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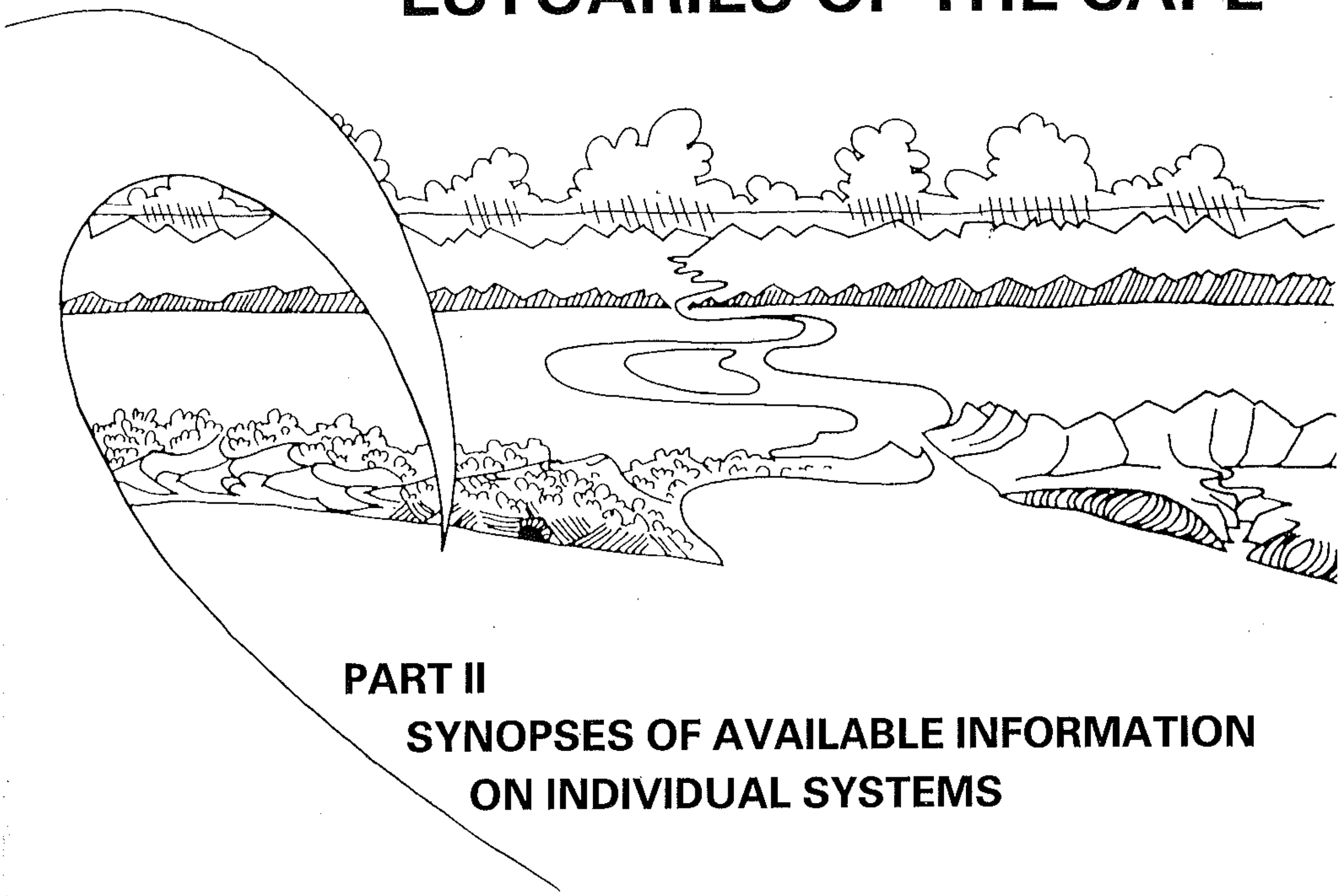
ESTUARIES OF THE CAPE



PART II
SYNOPSES OF AVAILABLE INFORMATION ON INDIVIDUAL SYSTEMS

REPORT NO. 29

HOUT BAY (CW 27)

CSIR RESEARCH REPORT 428

Stellenbosch, South Africa
December 1988

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PART II: SYNOPSES OF AVAILABLE INFORMATION ON INDIVIDUAL SYSTEMS

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(CW 27 – CSIR Estuary Index Number)

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ESTUARINE AND COASTAL RESEARCH UNIT – ECRU
DIVISION OF EARTH, MARINE AND ATMOSPHERIC SCIENCE AND TECHNOLOGY
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PREFACE

The Estuarine and Coastal Research Unit was established by the National Research Institute for Oceanology 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 from the Kei to 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 undertake investigations 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 "Estuaries of the Cape, Part I - Synopsis of the Cape Coast. Natural Features, Dynamics and Utilization" (by Heydorn and Tinley, CSIR Research Report 380). The report 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 "Estuaries of the Cape, Part II". These reports summarize, in language understandable to the layman, all available information on individual estuaries. 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, 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.

On 1 April 1988 the National Research Institute for Oceanology was incorporated into the new Division of Earth, Marine and Atmospheric Science and Technology (EMA) of the CSIR. In the process of restructuring, the Estuarine and Coastal Research Unit (ECRU) ceased to exist as an entity. However, the tasks undertaken by the ECRU continue to be performed by the Coastal Processes and Management Advice Programme of EMA.

D H SWART
MANAGER, COASTAL PROCESSES AND MANAGEMENT ADVICE PROGRAMME
DIVISION OF EARTH, MARINE AND ATMOSPHERIC SCIENCE AND TECHNOLOGY

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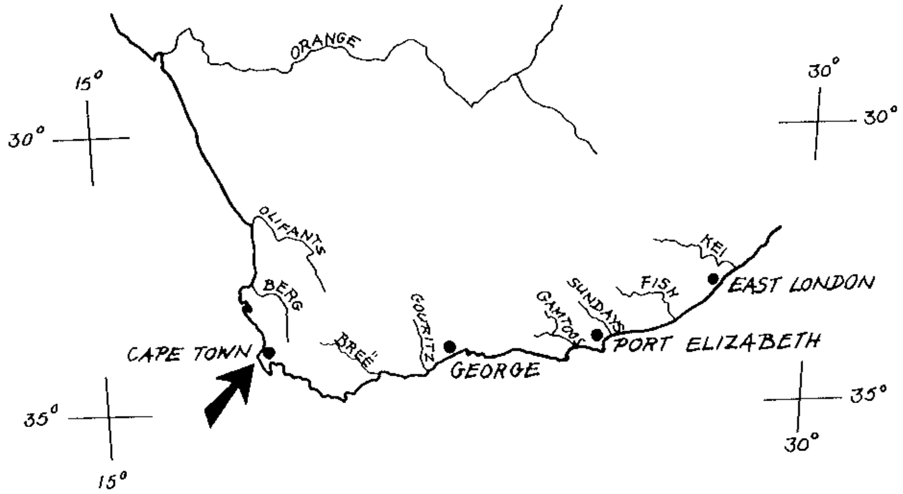
HOUT BAY

1. LOCATION

Hout Bay is a south-facing crescentic embayment on the west coast of the Cape Peninsula approximately 22 km south of Cape Town. The valley of Hout Bay is surrounded by mountains with the summit of Table Mountain, Maclear's Beacon (1 086m), marking the northernmost point of the catchment. The mouth of the Hout Bay River is located at 34°03'S, 18°21'E.



1.1 Accessibility

Three access roads lead into the Hout Bay Valley: Constantia Main Road and Rhodes Drive, from the southern suburbs of Cape Town, enter the valley over Constantia Nek following the old Cloof Pas road. Victoria Road runs along the Atlantic seaboard and enters the valley over Suikerbossie Nek. The third access road approaches Hout Bay village from the south linking it to Noordhoek via Chapman's Peak Drive.

Plans to establish a ferry service and a railway line between Hout Bay and Cape Town have been suggested at various times (Green, 1957) but have not been implemented.

1.2 Local Authorities

The Hout Bay River and its catchment fall under the jurisdiction of four authorities, namely the Cape Town City Council, Divisional Council of the Cape [1], the Directorate of Forestry [2] and the Chief Directorate: Nature and Environmental Conservation, CPA. (Figure 2). Details of land ownership will be given in Section 3.1.2.

[1]The Cape Divisional Council has been incorporated into the Western Cape Regional Services Council (WCRSC) comprising the Divisional Councils of the Cape, Paarl and Stellenbosch including the municipalities within their boundaries.

[2]The Directorate of Forestry was transferred to the Cape Provincial Administration on 1 April 1987.

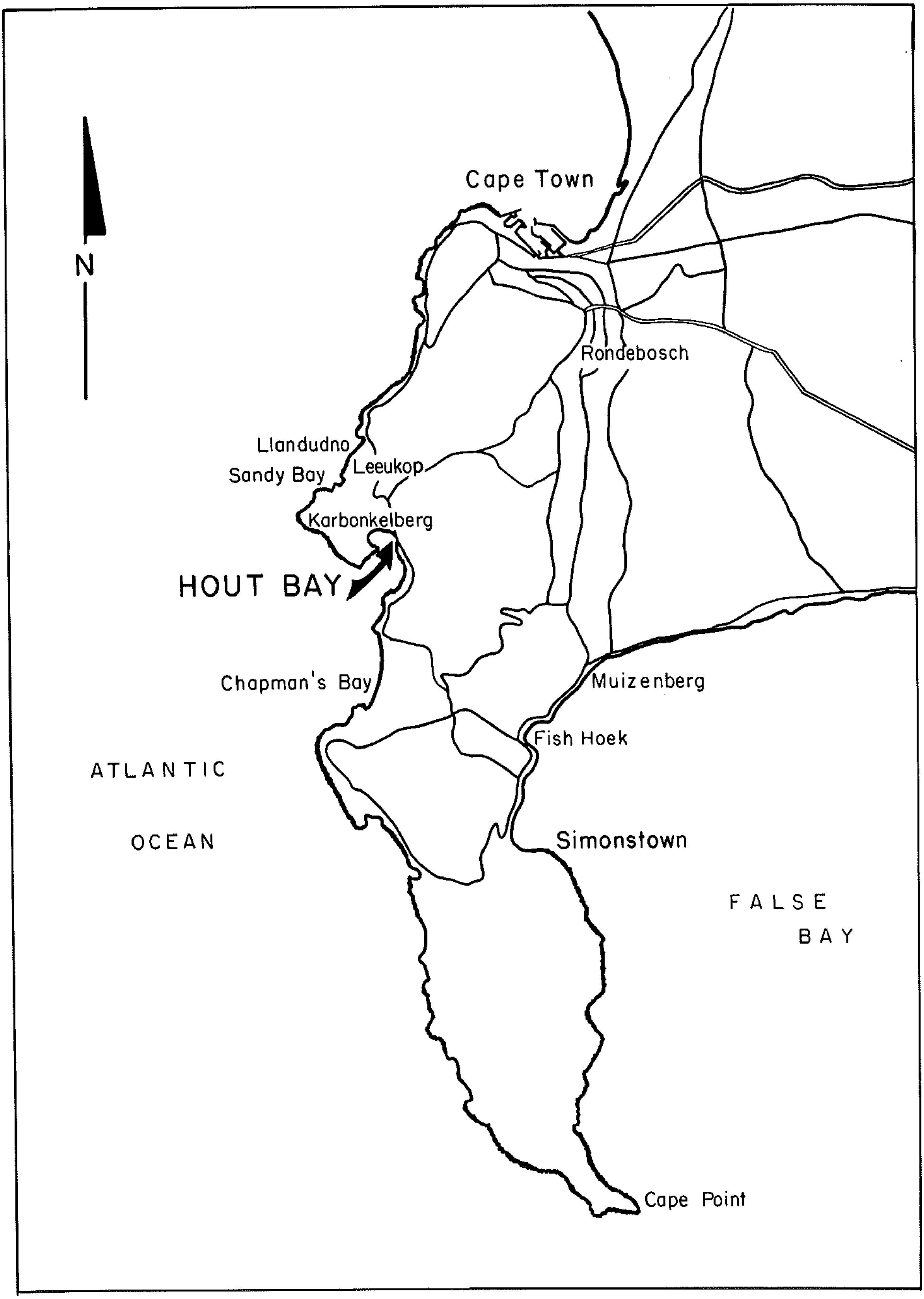


FIG. I: Hout Bay - Locality plan

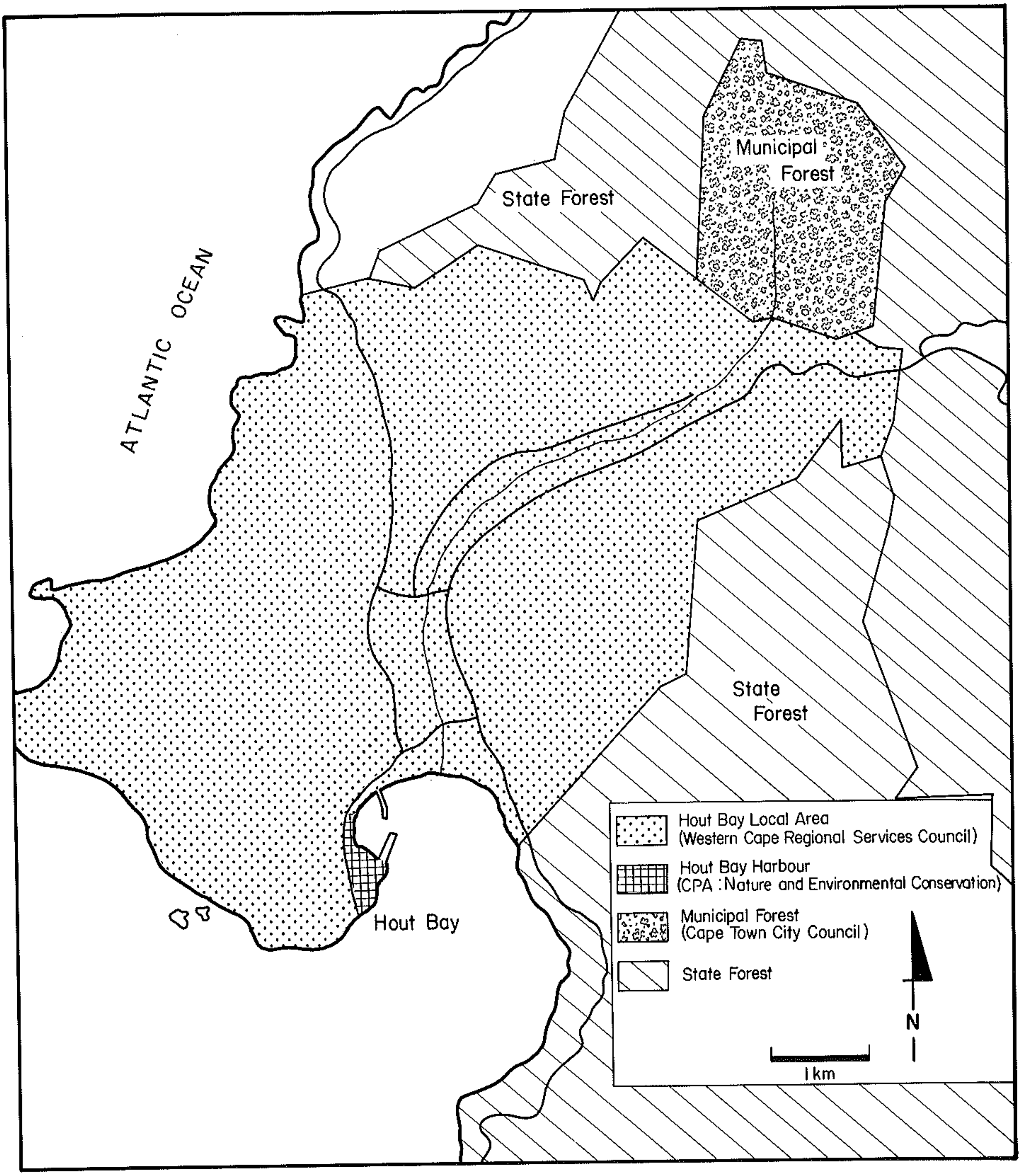


FIG. 2: Jurisdictional boundaries of the Hout Bay River catchment

2. HISTORICAL BACKGROUND

2.1 Past and Present Names of the River

On an early Dutch map of 1691, the British Admiralty Chart of 1870, and the Map of the Cape Division, 1899, the only name given to the river was the "Hout Bay River". By the turn of the century the streams above the confluence in Orange Kloof were given separate names: the stream leading from Woodhead Reservoir was called "Back Stream", while the stream leading from Alexandra and Victoria Reservoirs was called "Disa Stream". Below the confluence the river was known as the "Hout Bay River". The geological survey plans of 1906, however, referred to the river as the "Palmiet River" but this name has not been found on any other maps.

