Adelaide Desalination Project

June 2012 Infauna Survey

Interim Report

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August 2012

Introduction

The Adelaide Desalination Plant project (ADP) is one part of a state strategy to ensure a secure water supply for the future of South Australia.

AdelaideAqua was awarded the contract to design, build, operate and maintain this critical infrastructure. As part of the licensing conditions as issued by the Environment Protection Authority South Australia for the ADP, the licensee (AdelaideAqua) is required to undertake marine monitoring. A component of this monitoring schedule is the Ambient Marine Ecological Monitoring of which Infauna Survey is required. The schedule stipulated that two surveys per year of the macroinfauna and meiofauna in the soft sediment have to be undertaken at 20 sites, including 5 reference sites, with multiple samples at each site to characterise variability. Through a request for quotation process, SARDI was engaged to undertake the infauna survey in the first six months of 2012. This interim report gives the preliminary results to date of the survey carried out in June 2012.

Materials and Methods

Sampling sites

In previous surveys, ten transect sites (each of 800m in length) were surveyed directly off Port Stanvac, in the vicinity of the ADP outfall diffuser (Beattie *et al.* 2010). Additionally, five transect sites located in similar habitats at two reference locations (Glenelg in the north and Noarlunga in the south) were surveyed. Along each transect, samples were collected at every 200 m. Infauna were sampled using a suction sampler, while epifauna were collected using a hand held dredge and meiofauna were sub-sampled from sediment collected by a box corer (Beattie *et al.* 2010). Infauna and epifauna surveys were undertaken during Winter 2009 and repeated during Summer 2009, while meiofauna was sampled in Summer 2009 and Autumn 2010.

In this current survey (June 2012), the same locations as the previous surveys were used, i.e. Port Stanvac and a reference site each to the north (North Control off Glenelg) and to the south (South Control off Noarlunga). Ten sites at Port Stanvac, in the vicinity of the ADP outfall diffuser, were located at the “Near” end of the transects from the previous surveys. At the two control locations, five sites were located at the centre of the control zones from the previous surveys (Fig 1). From SARDI’s experiences in environmental assessment and monitoring (e.g.

recent works Loo *et al.* 2011a, Loo *et al.* 2011b), the number of sites used at Port Stanvac and the reference locations is deemed to be adequate for monitoring the potential impact of the ADP outfall diffuser.

The field sampling was carried out using MRV *Ngerin* between 18th and 26th June 2012. To locate the sites, a GPS loaded with the coordinates provided in the Scope of Work document was used and actual coordinates were recorded during the field sampling at each site.

During the sampling of the North Control sites, the substrate for most of the area was found to comprise mainly seagrasses and rhodoliths. This substrate was very different from the Port Stanvac sites. As such, the North Control sites were considered to be unsuitable as controls for this infauna monitoring. After discussions with MAJV, the North Control sites were moved 3.2 km to the northwest. Table 1 gives the GPS coordinates of the 20 sites where sediment samples were collected, with the locations shown in Figure 1.

Field sampling

At each site, 12 sediment samples were collected haphazardly from an area of about 10 m^2 for assessment using a HAPS Bottom Corer fitted with a sampling tube (67 mm internal diameter). The HAPS Bottom Corer is a sampler that provides consistent sample size, without loss of sediment, thereby allowing quantitative assessment of infaunal assemblages. The corer, which weighs approximately 120 kg, was lowered to the sea floor using a hydraulic winch. Upon contact with the sea bottom, a counter weight released the sampling tube, which then dropped into the sediment collecting a core sample. The HAPS Bottom corer was then winched up onto a specially built table where the sample tube was removed. For eight of the sediment samples, a subsample using a hand-held corer (30 mm internal diameter) was taken for meiofauna before the remaining sediment in the sample tube was extruded into a 2-litre plastic jar for macroinfauna assessment. The subsample was also extruded into a separate 2-litre plastic jar. All sediment samples were then labelled and preserved in 10% Bennett's solution (1:1 propylene glycol and formalin in approximately 1 litre of seawater). The remaining four sediment samples were for particle size analysis. Overlying water for these samples was gently decanted before the sample was extruded onto a tray and the top 40 mm of each core was sliced off and placed in separate Al-foil trays, labelled and sealed.

Table 1 Depth in m and coordinates in decimal degrees (WGS84) and Northing and Easting (GDA94, Zone 53) of the sites for sediment sampling carried out at Port Stanvac around the ADP outfall diffuser, North Control off Glenelg and South Control off Noarlunga.

