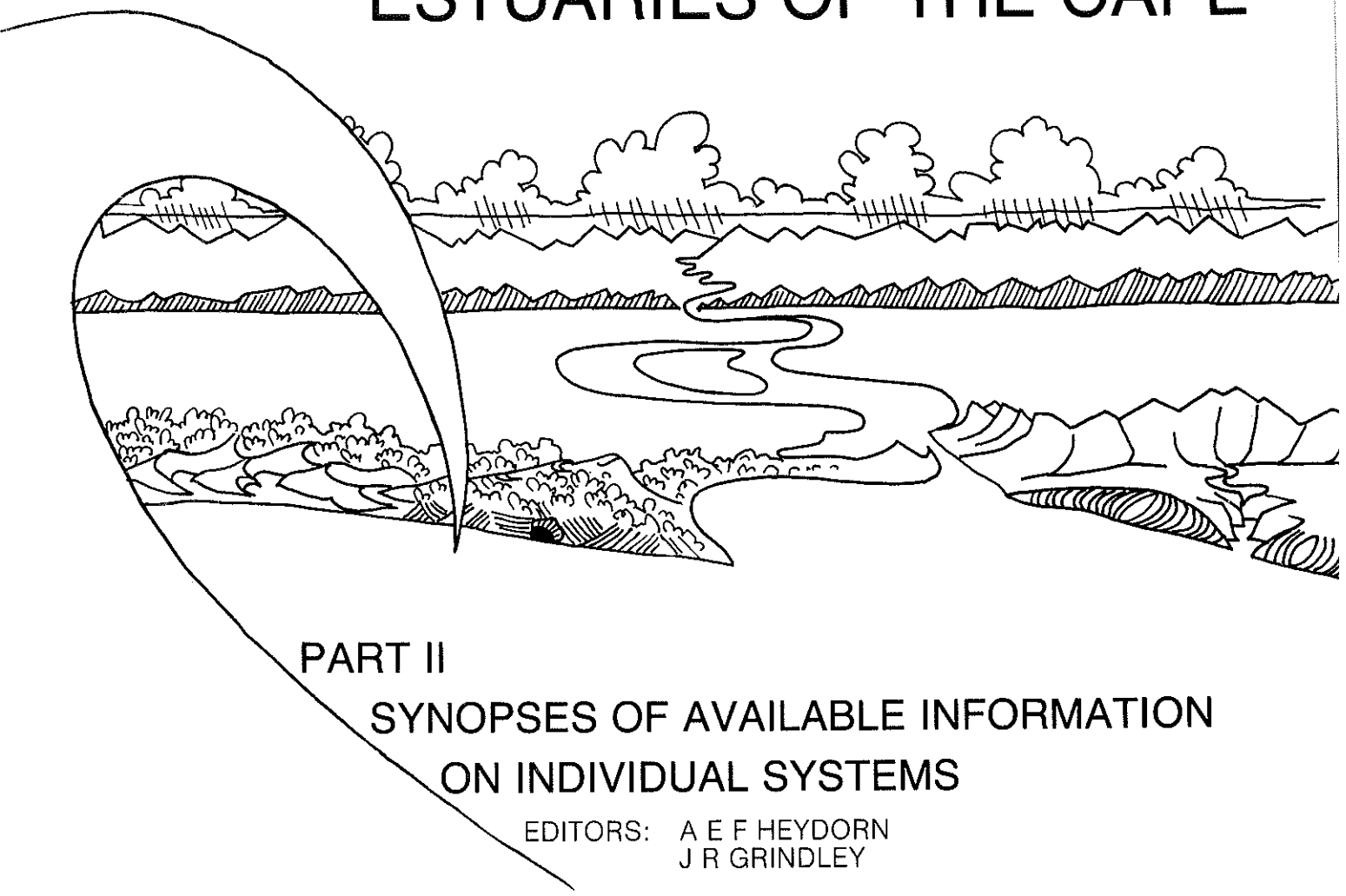
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY
ESTUARINE AND COASTAL RESEARCH UNIT – ECRU

ESTUARIES OF THE CAPE



PART II
SYNOPSES OF AVAILABLE INFORMATION ON INDIVIDUAL SYSTEMS

EDITORS: A E F HEYDORN
J R GRINDLEY

REPORT NO. 17
LOURENS (CSW 7)

CSIR RESEARCH REPORT 416

Stellenbosch, South Africa
October 1982

ESTUARIES OF THE CAPE

PART II: SYNOPSES OF AVAILABLE INFORMATION ON INDIVIDUAL SYSTEMS

REPORT NO. 17: LOURENS (CSW 7)

(CSW 7 — CSIR Estuary Index Number)

FRONTISPIECE: LOURENS ESTUARY — ALT. 500 m, NRIO 82–12–20

COMPILED BY: S CLIFF AND
J R GRINDLEY

SURVEYS : DECEMBER 1981 TO MAY 1982

SURVEY TEAM : MS S CLIFF (UNIV. OF CAPE TOWN)
PROF J R GRINDLEY (UNIV. OF CAPE TOWN)
MR M O'CALLAGHAN (BOTANICAL RESEARCH UNIT — 30 MARCH 1982)
DR G A W FROMME (NRIO — 17 JULY 1982)

ESTUARINE AND COASTAL RESEARCH UNIT — ECRU
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

CSIR RESEARCH REPORT 416

Stellenbosch, South Africa
October 1982

ISBN 0 7988 1812 3 (Set
ISBN 0 7988 1813 1 (Part 2)
ISBN 0 7988 2575 8 (Rep. No. 17)

Published in 1982 by:

National Research Institute for Oceanology
Council for Scientific and Industrial Research
P O Box 320, Stellenbosch, 7600

Printed by:

Creda Press, Cape Town

PREFACE

The Estuarine and Coastal Research Unit (ECRU) was established by the National Research Institute for Oceanology (NRIO) of the CSIR in 1979 with the following aims:

- to contribute information relevant to the development of a cohesive management policy for the South African coastline;

- to compile syntheses of all available knowledge on the 167 estuaries of the Cape between the Kei and the Orange rivers;

- to identify gaps in information, to conduct research to fill these and to stimulate Universities, Museums and other institutions to become involved in this kind of work;

- to contribute to *ad hoc* investigations carried out by NRIO on the impacts of proposed developments in the coastal environment, and especially in estuaries.

The Unit was established at the request of the Government, and the Department of Environment Affairs contributes substantially to the running costs.

In 1980 the Unit published its first report under the title "The Estuaries of the Cape, Part I - Synopsis of the Cape Coast. Natural Features, Dynamics and Utilization" (by Heydorn and Tinley)+. As the name of the report implies, it is an overview of the Cape Coast dealing with aspects such as climate, geology, soils, catchments, run-off, vegetation, oceanography, and of course, estuaries. At the specific request of the Government, the report includes preliminary management recommendations.

The present report is one of a series on Cape Estuaries being published under the general title "The Estuaries of the Cape, Part II". In these reports all available information on individual estuaries is summarized and presented in a format similar to that used in a report on Natal estuaries which was published by the Natal Town and Regional Planning Commission in 1978. It was found however, that much information is dated or inadequate and that the compilation of Part II reports is therefore not possible without brief prior surveys by the ECRU. These surveys are usually carried out in collaboration with the Botanical Research Institute and frequently with individual scientists who have special interest in the systems concerned. One of these is Prof JR Grindley of the University of Cape Town who is co-editor of the Part II series.

These surveys are, however, not adequate to provide complete understanding of the functioning of estuarine systems under the variable conditions prevalent along the South African coastline. The ECRU therefore liaises closely with Universities and other research institutes and encourages them to carry out longer-term research on selected estuarine systems. In this way a far greater range of expertise is involved in the programme and it is hoped that the needs of those responsible for coastal zone management at Local-, Provincial and Central Government levels can be met within a reasonable period of time.

Finally, the attempt has been made to write the Part II reports in language understandable to the layman. However it has been impossible to avoid technical terms altogether and a glossary explaining these is therefore included in each report.

FP Anderson
DIRECTOR

National Research Institute for Oceanology
CSIR

+CSIR Research Report 380

CONTENTS

FIGURES

APPENDICES

PLATES

LOURENS

1. HISTORICAL BACKGROUND

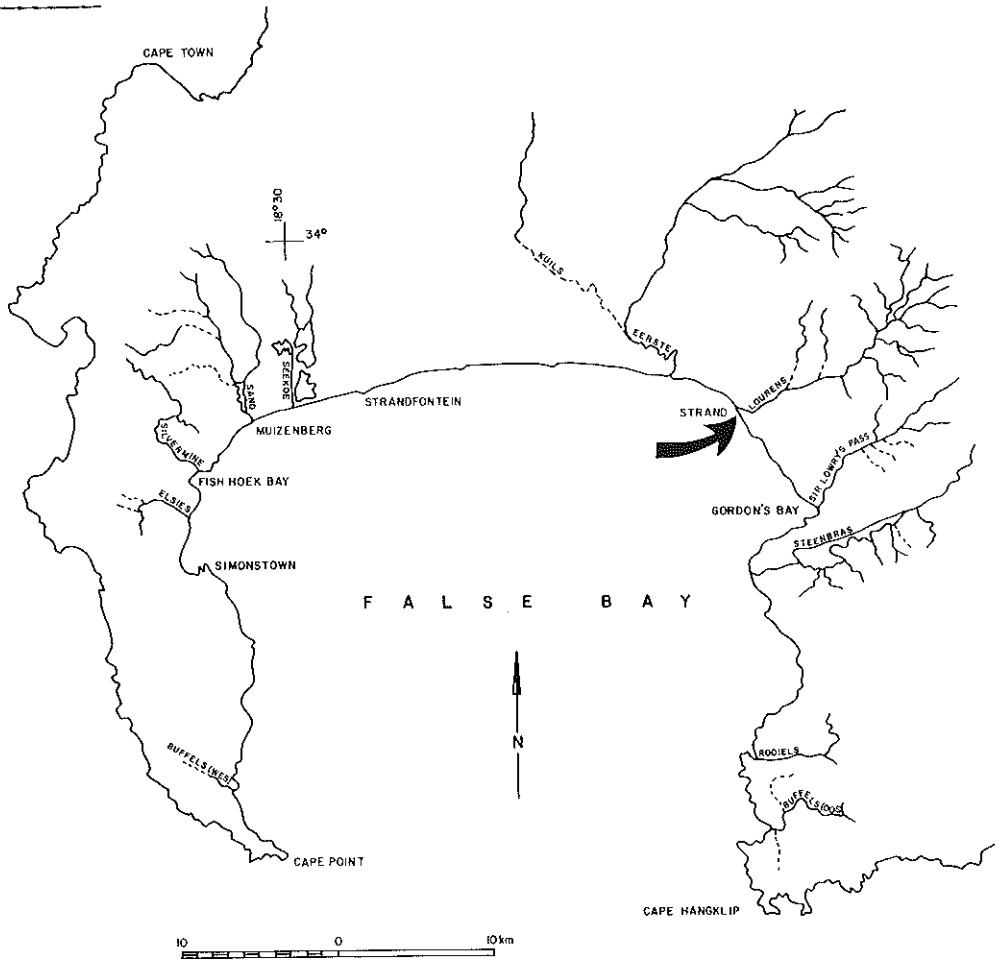
The Lourens River was known in the late 17th century as the Tweederivier, since it was the second river crossed (after the "Eersterivier") on the journey from the Cape Peninsula to the Hottentots Holland Mountains. In 1671 it was named the Breitenbach River after a Lieutenant van Breitenbach. In the early 18th century it was referred to as the Laurens River, after someone of that name was drowned in it, the spelling being subsequently changed to Lourens (Heap, 1977).

Farmers have been using the river for irrigation purposes since the early 18th century. Piped water systems were introduced following the proclamations of the Strand and Somerset West municipalities in 1897 and 1903, respectively; this practice is continued today. A Water Court Order of 1936 ruled how the water of the river should be apportioned amongst riparian owners, including farmers, municipalities and Cape Explosives Works Limited (now known as AECI) (Ninham Shand & Partners, 1974).

