25.66	55.25	36.61	7.94	322	9.50	79.80	5.29
Mean		25.73	55.43	36.75	8.00	335.57	12.67	79.30	5.25
Stdev		0.23	0.19	0.14	0.36	88.40	3.64	4.80	0.31
Min		25.44	55.17	36.55	7.55	262	8.4	72.2	4.77
Max		26.20	55.73	36.97	8.72	496.00	17.70	85.20	5.65
Reference Stations									
R1	4.5	25.89	55.73	36.97	7.72	260	14.00	87.40	5.76
R9	3.8	25.38	55.71	36.95	7.86	277	9.50	88.40	5.87
R10	5.5	25.64	55.53	36.82	7.74	332	5.90	70.40	4.67
R12	6.5	25.88	55.55	36.84	8.30	321	3.60	81.60	5.38
R13	5.5	25.85	55.37	36.70	8.48	321	12.70	81.70	5.40
Mean		25.73	55.58	36.86	8.02	302.20	9.14	81.90	5.42
Stdev		0.22	0.15	0.11	0.35	31.67	4.40	7.16	0.47
Min		25.38	55.37	36.70	7.72	260	3.60	70.40	4.67
Max		25.89	55.73	36.97	8.48	332.00	14.00	88.40	5.87
Impact Stations									
IM1	4.2	25.41	55.69	36.94	7.63	262	17.30	76.20	5.06
IM2	4.8	25.67	55.44	36.76	7.85	275	11.30	82.60	5.47
IM3	5.5	25.67	55.45	36.76	7.80	261	17.20	81.70	5.40
IM4	7.0	25.82	55.43	36.74	7.81	384	3.10	84.20	5.56
IM5 (R3)	7.5	25.89	55.48	36.78	7.66	348	0.20	83.20	5.49
IM6 (R4)	4.5	26.16	55.56	36.85	8.04	271	5.80	89.90	5.90
IM7 (R5)	6.7	26.31	55.77	37.00	7.72	333	7.30	84.90	5.55
IM8 (R6)	3.1	26.48	55.90	37.10	7.68	332	7.20	86.80	5.66
IM9 (R8)	5.7	25.89	55.57	36.85	7.76	257	8.20	81.70	5.39
IM10 (R2)	5.5	25.18	55.61	36.88	7.82	269	16.00	83.40	5.56
IM11 (R7)	7.2	26.04	55.58	36.86	7.96	277	11.40	82.80	5.45
IM12 (R11)	6.8	25.80	55.33	36.67	7.95	285	11.40	83.40	5.51
Mean		25.86	55.57	36.85	7.81	296.17	9.70	83.40	5.50
Stdev		0.36	0.16	0.12	0.13	41.88	5.44	3.24	0.19
Min		25.18	55.33	36.67	7.63	257	0.2	76.2	5.06
Max		26.48	55.90	37.10	8.04	384.00	17.30	89.90	5.90
Bottom Water Quality - all stations									
Mean		25.80	55.53	36.82	7.91	308.92	10.45	81.89	5.41
STDev		0.30	0.17	0.13	0.27	57.99	4.81	4.81	0.31
Min		25.18	55.17	36.55	7.55	257	0.2	70.4	4.67
Max		26.48	55.9	37.1	8.72	496	17.7	89.9	5.9

Table 9.2 provides the averages for bottom water quality variables from 2013 to 2024. Average temperature, conductivity, salinity, dissolved oxygen, pH and turbidity were comparable to current levels.

Table 9.2 Average water quality of bottom waters - 2013 to 2024

	Temperature °C	Conductivity mS/cm	Salinity ppt	Dissolved Oxygen % sat	Dissolved Oxygen mg/L	pH	Turbidity NTU
Sep-13	17.34	53.23	35.11	95.43	7.41	8.69	11.83
Mar-14		49.60	32.40	92.3		8.10	7.8
Mar-16	27.54	51.00	33.40	99.2	6.50	8.20	4.0
Mar-17	23.90	57.10	38.00	109.5	7.42	8.30	7.5
Mar-18	25.73	58.47	39.04	87.7	5.73	8.96	46.5
Mar-19	26.20	58.39	38.97	83.3	5.39	9.74	1.6
Mar-20	24.86	50.52	33.33	63.6	4.36	8.69	6.88
Mar-21	24.93	51.88	34.11	88.9	6.05	7.98	5.02
Mar-22	24.36	53.77	35.55	90.0	6.12	8.58	11.39
Mar-23	26.90	57.48	35.28	88.35	5.68	7.73	27.46
Mar-24	25.80	55.53	36.82	81.89	5.41	7.91	10.45

10. Conclusions

The results from the March 2024 benthic communities monitoring results show compliance to the Schedule 4 Environmental Conditions - underground mining of SSD5465 - Modification 4 in the Performance Measures table with respect to the Subsidence Impact Performance Measure for Benthic communities which display nil to minor environmental consequences due to underground mining.

The below summary of findings outlines the historical basis for this compliance statement and the compliance is detailed in the table below.

Conditions from SSD-5465 – Mod 4	Compliance Status and Comments
Schedule 4 Environmental Conditions – underground mining Performance Measures – Natural Environment Biodiversity – Benthic Communities Subsidence Impact Performance Measure – Minor environmental consequences, including minor changes composition and/or distribution.	Compliant – See section 16 - Conclusions

Measurements undertaken by generally accepted methods.	Compliant – See section 4 and 5
Measures Methods fully described.	Compliant – See section 4 and 5

In March 2024, 24 benthic stations were sampled in the study area. A total of 1369 organisms greater than 1mm in size were found, comprising 16 species. This compares with the results from March 2018, March 2019, March 2020, March 2021 and March 2022 where 1160, 832, 1032, 797 and 1196 organisms respectively were recorded representing approximately twelve species. As in previous years, polychaete worms and bivalve molluscs were the most frequently encountered animals. Stations were distinguished by the relative abundance of the dominant species. Water depth does not appear to be determining species composition.

Physical variables such as salinity, conductivity and turbidity of the bottom water had little influence on the species composition of the benthos. Dissolved oxygen concentration, however, can have a major effect on abundance. Major extinction events have occurred in the mud basin of Lake Macquarie. The evidence for this lies in the presence of large numbers of intact but dead bivalve shells entombed in the mud. The cause of extinction events appears to be prolonged dissolved oxygen depletion of bottom water. Prolonged dissolved oxygen depletion of the bottom water was measured during the water quality study conducted by Laxton and Laxton (1983 to 1997) and low dissolved oxygen levels were measured during the March 2020 benthic survey. In March 2024, dissolved oxygen levels of Lake Macquarie ranged from 4.67 mg/L to 5.90 mg/L or 70.4% to 89.9% saturation. Surface waters generally had higher concentrations of dissolved oxygen than the bottom waters.

