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# A Resource Survey of the Coastal Lands from Vlaming Head to Tantabiddi Well

## West Cape Range Region

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## Disclaimer

The contents of this report were based on the best available information at the time of publication. It is based in part on various assumptions and predictions. Conditions may change over time and conclusions should be interpreted in the light of the latest information available.

# Contents

# 1. Introduction

This report details a brief survey and development hazard assessment of near-coastal landforms of the west Cape Range region lying between Vlaming Head and Tantabiddi Well (west of Exmouth; **Figure 1**). It has been prepared in response to a request from the W.A. Department of Conservation and Environment and the Shire of Exmouth to assess land use capability for residential development of near-coastal landforms in the region.

The report comprises four parts: a brief review of the area's climate; discussion of the qeomorpholoqy of the major landform units; an assessment of the potential erosion hazards of the surveyed landforms and recommendations for development.

# 2. Climate

The climate of the Cape Range area is arid (Kenneally, 1982). Monthly mean maximum temperatures at Vlaming Head are about 33°C in February and 23°C in July. Minimum temperatures are about 23°C in February and 15°C in July. Annual rainfall at Vlaming Head averages 300 mm per year. The majority of the rainfall occurs in March and in May/June, when a monthly average of 68 mm and 60 mm falls respectively. Rainfall reliability is low, and intensity is high. Both are strongly influenced by the passage of tropical cyclones. During the last thirty years, 21 cyclones have crossed the coast between Roebourne and Point Cloates. In general, the proportion of annual rainfall due to cyclones is around 40-60%.

Winds are predominantly southeasterly and southerly on summer mornings, and southwesterly and westerly sea breezes on summer afternoons. Winds from the southeast dominate the winter wind pattern. Both summer sea breezes and winter winds may be strong. Cyclonic winds may be severe reaching speeds up to 150 km/hr (Bur. Meteorology, 1972).

# 3. Geomorphology

The region comprises four major landforms, namely

(1) the Cape Range

(2) marginal coralline terraces and quartzose dunes

(3) a coastal plain of coral flats and alluvial fans, and

(4) coastal dunes.

## *3.1 Cape Range*

The Cape Range forms a prominent anticline trending NNE - SSW along the Exmouth Peninsula. The range is gently undulating in the centre, with steep, highly dissected marginal slopes. It is predominantly composed of Tertiary marine limestones and aeolian sandstones (van de Graaff *et al*., 1980; Condon *et al*., 1955). The western margin of the Cape Range peninsula has been eroded by marine processes acting throughout the Pleistocene (1.5 mil. yrs - 10,000 yrs before present). This erosion has resulted in the formation of four marine terraces formed during interqlacial high sea level stands (van de Graaff *et al*., 1976). These terraces, which extend from Vlaming Head to Wealjugoo Hill comprise coralgal reef deposits, nearshore and beach sediments and aeolian (windblown) sediments. For the purposes of this survey, the three upper terraces (the Jurabi, Milyering and Muiron terraces) are mapped as one unit with the Cape Range on Figure 1.

## *3.1 Tantabiddi Terrace*

The Tantabiddi terrace is the lowest, youngest terrace (van de Graaff *et al*., 1976), and essentially forms the present coastal plain. It is a low (approx. 2-5 m above MLWS) plain of variable width (0.2-1.5 km wide), consisting of coral and coralgal reef deposits which grade into calcarenite, and are in part overlain by aeolianites. Some of the latter are lithified (van de Graaff *et. al*., 1976).

## *3.2 Alluvial Fans*

The Tantabiddi terrace is also partially overlain by Holocene (0-10,000 years Before Present) alluvial fans formed by deposition during stream run-off events. The fans comprise a mixture of fine-medium grained clayey sands with interspersed layers of coralline and limestone pebbles and cobbles. The depth of sediment comprising the fans thins both seawards and laterally (north and south) from their source point at the eastern margin of the Tantabiddi terrace.

## *3.3 Coastal Dunes*

Holocene coastal dunes overlie the seaward margin of the Tantabiddi terrace. These range from foredunes (the foremost dune ridge backing the beach), relict foredunes (former foredunes), blowouts (erosional troughs and hollows), to active sand sheets.

The beaches are typically reflective where incoming wave energy is reflected off the beach face. Beaches lying in the lee of reef breaks (gaps in the reef), where wave energy is focused, are embayed, slightly coarser, steeper, narrower beaches experiencing relatively higher levels of wave energy than beaches occurring behind unbroken stretches of reef. The latter tend to be flatter and wider than the former. Foredunes in the lee of reef breaks are accordingly steeper and more erosional than those in the lee of unbroken sections of reef.