The old stone bridge in Somerset West, built in 1845 by the Central Road Board, was one of the earliest in South Africa and has been declared a national monument.

During the operation of the Strand Sewage Works from 1948 to 1978, biologically-treated sewage was discharged into the estuary (F Sheffler, Strand Municipality, pers. comm.).

2. LOCATION



The Lourens River flows through Somerset West in a south-westerly direction and enters the sea to the west of Strand. The mouth is located at 34° 06'S and 18° 49'E, approximately 40 km south-east of Cape Town (1: 50 000 Sheet 3418BB Somerset West).

2.1 Accessibility

Access to the estuary is by means of Beach Road, which runs along the Strand beachfront.

AECI have fenced off the mouth area between the sea and the Beach Road bridge. This area is prohibited to the public, permits being required for access; it is patrolled by security officers with dogs.

2.2 Local Authorities

The river falls under the jurisdiction of the Stellenbosch Divisional Council.

In the upper catchment, the Landdroskloof and Sneeukopkloof streams which feed into the river, rise within the Hottentots Holland Nature Reserve, which is administered by the Directorate of Forestry. The Strand and Somerset West municipalities are the local authorities responsible for a major part of the river. The Strand municipal area extends along the southern bank of the river from the beach to the railway line and includes the disused sewage works site and pump station on the northern bank. The Somerset West municipal area ranges from Broadway to the boundary of private agricultural land on the northern bank and from the railway line to the bounds of residentially zoned land on the southern bank. The remainder of the land bordering the northern bank of the estuary is administered by AECI.

Figure 1 shows the boundaries of the local authorities in the lower catchment, as adapted from the 1: 50 000 Ground Plan No. RP1-92.

3. ABIOTIC CHARACTERISTICS

3.1 River catchment

3.1.1 Catchment characteristics

The river rises in Watervalkloof in the Hottentots Holland Mountains. It has a catchment area of 92 km^2 and is approximately 20 km in length (D Zietsman, Department of Environment Affairs, pers. comm.).

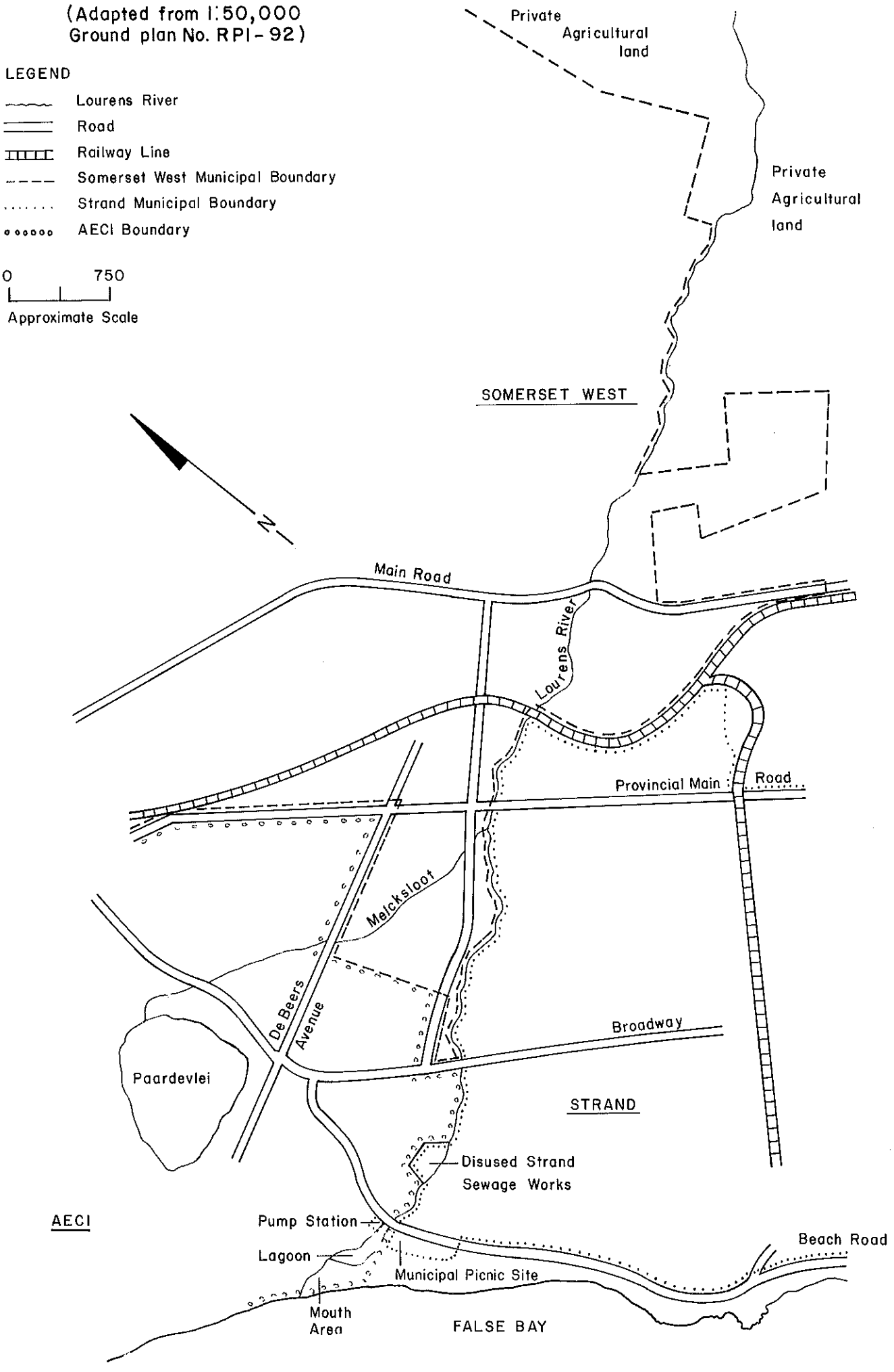
The river has no major tributaries but is supplemented by streams arising in Landdroskloof and Sneeukopkloof.

Geomorphology and Geology

The Lourens River rises in the deep kloofs of folded mountains, passes through a shallow valley surrounded by undulating hills and finally cuts across the flat coastal plain before emptying into the sea.

FIG. 1: Boundaries of the local authorities responsible for land adjacent to the Lourens River, in the lower catchment.

(Adapted from 1:50,000 Ground plan No. RPI-92)



The Hottentots Holland Mountains consist mainly of Table Mountain sandstone outcropping or near the surface, but areas of shallow soils overlying shale are also evident. The hills surrounding the river comprise shallow soils overlying granite of the Cape Granite System and shallow soils over shale and greywacke of the Malmesbury Group. The river valley is largely overlain by sediments deposited during the Tertiary to Quaternary periods and in many places these sediments have a depth of more than two metres. They are alluvial in origin and are composed of boulders and clay. Near the mouth of the river the transported soils of the Tertiary and Quaternary Periods are aeolian in origin and comprise mostly sand (MJ Mountain & Associates 1: 50 000 Engineering geological map of Somerset West and Hangklip area).

Rainfall

The Lourens River lies within a winter rainfall region (Heydorn and Tinley, 1980). Data collected at the Lourensford Estates office gauging station between October 1970 and September 1981, indicated a mean rainfall value of 34 mm for the summer months as compared with a mean of 110 mm for the seven months of the rainy season.

Total annual rainfall for the period January 1917 to December 1981, ranges from 637 mm in 1934 to 1 470 mm in 1977, with an average of 915 mm (Lourensford Estates, unpublished data).

Run-off

Total annual run-off recorded at the gauging station near the National Monument Bridge for the period October 1970 to September 1981 ranged from 8,09 x 10^6 m^3 to 50,17 x 10^6 m^3, with an average value of 21 x 10^6 m^3. Approximately 13 percent of the annual run-off occurs in summer and 87 percent from April to October (Directorate of Water Affairs, unpublished data).

Flow

A summary of the unpublished flow rate data collected at the gauging station at Lourensford Estates by the Engineering Consultants Ninham Shand & Partners, for the period October 1970 to September 1975, is given in Figure 2. An average monthly flow rate peak of 3,57 cumecs was obtained in August as compared with values of 0,07 cumecs for February and March.

Records obtained from the Directorate of Water Affairs show minimum daily flow rates of 0,00 cumecs for months between January and May from 1972 to 1975. During a field survey in March 1982, the river immediately above the head of the estuary was observed to be dry and reduced to stagnant pools.

3.1.2 Land Ownership/Uses

The river, including all associated tributaries and dams from their sources to tidal waters, is scheduled as a trout area as proclaimed by the Nature Conservation Ordinance No.19 of 1974.

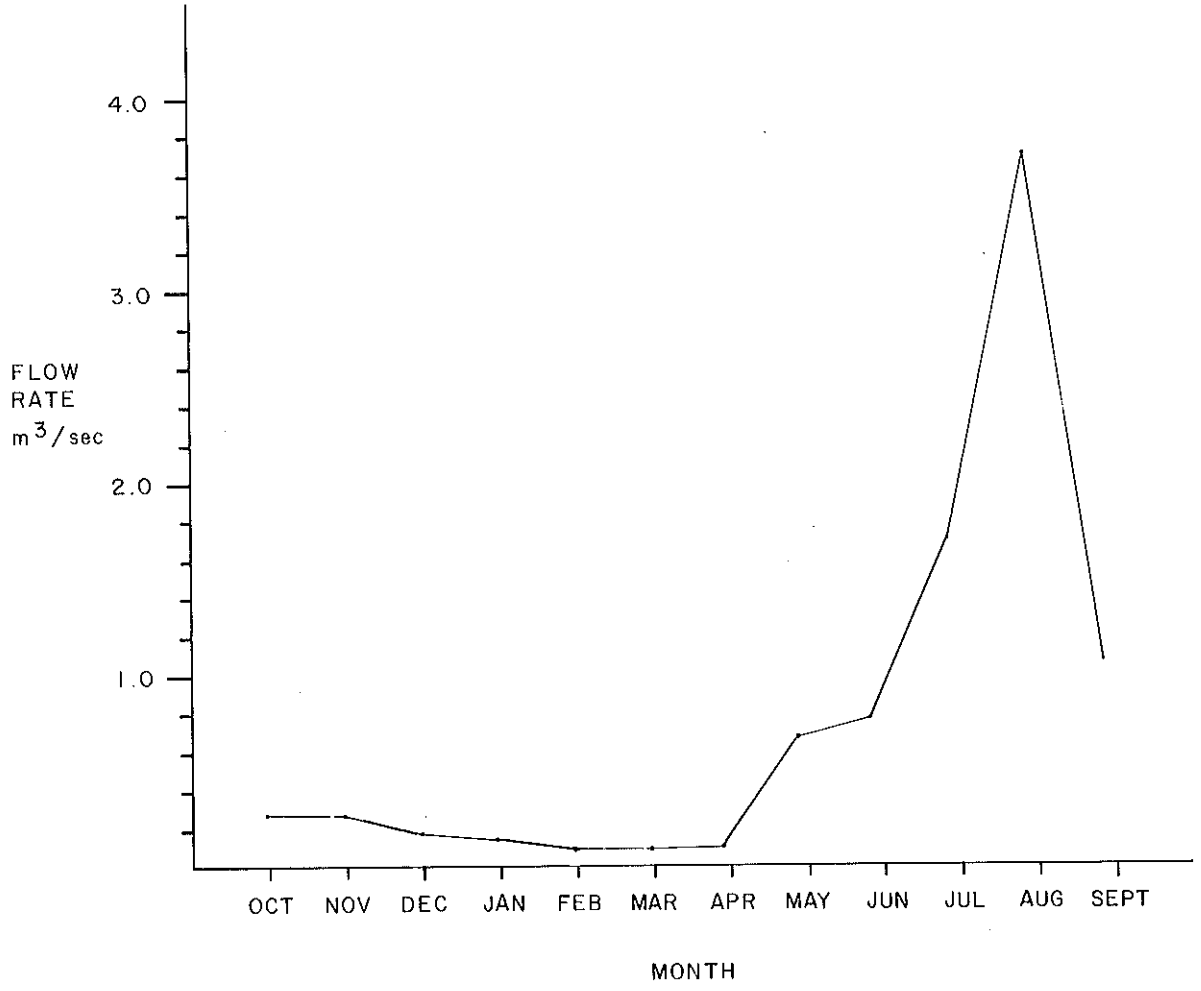


FIG. 2 : The average flow rate of the Lourens River for the period October 1970 to September 1975. Data was collected at the gauging station on Lourensford Estate (Ninham Shand & Partners, unpublished data.)

