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Whakatane District Council

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COASTAL STABILITY AT THE MAGEE SUBDIVISION, MATATA

A REPORT TO THE WHAKATANE DISTRICT COUNCIL

by

Dr Terry Healy

25-April-89

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1. STATEMENT OF BRIEF

On 8-Feb-89, I was asked by Mr B.J.Crossen, Chief Engineer to the Whakatane District Council, to prepare a report on the stability of the foreshore fronting the old Magee subdivision at the western end of Matata, including comment on the relationship between dune stability and the drain connecting the lagoon system within the hinter dune swale. In addition, comment was invited on the latest scientific views concerning the "greenhouse effect" and climatic change, and how it may affect the area.

2. FAMILIARITY WITH THE AREA

I am familiar with the Rangitaiki coastline from my long term research interest in the Bay of Plenty coast and as instigator of the Bay of Plenty Coastal Erosion Survey (Healy Harray and Richmond 1977) and subsequent coastal surveys (Healy 1978a,b). In addition I have undertaken two reports on behalf of the Whakatane District Council specifically on this site at Matata entitled "Matata Subdivision - Coastal Erosion" (1976) and "Matata Foreshore Planning" (1977).

3. SITE INSPECTION

On 15-Feb-89 I visited Whakatane and Matata. Accompanied by the Chief Engineer and W.D.C. Engineer, Mr K. Lloyd, a reconnaissance inspection of the state of the beaches and dunes from Piripai to Matata was made. At the site of interest we made a detailed inspection of the beach and dune system as well as the drainage system of the lagoons behind the foredune, and the Awatarariki Stream. Arising from our inspection I requested that representative cross sections of the dunes of concern be surveyed. Some 5 levelled transects were prepared [Fig.1a,1b,1c].

4. FRONTAL DUNE STABILITY AT MATATA

4.1. Site observation showed that the foredune fronting the Magee subdivision, extending northwest from the Patterson sand extraction site to the vicinity of the so-called White Sands lagoon, is clearly in a precarious state. I was particularly concerned to note the meagre reservoir of sand volume evident in the frontal dune, manifest by both the low elevation, narrow width, eroded state with a faceted dune face in which the undercut vegetation is slumping forward, and the low elevation of the swale behind the dune. [Figs 2 - 4] The dune cut face is typically only 1 - 1.5 m high. Storm surge and accompanying dune erosion in the relatively recent past have caused dune face retreat and undercut of the vegetation. [Figs 3,4] and in parts the dune face remains dangerously unvegetated, for should the beach experience a period of strong onshore winds, blowouts could easily develop, further depleting the frontal dune sand reservoir. In profiles A,B - fronting the present refuse dump site - the dune is only some 5-7 metres wide before the ground drops away to the hinter dune swale and the two lagoons located either side of the existing Matata refuse tip [Figs 3a,4a,b].

4.2. Field observation indicates that the frontal dune face is undergoing retreat, and evidently not recovering in post-storm conditions [Figs 3a,b,4a]. During normal beach-dune "cut and fill" cycles the dune would be expected to rebuild from natural aeolian processes after severe episodic storm events. Recent field observations along much of the Bay of Plenty and Coromandel beaches show this generally to be the case at the moment. However at Matata continuing dune face retreat is cutting into sand that is several hundred years in age, as evidenced from the brown coloured humous-iron colloid coated sand grains being eroded from the frontal dune [Fig. 3b]. This shows that the frontal dune in this location is not recovering, that sand replenishment over time is insufficient to rebuild the frontal dune, and thus the dune continues to undergo long term erosion - a trend identified from survey data in my earlier report (Healy 1977).

4.3. Continuation of this trend of frontal dune face erosion could lead to dire consequences. Specifically (a) the complete loss of the frontal dune along this sector, which will exacerbate both the extent of inland wave erosion in episodic severe storms; and (b) flooding of the hinter dune lowland swale from overwash of large episodic storm waves will be facilitated.

4.4. At several locations along the foredune there is clear evidence of overwash of the dune from identification of the flotsam line [Figs. 2b,4a]. This overwash evidently occurred from the large waves of cyclone Bola, and compares closely with my observations along the Papamoa dunes.

In this respect it should be noted that concern was raised in my earlier reports (Healy 1976,1977) about the history of erosion of the Matata frontal dune during this century, and its low elevation and delicate stability. It was reported as being overwashed in the "Wahine" storm of April 1968, an event accompanied by hinter dune swale flooding. The frontal dunes were also overwashed by the waves of cyclone Bola in March 1988, which, fortunately for the Neale property, was not as severe as the "Wahine" and July '78 storm events. These caused considerable dune erosion as well as flooding from wave washover. The return period of cyclone Bola storm severity is put at about 1 in 5 years, and the July '78 and Wahine events at about 1 in 10 year events. However recent views on the circulation changes expected in the future associated with the anthropogenically induced climatic warming from the "greenhouse effect" suggests that a significant increase in the likelihood and frequency of northeasterly storms of the cyclone Bola type (Salinger 1987).

4.5. Cause of the trend of long term erosion at this site was not able to be identified in my earlier reports. But our understanding of coastal processes has advanced significantly in the past few years, and it is now recognised that many cases of persistent beach erosion are frequently associated with the phenomenon of wave focussing - where wave refraction processes concentrate wave energy along certain sectors of the shoreline (Healy 1987). This process results in the duneline being eroded into shallow embayments which may be semi-permanent in nature. Such a process has been clearly demonstrated as the cause of erosion of the dune fronting the Marsden Point power station in Bream Bay (Healy 1987; Black and Healy 1988), and also caused cut through of the dune system and created a new and dominant harbour entrance at Mangawhai, Northland, during the July '78 storm.