On the Trigonometrical Survey Map (TSO 101/793) of 1932 (revised in 1949) an alteration to the naming of the streams above the confluence is shown. The "Back Stream" is now referred to as the "Disa Stream", and the stream running from the Alexandra and Victoria Reservoirs into the De Villiers Reservoir as the "Original Disa Stream". However, locally and amongst people working on the river, the most widely accepted name for the river below the confluence is the "Hout Bay River", and the "Disa Stream" and "Original Disa Stream" refer to the waters above this point (Figure 10). These names are used throughout this report, and the catchment is therefore referred to as the Hout Bay River Catchment.

2.2 Historical Aspects

Evidence of Late Stone Age occupation of a cave near the estuary is documented by Buchanan (1977). A ship's pilot gave the name "Chapmans Chaunce" to the bay in 1607, and this was the earliest English name of the bay to appear on maps of Southern Africa (Raven-Hart, 1967). By 1615 the forests of Hout Bay were being exploited by early travellers and members of Van Riebeeck's party who explored Hout Bay reported that they found "a fine large forest of very tall straight growing trees ... and ... a fine fresh river flowing to the sea, wide and deep enough for rowing boats" (Thom, 1952). The forests then grew to within 4 km of the beach and Van Riebeeck considered floating timber down the river to the sea. He recorded that timber growing near the beach was cut and taken by sea to Cape Town to be burnt in the lime kilns. Early maps show the river running though extensive swamp and marshland and in 1800 William Duckitt, an agricultural advisor, described the river in these words: "There is a great quantity of water issuing from the cliff, which spreads itself along the flat of Hout Bay, in length about 3 miles, in breadth about 400 yards. It is covered with amazing strong palmities ...". A track over "Cloof Pas" opened up access for farming activities in the valley. In 1677 Simon van der Stel signed the first agreement to rent land for agricultural purposes, and by 1681 Kronendal and Ruiteplaats were granted as freehold farms. By the middle of the 19th Century, wine, vegetables, meat and milk were sold locally and to the passing ships, and the valley was famous for its merino sheep and horses (Laidler, 1926; Burman, 1962).

An outbreak of phylloxera, a vine disease, in the early part of the century caused a shift in agriculture from vineyards to market gardening. Because of its sheltered position, Hout Bay farmers were able to produce early spring vegetables for Cape Town. This made farming a profitable concern and an increasing amount of land was opened up for agriculture. The war years (1939-1945) gave agriculture an added boost as there was a great demand for vegetables to supply ships which came into Table Bay, and Hout Bay's proximity was greatly to its advantage (Bisschop, *Sentinel News* , June/July 1979).

FIG. 3: Hout Bay beachfront in the early part of this century looking Eastwards across the wide sandy beach, backshore lagoon and meandering estuary, towards Constantiaberg and Chapmans Peak Drive. (Photo: Hout Bay Museum).

By 1944 approximately 104 ha (or 3 percent of the catchment) was cultivated (see Section 3.1.2), and between 1944 and 1958 an additional 249 ha were brought under the plough. These new fields were all situated in the valley floor, and by 1958 the banks of virtually the entire length of the river, downstream from Orange Kloof, were disturbed and most of the palmiet (*Prionium serratum* L F Drége) had been removed. It was during this period that the first major bed erosion occurred in the river channel.

FIG. 4: A view of the bay and beach in 1903 looking west with the Sentinel and Karbonkelberg in the background. The sand corridor linking Hout Bay beach and Sandy Bay can be seen in the right of the picture. (Photo: Hout Bay Museum).

FIG. 5: Dense palmiet *(Prionium serratum)* growth in the lower reaches of the river, 1887. (Photo: Hout Bay Museum).

Water was led from the river in furrows to irrigate the lands, but in summer the supply fell far short of the demand and farmers were known to resort to fist-fights over water rights. On Mr Daniel's farm, Longkloof, the entire flow could run through a pipe one foot (30 cm) in diameter in the summer months of the mid 1940s (M V Daniel, pers. comm.);

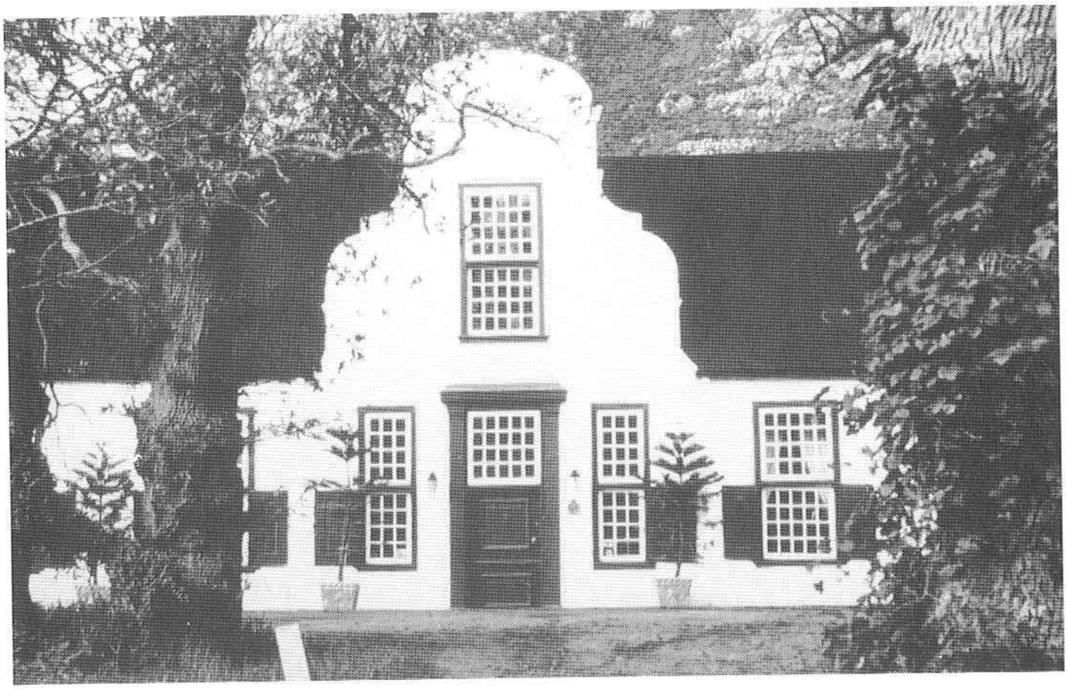


FIG. 6: Kronendal was one of the earliest farmsteads in the valley. The front section of the house and the gable were added in 1800; the back section and kitchen are much older, but the date of their construction is unknown. (Photo: Hout Bay Museum).

water from the river was used for domestic purposes as well as for irrigation, and farmers downstream would sometimes block the meagre flow in the river bed and divert it onto their lands, mounting guard over their furrow with a shotgun!

Aluminium sulphate, used by the Orange Kloof filtration plant to remove the dark-brown peat-stained colour from the water, was discharged directly into the river in the past. At times of low flow this caused great inconvenience, blocking pipes and making the use of river water for domestic purposes impossible (M V Daniel, pers. comm.).

During the 1960s the agricultural boom began to decline in Hout Bay. Irrigation schemes were established at other centres and Hout Bay lost its competitive advantage in being close to Cape Town. A major factor which doomed the valley's agricultural future was the South African tradition of subdividing farms among the sons on the death of the father. Farms became too small to be viable and the expansion of Cape Town put increasing pressure on farmers to sell their land to property developers (Bisset, 1976).

The agricultural boom had encouraged farmers to remove the palmiet and other reeds from the flat land adjoining the river in order to increase the area of their fields (M V Daniel, pers. comm.); subsequently when the farming activities were reduced in the 1960s these disturbed lands rapidly became infested with alien vegetation. Alien acacias, already in the area, flourished and formed a canopy shading out the remaining palmiet and other indigenous riverine vegetation. The increase in wooded areas can clearly be seen when Figures 18a and 18b (respectively for 1944, 1958, 1968 and 1977) are compared. Unlike the deep-rooted palmiet, these shallow-rooted trees afford little stabilization to the banks and their presence is a major factor contributing to the continuing erosion of the river banks.

Sediment from the eroding upper reaches causes massive deposition in the lower river and estuary and drag-line dredging operations have been necessary since the 1970s to maintain a reasonable depth along the river channel (R Gilmore, Deputy Engineer, Western Cape Regional Services Council). This has straightened the course of the lower river and dredge spoil levees have been formed on either side of the river channel from Victoria Road bridge to the estuary.

Fishing has always been a feature of Hout Bay and the earliest commercial fishing commenced in 1889. Snoek was smoked and exported to Mauritius, and the Hout Bay Canning Company, established in 1903, canned and exported crayfish.

FIG. 7: Fishing sheds on Hout Bay beach. The first shed was built in *ca*. 1889 by Crisp Arnold who exported snoek to Mauritius. (Photo: Hout Bay Museum).

Between the First and Second World wars several small fishing companies operated from Hout Bay and in 1946 five of them combined and pooled their resources to form South African Sea Products Limited (*SA Shipping News and Fishing Industry Review*, August 1953). Today five factories operate from Hout Bay (SA Sea Products, Chapmans Peak Fisheries, KDB Holdings, Live Rock Lobster and Irvin and Johnson), and between 100-200 fishing boats use the harbour (Mr De Jong, Hout Bay Harbour Master, pers. comm.). The Hout Bay Harbour Industrial Area (9,1 ha in extent) is State-owned under the jurisdiction of the Chief Directorate: Department of Nature and Environmental Conservation, CPA. The accompanying housing area is under the jurisdiction of the WCRSC.

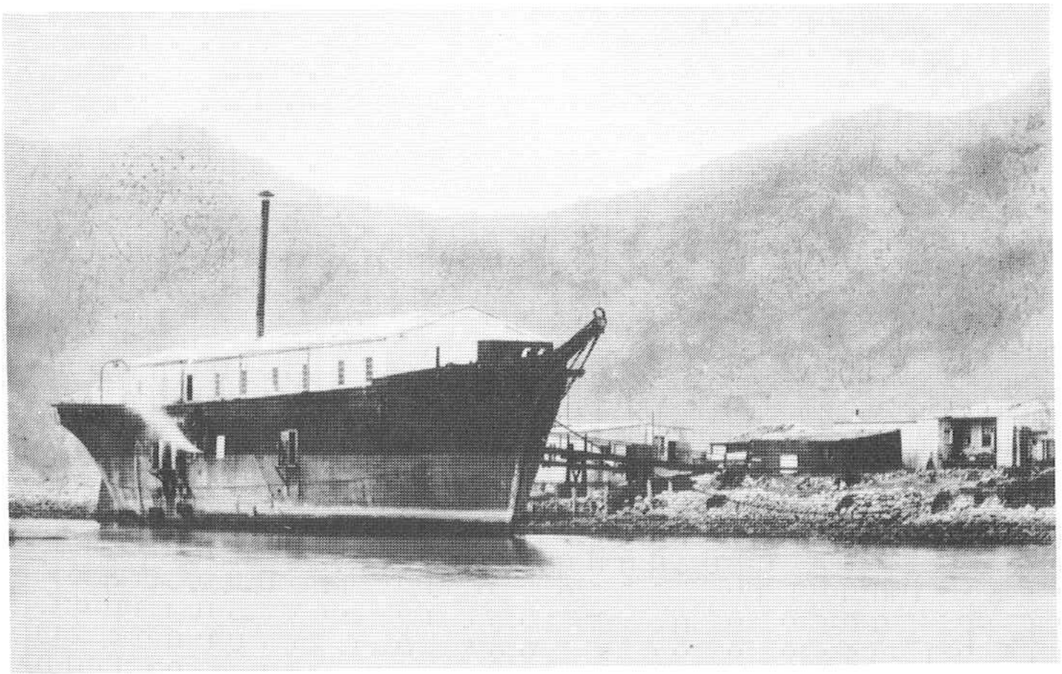


FIG. 8: The Hout Bay Canning Company operated a successful export business from the hulk of the *Morrow* from 1903-1918 during construction of the harbour. (Photo: Hout Bay Museum).

Although Hout Bay has been a fishing centre for a long time development of the harbour began in 1937 when a 600 ft long breakwater was built. South (1938) and north (1968) breakwaters were added and the harbour basin now has a water area of 16,4 ha.

The fishing industry is the sole large-scale industry in Hout Bay and has had a significant effect on the population of the area. In the 1940s and 1950s the number of people living in the area increased markedly as the labour requirements of the factories grew. The fishing industry also gave added impetus to the need to improve the quality of the roads and for the introduction of electricity; both these factors made Hout Bay more attractive to property developers and encouraged the transition from a rural to a semi-urban settlement.

The valley has experienced several minor land "booms" in the past. The first was precipitated by plans to connect it to Cape Town by rail, and another a few years later when it was announced that a fast steamer service for commuters would operate between Hout Bay and Table Bay (Green, 1957). It was, however, the advent of the motor car and good roads which turned Hout Bay into a suburb of Cape Town. Scott and Penzance estates, on the slopes of Constantiaberg and Beach Estate, near the harbour, were marketed in the 1930s and a more affluent group of commuters made their homes in Hout Bay. Soon after their arrival, representations were made to the authorities for the provision of better roads, a water supply and health facilities, and in 1937 Hout Bay was first proclaimed a Local Area under the jurisdiction of the Divisional Council of the Cape (now within the Western Cape Regional Services Council). Since then, several proclamations have redefined the boundary of the local areas, the most recent being 1979.

FIG. 9: In 1891 the Woodhead tunnel was completed; this 640m long tunnel led water from Disa stream through the mountain to Slangolie Ravine south of Camps Bay, providing Cape Town with a supply of potable water (Photo: Hout Bay Museum).

The exploitation of the water supply from the upper catchment began late last century when the Wynberg Water Supply Act (Act 34 (Cape Colony) of 1887) and the Cape Town Municipality Additional Water Supply Act (Act 35 (Cape Colony) of 1887) vested these two municipalities with far reaching rights to use, divert and impound "all the water of the upper source and the tributary of the Hout Bay River, known as the Back Stream ..." (Cape of Good Hope Acts of Parliament 1884-1888). These rights were exercised initially by the construction of the Woodhead Tunnel in 1888 which led water from the Disa Stream through the mountain to Slangolie Ravine above Camps Bay.

In 1897 Woodhead Reservoir (954,000 Ml) was constructed on the headwaters of the Disa Stream and seven years later Hely-Hutchinson Reservoir was built slightly upstream (924,646 Ml). The Victoria (128,425 Ml) and the Alexandra (125,724 Ml) Reservoirs were built in 1903 on the Original Disa Stream, to supply Wynberg with potable water, and in 1907 the larger De Villiers Dam (242,443 Ml) was completed.