Trout fishing is carried out particularly in the upper catchment and trout up to 47 cm have been caught (P Nel, Vergelegen Estate, pers. comm.).

The Hottentots Holland Nature Reserve is managed to preserve its natural resources and also serves as a recreational area. The remainder of the upper catchment is privately owned agricultural land. A variety of crops are grown including pine trees, fruit trees, especially apples, pears, plums, lemons and grapes, orchids and kikuyu for sale as "roll-on-lawn". Sheep and cattle are kept on pasturelands or in yards, and a large piggery operates on one farm. Irrigation is carried out by means of numerous furrows leading off storage dams or the river itself. This network of furrows collects run-off from the lands and returns the water to the river. *Hakea sericea* which has encroached upon highlying ground is burnt and removed. Alien invaders such as various *Acacia* spp, *Lantana camara* and *Sesbania punicea* proliferate along the river bank but few farmers institute the necessary control measures.

Within the Somerset West municipal area, riparian land is mostly privately owned but is zoned public open space. There are several public service sites such as a power substation, an ambulance station and a public park (Radloff Park), which is used by picnickers and vagrants, for recreational purposes and for dumping. Littering and dumping are prevalent on undeveloped riparian land and on light industrial and business sites.

The majority of riparian land in Strand is designated public open space and numerous undeveloped residential plots exist; these are used by children for recreation, by vagrants and as sites for dumping and littering. There is an area of light industry below the Provincial Main Road and a caravan park above the head of the estuary.

According to the 1: 10 000 Hottentots Holland Basin Zoning Map, a narrow stretch of land bounding the banks of the river within both municipalities is zoned public open space.

The land owned by AECI stretches from the Somerset West municipal boundary to the Strand Sewage Works; this area, comprising the old maturation ponds, is at present a bird sanctuary.

Riparian owners in both municipal areas are apportioned water from the river (Ninham Shand & Partners, 1974). Strand Municipality has water rights for domestic use on private farmland and over the past three years obtained between 40 and 60 x 10^6 ℓ of water per month from the river. Most of their water is, however, supplied by Steenbras Dam (F Sheffler, pers. comm.). Somerset West Municipality receive on average 5,5 x 10^6 ℓ per day from the river in winter. A permit obtained from the Department of Environment Affairs allows 1 300 x 10^6 ℓ per annum of surplus water to be drawn during winter months; this is pumped into a storage dam to be used during summer. Although the demand increases to an average of 11 x 10^6 ℓ per day during summer months, only 4,5 x 10^6 ℓ are obtained directly from the river (CFB Krige, Somerset West Municipality, pers. comm.).

According to the Water Court ruling of 1936, AECI is entitled to the balance of the water reaching Melcksloot, which discharges into Paardevlei (Ninham Shand and Partners, 1974).

3.1.3 Obstructions

Eight bridges, mostly double-span in type, are present in the catchment area. The two span National Monument arch bridge on Main Street in Somerset West, is built at the present one in two year flood recurrence interval level and this contributes to serious flooding problems (Hawkins, Hawkins and Osborne, 1981), (see *Abnormal Flow Patterns*). The railway bridge stands approximately one m above the summer flow level; it is heavily corroded and may prove to be a threat during flooding.

Six stone weirs are present; one weir built from sandfilled plastic bags was recorded in the upper catchment. Two concrete walls placed along the banks of the river in order to maintain its course, were cracked and broken and are potentially dangerous

obstructions. Concrete blocks, walls and concrete pipes which have been dumped, also obstruct river flow.

Logs, branches and fallen or cleaved trees were noted in the water or on the banks along much of the river course.

Within both municipal areas, residences and business sites are situated on the floodplain; these could have serious consequences during times of flooding.

3.1.4 Siltation

Concrete retaining walls, barrels, sandbags and boulders have been used along the extent of the river to support the banks, where erosion has occurred during times of flooding.

According to Mr Sheffler, the river water may become muddy in winter, resulting in the clogging of the filters used during filtration of water prior to domestic use.

3.1.5 Abnormal Flow Patterns

Flood levels were recorded by the Directorate of Water Affairs at the gauging station above the National Monument Bridge, Somerset West, during the period October 1970 to September 1981. The height of the southern bank at this point is 1,5 m above the river bed. Floods occurred in 1971, 1976, 1977, 1978, 1979 and 1981; serious flooding occurred in January 1981 when the water level was 2,48 m above the river bed, resulting in the flooding of the Somerset Oaks Old Age Home and the Pick and Pay supermarket near the historic bridge. The Consulting Engineers, Hawkins, Hawkins and Osborne were commissioned by the Somerset West Municipality to analyse the flood problems associated with the historic bridge. It was estimated that the flow capacity of the river in its natural condition prior to the construction of any bridges, was 86 cumecs, while the flow capacity of the bridge without blockages is 36 cumecs, which is equivalent to a flood associated with a one in two year flood recurrence interval. A one in five year flood of 85 cumecs would cause the banks to be overtopped by approximately one metre. Due to the limited capacity of this bridge to withstand flow rates greater than 36 cumecs, without any blockages, it was recommended that a bypass canal with a capacity of 150 cumecs, be constructed. It was also noted that flooding would occur approximately every five years, until flood control measures are undertaken along the full length of the river. A shortage of funds has prevented canalisation from proceeding (AB Smit, Somerset West Municipality, pers. comm.).

3.2 Estuary

This section is contributed by GAW Fromme, Sediment Dynamics Division, NRIO.

3.2.1 Estuary characteristics

Geomorphology

Geomorphologically the Lourens River estuary is similar to the

estuary of the Eerste River, except that the dune belt through which the Lourens River flows before reaching the beach is much flatter and is artificially disturbed by the developments of the western outskirts of the town Strand. The river emerges below the road bridge at an angle of 60 degrees from north-east on to the beach where it forms a small elongated east/west orientated lagoon which lies embedded in the slack area of the backshore zone, being dammed up behind a beach bar. About 200 m below the road bridge an overflow pond opens into the estuary via a culvert (see Landownership/Uses). A small stream rising at Heldersig and entering the estuary above Beach Road bridge, was observed to be dry between the months of December and May 1982.

During the ECRU survey on 7 July 1982, during LWOST, the beach bar was two metres high at its eastern root (adjacent to the large vegetated dune ridge at the west end of the Strand beach). It wedged out to 0,5 m height at approximately 200 m distance from its root, where a channel 15 m wide and 0,3 m deep, formed a strong overflow from the lagoon to the sea. The dimensions of the lagoon during the time of the survey were approximately 300 m long, 30 to 40 m wide, and about one metre deep while between December and May 1982 the lagoon was 1,5 m deep. When the beach bar is built up higher by strong wave action, the channel sometimes extends several hundreds of metres along the shore towards the west until it finds its way down to the foreshore and to the sea.

Tidal range

During the survey on 7 July 1982, salinity measurements were determined during LWOST and HWOST. From the mouth, where the salinity was equal to that of sea water (35 parts per thousand), the salinity decreased rapidly to 12 parts per thousand during HWOST, and to zero during LWOST, only 30 m upstream of the mouth (upper end of mouth channel). Further upstream all salinities were zero during LWOST, but during HWOST a low salinity of 1,5 parts per thousand was recorded 200 m upstream. At the Beach Road bridge (300 m upstream) the salinities reached zero even during HWOST.

Sea debris (kelp, driftwood, litter) was also observed to be washed up through the lagoon or over the beach bar as far as the Beach Road bridge. The fresh water character of the lagoon during low water spring tide conditions, and a downstream current in the backshore section of the lagoon observed on 7 July 1982 (200 to 300 m upstream of mouth) during high water spring tide, indicate, however, that the lagoon has only a restricted tidal character during winter months. During summer months, however, saline water extended as far as the pipe bridge in Strand.

Bottom material

In the lagoon, which is situated in the backshore zone, fine to coarse sediments are present. The finer fractions are found along the landward bank of the lagoon and medium sized sand occurs at the seaward side. The latter depositions are caused by wave wash over the beach bar (ECRU survey, 7 July 1982).

Beach characteristics

Three typical beach zones can be distinguished at the mouth of the Lourens River:

(a) A slightly inclined foreshore ($0^{o}30'$ to $1^{o}30'$) leading up to a 0,5 to 2 m high beach bar;

(b) A flat or landwards inclined backshore containing the lagoon or runnels spreading out from the lagoon;

(c) The higher elevated dune belt (3 to 4 m above the backshore), extensively altered by industry (AECI) and town development (Strand).

During the ECRU survey, the foreshore beach slopes were measured at the mouth (less than $0^{o}30'$, delta); 100 m west of the mouth (greater than $0^{o}30'$ to 1^{o}), and 100 m east of the mouth (1^{o} to $1^{o}31'$). The easterly beach was, thus, steeper than the westerly beach.

3.2.2 Estuary mouth dynamics

History of mouth behaviour

Aerial photographs from 1944, 1953, 1966/67, 1973, 1977, 1979 and 1981 show that the Lourens River has always developed a backshore lagoon from east to west, which is in accordance with the south-westerly direction of the emergence of the river from the hinterland onto the beach. The dimensions of the backshore lagoon varied in length from 100 to 400 m and 20 to 50 m in width.

At times when the capacity of the lagoon basin in the backshore slack is exceeded, overflow channels usually develop at the west end of the lagoon and cut through the beach bar. On the photographs the overflow channels are shown to run either straight down to the foreshore, or to form meanders and loops before reaching the sea, or to form long westward-going runnels in the slack of the backshore, sometimes up to about 400 m in length, before cutting through the beach bar. Occasionally during the dry summer season, the lagoon is closed or has only a small outflow to the sea.

Inshore oceanography

For the investigation of littoral dynamics it is necessary to make an assessment of the wave climate on the coast. Wave data covering a 20-year period on deep-sea wave direction, height and period (Swart and Serdyn, 1982) and wave refraction diagrams for False Bay (Valsbaai Strandverbeteringe, 1980) were used to compute the *total inshore wave energy* and the *average energy wave height* at each river mouth studied for the series of ECRU Part II reports on False Bay.

It was found that the inshore wave energy for the coast at the Lourens River mouth was relatively high compared with the mean energy calculated for the ten beaches (river mouths) around False

Bay, namely, 20 per cent above this mean. The average energy wave height was 1,02 m. The Lourens River mouth can thus be considered to represent a medium to high energy beach.

Regarding coastal currents at the Lourens River mouth, Glass (1980) bases the assumption of a west going current on predictions by wave refraction (Shipley, 1964). Atkins' current tests (quoted by Harris, 1978) lead to the conclusion that the coastal currents along this section of False Bay could alternate with the prevailing winds and in- or out-going tides, and that the eastbound component appears to be the predominant one.

Conclusions on mouth behaviour

The dynamics of the Lourens River estuary and mouth is mainly governed by the hydro-sedimentological mechanics of the beach bar which dams up the lagoon. River flow will influence the size and configuration of the lagoon in so far as rising water levels will overflow or breach the beach bar at a low section. The position of the breach will be decisive for the length of the lagoon in the backshore zone and for the length and shape of the runnels flowing over the beach bar down to the foreshore.

