Macquarie Harbour Waste Capture System (WCS)

MONTHLY PROGRESS REPORT

Submission date: 1 November 2017
Report closing date: 31 October 2017
Report number: 4
Next report due: 30 November 2017

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Section 1.0: Purpose

The purpose of the Monthly Report is to determine:

1. that Waste Capture Systems (WCS) are in good working order
    - Report by exception. Any problems observed, repairs undertaken, actions needed, issues resolved or requiring resolution. Log of number of times each liner is emptied, volume of liquid captured and mass of solids captured.
2. if WCS are effective in reducing impact to sediments and water quality at the Harbour bottom
    - **a.** monthly progress updates covering issues as per the EMP
    - **b.** when the project is nearing completion, a summary report will be required as per the EPN

Section 2.0: WCS Installations and Standing Biomass

Table 1 summarises all WCS installation dates and current standing biomass for each WCS. Total biomass for the 2016 salmon input year, 150% of total biomass in excess of 13t/ha and total biomass with WCS deployed is also provided in *table 1.*

Reporting Date		31/10/2017
WCS Location	Installation Date	Standing Biomass (kg)
G17A	6/06/2017	113,645.10
G15A	15/06/2017	123,297.80
G13A	24/06/2017	127,126.00
G11A	28/06/2017	115,823.10
G9A	4/07/2017	117,970.20
G7A	23/07/2017	121,889.60
G5A	26/07/2017	109,217.10
G3A	28/07/2017	121,373.40
G1	3/08/2017	126,505.20
M1	9/08/2017	150,770.80
M6	13/08/2017	149,395.50
M5	20/08/2017	144,701.70
M4	23/08/2017	128,999.30
G16	30/08/2017	137,081.70
M3	9/09/2017	128,091.10
G10	14/09/2017	129,692.20
G13	22/09/2017	141,354.30
G11	28/09/2017	133,099.70
G14	7/10/2017	128,554.00
G18	9/10/2017	128,741.70
G12	10/10/2017	127,507.10
G8	17/10/2017	125,974.90
G17	24/10/2017	111,705.10
Total Biomass (kg)		5,440,108
Required Waste Capture Biomass (Kg)		2,700,162
Actual Waste Captured Biomass		2,942,517

Table 1: WCS installations and Standing Biomass

Section 3.0: Waste extraction quantities and calculations

Table 2 summarises total feed input and waste extracted for all WCS since installation dates, together with theoretical waste volumes which would have been produced by the biomass with WCS deployed. 'Total solid waste removed' is calculated using the median TSS value provided in the waste characterisation section of this report. Total waste produced by biomass in excess of 13t/ha vs total waste removed from all WCS is shown in *table 3. Table 3* also shows the percentage of waste removed from the pens with liners and compares it to the total waste produced by those pens.

The refit of the Sea Hauler has been going well with the extraction process. Further engineering solutions towards the end of the month on the overall extraction process increased the efficiency of the system. Due to the number of weather events experienced in the harbour this past month, the overall extraction volumes were down slightly from our target. To be clear, the waste was captured and sitting in the liner; it was the pumping out of the waste that was delayed. We will increase our waste removal volumes going into October to compensate.

NOTE: The calculation of Total Solid Waste Removed for G17A, G15A and G13A includes extraction data where the early versions of the trial were obtaining an average of 3.00% TSS. All extractions starting on July 3 were calculated with a TSS of 4.79% based on the laboratory data obtained as seen in *Table 5*.

WCS Location	Installation Date	Date Of Most Recent Waste Extraction	Total Feed Input From Installation date (kg)	Total Waste Extraction From Installation Date (L)	Total Solid Waste Removed (kg) @ 4.79% of Waste Extraction
G17A	6/06/2017	11/10/2017	46544	78500	3558
G15A	15/06/2017	31/10/2017	60517	82100	4466
G13A	24/06/2017	31/10/2017	56255	101600	4831
G11A	28/06/2017	25/10/2017	35075	78100	4459
G9A	4/07/2017	31/10/2017	33133	84000	5006
G7A	23/07/2017	31/10/2017	41502	78250	3748
G5A	26/07/2017	27/10/2017	40656	85800	4110
G3A	28/07/2017	30/10/2017	40073	93500	4479
G1	3/08/2017	30/10/2017	43665	71500	3425
M1	9/08/2017	30/10/2017	41674	70300	3367
M6	13/08/2017	30/10/2017	42894	56450	2704
M5	20/08/2017	31/10/2017	38786	66200	2467
M4	23/08/2017	30/10/2017	32182	51500	3171
G16	30/08/2017	31/10/2017	31959	43500	2084
M3	9/09/2017	28/10/2017	28042	54250	2599
G10	14/09/2017	30/10/2017	29354	33250	1593
G13	22/09/2017	31/10/2017	19379	20500	982
G11	28/09/2017	25/10/2017	20173	27500	1317
G14	7/10/2017	31/10/2017	12162	23500	1126
G18	9/10/2017	28/10/2017	11374	21500	1030
G12	10/10/2017	28/10/2017	10322	19000	910
G8	17/10/2017	28/10/2017	6848	13500	647
G17	24/10/2017	31/10/2017	3887	5000	240
Totals			726456	1259300	62316

Table 2: Waste Capture Analysis

Total waste (kg) produced by fish with WCS	Total waste (kg) produced by fish over 13mt/ha	Total waste (kg) removed from all WCS	% waste removed vs % waste produced by fish with WCS	% waste removed vs % waste produced by fish over 13 mt/ha
98670	61622	62316	63%	101%

Table 3: % Waste Removed

Section 4.0: WCS inspections and issue resolutions

The integrity of all WCS has continued to be regularly inspected by Tassal divers. All records of inspections have been recorded on official Tassal dive sheets, these are legal documents which are archived and kept for seven years. Records of these dive inspections can be provided upon request.

This month during a routine dive inspection on October 3rd on cage 17a, where we had a first generation liner, divers discovered a liner fail at the seam at the sump portion of the liner which had come apart. The combination of this first trial liner and the extraction cone design at the time were contributing factors. This was reported to the EPA on October 4th. This linerwas removed and reinstalled on October 11and has been functioning fine since. All liners were and continue to be inspected for similar issues and thus far there has been no further incidents.

Table 4 summarises any issues which were identified during inspections and subsequent corrective action taken.

WCS Location	Installation Date	Inspection Dates	Issues Identified/Resolved
G17A	6/06/2017	1 per week	3/10/17 - during a routine inspection, divers discovered a tear at the bottom of the liner. Liner was removed and re-installed on Oct 11,2017. This was a first generation liner, no others are showing issues.
G15A	15/06/2017	1 per week	Nil
G13A	24/06/2017	1 per week	Nil
G11A	28/06/2017	1 per week	Nil
G9A	4/07/2017	1 per week	9/7/17 - During Inspection of camlock connection of waste hose to sump, it was noted that the split pin of one of the securing arms was missing and the securing arm had come undone (still held tight by one securing arm). Issue was resolved by securing shut with cable ties and snood, this was repeated for all other WCS's and is now standard practice for installation. 1/9/17 - pumping clear water, suspected broken camlock. Divers sent to inspect. Diver inspection revealed no issue. Next pumping no issues
G7A	23/07/2017	1 per week	Nil
G5A	26/07/2017	1 per week	Nil
G3A	28/07/2017	1 per week	Nil
G1	3/08/2017	1 per week	Nil
M1	9/08/2017	1 per week	Nil
M6	13/08/2017	1 per week	Nil
M5	20/08/2017	1 per week	Nil
M4	23/08/2017	1 per week	Nil
G16	30/08/2017	1 per week	Nil
M3	9/09/2017	2 per week	Nil
G10	14/09/2017	3 per week	Nil
G13	22/09/2017	4 per week	Nil
G11	28/09/2017	5 per week	Nil

Table 4: WCS inspections and issues resolutions

Section 5.0: Environmental monitoring, modelling and testing

General notes:

- Fine scale water quality monitoring associated with waste capture vacuuming has been conducted at Gordon MF219
- Monitoring of broad scale sites has been undertaken to document background water quality characteristics
- We are awaiting results from the AST laboratory analyses for the October 2017 sampling event
- Sediment sampling has been conducted, including broad and fine scale sites, at Gordon MF219 and Middle Harbour MF214

Survey dates:

1. 4th October 2017 – Broad scale water quality monitoring
2. 5th October 2017 – Fine scale water quality monitoring, pre- and post- vacuuming
3. 13-15th October 2017 – Sediment sampling

Section 5.1: Fine Scale Water Quality Monitoring (Pelagic Water Quality Monitoring)

The sampling sites for the October 2017 survey were aligned with the previous surveys (Figure 1). As per previous sampling events, a gradient approach was used in a North and South direction away from vacuuming activities in favour of an upstream/downstream approach, as currents were deemed to be highly variable at the depth of the liners. The sampling approach used in October 2017 will continue for future sampling events. Water samples were taken at the surface, middle (20 m) and 1 m from the bottom.

