ATTACHMENT J

ECOLOGICAL ASSESSMENT

PLANNERS PLUS LIMITED

Land Development, Resource Consent and Planning Specialists.

Brian T. Coffey and Associates Limited

Environmental Consultants

Solutions for Water Resource Managers

Buffalo Beach Seawall, Mercury Bay, Whitianga
Ecological Considerations for Resource Consent Applications

Prepared for:
Meritec Group Limited
P.O. Box 834, Hamilton
Attention: Dave Burton

Prepared by:

Brian Coffey

Inquiries and reference: please quote
Brian T. Coffey and Associates Limited
CBI. Buffalo Beach / Meritec, October 2001

417 Given Avenue P.O. Box 83 Whangamata, New Zealand
Telephones 64 [07] 865 6671 / (025) 937 865 Facsimile 64 [07] 865 6672 Email: bricoff@wave.co.nz

1.0. Summary

A survey of macro-benthos in the surrounds of an existing seawall at Buffalo Beach, Mercury Bay, Whitianga, was conducted on 17 October 2001.

Beach nourishment is proposed along the seaward side of this wall.

The Study Area was typical of an exposed sand beach in northern New Zealand which is typically low in biodiversity. There are a limited number of animals which are adapted to cope with the mobile substrate associated with wave action (and at times strong winds) which constantly resort sand - shell deposits along such shorelines. Infauna must continually re-embed themselves or at least repair their temporary burrows. De-watered intertidal substrate is typically difficult for larger animals to burrow into because of the low water content and large size of the particles; but such firmness makes it easy to crawl on. Little organic matter is present in de-watered intertidal sediments and water (and oxygen) circulation is high. As a result the anoxic layer is usually deep and a low organic content means that larger deposit feeders are rare

The profile of open sandy beaches changes quite markedly on a seasonal basis in response to exposure conditions with high rates of sand removal being associated with storm events.

The following zonation of New Zealand's open sandy beaches which is based on small burrowing crustaceans (Morton and Miller, 1968) was consistent with the zonation present within the study area.

* Two small crustaceans are the primary colonisers of the upper shore: a sandhopper *Talorchestia quoyana* and a sea slater (isopod) *Scyphax ornatus*.

* Eurydicid isopods and Haustoriid amphipods are generally characteristic of the middle beach.

* Haustoriid amphipods, the paddle crab *Ovalipes catharus* and the ghost shrimp *Callinanassa filholi* are generally characteristic of the lower beach.

A harvestable bed of tuatua (*Paphies subtriangulata*) was present in shallow subtidal sediments of the study area and the nut shell (*Nuclea hartvigiana*) and morning star shell (*Tawera spissa*) was present in offshore sediments at a depth of 3 - 4 metres.

Whilst relatively intact shell material of other bivalves (*Mactra discors, Panopea zelandica, Myadora striata, Angulus gaimardi, Zenatia acinaces, Resania lanceolata Spisula aequilatera, Bassina yatei, Dosinia anus, Paphies australis, Perna canaliculus* and *Austrovenus stutchburyi*) and univalves (*Zethalia zelandica, Calliostoma selectum, Stuthiolaria spp., Austrofucus glans, Xymene ambiguous, Phenatoma rosea, Cirsotrema zelebori, Sigapatella sp. and Semicassis pyrum*) were present on the beach, no live specimens of these taxa were collected within the study area.

It appears likely (from a comparison of dune vegetation in the vicinity of the Study Area) that the residential dwellings between Buffalo Beach Road and the existing seawall have been developed on an area of foredunes (although it may have included a range of sand-fixing shrubs such as *Coprosma acerosa*, *Pimelea arenaria*, *Cassinia spp.* and *Lupinus arboreus* behind dune grasses).

It is not immediately obvious where the most likely zone for dune shrub (pohuehue, mingimingi, manuka, flax and cabbage trees) was before the area was developed but the true sanddune forest community with pohutukawa (*Meterosideros excelsa*) as the dominant tree species almost certainly existed westward of the present Buffalo Beach Road alignment.

No fatal flaws are anticipated with the beach nourishment proposal in terms of the recolonisation of the low diversity and low abundance of open beach communities currently present in the intertidal zone of the Study Area. Most intertidal species present in the Study Area are expected to survive burial with up to 0.6 m depth of coarse clean sand or to rapidly recolonise the area (within 3 - 4 months) from adjacent undisturbed habitat following a beach nourishment event.

The development of residential properties between Buffalo Beach Road and the existing seawall appears to have displaced an area of foredune grasses and possibly the *Cassinia* zone of a natural sand dune community.

The existing seawall has been constructed within that zone where fore dunes and their associated sand dune grasses would normally migrate in response to medium to long term erosion and accretion events.

At this time, as the constructed seawall is seaward of the undisturbed foredune communities to the south, it is clearly a physical obstacle to the natural inland migration of foredune communities within the Study Area.

It is more difficult to speculate on the effect(s) of the constructed seawall during any future period of general accretion (seaward migration of foredune communities in the area). One hypothesis is that foredune communities may form to seaward of the constructed seawall at the time such communities to the south of the constructed seawall migrate seaward past the position of the constructed seawall.

Colour Plates (cover plate: eroded foreshore dunes to the south of the seawall as of October 2001).

Plate 1: View from southern end of the seawall to the north showing contoured sand up to the top of the wall as of October 2001.

Plate 2: View from north to south along the wall showing "wetter" (muddier) intertidal zone in front of the northern section of wall as of October 2001.

Plate 3: Rip rap in front of the middle and northern section of the sea wall.