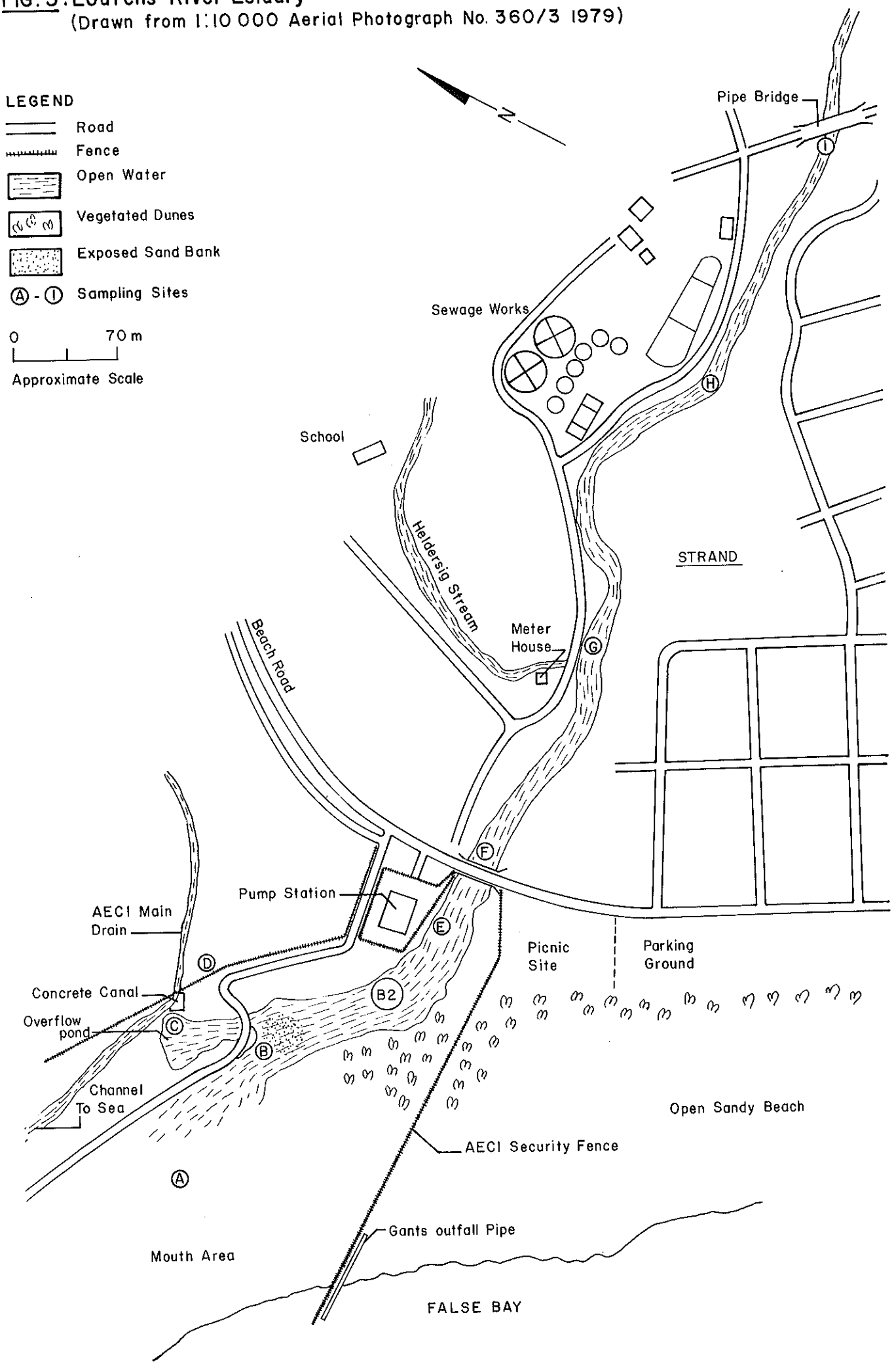
3.2.3 Land Ownership/Uses

Strand Municipality has jurisdiction over land on the southern bank. The area of land between Beach Road and the head of the estuary is zoned private residential and public open space. Undeveloped sites are used by children for recreational purposes and are frequented by vagrants. Fishing is also fairly popular.

Below Beach Road the AECI security fence extends into the sea below the low water mark. A municipal picnic area and parking ground adjoin this fence. An outfall pipe from Gants Foods (Pty) Ltd cannery discharges effluent wastes into the sea, immediately to the south of the AECI fence. The pipe reaches the level of low equinoctial tides, so that effluent wastes almost always pour directly into the sea (Bally *et al.*, 1980). On the northern bank, the disused Strand Sewage Works' site is owned by the Strand Municipality; this land is soon to be returned to AECI (F Sheffler, pers. comm.). The ground between this plot and Beach Road belongs to AECI; this area was enclosed within a security fence in August 1982 to prevent vagrancy and dumping and a programme to remove alien vegetation is under way (HH van Niekerk, AECI, pers. comm.). Sewer pipes from Strand and Somerset West pass along the length of the bank and an emergency overflow pipe leads into the estuary. A meter house is sited in AECI grounds.

The land below the Beach Road bridge on the northern bank excluding the pump station site, is State land. The pump station which pumps sewage to the treatment works at Macassar, is situated below the bridge; an emergency overflow pipe opens into the estuary. The remainder of the State land is enclosed within an AECI fence for security reasons. Within this area, the AECI main drain opens into a channel which discharges into the sea approximately one km north-west of the river mouth. A concrete canal leads from the main drain into the overflow pond and may allow this water to pass into the estuary when the mouth of the

FIG. 3: Lourens River Estuary
(Drawn from 1:10 000 Aerial Photograph No. 360/3 1979)



stream becomes blocked or when there is excess flow in the drain (D Loubser, AECI, pers. comm.), (Figure 3).

3.2.4 Obstructions

There are only two single-span bridges crossing the estuary. At the head of the estuary is a pipe bridge which bears a sewer pipe from Strand and a waterworks pipe from Steenbras Dam to Cape Town. The Beach Road bridge supports two sewer pipes leading from pump stations along the beach to the main station. Both these bridges are of such dimensions that they will not impede heavy flows unless blockages occur.

Fallen trees and logs are present along the banks of the estuary providing evidence of the effects of past floods.

3.2.5 Physico-chemical characteristics

Surface and bottom water samples were collected monthly during low water neap tides, from December 1981 to May 1982 at nine sites along the estuary, including the overflow pond (Figure 3). A summary of the analyses is given in Appendix I.

The data indicated a tidal interchange of up to approximately 1 300 m from the mouth, with salinities decreasing from the mouth to the head. Salinities at depths greater than 1,25 m were higher than surface salinities, during summer months. It was evident that during summer the estuary may become slightly hypersaline, while in winter it is practically fresh from head to mouth. Average water temperatures decreased from 27°C in December to 12°C in May. Secchi disc readings were approximately 100 cm, except in January, when the mouth was closed and the value dropped to 74 cm. The water was found to be well oxygenated during the six-month sampling period. In February and March, minimum mean pH values of 4,1 and 5,4 were noted; this was attributed to the influx of water of pH 3,0 from the AECI main drain. Eagle (1976) and Bartlett (1980) recorded pH values of 5,3 and 7,45 at the mouth of the AECI main drain channel to the sea.

Nutrients

Average organic carbon values ranged between 3,7 and 10,6 µmol/ℓ and phosphate concentrations between 0,4 and 3,6 µmol/ℓ. Mean nitrate levels between 3,9 and 518 µmol/ℓ were recorded. Nitrate measurements at the AECI main drain gave an average value of 4248,0 µmol/ℓ. Nitrate concentrations obtained by Eagle (1976) and Bartlett (1980) were 115,5 µmol/ℓ and 490,0 µmol/ℓ respectively. Bally *et al.* (1980) recorded subtidal nitrate values of between 10 and 74 µmol/ℓ to the north of the AECI fence. Thus it is shown that nitrate concentrations in the estuary can periodically reach very high levels.

3.2.6 Pollution

Sewage

Biologically treated sewage from the AECI labourers compounds (GC Kies, Directorate of Water Affairs, pers. comm.) was observed

to be emptying into the estuary via the AECI main drain in February and March 1982.

In January 1982, a break in the rising main carrying raw sewage to the treatment works at Macassar, resulted in the discharge of the effluent into the estuary via the emergency overflow pipes, for approximately 16 hours. The mouth was dredged open and water was redirected down the river by the closure of the AECI Melcksloot sluices in order to clear the system.

Pesticides, herbicides and fertilizers

These are applied in the upper catchment where agriculture is practised and may enter the river.

Other forms of pollution

The AECI main drain containing cooling water used at the power station and in nitrate and sulphate treatments and stormwater from AECI, Somchem and Triomf Fertilizer (Pty) Ltd (GC Kies, pers. comm.), was observed to be emptying into the estuary in February and March 1982. A standard volume of 953,4 m^3 per day is released into this drain but this may increase to 1 000 m^3 per day. Seepage from the Triomf Fertilizer plant and the AECI nitric acid and ammonium nitrate plants into the drain, may account for the high nitrate and low pH levels obtained. This water serves as a nutrient input into the estuary. AECI is permitted to discharge industrial waste water into the estuary in accordance with the General Water Quality Standards (Amendment to the Water Act as set out in the Government Gazette No. 217, R553 of 5 April 1962), although certain of these have been waived (GC Kies, pers. comm.). The effluent does not comply with the required criteria and the Directorate of Water Affairs is investigating the necessity for a more stringent permit (JA Lusher, pers. comm.).

A number of storm water drains empty into the river; this could be a source of enrichment or pollution.

The dumping of wasteproducts and debris including bricks, rubble, concrete, polystyrene, tins, plastics, tyres and clothing occurs alongs the length of the river. The beach is consequently strewn with litter.

Apart from pollution caused by the dumping of waste concrete by a concrete firm (HH van Niekerk, pers. comm.), the extent of the pollution contributed by light industrial companies bordering the river, was not ascertained. The discharge of industrial waste water or effluent into the Lourens River from its source to tidal waters should comply with the Special Water Quality Standards as specified in the above-mentioned Amendment to the Water Act. However, the Directorate of Water Affairs no longer monitor the river for pollution, since no major discharges into the river have been identified (GC Kies, pers. comm.).

Gants Foods' cannery discharge contains small fragments of food wastes, in particular fruit and vegetables. This is a potential source of pollution to the estuary on incoming tides.

3.2.7 Public health aspects

Water samples collected in May 1982, were analysed for bacteria, by the Department of Health. At sites A, B, C and D (see Figure 3) *Escherichia coli* and coliform bacteria were innumerable, while at site E neither organisms were present. Since the estuary has limited recreational use these values are probably not significant.

Bally *et al.* (1980) recorded a decrease in the numbers of coliform bacteria to the north-west of the Gants Food's outfall pipe; *E. coli* was absent in this area.

4. BIOTIC CHARACTERISTICS

4.1 Flora

4.1.1 Phytoplankton/diatoms

On 12 February 1982 and 16 March 1982 the estuary was turbid with a brown suspension caused by a filamentous organism that may have been part of a fungal mycelium and a gelatinous matrix containing various diatoms and unicellular and colonial green algae, including *Scenedesmus* sp. and *Coelastrum* sp.

Various planktonic and epiphytic pennate diatoms were recorded in the above samples.

4.1.2 Algae

Estuary

Dense algal mats covering both the surface and the bed of the estuary were observed throughout the estuary from December 1981 to March 1982. These were identified as *Cladophora* sp., *Enteromorpha* sp., *E. plumosa* and *Chaetomorpha* sp. During April 1982, the surface algal mats were greatly reduced in extent and in May only isolated patches were recorded on the estuary bed.

Adjacent shoreline

Sandy beach without attached algae.

4.1.3 Aquatic vegetation

No aquatic macrophytes were recorded in the estuary.

4.1.4 Semi-aquatic vegetation

The following marginal plants were recorded:

Juncus kraussii
Phragmites australis
Typha capensis
Cyperus textilis
Paspalum vaginatum
Scirpus nodosus

There are no areas of salt marsh vegetation along the estuary.

