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COASTAL CRC

Coastal Water Habitat Mapping Project
Coastal Geomorphology and Classification Subproject

Milestone Report CG3-02

Report on Cockburn Sound Field Survey March 2004

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Introduction

This report describes the field survey carried out in Cockburn Sound, Western Australia by Geoscience Australia (GA) staff for the Coastal Geomorphology and Classification Subproject (CG) of the Coastal Water Habitat Mapping Project (CWHM). It documents the various sampling techniques and procedures used to collect surface and subsurface samples from the Sound; details of the vibracores and grab samples recovered and the proposed analyses to be performed on these samples.

The results of the analysis of the grab samples will be used to classify the various surface sediment types encountered as well as map their distribution within Cockburn Sound. The analysis and interpretation of the vibracores will allow the reconstruction of the stratigraphic framework of Cockburn Sound. This information will be used in conjunction with the findings of the other subprojects in the CWHM Project. For example, it will assist in ground-truthing the results of the both the single and multi-beam sonar surveys that have and are to be carried out within Cockburn Sound by Curtin University. It will also provide key substrate information for incorporation into a more comprehensive benthic habitat classification for the sound.

Study Area

Cockburn Sound (32^0 12'S, 115^0 43'E) on the west coast of Australia, is a shallow coastal basin, lying between Garden Island to the west and the mainland to the east (Figure 1). It is 16 km long and covers an area of approximately 124 km^2. The northern opening between Woodman Point and Garden Island is ~8 km wide. The southern opening, between Garden Island and Cape Peron, was originally 2 km wide but was partially closed by construction of a causeway and two bridges in 1972 to provide vehicular access to the naval base. The Sound is bounded in the north by Parmelia Bank, a shallow sand bank which extends eastwards from Woodman Point out to Carnac Island, leaving a north-westward opening to the sound (Challenger Passage) less than 10m deep. Access for large vessels to the deeper sound is via a dredged navigation channel through Parmelia Bank.

The majority of Cockburn Sound comprises a large, relatively flat, deep water central basin around 18 to 20m deep. There is a shallower basin (average 7 to 9m deep) in the northeast of the Sound that has been extensively dredged for navigation and access to the boat harbour and various wharves along this section of the mainland coast. A large sand flat (Southern Flats) with water depths of only a few metres forms the south-western part of the Sound. The southeastern side (south of James Point) and western side (bordering Garden Island) of the sound are characterised by a narrow coastal margin less than 500m wide where the water depth shoals rapidly to a couple of metres. There are no existing published detailed bathymetric maps of Cockburn Sound and as part of our survey we obtained gridded bathymetric data from the WA

Department of Planning & Infrastructure from which GA generated a contoured bathymetric chart (Figure 1).