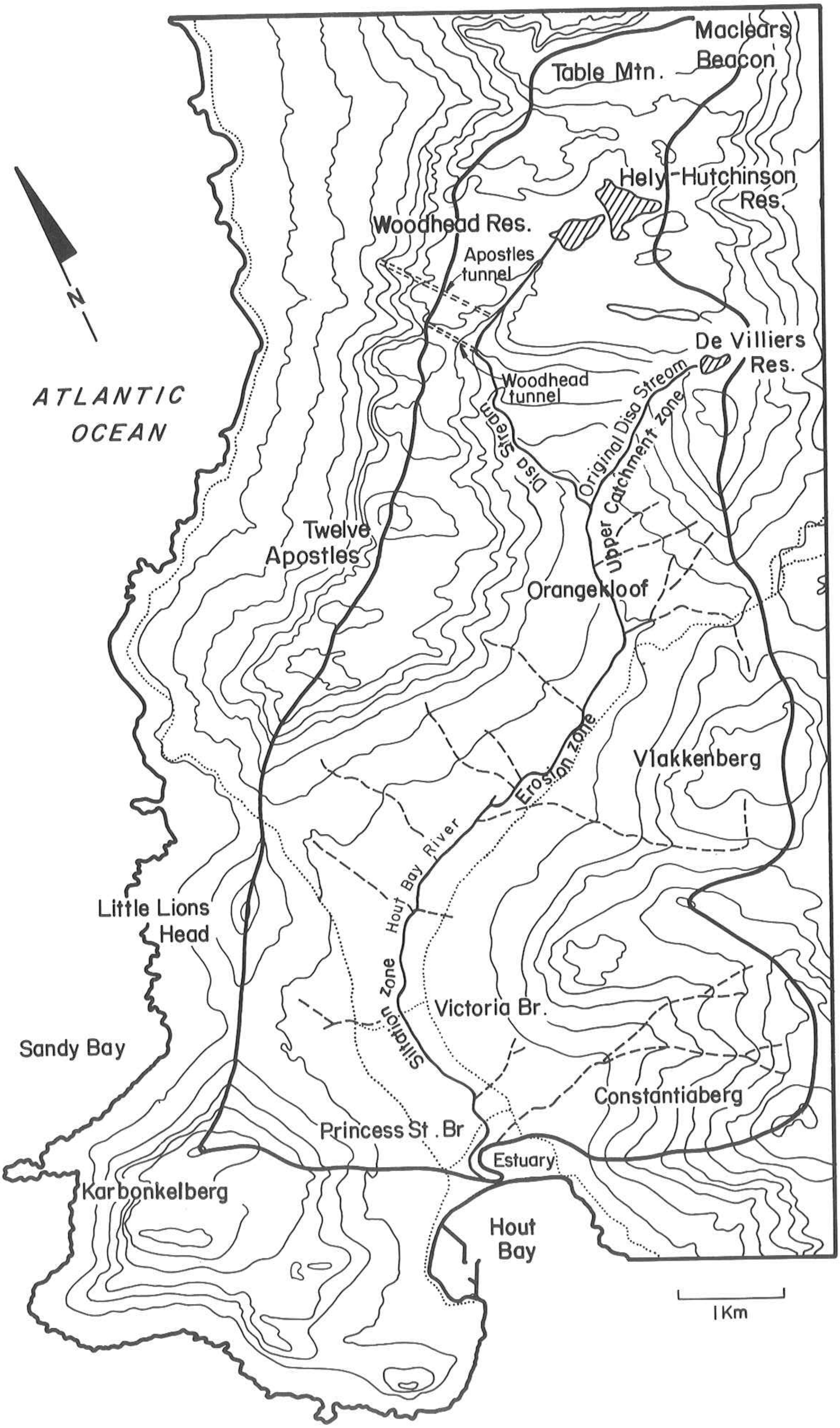


FIG.10: Hout Bay River Catchment

3. ABIOTIC CHARACTERISTICS

3.1 River Catchment

3.1.1 Catchment Characteristics

The total area of the catchment, calculated from maps and aerial photographs, is 33,8 km^2. The Hout Bay River rises on Table Mountain and drains the sloping Back Table into two streams: Disa Stream, which has cut deeply into Disa Gorge, and the Original Disa Stream, which flows down from Klaasenkop above De Villiers' Reservoir.

The streams join in Orange Kloof and the river runs the length of the valley through farmlands and residential areas to the sea. Five dams with a total volume of 2 375,000 Ml control the headwaters of these two streams which supply potable water to Cape Town.

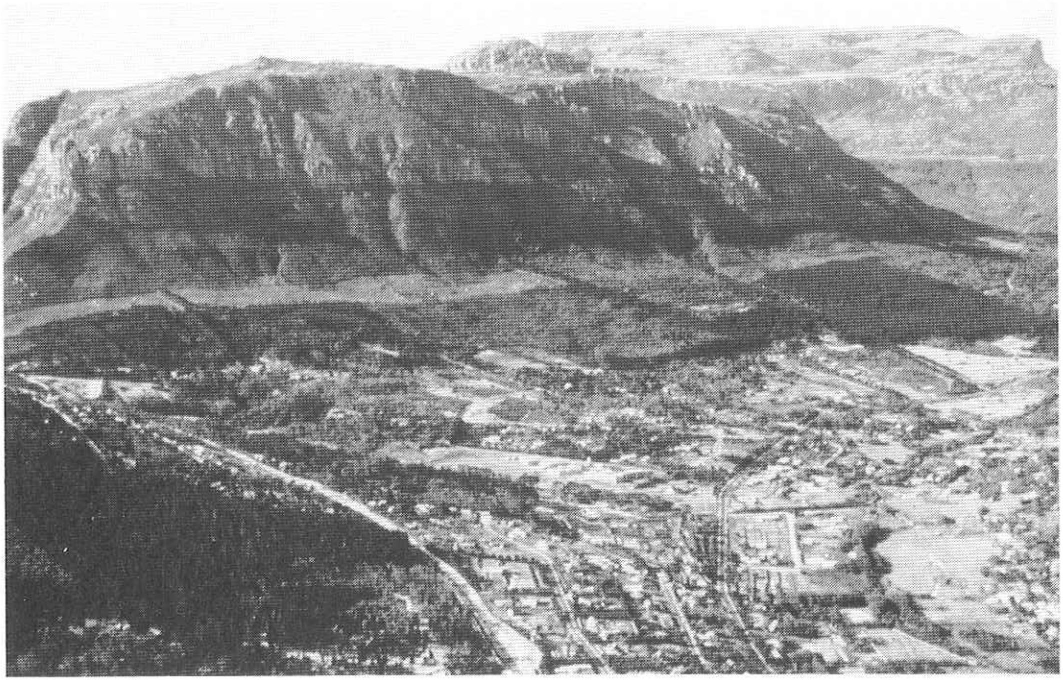


FIG. 11: A view of the lower sections of the Hout Bay valley flanked by the Twelve Apostles (on the left) and the sloping Back Table at the head of the valley. (Photo: WCRSC).

Taking the longer perennial tributary, the Disa Stream, as the main river course, the length of the river is 12 km, and approximately 26 km of tributaries join the river on its course to the sea (D Zietsman, Directorate of Water Affairs, pers. comm.). Many of the tributaries are wet-weather or intermittent streams, which are dry for most of the year, but flow strongly after winter rains. The Hout Bay River is typical of the rivers of the fynbos biome, being acid, short, steep and fast-flowing. Although it rises at a slightly lower altitude than the rivers rising in the Hottentots Holland mountains, its shorter length results in a steeper river profile (Figure 31).

FIG. 12: The upper catchment: in this zone the steep, fast flowing stream has a rocky bed and predominantly indigenous vegetation line the banks. (Photo: S Grindley, 1983).

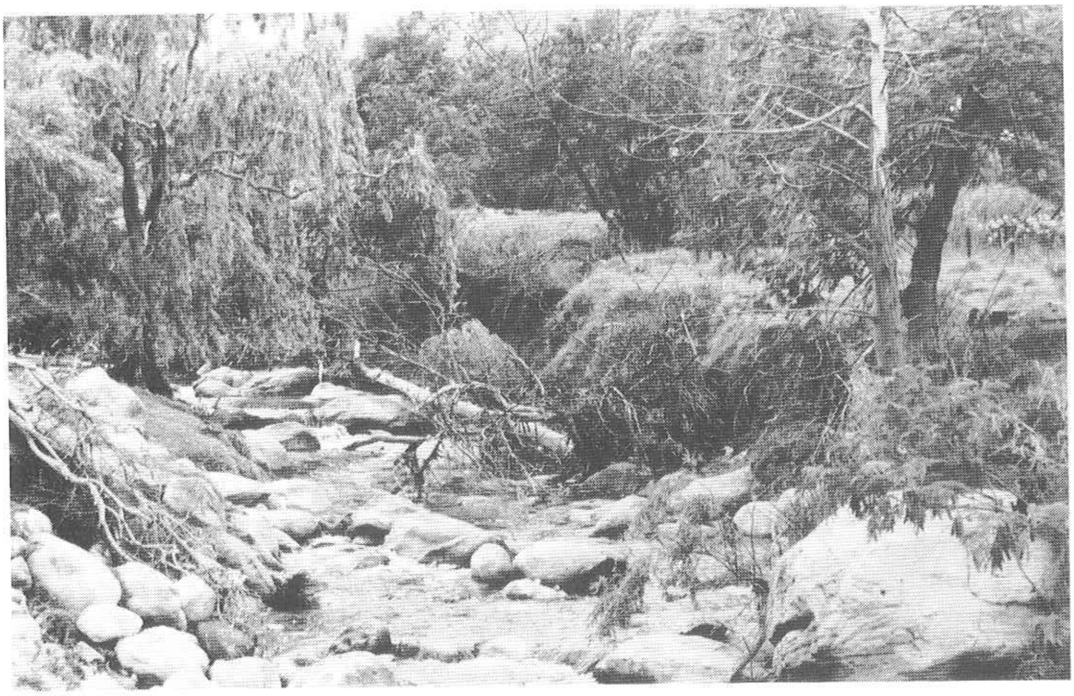


FIG. 13: The erosion zone: both bed and bank erosion have degraded this section of the river. (Photo: S Grindley, 1983).

FIG 14: The siltation zone: the flatter gradient of this section of the river results in extensive silt deposition from upstream erosion. Alien vegetation has colonized the levees of dredge spoil and reeds encroach into the shallow river channel. (Photo: Hout Bay Museum).

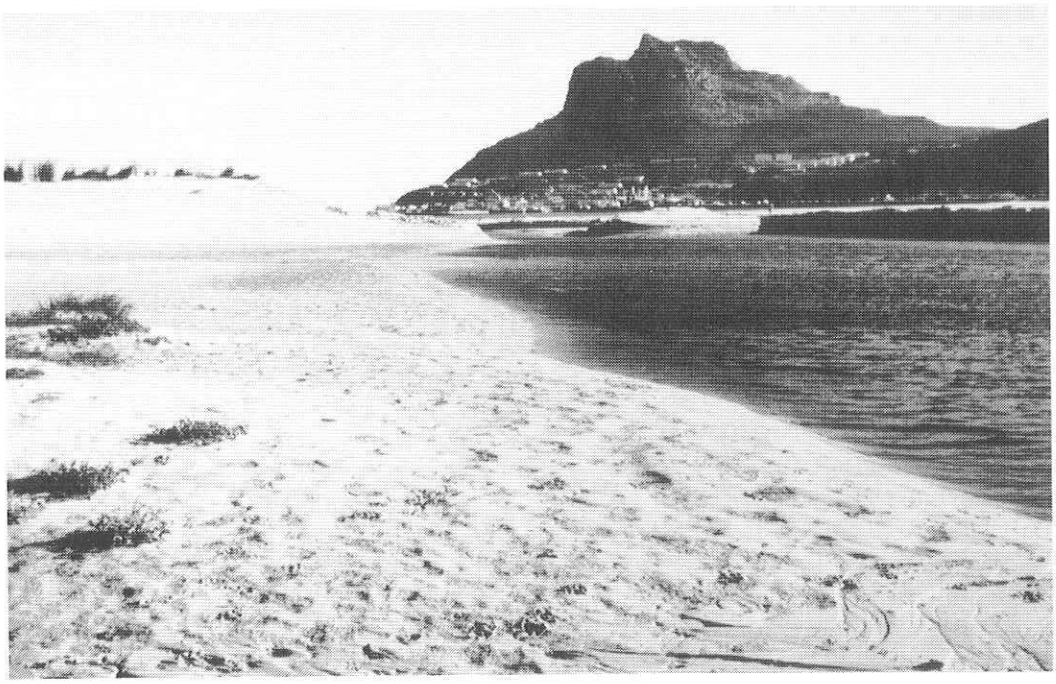


FIG. 15: The coastal zone: the river widens into a short lagoon before running over the sand to the sea. During low flow a sandbar closes the lagoon. The Sentinel is in the background with Hangberg settlement and the fishing harbour at its foot. (Photo: ECRU 82-04-18).

Four distinct river zones, have been identified (Hill Kaplan Scott Inc., 1979), namely:

1.	The upper catchment	- Table Mountain and the Orange Kloof Forest Reserve
2.	The erosion zone	- Longkloof to approximately 1 km above Victoria Road bridge
3.	The siltation zone	- Upstream of Victoria Road bridge to the estuary
4.	The coastal zone	

These zones correspond closely with the underlying geological formation within the catchment. The mountainous upper catchment is relatively undeveloped and the streams run through fynbos and indigenous forest in Orange Kloof. This area is under the jurisdiction of Cape Town City Council who manage it as a water catchment and forest reserve. The erosion zone begins where the valley opens out and the profile becomes less steep, and it marks the upper limit of intensive residential development; the major environmental problems involving the river occur within this zone. The lower reach, or siltation zone, is characterized by a relatively flat river gradient, and a broad flood plain. A short tidal estuary, which is closed by a sandbar in the summer months, flows through an area of marine sand deposits into Hout Bay.

Geology

The Hout Bay River catchment has a simple geology; Table Mountain sandstone overlies a granite base with a narrow band of shale at approximately 200m (Hill Kaplan Scott Inc., 1979) (Figure 16). This granite basement gives the valley its gentle lower slopes, although the rock itself is not often exposed. Sandstones were laid down on the eroded surface of the Cape Granite 320 million years ago (Mabbutt, 1952) and are known as the Table Mountain Group. These sandstone deposits are the dominant rock in the Cape Peninsula giving the mountains their characteristic tabular form. Sandstone weathers slowly and the narrow kloofs, such as Disa Gorge, have followed the faults which have fractured the horizontal bedding planes (Mabbutt, 1952). It is relatively more porous than granite and in the Hout Bay valley, underground springs are located on the contact zone (Borchers, 1979). Oxides of manganese and iron are sparsely distributed throughout the sandstone of the Table Mountain Group, and several deposits occur within the catchment.

Soils

Most of the catchment above the 200m contour is classified on the Soil Map of The Cape Peninsula (1976) as rocky with shallow soil. In these areas the parent sandstone is exposed and the sandy soils formed by weathering are soon removed by the high rainfall. Limited areas of shallow to moderately deep grey sandy soils of the Cartref form occur on the upper slope of Vlakkenberg, Constantiaberg and the Twelve Apostles. The red and yellow apedal soils of Orange Kloof have a clay content > 15 percent, the underlying material being gleyed as a result of the excess water in the area (Macvicar *et al.*, 1977). An augerhole drilled on the west side of the river opposite the Orange Kloof Forest Station in March 1983 revealed that the water table was only 50 cm below the surface.

Long fingers of shallow non-hydromorphic soils on weathered rock or clayey substrata of the Glenrosa and Swartland forms penetrate the apedal soils of Orange Kloof, following the drainage lines. These soils are also found on the lower slopes of Vlakkenberg, and in two gullies on Constantiaberg. Alluvial deposits of Dundee and Oakleigh forms with unconsolidated underlying material (Macvicar *et al.*, 1977) form a broad strip running the length of the valley to approximately the 100m contour, and along the main drainage pathways.