4.1.5 Terrestrial Vegetation

This section is contributed by M O'Callaghan of the Botanical Research Unit, Stellenbosch.

Very little natural vegetation is still to be found around the lower Lourens River. However, a number of mapping units were identified during March 1982. Their spatial distribution is shown in Figure 4 while Appendix II gives some of the species and physical features of each mapping unit.

The Fore Dune Area: These dunes are typical of the region and have a sparse covering of *Ehrharta villosa* (pypgras), *Senecio elegans* (strandblommetjie) and *Trachyandra divaricata*.

Pennisetum clandestinum/Tetragonia fruticosa Disturbed Dune Vegetation: This unit, found mainly around the overflow pond, contains numerous dune plants such as *Tetragonia fruticosa* (kinkelbossie), *Carpobrotus edulis*, *Geranium incanum* (bergtee) and *Pelargonium capitatum*. However, this area has been disturbed and *Pennisetum clandestinum* (kikuyu) has taken over large areas. Areas of *Acacia saligna* and *A. cyclops* have been cleared but young plants were recorded.

Typha capensis Swampland: There is an extensive *Typha capensis* swampland to the west of the overflow pond bounding the channel to the sea. These bullrushes could be playing an important role in utilizing excessive nutrients contained in the water entering this area and these swamps should therefore be preserved.

Conyza cf *ambigua/Cynodon dactylon* Weed Area: Immediately above Beach Road, cover is sparse with numerous weed species e.g. *Conyza* cf *ambigua*, *Sonchus oleraceus* and numerous other species which, due to the season, could not be identified. It seems that much soil and gravel has been deposited here resulting in this pioneer vegetation.

Pennisetum clandestinum with numerous shrubs and trees: This unit covers large areas adjacent to the river. Most of the ground cover is made up of *P. clandestinum*, but numerous trees and shrubs are present. These include natural dune plants such as *Carpobrotus edulis* (Hottentots fig), *Colpoon compressum* (basbessie), *Rhus glauca* (korentebessie) and numerous exotic species e.g. *Eucalyptus lehmannii* (spider gum), *Meterosideros excelsa* and *Myoporum serratum*, *Acacia saligna* and *A. cyclops*.

The river banks are fringed with a number of different vegetation types. Near the mouth, *Paspalum vaginatum* is found while numerous patches of *Phragmites australis* are to be found along the river course. Other vegetation types fringing the river contain a number of *Rhus* species, wattles and garden trees such as willows and poplars. Nearer the water, plants such as *Cyperus textilis* (kooigoed) *Juncus kraussii* and *Paspalum vaginatum* are present.

4.2 Fauna

4.2.1 Zooplankton

A zooplankton sample was collected at site B2 (Figure 3)

in February 1982 and a non-quantitative analysis was carried out. The results of the analysis are given in Appendix III. The sample consisted mainly of harpacticoid copepods, the copepod *Acartia longipatella* and rotifers.

4.2.2 Aquatic Invertebrates

In February 1982, four two-minute trawls at site B2 (Figure 3) using a "D" net, revealed twelve crown crabs *(Hymenosoma orbiculare)*. Midge larvae of the Chironomidae family were found in sand with an oxygen tension of 41 percent near site B (see Figure 3) in May 1982. Tube dwellings of these midges were recorded in the sand banks. No prawn holes were evident on the sand flats near the estuary mouth; digging and sieving of the sand did not reveal any macrofauna.

Bally *et al.* (1980) recorded the following macrofauna on the sandy beach between high and low tide, within the AECI fence; *Scololepis squamata, Eurydice longicornis, Nephthys capensis, Bullia rhodostoma* and *Bullia pura*. Nematodes were found to dominate the meiofaunal samples, harpacticoid copepods being found in low numbers due to the fineness of the sand.

4.2.3 Insects

No data.

4.2.4 Other Invertebrates

Terrestrial snails of the genus *Tranchycystis* were found in March 1982 on *Tetragonia fructicosa* plants.

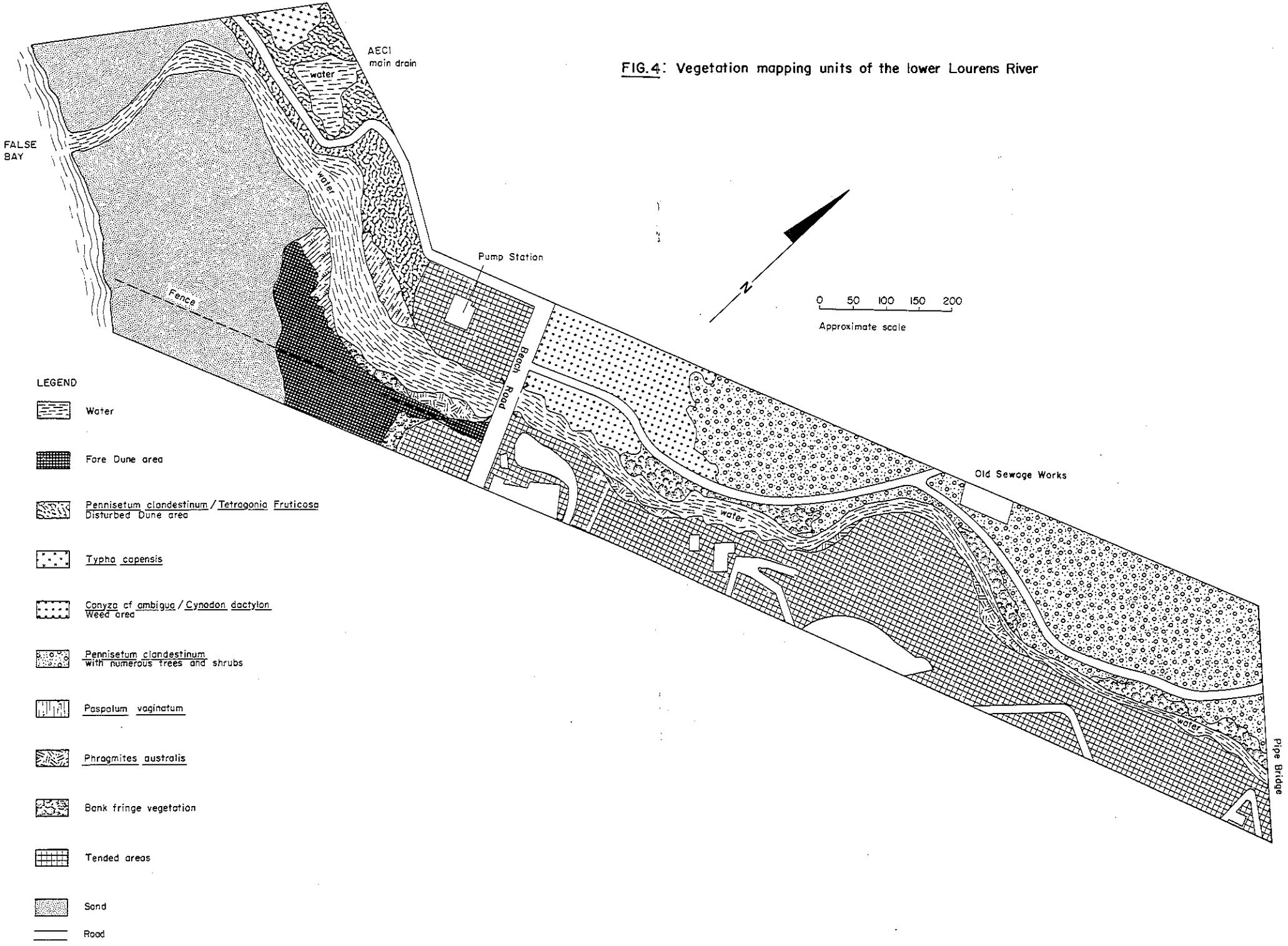
4.2.5 Fish

Following the discharge of raw sewage into the estuary in January 1982, (see *Pollution Sewage*) four lorry loads of dead fish were collected by the Strand Municipality; five different species were noted (D Joubert, Strand Municipality, pers. comm.). These were identified by the Department of Nature and Environmental Conservation as white steenbras *(Lithognathus lithognathus)*, harder *(Liza richardsoni)* and probably sea barbel *(Arius feliceps)*, leervis *(Lichia amia)* and elf *(Pomatomus saltator)* (MR Brett, Department of Nature and Environmental Conservation, pers. comm.).

Twenty-four dead *L. richardsoni* of maximum length 40 cm, were found near site C (Figure 3) during a field survey in January 1982.

Gill netting for four hours in February 1982 at site B2 (Figure 3), revealed two *L. richardsoni* and one *L. amia*, 17 cm in length. Three "D" net trawls of two minutes each, produced one juvenile white stumpnose *(Rhabdosargus globiceps)*, two gobies *(Psammogobius knysnaensis)* and four *L. richardsoni*. Shoals of up to 1 000 juvenile *L. richardsoni* (two to three centimetres) were observed in the shallows.

FIG. 4: Vegetation mapping units of the lower Lourens River



A net sample collected by Brett (pers.comm.) in May 1982 revealed Cape silverside *(Hepsetia breviceps)* and the goby *(Glossogobius platygobius)*.

4.2.6 Reptiles and Amphibians

At the head of the estuary a common or brown water snake *(Lycodonomorphus rufulus)* approximately 50 cm in length was observed in February 1982.

Appendix IV gives a list of the reptiles and amphibians recorded for the area covered by the 1: 50 000 Sheet 3418BB Somerset West. Records were obtained from Poynton (1964), Greig and Burdett (1976), FitzSimons (1943) and (1962) and unpublished records from the Cape Department of Nature and Environmental Conservation. Endangered species according to McLachlan (1978) are indicated.

4.2.7 Birds

Appendix V lists the species recorded at the estuary by Bally *et al.* in March and April 1980, Underhill and Cooper in January 1981 and the compilers of the report, between December 1981 and April 1982. Only wader species were recorded by Summers *et al.* in 1976.

A total of thirty-three species of birds have been recorded at the estuary. Large flocks of Common, Arctic and Sandwich Terns and Reed Cormorants roost near the mouth of the estuary within the AECI fence.

4.2.8 Mammals

The spoor of two Cape clawless otter *(Aonyx capensis)* was observed on the exposed sand flats in June 1982. There was also evidence of the Cape dune mole-rat *(Bathyergus sucillus)* near the pump station. Van Niekerk (pers. comm.) has noted the presence of Cape clawless otter, water mongoose *(Atilax paludinosus)*, Steenbok *(Raphicerus campestris)* and Grysbok *(Raphicerus melanotis)* at the estuary mouth.

Appendix VI gives a list of the mammals recorded as being present in the area covered by the 1: 50 000 Sheet 3418BB Somerset West, within which the Lourens River estuary and catchment fall (Stuart *et al.*, 1980). Rare and threatened species are indicated (Meester, 1976 and Skinner *et al.*, 1977).

5. SYNTHESIS

There is very little information pertaining to the Lourens River; this report is therefore compiled mainly from personal communications and field observations.

The Lourens River rises in the Hottentots Holland Mountains and has a catchment area of 92 km^2. Approximately 87 percent of the annual run-off for the area occurs in winter, summer run-off being low and flow rates may be reduced to zero during dry years. Consequently the estuary may become periodically closed or reduced to a small outflow due to the formation of a beach bar

resulting in the damming of the lagoon. On such occasions the estuary may become hypersaline and salinities at depths of about 1,5 m may be greater than surface values.

Dense algal mats are found throughout the estuary and the water is well oxygenated. With greater flow rates in winter, the bar is breached and the water level is lowered (by 0,5 m in May 1982); the estuary becomes practically fresh and algal mats are largely reduced.

The mouth of the estuary is enclosed within an AECI security fence thus providing a protected roosting site for birds. Large flocks of terns, gulls and cormorants were observed on the beach. The estuary serves as a nursery ground for several fish species, but is generally poor in both aquatic and terrestrial fauna. There are no saltmarsh areas present and the terrestrial flora includes numerous alien species.