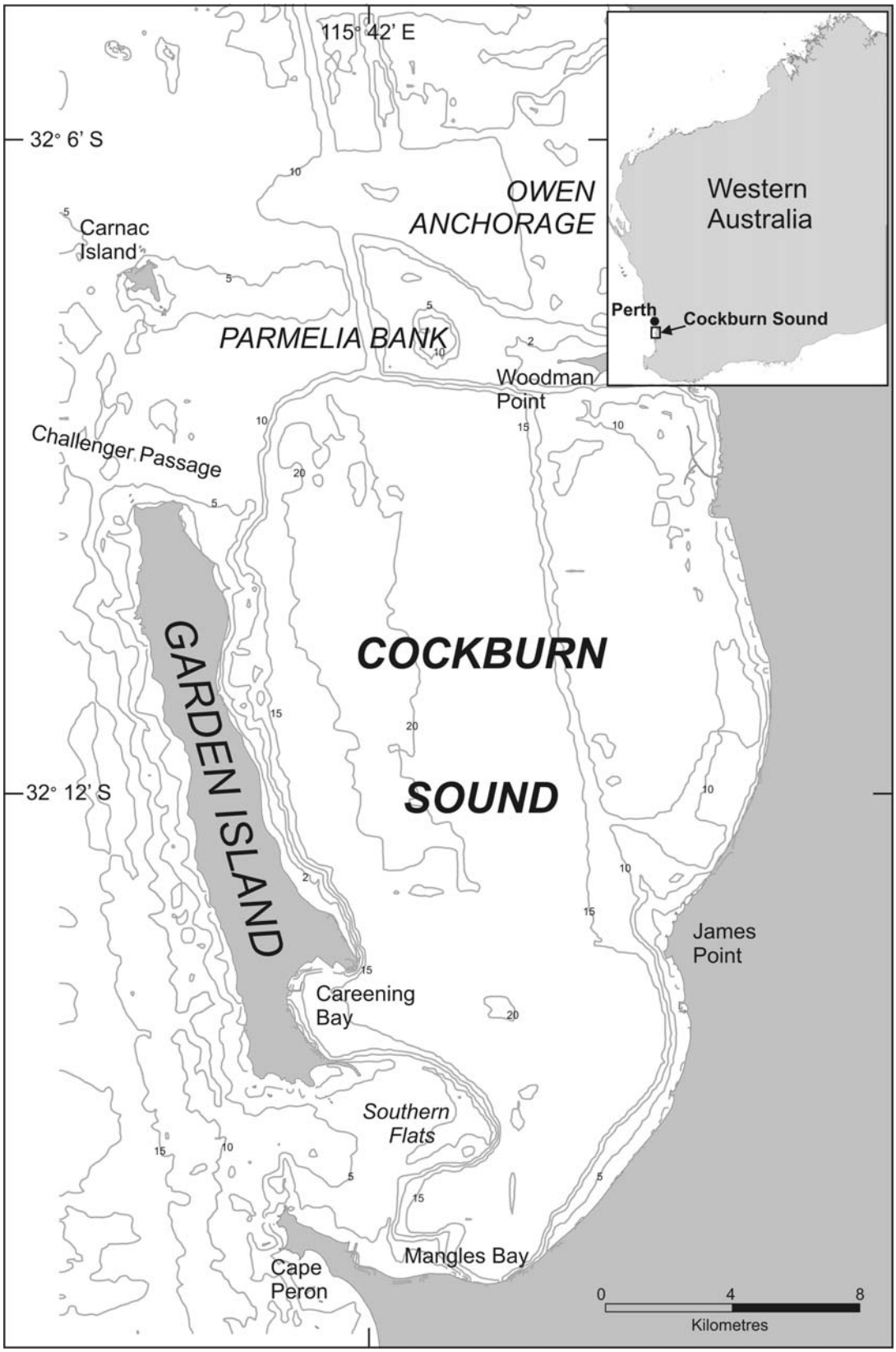


Figure 1: The Cockburn Sound study area.

Field Investigations

The vibracoring and grab sampling programme was conducted over a three-day period from 10 to 12 March 2004. The field survey was undertaken by the following personnel:

Dr Brendan Brooke (Geoscience Australia)
David Ryan (Geoscience Australia)
Darren Skene (Geoscience Australia)
Jamie Strickland (Fremantle Ports)
Mark Small (Fremantle Ports)

Assistance was also provided by Rob McCauley (Curtin University) and Lee Woolhouse, a hydrographic surveyor from Fremantle Ports.

Vessel

The field programme of vibracoring and grab sampling was conducted from the vessel *FP Response* hired from Fremantle Ports by the Coastal CRC. The *Response* is a 25m aluminium single-hulled, 2000 hp, twin screw vessel capable of a top speed of 20 knots (Figure 2). The aft deck has a 4.5m x 4.5m timber working area plus winch, crane and roller areas. It is equipped with a hydraulic crane (rated lifting capacity of 8 tonnes at 4.2m radius) and two three tonne deck winches (Figure 3).

Figure 2: Fremantle Ports' *FP Response* used for the field investigation in Cockburn Sound.

Figure 3: Back deck of FP Response. Note the hydraulic crane in the foreground, concrete mooring block and in the background, the hydraulic winch and generator.

To maintain position while vibracoring, a concrete mooring block (~1.5 tonne) was lowered to the seabed from the port side of the stern of the vessel with the aid of one of the hydraulic winches. No anchors were used for the grab sampling.

Although the vessel had three phase power onboard, there were no outlets. As the vibracorer requires three-phase 415 V power supply, a 10 KVA generator was hired for the duration of the drilling. It was secured midship on the back deck and turned on at each site during deployment of the vibracorer.

