

APPENDIX A: Copy of the proposal for the current investigation

APPENDIX B: Minutes of the scoping meeting of 9 March 1993

APPENDIX C: Summary of Late Gondwana to Recent geological events along the Natal Coast

APPENDIX D: Geological history of the Lake St Lucia region and the Zululand coastal plain

APPENDIX E1: Summary of features in the borehole logs of Davies, Lynn and

Copy for

RG(M) - Durban

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DIVISION OF EARTH, MARINE AND ATMOSPHERIC SCIENCE  
AND TECHNOLOGY, CSIR

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FURTHER INVESTIGATION OF THE GEOLOGY AND  
GEOHYDROLOGY OF THE DUNE CORDON ON THE EASTERN  
SHORES OF LAKE ST LUCIA

by

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## EXECUTIVE SUMMARY

After studying a draft version of a report by Dr V Semeniuk on an investigation conducted on behalf of the Natal Parks Board and entitled "Assessment of impact of proposed sand dredge mining operations Lake St Lucia area - A declared Ramsar site (1992)", the CSIR commissioned a study to investigate the main concerns listed in this report. A scoping meeting involving staff of Richards Bay Minerals (RBM), the Natal Parks Board (NPB) and the CSIR was held during which it was agreed that the main questions to be answered were:

- Is there geological evidence of layering within the dune that will impede the vertical flow of water through the dune?
- If such layers are present, what is the nature and extent of these layers?
- What effects do these layers (if present) have on the dune vegetation?
- Will the presence and nature of these layers significantly change the results of the geohydrological modelling done by Kelbe and Rawlins (1992)?

In order to address these problems, it was further agreed at this meeting that:

- 1) NPB officials, in consultation with Dr Semeniuk, would identify suitable sites for approximately six new boreholes in such a way as to address the concerns raised by the NPB and at the scoping meeting.
- 2) Drilling would be confined to the "coversands" ( that is, the uppermost, unconsolidated sand containing heavy minerals and extending to a depth of up to 70 m as defined by Davies, Lynn and Partners, 1992) and a few metres into the underlying, presumably calcretised, succession. Detailed geological descriptions of each borehole would be made by the project team. Water levels would also be determined for individual boreholes where possible.
- 3) Borehole descriptions of 29 boreholes previously drilled by Davies, Lynn and Partners, selected in a way as to be representative of the area, would be carefully re-examined for indications of the existence of a weathered horizon, particularly at the interface between the "coversands" and the directly underlying formation.

- 4) At the request of the NPB, Mr McCarthy would compile a short description of the geological history of the Eastern Shores and the northern Natal coastal plain in general.
- 5) The NPB would monitor the response of water levels in boreholes during heavy rainstorms in order to assess recharge by rain water into the dunes.

The questions listed above were addressed by firstly establishing a clear understanding of the geological history and processes that operated in the area. This was done by compiling available published geological and related information on the area, analysing the geological descriptions of previously drilled boreholes, studying samples from the 37 newly drilled boreholes, visiting geological exposures in the area (and especially the quarry near Cape Vidal since it provides the only known outcrop with exposures of the dune cordon interior) and studying relevant reports prepared for the St Lucia EIA.

A major point which was established during the present study is the realisation that the coastal sediments, including beach and dune sands, which constitute the dune cordon east of Lake St. Lucia, are remarkably uniform, essentially quartzose sands with very little (<5%) feldspar and shell fragments. Samples taken from modern beach and dune sands at Cape Vidal and from the high dune inland of Cape Vidal also all demonstrate a marked paucity of feldspar grains.

All features pertaining to clay production and illuviation, primarily arising from the breakdown of feldspar mineral grains, which are so noticeable in the vicinity of Richards Bay and southwards along the coast, are reduced to almost negligible proportions in the 'coversands' of the Kingsa/Tojan lease area. This paucity of fines has important implications for the possible presence, size and extent of semi-impervious or impervious layers (aquatards and aquacludes respectively) within the aeolian sands comprising the 'Coversands' and 'Older Aeolianite' of the Kingsa/Tojan lease area.

Fine-scale colour banding evident in the quarry south of Cape Vidal is due to variation in the colouring of the sand grains. This does not appear to affect the high permeability of the sands nor is the ground water flow direction and rate modified by the presence of these colour bands. Mason (1992) also gives abundant evidence to prove that it is impossible for fine sediment (silt and clay) to migrate through the coarser unconsolidated dune sand so as to create layers enriched in fines.