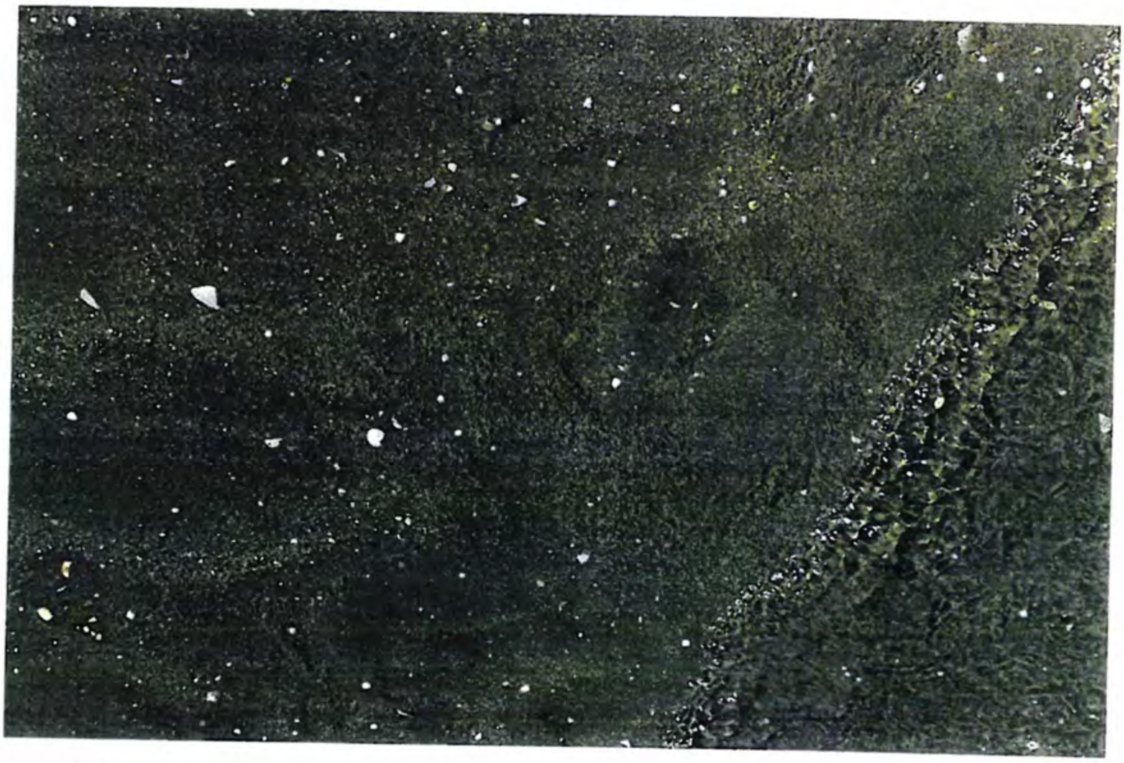


Plate 4: Flocculent organic matter sourced from a freshwater stream discharging into Mercury Bay on the northern side of the seawall.

2.0. Introduction

The Meritec Group Limited is currently preparing a consent application for an existing seawall and for a beach nourishment regime (initial beach nourishment of 10,000m^3) to provide for the protection of residential properties on the foreshore of Buffalo Beach, Mercury Bay, Whitianga (see Figures 1 and 2). We understand sand for the beach nourishment programme will be sourced from the Whitianga Waterways Project.

Our subcontracting brief from Meritec was to provide:

- a footprint survey of area where beach nourishment is proposed and comment on what may have been in the area now occupied by the existing seawall erected by property owners.
- advise on the ability of the organisms identified to withstand burial.
- comment on recolonisation of the area following the beach nourishment action(s)
- a description of the existing ecological environment of the study area and a commentary of the effects of beach nourishment and the placement of the seawall.

3.0 Methods and Approach

Quantitative survey work was undertaken on 17 October 2001.

Methodology used for surveying beach and subtidal sites was generally consistent with guidelines recommended by the Department of Conservation for 3rd order Coastal Resource Inventories[1].

A sketch map of the study area (see Figure 3) was overlain by the NZ map grid projection[2] to enable position fixing with a 12 channel GPS receiver[3] and / or triangulation from surrounding landmarks.

A chart-recording echo-sounder (Furuno 450) mounted in a power boat was used to produce a plot of water depth along each of echo-sounding profiles A, B and C. Water depths were corrected for water level at 1200 hours on 17 October 2001.

On the basis of a constant boat speed along each echo-sounding profile, each echo-sounding profile was scaled to the distance covered to provide a scaled depth profile.

Benthos (both surface dwelling organisms and infauna) were described at each of the 16 sampling sites shown in Figure 3 on the basis of 5 randomised Cofkyd scoop samples. The Cofkyd scoop takes a 40 cm long box-section sample of surficial sediments where the box section is 12 cm x 12 cm (surface area of 0.048 m^2). Subtidal Sampling Sites AS2, AS3, BS2, BS3, CS2, and CS3 were sampled by a SCUBA diver. Subtidal sampling Sites AS1, BS1 and CS1 and intertidal Sampling Sites AI1, AI2, AI3, BI1, BI2, BI3, CI1, CI2 and CI3 were sampled at low tide on the afternoon of 17 October 2001.

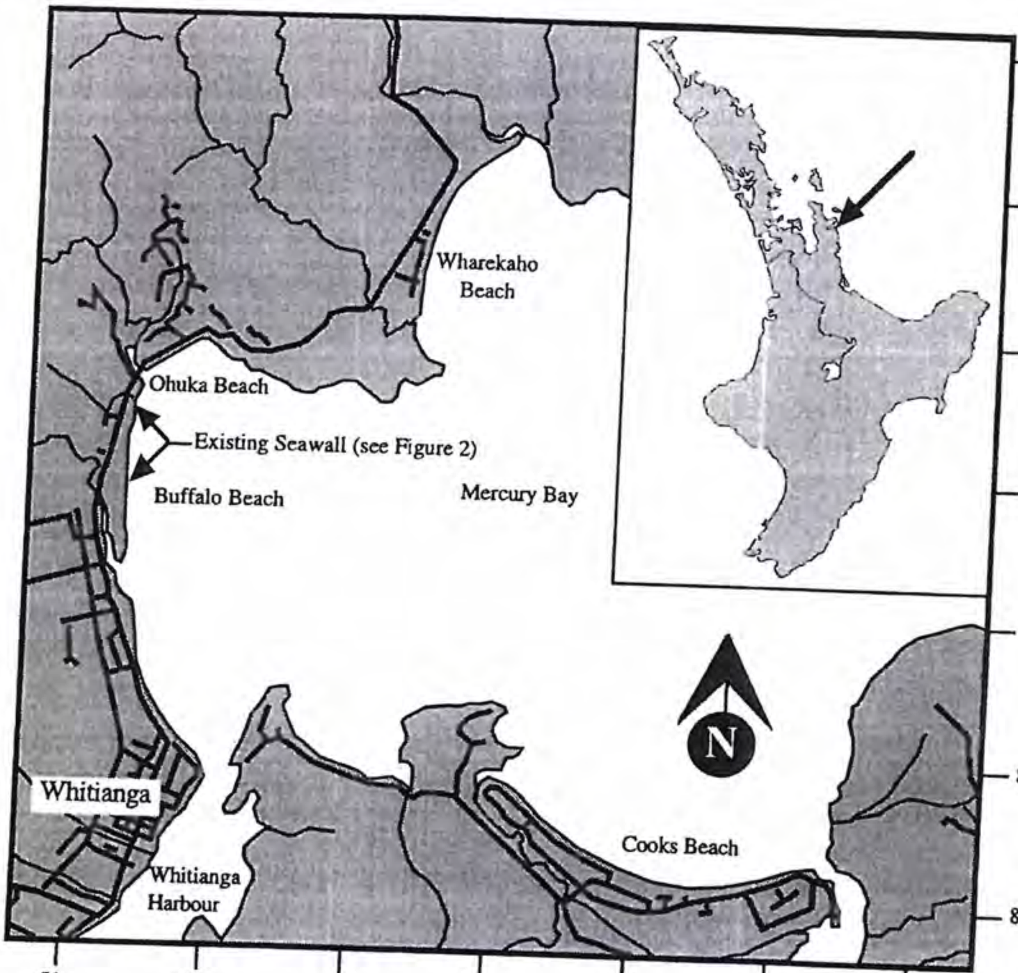
Biological taxa were separated from each sample using a 0.5 mm sorting tray. Specimens recovered from each quadrat were preserved in isopropyl alcohol in labelled containers of an appropriate size and returned to the laboratory for identification and counting.