Navigation

Vibracore and grab sites were predetermined prior to their collection in consultation with Rob McCauley at Curtin University to ensure common sites for the multibeam and sediment surveys. The sediment sample sites were loaded into the vessel's differential global positioning system (DGPS), allowing the ships master to subsequently position the vessel accurately over the sample site.

The GPS was configured for the WGS84 map datum and Universal Transverse Mercator coordinate system. Once the vessel was on location and the vibracorer or grab deployed, a position fix was taken using a Garmin handheld GPS off the stern of the vessel directly above where the vibracorer or grab were deployed. The uncertainty in the horizontal accuracy of the sample location is estimated at less than 10m.

Vibracoring

The drilling was carried out using a vibracoring system hired from geological and environmental consultants, Quaternary Resources Pty Ltd (Sydney). Vibracoring is best suited for the sampling of unconsolidated sediment sequences due to its rapid sampling rate and the recovery of relatively undisturbed, *in-situ* samples. The method uses a submersible, electrically driven, vibrating head to drive a disposable aluminium core barrel (80mm OD,

76mm ID) into the seabed. Standard core barrels are 6.5 m long or are cut into two 3.25 m lengths. The core barrel is attached to the vibrating head by sliding it over a 25 cm stub and clamping it tightly to the stub. A drill bit/core catcher is riveted to the end of the core barrel to prevent any sediment loss from the bottom of the core barrel during recovery. The standard operation configuration is to have the head and core barrel inside a fully enclosed and free standing, aluminium tower, however, on this occasion it was decided to operate the head without the tower. The core barrel is recovered at either full penetration or refusal, but without using the tower, the rate of penetration was estimated by the amount of rope going over the side when the corer was running.

The vessel was located at each coring location with the aid of the differential GPS (DGPOS) where, once on location, the concrete block was lowered to the seabed to maintain the vessels position during the drilling procedure.

The vibracorer was deployed off the stern of the vessel using both the capstan of the hydraulic winch and the crane. Deployment and recovery of the vibracorer was achieved through the coordinated operation of the winch and crane and the assistance of all personnel onboard. A 28mm diameter polypropylene rope was shackled to the top of the vibrating head, threaded through a block on the crane and wound around the hydraulically driven capstan midships. All signals for the deployment and recovery of the vibracorer were given by the operator at the winch.

The basic procedure for the deployment, operation and recovery of the vibracorer is shown in Figure 4 and can be summarised as:

- Clamp either a new 3.25 m or 6.5 m barrel (with core catcher) onto the head of the vibracorer, which sits in a tyre cradle.
- The lifting rope is then taken up with the capstan of the hydraulic winch and the head and barrel are lifted off the deck. The end of barrel is then lowered over the side of the vessel so that the corer is vertical (end of the barrel in the water).
- The lifting rope is paid out around the capstan until the bottom of the core barrel is touching the seabed. The generator and then the corer are started. The lifting rope is payed out as the corer vibrates and the barrel cuts into the seabed. Penetration is measured by the amount of rope paid out. The corer is turned off at full penetration or refusal.
- Vibracorer recovery is essentially the reverse of deployment – the corer is lifted back on deck and the vibracorer head secured in the cradle.
- The core barrel is then removed, sediment recovery measured, the core cut into 2 m lengths, core catcher removed and all ends capped and taped and then core segments safely stowed. Notes are made on condition of the core (e.g. if the core bent due to movement of the boat during pull out), type of sediment in the bottom of the core barrel and any other relevant information.

The entire coring process including deployment and recovery of the vibracoring system, generally took around 10 minutes. Actual drilling time typically was less than 1 minute to penetrate 3 m and less than 2 minutes to penetrate 6 m. At each location the water depth, time and GPS position (easting and northing) of the vibracorer off the stern of the vessel was recorded. Once the core barrel was removed from the vibracorer, the length of sediment recovered in the barrel was logged.

a)

b)

c)

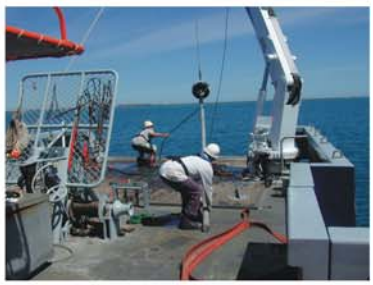
d)

e)

f)

g)

h)



i)

Figure 4: Setup, deployment and recovery of cores using the electric vibracoring system: a) vibracorer head sitting in the tyre cradle; b) - d) deployment of the vibracorer; e) – h) recovery of the vibracorer; i) One of the 6m vibracores recovered in the survey.