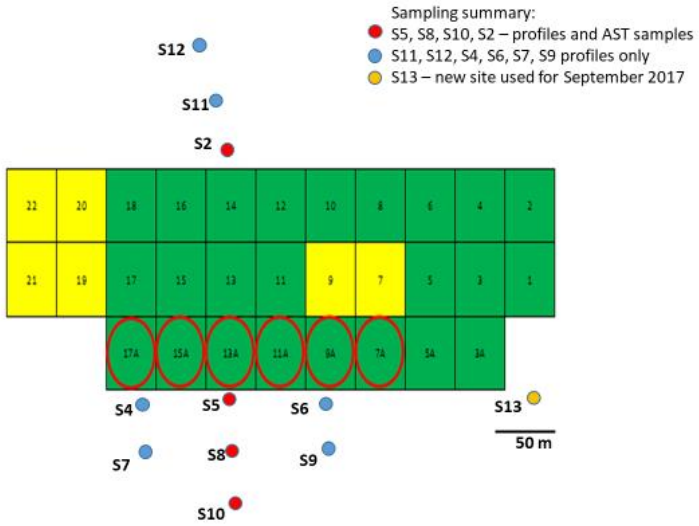


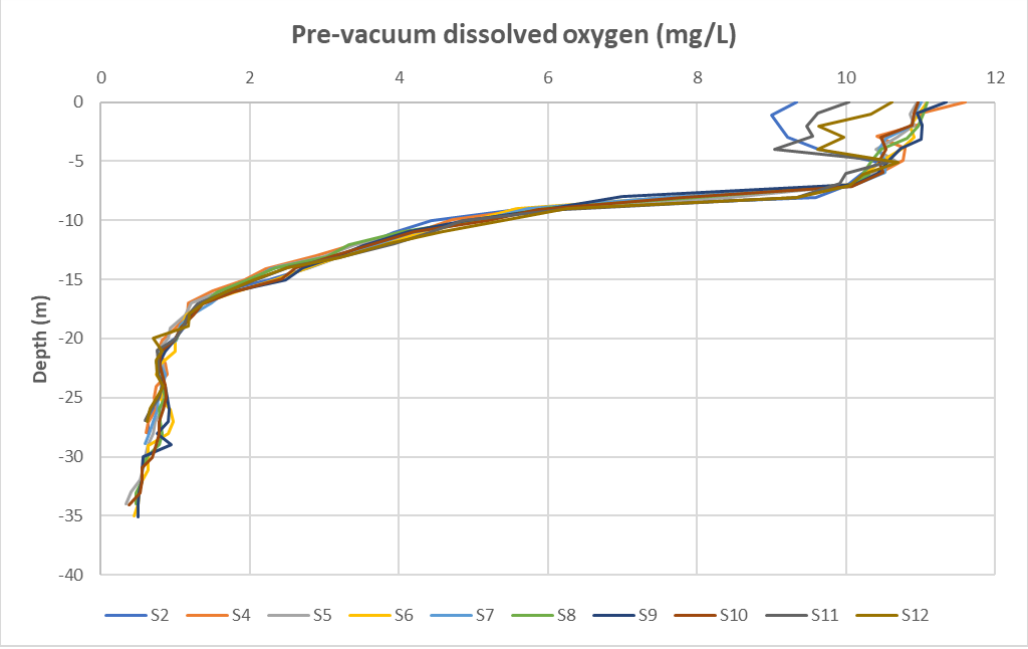
Figure 1 – Indicative position of October 2017 fine scale sampling sites. Map not to scale*. Note that S13 was sampled in September 2017 but not during the October 2017 survey*

Results

Physio-chemical parameters

Dissolved oxygen profiles taken every metre for fine scale monitoring during October 2017 are shown in Figure 2 and summarised every 5 m through the water column in Table 1. Other physio-chemical parameters are summarised in Tables 2-6. There was no evidence of a shift in dissolved oxygen concentrations associated with a gradient away from the pens in both pre- and post- vacuuming sampling. Dissolved oxygen concentrations in bottom waters were observed to be much lower than those in previous sampling events. This was a trend also observed in broad scale sampling and there is no evidence this is associated with waste capture vacuuming operations.

Unlike dissolved oxygen profiles observed during previous surveys where all sites were very similar, surface water dissolved oxygen concentrations in the top 5 m were more variable. At some sites (S2, S11, S12 pre-vacuum; S2, S8 post-vacuum) oxygen levels were lower than remaining sites. Wind direction during fine scale sampling in October 2017 was from the South-East - a direction not observed during previous sampling events. While speculative, it is plausible that the lower surface dissolved oxygen at these sites may have been caused by these particular sampling locations being in the lee of the prevailing wind conditions on the day of sampling.



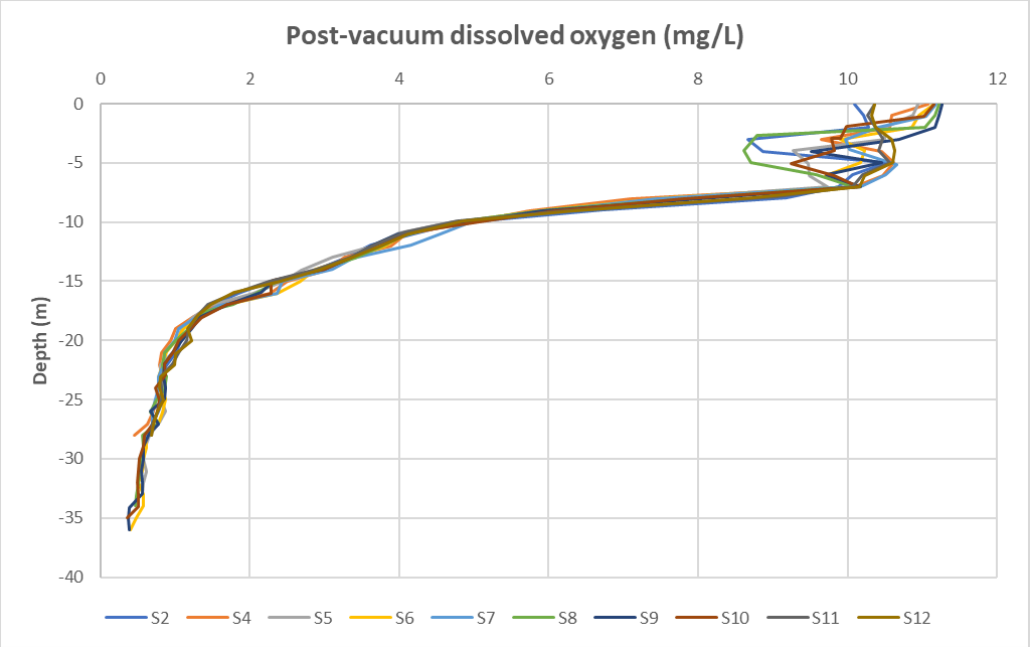


Figure 2 – pre- and post- vacuum dissolved oxygen profiles.