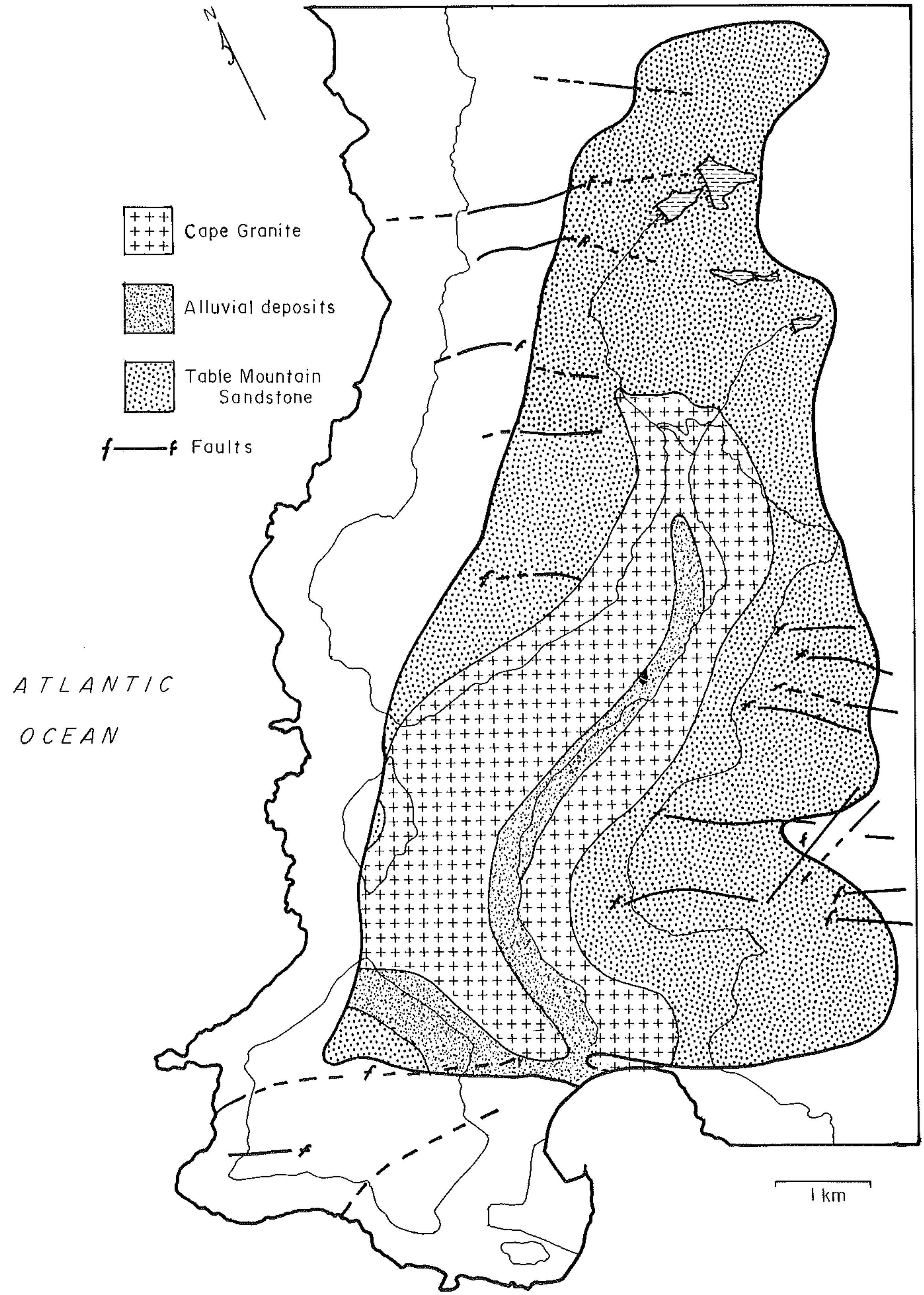


FIG. 16 : The geology of the catchment (after Geology Sheet 247, 1933)

Red and yellow apedal soils with a clay content of > 15 percent are found throughout most of the remaining areas of the catchment. These soils are of Avalon, Bainsvlei, Clovelly and Hutton forms some of which occur on gleyed underlying material. The sand corridor which runs across Leeukoppie Nek consists of acid Fernwood 11 soil with upper regic sand of medium grade, while Fernwood 31 is found in the flat low-lying areas around the bay and at the foot of the sand corridor.

The pH of the soil, which influences the availability of the nutrients to plants is usually five in the Hout Bay Valley (Smith-Baillie *et al.*, 1976).

Rainfall and run-off

The catchment lies within the winter rainfall region, which is characterized by hot dry summers and cool wet winters. Cold frontal depressions in winter bring cool temperatures and rain as they pass eastwards over the southern ocean; these periods of low pressure are usually followed by bright sunny weather in the intervals of high barometric pressure (Mabbutt, 1952). There is a wide variation in the quantity of precipitation received at different points within the catchment due to its mountainous nature, with the average annual precipitation increasing markedly with altitude.

TABLE 1: INCREASE IN PRECIPITATION WITH ALTITUDE

Station	Period of recorded precipitation in years	Altitude m	Average annual precipitation mm
Skaife Street	10	50	882
Orange Kloof	55	200	1 227
Woodhead Tunnel	55	686	1 273
Woodhead Dam	53	747	1 621
Table Mountain House	39	761	1 759
Maclear's Beacon	53	1 092	1 983

Winter rainfall is brought by the prevailing north-westerly wind and the catchment receives 60,6 percent of its annual precipitation during the months May to August, while January and February receive the least (4,6 percent and 4,0 percent of the mean annual precipitation respectively).

Mist adds appreciably to the total precipitation in mountainous areas, particularly during the summer months. Fuggle (1981) estimates that over 500mm per annum may be precipitated from cloud which is not recorded in standard rain gauges.

Recent research by Snow (1985), on Table Mountain has indicated that, under misty conditions with no rain, a single plant can produce up to 28 ml per hour from leaf drip and stemflow. He estimates that this could represent an additional 10 percent to the precipitation recorded as rainfall. During 1958 records kept at Table Mountain House show that the mountain was under cloud for 1 365 hours' (Moll and Campbell, 1976); the precipitation from mists could therefore add significantly to the total water budget of this catchment, and to the free water available to plants.

Evaporation

Evaporation during summer amounts to over 40 percent of the total annual evaporation. Evaporation has a direct influence on the amount of run-off from a catchment as more precipitation is lost through evaporation than through stream flow or storage combined (Hewlett, 1982).

Hydrological models applied to the catchment

Three mathematical models have been applied to the Hout Bay catchment (Grindley 1984). Pitman's (1973) model was used to generate monthly river flows from rainfall figures. The simulated mean annual run-off from the catchment is 39,10 million m^3 of which 57 percent occurs within the months of May, June, July and August. June has the highest annual run-off accounting for 16,2 percent of the total, whereas February with 2,8 percent has the least.

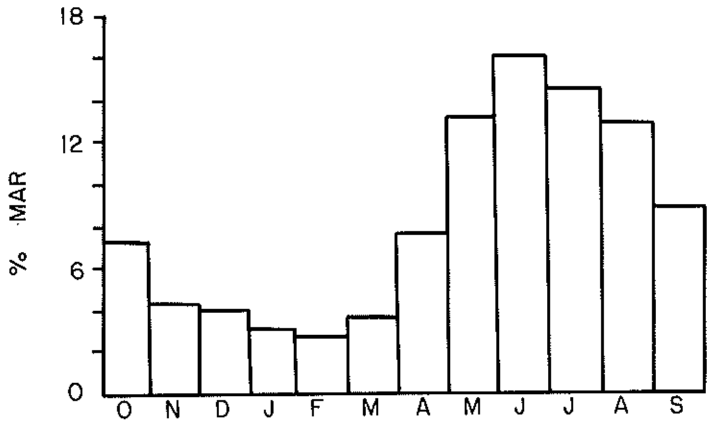


FIG. 17: Monthly run-off from the catchment as a percentage of the mean annual run-off (MAR). (From S Grindley, 1984).

To model the effects that changes in land-use may have on the total water yield the United States Soil Conservation Service Hydrograph Generating Technique (SCS model), was used. This model was devised for the estimation of storm run-off volumes and peak discharge rates in small catchments, by incorporating such physical characteristics as land-use, treatment and condition, soil characteristics and the antecedent moisture status of the catchment.

Multiple runs of the SCS model were made to show how storm run-off would differ according to the land-use pattern in the catchment. Strong trends indicate that changes in land-use, particularly in the valley floor, have had a significant impact on the run-off volume from the catchment. The Rational model, devised by the Department of Water Affairs (1977), was applied to give the approximate time of concentration of the catchment and peak discharge rates for different return periods (Grindley, 1984).

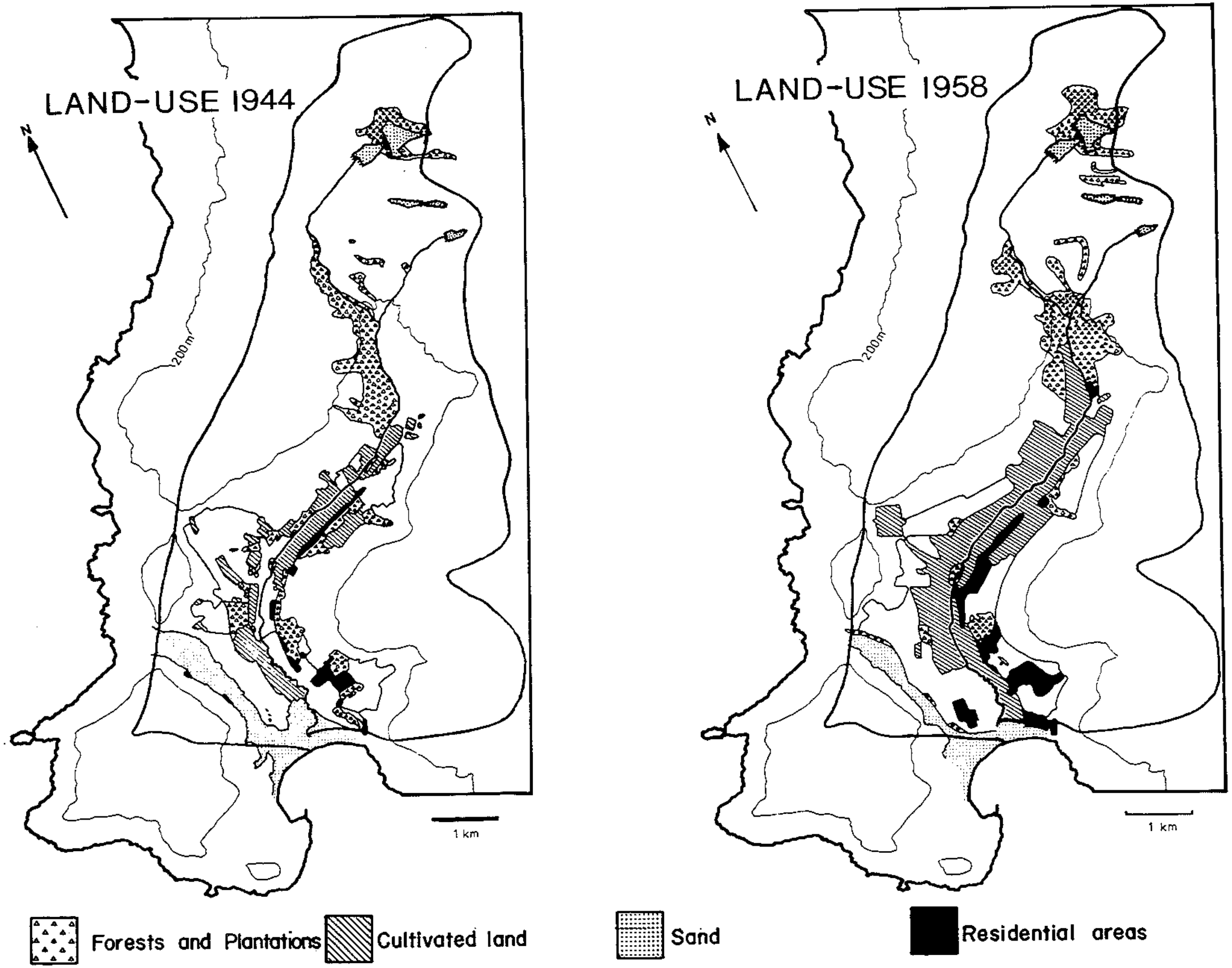


FIG. 18a: Land use patterns in the Hout Bay River catchment 1944 and 1958 (from S. Grindley, 1984).

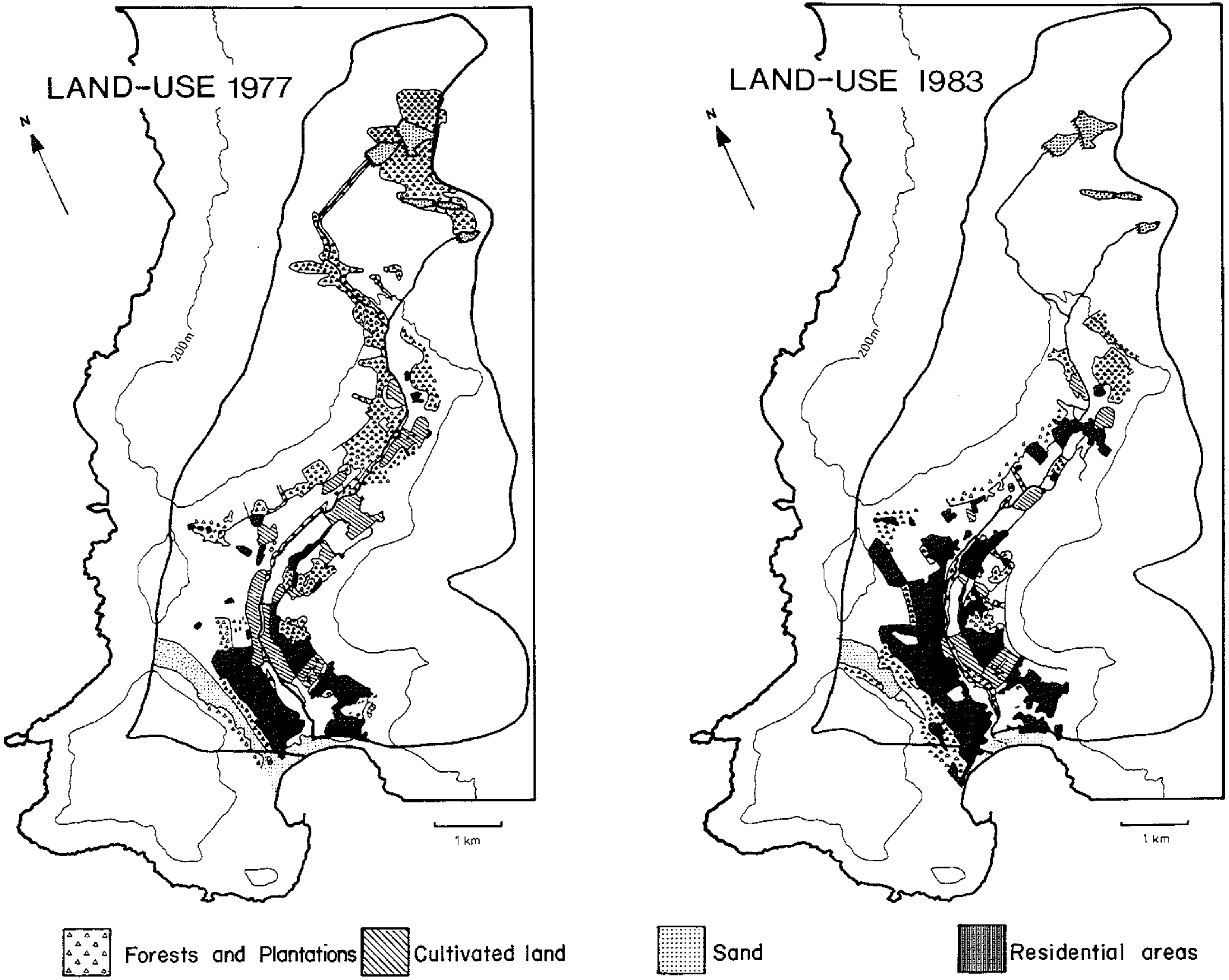


FIG. 18b: Land use patterns in the Hout Bay River catchment 1977 and 1983 (from S. Grindley, 1984).