Figure 5 shows the locations of the vibracores collected in the survey area. A total of 12 vibracores (length: 10 x 3 m and 2 x 6 m) were collected. Eleven cores were collected along three east-west transects in the southern, central and northern part of Cockburn Sound in water depths ranging from 5.0m to 21.0m, and one core in the deeper part of Owen Anchorage just to the north of the sound. An additional core was attempted, however this was lost on recovery as the core barrel snapped.

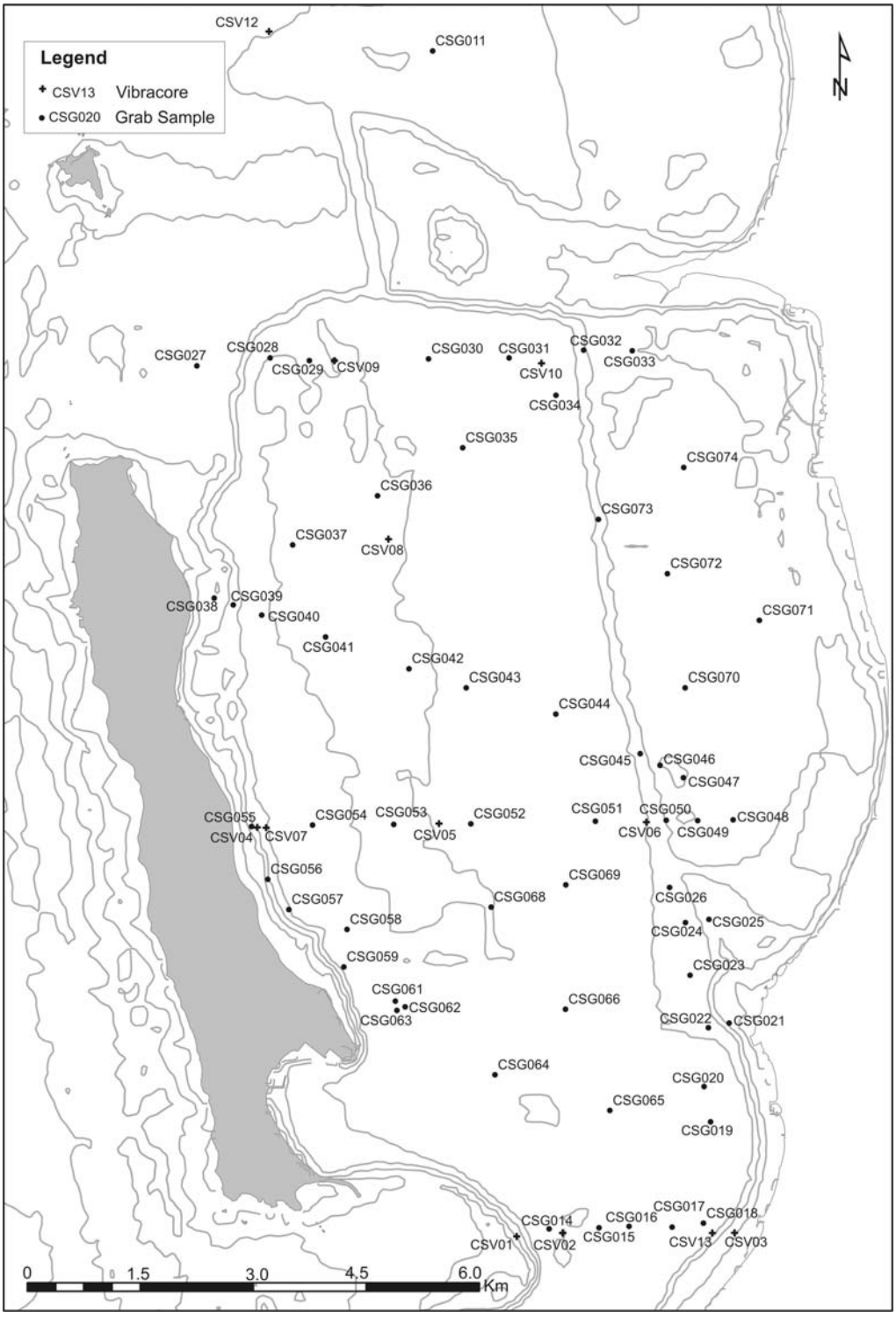


Figure 5: Vibracore and grab sample locations within the Cockburn Sound survey area.

Grab Sampling

A total of 63 samples of surface sediment were collected in the survey and their locations are shown in Figure 5. The majority of the sampling was conducted using a small stainless steel Van Veen grab (Figure 6) on loan from Quaternary Resources Pty Ltd. The grab was deployed and recovered by hand, which made the collection of surface sediment samples considerably quicker than using a bigger grab. Because of its smaller capacity, however, two grabs were collected at the majority of sites to ensure that there would be a large enough sample for the analyses. Several grabs per site were collected where there were extensive seagrass beds because of the small volume of sediment recovered at these sites (the bulk of the sample was seagrass).