Table 1 – Dissolved oxygen (mg/L) every 5 m at each site.

Category	Depth (m)	Cage (north) S2	Cage S4	Cage S5	Cage S6	50 m south S7	50 m south S8	50 m south S9	100 m south S10	50 m north S11	100 m north S12
Pre-vacuum	0	9.33	11.01	10.95	11.08	11	11.09	10.95	10.96	10.04	10.61
	5	10.44	10.47	10.67	10.47	10.54	10.35	10.56	10.44	10.59	10.69
	10	4.44	4.72	5.17	4.98	5.08	5	4.89	5.19	4.85	5.46
	15	2.25	1.93	1.97	2.33	2.04	1.97	2.48	2.43	2.08	2.05
	20	1	0.83	0.9	1	1.01	1.01	1	1	1	0.7
	25	0.78	0.72	0.82	0.8	0.77	0.86	0.89	0.88	0.78	0.74
	30			0.59	0.64		0.62	0.57	0.69		
	35				0.45			0.5			
Post-vacuum	0	10.09	11.08	10.94	11.16	11.18	11.22	11.27	11.16	10.36	10.36
	5	10.53	10.62	9.48	10.17	10.66	9.58	10.46	9.25	10.57	10.61
	10	4.77	4.89	4.71	4.78	4.92	4.75	4.92	5.06	4.78	4.86
	15	2.24	2.5	2.44	2.67	2.43	2.37	2.33	2.31	2.26	2.41
	20	1.07	0.94	1.03	1.01	0.99	1	1.08	1.05	1.15	1.22
	25	0.83	0.73	0.82	0.87	0.73	0.75	0.86	0.79	0.82	0.84
	30			0.57	0.58		0.55	0.57	0.52		
	35				0.48			0.37	0.36		

Table 2 - Temperature (°C) every 5 m at each site.

Category	Depth (m)	Cage (north) S2	Cage S4	Cage S5	Cage S6	50 m south S7	50 m south S8	50 m south S9	100 m south S10	50 m north S11	100 m north S12
Pre-vacuum	0	11.13	11.25	11.17	10.91	10.98	10.96	10.99	11	11.12	11.12
	5	11.31	11.26	11.39	11.43	11.37	11.38	11.39	11.25	11.31	11.27
	10	12.71	12.6	12.44	12.54	12.47	12.54	12.63	12.48	12.43	12.4
	15	14.11	14.28	14.24	14.14	14.21	14.25	14.11	14.11	14.16	14.2
	20	14.68	14.72	14.7	14.65	14.67	14.66	14.64	14.66	14.63	14.68
	25	14.83	14.83	14.87	14.84	14.84	14.86	14.85	14.84	14.83	14.82
	30			14.83	14.84		14.83	14.82	14.85		
	35				14.79			14.81			
Post-vacuum	0	11.46	11.16	11.07	11.28	11.15	11.37	11.31	11.54	11.51	11.57
	5	11.46	11.49	11.24	11.27	11.32	11.37	11.39	11.32	11.42	11.45
	10	12.6	12.6	12.68	12.62	12.54	12.65	12.56	12.57	12.63	12.6
	15	14.13	13.99	14.02	13.98	14.06	14.05	14.05	14.04	14.1	14.08
	20	14.63	14.71	14.65	14.63	14.69	14.65	14.63	14.64	14.59	14.57
	25	14.82	14.81	14.83	14.85	14.81	14.83	14.84	14.83	14.81	14.82
	30			14.83	14.83		14.83	14.83	14.83		
	35				14.82			14.82	14.81		

Table 3 – pH every 5 m at each site.

Category	Depth (m)	Cage (north) S2	Cage S4	Cage S5	Cage S6	50 m south S7	50 m south S8	50 m south S9	100 m south S10	50 m north S11	100 m north S12
Pre-vacuum	0	7.12	7.27	7.3	7.31	7.3	7.32	7.34	7.35	7.22	7.33
	5	7.35	7.38	7.35	7.33	7.36	7.34	7.36	7.39	7.39	7.44
	10	7.56	7.53	7.56	7.56	7.57	7.58	7.59	7.62	7.58	7.64
	15	7.43	7.35	7.36	7.4	7.38	7.38	7.44	7.45	7.42	7.43
	20	7.34	7.27	7.28	7.3	7.31	7.32	7.32	7.33	7.34	7.32
	25	7.32	7.27	7.28	7.29	7.29	7.31	7.32	7.33	7.33	7.33
	30			7.27	7.28		7.3	7.3	7.32		
	35				7.28			7.3			
Post-vacuum	0	7.19	7.33	7.31	7.33	7.32	7.33	7.37	7.37	7.22	7.23
	5	7.32	7.42	7.21	7.32	7.43	7.29	7.33	7.15	7.4	7.43
	10	7.61	7.61	7.6	7.6	7.6	7.61	7.62	7.63	7.62	7.62
	15	7.45	7.46	7.45	7.47	7.45	7.45	7.45	7.45	7.46	7.47
	20	7.36	7.34	7.35	7.35	7.34	7.35	7.36	7.36	7.37	7.38
	25	7.35	7.33	7.33	7.34	7.33	7.34	7.35	7.35	7.35	7.35
	30			7.32	7.32		7.33	7.33	7.33		
	35				7.32			7.33	7.33		

Table 4 – Salinity (ppt) every 5 m at each site.

Category	Depth (m)	Cage (north) S2	Cage S4	Cage S5	Cage S6	50 m south S7	50 m south S8	50 m south S9	100 m south S10	50 m north S11	100 m north S12
Pre-vacuum	0	3.74	3.5	3.44	3.06	3.17	3.15	3.18	3.2	3.44	3.28
	5	5.52	5.87	5.12	5.16	5.18	5.18	5.23	5.26	5.21	5.2
	10	26.65	26.28	25.75	26.1	25.73	26.18	26.47	25.97	25.57	25.64
	15	29.95	30.09	30.05	29.89	30.01	30.1	29.87	29.92	29.96	30.01
	20	30.63	30.7	30.66	30.59	30.63	30.61	30.59	30.64	30.63	30.64
	25	30.83	30.88	30.91	30.87	30.87	30.88	30.87	30.85	30.84	30.84
	30			30.91	30.92		30.91	30.91	30.9		
	35				30.98			30.93			
Post-vacuum	0	3.31	2.88	2.95	2.75	2.9	2.79	2.86	2.75	3.25	3.32
	5	5.15	4.79	4.75	4.75	4.71	5.74	4.73	4.57	4.94	4.86
	10	26.25	26.4	26.61	26.46	26.16	26.59	26.43	26.38	26.33	26.35
	15	29.92	29.68	29.74	29.63	29.74	29.77	29.59	29.6	29.88	29.84
	20	30.58	30.66	30.6	30.57	30.65	30.6	30.55	30.57	30.55	30.53
	25	30.8	30.82	30.84	30.86	30.83	30.84	30.83	30.84	30.81	30.8
	30			30.91	30.92		30.93	30.92	30.94		
	35				30.96			30.97	30.95		

Table 5 – Turbidity (ntu) every 5 m at each site.