Bottom sediment in the study area was composed of fine black mud with varying proportions of black sand and shell fragments.

These results appear to support the notion that increasing the water depth within the subsidence limit of 0.78m defined in Development Consent SSD-5465 (MOD 4) has, to date, had little to no discernible effect on the composition and abundance of organisms making up the benthos of the mud basin.

11. References

Laxton, J.H. and Emma Laxton (2007). Aquatic Biology of Chain Valley Bay Lake Macquarie, NSW. Report to Peabody/Lake Coal Chain Valley Colliery.

12. Acknowledgements

We wish to acknowledge the help of Mr Lachlan McWha in facilitating the study.

Appendix 1 – Water quality profiles for control, impact and reference stations Mar 2024

	Date Time	Depth	Temp (oC)	Cond ms/cm	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)	
C1	18/03/2024 14:33	0.3	25.98	55.75	36.99	7.71	302	5.0	92.0	6.05	
	18/03/2024 14:33	0.5	25.93	55.72	36.96	7.71	295	5.4	91.9	6.06	
	18/03/2024 14:33	1.0	25.88	55.74	36.98	7.71	288	5.1	92.5	6.1	
	18/03/2024 14:34	1.5	25.84	55.73	36.97	7.70	288	5.6	92.6	6.11	
	18/03/2024 14:34	2.0	25.80	55.73	36.97	7.69	294	5.3	92.7	6.12	
	18/03/2024 14:34	2.5	25.65	55.64	36.91	7.67	289	6.1	92.1	6.1	
	18/03/2024 14:34	3.0	25.52	55.66	36.92	7.63	278	8.3	91.8	6.09	
	18/03/2024 14:34	3.5	25.49	55.73	36.97	7.59	272	11.5	89.4	5.94	
	18/03/2024 14:34	4.0	25.45	55.74	36.98	7.55	270	18.8	83.2	5.53	
	18/03/2024 14:35	4.5	25.44	55.73	36.97	7.55	263	15.6	75.3	5	
	18/03/2024 14:35	4.8	25.44	55.73	36.97	7.55	262	14.8	75.2	5	
	Average			25.67	55.72	36.96	7.64	281.91	9.23	88.06	5.83
	Stdev			0.22	0.03	0.02	0.07	13.62	5.07	6.90	0.44
	Min			25.44	55.64	36.91	7.55	262.00	5.00	75.20	5.00
Max			25.98	55.75	36.99	7.71	302.00	18.80	92.70	6.12	
C2	18/03/2024 13:49	0.3	25.82	55.41	36.73	7.87	277	7.0	87.0	5.75	
	18/03/2024 13:50	0.5	25.81	55.42	36.74	7.88	275	6.5	87.0	5.75	
	18/03/2024 13:50	1.0	25.80	55.49	36.79	7.88	274	6.4	87.2	5.77	
	18/03/2024 13:50	1.5	25.79	55.50	36.80	7.89	274	6.3	87.8	5.8	
	18/03/2024 13:50	2.0	25.78	55.49	36.80	7.88	273	5.9	88.2	5.83	
	18/03/2024 13:50	2.5	25.77	55.50	36.80	7.88	272	5.8	88.1	5.83	
	18/03/2024 13:51	3.0	25.77	55.51	36.80	7.88	271	6.2	88.1	5.82	
	18/03/2024 13:51	3.5	25.75	55.44	36.76	7.87	271	8.7	87.6	5.79	
	18/03/2024 13:51	4.0	25.71	55.39	36.72	7.85	270	12.8	86.3	5.72	
	18/03/2024 13:51	4.5	25.64	55.36	36.70	7.82	270	17.7	85.2	5.65	
	Average			25.76	55.45	36.76	7.87	272.70	8.33	87.25	5.77
	Stdev			0.05	0.05	0.04	0.02	2.31	3.91	0.94	0.06
	Min			25.64	55.36	36.70	7.82	270.00	5.80	85.20	5.65
	Max			25.82	55.51	36.80	7.89	277.00	17.70	88.20	5.83
C3	18/03/2024 13:42	0.4	25.83	55.47	36.78	7.96	288	6.0	85.4	5.64	
	18/03/2024 13:42	0.5	25.82	55.48	36.78	7.96	286	6.2	85.4	5.64	
	18/03/2024 13:43	1.0	25.81	55.48	36.78	7.95	285	6.3	85.4	5.64	
	18/03/2024 13:43	1.5	25.81	55.47	36.78	7.95	285	6.3	85.4	5.65	
	18/03/2024 13:43	2.0	25.78	55.48	36.78	7.94	284	6.3	85.5	5.65	
	18/03/2024 13:43	2.5	25.75	55.48	36.78	7.93	284	7.1	85.2	5.63	
	18/03/2024 13:43	3.0	25.74	55.49	36.79	7.92	282	7.6	84.4	5.59	
	18/03/2024 13:43	3.5	25.71	55.44	36.76	7.91	282	9.0	83.8	5.55	
	18/03/2024 13:44	4.0	25.69	55.48	36.78	7.90	281	9.2	81.9	5.42	
	18/03/2024 13:44	4.5	25.69	55.47	36.78	7.90	280	8.0	82.7	5.48	
	18/03/2024 13:44	5.0	25.67	55.47	36.78	7.89	279	10.5	83.2	5.51	
	18/03/2024 13:44	5.5	25.66	55.48	36.78	7.87	279	12.7	82.9	5.49	
	18/03/2024 13:44	6.0	25.65	55.49	36.79	7.86	278	16.4	81.0	5.36	
	18/03/2024 13:45	6.0	25.66	55.39	36.72	7.83	273	16.4	77.2	5.12	
	Average			25.73	55.47	36.78	7.91	281.86	9.14	83.53	5.53
Stdev			0.07	0.03	0.02	0.04	3.90	3.62	2.35	0.15	
Min			25.65	55.39	36.72	7.83	273.00	6.00	77.20	5.12	
Max			25.83	55.49	36.79	7.96	288.00	16.40	85.50	5.65	