SiteID	Depth (m)	Latitude	Longitude	Northing	Easting
Port Stanvac					
PS01	15.0	138.47075	-35.09733	269449.80	6113236.01
PS02	17.5	138.46877	-35.09598	269265.17	6113381.18
PS03	19.0	138.46710	-35.09487	269110.06	6113501.19
PS04	20.3	138.46532	-35.09387	268944.64	6113607.99
PS05	20.5	138.46667	-35.09213	269062.84	6113803.41
PS06	20.5	138.46760	-35.09038	269143.00	6113999.71
PS07	20.0	138.46903	-35.08870	269268.95	6114189.77
PS08	19.2	138.47065	-35.08965	269419.04	6114088.13
PS09	18.5	138.47247	-35.09078	269587.88	6113966.61
PS10	15.0	138.47465	-35.09185	269789.96	6113853.33
North Control					
NC01	21.8	138.41893	-34.98743	264409.88	6125306.61
NC02	21.5	138.42333	-34.98998	264818.89	6125034.11
NC03	20.0	138.42225	-34.99435	264732.50	6124547.14
NC04	21.5	138.41660	-34.99457	264217.33	6124509.77
NC05	21.0	138.41558	-34.98992	264111.17	6125023.22
South Control					
SC01	21.0	138.43860	-35.15040	266670.07	6107274.07
SC02	19.0	138.44265	-35.15240	267044.80	6107061.70
SC03	19.5	138.44170	-35.15612	266968.85	6106647.16
SC04	21.1	138.43697	-35.15622	266537.88	6106624.96
SC05	21.0	138.43583	-35.15212	266422.90	6107077.14

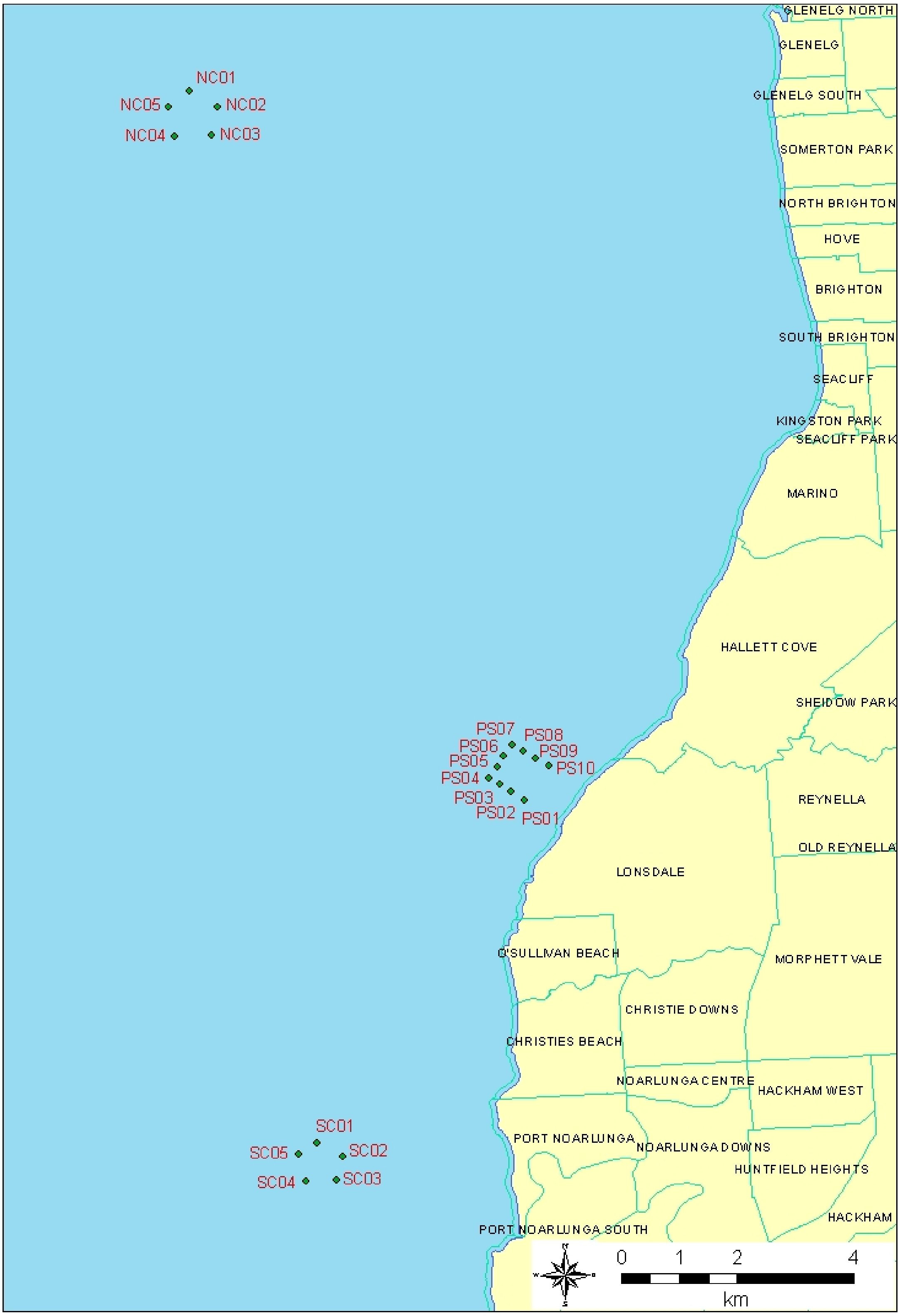


Figure 1 Location of the ten sites at Port Stanvac around the ADP outfall diffuser and the five sites each at North Control off Glenelg and South Control off Noarlunga.

