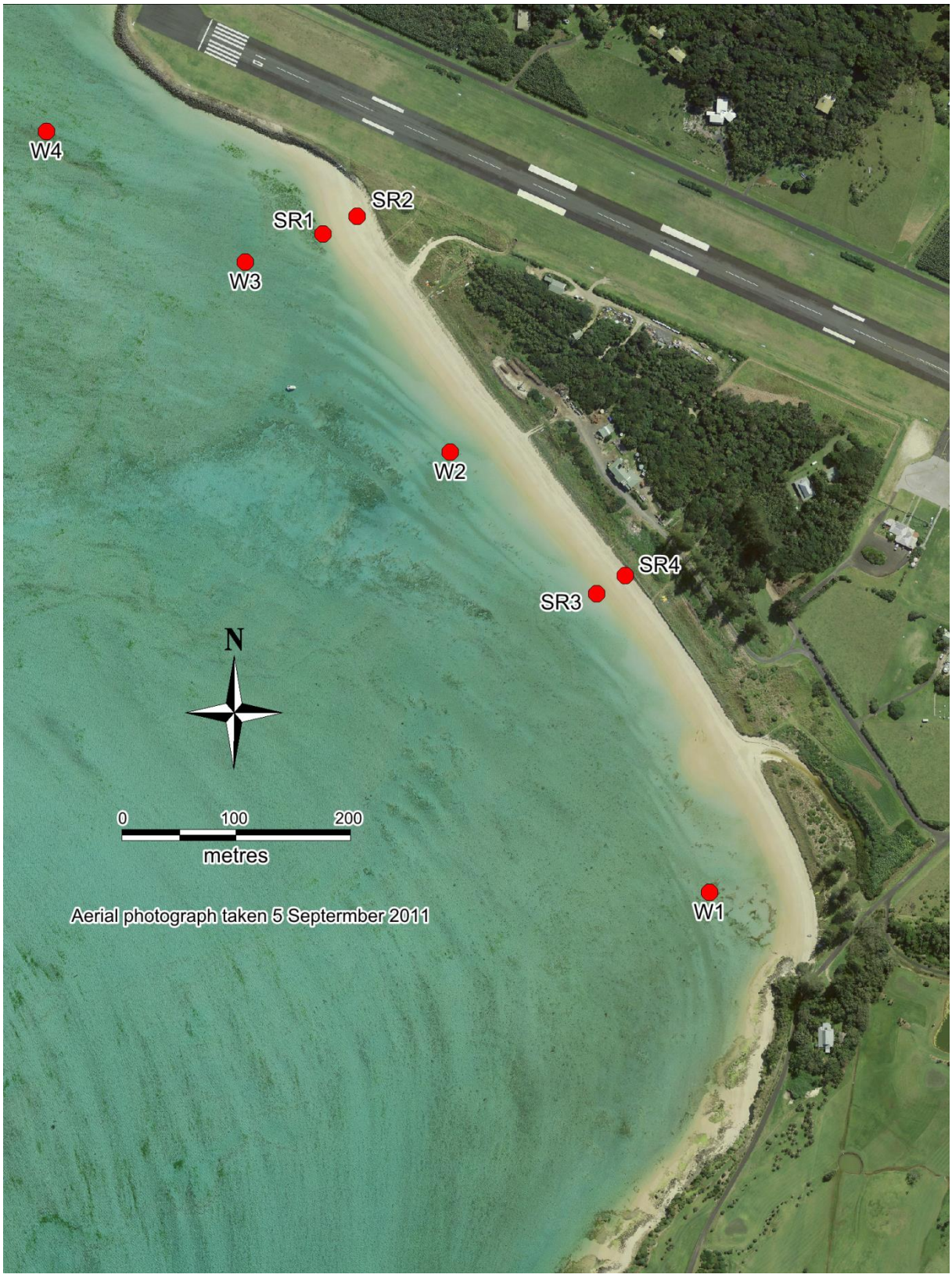

Figure C2: South Runway (Cobbys) Beach and southern Lagoon waterway sediment sampling locations