3.1.2 Land Ownership/Uses

Hout Bay has gradually changed from a rural to a semi-urban environment, and there has been a corresponding shift in land-use from agricultural to residential as shown in Figures 18a and 18b. Table 2 shows that the percentage of the total catchment under cultivation has dropped from a high of 10,4 in 1958 to 1,14 in 1983 whereas that used for residential purposes increased from 0,4 in 1944 to 7,8 in 1983.

TABLE 2: APPROXIMATE AREAS (ha) OF DIFFERENT LAND-USE BELOW THE 200m CONTOUR CALCULATED FROM AERIAL PHOTOGRAPHS (S Grindley, 1984)

	1944		1958		1968		1977		1983	
	ha	%	ha	%	ha	%	ha	%	ha	%
Forest/Plantation	175	5,2	204	6,0	*	*	375	10,6	*	*
Cultivated lands	104	3,1	353	10,4	90	2,7	98	2,9	48	1,14
Residential areas	24	0,7	67	2,0	135	4,0	146	4,3	264	7,8
Sand corridor	144	4,3	90	2,7	85	2,5	70	2,1	41	1,2

* No data available.

Although Hout Bay accommodates only 0,53 percent of the population of Metropolitan Cape Town (Clark, 1986), the high quality of living environment offered in the valley has placed increasing demands on residential land. The form of development in Hout Bay has been influenced by its unique natural environment as well as historic, socio-economic and statutory forces.

The upper portion of the catchment on the Back Table of Table Mountain is controlled by the Cape Town City Council. This falls within the Cape Peninsula Nature area which is managed primarily for outdoor recreation and the conservation of indigenous flora. Orange Kloof Forestry Reserve is also under municipal control but is managed as a water catchment and forestry area. Access to the Reserve is restricted and certain areas of fynbos have been protected from fire for over 30 years, and remnants of the originally widespread Hout Bay forests are represented here. Studies of the past and present extent of these forests have been undertaken by Moll and Campbell (eds) (1976). Shaughnessy's (1980) historical investigation into the spread of alien pest plants in the Cape Town region, gives a detailed account of the early afforestation of the Back Table. In the late 19th Century *Pinus pinaster*, *P. pinea*, *P. halepensis* and *Acacia* spp. were planted. The cluster pine *(P. pinaster)* spread over much of the Back Table and *A. melanoxylon* became a dominant tree along the Disa River. The Parks and Forestry Branch of the Cape Town City Council are now committed to felling these alien trees on the Back Table, and clearing seedlings to prevent regeneration. Established plantations of *Pinus radiata*,*P.canariensis* and *P.pinea* in the lower portion of the Orange Kloof Forestry Reserve are managed for timber production, but will be phased out as they mature and are felled (P le Roux, Forester, Orange Kloof Forest Reserve, pers. comm.).

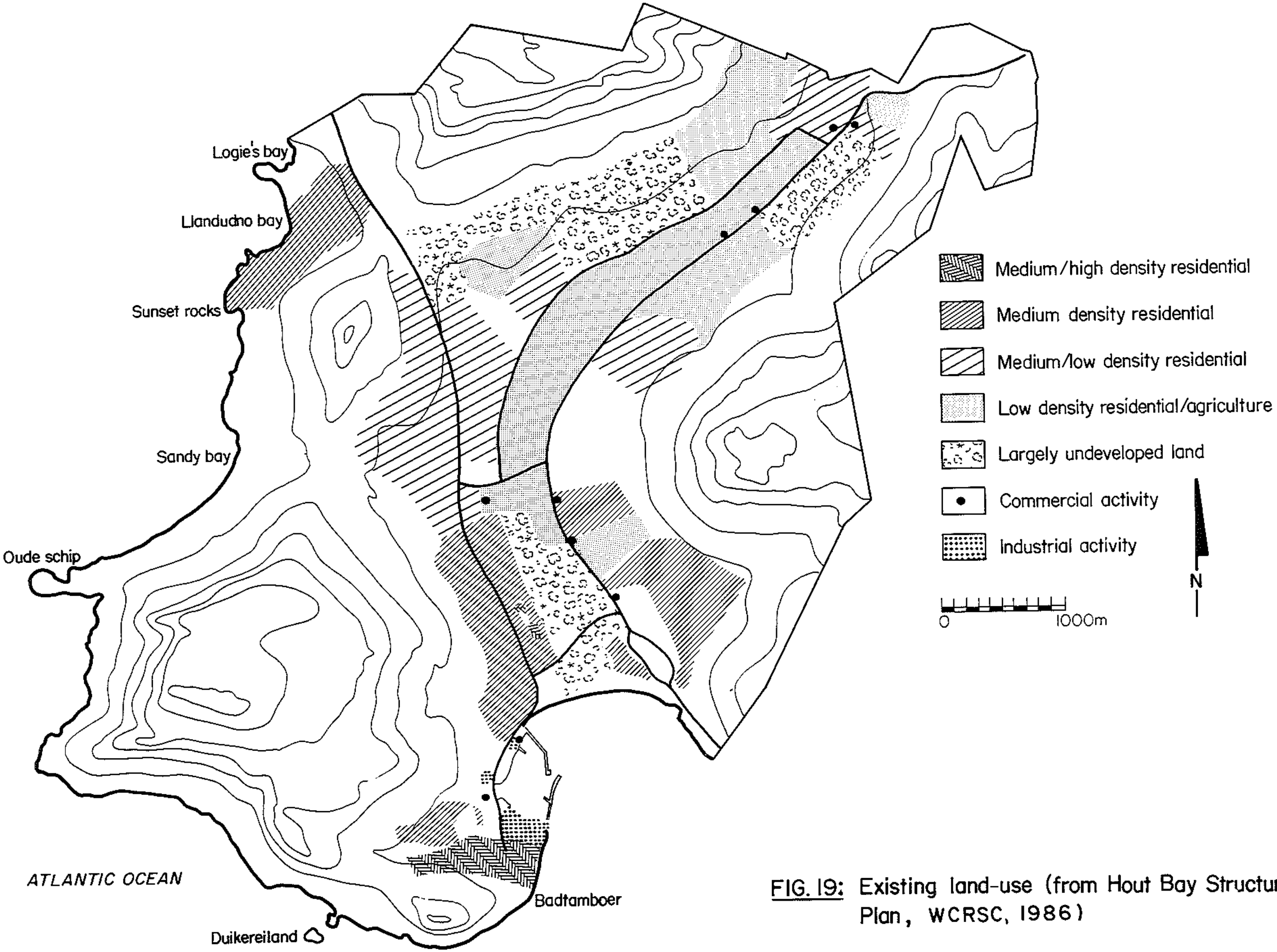


FIG. 19: Existing land-use (from Hout Bay Structure Plan, WCRSC, 1986)

The Woodhead and Hely-Hutchinson reservoirs provide potable water to the filtration plant above Camps Bay, via the Woodhead Tunnel. Water from the De Villiers Dam is purified at a water purifying plant in Orange Kloof. Residual sludge from the purification process is sprayed onto the ground to minimize the amount of aluminium sulphate reaching the river. (Water quality is discussed in more detail in Sections 3.2.4 and 3.2.5).

Broadly, the valley has been zoned for low density development on the valley floor, denser residential housing on the lower slopes of the mountains, a commercial node to the east of the estuary and an industrial area behind the fishing harbour (Figure 19). Two parallel strips of urban development (*ca.* 550m wide) run the length of the valley, bounded by the low density semi-rural development adjoining the Hout Bay River, and the undeveloped upper mountain slopes. The boundary of the Nature Area, which includes all the surrounding mountains, has set a limit to the spread of development up the mountain slopes, and with few exceptions, there is no development at all above the 150m contour.

As a result of the agricultural zoning of the valley floor, for most of the length of the river, riparian plots are in excess of $8000m^2$. This allows for a semi-rural lifestyle with paddocks, cultivated fields and livestock (particularly horses) being a pleasant feature of the area. Market gardening, on a large scale, takes place on one remaining farm situated below Victoria Road (Figure 20).

FIG 20: Market gardening below Victoria Road Bridge. (Photo: WCRSC).

Water is pumped from the river by some riparian owners to water livestock and irrigate lands, and animals crossing the river have aggravated erosion of the river bank in places.

FIG. 21: A view of the beach front showing the estuary flowing out through two channels. The movement of the mouth is constrained by a sea-wall and hardened parking area to the west. Reed-beds flank the lower reaches of the river. (Photo: ECRU, 79-10-23, altitude 250m).

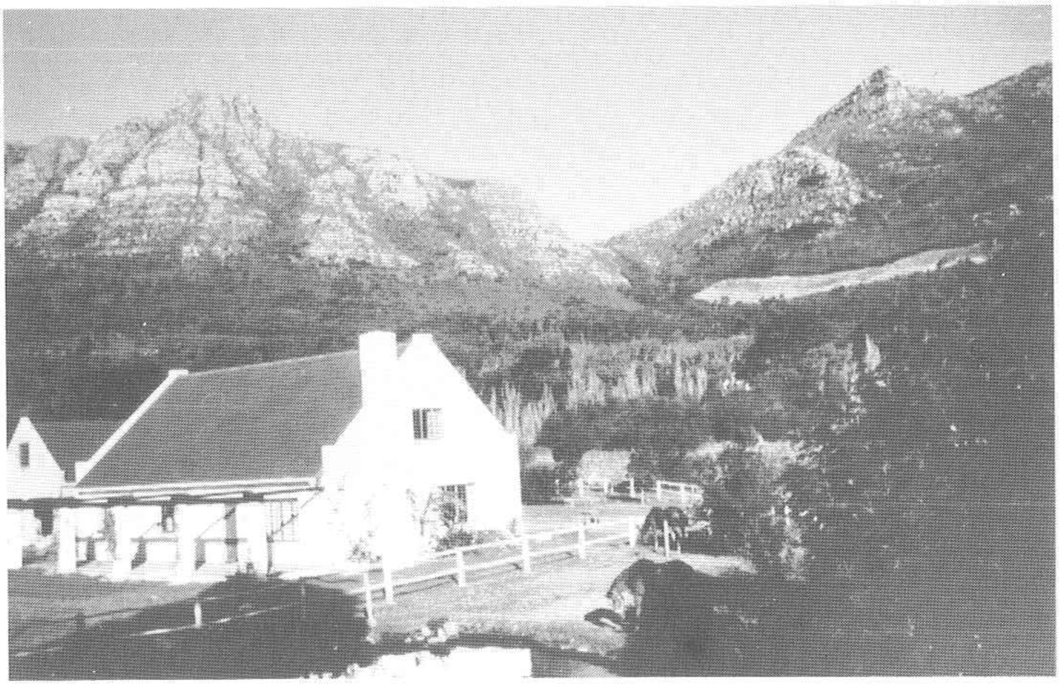


FIG. 22: A small-holding typical of the middle to upper income developments in the valley above Victoria Road bridge. (Photo: WCRSC).

FIG. 23: High density, low-income apartments adjacent to the harbour area. (Photo: WCRSC).

Extensive *Phragmites* swamps still exist between Victoria Road and Princess Street although dumping of rubble and the spread of alien vegetation has diminished their extent (Figure 21). At present the full potential of this area has not been realized because access is difficult and the dense vegetation along the river banks has encouraged squatter settlements. However, these reed beds have great value as a natural area and recreational resource, as well as serving as a buffer to flood waters. The draft Hout Bay Structure Plan (Clark, 1986) proposes that approximately half of the existing reed bed area on the western side of the river be designated for playing fields and educational purposes, while the lower portion of the reedbeds has been reserved as a nature area.

The village comprises a loose arrangement of buildings which is the focus of commercial civic activities in the valley. This concentration of commercial activity has resulted in traffic congestion on Saturday mornings and during peak holiday periods. The greatest amount of undeveloped commercially zoned land is presently available in the village, and its further growth will aggravate the problem of inequitable distribution of facilities, especially insofar as the harbour residents are concerned, and could result in a demand for larger shopping complexes unsympathetic with the village atmosphere.

The harbour area is characterized by high density, low-income public housing, where the overcrowded living conditions, the high incidence of disease and poverty result in a low quality of life for the Coloured residents (Figure 23). The absence of urban landscaping has also made this area a prominent visual eyesore in an area of the highest recreational and tourist value. Fish processing factories and fish shops, line the shoreline while fishing boats and pleasure crafts fill the harbour.

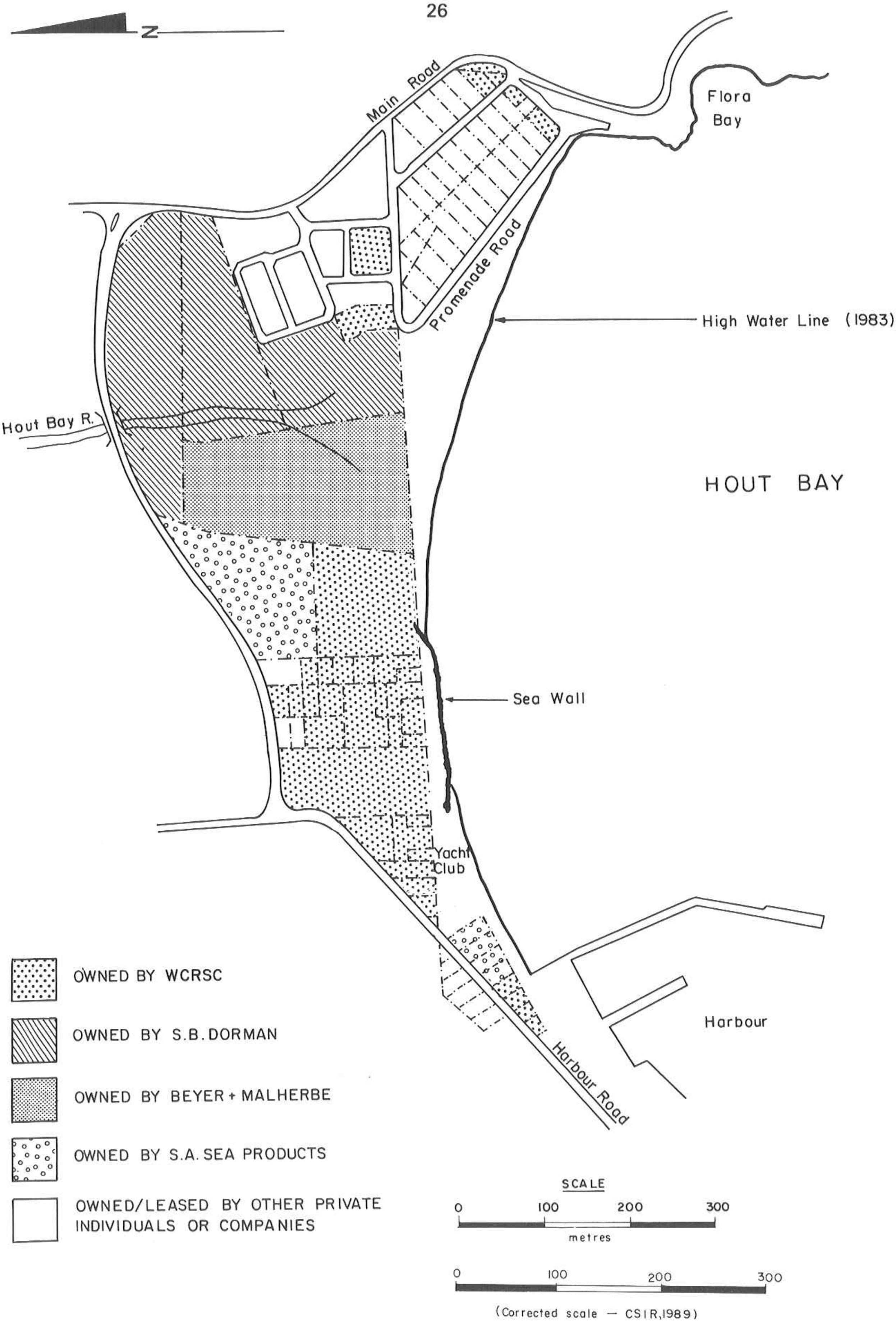


FIG. 24: Cadastral boundaries and ownership (from Hill Kaplan Scott Inc., 1984)