# 4. Potential Development Hazards

Given that it was desired to develop a near-coastal site, only three landform units were assessed for their capability to sustain residential development. These were (i) the coastal dunes, (ii) the Tantabiddi terrace and (iii) the overlying alluvial fans. These landforms are shown on Figure 1.

## *4.1 Coastal Dunes*

The coastal dunes have been sub-divided into four landform units, foredunes, relict foredunes, blowouts, and sand sheets (**Figure 1**). The foredunes are generally high and steep, commonly scarped, and suffer occasional wind and wave attack especially during cyclones. Water relations on the dunes are poor principally due to the arid nature of the climate, and the vegetation cover is sparse in many places. Even minimal disturbance of the vegetation may result in the formation of erosional sand patches and blowouts.

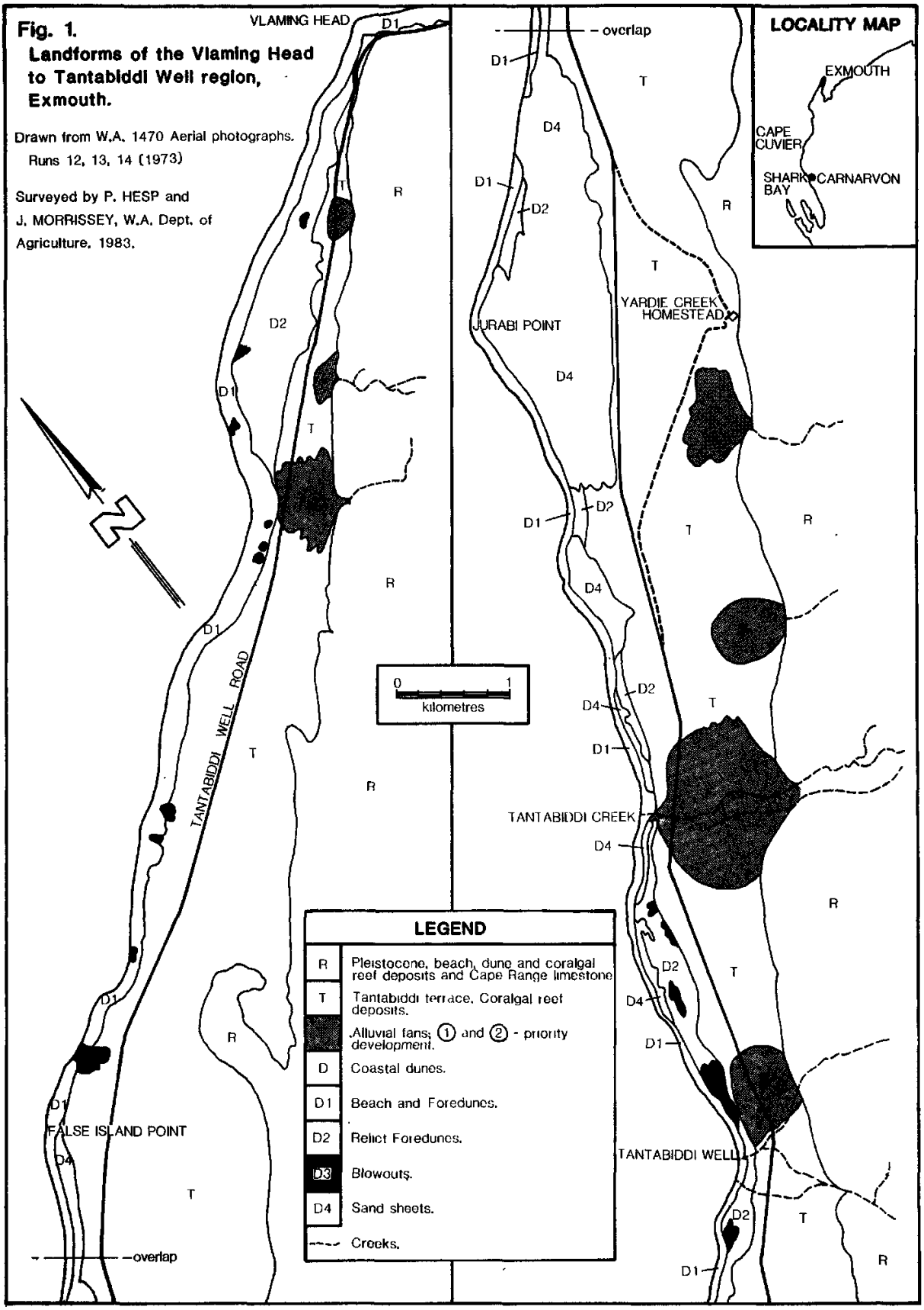
Fig. 1.
Landforms of the Vlaming Head to Tantabiddi Well region, Exmouth.
Drawn from W.A. 1470 Aerial photographs. Runs 12, 13, 14 (1973)
Surveyed by P. HESP and J. MORRISSEY, W.A. Dept. of Agriculture. 1983.
VLAMING HEAD
overlap
LOCALITY MAP
EXMOUTH
CAPE CUVIER
SHARK BAY
CARNARVON
YARDIE CREEK HOMESTEAD
JURABI POINT
TANTABIDDI WELL ROAD
TANTABIDDI CREEK
TANTABIDDI WELL
FALSE ISLAND POINT
0
1
kilometres
LEGEND
R Pleistocene, beach, dune and coralgal reef deposits and Cape Range limestone
T Tantabiddi terrace. Coralgal reef deposits.
Alluvial fans; (1) and (2) - priority development.
D Coastal dunes.
D1 Beach and Foredunes.
D2 Relict Foredunes.
D3 Blowouts.
D4 Sand sheets.
Creeks.