Laboratory processing

All samples were processed in the laboratory at SARDI Aquatic Sciences, West Beach, Adelaide. For the macrofauna samples, the Bennett's solution in the sample jar was decanted before further processing. The samples were gently washed and screened using 500 µm sieves. Animals in the retained sediment were picked out with the aid of a stereomicroscope and identified. More common animals were identified to intermediate taxonomic levels, mostly to the family level. This is generally sufficient for identification of natural and anthropogenic spatial and temporal variability of assemblages in sediments (Olsgard and Somerfield 2000, Somerfield and Clarke 1995). The animals were then enumerated and preserved in 70% ethanol for storage. The samples for meiofauna were initially processed similarly to the macrofauna, but were washed through stacked 500 µm and 53 µm sieves. The material retained on the 500 µm sieve was added to the macrofauna sample while the material retained on the 53 µm sieve was further processed using a modified Ludox™ flotation method for meiofauna. The meiofauna were then identified, enumerated and preserved in 70% ethanol for storage.

Samples for sediment grain size were oven-dried at 90°C. Each of the dried samples was gently homogenised and a 50 g subsample was weighed into a dish. The subsample was then dry sieved through 2 mm and 1 mm sieves with the fraction retained on each sieve weighed to obtain the coarse fractions. The finer fraction (<1 mm) was kept for further analysis using laser diffraction on a Mastersizer 2000 Particle Size Analyser. The samples were stirred in a sonicator with a dispersing agent (50 g/L sodium hexametaphosphate in MilliQ water) for 15 minutes before analysis in the Mastersizer.

Data Analysis

As the processing of samples for macrofauna and meiofauna has not been completed, no analysis of the data is reported here. However, particle size analysis has been completed, therefore the data was analysed as described below.

The grain size distributions for fractions greater than 1 mm were determined as % weight by sieving through graded sieves, while the distribution of finer fractions (<1 mm) is given as a % volume distribution by laser diffraction. Due to the different techniques used, the results are presented separately and are not combined to give a single size distribution. Grain size parameters for the finer fractions were determined using the software package GRADISTAT (Blott and Pye 2001). The parameters used to describe grain size distributions included the mean, sorting (the spread of the sizes around the mean, equivalent to standard deviation), the symmetry or the preferential spread (skewness) to one side of the mean, and the degree of concentration of the grains (kurtosis) relative to the mean (see Table 2). These parameters were calculated using the Folk and Ward method as it is relatively insensitive to large variations in the tails of the sediment distribution (Blott and Pye 2001). Additionally, GRADISTAT was used to quantify grain size composition by determining the percentage falling into each of 6 size fractions, from clay (<4 μm) to coarse sand (500-1000 μm) for each sample.

Table 2 Definitions, abbreviations used in results, and criteria for calculated grain size distribution parameters (modified from Blott and Pye 2001).

Parameter	Value range	Description and definition
Mean / Size fraction	< 4	Clay
	4 to 63	Silt
	63 to 125	Very fine sand
	125 to 250	Fine sand
	250 to 500	Medium sand
	>500	Coarse sand
Sorting (standard deviation)	< 1.27	Very well sorted (small spread)
	1.27 to 1.41	Well sorted
	1.41 to 1.62	Moderately well sorted
	1.62 to 2.00	Moderately sorted
	2.00 to 4.00	Poorly sorted
	4.00 to 16.00	Very poorly sorted
	>16.00	Extremely poorly sorted (large spread)
Skewness	-0.3 to -1.0	Very fine skewed
	-0.1 to -0.3	Fine skewed
	-0.1 to +0.1	Symmetrical
	+0.1 to +0.3	Coarse skewed
	+0.3 to +1.0	Very coarse skewed
Kurtosis	<0.67	Very platykurtic (very flattened distribution)
	0.67 to 0.90	Platykurtic (flattened distribution)
	0.90 to 1.11	Mesokurtic (normal distribution)
	1.11 to 1.50	Leptokurtic (peaked distribution)
	1.50 to 3.00	Very leptokurtic (very peaked distribution)
	>3.00	Extremely leptokurtic

Results and Discussion

Particle size

Analysis of coarse (>1 mm) fractions of sediment showed variability among all sites, even for sites within the same zone (Port Stanvac, North Control and South Control). Only 3 sites (PS03, PS05 and SC04) had a high proportion of gravel (>40% of particles >2 mm, Figure 2). These particles comprise mostly shell grit and pebbles. Sites NC04 and PS03 had a substantial proportion (41.0% and 34.4% respectively) of very coarse sand (1-2 mm particles) while all the remaining sites had predominantly fine particles (<1 mm, Figure 2).