Geomorphic evidence of a shallow duneline embayment at Matata was observed during the field inspection and is also to be seen in the recent aerial photographs of the duneline. Such embayments are a typical feature of the Bay of Plenty dunelines, and result from offshore bathymetric irregularities acting as focal points for the larger longer period waves.

Although time did not permit a full wave refraction analysis for Matata for the purposes of this report, the numerical wave refraction simulations carried out as part of the hazard analysis for the Whakatane Spit during marina investigations (Healy 1984) clearly show that design storm waves indeed focus on Matata beach [Fig.6].

4.6 The unstable and precarious state of this frontal dune was correctly identified by the Chief Engineer in his report to the Works Committee of 2-Feb-89 when he stated that the dune "in this area has a very sparse sand reservoir and it would take very little for the sea to break through the dune under erosion conditions and inundate the low lying areas as occurred during the Wahine storm".

5. COASTAL HAZARD DELINEATION AND FORESHORE PLANNING

In my earlier report relating to foreshore planning at Matata (1977) I argued for a hazard zone or development set-back line of 100 metres. Since then various methods for defining coastal hazard have been tested and accepted at Planning Tribunal and local authority Planning Committee hearings.

The major coastal hazards of immediate concern identified for the Matata sector are dune erosion and wave overwash and flooding potential.

Concerning the planning response to coastal hazards, it is now widely accepted that in planning for a <u>foreshore protection</u>, <u>coastal hazard</u>, or <u>development set-back</u> zone, an holistic approach involving all relevant factors is necessary. However in my experience the three most significant limiting conditions are:

i) The requirement, adopted from Dutch coastal engineers, to retain a sand reservoir of $400m^3$ per linear metre of beach above the mean sea level datum, after the worst known storm cut event for a given sector of coast;
ii) The requirement to allow for extreme event wave washover and potential flooding of the hinter dune swale; and,

iii) The need to plan for potential sea level rise inducing duneline retreat as predicted by the Bruun Rule (Bruun 1962, 1983, 1986, 1987; Dubois 1977; Weggel 1979)).

For the Bay of Plenty coast the worst recorded storm cut is 130 - $140m^3/m$, so that it is appropriate to plan for 500 - $530m^3/m$ for long term foreshore protection. This standard was recently adopted by the Tauranga County Council for development set-back at the Papamoa dunes (Healy 1988).

Design storm wave analysis was carried out for the Whakatane Spit hazard investigations (Healy 1984) which realised a design wave run-up of 4.54m above mean sea level for that site. Recent design storm wave calculations for the Papamoa dunes predicted a run-up of 4.82m above mean sea level - which was within 10 cm of the flotsam line deposited by cyclone Bola at that site (Healy 1988). Although a separate calculation has not been made for Matata, it is clearly between 4.8 - 5.0 m judging from the evidence of the flotsam line from cyclone Bola which is located on the swale side of the foredune crest [Figs 2a,b,4a]. It is likely to be higher at Matata because of the wave focussing phenomenon.

Application of the Bruun Rule and its various modifications at Papamoa predicted a duneline retreat of between 35 - 115 m depending on the values accepted for sea level rise by the year 2100 (Healy 1988).

In terms of the application of these limiting conditions to Matata, the coastal hazard zone must extend back a considerable distance from the base of the frontal dune, and well beyond the limits of the levelled profiles A-E produced for this report. Analysis of the profiles surveyed on 17-Feb-89 is given below:

Profile	Area above M.S.L.	Distance
A	217 m^2	33 m dune toe to drain
B	195 m^2	30 m dune toe to drain
C	305 m^2	62 m dune toe to house lagoon
D	291 m^2	61 m dune toe to carshed
E	362 m^2	93 m dune toe to edge of 2nd dune

Clearly none of the profiles comes anywhere close to the limiting requirement of 500 - 530 m^2, and the resulting hazard zone at this site certainly extends well beyond 100m inland from the toe of the dune.

Moreover, to avoid damage from episodic flooding within the hinter dune swale from wave washover, a natural process that can be expected to recur every few years on average, all developments should be above 5.0 m R.L.

6. COMMENT ON THE NEALE DWELLING IN RELATION TO COASTAL HAZARD

It is noted in regard to the Neale property that the house floor level of 3.64 m R.L. and the house distance of only 70 m from the frontal dune face is well within the hazard zone. In my opinion such a development should not have been permitted, and that property will be subject to continuing hazard problems in the future, which will be exacerbated if the frontal dune system deteriorates further..

7. COMMENT ON DRAINAGE PROBLEMS OF THE SWALE AND INTER-CONNECTED LAGOONS

W.D.C file notes report that the flooding of the lagoons, which has resulted in flood damage to the Neale property carshed, is attributed to the backflow from the Awatarariki Stream at times of flood.

The data on water levels collected by the W.D.C. Engineering staff clearly show that the White Sands lagoon water levels remain higher at almost all times, except when the stream floods back into the Neale lagoon. It seems clear that under normal conditions the White Sands lagoon is fed from ground water or a spring, which are typically to be expected at the base of a high steep escarpment as occurs to the west of the lagoon. The lagoon water is held perched by the peaty deposits in the lagoon but then overflows through the porous sand of the swale until it reaches and nourishes the Neale lagoon. It is to be noted that "medium" sized dune sand is typically 35-40% pore space so that groundwater seepages through the sands are to be expected wherever an hydraulic head is set up.