1

2 Geodetic Datum 1949. International Spheroid.

3 Eagle™ Explorer

Figure 1: Locality Sketch for Study Area.



Map refs. per NZMS 260: T11, Whitianga.

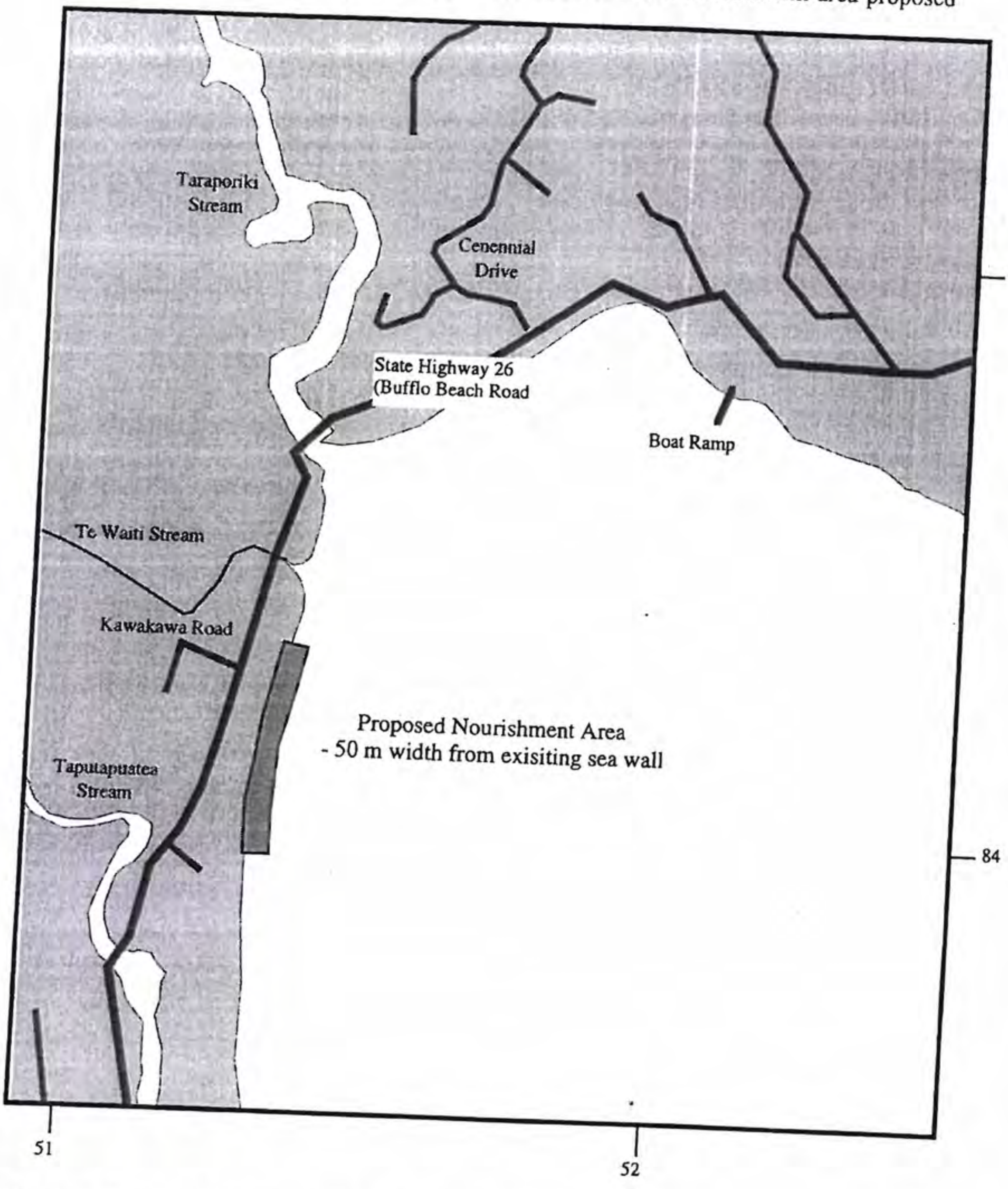
Field staff also recorded the presence of macrobiota present on the surface of the seabed in the vicinity of each sampling site. In the case of the swimming crab *Ovalipes catharus*, a diver reported disturbance of these animals when using the CofKyd scoop at each subtidal sampling site.

Line transect analysis was used to describe surficial features of the intertidal zone from the seawall to the low tide mark at the three localities shown in Figure 3.

4.0 Results and Discussion

Rip rap associated with the sea wall extends 30 m northward from residential property boundaries to front a reserve area to the south of the mouth of the Te Waiti Stream. The northern boundary of this rip rap is 376 m from the southern tow of the constructed sea wall. The form of the precast blocks used for the primary construction of the seawall is shown in Plate 3 and the Cover Plate.