	Date Time	Depth	Temp (oC)	Cond ms/cm	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)	
C4	18/03/2024 7:32	0.3	26.94	55.68	36.93	8.82	463	0.2	87.6	5.68	
	18/03/2024 7:32	0.5	26.93	55.68	36.93	8.76	456	0.6	87.5	5.67	
	18/03/2024 7:33	1.0	26.90	55.68	36.93	8.71	454	0.7	87.5	5.67	
	18/03/2024 7:33	1.5	26.88	55.66	36.92	8.66	452	0.9	87.4	5.67	
	18/03/2024 7:34	2.0	26.67	55.64	36.90	8.54	446	1.8	87.6	5.7	
	18/03/2024 7:34	2.5	26.37	55.62	36.89	8.44	442	1.8	87.2	5.71	
	18/03/2024 7:34	3.0	26.38	55.61	36.88	8.43	442	1.8	87.2	5.7	
	18/03/2024 7:34	3.5	26.32	55.61	36.88	8.37	441	2.2	86.9	5.69	
	18/03/2024 7:34	4.0	26.32	55.60	36.88	8.36	440	2.2	86.8	5.69	
	18/03/2024 7:35	4.5	26.27	55.50	36.80	8.32	443	3.2	86.5	5.67	
	18/03/2024 7:35	5.0	26.21	55.59	36.87	8.26	439	3.4	86.3	5.66	
	18/03/2024 7:35	5.5	26.20	55.59	36.87	8.26	439	3.4	86.2	5.66	
	18/03/2024 7:35	6.0	26.20	55.46	36.77	8.21	442	6.1	85.4	5.61	
	18/03/2024 7:36	6.5	26.20	55.53	36.82	8.18	435	5.5	85.0	5.58	
	18/03/2024 7:37	6.7	26.20	55.55	36.84	8.04	417	8.4	84.7	5.56	
		Average		26.47	55.60	36.87	8.42	443.40	2.81	86.65	5.66
		Stdev		0.30	0.07	0.05	0.23	10.57	2.30	0.96	0.04
	Min		26.20	55.46	36.77	8.04	417.00	0.20	84.70	5.56	
	Max		26.94	55.68	36.93	8.82	463.00	8.40	87.60	5.71	
C5	18/03/2024 13:12	0.2	26.09	55.24	36.61	8.44	333	3.5	95.8	6.31	
	18/03/2024 13:13	0.5	26.09	55.25	36.61	8.41	330	4.1	95.8	6.31	
	18/03/2024 13:13	1.0	26.10	55.24	36.61	8.41	328	4.3	95.3	6.27	
	18/03/2024 13:13	1.5	26.10	55.25	36.61	8.40	327	4.3	94.9	6.25	
	18/03/2024 13:13	2.0	26.09	55.25	36.61	8.39	326	4.7	94.8	6.24	
	18/03/2024 13:13	2.5	26.05	55.27	36.63	8.36	324	4.7	94.2	6.2	
	18/03/2024 13:14	3.0	26.02	55.26	36.62	8.34	322	4.6	93.3	6.15	
	18/03/2024 13:14	3.5	25.98	55.23	36.59	8.31	321	4.8	92.5	6.1	
	18/03/2024 13:14	4.0	25.90	55.27	36.62	8.28	320	5.1	91.4	6.04	
	18/03/2024 13:14	4.5	25.87	55.17	36.55	8.25	319	5.6	90.0	5.95	
	18/03/2024 13:14	5.0	25.89	55.18	36.56	8.24	318	7.3	88.2	5.83	
	18/03/2024 13:14	5.5	25.89	55.15	36.54	8.22	317	8.5	87.3	5.77	
	18/03/2024 13:15	6.0	25.83	55.14	36.53	8.19	316	12.2	85.6	5.66	
	18/03/2024 13:16	6.7	25.79	55.17	36.55	8.10	309	11.8	80.8	5.34	
		Average		25.98	55.22	36.59	8.31	322.14	6.11	91.42	6.03
		Stdev		0.11	0.05	0.03	0.10	6.36	2.82	4.52	0.29
		Min		25.79	55.14	36.53	8.10	309.00	3.50	80.80	5.34
	Max		26.10	55.27	36.63	8.44	333.00	12.20	95.80	6.31	
C6	18/03/2024 7:16	0.3	26.83	55.70	36.95	10.39	551	0.1	81.0	5.25	
	18/03/2024 7:16	0.5	26.83	55.70	36.95	10.30	547	0.1	81.0	5.25	
	18/03/2024 7:17	1.0	26.82	55.66	36.92	10.21	541	0.1	104.3	6.77	
	18/03/2024 7:17	1.5	26.74	55.62	36.89	10.08	537	0.5	93.0	6.05	
	18/03/2024 7:18	2.0	26.63	55.49	36.79	9.91	531	1.9	115.7	7.54	
	18/03/2024 7:18	2.5	26.29	55.40	36.72	9.75	527	2.3	93.9	6.15	
	18/03/2024 7:18	3.0	26.17	55.39	36.72	9.63	523	2.3	90.0	5.91	
	18/03/2024 7:19	3.5	26.11	55.42	36.74	9.50	520	3.1	87.7	5.76	
	18/03/2024 7:19	4.0	26.10	55.38	36.71	9.38	515	3.8	85.9	5.65	
	18/03/2024 7:20	4.5	25.84	55.40	36.73	9.18	513	7.4	77.9	5.15	
	18/03/2024 7:20	5.0	25.74	55.45	36.76	9.06	511	9.6	74.7	4.94	
	18/03/2024 7:22	5.5	25.74	55.54	36.83	8.72	496	10.1	72.2	4.77	
		Average		26.32	55.51	36.81	9.68	526.00	3.44	88.11	5.77
		Stdev		0.43	0.13	0.09	0.53	16.23	3.63	12.53	0.80
		Min		25.74	55.38	36.71	8.72	496.00	0.10	72.20	4.77
		Max		26.83	55.70	36.95	10.39	551.00	10.10	115.70	7.54

