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MANAGEMENT OF THE MFOLOZI FLATS

A PROPOSAL

by

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INTRODUCTION

This report was compiled in response to an inquiry from Mr PG Reyneke, Department of Environment Affairs, dated 8 September 1986. The aim of this report is to comment on various aspects of the Mfolozi Sandflat management plan as submitted by the **ad hoc** Planning Committee. Thus this document addresses the future use of the section of the Mfolozi Flats, expropriated by the State after cyclone Domoina, that is considered unproductive for sugar cane. In its present condition the land presents, in the short term, a threat to farmlands and downstream estuaries but in the longer term could serve as an important sediment trap. Considering the above, this report specifically addresses two of the objectives of the **ad hoc** Mfolozi Sand Plain Planning Commission. These are:

1. To prevent further sand movement by wind or water on to adjacent agricultural land and into the estuarine and marine environment, and

2. To retain the function of the area as a natural floodplain and sediment trap in times of flood.

In the latter part of the report a management plan for the flats is proposed. Such a plan takes into account the natural floodplain processes, is cost effective, and eliminates the need for a major dam on the Mfolozi River.

ENVIRONMENTAL SETTING AND NATURAL FUNCTION OF THE MFOLOZI FLATS

A brief outline will be presented below. For a more detailed discussion of the Mfolozi Flats/St Lucia problem the reader is referred to the publication "Fluvial Processes in the Mfolozi Flats and the consequences for St Lucia Estuary" by van Heerden and Swart contained in the proceedings of the 2nd South African National Hydrology Symposium (see appendix).

The Mfolozi Flats forms the coastal plain or receiving basin of the Mfolozi River.

levees or banks during floods and most of the sediment would have been deposited on the flats. Consequently, during floods the sediment-free waters reaching the coast would have scoured out the combined St Lucia/Mfolozi estuaries such that this system was never stressed by the input of excessive sediment.

In the late 1920s channelization of the Mfolozi River was undertaken. After 1927 the river waters only overflowed the artificial levees, constructed by the farmers, during large floods so that most of the Mfolozi sediment load was transported through the flats to the coast. Sedimentation became such a problem in the estuaries that in 1950 remedial measures were started. This costly dredging activity continues to the present. It is extremely important to note at this juncture that the major long-term problem in the St Lucia system is **sedimentation.** Once sediments enter the estuary or the lake they are extremely difficult to remove. In addition, dredging is costly and in systems like St Lucia can be extremely harmful to the environment. The more "spectacular" problem, highlighted in the media, associated with salinity is now thought by scientists to be not as serious as earlier workers speculated. The St Lucia system is very resilient in terms of salinity extremes and bounces back readily. However, if fresh water extraction from its tributaries was to increase, salinity fluctuations could become a far greater problem.

During cyclone Domoina, a major channel switch occurred and vast amounts of sediment were deposited on the Mfolozi Flats while the Mfolozi and St Lucia Estuaries were deeply scoured. These responses to a flood-induced channel switch demonstrated the ability of the flats to retain river-borne sediments. Consequently the relatively sediment-free floodwaters were responsible for scouring both the Mfolozi and St Lucia Estuaries.

THE SAND DEPOSIT

On 22/10/86 I toured the sand flat area by 4-wheel drive with Mr H de Waal of the Sugar Co-op and on 24/10/86 I flew the area with Mr RH Taylor of the Natal Parks Board.

The sands do not appear to present a major sand blow problem. The Napier Fodder planted by Forestry acts as effective sand barriers and hummocky dunes are forming where natural vegetation has taken hold. Lower-lying areas of the sand flat are very well vegetated, specifically around the pans that exist along courses cut during cyclone Domoina. Various species of water fowl were seen at all the pans.

It was surprising how vegetated this supposedly "barren" deposit had become and it appeared that a period of good rains would do much to encourage the spread of vegetative cover. The most serious problem with the flats in their present condition is the effect of another Domoina occurring in the immediate future. Response to a major flood would be largely dependent upon the type of vegetation cover and human utilization - including the earthworks, spillway etc constructed by the farmers.

FUNCTION OF THE SAND DEPOSIT

Ideally, an area is needed on the flats that could be used to trap flood sediments such that farmland is not destroyed nor is the St Lucia System stressed more than at present. Because of flood plain processes and hydrodynamics the trap site should have the following attributes.

