ATTACHMENT C

REPORT TO THE AUSTRALIAN HERITAGE COMMISSION

CAPE RANGE AND ADJACENT COASTAL PLAIN – ASSESSMENT OF GEOMORPHOLOGICAL VALUES

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EXECUTIVE SUMMARY

From the review of the material provided by the Australian Heritage Commission, discussion with the Objectors and wider considerations, it is concluded that a revision of the boundaries of the Cape Range National Register listing is appropriate.

Objections raised which relate to biological issues (specifically troglobite- and stygo-fauna) fall outside the concerns of this report, and hence are not discussed. Many of the other concerns are with possible problems resulting from listing rather than with substantive issues related to the bases for listing the area on the National Register.

The view is taken in this report that the proposed boundary changes do not provide the necessary regional integrity required by the geomorphology. Consequently, a modification of the proposed boundary changes is advocated. These additional adjustments would result in: (i) parts of the Learmonth region to be excluded from the area proposed for inclusion on the National Estate; and (ii) an extension of the southern limits of the area to approximately Ningaloo Homestead. These additional revisions use the geological (outcrop) boundary of the Trealla Limestone and Exmouth Sandstone and the southern limits of the uplifted reef/terrace complexes, to define the Cape Range and its associated terrains expression.

Attention is drawn to the need to adopt boundaries that acknowledge the regional integrity of the geomorphology. Individual terrain types, landforms or other geological features only attain their scientific and cultural significance when evaluated in their wider functional context. It is proposed that consideration is given to a revision of the 'statement of significance' to include a full recognition of the geological and geomorphological significance of the Cape Range.

It is recognised that the geomorphology and geology of the region have a context within the overall ecology of the region and that a greater understanding of the ecology of the area is required.

1. Introduction

The report undertakes an assessment of the geomorphological values of the Cape Range and adjacent coastal plain. The evaluation is undertaken in the context of the proposed boundary adjustments to the area to be included in the Register of the National Estate and the objections which have been raised to this proposal.

2. Specific aspects to be addressed:

(i) Is the database information produced by the Commission accurate and comprehensive?

The information provided is focused on biological concerns and while there is a very limited literature on the geology and geomorphology of the region, some relevant work has been overlooked. The references pertaining to work are given in Appendix 1.

(ii) Comment on those grounds for objection which relate to the national estate significance of the place.

Many of the objections raised appear to be based on misconceptions as to what inclusion on the Register implies. Some objections raised are not based on substantive points of direct relevance to National Estate listing, but are more concerned with anticipated difficulties which are perceived to follow from such a listing. It should be noted that as the report was commissioned to assess the geomorphological values of the Cape Range and adjacent coastal plain, specific objections which deal with biological concerns/considerations cannot be addressed. Implicit in a number of objections is the awareness that more work needs to be undertaken before the heritage value of the area can be fully assessed. This is a requirement for the Cape Range which needs to be met, and if achieved, should overcome the misunderstandings which may have led to some of the concerns of the Objectors.

Objectors and issues raised:

Exmouth Limestone-

(i) Duplication of Government Process – outside terms of reference.
(ii) Land Use Planning – outside terms of reference.
(iii) AHC Official Statement of Significance – the concern is with biological issues and consequently cannot be addressed.

Whitecrest Enterprises Pty Ltd

(i) Land Use Conflicts – outside terms of reference.
(ii) AHC Official Statement of Significance – much of this is concerned with various aspects of faunal distributions and their significance and hence falls outside the concern of this report.

The point is made that the area in the vicinity of the Whitecrest landholding has no special significance. This is a view which has to be reconciled with the need to define boundaries which provide a regional integrity to the geomorphology of the Cape Range. The geomorphological significance of the Cape Range cannot be reduced to simply listing specific attributes.

Department of Defence

The objections raised do not relate to questions of the geomorphological significance of the area.