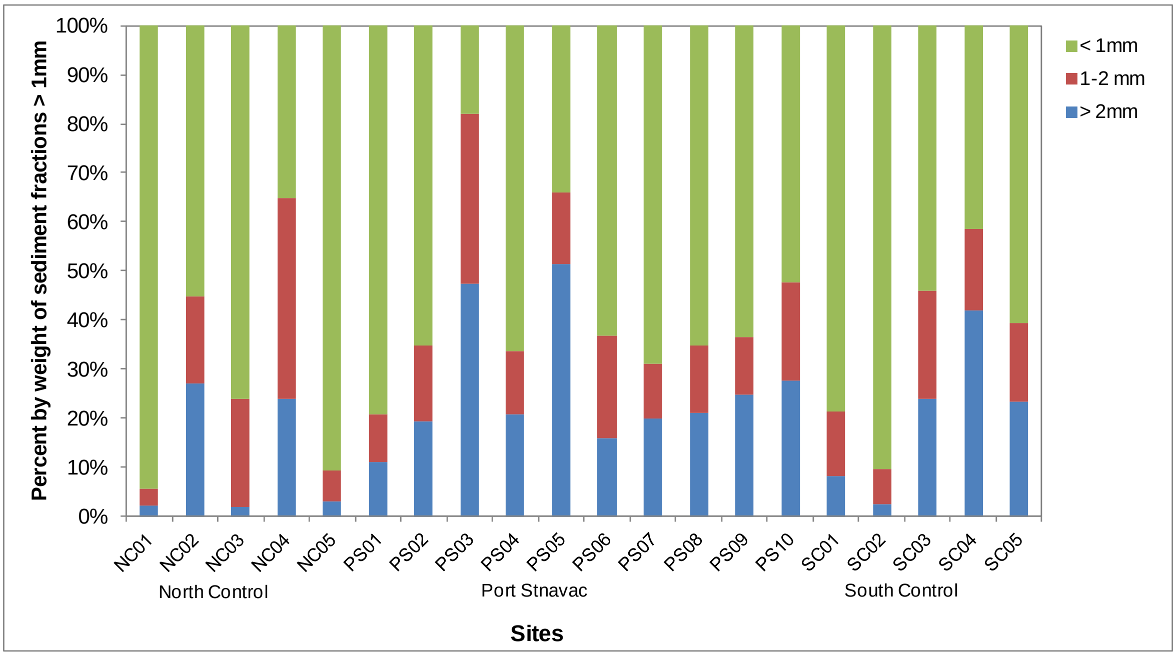


Figure 2 Sediment particle size composition showing proportion of gravel (>2mm), very coarse sand (1 to 2mm) and fine fraction (<1mm) for the sites at Port Stanvac (PS*), North Control (NC*) and South Control (SC*).

Further analysis of the fine fractions (<1 mm) showed that most sites at Port Stanvac were dominated by very fine to fine sand (63 to 250 µm, Figure 3) while the sites at both North Control and South Control were more variable, with most sites dominated by fine to coarse sand (125 to 1000 µm, Figure 3). Two sites at South Control (SC03 and SC04) and two sites at Port Stanvac (PS03 and PS05) had higher clay/silt fractions compared to the other sites.

This characterisation of sites was further confirmed by Principle Component Analysis (PCA) of the sediment fractions. The PCA plot with superimposed vectors gave a good description of the structure, with PC1 accounting for 60% of the variability, differentiating sites with clay/silt and very coarse sand/gravel from sites with medium/coarse sand (left to right), and PC2 accounting for a further 27.6%, differentiating sites with very fine/fine sand (mostly from Port Stanvac) from the rest (Figure 4).

GRADISTAT analysis of results for fine (<1 mm) fractions showed that particle size distributions for all sites at Port Stanvac (except PS01) were generally leptokurtic to very leptokurtic, fine to very fine skewed with poor sorting (see Data Analysis section and Table 2 for definition of terms). Sediments at Site PS01 were mesokurtic and moderately sorted with a symmetrical distribution (Table 3). Sites at North Control had variable particle size distributions, with a platykurtic and symmetrical distribution of fine sand at Site NC01, leptokurtic and fine/very fine skewed distribution of medium sand at Sites NC02, NC03 and NC04, and mesokurtic and symmetrical distribution of medium sand at Site NC05. The sorting was also variable with the fine/medium sand being poorly or moderately well sorted (Table 3). Distributions of sediment particle size were also variable for sites at South Control, ranging from mesokurtic and fine skewed or symmetrical to leptokurtic and very fine skewed distribution and generally poorly sorted of very fine sand and medium sand (Table 3).