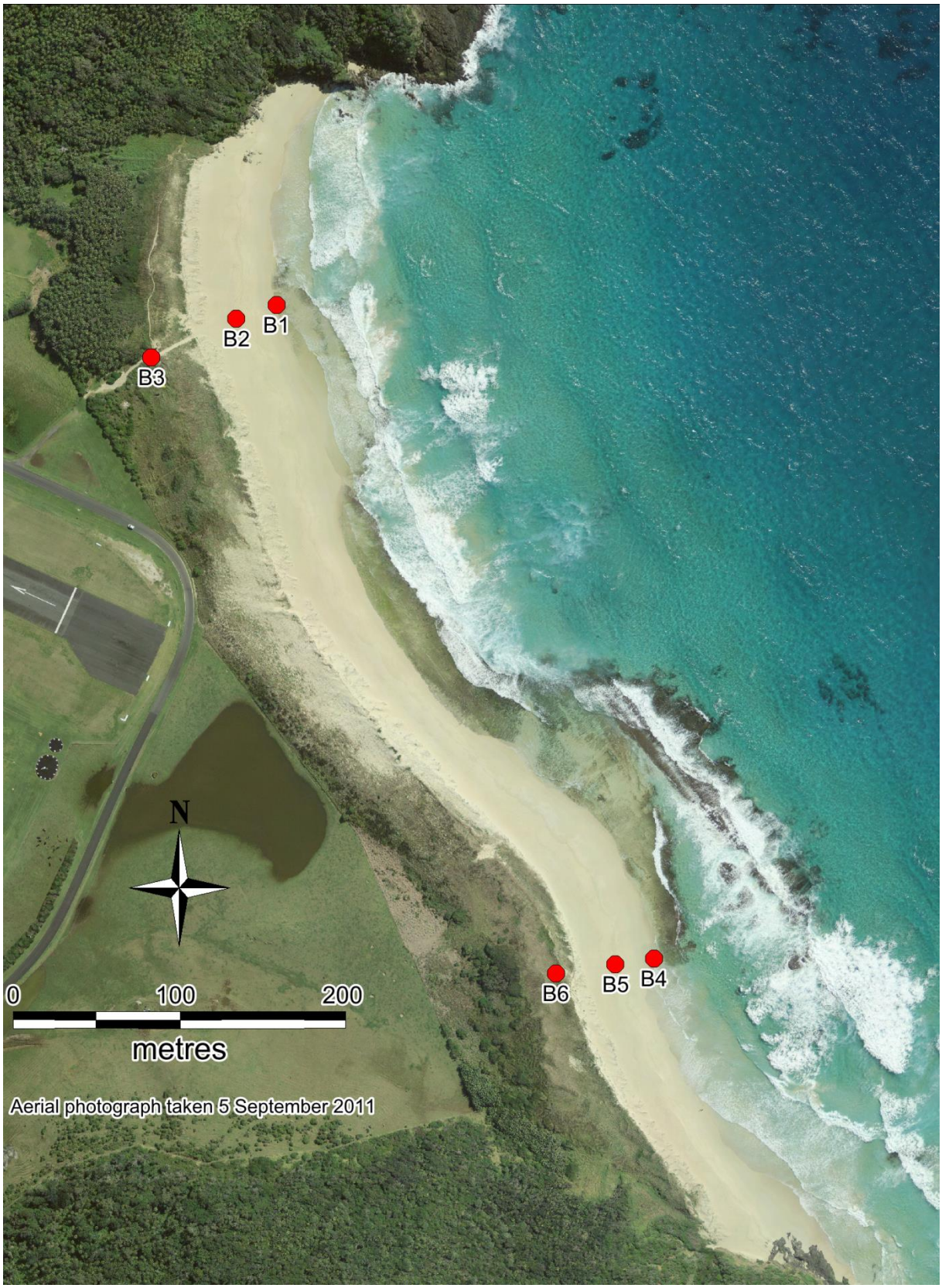

Figure C3: Blinky Beach sediment sampling locations

Figure C4: Neds Beach sediment sampling locations

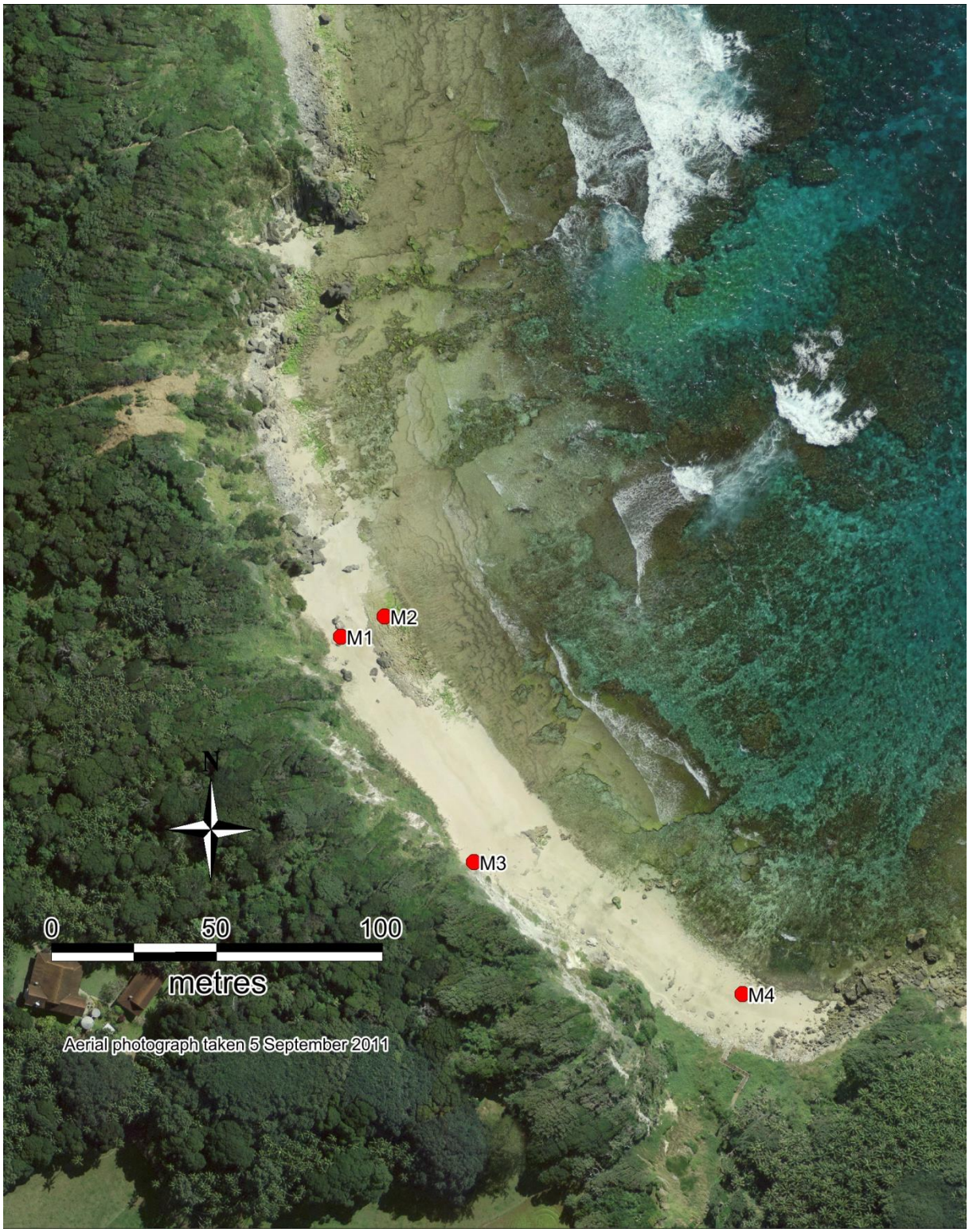

Figure C5: Middle Beach sediment sampling locations

Table C1: Description of sediment sampling locations

Sample	Notes
L1	3m landward of water level
L2	L1 section, 3m seaward of visible base of Seabees
L3	1m landward of water level and 13m seaward of visible base of Seabees
L4	L3 section, 1.5m seaward of visible base of Seabees
L5	1m landward of water level
L6	L5 section, from eroding bank 4-5m high
L7	L7,8,9 same section. 1m landward of water level
L8	High Water Mark
L9	0.5m up 1.8m high scarp
L10	1m landward of water level. Beach 35m wide cross-shore from water level to scarp
L11	L10 section. At High Water Mark
L12	1m landward of water level
L13	L12 section. At High Water Mark
L14	3m landward of water level
L15	L14 section. At most seaward line of shells. 21m from L14 to L15
L16	1m landward of water level.
L17	L16 section . At Spinifex edge. 20m from water level to L17
L18	1m landward of water level
L19	L18 section, at High Water Mark. 5m seaward of scarp
L20	1m landward of water level
L21	L20 section, 5m seaward of scarp edge. 16m from water level to scarp edge and vegetation line
L22	1m landward of water level
L23	L22 section. 25m landward of water level.
L24	In dune (sand builds up in this area and is removed monthly for slipway access)
L25	1m landward of water level
L26	L25 section at High Water Mark, 25m from water level
W1 to W16	Note that all W samples were obtained off a boat
SR1	1m landward of water level (sample lost)
SR2	Same section as SR1, at High Water Mark (34m from water level)
SR3	1m landward of water level
SR4	Same section as SR3, at High Water Mark (32m from water level)
B1	B1 to B3 in section. At water level.
B2	26m landward of water level
B3	At dune crest, about 94m landward of water level
B4	B4 to B6 in section. 10m landward of water level.
B5	29m landward of water level, near High Water Mark