Category	Depth (m)	Cage (north) S2	Cage S4	Cage S5	Cage S6	50 m south S7	50 m south S8	50 m south S9	100 m south S10	50 m north S11	100 m north S12
Pre-vacuum	0	1.5	1.2	1.3	1.3	1.3	1.3	1.2	1.3	1.4	1.2
	5	1	1.2	1.1	1.1	1.2	1.2	1.1	1.1	1.1	1.1
	10	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5
	15	0.2	0.1	0.1	0.4	0.1	0.2	0.2	0.2	0.2	0.2
	20	0.1	0.1	0.1	0.1	0.2	0.1	0.3	0.1	0.2	0.2
	25	0.1	0	0	0.3	0.1	0	0.1	0.2	0.1	0.1
	30			0	0.1		0.1	0.1	0.1		
	35				1			0.1			
Post-vacuum	0	1.3	1.4	1.5	1.5	1.6	1.4	1.3	1.4	1.4	1.2
	5	1	1.1	1.2	1	1	1	1	1	1	1
	10	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4
	15	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2
	20	0.2	0.1	0.2	0.2	0.2	0.6	0.2	0.2	0.2	0.2
	25	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
	30			0.1	0.1		0.1	0.1	0.1		
	35				0.7			1.8	0.7		

Table 6 – Conductivity (mscm) every 5 m at each site.

Category	Depth (m)	Cage (north) S2	Cage S4	Cage S5	Cage S6	50 m south S7	50 m south S8	50 m south S9	100 m south S10	50 m north S11	100 m north S12
Pre-vacuum	0	6.83	6.41	6.32	5.65	5.84	5.81	5.86	5.89	6.31	6.03
	5	9.83	10.41	9.17	9.23	9.26	9.26	9.35	9.39	9.32	9.29
	10	41.6	41.08	40.33	40.82	40.3	40.94	41.34	40.64	40.09	40.18
	15	46.19	46.39	46.34	46.12	46.27	46.4	46.09	46.16	46.22	46.28
	20	47.14	47.23	47.18	47.08	47.14	47.11	47.07	47.14	47.13	47.14
	25	47.41	47.48	47.52	47.46	47.47	47.48	47.46	47.44	47.42	47.42
	30			47.52	47.53		47.51	47.52	47.5		

	35				47.61			47.55			
Post-vacuum	0	6.08	5.34	5.45	5.1	5.36	5.17	5.3	5.11	5.97	6.1
	5	9.22	8.6	8.54	8.54	8.47	10.19	8.51	8.24	8.86	8.72
	10	41.04	41.25	41.54	41.34	40.91	41.52	41.3	41.23	41.15	41.18
	15	46.16	45.82	45.9	45.75	45.9	45.95	45.7	45.71	46.1	46.05
	20	47.07	47.18	47.09	47.04	47.15	47.09	47.02	47.05	47.02	46.99
	25	47.37	47.4	47.43	47.45	47.41	47.43	47.41	47.42	47.39	47.36
	30			47.51	47.54		47.55	47.54	47.56		
	35				47.59			47.6	47.58		

Nutrients and other analytes

Results from the October 2017 survey are yet to be received and will be summarised in the next monthly report. AST laboratory results from the September 2017 survey are shown in Table 7. No gradient trends or changes between pre- and post-vacuuming were apparent for all analytes tested. All Biological Oxygen Demand (BOD) samples recorded levels below the detection limit (<2 O_2/L) and with the exception of one site, all TSS samples were also below the detection limit (<2 mg/L). Despite the sampling plan being hindered for the September 2017 survey, the post-vacuuming sample that was collected appears to indicate there is no plume associated as a result of vacuuming activities. The pre-vacuuming samples also indicate there is no gradient of change associated with increasing distance from lined pens.

Table 7 - Nutrients and other analytes – September 2017 survey. Note for depth, S = surface, M = 20 m, B = 1 m from seabed.

Category	Site	Depth (m)	Turbidity (NTU)	BOD (mgO2/L)	TSS	Ammonia (mg-N/L)	Nox (mg-N/L)	Nitrogen, total (mg-N/L)	NPOC (mg/L)	NPOC dissolved (mg/L)	Phosphorous, dissolved (mg-P/L)	Phosphorous, total (mg-P/L)
Pre-Vacuum	S2	S	1.2	<2	<2	0.021	0.031	0.37	10	9.5	<0.003	<0.01
		M	0.9	<2	<2	<0.005	0.13	0.42	1.4	1.4	0.01	0.02
		B	1	<2	2	<0.005	0.13	0.39	1.3	1.3	0.013	0.03
	S5	S	1.5	<2	<2	0.023	0.028	0.38	11	10	0.004	<0.01
		M	0.8	<2	<2	<0.005	0.13	0.38	1.5	1.6	0.011	0.03
		B	1	<2	<2	<0.005	0.14	0.4	1.3	1.3	0.013	0.03
	S8	S	1.7	<2	<2	0.024	0.03	0.36	11	10	0.003	<0.01
		M	0.8	<2	<2	0.006	0.13	0.38	1.5	1.5	0.011	0.03
		B	0.9	<2	<2	<0.005	0.14	0.41	1.4	1.3	0.014	0.03
	S10	S	1.7	<2	<2	0.024	0.031	0.32	11	9.8	<0.003	<0.01
		M	0.6	<2	<2	<0.005	0.13	0.39	1.4	1.4	0.01	0.03
		B	0.6	<2	<2	<0.005	0.14	0.46	1.4	1.3	0.013	0.03
Post-Vacuum	S13	S	1.6	<2	<2	0.021	0.036	0.37	9.8	8.9	0.003	<0.01
		M	0.7	<2	<2	<0.005	0.13	0.39	1.5	1.5	0.01	0.03
		B	0.5	<2	<2	<0.005	0.14	0.41	1.3	1.3	0.014	0.03

5.2 Broad scale water quality monitoring:

Broad scale water quality monitoring was undertaken at 9 sites on 4th October 2017 (Figure 3). The sampling sequence was M1, M2, M3, M4, M5, M6, M7, M8, M9. For broad scale sites "middle" was sampled at 15 m, except M6 where "middle" was sampled at 10 m as this site is only 17 m deep. Dissolved oxygen profiles taken every meter during the October 2017 survey are depicted in Figure 4, while Table 8 shows a tabulated summary every 5 m through the water column. Dissolved oxygen concentrations at 20 m in the broad scale sites (1.16 mg/L average across 7 sites at 20 m) were generally comparable to those observed at fine scale sites at 20 m depth (0.94 mg/L average across 4 cage edge sites). Similar to the fine scale sites, dissolved oxygen concentrations in bottom waters were much lower in October (bottom water average 0.92 mg/L) at all sampling sites compared to previous surveys (e.g. September 2017; bottom water average 1.66 mg/L; September 2017). Consistent with previous sampling events, results for other analytes at broad scale sites were comparable to fine scale sites.