Tap Oil N.L./ Sun Resources/ Victoria Petroleum N.L./ W.G. Martinick & Associates Pty Ltd/ Premier Oil Pty Ltd

No substantive objections are raised which have direct bearing on issues related to the geomorphological significance of the region.

It is claimed that the current listing already covers sufficient land. As far as the geomorphology is concerned, the present listing draws boundaries which exclude important geomorphological units. A justification of the proposed boundary revisions is given in other sections of this report.

Department of Minerals and Energy Western Australia

The objection raised does not question whether listing the Cape Range on the Register is appropriate, but requests to exclude areas of high resource potential. The request is based on the view that this " would still ensure the retention of the natural attributes that were used as the criteria for listing". It should be noted that the area identified as a proposed 5(g) reserve covers a large section of the southern Cape Range, some of which falls within the boundaries of the existing National Estate listing". National Estate listing appears not to have proven an obstacle for defining the extent of the proposed 5 (g) reserve.

Are the boundaries of the proposed area appropriate, given the significance of the place? What adjustments to the boundary, if any, are needed to define the significant area accurately and closely?

The proposed boundaries are suitable for the region north of Learmonth but some changes are suggested for the southern area – see below. The changes are proposed with the objective of defining a region, which is a sufficiently large and cohesive entity to capture the geomorphological integrity of the landscape pattern. This must be achieved in such a way as to reflect the functioning and dynamics of geomorphological processes and events, which 'patterned' the area. In order to provide some context for why the boundaries are proposed, a summary of the geomorphology of the Cape Range is given below. A more comprehensive description of the regional geomorphology is given by Wyrwoll et al. (1993).

The Cape Range region of northwestern Australia forms a distinctive north-northeast striking peninsular, set at an angle to the regional-trend of the coastline, and rising to a height of some 320 m. Uplift during the Late Cenozoic has resulted in the regionally dominant Cape Range Anticline. The resultant range reflects structural inversion involving reverse movement along a major fault, terminating in a blind-thrust, and leading to the folding of the Cenozoic cover. The compressional event, which forced the deformation, is thought to date to the Late Miocene (Malcolm et al. 1991), but there are regional indications of major deformation affecting likely Pleistocene units. The topography of the range essentially follows the geometry of the anticline, so that as the anticline plunges to the south and "opens-up" a lower relief expression is attained. At its northern limits, the range ends more abruptly and is bounded by low-relief terrains made up by a complex, possibly two, of aerially extensive Pleistocene marine morphostratigraphic units.

In response to uplift the range has been dissected, with deep canyons incised into the margins of the structure. The degree of dissection reflects both the uplift pattern and lithological controls – so that, in areas of Mandu Calcarenite (a soft, marly to chalky calcarenite), wide canyons are most strongly developed. Uplift and dissection has provided ready access to exposures of stratotypes of the various formations. Coarse conglomerate deposits form channel gravel sequences in the canyons which terminate in alluvial fans on the coastal plain. Small uplifted fan-delta gravel-complexes occur at the mouth of some canyons.

Weathering and dissolution of the limestones has led to the development of karst terrains, including extensive networks of cave systems (see Hamilton-Smith et al., 1998, for a general overview of the karst geomorphology). The Tulki Limestone is the dominant karst host, due to its lithological characteristics (partly marly foraminiferal packstone), the hydraulic implications this implies, as well as higher order structural controls – at joint and higher levels. Siliciclastic sand plains cover parts of the range and extend into the near-coastal region. The sands represent residues after the weathering of quartzose calcarenites. The sand plains have been partly reworked into dune forms, which are vegetated and are now largely stable. Distinctive dune fields occur both on the range and at the northern end of the peninsular. The northern linear "desert" dunes (two depositional events) have been partially dated using luminescence techniques and indicate more arid regional climates during the Pleistocene (Wyrwoll 1993).