In this regard the reported pore water seepage from the foredune into the connecting drain at times of high seas is quite consistent with my understanding of the hydrology of the system. At profiles A and B this involves a head of 1 m from the toe of the foredune over 30 m horizontal distance to the ditch, so that at times when high waves reach the toe of the foredune it is to be expected that groundwater charged from wave run-up would seep back into the lagoons and interconnecting drain.

Moreover, wave overwash of the foredune during cyclone Bola and similar events quite clearly adds to the flooding of the lagoon system; such flooding is not, in my view, attributable solely to the stream overbank flow, and these lagoons will likely flood from high wave events as well as overbank stream flow in the future.

If my understanding of the system is correct, then there is little point in the inter-connecting drains between two lagoons. It may assist the water to flow back from the Neale lagoon to the White sands lagoon at time of Awatarariki Stream flood, but at times of high seas both lagoons rise in water level regardless. From a coastal protection point of view, the drain could accelerate destruction of the frontal dune in that sector should flows through the drain ever reach a scouring velocities or should pore water pressures from high waves develop pipes through the dune, as they might in times of extreme storm waves with concomitant flooding. It would be preferable coastal management practice to infill the drain and undertake dune enhancement and conservation procedures.

Concerning property damage associated with these natural events, the development was permitted under section 641a which stipulates that any such building must be relocatable in the event of erosion or inundation.

8. IMPACT OF GLOBAL WARMING ON THE BAY OF PLENTY COASTAL ZONE - PLANNING IMPLICATIONS

Much has been aired in the press recently about climatic change associated with the "greenhouse effect" - the situation whereby increase in atmospheric CO_2 and chlorofluorocarbon concentrations is expected to induce a substantial atmospheric warming, which may cause significant sea surface temperature warming.

One major impact from the climatic warming may be sea level rise due to melting of the polar ice caps. The accepted sea level rise by the U.S. Environmental Protection Agency in 1986 was between 0.6 to 2.3 m rise by the year 2100, while the U.S. National Research Council opted for a value close to 1 m. (Hoffman et al 1986; Thomas 1986; Titus 1986,1987).

More recent work has concentrated on attempting to ascertain whether the effect can be discerned in the tide gauge records (Pirazzoli 1986). Earlier, Schofield (1967) showed that there was a long term rise in mean sea level of about 18 cm/100y evident in the Auckland tidal records, but that in recent decades the rate had increased to about 30cm/100y. Detailed re-examination of the tidal records by Hannah (1988) resulted in a predicted sea level rise applicable to the New Zealand coast, based on thermal expansion of the ocean from the expected temperature increase of 2-3°C, of about 25 cm over the next 100 years. This is consistent with the predictions of Professor Walter Munk from Scripps Institute of Oceanography, who demonstrated at the 1988 International Coastal Hazards Conference that thermal expansion of the oceans will result in a rise of about 45 cm over the next 100 years. However should melting of the ice caps also contribute, the rise will be somewhat greater.

Accordingly, for coastal planning purposes it would be prudent to allow for a 50 - 60 cm sea level rise. Application of the Bruun Rule for this magnitude sea level rise predicts a duneline retreat generally of between 60 - 100 metres for Bay of Plenty beaches, but I have not as yet applied this model directly to Matata. Such retreat may be offset from active efforts at frontal dune enhancement and beach nourishment.

A second major impact from the climatic warming is the expectation of higher sea surface temperatures north of new Zealand. This will likely increase the frequency of tropical weather systems such as cyclone Bola affecting the Bay of Plenty. Accordingly erosive and wave flooding events may be expected with greater frequency than in the past. Additionally, the high rainfall episodes associated with the cyclone depressions will increase the likelihood of flooding from the Awatarariki Stream.

9. ENVIRONMENTAL REINSTATEMENT AFTER MATATA REFUSE TIP CLOSURE

An environmentally acceptable enhancement programme should be commenced upon closure of the tip. Apart from the groundwater considerations, about which I have no data, it would be prudent to institute a programme of enhancement aiming both to restore the natural character of the dunes, and to build up the reservoir of sand in the foredune. To ensure its stability, planting of natural dune sand-binding grasses such as Spinifex, Pingaeo, and Muehlenbeckia must be instituted. If substantial sand is available as part of the tip "cover up", sand should also be placed along the frontal dune in an effort to increase its reservoir capacity. Wind trapping sand netting fencing should be employed at sensitive locations. The programme will need fairly constant monitoring.

Consideration must be given to public accessway to the beach, particularly during any "re-contouring" programme. If it is likely that considerable public traffic to the beach will be generated, care must be taken to reduce the possibility of damage to the sensitive dune vegetation and blowout scour. It would be prudent to plan for channeled walkways of the raised slatted wooden type, now widely used overseas.

Should the dune retreat continue, it may be necessary to fence off the remaining ridge as a "conservation area", and undertake the measures given above. In this case, notices informing the public and requesting their cooperation should be erected.