While the relict foredunes in the region are not exposed to direct wave attack, in general they retain the characteristics noted for foredunes. Soil development is negligible, the vegetation cover is easily disturbed and wind stress is high. Dune slopes may be steep (~20°) and crests narrow. The fact that many relict foredunes presently display blowouts or are now developing into sand sheets indicates the high sensitivity and fragile nature of these dunes.

The blowouts and sand sheets are largely unvegetated sand bodies, moving northwards under the influence of very strong southerly winds. In this environment, with little available water to re-establish vegetation, with high air and surface temperatues, and with high aeolian sand transport rates, it would be difficult to stabilise these landforms.

Table 1 summarises the potential development hazards for the coastal dunes and other landforms in the region. In general, development on foredunes, relict foredunes, blowouts and sand sheets should be avoided, planned pedestrian access being the only exception.

## *4.2 Coastal Plain*

### 4.2.1 Tantabiddi Terrace

The Tantabiddi Terrace, a Pleistocene emerged coral reef, forms the major portion of the coastal plain. This terrace displays a gentle seaward slope, and is overlain in places by alluvial sediments of variable depths. Where the alluvial (cover) sediments are thin to non-existent, the coral boundstone and calcarenite forms a relatively uniform, very hard sheet. The sediments and underlying water table are relatively saline to highly saline, and support a mixed halophytic vegetation community dominated by Saltwater couch (*Sporobulus virginicus*), and including Saltwort (*Frankenia* sp.) Saltbush (*Atriplex* sp.) and *Sclerolaena* sp. Salinity tests on terrace sediments near Tantabiddi Creek indicated salinities of 19,000 mg/L (19 parts per thousand). Field tests on water from natural sinkholes on the Tantabiddi terrace indicated salinities of 20,000 mg/L (20 parts per thousand; seawater is 35 parts per thousand). In localised areas along the eastern margin of the coastal dunes, the saline water table appears to be very close to the surface and saltwater couch and saltwort species dominate the vegetation cover.

The presence of saline (halopytic) vegetation species, and high soil and water salinities represent a major limitation to development on the Tantabiddi terrace. Firstly, it will not be possible to establish vegetation other than halopytic species on the terrace. Destruction of the existing vegetation would also lead to soil erosion. Secondly, it will not be possible to water surfaces within the developed areas without increasing surface and near-surface salinities and inducing further potential soil erosion.

### 4.2.2 Alluvial fans

Alluvial sediments form relatively discrete fans, which extend seawards in a triangular fashion from their exit points at the eastern margin of the Tantabiddi terrace. The

sediments are predominantly red brown (5 YR 4/4) sands and clayey sands, containing minimal chloride (0.1gm/kg or <0.01%). Lenses of coralline and limestone cobbles and gravel are common in the central and eastern portions of the fans, and may be present (although unsighted) in the western portions. The fans thin laterally (north and south) and longitudinally (east-west) and the sediment thickness is highly variable. Pit exposures in the central portions (east of the Vlaming Head to Tantabiddi Well road) indicate local minimum depths of 1.5 - 2 metres. Nearer the coastal dunes, thicknesses vary from 0.25 cm on the margins to 75 to >100 cm on the middle seaward end of the fans. Levee banks are common along creek margins.