Once on location, the grab was set open and allowed to descend to the seabed under its own weight. On impact with the seabed, the jaws of the grab penetrated the top few centimetres of the substrate and the clip holding the jaws open then released. Tension was then placed on the rope which closed the jaws around the sediment sample. The grab was then quickly recovered to the back deck. Any excess water was poured from the grab, the jaws opened and the sample placed in marked plastic bags and sealed. The procedure was then repeated and the two samples combined to provide a representative sample of the seabed at each location.

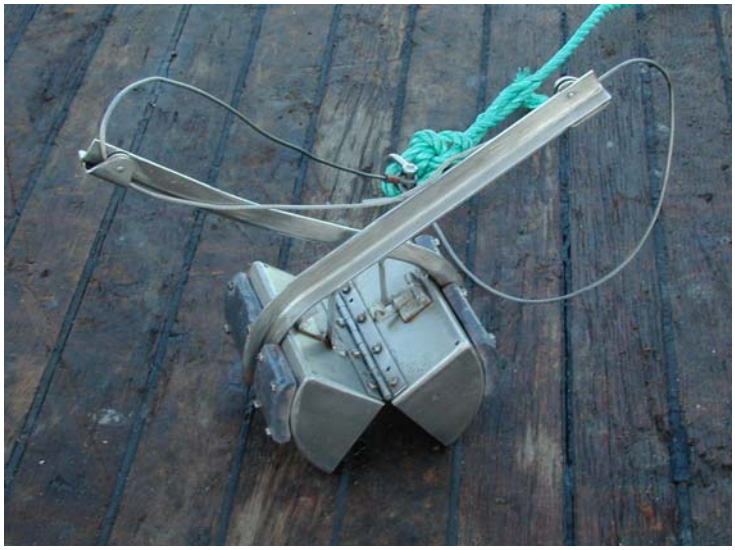


Figure 6: Small (0.5 litre) stainless steel Van Veen grab.

Unfortunately towards the end of the final day's sampling, the vessel was in gear when the grab was deployed and as a result the rope was drawn into the propeller and the small Van Veen grab was lost.

The remaining ten grabs were collected using a larger Van Veen grab (Figure 7). Because of its greater weight, it was deployed and recovered using a rope around the capstan of the vessel's hydraulic winch. Although successful, this method took longer and, in some cases, a proportion of the sample was washed out of the grab during its assent from the seabed.

During the collection of the grabs the time and water depth were noted, a handheld GPS position at the stern of the vessel recorded (Table 2) and a brief description of the sediment recovered in the grab was recorded (Table 3).

Figure 7: Larger Van Veen grab loaded and ready for deployment.