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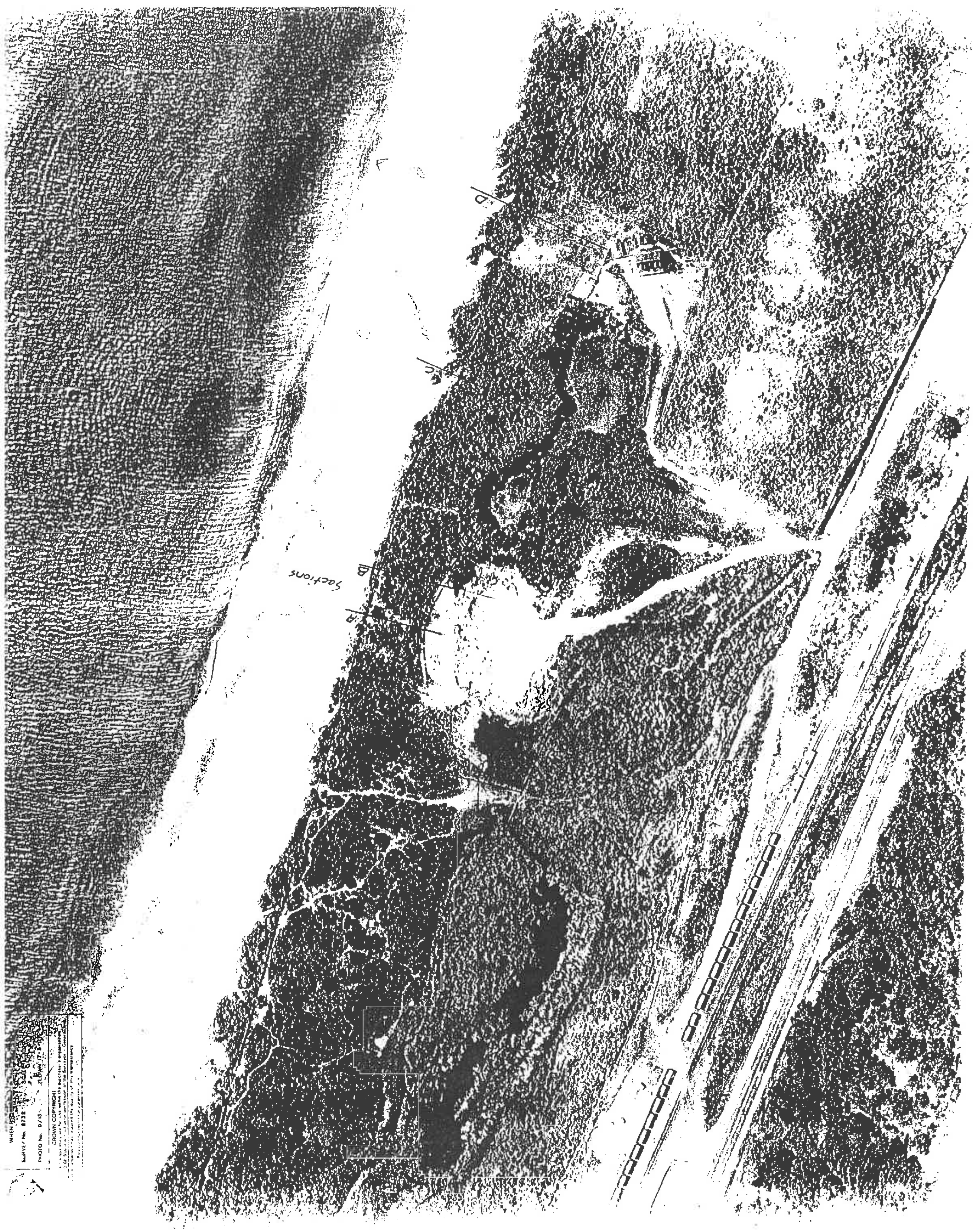