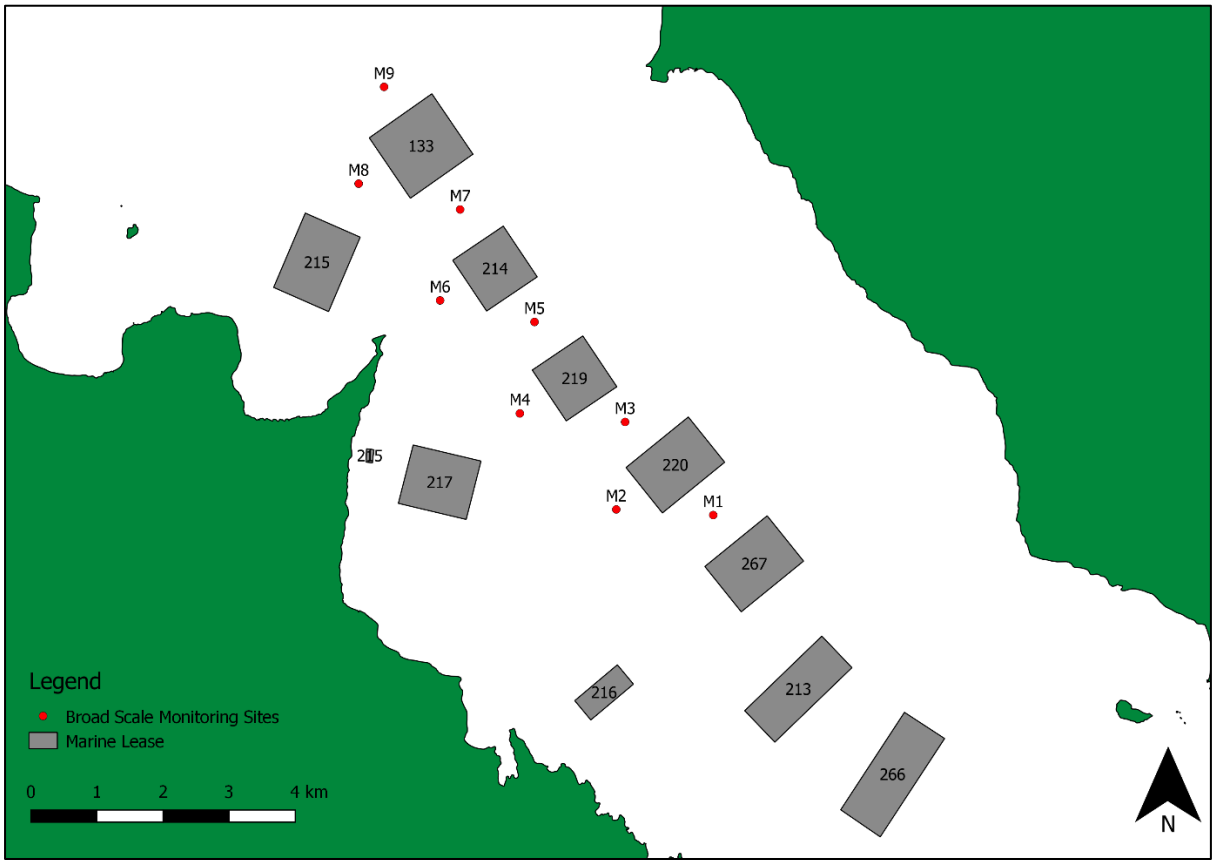


Figure 3 – Broad scale water quality monitoring sites.

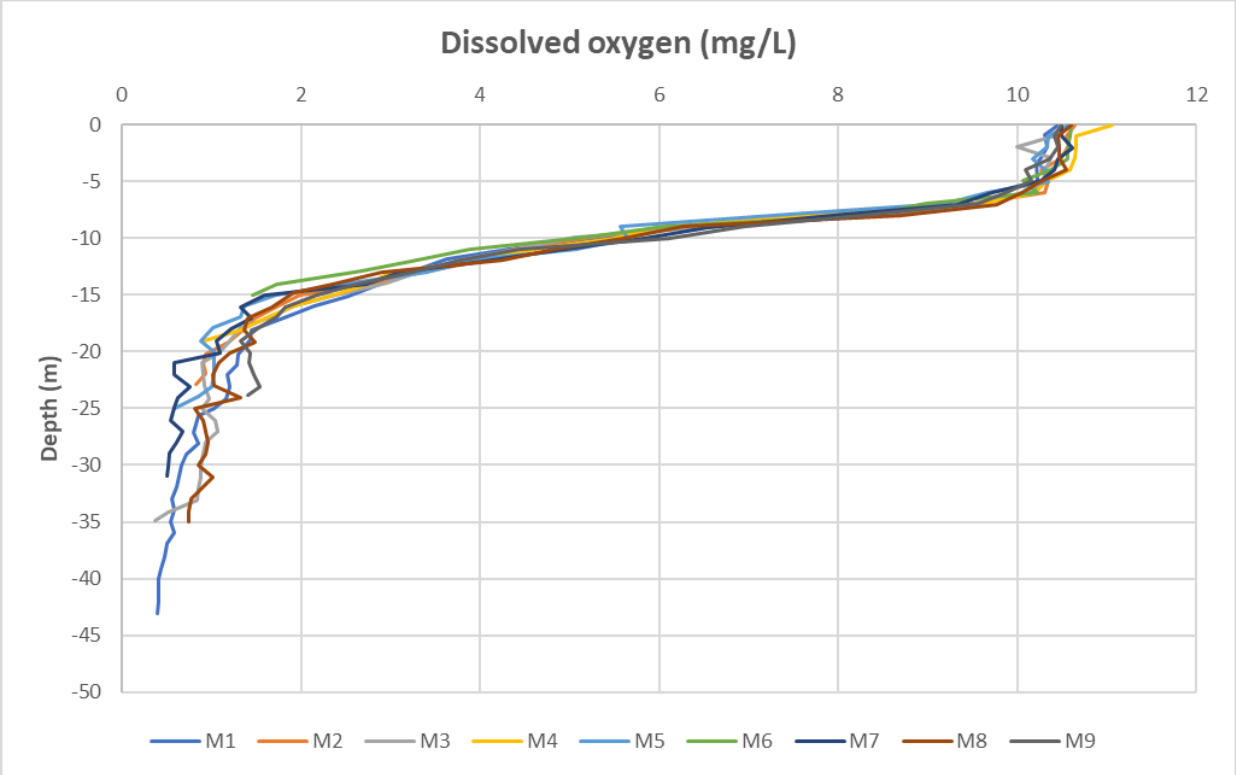


Figure 4 - Dissolved oxygen profiles for broad scale monitoring sites, October 2017.

Table 8 – physio-chemical data from broad scale sites summarised every 5m during the October 2017 survey.

		Site								
	Depth	M1	M2	M3	M4	M5	M6	M7	M8	M9
Temp (C)	0	11.43	11.51	11.51	11.33	11.56	11.35	11.52	11.47	11.54
	5	11.33	11.3	11.25	11.14	11.08	11.05	11.23	11.2	11.11
	10	12.3	12.36	12.42	12.27	12.26	12.47	12.26	12.31	12.03
	15	14.02	14.26	14.09	14.07	14.31	14.37	14.33	14.2	14.01
	20	14.68	14.71	14.73		14.67		14.58	14.55	14.5
	25	14.82		14.83		14.78		14.73	14.66	
	30	14.86		14.84				14.76	14.64	
	35	14.83		14.83					14.63	
	40	14.75								
D.O.(mg/l)	0	10.31	10.64	10.48	10.65	10.58	10.6	10.5	10.6	10.5
	5	10.22	10.35	10.29	10.33	10.35	10.07	10.27	10.25	10.16
	10	5.25	5.24	5.05	5.5	5.65	5.18	5.82	5.6	6.11
	15	2.52	1.99	2.32	2.36	1.72	1.46	1.6	1.92	2.18
	20	1.3	0.94	1.08		1.03		1.1	1.21	1.43
	25	1.03		0.9		0.59		0.59	0.81	
	30	0.66		0.88				0.52	0.86	
	35	0.54		0.37					0.74	
	40	0.41								

		Site								
	Depth	M1	M2	M3	M4	M5	M6	M7	M8	M9
pH (pH)	0	7.3	7.37	7.35	7.42	7.37	7.46	7.45	7.5	7.47
	5	7.31	7.35	7.4	7.43	7.46	7.41	7.48	7.5	7.53
	10	7.51	7.56	7.55	7.61	7.63	7.61	7.66	7.65	7.67
	15	7.36	7.34	7.38	7.41	7.36	7.34	7.36	7.39	7.42
	20	7.27	7.26	7.29		7.31		7.33	7.35	7.38
	25	7.26		7.28		7.28		7.29	7.33	
	30	7.24		7.29				7.3	7.34	
	35	7.24		7.27					7.34	
	40	7.25								
Conductivity. (mscm)	0	8.82	8.53	9.02	9.14	9.49	10.04	10.4	10.95	11.33
	5	10.21	10.44	11.17	10.67	11.42	11.25	12.3	12.09	13.59
	10	39.68	40.32	40.19	39.73	39.45	40.57	39.37	39.75	37.58
	15	45.72	46.29	45.9	45.95	46.32	46.42	46.44	46.19	45.81
	20	47.02	47.13	47.12		47.18		47.16	47.15	47.23
	25	47.4		47.44		47.44		47.4	47.39	
	30	47.53		47.57				47.51	47.52	
	35	47.55		47.55					47.56	
	40	47.62								
Turbidity (ntu)	0	1.1	1.2	1.2	1.1	1.1	1.2	1.1	1.1	1.3
	5	1.2	1.2	1.1	1.1	1.2	1.1	1.2	0.9	1
	10	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
	15	0	0.1	0.2	0.2	0.2	0.3	0.2	0.2	0.3
	20	0	0.1	0.1		0.1		0.2	0.2	0.2
	25	0		0		0.3		0.4	0.1	
	30	0		0				0.3	0.1	
	35	0		2.6					0.2	
	40	0.3								

Nutrients and other analytes measured in the laboratory were collected during the September 2017 survey and are summarised in Table 9. Trends were similar to those observed in previous surveys, and all survey sites were generally comparable.