Certainly, no significant development of laterally extensive or vertically significant fines-rich layers is evident in field exposure within the quarry or in any of the boreholes within the

proposed mining path or the mining lease area. The current drilling operation did not provide any evidence of perched water levels within the dune structure. Nor was evidence found to substantiate claims in the report by Semeniuk (1993) of the presence of clay layers in the dunes which might act as a mechanism for generating perched water levels; or to control the movement of ground water in the dune cordon significantly. From this it must be concluded that perched aquifers cannot act as a source of water to the wetlands. As a result of these observations the role of clay layers in the dune structure as controlling mechanism for localised variations in the soil moisture, and hence the vegetation, is questioned. Thicker, fines-rich layers are apparent in estuarine sediments of the lower-lying areas within the wetlands of the Eastern Shores region of Lake St Lucia, but these are outside the proposed mining path and close to the present water table. They will thus not be affected by the proposed mining process which will never approach the depth of the water table within the proposed mining path. Reference by Semeniuk (1993) to the possible presence of "high level impermeable or less permeable layers" which "can result in perched aquifers", in part based on the presence of illuviated clay layers in Quaternary dune sediments as reported by various authors in reports on the coastal areas of Natal, does not apply in the Kingsa/Tojan lease area because of the limited presence of fines (both primary and secondary) in the dune sediments from this area.

A study of the sediment profile in the quarry near Cape Vidal, along with that of the sand samples from the recent drilling, brought to light some important differences between the red sand profiles on aeolianites in the dune cordon east of Lake St. Lucia compared with areas further south along the Natal coast. The development of red sands on older aeolianites along the Eastern Shores of Lake St. Lucia is markedly different to that evident elsewhere in Natal. It is the view of the present study team that the borehole samples provide no conclusive evidence for the existence of a 'Coversand', that is, a separate and younger coastal dune sand deposit, overlying the older aeolianite. The situation of a dune cordon comprising multiple generations of dune development has been observed elsewhere in Natal and it was suggested that a similar situation might apply in the Kingsa/Tojan lease area. Weathered soil profiles, together with illuviated horizons might have developed with time on these surfaces in which case they could possibly act as either aquatards or aquacludes. No evidence for such soil profiles could be found in any of the boreholes drilled during this investigation nor could evidence be found in the borehole descriptions prepared by Davies, Lynn and Partners. A well defined soil horizon, such as that at the top of the Port Durnford Formation at the current RBM mining operations, is not apparent east of Lake St. Lucia. The presence of calcarenites at depth may simply be a function of the degree of alteration of the dune sediments at higher levels with associated leaching of carbonate shell fragments and the

precipitation of carbonate cement at greater depth. In view of the lack of weathering or other lithological horizons which may be linked to the sequence of formation of the dune deposits in this area, it is neither possible nor relevant to derive an unambiguous age structure for the various units present.

Water levels determined during this study are consistent with those described by Davies, Lynn and Partners (1992). In all cases the static ground water levels are not more than 8 metres above mean sea level. An important feature which is apparent from the Davies, Lynn and Partners (1992) investigation is that the ground water divide in the area between the eastern shore of Lake St. Lucia and the sea, is situated west of the dune cordon. This is also confirmed by the current investigation. Nowhere is this ground water divide within the proposed mining path and in only one instance is it within the Tojan lease area. The closest point at which the ground water divide approaches the proposed mining path is in the area modelled by Kelbe and Rawlins (1992), supporting their choice of this locality for worst-case modelling purposes since this area probably reflects the highest proportion of ground water flow towards the lake in the entire lease area.

It is thus apparent that water which infiltrates the dune cordon and reaches the ground water table, i.e. through rainfall, mining, etc and which does not leave the dune cordon as surface flow, will flow eastwards towards the sea. The dune cordon does not act as a major reservoir for ground water supplying Lake St. Lucia and, contrary to the statements of Semeniuk (1993), it is unlikely that ground water levels in the wetlands will be significantly affected by ground water flowing from the dune cordon towards Lake St Lucia. This is in agreement with the results from the simulation done by Kelbe and Rawlins (1992).

Unlike the situation at the present RBM operations south of Richards Bay, the low permeability zone at the top of the Port Durnford Formation is situated well beneath sea level and direct comparisons between the geohydrology of the present and proposed mining operations are not appropriate. The geohydrological conditions around Lake Sibayi, approximately 100 km north of the Kingsa/Tojan lease area provides an additional important constraint for potential ground water flow in the dune cordon east of Lake St. Lucia. Water from Lake Sibayi escapes through and below the dune cordon east of the lake and exits on the beach as springs beneath mean sea level. A similar situation may well be found to occur for the Kingsa/Tojan lease area if mining is permitted. The seepage pattern, based on stable isotope and water chemistry evidence, suggests low ground water levels similar to those found at St Lucia. The water seepage in such a case would not induce the elevated water table in the dunes, as hypothesised by Semeniuk (1993), hence extensive erosion induced by

elevated water tables in the dunes is not anticipated.

On the main questions addressed in this report, all information indicates that there is no evidence for a geological layered structure in the dune cordon that would impede vertical ground water flow in the dunes. The dune vegetation will therefore not be affected and the simulation of geohydrological conditions done previously can be accepted.