Sample	Notes
B6	62m landward of water level, in dune
N1	Edge of boulders
N2	Near water level
N3	20m cross-shore along beach to Spinifex edge
N4	Heavily weathered calcarenite at back of beach (tube shapes to 10cm long)
N5	3m landward of water level on beach
N6	Edge spinifex
N7	3m landward of water level on beach
N8	7m landward of High Water Mark, 8m seaward of vegetation line
M1	Rock, recent scree at base of vegetation
M2	Sand, edge of bedrock in lower beach
M3	Brown, striated cemented sand with shell, below "white" bluff at back of beach
M4	3m landward of water level on beach

C2. SAMPLING PHOTOGRAPHS

Figure C6: L7, L8 and L9 sampling area near Pinetrees boatshed

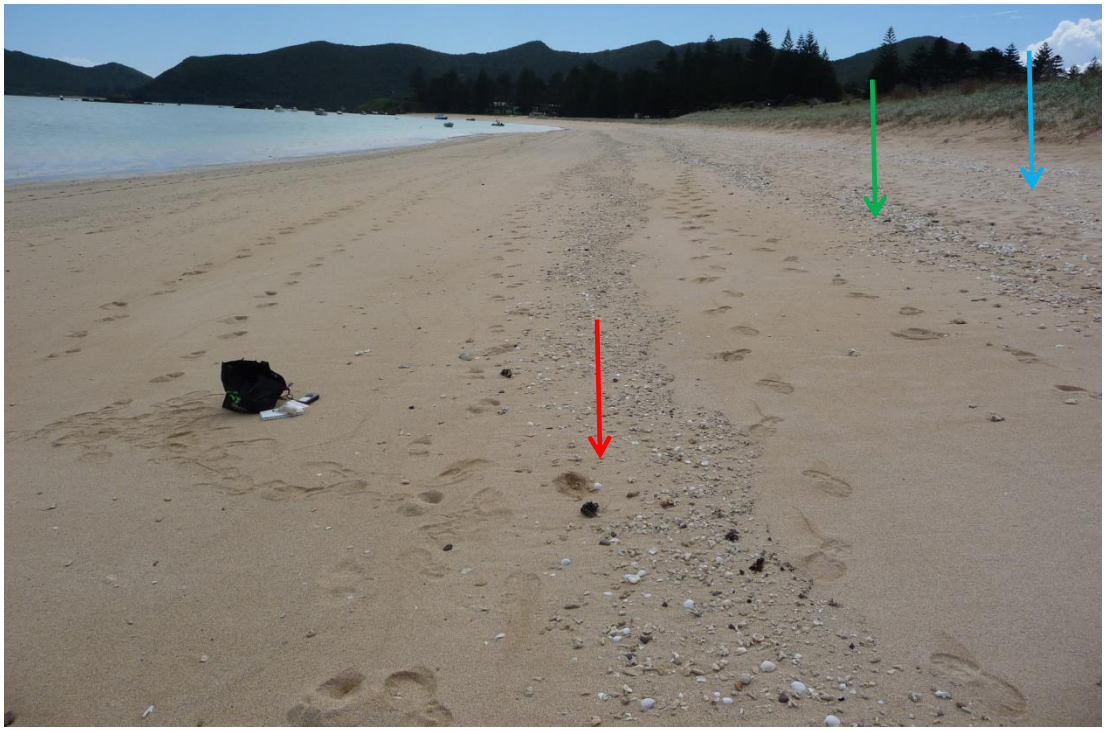

Figure C7: L15 sampling location at red arrow (note two more landward lines of shells at green and blue arrows respectively)

Figure C8: Elevated view of L15 sampling area with three lines of shells

Figure C9: B4, B5 and B6 sampling area at Blinky Beach

Figure C10: N4 sampling area

Figure C11: Collecting N4 sample

Figure C12: Collecting N8 sample

Figure C13: M1 sampling area (scree at base of slope)

Figure C14: M3 sampling area

C3. ANALYSIS RESULTS

C3.1 General Nature of Reef Sediments

This section is mostly sourced verbatim from information provided by Dr Ed Frankel.