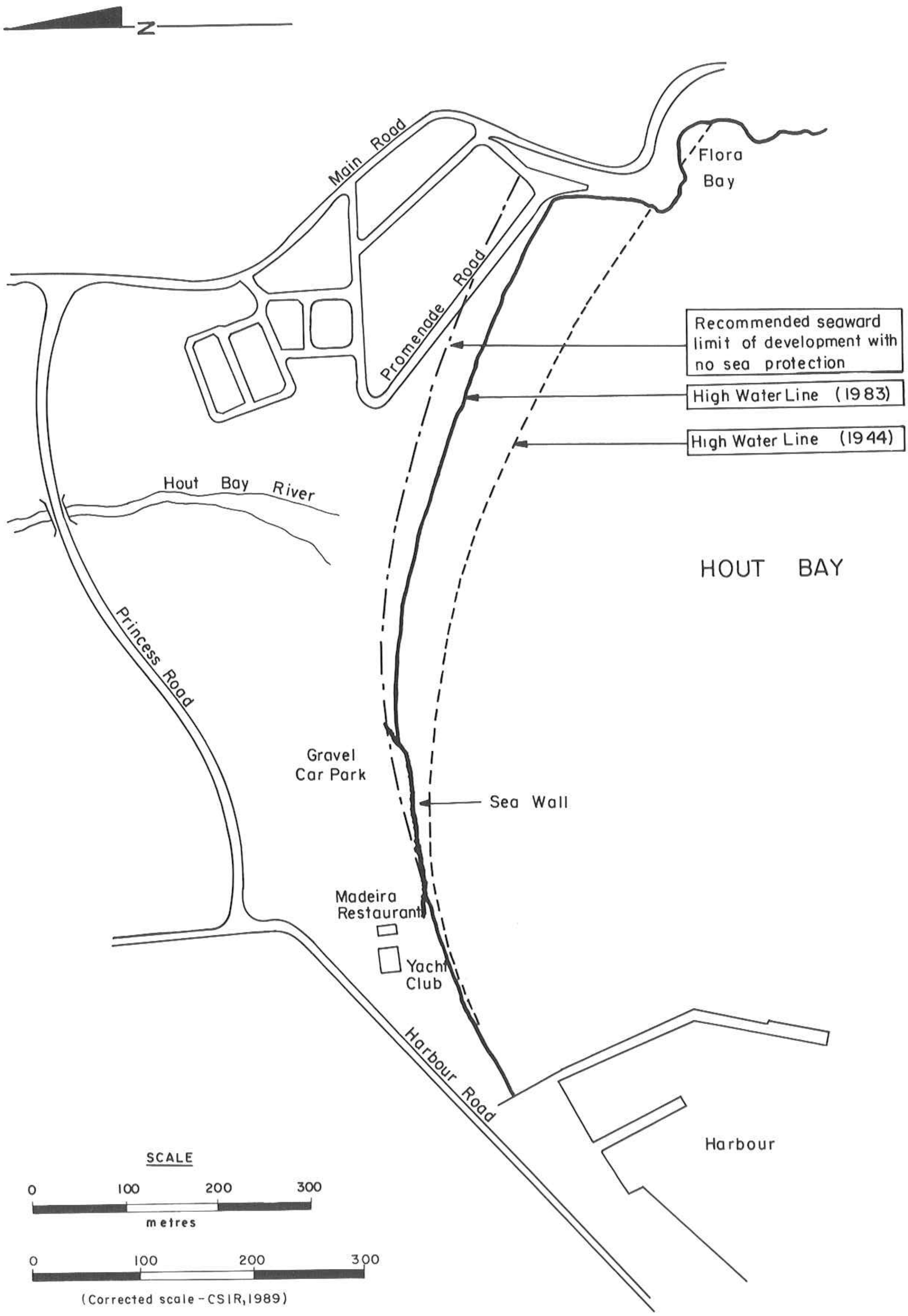


FIG. 25: Hout Bay – beach erosion 1944-1983 (from Hill Kaplan Scott Inc., 1984)

The coastal zone is largely undeveloped. South of Princess Street bridge the estuary runs through approximately equal sections zoned for public open space, single residential dwellings and public amenities before spilling across the sandy beach to the bay. As yet none of this riparian stretch has been developed, the vegetated secondary dunes being used for recreation and as a haunt for vagrants and squatters. Figure 24 shows the cadastral boundaries and ownership of the coastal zone.

The harbour walls have reduced the spending areas of the beach by about 30 percent resulting in a recession of the beach line in the eastern corner by approximately 80m since 1944 (Clark, 1986). As the beach has not yet established an equilibrium profile it is recommended in the Hout Bay Structure Plan (Clark, 1986) that development should not be permitted seaward of the estimated recession line (Figure 25). Promenade Road, built to give access to the eastern section of the beach, and to provide parking facilities, has severed the functional interaction between the beach and frontal dune, and as a result is frequently covered with wind-blown sand. During periods of high seas the area is inundated with water (Figure 41) and storm-wave erosion at its base is exacerbated by the receding beach line.

Wind-blown sand has been a major problem in the development of the Hout Bay beach front. Sand blown from deflating dunes at the river mouth have continuously encroached onto Princess Street, Harbour Road and adjacent properties, and in 1956/7 moving dunes seriously threatened houses in Beach Estate. The construction of a sea-wall and a hardened parking area have given some protection to Beach Estate, but this has resulted in the creation of a sterile windswept expanse which is of little value to beach users and retains no semblance of a natural beach profile.

At present the planning of the beach front is under review and the consulting engineers, Hill Kaplan Scott Inc., have, in association with Oberholzer and Van Papendorp (landscape architect) been appointed to look at future planning options. The *ad hoc* developments of the past have resulted in an insensitively and poorly planned facility which has failed to make use of the great natural potential of the area.

3.1.3 Existing Land-use Controls

The first General Plan subdivisions were approved early this century - Beach Estate in 1902 and Penzance and Longkloof shortly thereafter. During the 1950s the Joint Town Planning Committee drew up the basic zoning pattern for Hout Bay which was formalized by the Town Planning Scheme in 1968. The existing Town Planning Scheme (now called the "Zoning Scheme") comprises zoned land-use rights and minimum subdivision standards. Land-use within the harbour area and the Cape Peninsula Nature Area is controlled by the WCRSC zoning scheme and by the Department of Environment Affairs[1], a permit being required from the latter for any changes in land-use. The new Land-use Planning Ordinance No. 15 of 1985 is aimed at phasing out undesirable land-use rights, avoid blanket overzoning and allow the natural market forces to determine land-use patterns. Provision was also made for greater public involvement in the decision making process. Land-use planning in Hout Bay is also guided by the Cape Metropolitan Area Draft Guide Plan (1984). This recommends that urban densities be kept as low as possible (avoiding development below the 50-year floodline or on gradients steeper than 1:6) and that special attention be given to the protection of the areas natural assets, and their best use for recreational purposes.

[1]Responsibility for these areas was delegated to the Cape Provincial Administration on 1 April 1987.

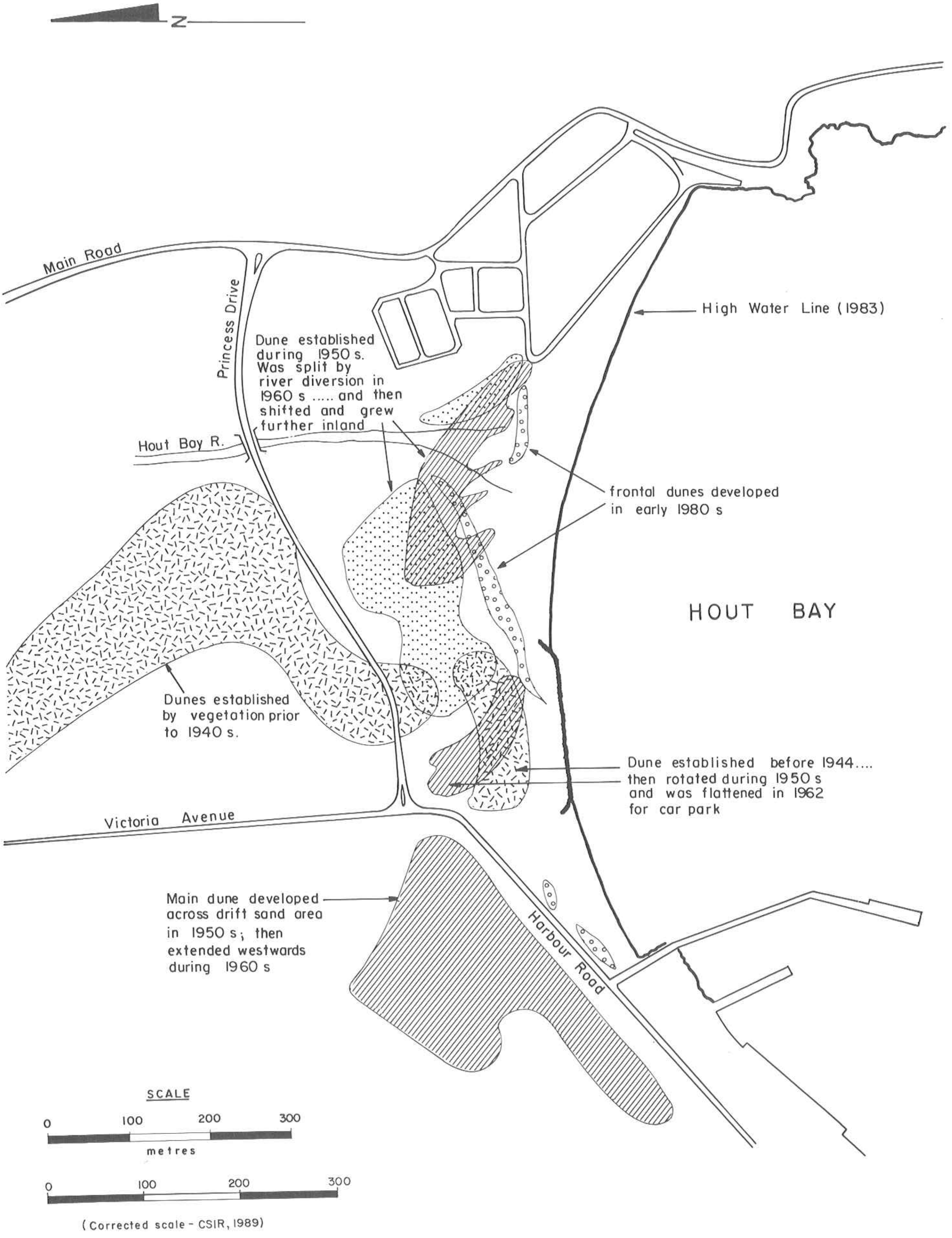


FIG. 26: Hout Bay - Changing dune regime (from Hill Kaplan Scott Inc., 1984)

Residential development and population growth

As Hout Bay is only 32 percent developed (1986) in terms of existing development rights, a considerable amount of development is anticipated. At present approximately 10 000 people live in the Hout Bay/Llandudno area; 49 percent in the harbour residential area (which is the only designated residential area for Blacks and Coloureds); 45 percent in the Hout Bay valley and 6 percent live in Llandundo (Clark, 1986). The draft Hout Bay Structure Plan (Clark, 1986) provides implementation details for development, allowing for the settlement of a capacity population of 26 000 over time.

As a result of influx of young White families and the high birth rate of the Coloured families, the community is a predominantly young one in which the White community is expanding faster than the Coloured community.

The present community has a great disparity of income, ranging from the extremely wealthy to the very poor. Great social diversity is also present, making Hout Bay a community more representative of a total urban community than is found in suburbs elsewhere in the Metropolitan Area (Clark, 1986).

3.1.4 Obstructions

Five dams impound the headwaters of the Disa and Original Disa streams and the Cape Town City Council owns and manages the upper catchment as a source of potable water. The Hely-Hutchinson Reservoir is a feeder for the Woodhead Reservoir and the Victoria and Alexandra reservoirs act as feeders for the De Villiers Dam.

<u>TABLE 3</u>: <u>The capacity of the storage dams</u>

	Storage dam	Full depth at wall (m)	Capacity Ml	Date of construction
Disa Stream	Hely-Hutchinson	15,24	924,646	1904
	Woodhead	37,19	954,000	1897
Original Disa Stream	Victoria	6,4	128,425	1903
	Alexandra	12,12	125,724	1903
	De Villiers	27,84	242,443	1907

The catchment area above the dams represents roughly 7,5 percent of the total catchment of the Hout Bay River, and according to the City Engineer , may contribute 15 percent of the maximum flood flow and 20 percent of the flow from the river catchment above the Longkloof (Hodson, *in litt.* 1983).

When the reservoirs are full, flood-water flows over an uncontrolled spillway, the discharge depending on the duration and amount of rainfall in the catchment. When stream flow is insufficient to supply the requirements of Kloof Nek and Constantia Nek filtration plants, water is released from outlets at the base of the Woodhead and De Villiers Reservoirs.

During rainy conditions when the flow in the streams is adequate, the outlets remain closed. Under normal conditions the dams are kept at about 20 to 30 per-cent of full capacity at the commencement of the winter. If they fill before the end of winter a maximum amount of water is released from them to ensure that the potential of the catchment is exploited most efficiently (Hodson, *in litt.*, 1983). The monthly volumes of water drawn from the dams fluctuates widely throughout the year in response to rainfall and demand.

A 4,1m weir across Disa Stream at the intake to the Apostles Tunnel diverts the stream into the tunnel through four grids; sluice gates at this point make it possible to control the volume of water entering the tunnel during periods of high rainfall. During the dry summer months the river flow is much-reduced and the Disa Stream may become totally dry immediately below the intake to the tunnel. No compensating water is released from the dams during summer, and when Hout Bay was primarily an agricultural community which depended on an adequate water supply for irrigation, much hardship was caused by this meagre summer flow. By the end of summer, reservoirs are usually empty.

Two road bridges and a pedestrian bridge cross the river in the Orange Kloof Forest Reserve, and a low weir dams the river approximately 1 km below the tunnel intake. The river is relatively unspoilt in these upper reaches with indigenous riverine forest growing along much of its length.

From the Forest Reserve boundary to Longkloof, dense stands of *Acacia* spp. line the river banks. These shallow rooted trees offer little protection to the banks and are often uprooted during spates, diverting flood water and causing obstructions under bridges which aggravate flooding of adjacent lands. A low narrow road bridge at Longkloof constricts the river channel just upstream of the spillway. This spillway was constructed in 1961 to halt the massive erosion of the river bed. It is a two-tiered concrete drop structure over which the river descends some six metres. (Figure 34)

The Longkloof spillway was damaged during the 1983 spate when flood water, bypassing the bridge, swept around the eastern side of the spillway seriously undermining it. Repair work has since been undertaken by the local authority.

Approximately 1,5 km below Longkloof a cable bridge is suspended above the river. It has no supporting piers in the river bed and does not obstruct water flow (R Gilmore, Deputy Engineer, WCRSC pers. comm.).