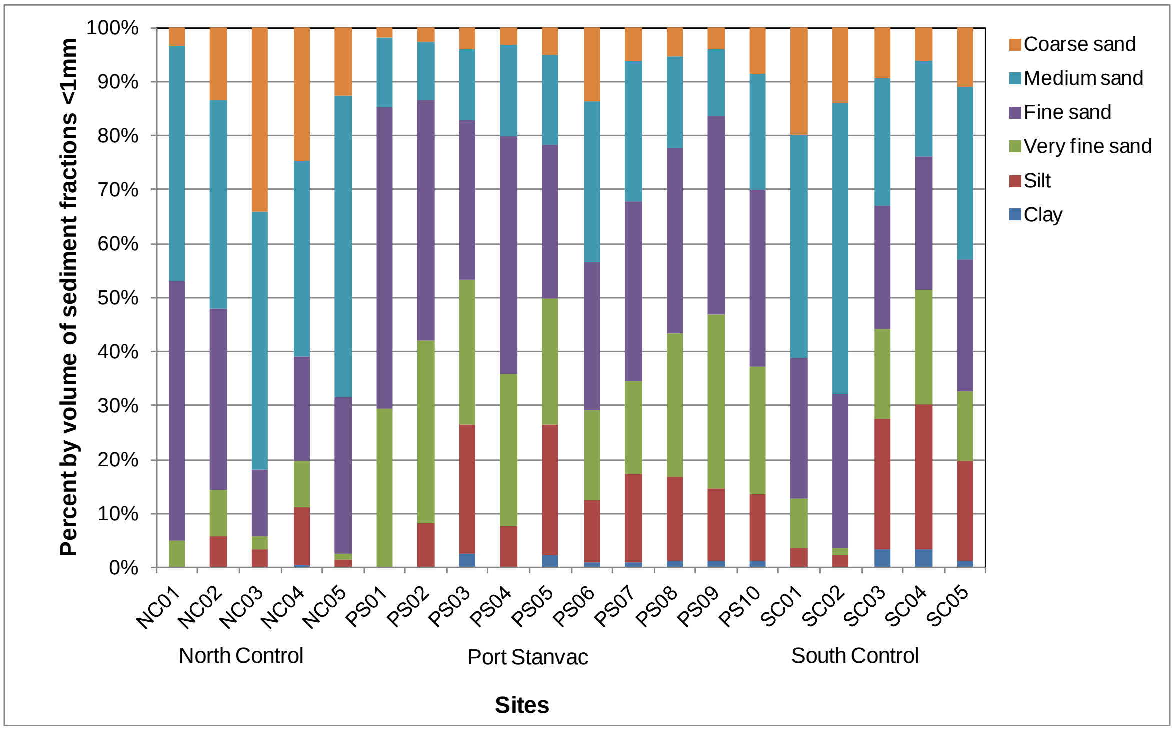


Figure 3 Sediment particle size composition showing proportion of gravel (>2mm), very coarse sand (1 to 2mm) and fine fraction (<1mm) for the sites at Port Stanvac (PS*), North Control (NC*) and South Control (SC*).