Figure 2 Inset for Figure 1 showing position of beach nourishment area proposed

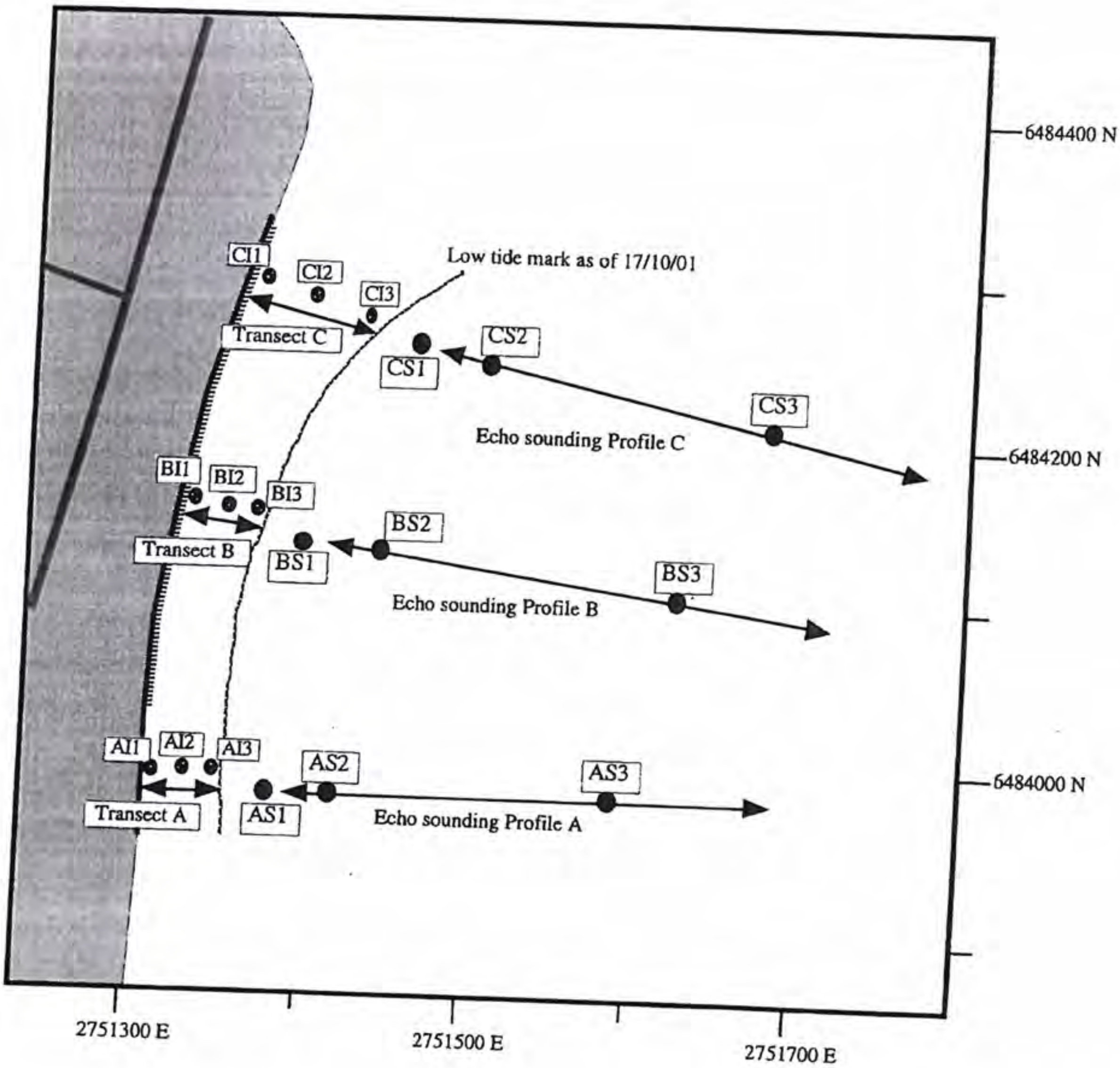


The central and northern sections of the existing seawall are 1.5 m above the level of the upper beach. They have a 4 m wide lining of rip rap (up to 1m diameter rocks - see Plates 2 and 3) on their seaward side and local residents have used a variety of material such as hay bales to support this structure on its landward side.

The southern section of the seawall is not supported by rip rap on its seaward side and the upper beach profile has contoured up to the top of the wall (see Plate 1).

Dune erosion to the south of the existing wall is shown in the Cover Plate.

Figure 3: Location of Echo-sounding Profiles (A, B and C), Intertidal Line Transects (A, B and C) low tide mark as of 17/10/01 and the 16 benthic sampling sites used for a footprint survey of the Study Area



A scaled depth profile for each of echo sounding profiles A, B and C, offshore of the Study Area is presented in Figure 4.

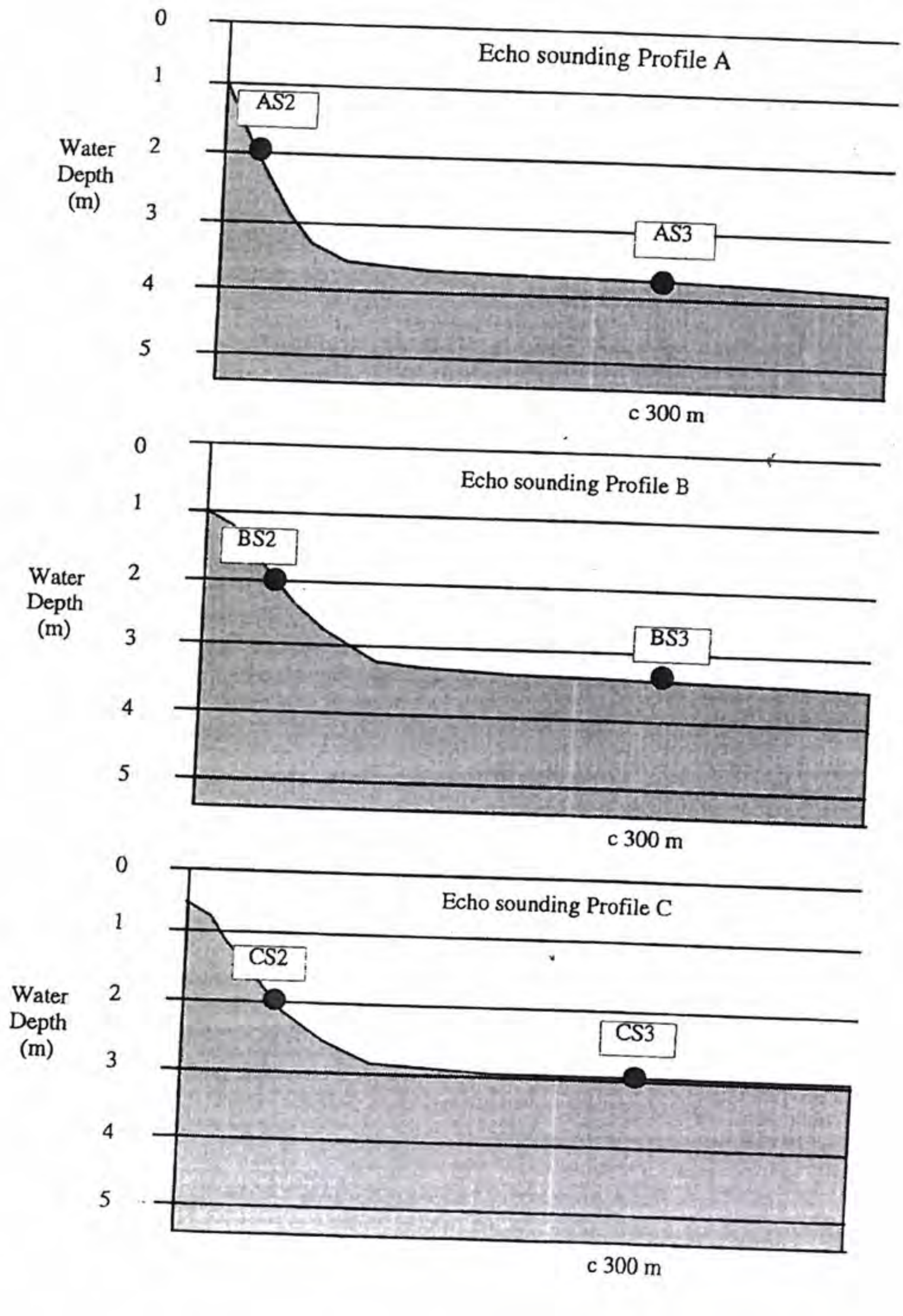
Line transect data for each of intertidal transects A, B and C are summarised in Appendix A.