1) It should be located in the upper flats, close to where the rock-confined, river-valley waters start to spread out as they move downstream with attendant velocity reductions.

2) The site needs to have an elevation lower that the river levees and must be of such a size to accommodate many millions of cubic metres of sediment.

3) The trap site should have a vegetative cover that would encourage sedimentation.

4) Some earthworks to improve the traps ability to retain sediments may be necessary.

The 2500 ha of expropriated land **has** these characteristics.

1) It is located in the upper section of the flats.

2) In general, the sand surface varies between +7m above sea level at its easterly edge (along Msunduze River) to +17m at its northwest edge. The river levee height varies in from +20m near the SAR bridge to +17m opposite the easterly limit of the sand deposit. Similarly the base of the Mfolozi River varies from +14.5m to +12.0m (Information from orthophotos compiled by Aircraft Operating Company (Pty) Ltd for Umfolozi CO-OP Sugar Planters Ltd). The fact that the sand flat lies at or below the base level of the river together with the 8m fall across the sand deposit in a north-south direction means that the flat is a large depression in which sediments could be trapped (Figure 1).

It must be pointed out that utilizing data given to me by the CO-OP would suggest that previous estimates of the volume of sand deposited during Domoina, namely $80x10^6m^3$, is much too high. My own estimate is that Domoina deposited $12x10^6m^3$ of sediment.

Arithmetically, it can be shown that the sand flat area had the potential, before Domoina, to trap $96x10^6m^3$ of sediment. Thus it still has the ability to trap an additional $84x10^6m^3$. Assuming an average annual sediment load of $1.5x10^6m^3$ and loads for Domoina - sized floods of $12x10^6m^3$, the trap site could retain another 7 Domoinas or 54 years of the normal sediment load.

3) If the sediment trapping function is considered important, then the sort of vegetation cover utilized necessitates careful consideration. My work in coastal Louisiana plus that of others in similar environments, has shown that trees have numerous effects on sedimentation on flood plains (Coleman 1976, Van Heerden 1983).

I Trees planted in patches, irrespective of tree spacing, force the flow around the patches such that erosion is enhanced in areas where no trees occur. As a result sediment is transported past the area with trees to locations farther down stream. If the Mfolozi sand deposit was planted with trees sediments could bypass the sand area, with possible scour on the outer fringes, and be deposited on farm lands farther seawards.

II Sedimentation within a stand of trees is limited because flow velocities are dramatically reduced at the outer edge of the trees due to the frictional effects of the trunks and foliage.

III There is a tendency for the outer edges of the tree stand to collect debris and to collapse leading to the formation of a very effective debris barrier to sediment penetration into the tree stand.

If the prime aim is to stabilize the area then trees would no doubt work as well as grass. However, if the aim is stabilization plus sediment trapping then a long stalked grass would form the best cover. Such grass has important attributes.

1) The roots help bind the soil,

2) The long stalks, when knocked flat in a flood, tend to add an additional protective layer to the soil.

4) Limited earthworks would enhance the sand flats ability to trap sediments. These will be expanded upon in the next section.

A LEAST INTERFERENCE MANAGEMENT PLAN FOR THE MFOLOZI FLATS

1. Rationale

Geomorphological relationships, as determined from the 1937 aerial photographs, reveal that the present sand area used to function as a sediment trap during floods. The river upstream of the bend marked A on Figure 1 was very wide. However the width narrowed significantly at the bend A. Leading off from the bend in a south easterly direction was a linear depression 300m wide and approximately 1km long. Point A then was where the Mfolozi flow bifurcated during floods and the linear depression had the potential to divert large volumes of flood waters over the sand flat area during floods. This point would also have been the location of the next major channel switch on the flats if artificial levees had not been constructed.

The orthophotos of 1977 reveal that the depression was still present and that approximately 500m along the linear depression the base was 4m below the height of the natural levees of the river. The same ortho photos show that 1500m down the linear depression, the base level in 1977 was equal to that of the river. Due to these topographic relationships, point A was still a potential diversion point even after the farmers constructed their artificial levees and this was the point where the channel switch occurred during Domoina. The linear depression served as the main feeder of Domoina waters and is present today as an even longer depression, bounded by the "new" sand deposits. During Domoina a well developed distributary channel network was formed leading off from this main channel. This delivery channel "infrastructure" is still present and would ensure the distribution of any future flood derived sediments over the whole area. As revealed earlier, the sand flat area has dimensions capable of trapping 7 Domoina-sized floods or 54 years of normal deposition. If one assumes a Domoina every 30 years then the sand flat would reach saturation by the year 2034 (assuming 1 Domoina and 48 years of "normal" sized floods). In other words the sand flats, if properly managed could store the next 50 years worth of Mfolozi River sediment. This is ample time to start to address the problems in the catchment.