Sediments in coral reefs are composed of the skeletal remains of a vast number of different organisms. In general, terrigenous[1] materials are absent, however they may be present in particular instances such as fringing reefs adjacent to land where considerable debris may be washed onto and into the reefs. In addition, offshore systems may be contaminated by inter-reef terrigenous materials washing into the reef under the influence of wave action in storms for example.

The huge variety of organisms that create, live in and on, and sometimes destroy coral reefs all grow to different sizes and have different skeletal architecture composed of complex components of different shapes and sizes. Skeletal parts also have different chemical compositions. In addition, the micro texture of the structures varies enormously. For example, the shell of a clam is large, relatively thick and dense and is consequently very robust and difficult to break down mechanically. By way of contrast, echinoderm ossicles are relatively small and have a delicate three dimensional open pore structure which breaks down readily even under mild mechanical conditions.

In addition different biota inhabit different ecological niches and consequently may not contribute to the composition of the sediment in those areas where they do not live.

For these reasons different depositional environments within reefs contain sediments of different sizes, compositions and textures. Consequently, 'classical' grain size studies are not usually of significant use in interpreting hydrodynamic conditions around these systems.

However in the case of Lord Howe Island, because of the nature of the problem at hand, even though the sediments are almost exclusively reef derived, it is possible to make some use of 'classical' grain size techniques. This is helped to a large extent by the somewhat restricted compositional makeup of the reef-lagoon, beach and dune sediments, as discussed in Section C3.2.

C3.2 Composition of Lord Howe Island Sediment Samples

The text below is mostly sourced verbatim from information provided by Dr Ed Frankel.

The marine sediments of the reefs, lagoon, dunes and beaches of Lord Howe Island were found to be composed of skeletal carbonates with less than 1% (and frequently only a trace) of terrigenous component. The latter, when present, was basaltic rock fragments and accessory ('heavy') minerals.

In general the sediments were predominantly sand sized (grain size between 62 microns and 2 mm) with gravel when present (greater than 2mm grain size and generally less than 25mm, that is mostly fine to medium gravel).

No mud (smaller grain size than 62 microns) was present in any of the materials examined. The lack of a mud sized fraction is quite common in coral reef lagoons even though these are ideal sediment sinks. It is probable that carbonate mud particles (micrite) are flushed from the systems almost as soon as they are formed by mechanical or bioerosion of the reef materials.

[1] Terrigenous sediment is derived from land erosion.

In the case of Lord Howe Island, mud produced in and on Neds, Middle and Blinky Beaches would be flushed by the ambient (relatively vigorous) wave climate. Lagoon Beach and Cobbys Beach and the Lagoon are probably more influenced by reasonably strong tidal currents and a somewhat gentler wave climate as the mud removal/dispersal mechanisms.

Gravel and sand occurred in varying proportions depending on where/when the samples were collected. Gravel was generally angular. The sands varied from finer to coarser overall and ranged through the entire spectrum of textural maturity from angular and 'dull' (immature) to well-rounded and polished (highly mature).

The coarser sediments were dominated by corals and molluscs with significant amounts of 'free' and encrusting coralline algae. In occasional instances large benthic foraminifera (for example *Marginopera* species) were present in the coarse sand and occasionally in the gravel. Only in the finer sand fractions were other components such as echinoderms, sponges and bryozoans present in anything other than trace amounts.

The proportion (by mass) of sand and gravel in each of the samples tested is provided in Table C2. As noted previously, the proportion of mud in all samples was 0%.

Table C2: Sand and gravel proportions in tested samples

Location	Sand proportion by mass (%)	Gravel proportion by mass (%)
L1	86.3	13.7
L2	100.0	0.0
L4	98.9	1.1
L5	62.6	37.4
L6	100.0	0.0
L7	47.8	52.2
L8	98.8	1.2
L12	74.7	25.3
L14	71.9	28.1
L18	100.0	0.0
L19	100.0	0.0
L20	100.0	0.0
L22	99.4	0.6
L23	100.0	0.0
W1	97.2	2.8
W2	96.4	3.6
W3	74.1	25.9
W4	72.8	27.2
W5	87.9	12.1
W7	89.7	10.3

Location	Sand proportion by mass (%)	Gravel proportion by mass (%)
W8	97.9	2.1
W9	96.9	3.1
W13	96.6	3.4
W14	96.6	3.4
W15	91.0	9.0
W16	89.3	10.7
SR1	100.0	0.0
SR2	100.0	0.0
SR3	97.9	2.1
SR4	100.0	0.0
B2	100.0	0.0
B3	100.0	0.0
B5	100.0	0.0
B6	100.0	0.0
N1	0.0	100.0
N2	100.0	0.0
N3	100.0	0.0
N5	100.0	0.0
N6	100.0	0.0
M3	100.0	0.0
M4	99.8	0.2

The text below is based on interpretation by Haskoning Australia.