Table 9 – Nutrients and other analytes sampled from broad scale sites in the September 2017 survey. S = surface, M = 15 m, B = 1 m from seabed.

Site	Depth (m)	Turbidity (NTU)	TSS	Ammonia (mg-N/L)	Nox (mg-N/L)	Nitrogen, total (mg-N/L)	NPOC (mg/L)	NPOC dissolved (mg/L)	Phosphorous, dissolved (mg-P/L)	Phosphorous, total (mg-P/L)
M1	S	1.8	<2	0.028	0.037	0.48	10	9.3	<0.003	0.01
	M	0.6	<2	<0.005	0.11	0.36	2	2	0.006	0.02
	B	1.2	<2	<0.005	0.14	0.4	1.4	1.4	0.013	0.03
M2	S	1.5	<2	0.025	0.038	0.41	9.7	9	<0.003	<0.01
	M	0.6	<2	<0.005	0.12	0.38	1.5	1.6	0.008	0.02
	B	0.6	<2	<0.005	0.13	0.39	1.3	1.3	0.011	0.03
M3	S	1.5	<2	0.026	0.038	0.33	9.7	8.9	<0.003	<0.01
	M	0.5	<2	<0.005	0.12	0.31	1.6	1.6	0.008	0.02
	B	0.7	<2	<0.005	0.14	0.4	1.3	1.3	0.013	0.03
M4	S	1.3	<2	0.02	0.038	0.32	9.4	8.7	<0.003	<0.01
	M	0.8	<2	<0.005	0.13	0.38	1.5	1.6	0.009	0.02
	B	0.6	<2	0.005	0.12	0.39	1.6	1.5	0.009	0.02
M5	S	1.7	<2	0.018	0.043	0.34	8.9	8.3	<0.003	0.01
	M	1	<2	<0.005	0.11	0.4	1.8	1.8	0.007	0.02
	B	1	<2	0.041	0.1	0.42	1.4	1.4	0.013	0.04
M6	S	1.7	<2	0.017	0.038	0.33	9.3	8.6	<0.003	<0.01
	M	1	<2	0.009	0.072	0.31	4.8	4.7	<0.003	0.01
	B	0.9	<2	<0.005	0.12	0.4	1.7	1.6	0.008	0.02
M7	S	1.7	<2	0.015	0.039	0.42	8.8	8.2	<0.003	<0.01
	M	0.8	<2	<0.005	0.12	0.38	1.7	1.7	0.008	0.02
	B	1.2	<2	<0.005	0.13	0.41	1.5	1.5	0.01	0.03
M8	S	1.7	<2	0.014	0.041	0.34	8.8	8	<0.003	<0.01
	M	0.9	<2	0.007	0.11	0.39	2	2	0.007	0.02
	B	1.1	<2	<0.005	0.13	0.42	1.4	1.4	0.012	0.03
M9	S	1.9	<2	0.018	0.044	0.43	8	7.3	<0.003	<0.01
	M	0.6	<2	<0.005	0.12	0.37	1.6	1.7	0.008	0.02
	B	0.7	<2	<0.005	0.13	0.42	1.4	1.3	0.013	0.03

Section 5.3: Visual Benthic Characterization and Monitoring

Section 5.3.1: Waste capture sediment survey – October 2017

Sediment sampling was undertaken from 13-15th October 2017. Samples were taken at MF214 and MF219 at fine (Figures 5 & 6) and broad scales (Figures 7 & 8). Fine scale sites were sampled at the edge of a pen bay and 50 m distance. Pen bay sites where sediment sampling was undertaken aligned with sites surveyed by ROV as part of the visual assessment of seabed condition.

Broad scale sampling followed the IMAS sampling protocol of 5 sites on a transect at 0 m, 50 m, 100 m, 250 m and 500 m away from a pen bay. The survey will be repeated in 4 months in February 2018. It should be noted that sampling was designed to complement survey activities being undertaken concurrently by IMAS.

Broad-scale and fine-scale sediment sampling included the following parameters:

- Nutrients:

  Total organic carbon, ammonia, nitrate/nitrite, total nitrogen, total phosphorus
- Redox potential
- Sulphides
- Infauna analysis

Sediment samples are currently being processed and results will be included in upcoming reports.

Sediment traps were also deployed at selected locations at MF219 (see Figure 6) on October 15th. The sediment traps will be retrieved in early November.