2. Implementation

Here one has to look at the following:

- sediment feeder or inlet
- sediment distribution
- protection for downstream farm lands

i) **Sediment feeder** The low linear depression located at Point A (Figure 2) has operated as a flood-water diversion point for many decades and was the course chosen during Domoina. It still exists as a depression with its base level similar to the base level of the Mfolozi River (i.e. +14.5m above sea level). If a weir was constructed at the diversion point with an overflow height of 16.5m above sea level then the normal river flow would be confined in the river. However, higher than normal flow would spill into the sand flat (trap depression).

ii) **Sediment distribution** As mentioned earlier, the distributary channel system created in the trap depression during cyclone Domoina is still more or less existant. Therefore, there should be no real problem in the distribution of the sediment load over the surface of the trap depression. As the sand flat is a natural fluvial delta, most of the sediment will be deposited at the upstream ends. The trap surface will continue to slope downstream and with time this slope or delta front will migrate downstream.

Initially, to assist stabilization by vegetation, some fertilization plus seeding with indigenous long-stemmed grasses would be required. Becaused the area is to act as a sediment trap in all but normal river flows fine-grained organic-rich sediments will, from time to time in averaged-sized floods, be deposited in the trap depression - such will improve the fertility of the soil in the long term.

iii **Protection for downstream farmlands** A berm or weir could be constructed across the lower end of the trap depression linking the artificial levees bounding the Mfolozi River to the high ground to the south. (Figure 2). If the weir had a height of +13m it would be about 1m higher than the base of the Mfolozi River at this point. The weir would then be 3m above the surrounding sand flats.

The Msunduze River, which lies along the southern edge of the trap depression, could

serve as the main conduit for the **sediment-free** waters leaving the trap during floods. A solid spillway with a height of +12m above sea level could be constructed for the width of the Msunduze River. Flood waters would then traverse the farmlands to the sea, causing minimal damage due to too high a sediment load.

The present spillway and other constructions developed by the farmers could, with some modification, be incorporated into the proposed management plan. However, any feature which serves to restrict the spreading of sediment over the trap depression would have to be suitably modified.

4. Utilization

The trap depression could serve as a waterfowl hunting reserve. It would be surrounded by high ground and if firearms were restricted to shotguns, then there would be no danger to nearby farm workers.

As sediments accumulate in the trap, the higher-lying upstream portions may attain elevations which would become suitable for growing sugar cane. However, once again farm roads, tracks etc should not interfere with the free movement of sediment.

5. Costs and Benefits

I am not in a position to speculate on the actual costs of implementing this plan. However, the farmers claim that a large dam on the Mfolozi, within the game reserve, would be the best proposition. They do not have a water problem thus their main reason for a dam would be as a sediment trap. Correct utilization of the Mfolozi Flats as a sediment trap would require minimal construction and would be far cheaper than a large dam on the Mfolozi River. Secondly, prime game reserve lands are hard to come by. Refraining from building a dam would ensure that the Mfolozi Game Reserve is not adversely affected. There must be a real value to maintaining this game reserve as a foreign exchange earning feature.

The dredging at the St Lucia mouth is costing an estimated R1 million p.a. Correct utilization of the Mfolozi Flats would reduce the sediment load reaching the estuary and hence reduce the cost of dredging. The St Lucia Link Canal is of no value at present due partly to its location and partly to too high sediment loads in the river. An effictive sediment trap on the flats could mean an operative Link Canal.

SUMMARY

The management plan proposed in this document requires:

1) That there be a free, open conduit for higher than normal river flows to enter a sediment trap area,

2) That sediment-laden waters be able to spread unhindered over the trap depression, and

3) A seaward berm with a spillway into the Msunduze River such that sediment-free waters can pass freely to the coast.