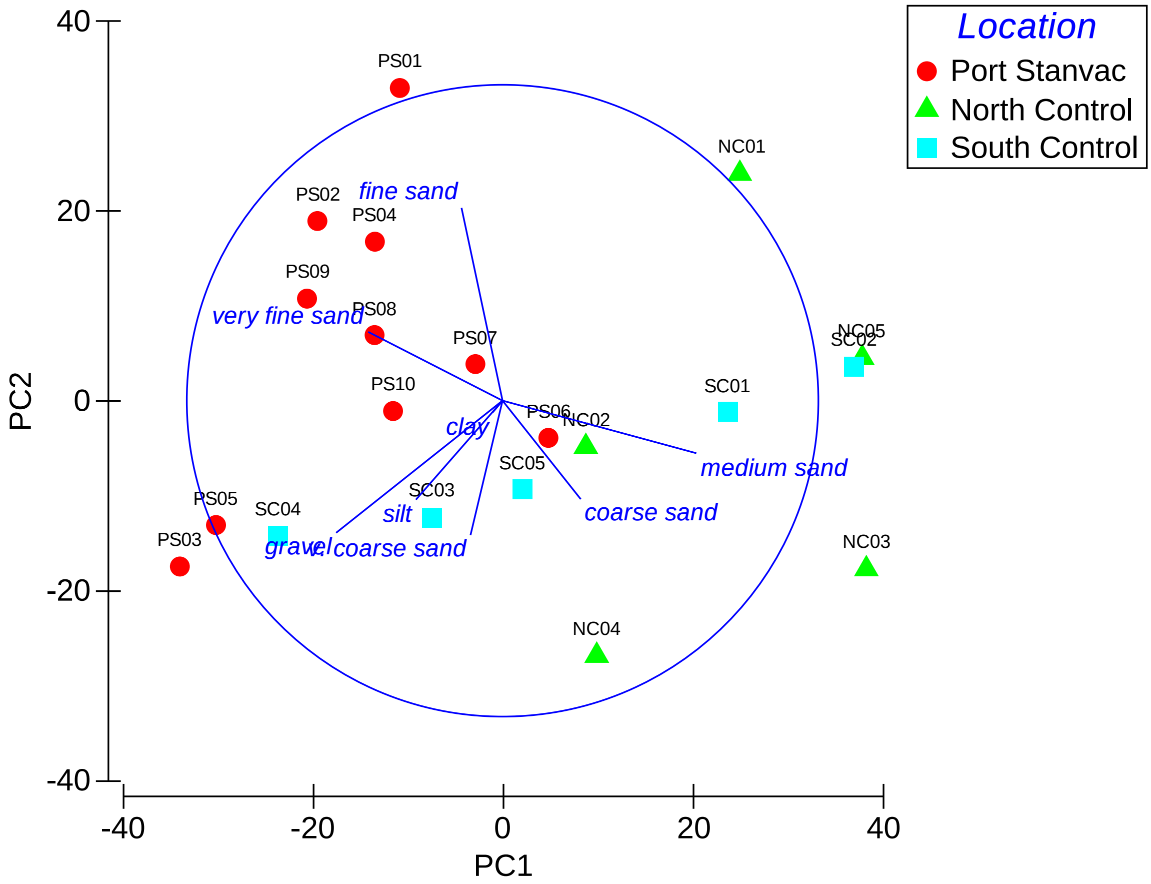
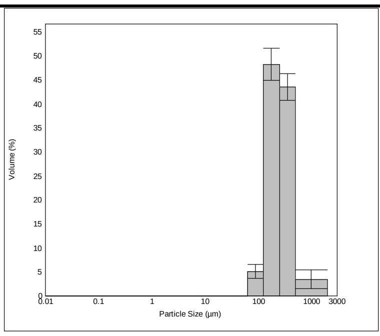
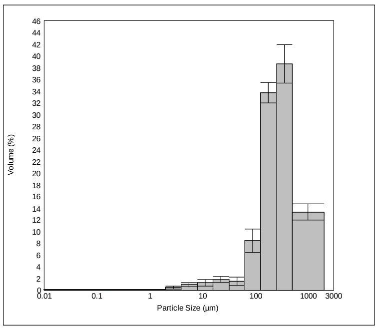
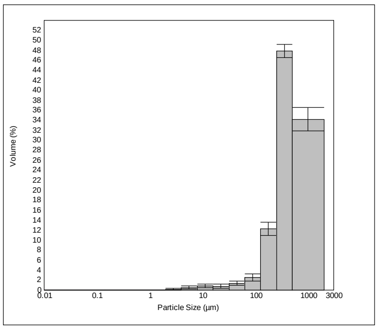
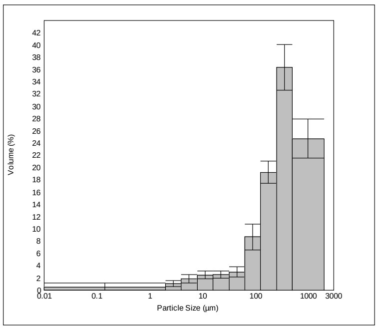
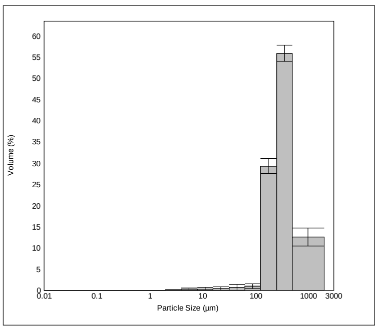
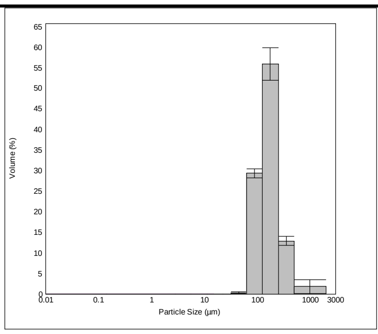
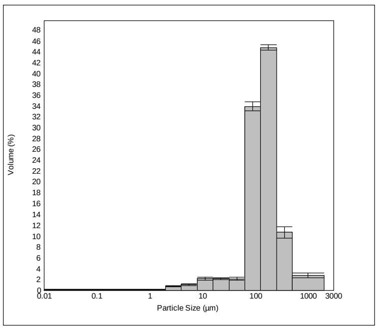
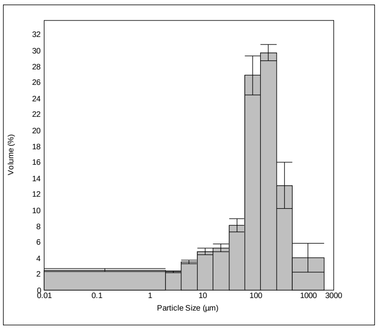
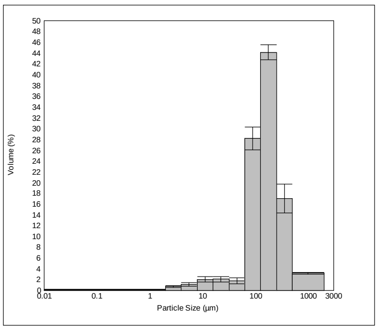
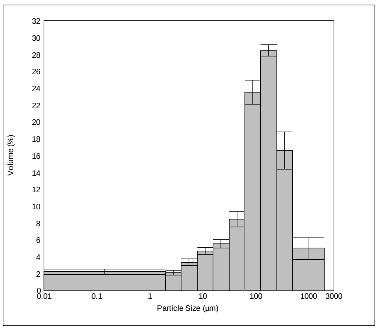