Most Lagoon Beach tested samples were close to entirely sand sized. The samples with significant gravel proportions were L1, L5, L7, L12 and L14, which were all collected within a distance of 1m to 3m of the water level, in the southern half of the beach. Other samples collected near the water level in the northern half of the beach (L18, L20, L22) were close to entirely sand sized.

Most Lagoon Waterway tested samples were close to entirely sand sized. The samples with significant gravel proportions were W3 and W4 (and W5, W7, W15 and W16 to a lesser extent), which were all collected offshore of the southern half of Lagoon Beach and offshore of the northern end of Cobbys (South Runway) Beach. Samples W1, W2, W8, W9, W13 and W14 were close to entirely sand sized, and scattered offshore of the southern half of Cobbys Beach, northern half of Lagoon Beach (except W13 was in the south) and near North Passage.

All Cobbys (South Runway), Blinky, Neds and Middle Beach tested samples were close to entirely sand sized (except for N1).

The text below is mostly sourced verbatim from information provided by Dr Ed Frankel.

Compositional descriptions of the tested samples are provided in Table C3. Note that in the Lagoon Waterway (W samples) sands there were generally very minor amounts of foraminifera, echinoderms, sponges and crustaceans. Also note that:

- "a" means angular;
- "DP" means 'dull'/eroded/weathered/pitted;
- "M/C" refers to mollusc / coral and coralline algae (including encrusting);
- "P" means polished;
- "Pm" means slightly polished;
- "r" means rounded
- "sa" means subangular;
- "sr" means subrounded;

Table C3: Compositional description of tested samples

Location	Sand	Gravel	Sorting
L1	sr-r Pm M/C	M/C to10mm	well
L2	sr-r Pm M/C	-	well
L4	sa-r Pm M/C	M/C to 5mm	
L5	sa-sr Pm M/C	M/C to 20mm, rock fragments to 10mm	moderate
L6	a-sr M/C	-	moderate- well
L7	sa-r M/C	M/C to 20mm	
L8	sa-sr Pm M/C	M/C to 5mm	well
L12	sa-sr M/C	M/C to 10mm	moderate- well
L14	sa-sr M/C	M/C to 10mm	
L15[2]	sa-sr M/C	-	
L18	sa-sr Pm M/C	-	moderate- well
L19	sa-sr Pm M/C	-	well
L20	sa-sr M/C	-	
L22	sa-sr Pm M/C	M/C to 5mm	moderate- well
L23	sa-sr Pm M/C	-	moderate- well
W1	a-sr DP M/C	M/C to 10mm	
W2	a-sr DP M/C	M/C to 5mm	
W3	a-sr DP M/C	M/C to 5mm	
W4	a-sr DP M/C	M/C to 5mm	moderate- well
W5	a-sr DP M/C	M/C to 15mm	
W7	a-sr DP M/C	M/C to 10mm	moderate
W8	a-sr DP M/C	M/C to 5mm	moderate
W9	a-sr DP M/C	M/C to 10mm	moderate
W13	a-sr DP M/C	M/C to 5mm	

[2] Note that L15 did not have particle size testing undertaken.

Location	Sand	Gravel	Sorting
W14	a DP M/C	M/C to 5mm	
W15	a DP M/C	M/C to 15mm	poor
W16	a M/C	M/C to10mm	
SR2	a M/C	-	moderate- well
SR3	a M/C	M/C to 5mm	
SR4	a M/C	-	moderate
B2	r-wr P M/C <1% rock fragments	-	very well
B3	wr P M/C <1% rock fragments	-	very well
B5	wr P M/C <1% rock fragments	-	Well
B6	wr P M/C <1% rock fragments	-	Well
N1	-	rock fragments 25-50mm	
N2	a-r Pm M/C 3% rock fragments	-	very well
N3	a-r P M/C 3% rock fragments	-	
N5	a-sr P M/C 3% rock fragments	-	well
N6	a-sr Pm M/C 3% rock fragments	-	
M3	sa-sr DP M/C	-	moderate
M4	sr-wr P M/C	C to 5mm	