Cofkyd scoop data for each of the 16 sampling sites shown in Figure 3 are summarised in Appendix B.

There was a relatively uniform fall across the middle and lower intertidal zones to low water level at each of Transects A, B and C (see Colour Plates 1 and 2).

Below the low water mark offshore of the Study Area there was a rapid drop off to a relatively flat seabed at 3 - 4m depth offshore of Transect A (see echo sounding profile A, Figure 4) and 3m depth offshore of Transect C (see echo sounding profile C, Figure 4) with an intermediate depth offshore of Transect B (see echo sounding profile B, Figure 4).

Figure 4: A scaled depth profile for each of echo sounding profiles A, B and C, offshore of the Study Area showing depth of Subtidal Sampling Sites AS2, AS3, BS2, BS3, CS2 and CS3 which were sampled by a SCUBA diver. Sampling Sites AS3, BS3 and CS3 were 290 - 310 m offshore of the existing seawall.



This reflected the proximity of Transect C and echo sounding profile C to Ohuka Beach relative to Transect A and echo sounding profile A (see Figure 1).

No visually obvious macrobiota were recorded along Transects A, B and C (see Appendix A) or at Sampling sites AI1, AI2, AI3, BI1, BI2, BI3, CI1, CI2 or CI3.

The paddle crab *Ovalipes catharus* was observed (disturbed) by divers at Sampling Sites BS2, CS2, AS3, BS3 and CS3 (see Appendix B).

A low density of the polychaete *Aglaophamus macroura*, the sea lice *Cirolana arcuata* and *Isocladus amartus*, the amphipod *Haustorius sp.*, the burrowing amphipod *Paracocophium excuvatum*, the sea slater *Scyphax ornatus*, the pill bug *Sphaeroma quoyana* and the sand hopper *Talorchestia chiliensis* were sieved from sediment samples at upper intertidal sampling sites (Sampling Sites AI1, BI1 and CI1 - see Appendix B).

A low density of *Aglaophamus macroura*, *Cirolana arcuata* the polychaete *Glycera americana* and *Orbinia papillosa*, *Haustorius sp.*, *Isocladus amartus*, the worms *Pseudonerine sp.* and *Traveria olens*, *Scyphax ornatus*, the nemertean *Sipunculus sp.* *Sphaeroma quoyana and Talorchestia chiliensis* were sieved from sediment samples at mid intertidal sampling sites (Sampling Sites AI2, BI2 and CI2 - see Appendix B)

A low density of *Aglaophamus macroura*, *Cirolana arcuata*, *Glycera americana*, *Haustorius sp.*, *Orbinia papillosa*, the common shrimp *Palaemon affinis*, the tuatua *Paphies subtriangulata*, *Pseudonerine sp.*, the ghost shrimp *Callinanassa filholi*, and the worm *Traveria olens* were sieved from sediment samples at low intertidal sampling sites (Sampling Sites AI3, BI3 and CI3 - see Appendix B).

A larva of a freshwater beetle (Elmid) was also present at Sampling Site BI3. This was almost certainly sourced from freshwater inflows from Te Waiti / Taraporiki Streams and divers also reported freshwater on the seabed at subtidal sampling sites. Similar material was present within the intertidal zone of the Study Area (see Plate 4).

A low density of *Aglaophamus macroura*, *Cirolana arcuata*, *Glycera americana*, the nut shell *Nuclea hartvigiana*, *Orbinia papillosa*, the hermit crab *Pagurus novaezelandiae*, *Palaemon affinis*, the tuatua *Paphies subtriangulata* and *Traveria olens* were sieved from sediment samples at shallow subtidal sampling sites (Sampling Sites AS1, BS1 and CS1 - see Appendix B).

A low density of *Aglaophamus macroura*, *Glycera americana*, *Nuclea hartvigiana*, *Orbinia papillosa*, *Pagurus novaezelandiae*, *Palaemon affinis*, *Paphies subtriangulata*, *Ovalipes catharu*, the morning star shell *Tawera spissa* and *Traveria olens* were sieved from subtidal sediment samples 300 m offshore of the Study Area (Sampling Sites AS3, BS3 and CS3 - see Appendix B)..

5.0 Discussion

The Study Area was typical of an exposed sand beach in northern New Zealand which is typically low in biodiversity. There are a limited number of animals which are adapted to cope with the mobile substrate associated with wave action (and at times strong winds) which constantly resort sand - shell deposits along such shorelines. Infauna must continually re-embed themselves or at least repair their temporary burrows. De-watered intertidal substrate is typically difficult for larger animals to burrow into because of the low water content and large size of the particles; but such firmness makes it easy to crawl on. Little organic matter is present in de-watered intertidal sediments and water (and oxygen) circulation is high. As a result the anoxic layer is usually deep and a low organic content means that larger deposit feeders are rare

The profile of open sandy beaches changes quite markedly on a seasonal basis in response to exposure conditions with high rates of sand removal being associated with storm events.

The following zonation of New Zealand's open sandy beaches which is based on small burrowing crustaceans (Morton and Miller, 1968) was consistent with the zonation present within the study area.

- Two small crustaceans are the primary colonisers of the upper shore: a sandhopper *Talorchestia quoyana* and a sea slater (isopod) *Scyphax ornatus*.
- Eurydicid isopods and Haustoriid amphipods are generally characteristic of the middle beach.
- Haustoriid amphipods, the paddle crab *Ovalipes catharus* and the ghost shrimp *Callinanassa filholi* are generally characteristic of the lower beach.

A harvestable bed of tuatua (Paphies subtriangulata) was present in shallow subtidal sediments of the study area and the nut shell (*Nuclea hartvigiana*) and morning star shell (*Tawera spissa*) were present in offshore sediments at a depth of 3 - 4 metres.

Whilst relatively intact shell material of other bivalves (*Mactra discors, Panopea zelandica, Myadora striata, Angulus gaimardi, Zenatia acinaces, Resania lanceolata Spisula aequilatera, Bassina yatei, Dosinia anus, Paphies australis, Perna canaliculus* and *Austrovenus stutchburyi*) and univalves (*Zethalia zelandica, Calliostoma selectum, Stuthiolaria spp., Austrofucus glans, Xymene ambiguous, Phenatoma rosea, Cirsotrema zelebori, Sigapatella sp.* and *Semicassis pyrum*) were present on the beach, no live specimens of these taxa were collected within the study area.

It appears likely (from a comparison of dune vegetation in the vicinity of the Study Area) that the residential dwellings between Buffalo Beach Road and the existing seawall have been developed on an area of foredunes (although it may have included a range of sand-fixing shrubs such as *Coprosma acerosa, Pimelea arenaria, Cassinia spp.* and *Lupinus arboreus* behind dune grasses).