For much of its extent the range is bounded by a narrow coastal plain. Extensive gravel complexes associated with alluvial fans cover large parts of the coastal regions. These represent the depositional response to uplift and incision. Along the eastern margin of the range, the fans are well entrenched in both their proximal and distal reaches. Channel modification is largely related to extreme discharge events, as is evident from estimates of the boundary shear stress necessary for large clast entrainment.

Pleistocene and possible Pliocene marine units are prominent in the morphostratigraphy of the coastal margins. They are best expressed along the western margins of the range, where a series of uplifted reef and near-shore/beach complexes result in a distinctive

terrace-staircase arrangement (Van de Graaff et al. 1976). Equivalent sea-level high stand units occur along the eastern margin of the Cape Range, with Last Interglacial (Marine Oxygen Isotope Stage 5e) fringing reef units being especially prominent (Veeh et al. 1979; Kendrick et al. 1991). In the Point Murat region of the northern most parts of the peninsular a Last Interglacial fringing reef unit has accreted on to what may be a Middle Pleistocene marine unit. But because of poor exposure little is known of the older unit. Also prominent along the eastern coastal margins are large composite 'linear mounded-ridge forms' dominated by stratified gravel-shingle, with some interbedded sand. These represent storm-beach deposits of Pleistocene and Holocene age and make up the Mowbowra Conglomerate Member (van de Graaff et al., 1980). A fringe of Holocene coastal deposits occurs throughout the region. These take the form of a coastal dune complex, associated beach and beach-face deposits and tidal flats. From stratigraphic evidence it is apparent that the Holocene sealevel highstand in this region may have been less than one metre above present sealevel.

The summary of the geomorphology was provided to emphasise that the Cape Range region possesses a comprehensive set of geomorphological attributes which combine to provide a distinctive regional landscape of significant scientific importance. Appropriate boundaries must be drawn so as to recognise the interplay of Late Cenozoic uplift, carbonate terrains, denudational processes, channel incision and canyon formation – fan deposition and sealevel events. It is the interplay of these processes and events that have given the region its distinctive geomorphological signature, and it is important that the boundaries adopted reflect this. The geomorphological significance of the Cape Range region cannot be reduced to simple listing of individual features. A regional perspective provides the integrated and functional context that leads to a scientific explanation of the geomorphology.

Figure 1 shows the boundaries which are considered appropriate to capture the geomorphological integrity of the wider Cape Range region. For the region north of Learmonth proposed boundaries follow those in the revised listing. However, the suggested boundary lies to the west of Learmonth airport and the associated military facilities. South of Learmonth the boundary follows the outcrop limits of the Trealla Limestone and Exmouth Sandstone, extending west to immediately north of Ningaloo Homestead. The area was extended to Ningaloo Homestead so as to include the southernmost extent of the uplifted reef complex, which characteristically defines the western edge of the Cape Range. By suggesting these boundaries the entire Cape Range and associated terrains are included in the area to be considered for listing as part of the National Estate.

Some specific points in the context of the boundaries proposed:

Inclusion of the North West Cape/Point Murat region

While this area is extensively disturbed it forms an integral part of the geomorphological structure of the wider Cape Range region. It consists of the Pleistocene marine units which have 'extended' the range. The region also contains distinctive and important dune terrains, which are of significance in their own right, but also form an integral part of the regional geomorphology.

Exmouth townsite
The townsite is excluded from the revised boundaries. The boundaries suggested by this report follow this suggestion as a matter of convenience. In this recognition is given to the fact that the townsite and its activities impart a strong and distinctive landscape imprint, to the extent that the townsite should be seen as an entity in its own right.

Learmonth Plain
The boundaries proposed lie to the west of Learmonth airport and the associated military installations. The boundary was drawn to give recognition of the fact that in this area there is the development of a broad coastal plain and associated linear dune terrains and that these define a boundary to the Cape Range terrains.

Given the definition of the "National Estate" contained in the Australian Heritage Commission Act and the criteria illuminating that definition, does this place, in your opinion, warrant entry in the Register?