	Date Time	Depth	Temp (oC)	Cond ms/cm	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)	
C7	18/03/2024 8:47	0.3	25.84	55.39	36.72	8.18	338	0.2	83.3	5.5	
	18/03/2024 8:48	0.6	25.87	55.39	36.72	8.18	336	0.3	83.5	5.51	
	18/03/2024 8:48	1.0	25.86	55.39	36.72	8.17	335	0.9	83.7	5.53	
	18/03/2024 8:48	1.5	25.86	55.40	36.73	8.16	334	1.3	84.1	5.55	
	18/03/2024 8:48	2.0	25.86	55.39	36.72	8.15	333	1.9	84.2	5.56	
	18/03/2024 8:48	2.5	25.86	55.40	36.72	8.14	332	2.1	84.4	5.57	
	18/03/2024 8:49	3.0	25.86	55.38	36.71	8.13	331	2.5	84.6	5.58	
	18/03/2024 8:49	3.5	25.82	55.33	36.67	8.11	330	3.5	84.0	5.55	
	18/03/2024 8:49	4.0	25.76	55.35	36.69	8.08	329	4.3	83.5	5.53	
	18/03/2024 8:49	4.5	25.76	55.24	36.60	8.07	328	4.7	83.1	5.5	
	18/03/2024 8:49	5.0	25.68	55.27	36.63	8.04	328	6.7	82.4	5.46	
	18/03/2024 8:50	5.5	25.65	55.31	36.66	8.02	327	7.5	81.8	5.42	
	18/03/2024 8:51	6.0	25.66	55.25	36.61	7.94	322	9.5	79.8	5.29	
		Average		25.80	55.35	36.68	8.11	331.00	3.49	83.26	5.50
	Stdev		0.08	0.06	0.05	0.07	4.32	2.92	1.30	0.08	
	Min		25.65	55.24	36.60	7.94	322.00	0.20	79.80	5.29	
	Max		25.87	55.40	36.73	8.18	338.00	9.50	84.60	5.58	
R1	18/03/2024 14:25	0.3	26.21	55.76	36.99	7.79	272	5.6	86.7	5.69	
	18/03/2024 14:25	0.5	26.17	55.73	36.97	7.79	270	5.7	86.9	5.7	
	18/03/2024 14:26	1.0	26.08	55.73	36.97	7.78	270	5.9	87.4	5.74	
	18/03/2024 14:26	1.5	26.02	55.73	36.97	7.77	269	5.8	88.9	5.85	
	18/03/2024 14:26	2.0	25.97	55.74	36.98	7.77	269	5.6	90.1	5.93	
	18/03/2024 14:26	2.5	25.95	55.73	36.97	7.76	268	5.7	90.6	5.96	
	18/03/2024 14:26	3.0	25.93	55.61	36.88	7.75	267	5.8	89.8	5.92	
	18/03/2024 14:26	3.5	25.88	55.72	36.96	7.73	266	6.8	89.2	5.88	
	18/03/2024 14:27	4.0	25.88	55.70	36.95	7.72	265	362.4	88.5	5.83	
	18/03/2024 14:28	4.5	25.89	55.73	36.97	7.72	260	14.0	87.4	5.76	
		Average		26.00	55.72	36.96	7.76	267.60	42.33	88.55	5.83
		Stdev		0.12	0.04	0.03	0.03	3.37	112.49	1.39	0.10
		Min		25.88	55.61	36.88	7.72	260.00	5.60	86.70	5.69
		Max		26.21	55.76	36.99	7.79	272.00	362.40	90.60	5.96
R9	18/03/2024 15:26	0.4	25.96	55.70	36.95	8.07	293	4.2	92.0	6.06	
	18/03/2024 15:26	0.5	25.96	55.70	36.95	8.06	291	4.4	92.0	6.06	
	18/03/2024 15:26	1.0	25.95	55.70	36.95	8.06	290	4.3	91.9	6.05	
	18/03/2024 15:26	1.5	25.94	55.70	36.95	8.05	289	4.3	91.9	6.05	
	18/03/2024 15:27	2.0	25.90	55.67	36.93	8.04	287	4.6	91.8	6.05	
	18/03/2024 15:27	2.5	25.81	55.65	36.91	8.02	286	5.9	91.8	6.06	
	18/03/2024 15:27	3.0	25.62	55.68	36.94	7.98	285	8.4	92.2	6.11	
	18/03/2024 15:27	3.5	25.49	55.61	36.88	7.95	285	5.6	90.4	6	
	18/03/2024 15:28	3.8	25.38	55.71	36.95	7.86	277	9.5	88.4	5.87	
		Average		25.78	55.68	36.93	8.01	287.00	5.69	91.38	6.03
		Stdev		0.22	0.03	0.02	0.07	4.66	1.96	1.23	0.07
		Min		25.38	55.61	36.88	7.86	277.00	4.20	88.40	5.87
		Max		25.96	55.71	36.95	8.07	293.00	9.50	92.20	6.11