It is not immediately obvious where the most likely zone for dune shrub (pohuehue, mingimingi, manuka, flax and cabbage trees) was before the area was developed but the true sanddune forest community with pohutukawa (*Meterosideros excelsa*) as the dominant tree species almost certainly existed westward of the present Buffalo Beach Road alignment.

No fatal flaws are anticipated with the beach nourishment proposal in terms of the recolonisation of the low diversity and low abundance of open beach communities currently present in the intertidal zone of the Study Area. Most intertidal species present in the Study Area are expected to survive burial with up to 0.6 m depth of coarse clean sand or to rapidly recolonise the area (within 3 - 4 months) from adjacent undisturbed habitat following a beach nourishment event.

The development of residential properties between Buffalo Beach Road and the existing seawall appears to have displaced an area of foredune grasses and possibly the *Cassinia* zone of a natural sand dune community.

The existing seawall has been constructed within that zone where fore dunes and their associated sand dune grasses would normally migrate in response to medium to long term erosion and accretion events.

At this time, as the constructed seawall is seaward of the undisturbed foredune communities to the south, it is clearly a physical obstacle to the natural inland migration of foredune communities within the Study Area.

It is more difficult to speculate on the effect(s) of the constructed seawall during any future period of general accretion (seaward migration of foredune communities in the area). One hypothesis is that foredune communities may form to seaward of the constructed seawall at the time such communities to the south of the constructed seawall migrate seaward past the position of the constructed seawall.

6.0 References

Department of Conservation, 1991: Second and Third Order Marine Survey Guidelines. - unpublished adaptation from C. Battershill's and C. Hay's Protocols for Marine Community and Ecological Surveys (in press). File Reference COA 026 CMR-001, Department of Conservation, P.O. Box 10 420 Wellington.

Morton, J. and Miller M., 1968: The New Zealand Sea Shore. Collins (Pub).London-Auckland.

Appendix A: Line Transect Data

Location Buffalo Beach, Whitianga	Date: 17 October, 2001	Recorder: BTC
Aerial Photograph refs.: -	Map refs.: see Figures 1 and 3	Grid ref.: see Figures 1 and 3
Transect No.: Line Transect A	Transect Bearing: 71° magnetic / ~~true~~	Length of Transect: 60 m
Site description (photograph refs) to re-locate transect marker on shoreline Eastern end of property protection wall at Buffalo Beach as of 17/10/01 (see Figure 3)		

CC = Cover Class		*Substrate*		*A = Abundance (.m⁻²)*	
1 = a little	*1- 5%*	*r / = bed rock / type*		*v = very abundant*	*(> 500*
2 = some	*6- 30%*	*b = boulders*	*(>256 mm)*	*a = abundant*	*(20 - 500)*
3 = nearly half	*31- 50%*	*c = cobbles - pebbles*	*(2 - 256 mm)*	*c = common*	*(6- 19)*
4 = more than half	*51- 75%*	*s = sand*	*(<2mm)*	*o = occasional*	*(<5)*
5 = almost all	*76 - 100%*	*m = mud - silt*	*(no visible grains)*		
		sh = dead shell debris			

Distance (m) along Transect	Water Depth (m)	Substrate	Vegetation Cover Class	Macroscopic Plants taxa	height (m)	CC	Macroscopic Animals taxa	A
0	-	top of concrete wall	0	no visually obvious maroflora			no visually obvious macrofauna	
0 - 5	-	sand wedge to top of concrete wall (no rip rap) drift line with wood and shell over dry sand	0	no visually obvious maroflora			no visually obvious macrofauna	
5 - 15	-	firm dry sand and 10% shell cover	0	no visually obvious maroflora			no visually obvious macrofauna	
15 - 44		60% shell cover over firm dry sand	0	no visually obvious maroflora			no visually obvious macrofauna	
44 - 60		80% shell cover over firm dry sand	0	no visually obvious maroflora			no visually obvious macrofauna	
60 m	low tide mark	40% shell cover over firm sand	0	no visually obvious maroflora			no visually obvious macrofauna	

Appendix A: Line Transect Data

Location Buffalo Beach, Whitianga	Date: 17 October, 2001	Recorder: BTC
Aerial Photograph refs.: -	Map refs.: see Figures 1 and 3	Grid ref.: see Figures 1 and 3
Transect No.: Line Transect B	Transect Bearing: 80° magnetic / ~~true~~	Length of Transect: 65 m
Site description (photograph refs) to re-locate transect marker on shoreline Middle of property protection wall at Buffalo Beach as of 17/10/01 (see Figure 3)		

CC = Cover Class		*Substrate*		*A = Abundance (.m⁻²)*	
1 = a little	*1- 5%*	*r / = bed rock / type*		*v = very abundant*	*(> 500*
2 = some	*6- 30%*	*b = boulders*	*(>256 mm)*	*a = abundant*	*(20 - 500)*
3 = nearly half	*31 - 50%*	*c = cobbles - pebbles*	*(2 - 256 mm)*	*c = common*	*(6- 19)*
4 = more than half	*51 - 75%*	*s = sand*	*(<2mm)*	*o = occasional*	*(<5)*
5 = almost all	*76 - 100%*	*m = mud - silt*	*(no visible grains)*		
		sh = dead shell debris			

Distance (m) along Transect	Water Depth (m)	Substrate	Vegetation Cover Class	Macroscopic Plants taxa	height (m)	CC	Macroscopic Animals taxa	A
0	-	top of concrete wall	0	no visually obvious maroflora			no visually obvious macrofauna	
0 - 4	- 1.5 m drop from top of wall to upper each	b coarse rip rap	0	no visually obvious maroflora			no visually obvious macrofauna	
4 - 11	-	firm sand and 5% shell cover drift line with wood and shell over firm dry sand	0	no visually obvious maroflora			no visually obvious macrofauna	
11 - 40		wet sand	0	no visually obvious maroflora			no visually obvious macrofauna	
45 - 65		20% shell cover over uniform relatively soft wet sand	0	no visually obvious maroflora			no visually obvious macrofauna	
65 m	low tide mark	40% shell cover over sand	0	no visually obvious maroflora			no visually obvious macrofauna	

Appendix A: Line Transect Data

Location: Buffalo Beach, Whitianga	Date: 17 October, 2001	Recorder: BTC
Aerial Photograph refs.: -	Map refs.: see Figures 1 and 3	Grid ref.: see Figures 1 and 3
Transect No.: Line Transect C	Transect Bearing: 85° magnetic / ~~true~~	Length of Transect: 100 m
Site description (photograph refs) to re-locate transect marker on shoreline: Western end of property protection wall at Buffalo Beach as of 17/10/01 (see Figure 3)		