The benefits include,

1) No costly dam on the Mfolozi River,
2) No destruction of Mfolozi Game Reserve lands,
3) Sediment trapping to the benefit of both farmers and the St Lucia/Mfolozi estuarine systems,
4) A new hunting reserve and possibly new sugar lands,
5) Reduced dredging costs at St Lucia, and
6) Possibly, that the St Lucia Link Canal may be usable in the future.

The plan offers a fairly natural solution to a natural problem enhanced by man's activities. However, ultimately the problems in the catchment will have to be addressed.

For the plan to succeed, requires co-operation and imaginative thinking from all parties.

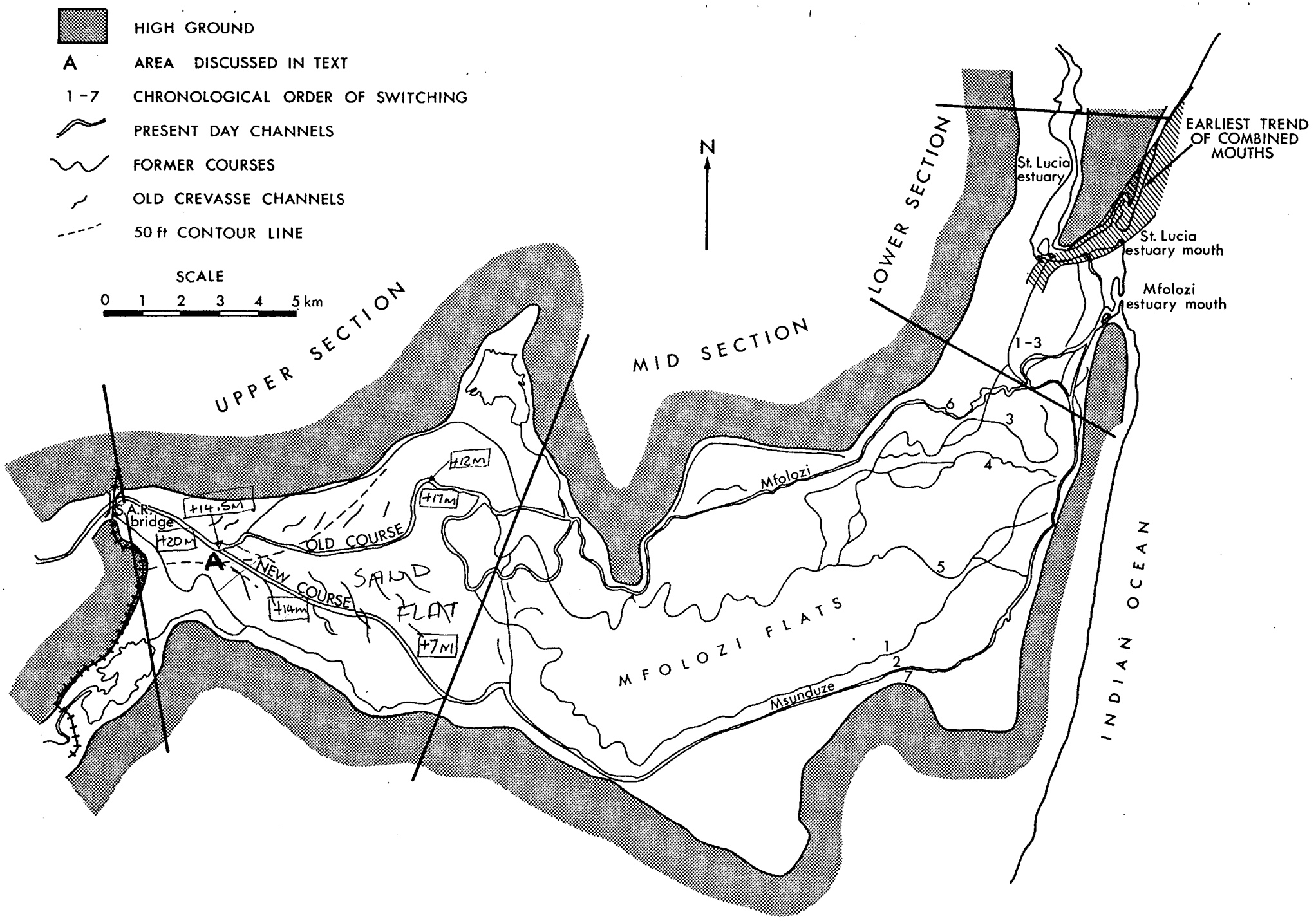

FIGURE 1 Former and present courses of Mfolozi River, note height relationships.