Sample Processing, Analysis and Interpretation

The grab samples collected will be described in hand specimen and subsampled for laboratory analysis. Processing of the vibracores involves cutting the aluminium barrels longitudinally and splitting the cut halves to expose the core sample. The core is photographed and logged prior to sampling. Logging includes visual estimates of colour, texture and composition of the various lithologic units, noting any major stratigraphic changes. Samples of the various units are collected from one of the core halves. The other half is archived for future reference. The reference half-core is wrapped in cling wrap, labelled and sealed within a plastic liner.

All grab and vibracore samples will be submitted to the GA laboratories for compositional and textural analysis including XRF, total calcium carbonate and laser grainsize analysis.

Results of the analysis of the grab samples will be used to develop relatively high-resolution GIS maps of the physical character and spatial distribution of surface sediments in the sound. The results of the vibracoring will be presented as graphic drill logs. The logs will be incorporated into three west-east oriented cross sections of the northern, central and southern areas of Cockburn Sound and one north-south cross-section in the middle of the sound. The various depositional sedimentary units identified in the cores will be used to develop a stratigraphic framework and the geomorphological evolution of Cockburn Sound.

Acknowledgements

The assistance of all personnel at Fremantle Ports is most appreciated.

The Western Australian Department of Planning and Infrastructure supplied the gridded bathymetric data of Cockburn Sound free of charge.

Vibracore ID	Northing (m) WGS84/UTM	Easting (m) WGS84/UTM	Water Depth (m) -not tide corr'ed	Date & Time (ESDST)	Measured Recovery (m)	Comments
CSV001	6431182.105	379613.654	13.4	11-MAR-04 04:34	2.73	bagged top (5cm) of core
CSV002	6431231.513	380226.454	20.2	11-MAR-04 03:57	6.10	discarded first core – barrel overfilled, 2nd core and grab taken
CSV003	6431230.575	382509.456	5.0	11-MAR-04 03:03	0.45	repeated as 1st core snapped
CSV004	6436613.294	376165.569	9.1	10-MAR-04 05:38	2.49	
CSV005	6436663.595	378581.203	21.0	10-MAR-04 07:05	5.53	
CSV006	6436682.944	381337.516	15.6	10-MAR-04 07:48	2.32	Repeated as-1st core snapped, 2nd core repeated as penetration <1m
CSV007	6436610.322	376285.334	15.4	10-MAR-04 06:14	2.26	
CSV008	6440433.007	377909.844	20.6	11-MAR-04 01:43	2.17	
CSV009	6442802.587	377191.778	19.7	11-MAR-04 01:02	3.00	grab taken as core barrel may have been overfilled with sediment?
CSV010	6442768.974	379943.800	17.6	11-MAR-04 00:30	2.40	
CSV011	6446911.005	378496.264	14.5	10-MAR-04 04:10	Core lost	core lost as barrel snapped on recovery, grab of surface taken
CSV012	6447172.649	376321.692	11.1	10-MAR-04 03:17	2.63	
CSV013	6431229.340	382212.674	8.6	11-MAR-04 06:45	2.90	grab taken - core barrel overfilled?