CC = Cover Class		*Substrate*		*A = Abundance (.m^{-2})*	
1 = a little	*1- 5%*	*r / = bed rock / type*		*v = very abundant*	*(> 500*
2 = some	*6- 30%*	*b = boulders*	*(>256 mm)*	*a = abundant*	*(20 - 500)*
3 = nearly half	*31 - 50%*	*c = cobbles - pebbles*	*(2 - 256 mm)*	*c = common*	*(6- 19)*
4 = more than half	*51 - 75%*	*s = sand*	*(<2mm)*	*o = occasional*	*(<5)*
5 = almost all	*76 - 100%*	*m = mud - silt*	*(no visible grains)*		
		sh = dead shell debris			

Distance (m) along Transect	Water Depth (m)	Substrate	Vegetation Cover Class	Macroscopic Plants taxa	height (m)	CC	Macroscopic Animals taxa	A
0	-	top of concrete wall	0	no visually obvious maroflora			no visually obvious macrofauna	
0 - 5	- 1.5 m drop from top of wall to upper beach	b coarse rip rap	0	no visually obvious maroflora			no visually obvious macrofauna	
5 - 11	-	firm fine sand and 10% shell cover drift line with wood and shell over dry sand	0	no visually obvious maroflora			no visually obvious macrofauna	
11 - 100		uniform relatively soft wet sand	0	no visually obvious maroflora			no visually obvious macrofauna	
100		5% shell cover over uniform relatively soft wet sand	0	no visually obvious maroflora			no visually obvious macrofauna	

Sampling Site AI1 (upper intertidal, Site A)								
Animals	common names	rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete							
Cirolana arcuata	sea louse							
Haustorius sp.	amphipod							
Isocladus amartus	sea louse							
Paracocophium excuvatum	burrowing amphipod	0	0	0	0	2	*0.4*	*0.89*
Scyphax ornatus	sea slater	2	0	0	2	0	*0.8*	*1.10*
Sphaeroma quoyana	pill bug	3	0	0	0	1	*0.8*	*1.30*
Talorchestia chiliensis	sand hopper	6	9	4	11	5	*7.0*	*2.92*

Sampling Site BI1 (upper intertidal, Site B)								
Animals	common names	rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete							
Cirolana arcuata	sea louse	0	0	0	0	2	*0.4*	*0.89*
Haustorius sp.	amphipod	0	1	0	0	0	*0.2*	*0.45*
Isocladus amartus	sea louse	0	0	0	2	0	*0.4*	*0.89*
Paracocophium excuvatum	burrowing amphipod	1	0	0	0	0	*0.2*	*0.45*
Scyphax ornatus	sea slater	0	2	0	2	0	*0.8*	*1.10*
Sphaeroma quoyana	pill bug							
Talorchestia chiliensis	sand hopper	10	3	7	2	6	*5.6*	*3.21*

Sampling Site CI1 (upper intertidal, Site C)								
Animals	common names	rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	0	1	0	0	0	*0.2*	*0.45*
Cirolana arcuata	sea louse	0	0	0	2	0	*0.4*	*0.89*
Haustorius sp.	amphipod							
Isocladus amartus	sea louse	0	0	0	0	1	*0.2*	*0.45*
Paracocophium excuvatum	burrowing amphipod	0	4	0	0	1	*1.0*	*1.73*
Scyphax ornatus	sea slater	1	3	0	0	2	*1.2*	*1.30*
Sphaeroma quoyana	pill bug							
Talorchestia chiliensis	sand hopper	7	3	8	11	6	*7.0*	*2.92*

	Sampling Site AI2 (mid intertidal, Site A)							
Animals	common names	rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	0	0	0	1	0	*0.2*	*0.45*
Cirolana arcuata	sea louse	0	4	0	2	0	*1.2*	*1.79*
Glycera americana	polychaete	0	0	1	0	0	*0.2*	*0.45*
Haustorius sp.	amphipod							
Isocladus amartus	sea louse	3	3	0	0	3	*1.8*	*1.64*
Orbinia papillosa	polychaete							
Pseudonerine sp.	worm							
Scyphax ornatus	sea slater	0	0	0	0	1	*0.2*	*0.45*
Sipunculus sp.	nemertean	0	1	0	1	0	*0.4*	*0.55*
Sphaeroma quoyana	pill bug	0	0	0	2	0	*0.4*	*0.89*
Talorchestia chiliensis	sand hopper							
Traveria olens	worm	0	0	0	1	1	*0.4*	*0.55*

	Sampling Site BI2 (mid intertidal, Site B)							
Animals	common names	rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	0	1	0	0	0	*0.2*	*0.45*
Cirolana arcuata	sea louse	2	0	0	2	3	*1.4*	*1.34*
Glycera americana	polychaete	1	1	0	0	0	*0.4*	*0.55*
Haustorius sp.	amphipod							
Isocladus amartus	sea louse	2	0	0	3	0	*1.0*	*1.41*
Orbinia papillosa	polychaete							
Pseudonerine sp.	worm	1	0	2	1	0	*0.8*	*0.84*
Scyphax ornatus	sea slater							
Sipunculus sp.	nemertean	0	0	1	1	0	*0.4*	*0.55*
Sphaeroma quoyana	pill bug	3	4	2	4	2	*3.0*	*1.00*
Talorchestia chiliensis	sand hopper	4	0	2	3	0	*1.8*	*1.79*
Traveria olens	worm	0	1	1	0	0	*0.4*	*0.55*

	Sampling Site CI2 (mid intertidal, Site C)							
Animals	common names	rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	0	1	0	0	1	*0.4*	*0.55*
Cirolana arcuata	sea louse	0	2	0	3	0	*1.0*	*1.41*
Glycera americana	polychaete	0	1	1	0	1	*0.6*	*0.55*
Haustorius sp.	amphipod	3	0	2	2	0	*1.4*	*1.34*
Isocladus amartus	sea louse	0	3	0	4	0	*1.4*	*1.95*
Orbinia papillosa	polychaete	0	0	0	1	0	*0.2*	*0.45*
Pseudonerine sp.	worm	0	3	0	2	0	*1.0*	*1.41*
Scyphax ornatus	sea slater	0	0	1	0	0	*0.2*	*0.45*
Sipunculus sp.	nemertean	0	1	0	0	2	*0.6*	*0.89*
Sphaeroma quoyana	pill bug	0	2	3	0	0	*1.0*	*1.41*
Talorchestia chiliensis	sand hopper	0	1	2	6	0	*1.8*	*2.49*
Traveria olens	worm	0	1	0	0	1	*0.4*	*0.55*

Appendix B: Quadrat Data

Animals	common names	Sampling Site AI3 (lower intertidal, Site A)						
		rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	0	2	0	2	0	*0.8*	*1.10*
Cirolana arcuata	sea louse							
Elmidae (larvae)	f.w. beetle larvae							
Glycera americana	polychaete	1	0	1	0	2	*0.8*	*0.84*
Haustorius sp.	amphipod	0	0	0	1	0	*0.2*	*0.45*
Orbinia papillosa	polychaete	2	1	0	1	0	*0.8*	*0.84*
Palaemon affinis	common shrimp							
Paphies subtriangulata	tuatua							
Pseudonerine sp.	worm							
Callinanassa filholi	ghost shrimp							
Traveria olens	worm	1	0	1	0	0	*0.4*	*0.55*