The operation of the Strand Sewage works on the banks of the estuary from 1948 to 1978, periodic discharges from the AECI main drain into the lagoon and the inflow from the Gants Foods' discharge pipe, as well as the presence of buildings and excavations on the estuary banks, may account for the low diversity of estuarine and terrestrial species recorded. The estuary receives pollution from several sources in particular from the AECI main drain from time to time and therefore contributes significantly to the pollution entering the north-eastern corner of False Bay.

Historically the river has been used by riparian owners as a source of water since the early 18th century. Private land owners, the municipalities of Strand and Somerset West and AECI, have water rights along the length of the river, as apportioned to them by a Water Court Order of 1936. Nevertheless increased run-off due to urbanisation and removal of natural vegetation has resulted in the increased vulnerability of land in the upper catchment to flooding. This has been further aggravated by developments on parts of the floodplain, such as the Somerset Oaks Old Age Home, and the presence of a National Monument Bridge in Somerset West, which has a flow capacity associated with a one in two yr flood. Consulting Engineers have recommended that a bypass canal be constructed in order to alleviate flooding (Hawkins, Hawkins and Osborne, 1981). This would contribute to the preservation of the historic bridge and the original river course, if properly designed.

The Lourens River passes through land owned or administered by numerous authorities or by private riparian owners; namely, a State nature reserve, private agricultural land, the municipal areas of Somerset West and Strand and AECI grounds. No overall planning or management policy exists for the river and consequently a number of problem issues may be identified as arising from this lack of co-ordinated control.

a) dumping and littering occur along a major part of the river, both on riparian land and in the river;
b) vagrancy is prevalent on undeveloped sites;

c) encroachment of the river banks of alien vegetation is evident;
d) blockage of the river by logs, trees and temporary weirs has been recorded;
e) alteration of the river course by riparian owners has been noted;
f) flood control measures are inadequate.

In 1980 the Lourens River Conservation Society was formed in Somerset West in an effort to bring about the preservation of the river in its natural state (BH Tromp, Lourens River Conservation Society, pers. comm.). Recognising that the existing legislation regarding the conservation of water bodies in South Africa, is inadequate, a request was made to the Minister of Environment Affairs that a River Management Board or Water Authority be established to allow for the co-operative planning and management of the river system as a whole and to prevent *ad hoc* development from taking place. No provision for such a control body has yet been made.

Since a major part of the riparian land within the two municipalities is zoned for public open space, a river trail could be developed for recreational purposes and the aesthetic appeal of a natural or landscaped water course could be substantial, particularly if the co-operation of riparian owners is obtained.

The recreational and aesthetic value of the estuary itself has been lost to a large extent due to the present pollution inputs and land ownership and zoning arrangements. AECI are at present showing concern regarding the conservation of their land adjacent to the estuary and proposals for a bird sanctuary have been made (HH van Niekerk, pers. comm.).

Nevertheless, unless the estuary can be included within an overall management scheme for the river, it will continue to be degraded and misused. Both local and governmental authorities and private enterprise such as AECI should give serious attention to this matter.

6. ACKNOWLEDGEMENTS

AECI, in particular Mr D Loubsher, are thanked for permitting access to the restricted estuary mouth area. Thanks must also be extended to the following persons and organisations for data and assistance supplied during the synthesis of the report:
Dr PD Bartlett of the Marine Pollution Monitoring Group, NRIO, Mr GC Kies of the Directorate of Water Affairs, Messrs A de Villiers and MR Brett of the Department of Nature and Environmental Conservation, Mr R Simons of Sea Fisheries Institute, the Municipality of Somerset West and Strand and the Department of Health, Cape Town.

The assistance of all members of ECRU is gratefully acknowledged.

The survey was carried out at the request of the Department of Environment Affairs. The encouragement of this Department, the NRIO Steering Committee for Estuarine and Coastal Research and the SA National Committee for Oceanographic Research is gratefully acknowledged.

7. GLOSSARY OF TERMS USED IN PART II REPORTS

abiotic: non-living (characteristics).
aeolian (deposits): materials transported and laid down on the earth's surface by wind.
alien: plants or animals introduced from one environment to another, where they had not occurred previously.
alluvium: unconsolidated fragmental material laid down by a river or stream as a cone or fan, in its bed, on its floodplain and in lakes or estuaries, usually comprised of silt, sand or gravel.
anaerobic: lacking or devoid of oxygen.
anoxic: the condition of not having enough oxygen.
aquatic: growing or living in or upon water.
arcuate: curved symmetrically like a bow.
barchanoid (dune): crescent-shaped and moving forward continually, the horns of the crescent pointing downwind.
bathymetry: measurement of depth of a water body.
benthic: bottom-living.
berm: a natural or artificially constructed narrow terrace, shelf or ledge of sediment.
bimodal: having two peaks.
biogenic: originating from living organisms.
biomass: a quantitative estimation of the total weight of living material found in a particular area or volume.
biome: major ecological regions (life zones) identified by the type of vegetation in a landscape.
biotic: living (characteristics).
breaching: making a gap or breaking through (a sandbar).
calcareous: containing an appreciable proportion of calcium carbonate.
calcrete: a sedimentary deposit derived from coarse fragments of other rocks cemented by calcium carbonate.
Chart Datum: This is the datum of soundings on the latest edition of the largest scale navigational chart of the area. It is -0,900 m relative to land levelling datum which is commonly called Mean Sea Level by most land surveyors.
coliforms: members of a particularly large, widespread group of bacteria normally present in the gastro-intestinal tract.
community: a well defined assemblage of plants and/or animals clearly distinguishable from other such assemblages.
conglomerate: a rock composed of rounded, waterworn pebbles 'cemented' in a matrix of calcium carbonate, silica or iron oxide.
cusp: a sand spit or beach ridge usually at right angles to the beach formed by sets of constructive waves.
"D" net: a small net attached to a "D" shaped frame riding on skids and pulled along the bottom of the estuary, used for sampling animals on or near the bottom.
detritus: organic debris from decomposing plants and animals.
diatoms: a class of algae with distinct pigments and siliceous cell walls. They are important components of phytoplankton.
dynamic: relating to ongoing and natural change.
ecology: the study of the structure and functions of ecosystems, particularly the dynamic co-evolutionary relationships of organisms, communities and habitats.
ecosystem: an interacting and interdependent natural system of organisms, biotic communities and their habitats.
eddies: a movement of a fluid substance, particularly air or water, within a larger body of that substance.
endemic: confined to and evolved under the unique conditions of a particular region or site and found nowhere else in the world.
enon: most striking formation in the Cape. Crammed with pebbles and boulders, phenomenally embedded and massive, yellow or brilliantly red in colour, producing remarkable hills. Curiously carved into crags and hollows.

epifauna: animal life found on the surface of any substrate such as plants, rocks or even other animals.

epiphyte: a plant living on the surface of another plant without deriving water or nourishment from it.

episodic: sporadic and tending to be extreme.

estuary: a partially enclosed coastal body of water which is either permanently or periodically open to the sea and within which there is a measurable variation of salinity due to the mixture of sea water with fresh water derived from land drainage (Day 1981).

eutrophication: the process by which a body of water is greatly enriched by the natural or artificial addition of nutrients. This may result in both beneficial (increased productivity) and adverse effects (smothering by dominant plant types).

flocculation (as used in these reports): the settlement or coagulation of river borne silt particles when they come in contact with sea water.

fluvial (deposits): originating from rivers.

food web: a chain of organisms through which energy is transferred. Each "link" in a chain feeds on and obtains energy from the preceding one.

fynbos: literally fine-leaved heath-shrub. Heathlands of the south and south-western Cape of Africa.

geomorphology: the study of land form or topography.

gill net: a vertically placed net left in the water into which fish swim and become enmeshed, usually behind the gills.

habitat: area or natural environment in which the requirements of a specific animal or plant are met.

halophytes: plants which can tolerate salty conditions.

HAT (Highest Astronomical Tide) and LAT (Lowest Astronomical Tide): HAT and LAT are the highest and lowest levels respectively, which can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions; these levels will not be reached every year. HAT and LAT are not the extreme levels which can be reached, as storm surges may cause considerably higher and lower levels to occur (South African Tide Tables 1980).

hummock (dune): a low rounded hillock or mound of sand.

hydrography: the description, surveying and charting of oceans, seas and coastlines together with the study of water masses (flow, floods, tides etc.).

hydrology: the study of water, including its physical characteristics, distribution and movement.

indigenous: belonging to the locality; not imported.

intertidal: generally the area which is inundated during high tides and exposed during low tides.

isohyets: lines on maps connecting points having equal amounts of rainfall.

isotherms: lines on maps joining places having the same temperature at a particular instant, or having the same average, extremes or ranges of temperature over a certain period.

lagoon: an expanse of sheltered, tranquil water. (Thus Langebaan lagoon is a sheltered arm of the sea with a normal marine salinity; Knysna lagoon is an expanded part of a normal estuary and Hermanus lagoon is a temporarily closed estuary (Day 1981)).

limpid: clear or transparent.

littoral: applied generally to the seashore. Used more specifically it is the zone between high- and low-water marks.

longshore drift: a drift of material along a beach as a result of waves breaking at an angle.

macrophyte: any large plant as opposed to small ones. Aquatic macrophytes may float at the surface or be submerged and/or rooted on the bottom.
marls: crumbly mixture of clay, sand and limestone, usually with shell fragments.
matrix: medium in which a structure is embedded.
meiofauna: microscopic or semi-microscopic animals that inhabit sediments but live quite independently of the macrofauna, or benthos.
metamorphic: changes brought about in rocks within the earth's crust by the agencies of heat, pressure and chemically active substances.
MHWS (Mean High Water Springs) and MLWS (Mean Low Water Springs): the height of MHWS is the average, throughout a year when the average maximum declination of the moon is 23°, of the height of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is greatest. The height of MLWS is the average height obtained by the two successive low waters during the same periods (South African Tide Tables 1980).
morphometry: physical dimensions such as shape, depth, width, length etc.
osmoregulation: the regulation in animals of the osmotic pressure in the body by controlling the amount of water and/or salts in the body.
pathogenic: disease producing.
photosynthesis: the synthesis of carbohydrates in green plants from carbon dioxide and water, using sunlight energy.
phytoplankton: plant components of plankton.
piscivorous: fish eating.
plankton: microscopic animals and plants which float or drift passively in the water.
quartzite: rock composed almost entirely of quartz recemented by silicon. Quartzite is hard, resistant and impermeable.
riparian: adjacent to or living on the banks of rivers, streams or lakes.
rip current: the return flow of water which has been piled up on the shore by waves, especially when they break obliquely across a longshore current.
salinity: the proportion of salts in pure water, in parts per thousand by mass. The mean figure for the sea is 34,5 parts per thousand, written 34,5°/$_{oo}$.
secchi disc: a simple instrument used to measure the transparency of water.
sheet flow: water flowing in thin continuous sheets rather than concentrated into individual channels.
slipface: the sheltered leeward side of a sand-dune, steeper than the windward side.
teleost: modern day bony fishes (as distinct from cartilaginous fishes).
trophic level: a division of a food chain defined by the method of obtaining food either as primary producers, or as primary, secondary or tertiary consumers.
trough: a crescent shaped section of beach between two cusps.
wetlands: areas that are inundated or saturated by surface or ground water frequently enough to support vegetation adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.
zooplankton: animal components of plankton.

8. REFERENCES

Literature cited

BALLY, R., *et al.*, (1980). The environmental effects of effluents from a food canning factory on a sandy beach ecosystem in False Bay. School of Environmental Studies. University of Cape Town. 55pp.

BARTLETT, P.D. (1980). Investigation of the beach around the AECI factory outfall, Somerset West. CSIR Report T/SEA 8013. Stellenbosch. 23pp.

CAPE DEPARTMENT OF NATURE AND ENVIRONMENTAL CONSERVATION. Jonkershoek. Reptile and Amphibian records (unpublished).

CAPE OF GOOD HOPE ORDINANCE 19 OF 1974. To consolidate and amend laws relating to nature conservation and to provide for matters incidental thereto. Cape Town. C.P.A. 21 February 1975.