FIGURE 1a

Matata Dump : Cross Sections Of Foredune

1/89 BAL

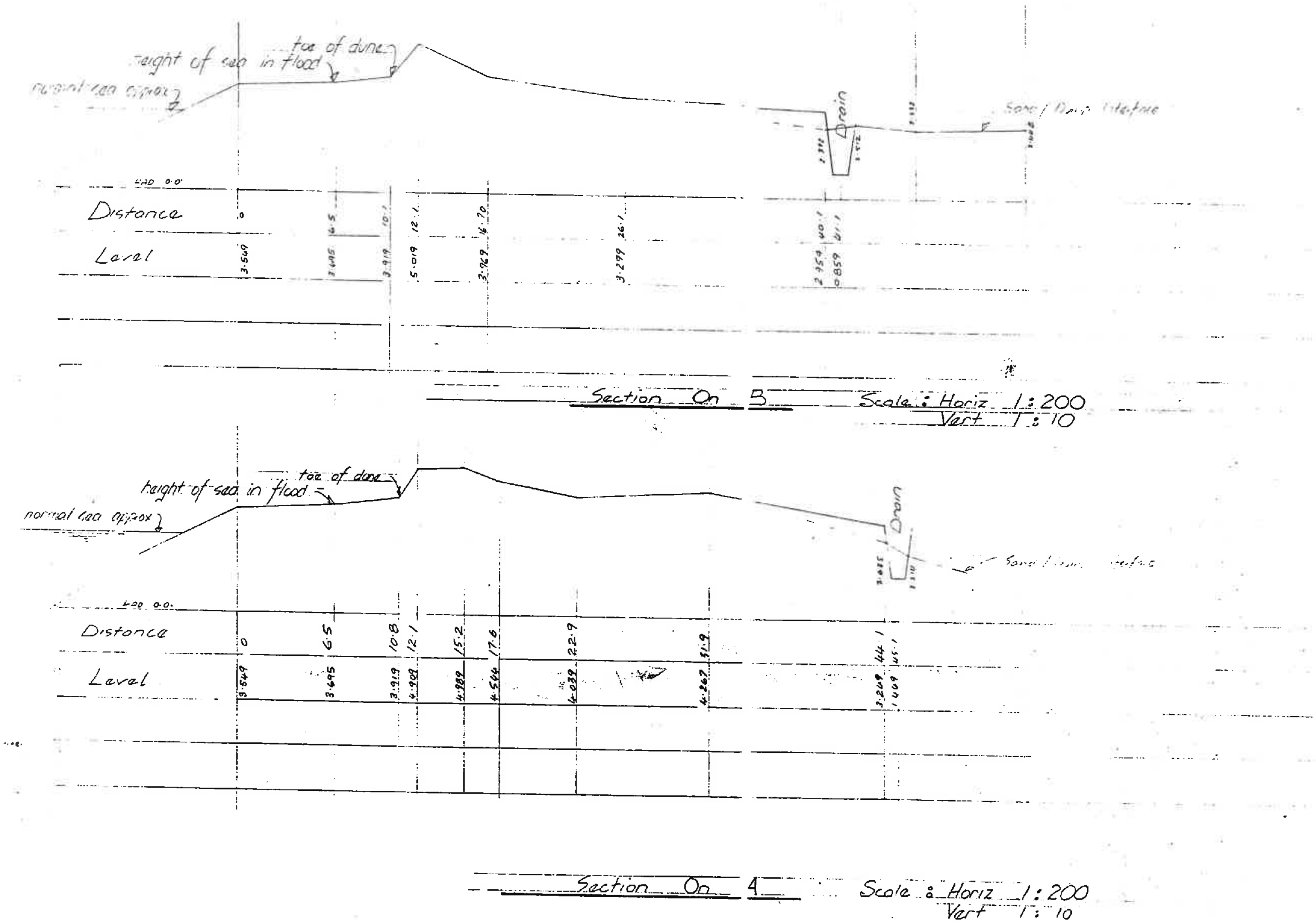


FIGURE 1b

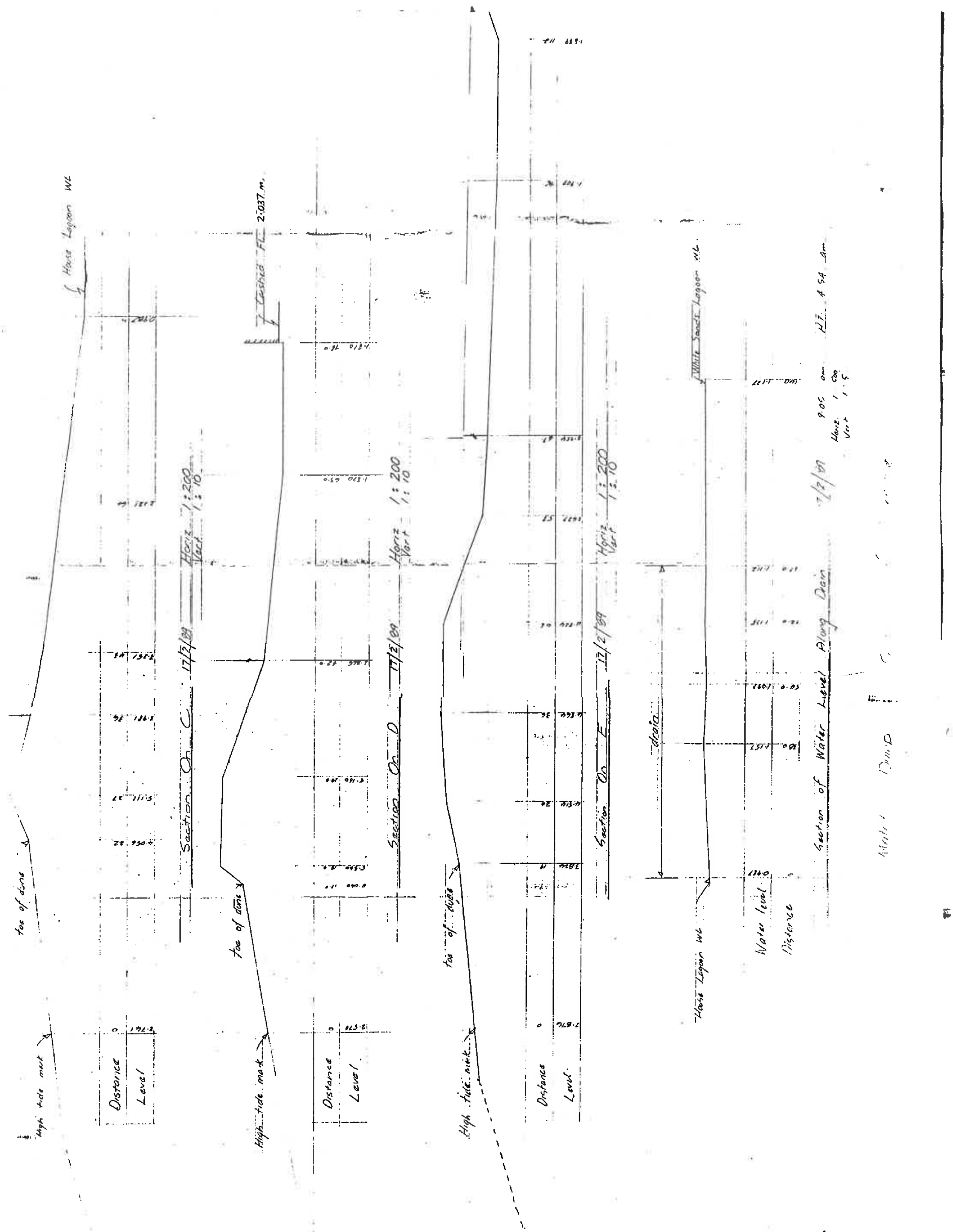

Horse Lagoon WL
2.037 m
toe of dune
High tide mark
Distance
Level
Section On C 17/2/89
Horiz 1:200
Vert 1:10
Section On D 17/2/89
Horiz 1:200
Vert 1:10
Section On E 17/2/89
Horiz 1:200
Vert 1:10
White Sands Lagoon WL
drain
Horse Lagoon WL
Water level
Distance
Section of Water Level Along Drain 7/2/89
Horiz 1:500
Vert 1:5