Animals	common names	Sampling Site BI3 (lower intertidal, Site B)						
		rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	0	1	0	2	0	*0.6*	*0.89*
Cirolana arcuata	sea louse							
Elmidae (larvae)	f.w. beetle larvae	0	0	1	0	0	*0.2*	*0.45*
Glycera americana	polychaete	1	1	0	0	0	*0.4*	*0.55*
Haustorius sp.	amphipod							
Orbinia papillosa	polychaete	1	0	2	0	0	*0.6*	*0.89*
Palaemon affinis	common shrimp	1	0	0	0	0	*0.2*	*0.45*
Paphies subtriangulata	tuatua							
Pseudonerine sp.	worm							
Callinanassa filholi	ghost shrimp							
Traveria olens	worm	0	1	0	0	0	*0.2*	*0.45*

Animals	common names	Sampling Site CI3 (lower intertidal, Site C)						
		rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	0	0	1	0	2	*0.6*	*0.89*
Cirolana arcuata	sea louse	0	1	0	0	0	*0.2*	*0.45*
Elmidae (larvae)	f.w. beetle larvae							
Glycera americana	polychaete	0	0	2	0	1	*0.6*	*0.89*
Haustorius sp.	amphipod	2	0	1	1	0	*0.8*	*0.84*
Orbinia papillosa	polychaete	2	0	1	0	0	*0.6*	*0.89*
Palaemon affinis	common shrimp							
Paphies subtriangulata	tuatua	0	0	0	1	0	*0.2*	*0.45*
Pseudonerine sp.	worm	0	0	1	0	0	*0.2*	*0.45*
Callinanassa filholi	ghost shrimp	0	0	0	0	1	*0.2*	*0.45*
Traveria olens	worm	0	2	0	2	0	*0.8*	*1.10*

Animals	common names	Sampling Site AS2 (subtidal 2 m, Site A)						
		rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	0	1	0	0	0	*0.2*	*0.45*
Glycera americana	polychaete	1	0	1	0	1	*0.6*	*0.55*
Nuclea hartvigiana	nut shell							
Orbinia papillosa	polychaete	3	0	1	1	0	*1.0*	*1.22*
Ovalipes catharus	paddle crab							
Pagurus novaezelandiae	hermit crab							
Palaemon affinis	common shrimp	0	2	0	0	1	*0.6*	*0.89*
Paphies subtriangulata	tuatua	1	0	1	0	0	*0.4*	*0.55*
Traveria olens	worm							

Animals	common names	Sampling Site BS2 (subtidal 2 m, Site B)						
		rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	0	1	0	0	0	*0.2*	*0.45*
Glycera americana	polychaete	0	1	1	0	0	*0.4*	*0.55*
Nuclea hartvigiana	nut shell	1	2	0	2	0	*1.0*	*1.00*
Orbinia papillosa	polychaete	2	1	0	1	0	*0.8*	*0.84*
Ovalipes catharus	paddle crab							
Pagurus novaezelandiae	hermit crab					p		
Palaemon affinis	common shrimp	0	0	0	1	0	*0.2*	*0.45*
Paphies subtriangulata	tuatua	0	1	0	0	0	*0.2*	*0.45*
Traveria olens	worm	0	0	0	0	1	*0.2*	*0.45*

Animals	common names	Sampling Site CS2 (subtidal 2 m, Site C)						
		rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete							
Glycera americana	polychaete	1	0	0	0	1	*0.4*	*0.55*
Nuclea hartvigiana	nut shell	0	2	0	0	1	*0.6*	*0.89*
Orbinia papillosa	polychaete	0	1	0	1	0	*0.4*	*0.55*
Ovalipes catharus	paddle crab		p					
Pagurus novaezelandiae	hermit crab	0	0	1	0	0	*0.2*	*0.45*
Palaemon affinis	common shrimp	0	1	0	0	0	*0.2*	*0.45*
Paphies subtriangulata	*tuatua*	*0*	*1*	*0*	*0*	*0*	*0.2*	*0.45*
Traveria olens	worm	0	2	0	1	0	*0.6*	*0.89*

Appendix B: Quadrat Data

Animals	Sampling Site AS3 (subtidal flats 300 m offshore)							
	common names	rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	1	0	0	2	1	*0.8*	*0.84*
Glycera americana	polychaete	0	1	0	1	0	*0.4*	*0.55*
Nuclea hartvigiana	nut shell	3	0	1	4	0	*1.6*	*1.82*
Orbinia papillosa	polychaete	0	3	1	0	1	*1.0*	*1.22*
Ovalipes catharus	paddle crab		p					
Pagurus novaezelandiae	hermit crab	0	0	0	1	0	*0.2*	*0.45*
Palaemon affinis	common shrimp	0	0	0	0	2	*0.4*	*0.89*
Tawera spissa	morning star shell	0	0	0	2	0	*0.4*	*0.89*
Traveria olens	worm							

Animals	Sampling Site BS3 (subtidal flats 300 m offshore)							
	common names	rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	1	0	2	0	0	*0.6*	*0.89*
Glycera americana	polychaete	0	0	0	1	0	*0.2*	*0.45*
Nuclea hartvigiana	nut shell	3	1	4	0	1	*1.8*	*1.64*
Orbinia papillosa	polychaete	2	0	1	0	0	*0.6*	*0.89*
Ovalipes catharus	paddle crab				p			
Pagurus novaezelandiae	hermit crab	0	0	0	0	2	*0.4*	*0.89*
Palaemon affinis	common shrimp	0	0	0	2	0	*0.4*	*0.89*
Tawera spissa	morning star shell	0	0	1	0	1	*0.4*	*0.55*
Traveria olens	worm	1	0	0	0	0	*0.2*	*0.45*

Animals	Sampling Site CS3 (subtidal flats 300 m offshore)							
	common names	rep#1	rep#2	rep#3	rep#4	rep#5	average	stdev
Aglaophamus macroura	polychaete	0	1	0	0	0	*0.2*	*0.45*
Glycera americana	polychaete	1	0	1	2	0	*0.8*	*0.84*
Nuclea hartvigiana	nut shell	2	1	3	2	0	*1.6*	*1.14*
Orbinia papillosa	polychaete	0	3	0	1	0	*0.8*	*1.30*
Ovalipes catharus	paddle crab	p		p				
Pagurus novaezelandiae	hermit crab	0	0	1	0	0	*0.2*	*0.45*
Palaemon affinis	common shrimp	0	2	0	2	0	*0.8*	*1.10*
Tawera spissa	morning star shell	0	1	0	0	0	*0.2*	*0.45*
Traveria olens	worm	0	0	1	1	0	*0.4*	*0.55*