The vegetation is dominated by Buffel grass (*Cenchrus ciliaris*) on the western portions, and *Cenchrus*, *Triodia* and *Acacia* species on the central and eastern portions.

The alluvial fans are well-drained, tend to have low chloride levels at least in the central portions, and are vegetated by the hardy Buffel grass which will limit wind erosion. They thus represent the best sites for development purposes. However, it is stressed that these fans are formed by deposition during run-off and storm flood events. To our knowledge, there is no information available on water or flood levels, flow rates and sedimentation rates for the west Cape Range streams, which would permit an assessment of the frequency of their inundation. Rainfall intensity and amount may be severe especially during cyclones. In a relative sense, only the alluvial fans are thus more appropriate for, and capable of sustaining development, than the coastal dunes and Tantabbidi terrace.

Three alluvial fans have been identified as potential development sites, and have been classified according to their capability to sustain development (Figure 1). Site 1 is situated at Tantabbidi Well extending from the National Park boundary 0.7 km northwards, and lying between the coastal dunes and the eastern edge of the Tantabbidi terrace (Figure 1). The small stream that is associated with this fan does not appear to be presently very active and its catchment is small.

Site 2 is situated four kilometres south of Vlaming Head (Figure 1), lying in the lee of the first bay south of the headland. The radial-shaped fan occupies an area approximately 0.8 km long (N-S) by 0.4 km wide. Here also the stream is small and active erosion and deposition processes do not appear to be significant. Catchment size is limited.

Site 3 is located around the Tantabbidi Creek area. This stream has the largest catchment in the area, and a relatively wide, deep, channel with a coarse cobble base. The channel is bordered by levee banks and the alluvial fan is relatively extensive. The alluvium is thickest nearest the creek channel and rapidly diminishes in depth north, south and west. Soils are saline and shallow in the area south of the creek betweeen the coastal dunes and approximately 50 - 100m east of the Vlaming Head to Tantabiddi Well road. Vegetation on the central portion of the fan principally consists of Buffel grass (Cenchrus). Site 3 is the least suitable of the three sites, because the stream appears to have greater competence and be more active than the other two sites noted above. In addition, the depth of alluvial sediment cover is highly variable (see Table 1).

**Table 1. Potential development hazard ratings for landforms of Vlaming Head to Tantabiddi Nell near-coastal region.**

| Map Unit | Hazard Rating | Limitations to Development | Planning Considerations |
|---|---|---|---|
| Dl, D2, D3, D4 | Very high | Wave erosion<br>Wind erosion | Areas where no form of development is recommended because of very severe physical limitations to development that are difficult to overcome. |
| T<br>F | | Saline soils and groundwater<br>Possible flooding<br>Variable soil depths and salinities. | Areas with severe physical limitations to development that will be difficult to overcome, requiring detailed site investigation and environmental design. |
| F1, F2 | Moderate | Wind erosion; and<br>Wind erosion of adjacent landforms; | Areas with moderate physical limitations to development. These limitations may be overcome by careful design, and by adoption of site management techniques to ensure site, and off-site surface stability. |
| - | Moderate-Low | - | - |
| - | Low | - | - |

# 5. Recommendations

The following recommendations are made:

(i) Any residential development should be restricted to the alluvial fans that locally overlie the Tantabiddi terrace.

(ii) Sites 1 and 2 on Figure 1 should be considered the most stable sites in the region, and ones that present the least hazard to development. Further drilling to test sediment depths and sediment and groundwater salt levels should be conducted before a firm decision to develop these sites is made. Site 3 cannot be recommended for development at this time. A more detailed land resource survey, and assessment of flood design levels would be required in the site 3 area if it were to be considered for development purposes.

(iii) Development on the adjacent coastal dunes should be restricted to pedestrian and boat access. It is important that the number of such access-ways should be limited, and carefully planned. No residential or recreational buildings should be erected on the coastal dunes. All dune vegetation should be retained.

(iv) A detailed management plan for protection and management of the coastal dunes should be drawn up concurrently with residential development plans. Such management plans should include adequate measures to restrict uncontrolled access onto the dunes.

# 6. Conclusion

The west Cape Range area has an arid climate, experiencing high winds and displaying a general lack of water. These factors, in addition to the geological nature of the area, place severe constraints on any development. Should development proceed, considerable effort will need to be expended in order to (i) create a residential environment free from the risk of land degradation, and (ii) protect the adjacent natural environment.

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