	Date Time	Depth	Temp (oC)	Cond ms/cm	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)	
R10	18/03/2024 8:33	0.3	25.89	55.59	36.87	8.03	359	0.1	85.1	5.61	
	18/03/2024 8:33	0.6	25.90	55.59	36.87	8.03	356	0.2	85.2	5.61	
	18/03/2024 8:34	1.0	25.89	55.60	36.87	8.02	354	0.4	85.1	5.61	
	18/03/2024 8:34	1.5	25.90	55.61	36.88	8.01	349	1.0	85.1	5.61	
	18/03/2024 8:34	2.0	25.91	55.59	36.87	8.00	347	1.3	85.1	5.61	
	18/03/2024 8:35	2.5	25.91	55.61	36.88	7.99	346	2.3	85.3	5.62	
	18/03/2024 8:35	3.0	25.91	55.46	36.77	7.98	344	2.1	85.4	5.64	
	18/03/2024 8:35	3.5	25.91	55.52	36.81	7.97	343	2.5	85.6	5.65	
	18/03/2024 8:36	4.0	25.89	55.56	36.85	7.95	340	2.6	85.7	5.65	
	18/03/2024 8:36	4.5	25.85	55.48	36.78	7.93	339	3.0	85.6	5.65	
	18/03/2024 8:36	5.0	25.75	55.44	36.75	7.88	337	3.1	84.4	5.58	
	18/03/2024 8:37	5.5	25.64	55.53	36.82	7.74	332	5.9	70.4	4.67	
	Average			25.86	55.55	36.84	7.96	345.50	2.04	84.00	5.54
	Stdev			0.08	0.06	0.05	0.08	8.06	1.62	4.30	0.28
Min			25.64	55.44	36.75	7.74	332.00	0.10	70.40	4.67	
Max			25.91	55.61	36.88	8.03	359.00	5.90	85.70	5.65	
R12	18/03/2024 12:50	0.3	26.06	55.68	36.94	8.63	346	4.0	86.3	5.67	
	18/03/2024 12:50	0.6	26.07	55.67	36.93	8.61	344	4.0	85.5	5.62	
	18/03/2024 12:51	1.0	26.06	55.69	36.94	8.59	341	4.6	98.3	6.46	
	18/03/2024 12:51	1.5	26.06	55.67	36.92	8.58	340	4.7	107.9	7.09	
	18/03/2024 12:51	2.0	26.06	55.62	36.89	8.57	338	5.6	97.3	6.4	
	18/03/2024 12:51	2.5	26.06	55.52	36.82	8.55	337	5.0	94.4	6.21	
	18/03/2024 12:51	3.0	26.05	55.57	36.85	8.54	336	5.1	94.4	6.21	
	18/03/2024 12:52	3.5	26.05	55.55	36.84	8.53	334	5.5	94.6	6.22	
	18/03/2024 12:52	4.0	26.05	55.55	36.83	8.52	334	5.4	94.7	6.23	
	18/03/2024 12:52	4.5	26.04	55.55	36.84	8.50	332	5.6	97.0	6.38	
	18/03/2024 12:52	5.0	26.01	55.57	36.85	8.48	331	5.7	97.4	6.41	
	18/03/2024 12:52	5.5	25.95	55.56	36.85	8.45	329	5.7	94.7	6.24	
	18/03/2024 12:53	6.0	25.89	55.74	36.98	8.40	328	10.5	91.7	6.05	
	18/03/2024 12:54	6.5	25.88	55.55	36.84	8.30	321	3.6	81.6	5.38	
Average			26.02	55.61	36.88	8.52	335.07	5.36	93.99	6.18	
Stdev			0.07	0.07	0.05	0.09	6.71	1.64	6.42	0.42	
Min			25.88	55.52	36.82	8.30	321.00	3.60	81.60	5.38	
Max			26.07	55.74	36.98	8.63	346.00	10.50	107.90	7.09	
R13	18/03/2024 12:19	0.3	25.93	55.54	36.83	8.90	345	0.9	95.6	6.3	
	18/03/2024 12:19	0.5	25.93	55.54	36.83	8.89	344	3.3	93.1	6.14	
	18/03/2024 12:20	1.0	25.94	55.53	36.82	8.86	341	3.2	85.5	5.64	
	18/03/2024 12:20	1.5	25.95	55.54	36.83	8.84	339	4.0	84.6	5.58	
	18/03/2024 12:20	2.0	25.95	55.55	36.83	8.81	338	4.4	84.2	5.55	
	18/03/2024 12:21	2.5	25.94	55.57	36.85	8.78	336	6.2	84.0	5.53	
	18/03/2024 12:21	3.0	25.94	55.52	36.81	8.76	334	5.4	83.9	5.53	
	18/03/2024 12:21	3.5	25.90	55.45	36.76	8.73	333	6.8	84.0	5.54	
	18/03/2024 12:21	4.0	25.87	55.38	36.71	8.70	332	8.2	83.7	5.52	
	18/03/2024 12:21	4.5	25.87	55.40	36.72	8.67	331	8.1	83.3	5.5	
	18/03/2024 12:22	5.0	25.86	55.41	36.73	8.66	330	9.4	83.1	5.49	
	18/03/2024 12:23	5.5	25.85	55.37	36.70	8.48	321	12.7	81.7	5.4	
	Average			25.91	55.48	36.79	8.76	335.33	6.05	85.56	5.64
	Stdev			0.04	0.08	0.06	0.12	6.69	3.23	4.24	0.28
Min			25.85	55.37	36.70	8.48	321.00	0.90	81.70	5.40	
Max			25.95	55.57	36.85	8.90	345.00	12.70	95.60	6.30	

	Date Time	Depth	Temp (oC)	Cond ms/cm	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)	
IM1	18/03/2024 14:42	0.3	25.92	55.73	36.97	7.80	272	5.7	91.3	6.01	
	18/03/2024 14:42	0.5	25.91	55.70	36.95	7.80	270	5.5	91.3	6.02	
	18/03/2024 14:42	1.0	25.86	55.66	36.92	7.79	269	5.4	91.5	6.04	
	18/03/2024 14:42	1.5	25.77	55.68	36.93	7.77	270	5.8	91.7	6.06	
	18/03/2024 14:42	2.0	25.71	55.70	36.95	7.76	269	5.5	91.6	6.06	
	18/03/2024 14:42	2.5	25.63	55.66	36.92	7.74	268	6.4	91.8	6.08	
	18/03/2024 14:43	3.0	25.52	55.62	36.89	7.72	267	9.1	91.5	6.07	
	18/03/2024 14:43	3.5	25.47	55.72	36.97	7.68	266	10.6	89.6	5.95	
	18/03/2024 14:43	4.0	25.42	55.65	36.91	7.64	266	12.7	84.4	5.61	
	18/03/2024 14:44	4.2	25.41	55.69	36.94	7.63	262	17.3	76.2	5.06	
	Average			25.66	55.68	36.94	7.73	267.90	8.40	89.09	5.90
	Stdev			0.20	0.03	0.03	0.06	2.81	4.04	5.06	0.33
Min			25.41	55.62	36.89	7.63	262.00	5.40	76.20	5.06	
Max			25.92	55.73	36.97	7.80	272.00	17.30	91.80	6.08	
IM2											
	18/03/2024 14:03	0.4	25.96	55.57	36.85	7.97	288	5.6	88.6	5.84	
	18/03/2024 14:03	0.5	25.94	55.57	36.85	7.97	286	5.5	88.7	5.84	
	18/03/2024 14:03	1.0	25.90	55.57	36.85	7.96	285	5.9	88.7	5.85	
	18/03/2024 14:03	1.5	25.88	55.57	36.85	7.96	284	6.1	88.7	5.85	
	18/03/2024 14:03	2.0	25.86	55.56	36.84	7.95	283	6.7	88.7	5.85	
	18/03/2024 14:04	2.5	25.82	55.39	36.72	7.94	282	7.1	88.6	5.86	
	18/03/2024 14:04	3.0	25.77	55.43	36.75	7.92	281	6.9	88.2	5.83	
	18/03/2024 14:04	3.5	25.76	55.40	36.72	7.91	280	6.4	87.5	5.79	
	18/03/2024 14:04	4.0	25.70	55.42	36.74	7.89	280	15.5	87.3	5.78	
	18/03/2024 14:05	4.5	25.67	55.45	36.76	7.85	275	10.8	83.5	5.53	
	18/03/2024 14:05	4.8	25.67	55.44	36.76	7.85	275	11.3	82.6	5.47	
Average			25.81	55.49	36.79	7.92	281.73	7.98	87.37	5.77	
Stdev			0.11	0.08	0.06	0.04	4.15	3.18	2.20	0.14	
Min			25.67	55.39	36.72	7.85	275.00	5.50	82.60	5.47	
Max			25.96	55.57	36.85	7.97	288.00	15.50	88.70	5.86	
IM3											
	18/03/2024 14:09	0.4	25.93	55.59	36.87	7.90	271	6.1	88.6	5.84	
	18/03/2024 14:10	0.5	25.93	55.57	36.85	7.90	270	6.3	88.6	5.84	
	18/03/2024 14:10	1.0	25.90	55.57	36.85	7.89	269	6.5	88.6	5.84	
	18/03/2024 14:10	1.5	25.83	55.57	36.85	7.88	268	7.3	88.6	5.85	
	18/03/2024 14:10	2.0	25.80	55.57	36.85	7.86	267	7.0	87.8	5.8	
	18/03/2024 14:10	2.5	25.78	55.58	36.86	7.86	266	6.6	87.5	5.78	
	18/03/2024 14:10	3.0	25.77	55.48	36.78	7.85	266	7.0	87.4	5.78	
	18/03/2024 14:11	3.5	25.77	55.48	36.78	7.85	265	7.6	87.2	5.76	
	18/03/2024 14:11	4.0	25.77	55.46	36.77	7.84	265	9.4	86.7	5.74	
	18/03/2024 14:11	4.5	25.77	55.45	36.76	7.84	265	10.0	86.0	5.69	
	18/03/2024 14:11	5.0	25.77	55.44	36.75	7.82	264	14.1	85.0	5.62	
18/03/2024 14:12	5.5	25.77	55.45	36.76	7.80	261	17.2	81.7	5.4		
Average			25.82	55.52	36.81	7.86	266.42	8.76	86.98	5.75	
Stdev			0.07	0.06	0.05	0.03	2.78	3.49	2.01	0.13	
Min			25.77	55.44	36.75	7.80	261.00	6.10	81.70	5.40	
Max			25.93	55.59	36.87	7.90	271.00	17.20	88.60	5.85	