FIGURE 1c

4/6/14

5.0 — minimum height of foredune at dump

3.62 — height of of wave action 22/1/89
house floor level

3.0

natural ground level vicinity of drain

typical wave action height (high tide)

Level m.

house lagoon WL 22/1/89 (Awatarariki Stream)
carshed floor level

2.0

White Sands lagoon 22/1/89

house lagoon WL Cyclone Bola

White Sands Lagoon WL Cyclone Bola
℄ Drain Invert at highest point

1.0 — normal White Sands WL and high tide L.

normal House Lagoon WL

(Comparative Levels At Matata Dump Site)

Figure 2a: Vicinity of surveyed profile E. Note the very low dune form which is a prime site for large wave washover.

Figure 2b: Undercut stringers of <u>Spinifex</u> indicate a phase of recent frontal dune cut as well as wave washover of the very low frontal dune which extended inland to the position of Mr Lloyd. The very small reservoir of sand in the frontal dune is obvious.

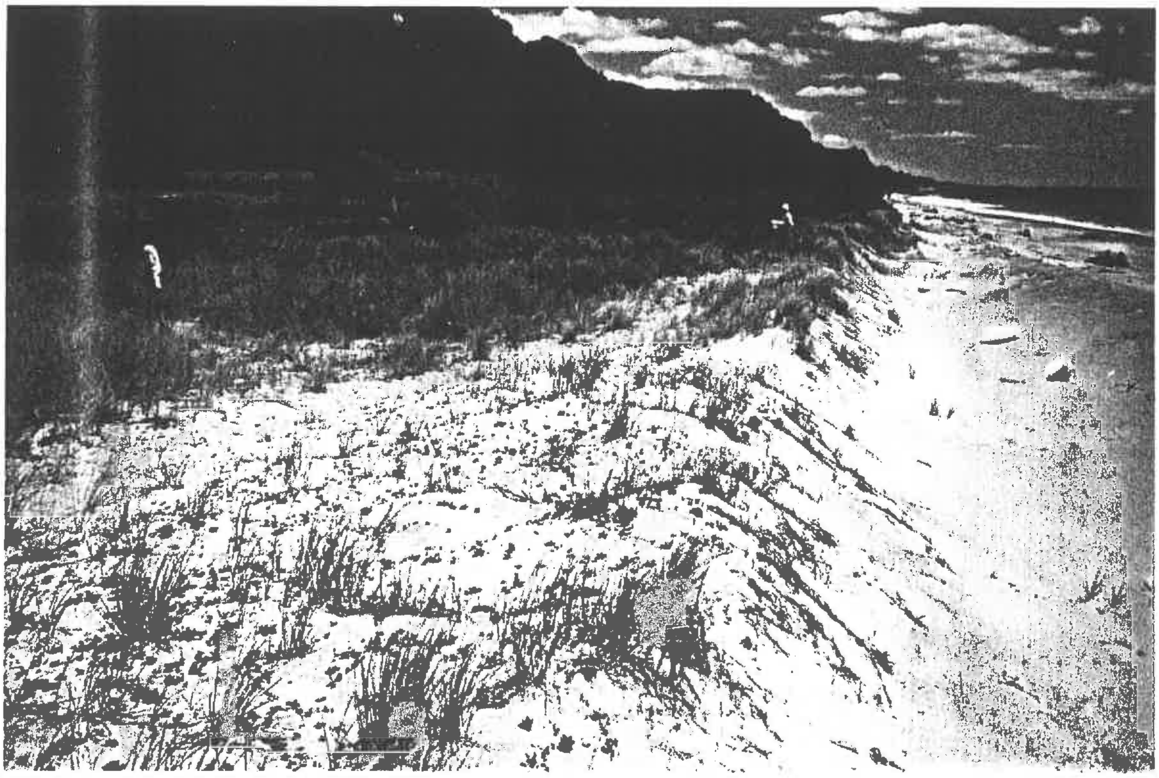


Figure 3a: Vicinity of profile B (?). The undercut vegetation and cut face of the dune, as well as the very small extent of the frontal dune remnant as indicated by the scale of the Council Engineers, is cause for concern.

Figure 3b: Undercut Muehlenbeckia on the dune face, normally found on back of the frontal dune,, indicates the extent of continued dune retreat. Note particularly the brownish colour tinge to the sand being eroded, indicating that this sand is of some considerable age

Figure 4a: Vicinity of profile C showing again the disturbingly low frontal dune which has been overwashed - note the flotsam line. Given an episode of strong onshore gales this un-vegetated dune could easily develop into a blowout, which would further deplete the frontal dune sand reservoir, as well as facilitate flooding of the hinter dune swale.