DIRECTORATE OF WATER AFFAIRS. Pretoria. River flow data for October 1970 to September 1971 (unpublished).

EAGLE, G.A. (1976). Investigation of the beach around the AECI factory outfall, Somerset West. NRIO Report SEA IR 7623, Stellenbosch.

FITZSIMONS, V.F.M. (1943). The lizards of South Africa. Trans. Mus. Mem. 1. 7pp.

FITZSIMONS, V.F.M. (1962). Snakes of Southern Africa. Cape Town. Purnell. 423pp.

GLASS, J. (1980). Geology, morphology, sediment cover and movement of False Bay. In: The future management of False Bay. Proceedings of a seminar held on 11 June 1980 in Cape Town. B. Gasson (ed.): 15-25.

GREIG, J.C. and BURDETT, P.D. (1976). Patterns in the distribution of Southern African terrestrial tortoises (Cryptodira: Testudinidae). Zool. Afr. 11(2): 249-273.

HARRIS, T.F.W. (1978). Review of coastal currents in South African waters. S. Afr. Natl. Sci. Programmes Report 30. 103pp.

HAWKINS, HAWKINS and OSBORNE, Consulting Civil Engineers, Cape Town, (1981). Lourens River flood control.

HEAP, P. (1977). The story of Hottentots Holland. 2nd edition. Cape Town. A.A. Balkema. 199pp.

HEYDORN, A.E.F. and TINLEY, K.L. (1980). Estuaries of the Cape. Part I. Synopsis of the Cape Coast. CSIR Research Report 380. 97pp.

LOURENSFORD ESTATES. Rainfall data for January 1917 to December 1981. (unpublished).

McLACHLAN, G.R. (1978). South African red data book - Reptiles and amphibians. S. Afr. Natl. Sci. Programmes Report 23. 53pp.

MEESTER, J.A.J. (1976). South African red data book - Small mammals. S. Afr. Natl. Sci. Programmes Report 11. 59pp.

NINHAM SHAND & PARTNERS, Consulting Engineers, Cape Town (1974). Report on the expropriation of water rights on the Lourens River. Report No. 198/74.

NINHAM SHAND & PARTNERS, Consulting Engineers, Cape Town. River flow data for September 1970 to November 1975 (unpublished).

POYNTON, J.C. (1964). The Amphibia of Southern Africa: a faunal study. Ann. Natal Mus. 17: 1-334.

SHIPLEY, A.M. (1964). Some aspects of wave refraction in False Bay. S. Afr. J. Sci. 60: 115-120.

SKINNER, J.D., *et al.*, (1977). South African red data book - Large mammals. S. Afr. Natl. Sci. Programmes Report 18. 29pp.

SOUTH AFRICA (Republic). WATER ACT NO. 54 OF 1956. AMENDMENT No. R. 553. Government Gazette no. 217, 5 April 1962.

STUART, C.T., *et al.*, (1980). Preliminary distribution maps of mammals of the Cape Province (excluding Cetacea). Cape Department of Nature and Environmental Conservation (unpublished research report). 174pp.

SUMMERS, R.W., *et al.*, (1976). The status of coastal waders in the South Western Cape, South Africa. Western Cape Wader Study Group, Cape Town.

SWART, D.H. and SERDYN, J. de V. (1982). Statistical analyses of visually observed wave data from Voluntary Observing Ships (VOS) for South African Coast. CSIR Report (to be published).

UNDERHILL, L.G. and COOPER, J. (1982). Counts of waterbirds at coastal wetlands in Southern Africa 1978-1981. Western Cape Wader Study Group and Percy Fitzpatrick Institute of African Ornithology (unpublished).

VALSBAAI STRANDVERBETERINGE VOORLOPIGE STUDIE VOLUME II: BYLAE (1980). Voorgelê aan O'Connell Manthè en Vennote. WNNR Verslag C/SEA 8046/21.

Maps

HOTTENTOTS HOLLAND BASIN 1:10 000 Zoning Map. (1979). Municipalities of Somerset West, Strand and Gordon's Bay and Stellenbosch Divisional Council.

MOUNTAIN, M.J. & ASSOCIATES. 1:50 000 Engineering geological map of the Somerset West and Hangklip area. Cape Province. Republic of South Africa.

SOUTH AFRICA 1:50 000 Sheet 3418BB Somerset West. 3rd edition. Pretoria. Government Printer 1981.

STELLENBOSCH DIVISIONAL COUNCIL. 1:50 000 Ground Plan no. RP1-92. 1966. Alterations in 1977, 1979.

Aerial Photography

{LOURENS ESTUARY} Bl. & Wh. Job No. 61/46. Photos Nos. 577, 601, Trig. Surv. Mowbray, 1:18 000, 1944.

{LOURENS ESTUARY} Bl. & Wh. Job No. 335. Photos Nos. 6113, 5754. Trig. Surv. Mowbray, 1:36 000, 1953.

{LOURENS ESTUARY} Bl. & Wh. Job No. 534. Photo No. 456. Trig. Surv. Mowbray, 1:36 000, 1966.

{LOURENS ESTUARY} Bl. & Wh. Job No. 719. Photo No. 1708. Trig. Surv. Mowbray, 1: 40-55 000, 1973.

{LOURENS ESTUARY} Bl. & Wh. Job No. 786. Photo No. 0662. Trig. Surv. Mowbray, 1:50 000, 1977.

{LOURENS ESTUARY} Bl. & Wh. Job No. 326. Photo No. 359/3, 360/3. Trig. Surv. Mowbray, 1:10 000, 1979.

{LOURENS ESTUARY} Col. Job No. 391. Photos Nos. 359/3, 360/3, Survey Department, University of Cape Town, 1:10 000, 1981.

APPENDIX I: Physico-chemical data for the Lourens Estuary. Data were collected at low water neap tides from nine sampling sites; average values are given here. Values in brackets indicate the range.

Month	State of Mouth	Temperature °C	Surface salinity parts per thousand	Bottom salinity parts per thousand	pH	Secchi disc depth cm	O_2 Conc. (as percentage of saturation level)	Organic carbon µmol/ℓ	Nitrate µmol/ℓ	Phosphate µmol/ℓ
Dec	Open	27,2 (26,0,0,29,0)	21 (0,24)	33 (32-36)	8,3 (7,2-8,8)	92	116	4,6 (2,1-9,1)	3,9 (1,1-11,1)	2,4 (0,7-10,8)
Jan	Closed	26,2 (24,5,5-27,0)	27 (4-38)	28 (15-36)	7,5 (6,5-7,9)	74	113	3,7 (1,7-7,2)	6,4 (1,1-28,2)	3,6 (1,1-11,1)
Feb+	Open	24,8 (22,0-26,0)	6 (0-11)	25 (15-32)	5,4 (3,6-7,6)	96	74	8,8 (5,2-12,7)	518,3 (2,5-959,2)	0,4 (0,2-0,8)
Mar+	Open	22,0 (21,0-23,5)	11 (1-19)	-	4,1 (3,0-8,2)	95	75	10,6 (8,0-15,5)	-	-
Apr	Open	18,3 (17,0-19,0)	3 (0-9)	16 (11-19)	7,7 (7,3-8,1)	100	84	5,9 (4,0-8,2)	23,1 (2,5-133,3)	1,5 (1,0-3,1)
May	Open	12,2 (11,5-13,0)	<1 (0-1)	0 (6,9-7,1)	7,0	>90	89	5,6 (4,0-9,2)	80,3 (40,0-300,0)	2,5 (1,2-8,4)

+months during which AECI main drain was flowing into the estuary

APPENDIX II: Species and physical features of the vegetation mapping units of the area studied at the Lourens estuary.

Mapping unit	+Area studied	% of area studied	Cover (%)	Average height (m)
Fore Dunes	0,83	4,08	10	0,30
Pennisetum clandestinum/ Tetragonia fruticosa Disturbed Dune Vegetation	0,96	4,72	100	0,20
Typha capensis Swampland	0,13	0,64	100	1,20
Conyza cf *ambigua/ Cynodon dactylon* Weed Area	1,06	5,21	20	0,50
Pennisetum clandestinum with numerous trees and shrubs	3,43	16,85	90	0,50
Paspalum vaginatum	0,27	1,32	100	0,10
Phragmites australis	0,18	0,88	90	1,50
Bank Fringe Vegetation	0,59	2,90	70	2,00
Tended areas, roads and buildings	6,40	31,43		
Sand	4,01	19,69		
Water	2,50	12,28		
Total	20,36			

(+estimated figures)

Fore Dune Area

Acacia cyclops (+); *Agropyron distichum* (1); *Ehrharta villosa* (2); *Felicia tenella* (r); *Manulea* cf *tomentosa* (+); *Senecio elegans* (+); *Tetragonia decumbens* (+); *Trachyandra divaricata* (1).

Pennisetum clandestinum/Tetragonia fruticosa Disturbed Dune Vegetation

Acacia cyclops (1); *A. saligna* (2); *Ehrharta villosa* (1); *Geranium incanum* (1); *Pelargonium capitatum* (+); *Pennisetum clandestinum* (4); *Polypogon strictus* (+); *Scirpus nodosus* (+); *Tetragonia decumbens* (1); *T. fruticosa* (2).

Typha capensis Swampland

Typha capensis (5).

Conyza cf *ambigua/Cynodon dactylan* Weed area

Pennisetum clandestinum with numerous shrubs and trees

Acacia cyclops (1); *A. karroo* (r); *A. saligna* (1); *Carpobrotus edulis* (1); *Colpoon compressum* (+); *Eucalyptus lehmannii* (1); *Meterosideros excelsa* (+); *Myoporum serratum* (+); *Pennisetum clandestinum* (4); *Rhus glauca* (4); *Tetragonia fruticosa* (2).

Paspalum vaginatum

Paspalum vaginatum (5).

Phragmites australis

Phragmites australis (5).

Bank Fringe Vegetation

Acacia longifolia (1); *A. mearnsii* (+); *A. saligna* (+); *Anneshorrhiza* sp. (r); *Cliffortia graminea* (r); *C. odorata* (r); *Cyperus longus* (+); *C. textilis* (+); *Paspalum vaginatum* (+); *Pelargonium capitatum* (+); *Populus* sp. (r); *Salix* sp. (+).

The symbols in brackets following each species name, represent Braun-Blanquet Cover Classes as follows:

r	1 - few individuals, cover less than 0,1% of area
+	occasional plants, cover less than 1% of area
1	abundant, cover 1 - 5% of area
2	any number, cover 6 - 15% of area
3	any number, cover 26 - 50% of area
4	any number, cover 51 - 75% of area
5	any number, cover 76 - 100% of area.

APPENDIX III: The relative abundance of species and developmental stages of zooplankton, as indicated by the number of + symbols (+ = present; ++++ = abundant)

CLASS/PHYLUM	SPECIES/DEVELOPMENTAL STAGE	ABUNDANCE
PROTOZOA	*Noctiluca scintillans* Amoeboid protozoan	+ +
ROTIFERA	Rotifer	++++
COPEPODA	*Acartia longipatella* adult	++
	A. longipatella juvenile	++++
	A. africana	+
	Acartia nauplius larva	++++
	Oithonia brevicornis	+
	Saphirella stage	+
	Harpacticoids	++++
	Harpacticoids bearing eggs	+++
	Copepod nauplius	+
CIRRIPEDIA	Cyprus larva	+
OSTEICHTHYES	Fish Egg	+

APPENDIX IV: A checklist of amphibians and reptiles recorded for the area covered by the 1: 50 000 Sheet 3418BB Somerset West. +Indicates endangered species (McLachlan, 1978).

Frogs (according to Poynton (1964) and Cape Department of Nature and Environmental Conservation (unpublished records).