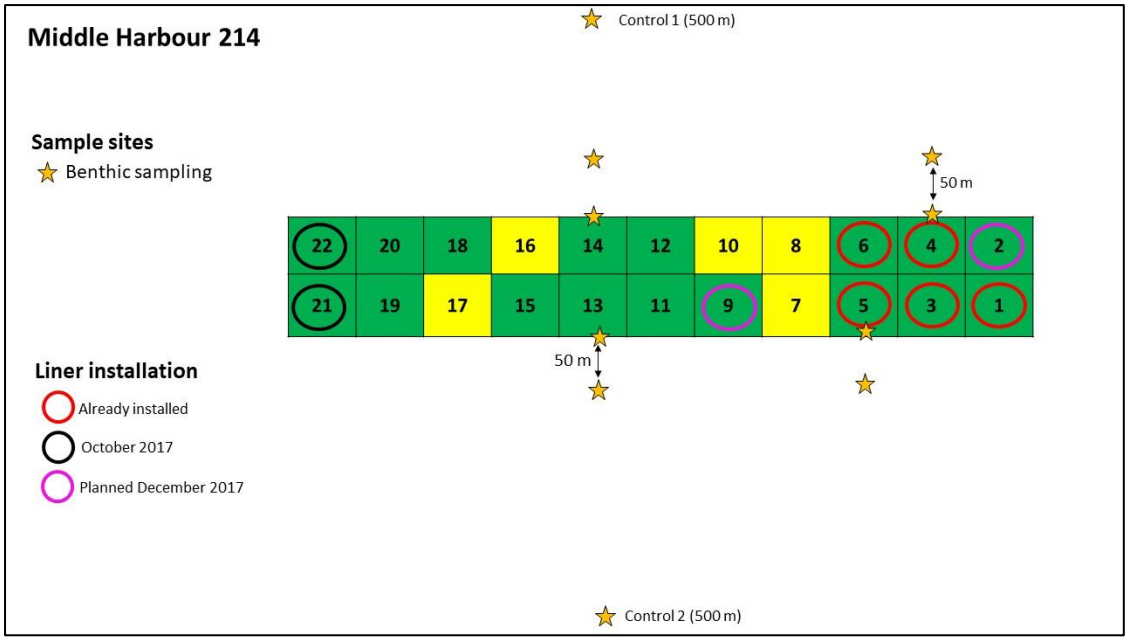


Figure 5 – Fine scale sampling design, Middle Harbour MF214

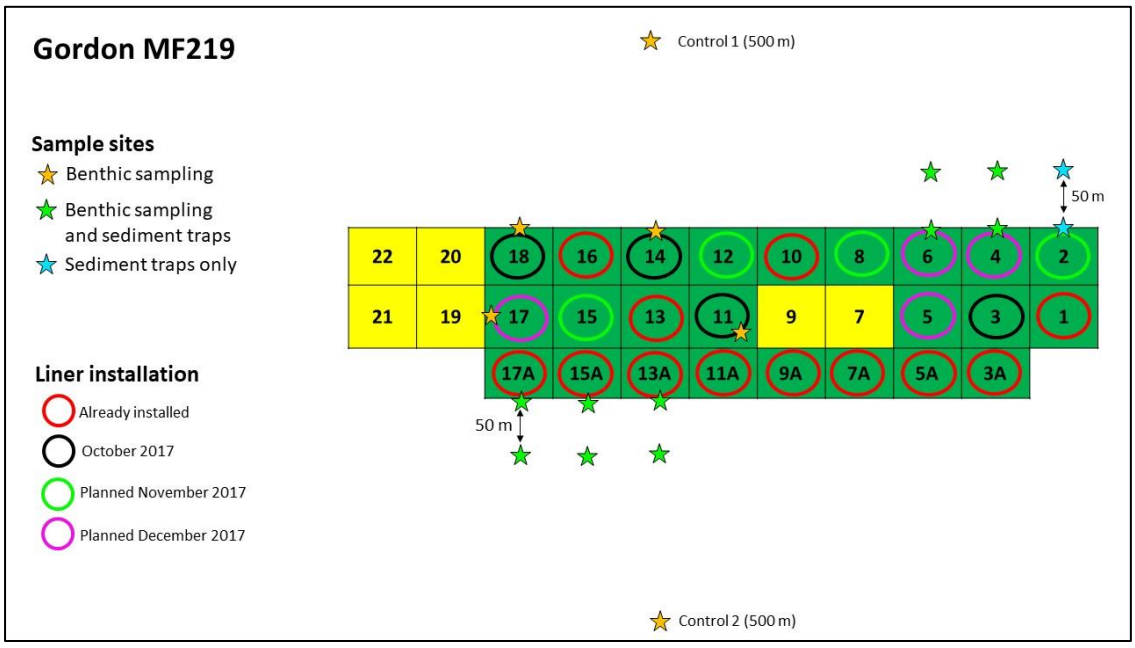


Figure 6 – Fine scale sampling design, Gordon MF219.

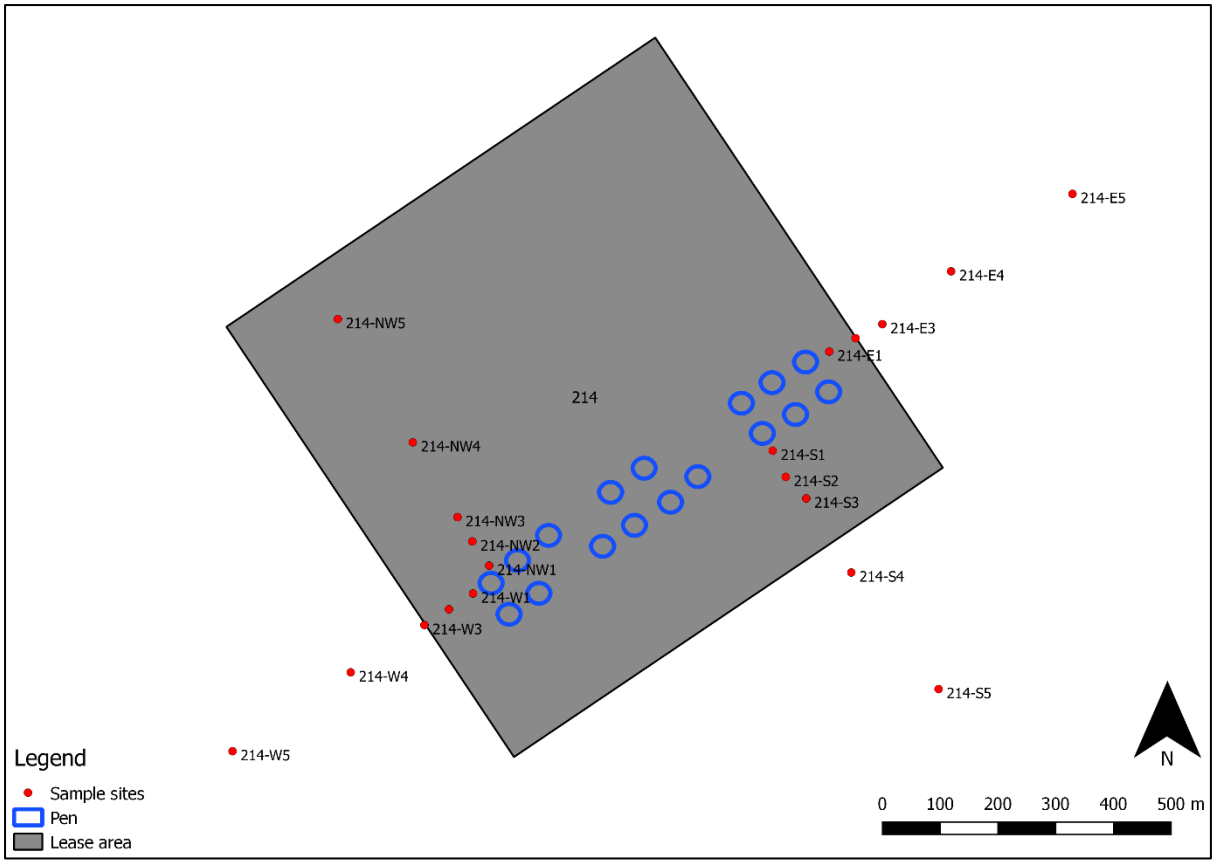


Figure 7 – MF214 broad scale sediment sampling locations.