	Date Time	Depth	Temp (oC)	Cond ms/cm	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)
IM4	18/03/2024 7:44	0.4	25.82	55.40	36.72	8.01	410	0.1	84.5	5.58
	18/03/2024 7:44	0.5	25.82	55.40	36.72	8.01	410	0.1	84.7	5.6
	18/03/2024 7:45	1.0	25.83	55.40	36.72	8.01	408	0.4	85.1	5.62
	18/03/2024 7:45	1.5	25.83	55.40	36.72	8.00	406	0.7	85.0	5.62
	18/03/2024 7:45	2.0	25.83	55.40	36.73	7.99	406	6.2	84.8	5.6
	18/03/2024 7:45	2.5	25.83	55.39	36.72	7.98	403	0.5	84.7	5.6
	18/03/2024 7:46	3.0	25.83	55.22	36.59	7.97	401	0.8	84.6	5.59
	18/03/2024 7:46	3.5	25.83	55.28	36.63	7.95	399	1.4	84.5	5.58
	18/03/2024 7:46	4.0	25.83	55.26	36.62	7.94	397	1.3	84.4	5.58
	18/03/2024 7:47	4.5	25.83	55.25	36.61	7.92	396	1.9	84.4	5.58
	18/03/2024 7:47	5.0	25.83	55.25	36.61	7.92	396	2.0	84.4	5.58
	18/03/2024 7:47	5.5	25.82	55.31	36.66	7.91	395	2.2	84.4	5.58
	18/03/2024 7:47	6.0	25.82	55.35	36.69	7.89	393	1.8	84.4	5.58
	18/03/2024 7:47	6.5	25.82	55.40	36.72	7.88	391	2.2	84.3	5.57
	18/03/2024 7:49	7.0	25.82	55.43	36.74	7.81	384	3.1	84.2	5.56
	Average			25.83	55.34	36.68	7.95	399.67	1.65	84.56
Stdev			0.01	0.07	0.05	0.06	7.55	1.54	0.26	0.02
Min			25.82	55.22	36.59	7.81	384.00	0.10	84.20	5.56
Max			25.83	55.43	36.74	8.01	410.00	6.20	85.10	5.62

	Date Time	Depth	Temp (oC)	Cond ms/cm	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)
IM5	18/03/2024 7:54	0.3	26.71	55.67	36.93	8.14	397	0.2	87.3	5.68
	18/03/2024 7:54	0.5	26.73	55.67	36.93	8.14	397	0.2	87.5	5.69
	18/03/2024 7:55	1.0	26.64	55.65	36.91	8.11	395	0.2	87.6	5.71
	18/03/2024 7:55	1.5	26.49	55.63	36.89	8.06	391	0.2	87.8	5.73
	18/03/2024 7:55	2.0	26.19	55.53	36.82	7.97	387	0.4	87.4	5.74
	18/03/2024 7:56	2.5	26.12	55.51	36.81	7.92	383	0.5	86.2	5.67
	18/03/2024 7:56	3.0	26.08	55.37	36.70	7.89	379	1.1	85.6	5.63
	18/03/2024 7:56	3.5	26.02	55.31	36.66	7.85	377	2.0	85.1	5.6
	18/03/2024 7:57	4.0	25.95	55.29	36.64	7.81	374	3.1	84.4	5.57
	18/03/2024 7:57	4.5	25.93	55.35	36.68	7.78	372	3.4	84.0	5.54
	18/03/2024 7:57	5.0	25.92	55.39	36.72	7.76	371	3.5	83.9	5.53
	18/03/2024 7:57	5.5	25.89	55.45	36.76	7.74	370	3.8	83.9	5.53
	18/03/2024 7:58	6.0	25.89	55.51	36.80	7.73	369	6.5	83.5	5.51
	18/03/2024 7:58	6.5	25.89	55.47	36.78	7.72	368	7.0	83.3	5.5
	18/03/2024 7:59	7.0	25.88	55.49	36.79	7.66	348	0.2	83.1	5.49
	18/03/2024 7:59	7.5	25.89	55.48	36.78	7.66	348	0.2	83.2	5.49
Average			26.14	55.49	36.79	7.87	376.63	2.03	85.24	5.60
Stdev			0.32	0.12	0.09	0.17	15.06	2.29	1.80	0.09
Min			25.88	55.29	36.64	7.66	348.00	0.20	83.10	5.49
Max			26.73	55.67	36.93	8.14	397.00	7.00	87.80	5.74

	Date Time	Depth	Temp (oC)	Cond ms/cm	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)	
IM6	18/03/2024 15:49	0.4	26.72	55.77	37.00	8.30	284	5.2	92.5	6.01	
	18/03/2024 15:49	0.5	26.72	55.78	37.01	8.28	281	5.1	93.1	6.05	
	18/03/2024 15:49	1.0	26.60	55.77	37.00	8.26	280	5.1	95.0	6.19	
	18/03/2024 15:49	1.5	26.56	55.81	37.03	8.24	278	5.1	95.3	6.21	
	18/03/2024 15:49	2.0	26.41	55.65	36.91	8.20	277	5.2	95.5	6.24	
	18/03/2024 15:50	2.5	26.23	55.68	36.93	8.14	276	5.8	94.2	6.17	
	18/03/2024 15:50	3.0	26.17	55.63	36.89	8.11	276	5.6	93.0	6.1	
	18/03/2024 15:50	3.5	26.12	55.58	36.86	8.08	275	7.2	92.2	6.06	
	18/03/2024 15:50	4.0	26.12	55.56	36.84	8.07	275	5.8	91.2	5.99	
	18/03/2024 15:51	4.5	26.16	55.56	36.85	8.04	271	5.8	89.9	5.9	
	Average			26.38	55.68	36.93	8.17	277.30	5.59	93.19	6.09
	Stdev			0.25	0.10	0.07	0.10	3.65	0.65	1.84	0.11
	Min			26.12	55.56	36.84	8.04	271.00	5.10	89.90	5.90
	Max			26.72	55.81	37.03	8.30	284.00	7.20	95.50	6.24