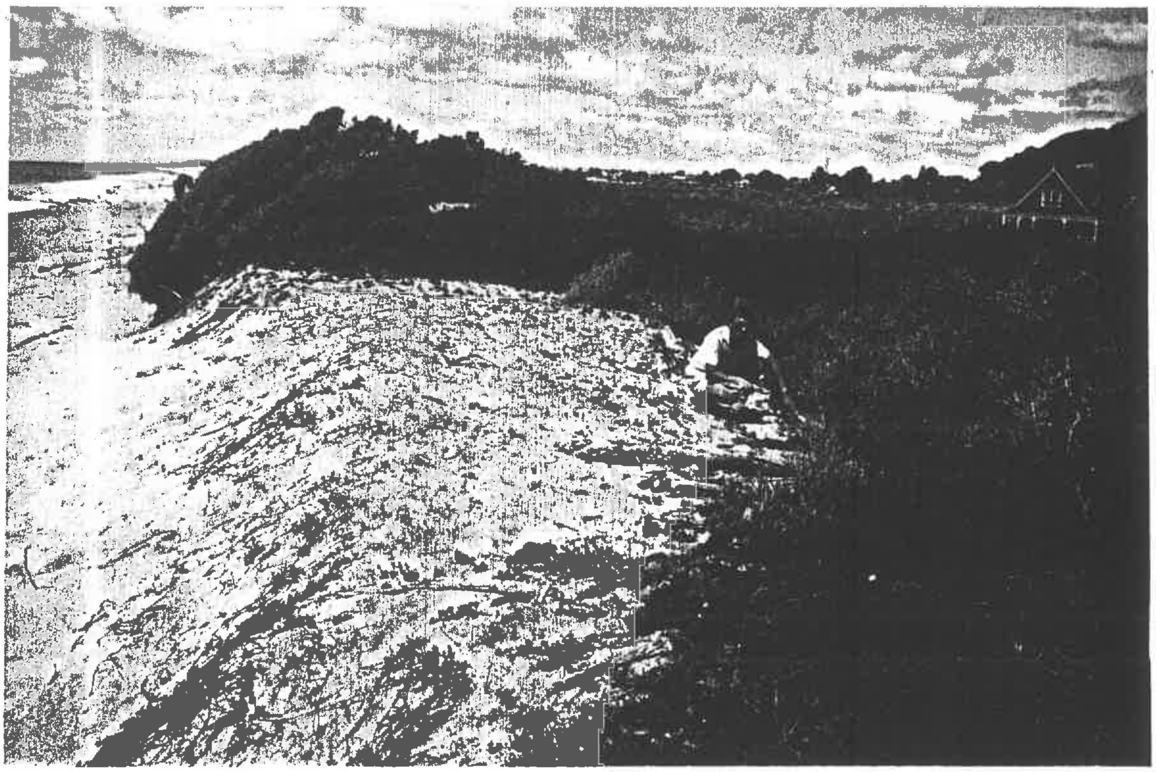
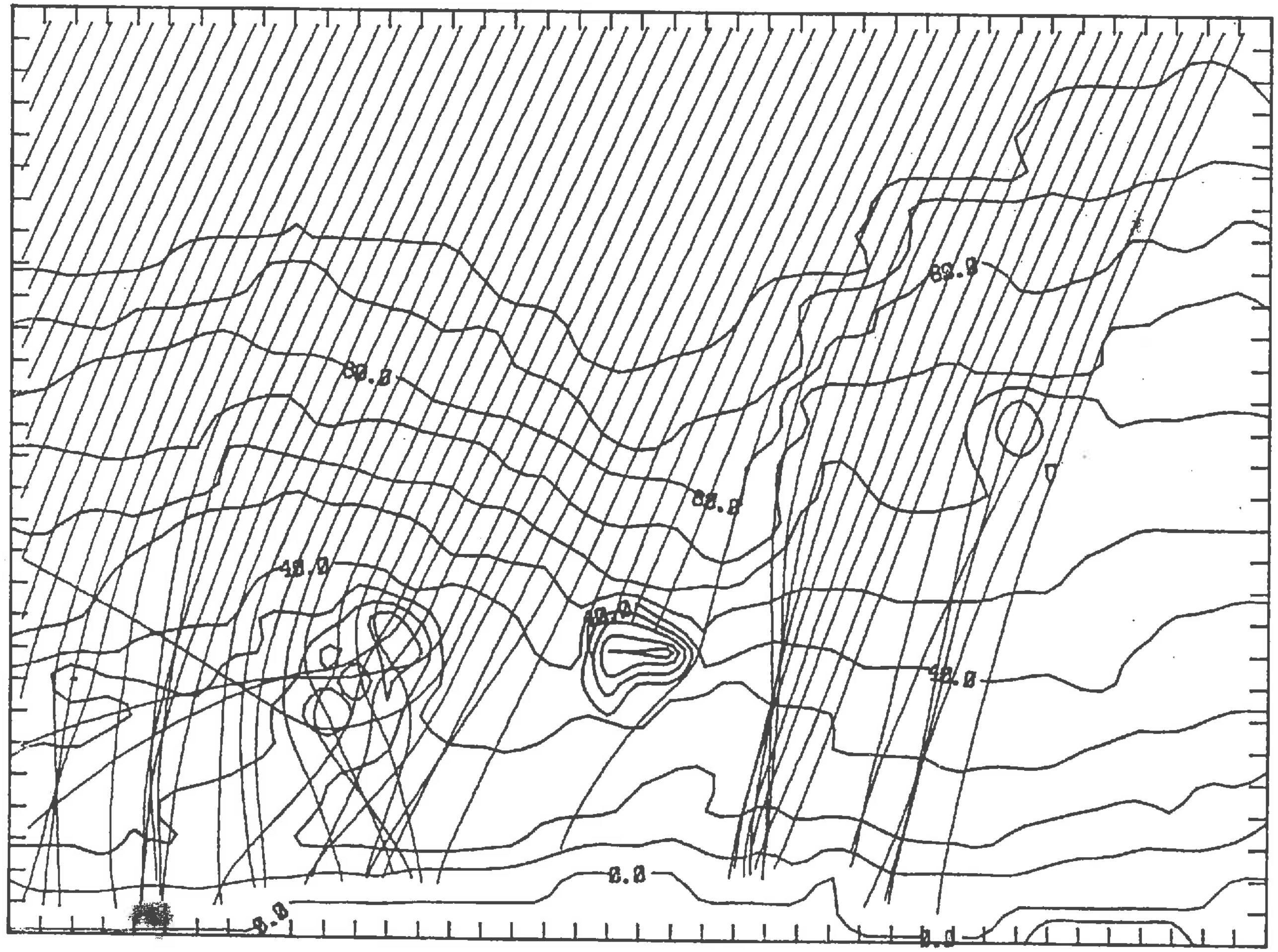