The river bed between Longkloof and the Victoria Road bridge has been modified at various times to facilitate the flow. River-widening works have been carried out since 1961 to remove silt deposits that accumulate in the channel. The discharge capacity of the Victoria Road bridge is also reduced by the narrowing of the channel downstream which creates a back-up effect upstream of the bridge. (Figure 35)

Princess Street bridge crosses the river upstream of the estuary and it is primarily between it and the Victoria Road bridge that the material eroded from upstream is deposited. Silt is dredged from the river channel both above and below Victoria Road bridge every five to six years to prevent the road bridges from being flooded (R Gilmore, pers. comm.). These operations have been necessary for approximately the last 15 years. The levees resulting from the dumping of dredge spoil have effectively cut off the river channel from the *Phragmites* reed beds which might have acted as silt trap. Between dredging operations beds of *Typha capensis* and *Phragmites australis* regrow on sandbars in the silted river bed considerably reducing the channel size.

The estuary is closed by a sandbar each summer when the river flow is low. Each year a channel is opened artificially when the water level reaches approximately 40 cm from the top of the barrier dune. This occurs at any time from late May onwards. Sometimes it is necessary to open the channel more than once in one year if windblown sand chokes the flow (R Gilmore, pers. comm.).

3.1.5 Abnormal Flow Patterns

The Hout Bay River is a high-energy system with the short, steep fast-flowing river falling more than 1000m over its length of 12 km. Although the catchment is small (33,8 km^2), the mean annual precipitation is high (1298mm) and the system is prone to heavy winter spates. Recent studies have shown that 57 percent of the MAR occurs in the four winter months May to August (Figure 17).

The upper catchment comprises rugged mountain terrain, where the average stream slope is 1:7. Hill Kaplan Scott Inc. (1985), in their investigation into the flood characteristics of the Hout Bay Valley, found that the swift stream run-off results in extremely high flood peaks of relatively short duration at the point where the mountain streams join the main river valley near the Orange Kloof Forest Station. The five dams in the upper catchment were found to have a considerable attenuating effect on small floods. However, recent studies have shown that flood waves can pass through a dam more rapidly than along a natural watercourse, and that the peak flood flow in larger floods (that is, 20-year floods or greater) could therefore be increased rather than reduced by the presence of these dams. Peak 20- and 50-year flood flows at the Orange Kloof Forest Reserve/WCRSC boundary have been estimated as 112 and 123 cumecs respectively. These peak flows are approximately 85 percent of the equivalent peak flood flows entering the estuary (Hill Kaplan Scott Inc., 1985).

FIG. 27: Remains of Palmiet swamp in Orange Kloof Forest Reserve.

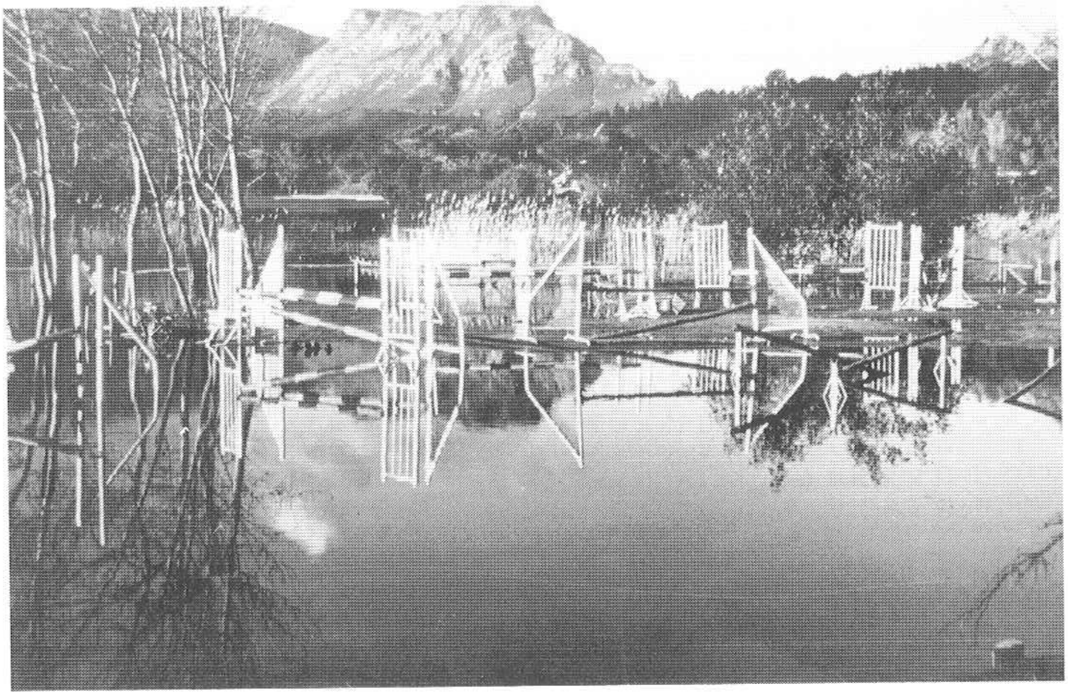


FIG. 28: Flooding of land upstream of Victoria Road bridge. (Photo: S Grindley, 1986).

In the past, flood water from the mountain streams probably moved through the Palmiet swamp on the valley floor as "sheetflows", but extensive modification of these swamp areas and the establishment of a single river channel have changed the flood regime considerably. At Longkloof smaller floods are channelled through the Longkloof Road bridge which has a discharge capacity of 25 cumecs (Hill Kaplan Scott Inc., 1985). Recent severe floods (August 1977 and June 1983) overtopped the bridge and a second flow path developed east of the bridge where the approach road is low-lying. The resulting bypass flow caused considerable erosion damage to Erf 1647 on both occasions.

The flood plain above the Longkloof spillway is relatively small and would have little effect in reducing flood flows, and it is estimated that the storage volume represents only a few minutes of the peak 50-year flood flow rate.

Downstream of the Longkloof spillway the river, restricted to a narrow course because of development, has eroded a channel up to 10m deep through the sand and peaty substrate. This increase in channel size has reduced flood inundation of adjacent properties, but has seriously destabilized the system resulting in continuous bed and bank erosion.

Upstream of Victoria Road bridge the river is characterized by a much flatter gradient and more extensive flooding of adjacent lands takes place (Figure 28). The aperture of the Victoria Road bridge is 30m wide but within 300m downstream the river channel narrows to 8m. The discharge from the bridge is reduced by these downstream channel conditions creating a back-up effect upstream of the bridge.

This results in water flowing over the eastern section of Victoria Road and flooding the farmlands during 20- and 50-year floods. Hill Kaplan Scott Inc. (1985) have estimated that the inundated areas attenuate the peak flow rates of 20- and 50-year floods considerably. They confirm that the recent dumping of waste material in the *Phragmites* flood plain on the western bank of the river midway between Victoria Road and Princess Street, will reduce this attenuation.

The flood discharge at the Victoria Road bridge and Princess Street bridge was estimated during the spate of June 1983. These flow values were calculated from surface flow measurements using Dackcombe and Gardiner (1983) coefficients with estimates of bed roughness (Grindley, 1984). At noon the discharge under Victoria Road bridge was approximately 94 cumecs, with an average depth of 1,7m. At Princess Street bridge the depth had increased to 4m with an estimated discharge of 209 cumecs. The river was carrying a very high silt load at this point (Figure 30) and a sandbank some 200m long was deposited under the bridge. This would have substantially reduced the discharge capacity of the bridge, but it was not possible to tell how large the deposit might have been at the time the measurements were taken. The bridge deck was not overtopped during the June 1983 flood and according to Hill Kaplan Scott Inc. (1985) neither a 20- nor a 50-year flood would submerge it. They warn, however, that if the attenuating effects of the flood plains between Victoria Road and Princess Street were reduced by dumping or indiscriminate building of flood berms the bridge deck could be overtopped by as much as 0,5m during a 50-year flood.

The Hout Bay River is prone to flooding, and reference to five major flooding events were found in a search of *The Argus* newspaper covering the period 1949-1983.

Date of flood	*The Argus* report
August 1957	9 November 1957
22 June 1960	22 June 1960
21 August 1974	21 August 1974
3 June 1977	28 September 1977
27 June 1983	28 June 1983.

There is no record of storm intensity or duration during these floods, but an indication of the antecedent moisture condition of the catchment can be gauged when the precipitation values of the two months preceeding each flood are examined. In each case, one of these values was above the average, which suggests that a high antecedent moisture content, particularly in the days immediately prior to the flood, is an important factor in the intensity of flooding within this catchment.

3.1.6 Erosion and Siltation

Closely related to the flooding of the river has been the process of erosion and sedimentation, and each has tended to exacerbate the other.

The Hout Bay River has a steep profile (Figure 31) and the erosion zone drops 70m over a distance of only three km. This steep channel slope increases the velocity of the water and its ability to transport particles.

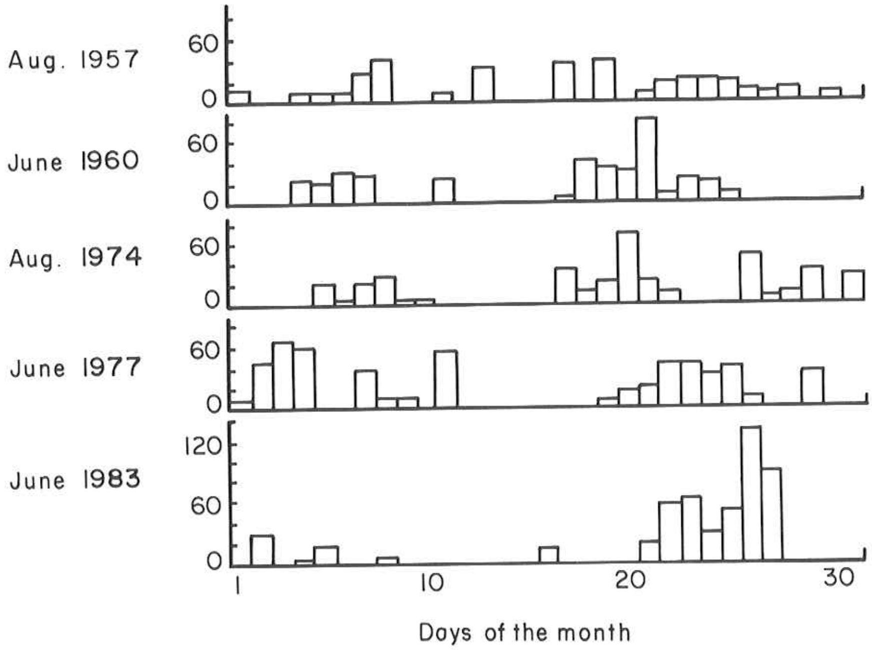


FIG. 29: Daily precipitation values (mm) for five recorded flood months between 1957 to 1983. (From S Grindley, 1984).

Total suspended solid (TSS) measurements taken during the flood in June 1983 show that little sediment was brought down from the upper catchment, while the TSS load increased significantly below the Longkloof spillway (that is, in the erosion zone). The most marked increase, however, occurred between Victoria Road bridge and Princess Street bridge (the siltation zone). This was probably due to the scouring action of the flood water on the accumulated silt deposits in this section of the channel. The decrease in velocity between Princess Street and the sea, as a result of the widening of the river channel, caused a significant amount of sediment to settle out leaving extensive sand deposits in the river channel and estuary, and reducing the TSS load to 0,52g/l. It was estimated that 5000m ^{3} of material was carried down the river during the flood in June 1983.

A history of the erosion of the Hout Bay River

The history of the erosion of the river is closely tied to the land-use patterns which have caused both physical and vegetational changes within the catchment. However, it appears that of all the perturbations, cultivation along the river banks has had the most direct effect on the speed and extent of river bed and bank erosion.

Early cultivation along the river began in the lower reaches, which are not prone to erosion, and the first reports of erosion were only made in the mid-1940s (Figure 36). An early resident at Sans Pareil (near the present World of Birds) recalls some slight erosion of the river channel in 1947, but also has clear memories of much of the river flowing through bullrushes and Palmiet. Figure 18a shows that by 1944, 3,5 km of the river bank was disturbed, and the initial erosion was probably triggered by an increase in disturbed riparian land in this area, exacerbated by a succession of high rainfall winters.

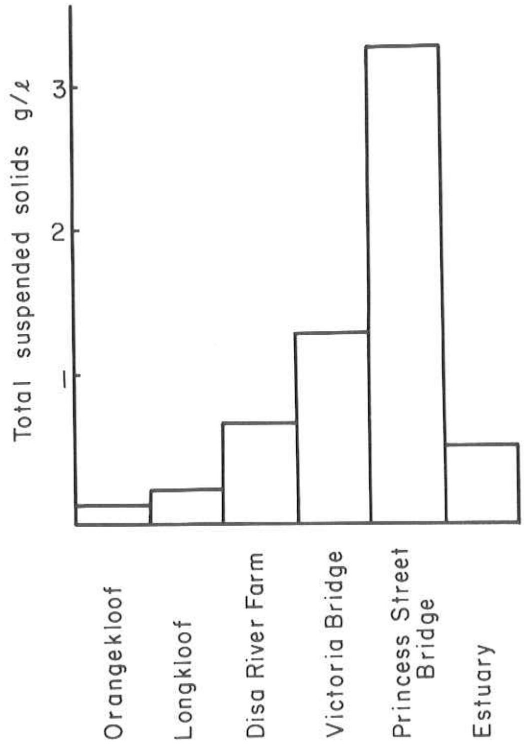


FIG. 30: Total suspended solids (g/l) in the Hout Bay River on 27 June 1983. (From S Grindley, 1984).

As palmiet was systematically removed by farmers to increase the size of their lands (M V Daniel, pers. comm.) the river became restricted to one channel for most of its length. This would have increased the depth and velocity of the flow, adding greatly to its eroding force. With each heavy winter rain the erosion crept further upstream, and by August 1957 *The Argus* newspaper carried these reports:

> "The erosion runs for about 4 miles (6,4 km) from the upper end of the Hout Bay Valley to the sea. Three 15 ft (4,6m) waterfalls have been carved from the river bed. At many places the stream itself is only 5 ft (1,5m) wide but the crumbling banks are 35 ft (10,7m) apart.
>
> Beneath one of the waterfalls huge lumps of black soil lie in the middle of a ravine that is now more than 100 ft (30,5m) wide ... (while) ... twenty yards (18,3m) from the edge of this ravine are fields tilled for planting cauliflowers".(*The Argus*, August 14,1957).

When the massive bed erosion reached Longkloof, Mr M V Daniel recalls a 20 ft (6,1m) high waterfall on his property. He stated that the cause of this erosion was "the accumulated result of veld fires, bad farming, holes dug in the river bed to pump water, and absent landlords who allowed cattle to stray and break down the river banks." (*The Argus*, November 9, 1957).