Table 1: Coastal CRC – Cockburn Sound March 2004 Vibracore Summary

Grab ID	Northing (m) WGS84/UTM	Easting (m) WGS84/UTM	Water Depth (m) (not tide corr'ed)	Date & Time (ESDST)	Comments
CSG002	6431231.513	380226.454	20.2	11-MAR-04 03:58	1 grab
CSG009	6442807.009	377190.781	19.7	11-MAR-04 00:50	1 grab
CSG011	6446915.029	378496.264	14.5	10-MAR-04 04:36	2 grabs
CSG013	6431229.340	382212.674	8.6	11-MAR-04 06:45	1 grab
CSG014	6431283.690	380044.928	19.6	11-MAR-04 05:04	2 grabs
CSG015	6431300.403	380708.058	19.1	11-MAR-04 05:16	2 grabs
CSG016	6431318.410	381107.350	19.0	11-MAR-04 05:51	2 grabs
CSG017	6431307.368	381678.468	18.4	11-MAR-04 06:03	2 grabs
CSG018	6431359.900	382094.317	18.1	11-MAR-04 06:10	2 grabs
CSG019	6432705.905	382189.825	16.4	11-MAR-04 07:31	2 grabs
CSG020	6433175.010	382104.260	16.1	11-MAR-04 07:40	1 grab
CSG021	6434015.988	382438.467	6.6	11-MAR-04 07:45	2 grabs
CSG022	6433956.218	382161.133	15.4	11-MAR-04 07:51	2 grabs
CSG023	6434652.997	381918.332	15.1	11-MAR-04 07:57	2 grabs
CSG024	6435350.775	381856.468	13.9	11-MAR-04 08:02	2 grabs
CSG025	6435393.209	382167.973	6.3	11-MAR-04 08:07	2 grabs
CSG026	6435818.413	381645.517	14.3	11-MAR-04 08:11	2 grabs
CSG027	6442735.949	375362.559	9.2	11-MAR-04 23:18	2 grabs
CSG028	6442839.885	376336.680	13.1	11-MAR-04 23:28	2 grabs
CSG029	6442805.206	376858.756	19.1	11-MAR-04 23:35	2 grabs
CSG030	6442828.721	378442.294	20.0	11-MAR-04 23:43	2 grabs
CSG031	6442841.468	379511.853	18.2	11-MAR-04 23:52	2 grabs
CSG032	6442945.204	380502.986	13.7	11-MAR-04 23:59	2 grabs
CSG033	6442935.049	381149.271	10.1	12-MAR-04 00:06	2 grabs
CSG034	6442344.381	380135.585	18.1	12-MAR-04 00:13	2 grabs
CSG035	6441647.812	378896.907	19.5	12-MAR-04 00:20	2 grabs
CSG036	6441008.918	377765.216	20.9	12-MAR-04 00:26	2 grabs
CSG037	6440356.614	376635.712	21.0	12-MAR-04 00:36	2 grabs
CSG038	6439652.020	375592.805	7.3	12-MAR-04 00:46	4 grabs
CSG039	6439561.984	375845.696	13.8	12-MAR-04 01:01	2 grabs
CSG040	6439425.803	376224.565	19.2	12-MAR-04 01:07	2 grabs
CSG041	6439134.544	377073.026	21.0	12-MAR-04 01:12	2 grabs
CSG042	6438712.206	378183.261	22.4	12-MAR-04 01:19	2 grabs
CSG043	6438467.409	378943.354	19.9	12-MAR-04 01:26	2 grabs
CSG044	6438118.985	380132.697	18.6	12-MAR-04 01:33	2 grabs

Table 2: Coastal CRC – Cockburn Sound
March 2004 Grab Sampling Summary

Grab ID	Northing (m) WGS84/UTM	Easting (m) WGS84/UTM	Water Depth (m) (not tide corr'ed)	Date & Time (ESDST)	Comments
CSG045	6437594.451	381254.246	14.6	12-MAR-04 01:39	2 grabs
CSG046	6437440.101	381518.151	8.2	12-MAR-04 01:44	2 grabs
CSG047	6437274.110	381830.266	5.1	12-MAR-04 01:50	4 grabs
CSG048	6436715.224	382490.090	10.1	12-MAR-04 02:23	2 grabs
CSG049	6436705.303	382017.901	8.1	12-MAR-04 02:30	2 grabs
CSG050	6436708.203	381601.184	13.1	12-MAR-04 02:36	2 grabs
CSG051	6436697.167	380660.472	18.6	12-MAR-04 02:41	2 grabs
CSG052	6436663.092	379002.611	20.3	12-MAR-04 02:50	2 grabs
CSG053	6436654.142	377978.907	21.2	12-MAR-04 02:57	2 grabs
CSG054	6436645.544	376901.459	19.4	12-MAR-04 03:06	2 grabs
CSG055	6436626.783	376089.985	4.3	12-MAR-04 03:40	3 grabs
CSG056	6435925.353	376305.010	4.1	12-MAR-04 03:49	3 grabs
CSG057	6435524.099	376587.046	15.6	12-MAR-04 03:58	2 grabs
CSG058	6435259.620	377359.442	20.0	12-MAR-04 04:05	2 grabs
CSG059	6434763.499	377317.379	17.6	12-MAR-04 04:11	2 grabs
CSG060	6434309.417	378001.497	20.1	12-MAR-04 04:17	2 grabs
CSG061	6434185.483	378021.840	20.1	12-MAR-04 04:23	2 grabs
CSG062	6434233.360	378130.595	20.1	12-MAR-04 04:29	2 grabs
CSG063	6432788.050	378113.000	17.9	12-MAR-04 04:37	No sample, grab lost
CSG064	6433329.631	379325.161	19.6	12-MAR-04 04:59	1 large grab
CSG065	6432856.537	380850.852	17.9	12-MAR-04 05:09	1 large grab
CSG066	6434200.030	380261.998	19.2	12-MAR-04 05:18	1 large grab
CSG068	6435556.472	379273.166	21.2	12-MAR-04 05:27	1 large grab
CSG069	6435850.996	380266.984	19.0	12-MAR-04 05:34	1 large grab
CSG070	6438467.020	381852.001	9.2	12-MAR-04 05:45	1 large grab
CSG071	6439356.892	382837.593	9.5	12-MAR-04 05:55	1 large grab
CSG072	6439974.665	381614.897	9.8	12-MAR-04 06:04	1 large grab
CSG073	6440696.804	380699.210	13.2	12-MAR-04 06:10	1 large grab
CSG074	6441386.393	381833.272	9.9	12-MAR-04 06:18	1 large grab