Figure 4b: Vicinity of profile A,B. A further example of the very limited extent of the frontal dune, and the clear danger from dune overwash. Note the embayment in the duneline, caused presumeably from wave focussing.

WHAKATANE SPIT RUN 8

H = 9.9 m
T = 15 s



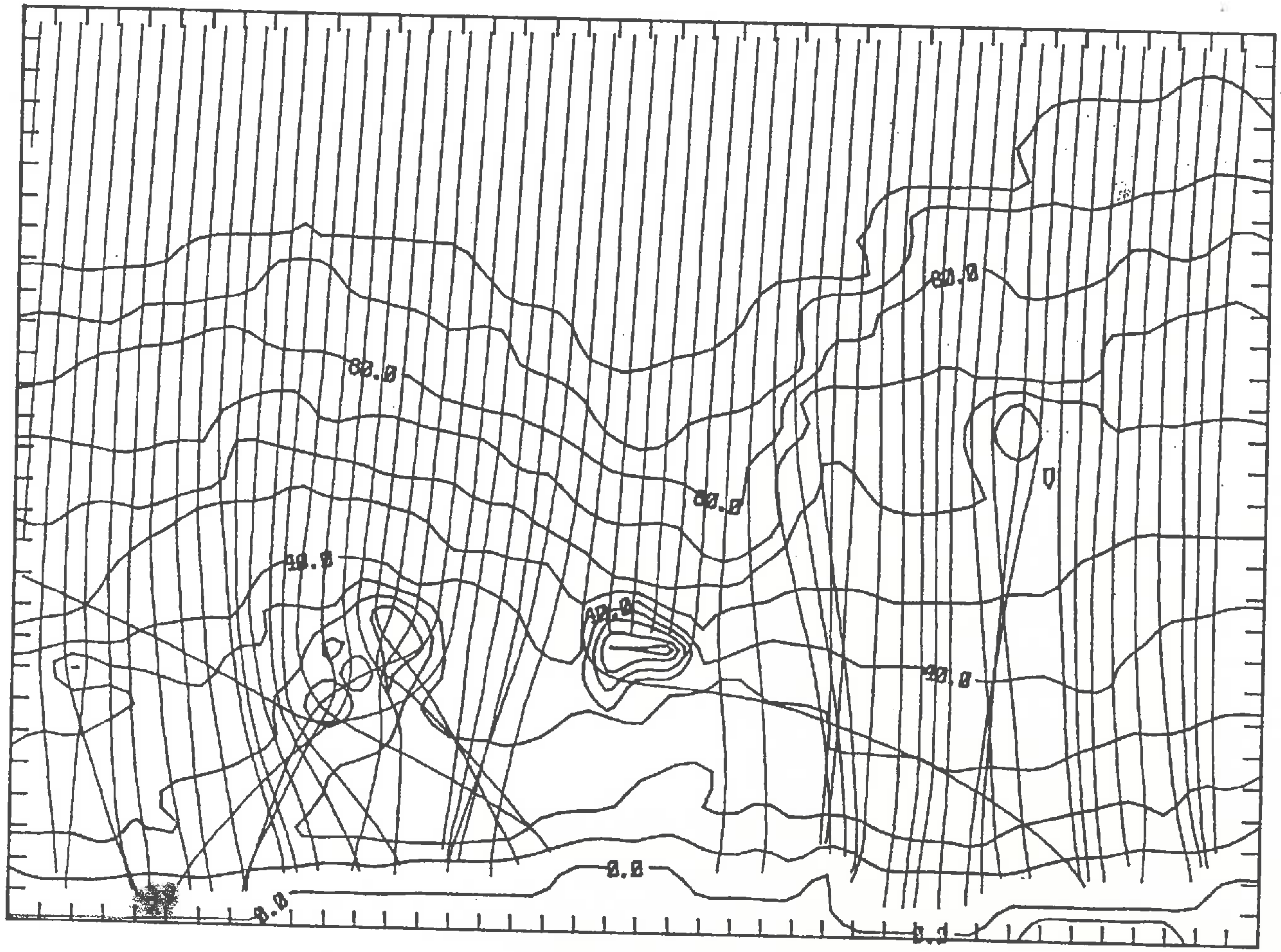
CONTOUR FROM -10.000 TO 130.00 CONTOUR INTERVAL OF 10.000 PT(3,3)= 17.100

FIGURE 5

WHAKATANE SPIT RUN 6

$H = 9.9m$

$T = 9s$



CONTOUR FROM -10.000 TO 100.00 CONTOUR INTERVAL OF 10.000 PT(3,3)= 17.100

FIGURE 5