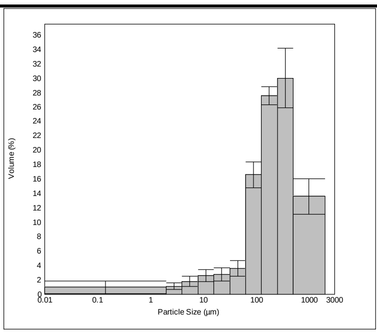
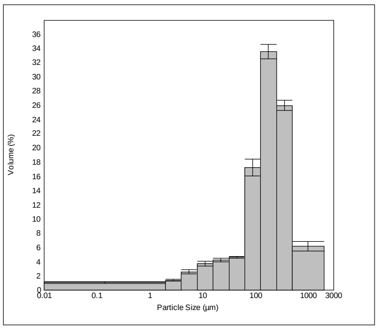
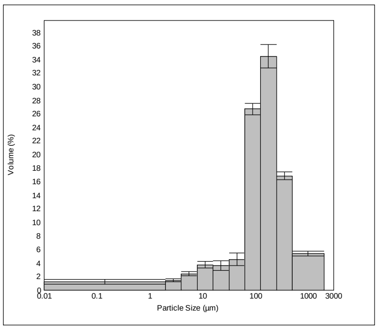
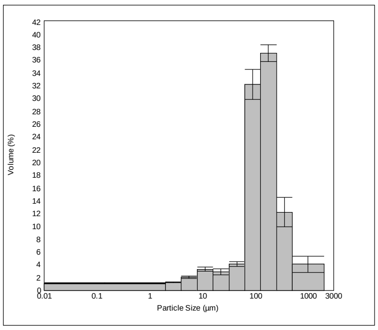
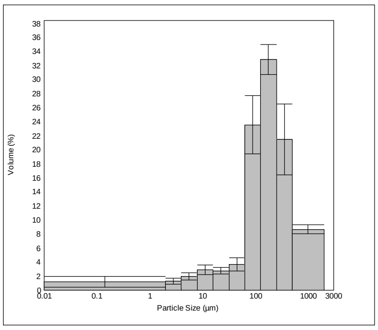
Figure 4 Principle Component Analysis of sediment particle size for the sites at Port Stanvac (PS*), North Control (NC*) and South Control (SC*) with superimposed vectors of sediment fractions. Vector length reflects the correlation between each fraction in PC1 and PC2, with the circle representing the vector length for a correlation of 1.

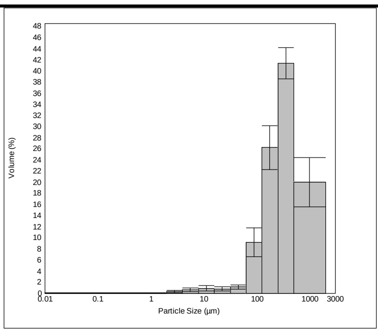
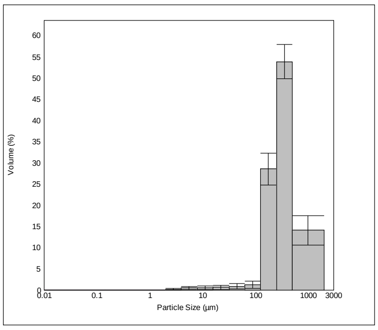
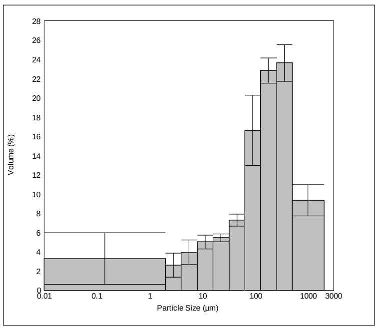
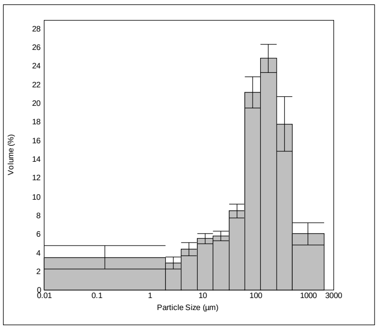
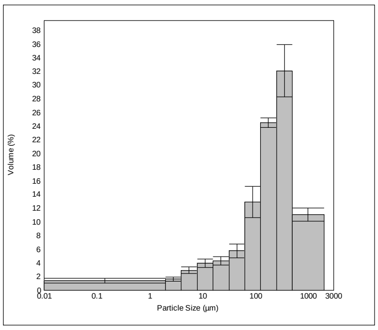
The particle size distributions indicated differences between the sites at Port Stanvac and the sites at both North and South Control. Whether these differences are potential drivers for the structure of the infauna assemblages, further analyses will be carried out when the data for macrofauna and meiofauna are available. These analyses and the results will be reported in the final report in December 2012.