Table 2 (cont.): Coastal CRC – Cockburn Sound March 2004 Grab Sampling Summary

Grab ID	Water Depth (m) (not corr'ed for tide)	Sample Description
CSG014	19.6	sandy mud
CSG015	19.1	sandy mud
CSG016	19.0	sandy mud
CSG017	18.4	silty sandy mud
CSG018	18.1	sandy mud
CSG019	16.4	sandy mud
CSG020	16.1	sandy mud
CSG021	6.6	sandy shelly mud
CSG022	15.4	sandy mud
CSG023	15.1	silty mud
CSG024	13.9	muddy sand
CSG025	6.3	sand & shell hash
CSG026	14.3	sandy mud & shell
CSG027	9.2	medium to coarse sand
CSG028	13.1	fine to medium sand with mud balls
CSG029	19.1	silty muddy sand
CSG030	20.0	muddy sand
CSG031	18.2	shelly muddy sand
CSG032	13.7	muddy sand & shell fragments
CSG033	10.1	coarse sand & shell & forams
CSG034	18.1	sandy mud
CSG035	19.5	muddy sand
CSG036	20.9	silty sandy mud
CSG037	21.0	sandy mud & shell fragments
CSG038	7.3	seagrass, shelly sand
CSG039	13.8	sandy mud & shell fragments
CSG040	19.2	sandy mud
CSG041	21.0	sandy mud & shell fragments
CSG042	22.4	sloppy sandy mud
CSG043	19.9	shelly sandy mud
CSG044	18.6	sandy mud
CSG045	14.6	muddy sand & shell fragments
CSG046	8.2	shelly sand
CSG047	5.1	seagrass, sand & shell hash
CSG048	10.1	coarse muddy sand
CSG049	8.1	fine to coarse sand
CSG050	13.1	silty muddy sand
CSG051	18.6	sandy mud
CSG052	20.3	sandy mud
CSG053	21.2	sandy mud
CSG054	19.4	sandy mud
CSG055	4.3	seagrass, coarse shelly sand
CSG056	4.1	seagrass, slightly muddy, coarse sand
CSG057	15.6	coarse muddy sand
CSG058	20.0	sandy mud
CSG059	17.6	sandy mud

Table 3: Coastal CRC – Cockburn Sound
March 2004 Grab Sampling Summary

Grab ID	Water Depth (m) (not corr'ed for tide)	Sample Description
CSG060	20.1	sandy mud
CSG061	20.1	fine sandy mud
CSG062	20.1	fine sandy mud
CSG064	19.6	sandy mud
CSG065	17.9	sandy mud
CSG066	19.2	sandy mud
CSG068	21.2	sandy mud
CSG069	19.0	sandy mud
CSG070	9.2	gravelly sand
CSG071	9.5	gravelly shelly sand
CSG072	9.8	gravelly shelly sand
CSG073	13.2	gravelly shelly sand
CSG074	9.9	gravelly shelly sand

Table 3 (cont.): Coastal CRC – Cockburn Sound
March 2004 Grab Sample Description