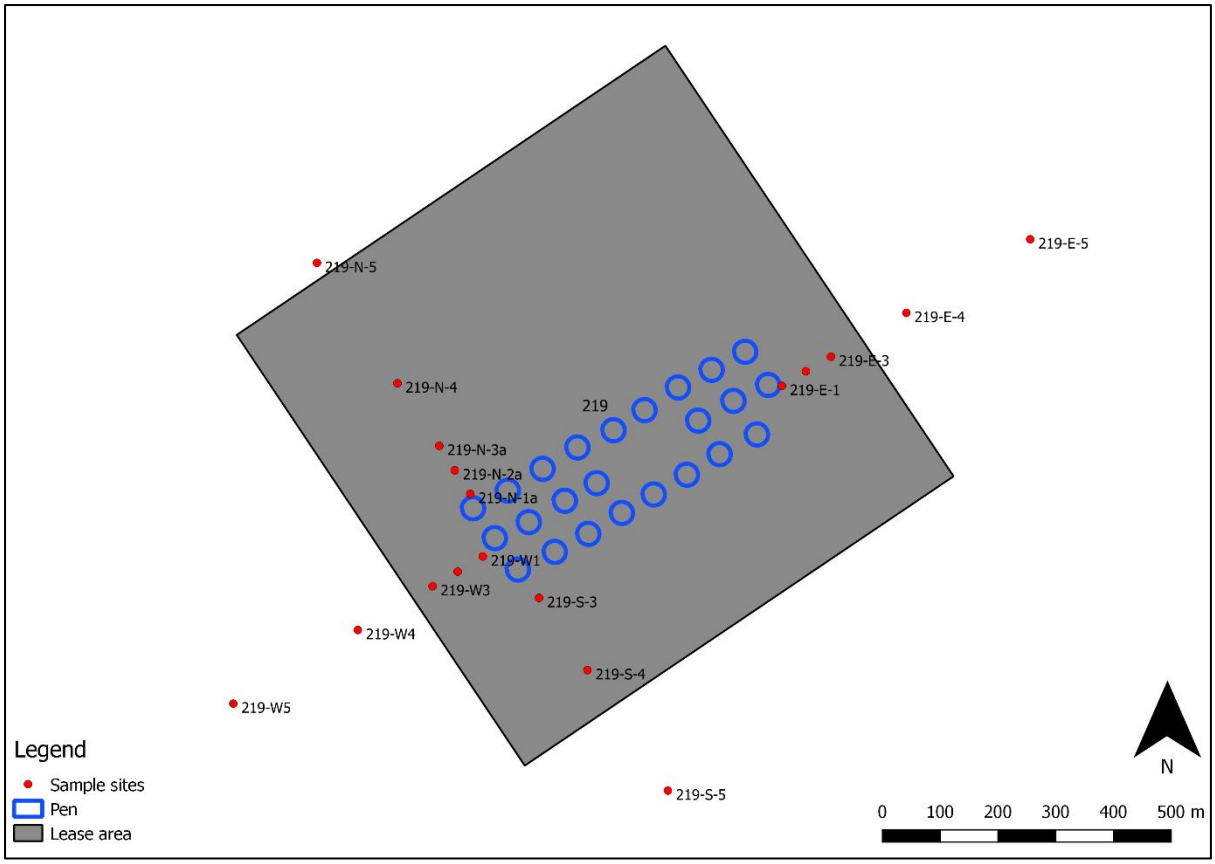


Figure 8 – MF219 broad scale sediment sampling locations.

Section 5.3.2: Waste capture ROV survey – October 2017

The aim of this visual observation study is to assess the effectiveness of the waste capture systems currently being installed at Tassal leases MF219 and MF214. Aquenal and Tassal developed an experimental design which was approved by the EPA. This experiment is scheduled to film bimonthly at these sites with a report to be produced at the end of the WCS project.

Tassal conducted the most recent round of bimonthly waste capture monitoring in early October. Footage has been supplied to the EPA, with databases and associated reporting forecast for submission on the week starting 30/10/17. Footage was collected at 14 locations covering both MF214 Middle Harbour and MF219 Gordon as outlined in the below table, with a focus on MF219 due to higher biomass.

Results from the October surveys indicated an overall decreased pellet and faeces observations at pen bays with waste capture systems installed. It is hypothesised that it will take longer to see significant visual improvement in overall benthic health due to shadowing effects from non-lined cages and low ambient benthic dissolved oxygen within the system.

Filming will continue to occur bimonthly (Next filming due to occur early December 2017) on the below cage positions and control points with control sites aligning with long serving IMAS research locations.

	MF214 Middle Harbour	MF219 Gordon
Short term		4
		6
		17
Medium term		11
		14
		18
Long term	4	13a
		15a
		17a
Non-Lined	13	
	14	
Off Lease Control		N5 transect
		S5 transect

Section 5.4: Waste Characterisation

Reiteration from the July report;

Tassal have conducted five separate analysis of waste from the WCS during the month of July to determine the system effectiveness with regards to solid waste removed vs solid waste produced. Sampling was taken from bulk homogenised samples during waste capture operations.

The variability in Total Suspended Solids (TSS) from bulk samples is a result of different sump designs and timing of the sampling during the extraction process. The refined sump designs have been producing a higher TSS than earlier models due to the restriction of ratholing during extraction. All waste is currently being extracted into 1000 litre IBC containers, depending on the time between extraction from WCS and amount of

waste produced by the fish, extraction volumes have been up to 8000 litres. Sub samples were taken from 1000 litre bulk homogenised samples, sub samples taken from the first or last 1000 litre bulk samples during extraction showed a lower TSS than sub samples taken from 1000 litre bulk samples from the middle of the total extraction volume.

From the July analysis results and results from the WCS trial, the median value of 4.79% Total Suspended Solids (TSS) from all samples has been applied to the waste capture extraction volumes in this report.

As stated in our trial report, Tassal will not undertake further TSS sampling unless there is a material change in waste composition, visual appearance or volume.

Table 5 below shows individual tests results, sample locations and dates of sampling.

Sample Date	Sample Location	TSS %
Trial results	Gordon 17A	3.05
4/07/2017	Gordon 11A	1.91
4/07/2017	Gordon 17A	2.16
4/07/2017	Gordon 15A	10.49
4/07/2017	Gordon 13A	6.52
6/07/2017	Gordon 13A	16.62
Median TSS		**4.79**

Table 5: WCS TSS sampling results

Section 5.4.1: Waste Treatment

The commissioning of the centrifuge commenced on Monday October 9, however due to equipment damage to the polymer agitator motor during transport the commissioning was interrupted. The commission was able to resume the following week.

Results have been mixed with good filtrate quality at times, however the quality has not been consistently of a standard for suitable discharge. The characterization of the filtrate and solid waste is ongoing. Early results have indicated the solids is 60% to 70% moisture, however this varies day to day. The challenge moving forward is to removed residual solids and clarify the filtrate and this is being pursued through addition of coagulants which has so far been successful in jar tests.

The disinfection system has yet to be installed and our intent is to dose with sodium hypochlorite which will be subject to EPA approvals. This will be implemented through November.

The summary table below represents, flow meter data for treatment activities during October. However, it should be noted this data is not entirely reliable due to calibration errors not being identified until part way through commissioning.

- Total waste delivered to the Wallaby is in fact 225 kL
- Volume of filtrate produced is excessive - this number should be approx 563 kL
- The volume of filtrate stored on board the Wallaby at the end of Oct was 309kL
- The total volume of filtrate discharged from the Wallaby during the month of Oct was 254 kL

- There were 31 bags of solids produced during Oct. Whilst these bags have a nominal capacity if 1,000L not all bags were full. So 31 m3 is an upper limit for the month. It's worth noting that less than 1 bag of solids was expected per day, however typically 2 bags and up to 4 bags are being produced per day.
- As a rough indication based on 31 m3 of solids from 225 kL of raw waste, then percentage solids is in excess of 10%

Total waste delivered [kL]	Volume treated by Centrifuge [kL]	*Estimated additional inputs [kL]*	Volume of filtrate produced [kL]	Ratio of filtrate to CTR Feed	Volume of filtrate discharged [kL]	*Estimated volume of filtrate stored onboard [kL]*	Actual volume stored onbaord [kL]	*Estimated volume of solids produced [m3]*	Volume of solids unloaded [m3]	Volume of solids stored onboard [m3]	percentage solids v/v
142	391	*249*	669	471%	254	*415*	309	*31*	31	0	13.7%

Section 6.0: Waste Disposal

Filtrate is continuing to be disposed at GTS until quality is improved and an alternative disposal path is in place. No solids have been removed from site to date, however first delivery to Dulverton should occur early next week.

The EMP for the waste treatment on-board the Wallaby has been submitted to the EPA and final approval was received on October 3, 2017. Throughout the month work has been conducted on the Wallaby with the installation of the waste treatment equipment in Strahan. We have the commissioning of the waste treatment plant starting on October 9, 2017. Once the plant is operational, testing of the bio-solids will be conducted.

Section 7.0: Weekly Reporting

Tassal have reported weekly to the EPA as per the Weekly biomass reporting template. This has confirmed that the biomass has at all times been below the biomass limit. The monitoring has presented the progress of installation of the WCS to pens and the rate of growth against the biomass limit.

Section 8.0: Complaints recording, management and resolution reporting

Tassal received no formal or informal complaints this month around the Waste Capture system.

Section 9.0: Consultation

Tassal continues to conduct various consultation with stakeholders with regards to WCS operations, as outlined in Tassal's WCS EMP and required by the WCS EPN.

This month Tassal staff met with the Economic Development Advisory Committee to provide an update on the project; the Tasmanian Seafood industry Council executives which included Rock Lobster, Oysters and Abalone; and with TARFish CEO as the peak of the recreational fishing body. Following the recent Strahan Aquaculture Community Forum meeting, stakeholders were provided a copy of the presentation by Tassal at the

meeting which included consultation with Brian Gardiner from the West Coast Recreational Fishing Association, Parks and Wildlife and tourism representatives. Continuing discussions and consultation continue with West Coast Council and TasWater.