Common Name	Species
Common Platanna	*Xenopus laevis*
Cape Ghost Frog	*Heleophryne purcelli*
Sand Toad	*Bufo angusticeps*
Raucous Toad	*Bufo rangeri*
+Cape Rain Frog	*Breviceps gibbosus*
Strawberry Rain Frog	*Breviceps acutirostris*
Cape Sand Frog	*Tomopterna delalandii*

Common Name	Species
Cape Rana	*Rana fuscigula*
Spotted Rana	*Rana grayii*
Cape Grass Frog	*Rana montana*
Dainty Frog	*Cacosternum boettgeri*
Chirping Frog	*Arthroleptella lightfooti*

Snakes (according to FitzSimons (1962) and Cape Department of Nature and Environmental Conservation (unpublished records)).

Common Name	Species
Pink Earth Snake	*Rhinotyphlops lalandii*
Brown Water Snake	*Lycodonomorphus rufulus*
Aurora House Snake	*Lamprophis aurora*
Mole Snake	*Pseudaspis cana*
Russet Garden Snake	*Duberria lutrix*
Herald Snake	*Crotaphopeltis hotamboeia*
Spotted Skaapsteker	*Psammophylax rhombeatus*
Cross-marked Grass Snake	*Psammophis crucifer*
Dwarf Garter Snake	*Elaps lacteus*
Rinkals	*Hemachatus haemachatus*
Cape Cobra	*Naja nivea*

Lizards (according to FitzSimons (1943) and Cape Department of Nature and Environmental Conservation (unpublished records)).

Common Name	Species
Marbled Gecko	*Phyllodactylus porphyreus*
Rock Agama	*Agama atra*
Cape Spiny Agama	*Agama hispida*
Cape Dwarf Chameleon	+*Bradypodion pumilum*
Speckled Skink	*Tetradactylus seps*
Common Skink	*Mabuyu capensis*
Plated Lizard	*Mabuya homalocephala*
Common Girdled Lizard	*Cordylus cordylus*

Tortoises and Terrapins (according to Greig and Burdett (1976) and Cape Department of Nature and Environmental Conservation (unpublished records)).

Common Name	Species
Geometric Tortoise	+*Psammobotes geometricus*
Angulate Tortoise	*Chersina angulata*
Padloper Tortoise	*Homopus aureolatus*
Cape Terrapin	*Pelomedusa subrufa*

APPENDIX V: Birds recorded at the Lourens Estuary.

Roberts No.	Species Common Name	Summers *et al.* (Waders only) 19/02/76	Bally *et al.* March, April 1980	Underhill & Cooper 05/01/81	S.Cliff J.R.Grindley Dec 1980 Feb 1981	S.Cliff March, April 1981
47	White Breasted Cormorant	-			11	4
48	Cape Cormorant	-	+		0	0
50	Reed Cormorant	-	+		219	119
55	Grey Heron	-			0	2
59	Little Egret	-			5	1
60	Yellow-billed Egret	-			2	1
72	Hamerkop	-			1	0
89	Egyptian Goose	-			3	2
212	Coot	-			0	2
231	Black Oyster-catcher	0	+		6	12
235	White-fronted Sandplover	5			22	3
245	Blacksmith Plover	0			29	29
254	Knot	0			0	60
255	Sanderling	30	+++		5	1
263	Greenshank	0			1	1
269	Avocet	0			0	3
270	Stilt	3			0	3
275	Dikkop	0			0	2
287	Southern Black-backed Gull	-	++		24	164
288	Grey-headed Gull	-			0	1
289	Hautlaub's Gull	-	++	11	160	96
291	Common Tern	-	+++	30 000		
294	Arctic Tern	-		13 000	22 000	60
296	Sandwich Tern	-				
298	Swift Tern	-			1	80
311	Rock Pigeon	-	++		10	3
394	Pied Kingfisher	-			4	5
397	Malachite Kingfisher	-			2	0
493	European Swallow	-			1	10
509	African Sand Martin	-			35	20
543	Cape Bulbul	-			2	1
686	Cape Wagtail	-			2	4
722	Bokmakierie	-			2	0

Bally *et al.*, (1980) recorded the frequency of occurrence of species as indicated by + symbols.

+++ = very frequent

++ = moderately frequent

\+ = rare

\- = indicates those species not counted

APPENDIX VI: Mammals recorded by Stuart *et al.*, 1980 for the area covered by the 1: 50 000 Sheet 3418BB Somerset West.

+ indicates rare, threatened species (Meester, 1976 and Skinner *et al.*, 1977.

Common Name	Species
Melck's House Bat	*Eptesicus melckorum*
Geoffrey's Horseshoe Bat	*Rhinolophus clivosus*
Egyptian Fruit Bat	*Rousettus aegyptiacus*
Dwarf Shrew	*Suncus etruscus*
Chacma Baboon	*Papio ursinus*
Southern Elephant Seal	*Mirounga leonina*
Grysbok	*Raphicerus melanotis*
Cape Greater Gerbil	+*Tatera afra*
Verreauxs Rat	+*Praomys verreauxi*
Black and White Dormouse	*Graphiurus ocularis*
Cape Dune Molerat	*Bathyergus sucillus*
Cape Clawless Otter	*Aonyx capensis*
Cape Wild Cat	*Felis libyca*
Serval	+*Felis serval*
Leopard	+*Panthera pardus*

APPENDIX VII: Summary of available information

ESTUARY / RIVERMOUTH / LAGOON: LOURENS ESTUARY

		Summary of available information / Sources of Information	Bally et al	Bartlett	Cape Depart. of Nature and Environmental Cons.	Cape of Good Hope Ordinance	Directorate of Water Affairs	Eagle	FitzSimons	FitzSimons	Glass	Greig and Burdett	Harris	Hawkins, Hawkins & Osborne	Heap	Heydorn & Tinley	Lourensford Estates	McLachlan	Meester	Ninham Shand & Partners
BIOTIC		Food Webs																		
	Fauna	Mammals																	*	
		Birds	*																	
		Reptiles & Amphibians			*				*	*		*						*		
		Fish			*	*														
		Fauna on soft substrates																		
		Fauna on hard substrates																		
		Insects																		
		Other invertebrates	*																	
		Zooplankton																		
	Flora	Terrestrial																		
		Phytoplankton																		
		Halophytes																		
ABIOTIC	Other	Historical													*					*
		Utilization													*					*
		Conservation				*														
		Modelling																		
		Aquaculture																		
		Management				*								*						
		Bacteriology																		
	Chemistry	Pesticide residues																		
		Metal residues																		
		Eutrophication																		
		General chemistry	*	*				*												
	Geomorphology	Sediment transport & deposition		*				*		*	*									
		Paleoenviroment									*									
		Geology																		
	Physics	Circulation & mixing								*	*		*							
		Density variations																		
		Hydrology					*							*		*	*			*
	Physiography	Morphology																		
		Catchment characteristics																		
YEAR (DATE OF INFORMATION)			1980	1980	-	1974	-	1976	1943	1962	1980	1976	1978	1981	1977	1980	-	1978	1976	1974

ESTUARY / RIVERMOUTH / LAGOON	YEAR (DATE OF INFORMATION)	ABIOTIC																						BIOTIC												
		Physiography		Physics			Geomorphology			Chemistry					Bacteriology	Other						Flora			Fauna										Food Webs
LOURENS ESTUARY		Catchment characteristics	Morphology	Hydrology	Density variations	Circulation & mixing	Geology	Paleoenviroment	Sediment transport & deposition	General chemistry	Eutrophication	Metal residues	Pesticide residues			Management	Aquaculture	Modelling	Conservation	Utilization	Historical	Halophytes	Phytoplankton	Terrestrial	Zooplankton	Other invertebrates	Insects	Fauna on hard substrates	Fauna on soft substrates	Fish	Reptiles & Amphibians	Birds	Mammals		
Sources of Information		Summary of available information																																		
Ninham Shand & Partners	-			*																															
Poynton	1964																													*					
Shipley	1964					*																													
Skinner et al	1977																																*		
South Africa (Republic)	1962															*																			
Stuart et al	1980																																*		
Summers et al	1976																															*			
Swart & Serdyn	1982					*																													
Underhill & Cooper	1982																															*			
Valsbaai Strandverbeteringe	1980					*			*																										
MR Brett (pers. comm.)	1982																												*						
D Joubert (pers. comm.)	1982																												*						
GC Kies (pers. comm.)	1982									*						*			*																
CFB Krige (pers. comm.)	1982			*															*																
D Loubscher (pers. comm.)	1982			*																															
JA Lusher (pers. comm.)	1982									*																									
P Nel (pers. comm.)	1982									*																			*					
F Sheffler (pers. comm.)	1982			*						*										*	*														

ESTUARY / RIVERMOUTH / LAGOON	YEAR (DATE OF INFORMATION)	ABIOTIC																						BIOTIC												
		Physiography		Physics			Geomorphology			Chemistry					Bacteriology	Other								Flora			Fauna									Food Webs
LOURENS ESTUARY		Catchment characteristics	Morphology	Hydrology	Density variations	Circulation & mixing	Geology	Paleoenvironment	Sediment transport & deposition	General chemistry	Eutrophication	Metal residues	Pesticide residues		Management	Aquaculture	Modelling	Conservation	Utilization	Historical	Halophytes	Phytoplankton	Terrestrial	Zooplankton	Other invertebrates	Insects	Fauna on hard substrates	Fauna on soft substrates	Fish	Reptiles & Amphibians	Birds	Mammals		
Sources of Information		Summary of available information																																		
AB Smit (pers. comm.)	1982			*											*																				
BH Tromp (pers. comm.)	1982														*			*																	
HH van Niekerk (pers. comm.)	1982														*			*	*													*			
D Zietsman (pers. comm.)	1982	*		*																															
S Cliff - Ecological Surveys	1982		*							*				*	*			*	*		*	*	*	*	*			*	*	*	*	*			
MAPS																																				
Hottentots Holland Basin 1:10 000	1979	*																	*																
Mountain & Assoc. Engineering Geol. 1:50 000	-						*																												
S.A. 1:50 000 Sheet 3418 BB	1981	*	*																																
Stellenbosch Divis. Council 1:50 000	1979	*																	*																
AERIAL PHOTOGRAPHY																																				
Trig Survey																																				
Job No 61/66	1944		*						*										*				*												
Job No 335	1953		*						*										*				*												
Job No 534	1966		*						*										*				*												
Job No 719	1973		*						*										*				*												
Job No 786	1977		*						*										*				*												
Job No 326	1979		*						*										*				*												

APPENDIX VII: (Cont.)

			Summary of available information	Land Survey Dept. Univ. of Natal Job No 391
BIOTIC		Food Webs		
	Fauna	Mammals		
		Birds		
		Reptiles & Amphibians		
		Fish		
		Fauna on soft substrates		
		Fauna on hard substrates		
		Insects		
		Other invertebrates		
		Zooplankton		
	Flora	Terrestrial		
		Phytoplankton		
		Halophytes		
ABIOTIC	Other	Historical		
		Utilization		*
		Conservation		
		Modelling		
		Aquaculture		
		Management		
		Bacteriology		
	Chemistry	Pesticide residues		
		Metal residues		
		Eutrophication		
		General chemistry		
	Geomorphology	Sediment transport & deposition		*
		Paleoenviroment		
		Geology		
	Physics	Circulation & mixing		
		Density variations		
		Hydrology		
	Physiography	Morphology		*
		Catchment characteristics		
YEAR (DATE OF INFORMATION)				1981
ESTUARY / RIVERMOUTH / LAGOON		LOURENS ESTUARY	Sources of Information	Land Survey Dept. Univ. of Natal Job No 391

PLATE I:

The lagoon during summer showing dense algal mats and the accumulation of debris due to low river flow and minimal tidal currents (Univ. of Cape Town, 81-12-17)

PLATE II:

The beach to the east of the river mouth is littered with logs and debris brought down the river during the rainy season. (Univ. of Cape Town, 81-08-13)

PLATE III:

Flocks of up to 10 000 Sandwich, Common and Arctic Terns may be seen roosting on the beach near the Lourens River mouth, during the summer months. (Univ. of Cape Town, 81-12-17).