It is my view that in terms of its geomorphology the Cape Range region qualifies as a place to be included in the National Estate on the basis of:

CRITERION A:
A.1 and A.2: The region is of importance in the evolution of the Australian landscape and landscape and geological processes generally. It exhibits an unusual richness of landscapes.

The region offers rare insight into operation of neotectonic processes and the geomorphological response they invoke in carbonate terrains. In addition to the geomorphology associated with the processes of karst formation, the region has extensive uplifted fossil reef tracts, terraces and other evidence indicating past sealevel events. The fossil reefs are mirrored in the present barrier and fringing reefs of the area. Significant areas of desert dunes attest to repeated climate changes in the Pleistocene. When combined, these elements form a landscape, indicative of the operation of geological processes, which has no equal in Western Australia.

CRITERION B:
B.1: The Cape Range region has a natural landscape which sets it apart from all other parts of Western Australia. When viewed from the continental scale, the geomorphology of the western part of the Australian continent is generally seen as being characterised by areas of low relief, limited erosion potential, tectonic stability and a long history of subaerial denudation. Instead, the major landscape elements of the Cape Range region are young, show marked relief related to recent tectonic activity, with distinctive carbonate/karst terrains. It should also be noted that because of the rugged nature of the terrains and the limited access, parts of the Cape Range have wilderness attributes.

CRITERION C:
C.1 The Cape Range is of considerable importance as a source of information to a wider understanding of Australian geological, paleoenvironmental and landscape evolution. While still only a very limited amount of geological and geomorphological work has so far been undertaken in the area, it is clear that the Cape Range region poses important scientific questions and opportunities.

At the most general level the Cape Range region offers the opportunity to study the relationship between tectonics and the denudational response specific to a carbonate terrain. Given its deformation style the Cape Range offers a structural setting which facilitates, as a first approximation, the development of relatively simple 'conceptual' models of the relationships between karst development and style of deformation/controls over Late Cenozoic time-scales.

Examples of more specific research issues which can be addressed:

(a) Detailed understanding of the nature and timing of tectonic activity and implication for wider understanding of the Cenozoic history of northwestern Australia.
(b) Karst developments and relationship to uplift, climate processes and sealevel events.
(c) Details of karst hydrology and the relationship to stream entrenchment
(d) The occurrence and paleoclimatic/ecological significance of cave sediments.
(d) Dating of speleothems and determination of their paleoclimatic significance.
(e) Dating and evaluation of the evidence for sealevel changes.
(f) Dating of terrestrial dune sequences and the evaluation of their wider paleoclimatic significance.

These questions have been formulated so as to illustrate the area's importance to research in relation to geomorphology, geology and global environmental history.

CRITERION D:
D.1: The karst terrains of the Cape Range have been identified as a representative class of Australia's natural environments (Hamilton-Smith et al., 1989). The uplifted fossil reef/terrace complexes also comply with this criterion.

Do you have any comments on the integrity of the place, or other views of a technical nature, which may assist the Commission in deciding whether the place should be entered in the Register of the National Estate?

The geological and geomorphological importance of this area directly emerges from even the relatively sparse volume of work that has so far been undertaken (summaries in Wyrwoll et al., 1993; Hamilton-Smith et al., 1998). This claim is reinforced by inclusion of the Cape Range in the listing of Carter (1987) as a place of geological significance.

It needs to be remembered that the geomorphology and geology of the region have a context in the wider ecology of the region – being elements of the wider geoecology. It is my view that in considering the listing of the region for inclusion on the National Estate, recognition must be given to the importance of the wider ecology of the region. A summary overview of the ecology of the Cape Range region is given by the collection of papers provided by Humphreys (1993), and this collection could be used as a starting point for an evaluation of the significance of the regional ecology.