	Date Time	Depth	Temp (oC)	Cond ms/cm	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)
IM7	18/03/2024 8:07	0.3	27.27	55.68	36.93	8.24	371	0.1	90.0	5.8
	18/03/2024 8:07	0.5	27.24	55.69	36.94	8.22	370	0.1	89.7	5.78
	18/03/2024 8:07	1.0	27.24	55.63	36.89	8.21	367	0.1	89.7	5.78
	18/03/2024 8:07	1.5	26.80	55.69	36.94	8.10	362	0.2	88.9	5.77
	18/03/2024 8:08	2.0	26.85	55.73	36.97	8.07	358	0.5	87.8	5.7
	18/03/2024 8:08	2.5	26.60	55.69	36.94	8.01	356	0.9	88.1	5.74
	18/03/2024 8:08	3.0	26.48	55.71	36.96	7.94	352	2.1	87.1	5.68
	18/03/2024 8:09	3.5	26.45	55.61	36.88	7.90	349	3.0	85.4	5.58
	18/03/2024 8:09	4.0	26.42	55.72	36.97	7.86	346	3.4	82.8	5.41
	18/03/2024 8:09	4.5	26.35	55.66	36.92	7.82	343	5.4	82.3	5.39
	18/03/2024 8:10	5.0	26.31	55.54	36.83	7.82	343	6.4	82.0	5.37
	18/03/2024 8:10	5.5	26.28	55.59	36.86	7.80	341	8.1	84.7	5.55
	18/03/2024 8:10	6.0	26.27	55.70	36.95	7.78	340	9.9	85.2	5.58
	18/03/2024 8:10	6.5	26.27	55.66	36.92	7.78	339	15.4	85.2	5.58
	18/03/2024 8:12	6.7	26.31	55.77	37.00	7.72	333	7.3	84.9	5.55
	Average		26.61	55.67	36.93	7.95	351.33	4.19	86.25	5.62
	Stdev		0.38	0.06	0.05	0.18	12.12	4.52	2.73	0.15
	Min		26.27	55.54	36.83	7.72	333.00	0.10	82.00	5.37
	Max		27.27	55.77	37.00	8.24	371.00	15.40	90.00	5.80
IM8	18/03/2024 8:18	0.4	26.92	55.79	37.01	7.99	364	0.2	87.7	5.68
	18/03/2024 8:18	0.5	26.91	55.79	37.02	7.98	366	0.4	87.8	5.69
	18/03/2024 8:18	1.0	26.90	55.79	37.02	7.97	361	0.7	87.9	5.7
	18/03/2024 8:19	1.5	26.85	55.80	37.02	7.95	358	1.4	87.9	5.7
	18/03/2024 8:19	2.0	26.80	55.81	37.03	7.92	356	2.4	87.2	5.66
	18/03/2024 8:19	2.5	26.62	55.79	37.02	7.88	355	2.8	87.2	5.68
	18/03/2024 8:19	3.0	26.53	55.81	37.03	7.84	350	3.4	86.8	5.66
	18/03/2024 8:19	3.5	26.52	55.72	36.97	7.83	349	3.8	86.6	5.65
	18/03/2024 8:20	4.0	26.50	55.73	36.97	7.81	347	4.3	86.5	5.65
	18/03/2024 8:20	4.5	26.50	55.78	37.01	7.80	344	4.3	86.7	5.66
	18/03/2024 8:20	5.0	26.48	55.68	36.94	7.78	343	5.2	86.8	5.66
	18/03/2024 8:20	5.5	26.48	55.65	36.91	7.77	341	5.1	86.8	5.66
	18/03/2024 8:21	5.8	26.47	55.69	36.95	7.76	340	5.6	86.8	5.67
	18/03/2024 8:21	3.3	26.45	55.72	36.96	7.75	339	10.8	86.8	5.67
	18/03/2024 8:21	3.5	26.42	55.87	37.08	7.73	338	14.6	86.5	5.65
	18/03/2024 8:22	3.1	26.48	55.90	37.10	7.68	332	7.2	86.8	5.66
	Average		26.61	55.77	37.00	7.84	348.94	4.51	87.05	5.67
	Stdev		0.19	0.07	0.05	0.10	10.15	3.83	0.50	0.02
	Min		26.42	55.65	36.91	7.68	332.00	0.20	86.50	5.65
Max		26.92	55.90	37.10	7.99	366.00	14.60	87.90	5.70	
IM9	18/03/2024 14:16	0.3	25.99	55.60	36.87	7.84	270	5.7	89.5	5.89
	18/03/2024 14:16	0.5	25.95	55.57	36.85	7.84	268	5.9	89.8	5.91
	18/03/2024 14:17	1.0	25.88	55.60	36.87	7.82	267	6.0	90.2	5.95
	18/03/2024 14:17	1.5	25.84	55.57	36.85	7.81	266	6.5	90.3	5.96
	18/03/2024 14:17	2.0	25.82	55.60	36.87	7.80	265	6.1	90.0	5.94
	18/03/2024 14:17	2.5	25.82	55.60	36.87	7.80	264	6.3	89.6	5.92
	18/03/2024 14:17	3.0	25.83	55.52	36.82	7.80	264	6.1	89.3	5.9
	18/03/2024 14:17	3.5	25.84	55.59	36.87	7.80	263	6.3	89.0	5.87
	18/03/2024 14:18	4.0	25.86	55.56	36.85	7.80	262	6.8	88.4	5.84
	18/03/2024 14:18	4.5	25.92	55.60	36.88	7.81	262	6.7	87.3	5.76
	18/03/2024 14:18	5.0	25.86	55.56	36.84	7.79	261	8.2	85.9	5.67
	18/03/2024 14:18	5.5	25.82	55.56	36.85	7.75	261	20.9	84.0	5.55
	18/03/2024 14:19	5.7	25.89	55.57	36.85	7.76	257	8.2	81.7	5.39
	Average		25.87	55.58	36.86	7.80	263.85	7.67	88.08	5.81
	Stdev		0.05	0.02	0.02	0.03	3.44	4.05	2.67	0.17
	Min		25.82	55.52	36.82	7.75	257.00	5.70	81.70	5.39
	Max		25.99	55.60	36.88	7.84	270.00	20.90	90.30	5.96