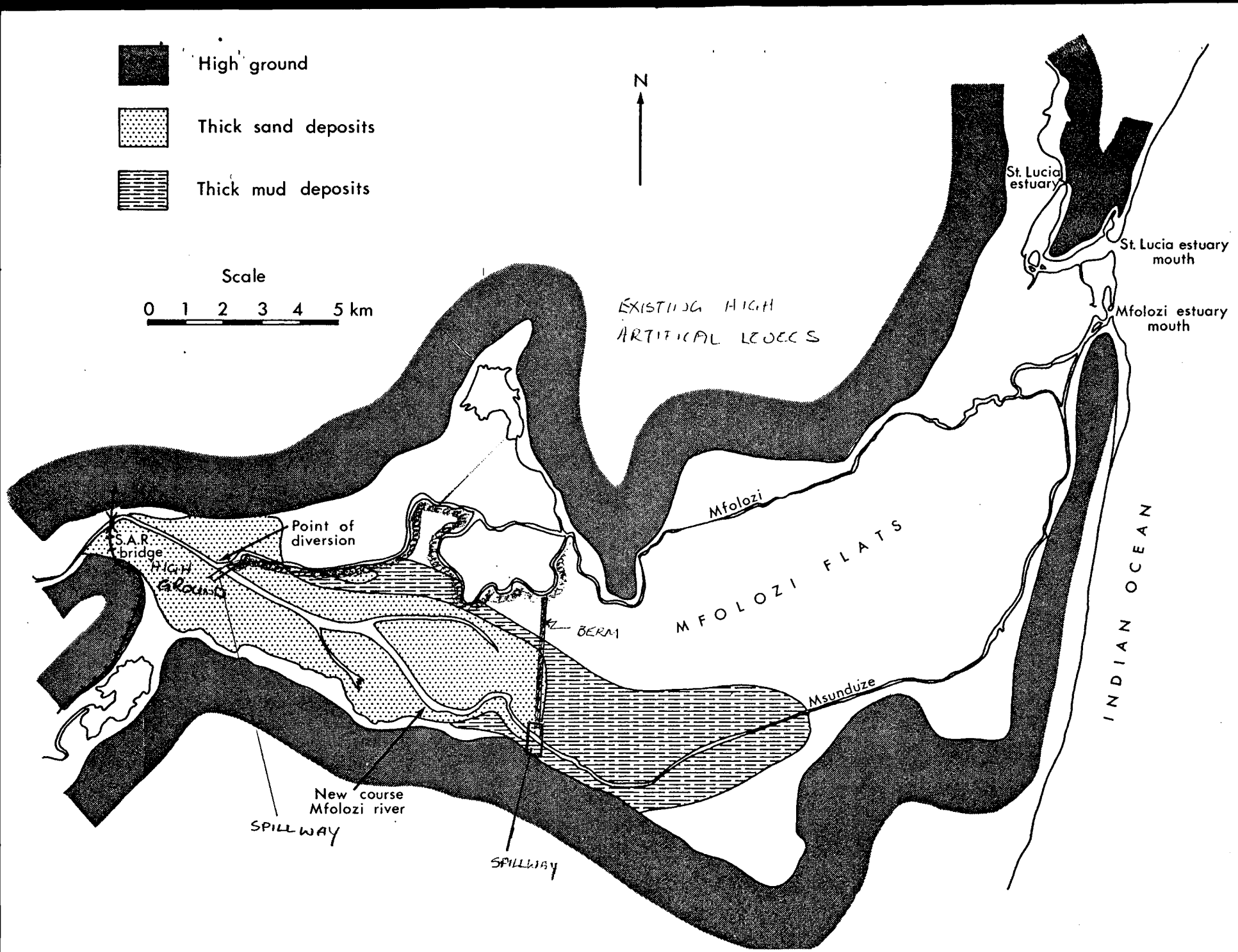

FIGURE 2 Domoina flood deposits and location of proposed earthworks.

APPENDIX

"FLUVIAL PROCESSES IN THE MFOLOZI FLATS AND THE CONSEQUENCES FOR ST LUCIA ESTUARY"