4. References

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Appendix 1 – Additional References

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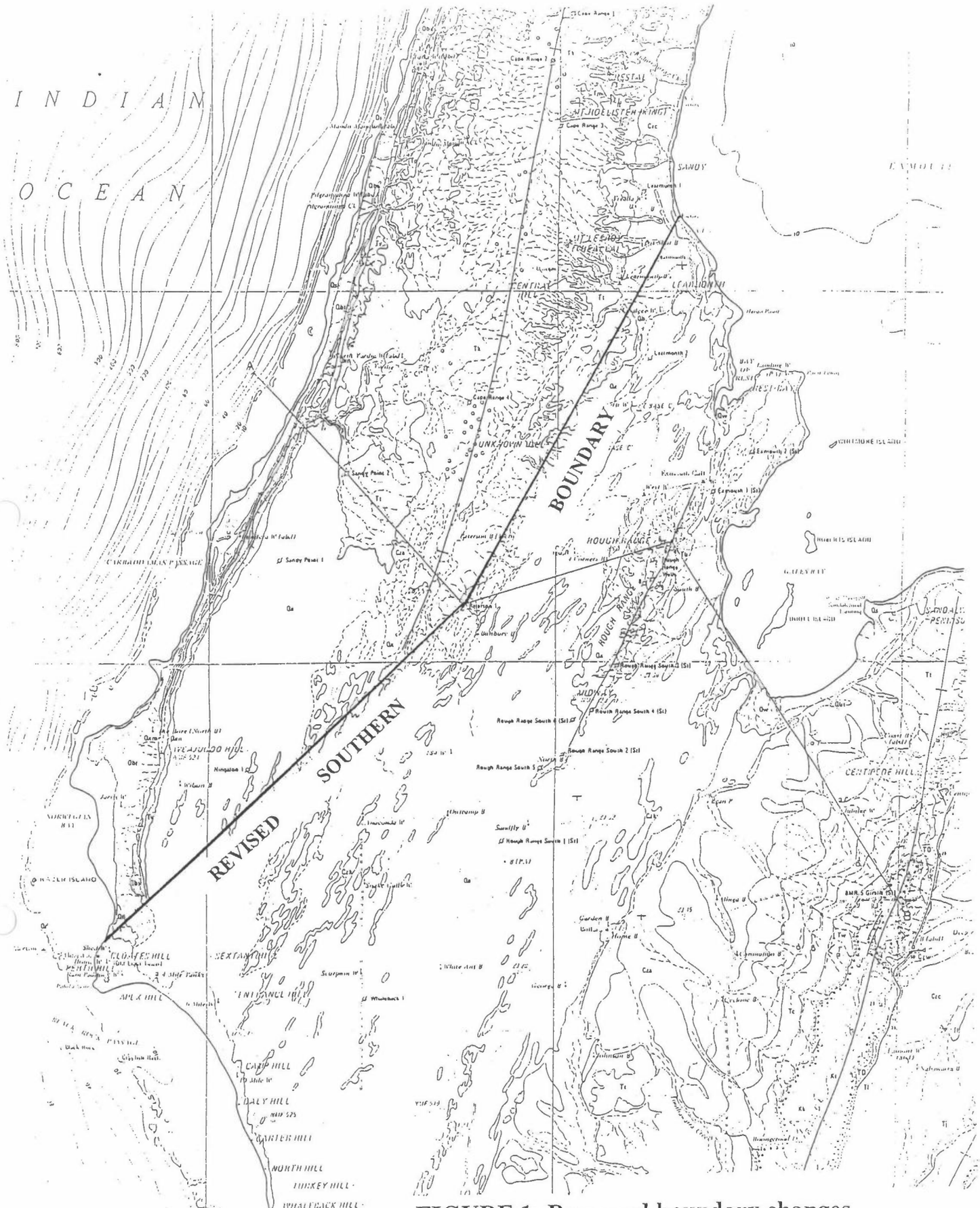

FIGURE 1: Proposed boundary changes for the Cape Range National Register