	Date Time	Depth	Temp (oC)	Cond ms/cm	Sal (ppt)	pH	ORP (mV)	Turb (ntu)	DO%	DO (mg/L)	
IM10	18/03/2024 15:02	0.3	25.63	55.78	37.01	8.02	289	7.6	89.2	5.91	
	18/03/2024 15:03	0.5	25.61	55.77	37.00	8.01	285	6.7	89.3	5.91	
	18/03/2024 15:03	1.0	25.45	55.75	36.99	7.98	282	6.6	89.4	5.93	
	18/03/2024 15:03	1.5	25.32	55.71	36.96	7.95	280	7.2	89.7	5.97	
	18/03/2024 15:03	2.0	25.28	55.60	36.87	7.93	279	7.8	89.3	5.95	
	18/03/2024 15:04	2.5	25.26	55.60	36.88	7.91	277	8.2	89.4	5.96	
	18/03/2024 15:04	3.0	25.21	55.57	36.85	7.89	276	11.9	89.4	5.96	
	18/03/2024 15:04	3.5	25.19	55.63	36.89	7.88	275	12.7	87.1	5.81	
	18/03/2024 15:04	4.0	25.19	55.63	36.90	7.87	274	14.1	86.1	5.74	
	18/03/2024 15:04	4.5	25.18	55.65	36.91	7.86	274	13.6	85.7	5.72	
	18/03/2024 15:06	5.0	25.18	55.61	36.88	7.82	269	17.1	83.3	5.56	
	18/03/2024 15:06	5.5	25.18	55.61	36.88	7.82	269	16.0	83.4	5.56	
	Average			25.31	55.66	36.92	7.91	277.42	10.79	87.61	5.83
	Stddev			0.17	0.07	0.06	0.07	5.99	3.86	2.43	0.15
	Min			25.18	55.57	36.85	7.82	269.00	6.60	83.30	5.56
Max			25.63	55.78	37.01	8.02	289.00	17.10	89.70	5.97	
IM11	18/03/2024 13:32	0.3	25.90	55.46	36.77	8.04	292	4.9	89.6	5.91	
	18/03/2024 13:32	0.5	25.90	55.46	36.77	8.04	290	5.1	89.7	5.92	
	18/03/2024 13:32	1.0	25.89	55.47	36.78	8.04	289	5.5	89.8	5.92	
	18/03/2024 13:32	1.5	25.89	55.47	36.78	8.04	288	5.6	89.9	5.93	
	18/03/2024 13:33	2.0	25.88	55.48	36.79	8.03	287	5.8	89.7	5.92	
	18/03/2024 13:33	2.5	25.88	55.48	36.78	8.03	287	5.8	89.5	5.9	
	18/03/2024 13:33	3.0	25.88	55.49	36.79	8.02	285	5.7	89.0	5.87	
	18/03/2024 13:33	3.5	25.87	55.39	36.71	8.01	285	5.9	89.0	5.88	
	18/03/2024 13:33	4.0	25.85	55.48	36.78	8.00	284	6.2	88.0	5.81	
	18/03/2024 13:34	4.5	25.87	55.53	36.82	7.99	283	6.5	86.9	5.74	
	18/03/2024 13:34	5.0	25.91	55.60	36.88	7.99	283	7.8	85.9	5.66	
	18/03/2024 13:34	5.5	25.97	55.56	36.84	8.00	282	7.5	85.0	5.6	
	18/03/2024 13:34	6.0	25.98	55.69	36.94	8.00	282	7.8	84.4	5.55	
	18/03/2024 13:34	6.5	26.03	55.64	36.91	8.00	281	8.4	83.8	5.51	
	18/03/2024 13:35	7.0	26.04	55.58	36.86	8.00	280	9.9	83.3	5.48	
18/03/2024 13:36	7.2	26.04	55.58	36.86	7.96	277	11.4	82.8	5.45		
Average			25.92	55.52	36.82	8.01	284.69	6.86	87.27	5.75	
Stddev			0.07	0.08	0.06	0.02	3.98	1.82	2.65	0.18	
Min			25.85	55.39	36.71	7.96	277.00	4.90	82.80	5.45	
Max			26.04	55.69	36.94	8.04	292.00	11.40	89.90	5.93	
IM12	18/03/2024 13:22	0.4	25.97	55.37	36.71	8.15	311	5.1	88.0	5.8	
	18/03/2024 13:22	0.5	25.97	55.38	36.71	8.15	310	5.0	87.9	5.8	
	18/03/2024 13:23	1.0	25.97	55.37	36.71	8.15	309	5.5	88.0	5.8	
	18/03/2024 13:23	1.5	25.97	55.38	36.71	8.13	307	6.6	87.6	5.77	
	18/03/2024 13:23	2.0	25.97	55.37	36.70	8.13	305	6.2	87.7	5.78	
	18/03/2024 13:23	2.5	25.92	55.33	36.67	8.11	305	6.7	87.3	5.76	
	18/03/2024 13:23	3.0	25.88	55.34	36.68	8.09	304	7.0	86.4	5.7	
	18/03/2024 13:24	3.5	25.86	55.33	36.67	8.08	303	9.3	86.4	5.71	
	18/03/2024 13:24	4.0	25.84	55.28	36.63	8.06	302	8.9	85.9	5.68	
	18/03/2024 13:24	4.5	25.83	55.34	36.68	8.05	300	9.4	85.2	5.63	
	18/03/2024 13:24	5.0	25.82	55.31	36.66	8.04	300	9.5	85.0	5.62	
	18/03/2024 13:24	5.5	25.81	55.36	36.69	8.02	299	10.7	84.3	5.58	
	18/03/2024 13:25	6.0	25.79	55.33	36.67	8.01	298	11.9	83.6	5.53	
	18/03/2024 13:25	6.5	25.78	55.23	36.60	7.99	298	893.7	82.6	5.47	
	18/03/2024 13:26	6.8	25.80	55.33	36.67	7.95	285	11.4	83.4	5.51	
Average			25.88	55.34	36.68	8.07	302.40	67.13	85.95	5.68	
Stddev			0.08	0.04	0.03	0.06	6.42	228.68	1.85	0.11	
Min			25.78	55.23	36.60	7.95	285.00	5.00	82.60	5.47	
Max			25.97	55.38	36.71	8.15	311.00	893.70	88.00	5.80	