Table 3 Particle size distribution and GRADISTAT-calculated parameters for sites at Port Stanvac (PS*), North Control (NC*) and South Control (SC*). All values are in µm. x-axis on distribution charts show particle size (1-1000 µm) and y-axis show % volume but are not to the same scale between sites.

SiteID	Particle size distribution	Parameters		
NC01		Mean	242.7	Fine Sand
		Sorting	1.590	Moderately Well Sorted
		Skewness	0.046	Symmetrical
		Kurtosis	0.742	Platykurtic
NC02		Mean	251.8	Medium Sand
		Sorting	2.154	Poorly Sorted
		Skewness	-0.157	Fine Skewed
		Kurtosis	1.246	Leptokurtic
NC03		Mean	399.1	Medium Sand
		Sorting	1.880	Moderately Sorted
		Skewness	-0.123	Fine Skewed
		Kurtosis	1.167	Leptokurtic
NC04		Mean	262.8	Medium Sand
		Sorting	3.069	Poorly Sorted
		Skewness	-0.378	Very Fine Skewed
		Kurtosis	1.445	Leptokurtic
NC05		Mean	295.8	Medium Sand
		Sorting	1.681	Moderately Sorted
		Skewness	-0.081	Symmetrical
		Kurtosis	1.025	Mesokurtic

SiteID	Particle size distribution	Parameters		
PS01		Mean	153.4	Fine Sand
		Sorting	1.681	Moderately Sorted
		Skewness	-0.038	Symmetrical
		Kurtosis	1.092	Mesokurtic
PS02		Mean	136.0	Fine Sand
		Sorting	2.093	Poorly Sorted
		Skewness	-0.173	Fine Skewed
		Kurtosis	1.404	Leptokurtic
PS03		Mean	89.72	Very Fine Sand
		Sorting	3.741	Poorly Sorted
		Skewness	-0.355	Very Fine Skewed
		Kurtosis	1.479	Leptokurtic
PS04		Mean	152.9	Fine Sand
		Sorting	2.194	Poorly Sorted
		Skewness	-0.159	Fine Skewed
		Kurtosis	1.386	Leptokurtic
PS05		Mean	99.87	Very Fine Sand
		Sorting	3.834	Poorly Sorted
		Skewness	-0.339	Very Fine Skewed
		Kurtosis	1.370	Leptokurtic

SiteID	Particle size distribution	Parameters		
PS06		Mean	193.9	Fine Sand
		Sorting	3.026	Poorly Sorted
		Skewness	-0.265	Fine Skewed
		Kurtosis	1.343	Leptokurtic
PS07		Mean	151.0	Fine Sand
		Sorting	3.136	Poorly Sorted
		Skewness	-0.318	Very Fine Skewed
		Kurtosis	1.380	Leptokurtic
PS08		Mean	137.2	Fine Sand
		Sorting	2.914	Poorly Sorted
		Skewness	-0.223	Fine Skewed
		Kurtosis	1.543	Very Leptokurtic
PS09		Mean	129.7	Fine Sand
		Sorting	2.555	Poorly Sorted
		Skewness	-0.204	Fine Skewed
		Kurtosis	1.630	Very Leptokurtic
PS10		Mean	163.4	Fine Sand
		Sorting	2.972	Poorly Sorted
		Skewness	-0.175	Fine Skewed
		Kurtosis	1.448	Leptokurtic

SiteID	Particle size distribution	Parameters		
SC01		Mean Sorting Skewness Kurtosis	286.8 2.085 -0.140 1.045	Medium Sand Poorly Sorted Fine Skewed Mesokurtic
SC02		Mean Sorting Skewness Kurtosis	295.7 1.713 -0.082 1.016	Medium Sand Moderately Sorted Symmetrical Mesokurtic
SC03		Mean Sorting Skewness Kurtosis	104.6 4.898 -0.387 1.192	Very Fine Sand Very Poorly Sorted Very Fine Skewed Leptokurtic
SC04		Mean Sorting Skewness Kurtosis	85.69 4.792 -0.366 1.217	Very Fine Sand Very Poorly Sorted Very Fine Skewed Leptokurtic
SC05		Mean Sorting Skewness Kurtosis	155.0 3.728 -0.405 1.300	Fine Sand Poorly Sorted Very Fine Skewed Leptokurtic

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