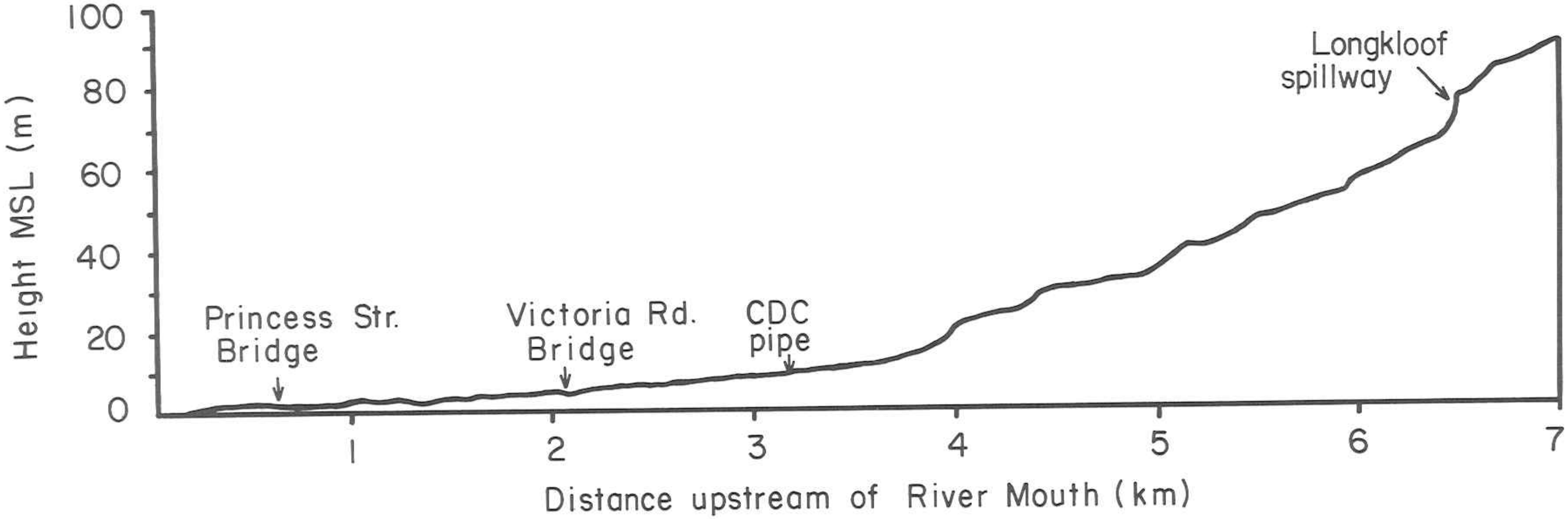


FIG. 31 : Longitudinal section of Hout Bay River (after Hill Kaplan Scott Inc., 1979)

FIG. 32: Palmiet *(Prionium serratum)*: little now remains along the river banks. (Photo: S Grindley, Nov. 1979).

FIG. 33: Shallow-rooted trees, particularly alien *Acacia* spp., give little protection to the river banks and are often uprooted during spates. (Photo: WCRSC).

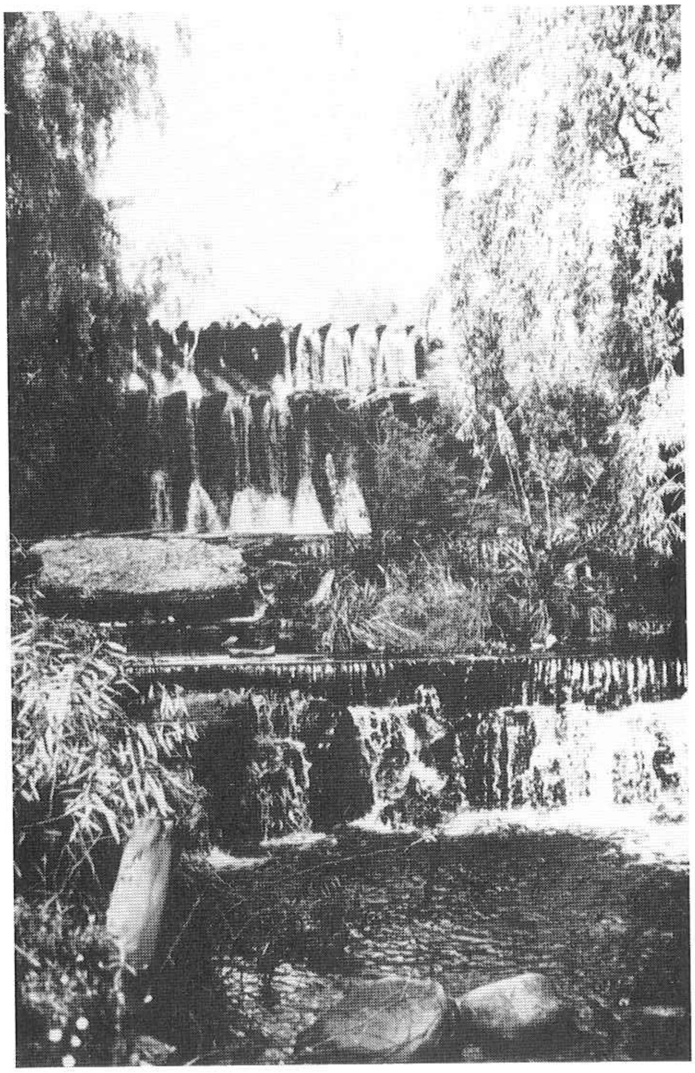


FIG. 34: The Longkloof spillway. (Photo: Hout Bay Museum, Oct. 1981).

Residents who witnessed this initial erosion tell of the speed with which these earth waterfalls moved upstream. Mr Goodwin of "Applegarth" farm estimated that the initial waterfalls moved upstream at the rate of 300m per year, with two or three waterfalls sweeping up the river in one season, while Mr Daniel of "Longkloof" farm recalls that one period of heavy rain could move a waterfall as much as 100m. As a result of the erosion upstream the river became silted up in the lower regions, and in August 1957 the channel below the Victoria Road bridge was so badly silted that there were "only a few feet to spare" *(The Argus*, August 14, 1957). In response to numerous requests from the Hout Bay farmers the WCRSC in 1960 finally agreed to build a retaining spillway at Longkloof with funding from the Department of Water Affairs, to halt the erosion of the river bed. However, heavy rains came before the structure was completed, washing the uncompleted structure away together with a large pump which was being used during construction, *(The Argus*, June 23, 1960). Bed erosion cut back 50m in barely six hours during that storm, and bank erosion widened the river course to 150 ft (45,7m) *(The Argus*, June 23, 1960), causing three bridges to collapse and threatening the safety of a cottage on the river bank at Disa River Farm. Extensive flooding was also caused in the upper and lower sections of the river.

FIG. 35: Silt and debris deposited under Victoria Road bridge after the flood in June 1983. (Photo: S Grindley).

The Longkloof spillway was rebuilt during 1961 at a cost of R10500. This structure successfully halted the large-scale bed erosion but bank erosion continued. However, in 1979 a new erosion point started above the Longkloof spillway (Figure 36(6)), on the boundary of the Orange Kloof Forestry Reserve, and in August 1982 a new earth waterfall was deliberately made approximately 100m above Longkloof bridge (Figure 36(8)) when the bed of the river was bulldozed by one of the riparian owners. This waterfall moved upstream in the 1983 floods initiating channel erosion of the river bed above it and scouring out a large pool downstream.

3.2 Estuary

(This section was contributed by Dr G A W Fromme of the former Sediment Dynamics Division of the NRIO).

For the purpose of this report the estuary is considered to be that portion of the river, and land adjacent to it, from Princess Street bridge to the sea.

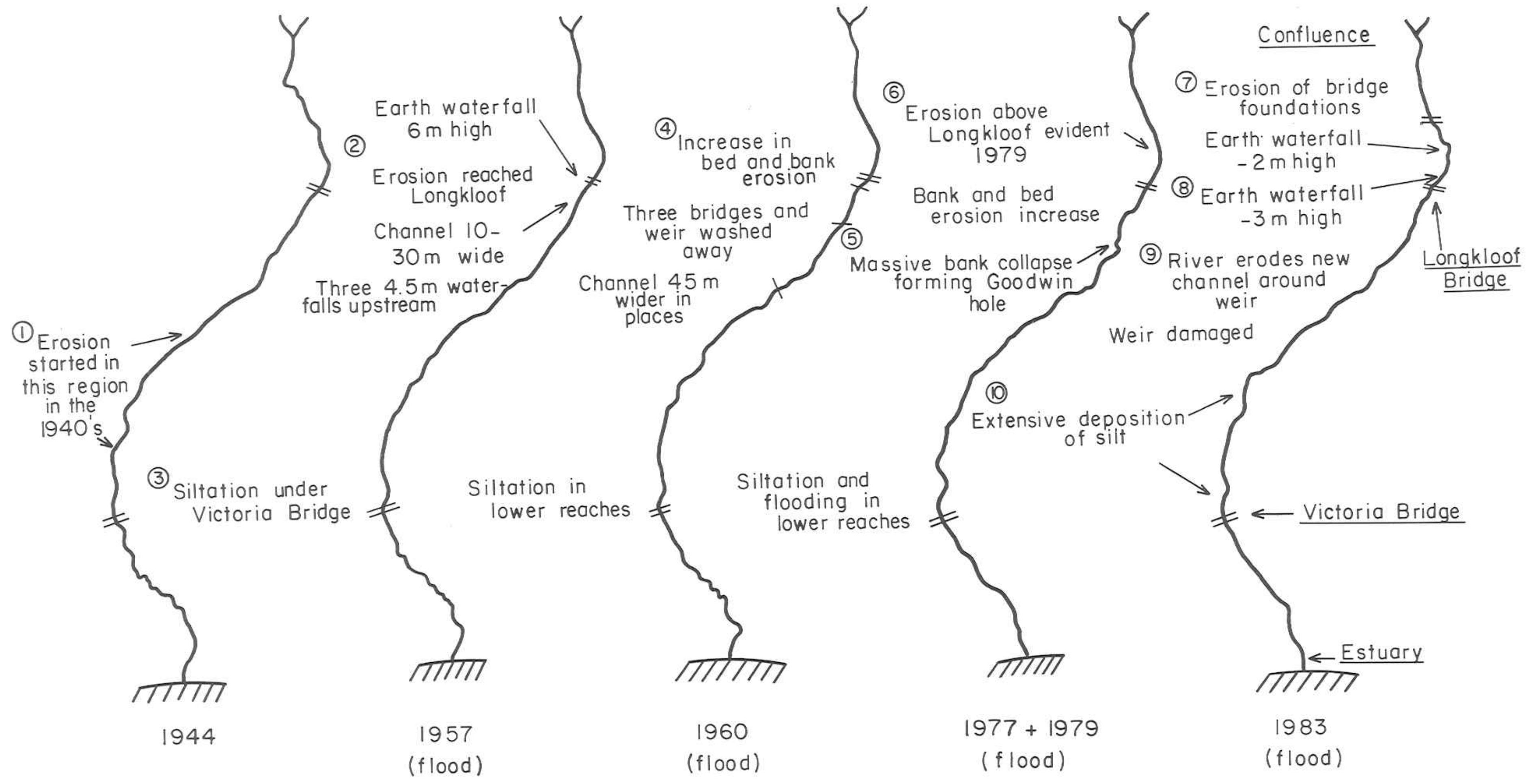


FIG. 36: Progress of erosion up the Hout Bay River 1944 - 1983 (after Hill Kaplan Scott Inc., 1984).

3.2.1 Estuary Characteristics

Hout Bay is a deep cove-like embayment, about 2,5 km long and 2 km wide. It is surrounded by mountain and rocky sandstone cliffs of the Table Mountain Group, and is open to the Atlantic Ocean to the south.

The Hout Bay River emerges from the flood plain of its lower reaches, which are still partially covered by natural reedbeds, into the coastal dunes and onto the beach. There is a small lagoon, approximately half a kilometre in length and 20 to 40m in width which becomes dammed up behind the beach berm during the dry summer months when river flow is weak. During the winter when heavy rainfall causes flooding, the beach berm is breached and the lagoon enters an estuarine phase. Because salinities as low as 2-4 parts per thousand (Eagle *et al.*, 1980) were measured only 100 to 200m upstream of the mouth this section can hardly be classified as an estuary, but rather as a river mouth.

3.2.2 Historical Perspective

In its present state Hout Bay River must be seen as a product of large-scale artificial changes to the catchment, the course and the mouth of the river and of its adjacent beaches. These human activities have resulted in extensive geomorphological alterations of the lower Hout Bay Valley and of the beach, which has led to general hydrological and sedimentological deterioration of the entire area.

In the past, extensive indigenous forests in the mountain catchment buffered peak storm run-off. In the lower reaches of the river, which now constitute the farming and village area of Hout Bay, a braided system of streams flowed through a marshland densely overgrown by palmiet and reeds. This system absorbed winter rain floods and prevented erosion in the higher section of the zone as well as siltation in the vicinity of the river mouth. According to records by Van Riebeeck's men (1652) the river was deep and wide enough for rowing boats to be used from the mouth to nearly 1 km upstream, where the river became overgrown with vegetation (Thom, 1952).

The large-scale destruction of the mountain forests and alteration to the flood plains in the valley has increased the impact of floods. The river, now forced into an artificially maintained channel, cuts deeply into the original flood plain. This has resulted in bed and bank erosion of the channel area, and siltation at the river mouth. A further result of this deterioration is the build-up of large sand dunes at the river mouth, which are fed by the sand washed down by the river, and which cause driftsand problems in the urban areas around the river mouth.

The earliest available aerial photographs, taken in 1944, show that there was a large open triangular sandy embayment at the river mouth which extended over half a kilometre upstream to what is now known as the Princess Road bridge. The river mouth periodically shifted across this sandy plain over a distance of 400m (Hout Bay beachfront, 1980; Hill Kaplan Scott Inc., 1984).

From 1944 to the present this natural and highly dynamic buffer zone between the sea, the river and the hinterland was confined by artificial embankments to an unnaturally narrow strip of beach. In its natural state (1944) Hout Bay beach had an unhindered connection to a large strait of driftsand running across the Karbonkelberg ridge to Sandy Bay on the Atlantic coast (Section 3.2.3).

FIG. 37: Aerial view of Hout Bay Valley, 1944 (Photo: Directorate of Surveys and Mapping).

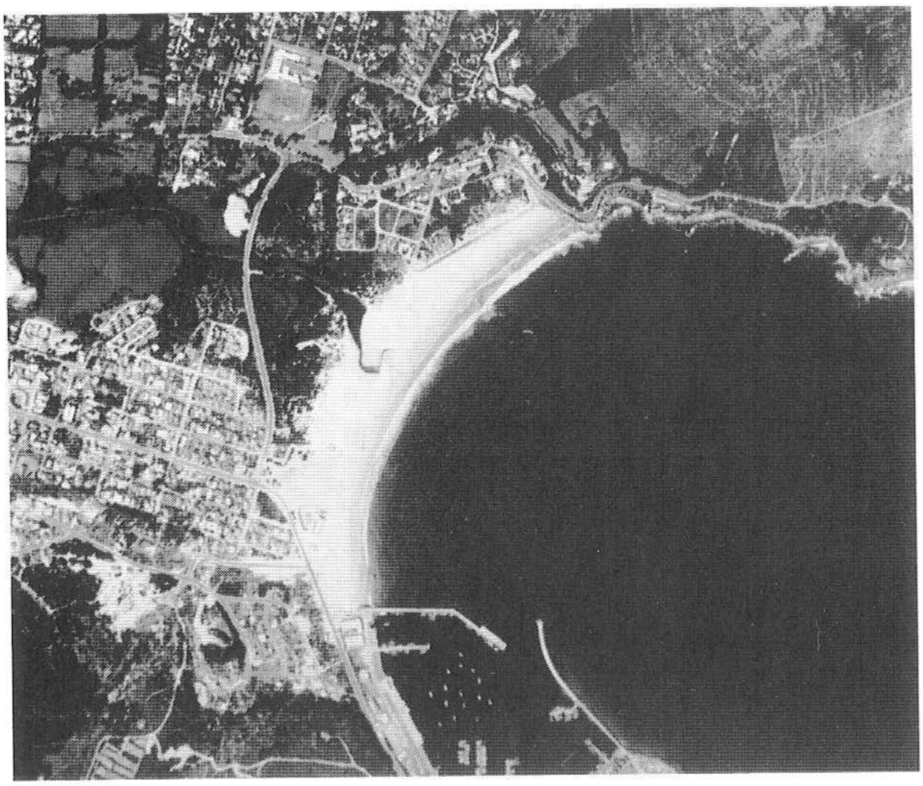


FIG. 38: Aerial view of Hout Bay, 1987 (Photo: ECRU).

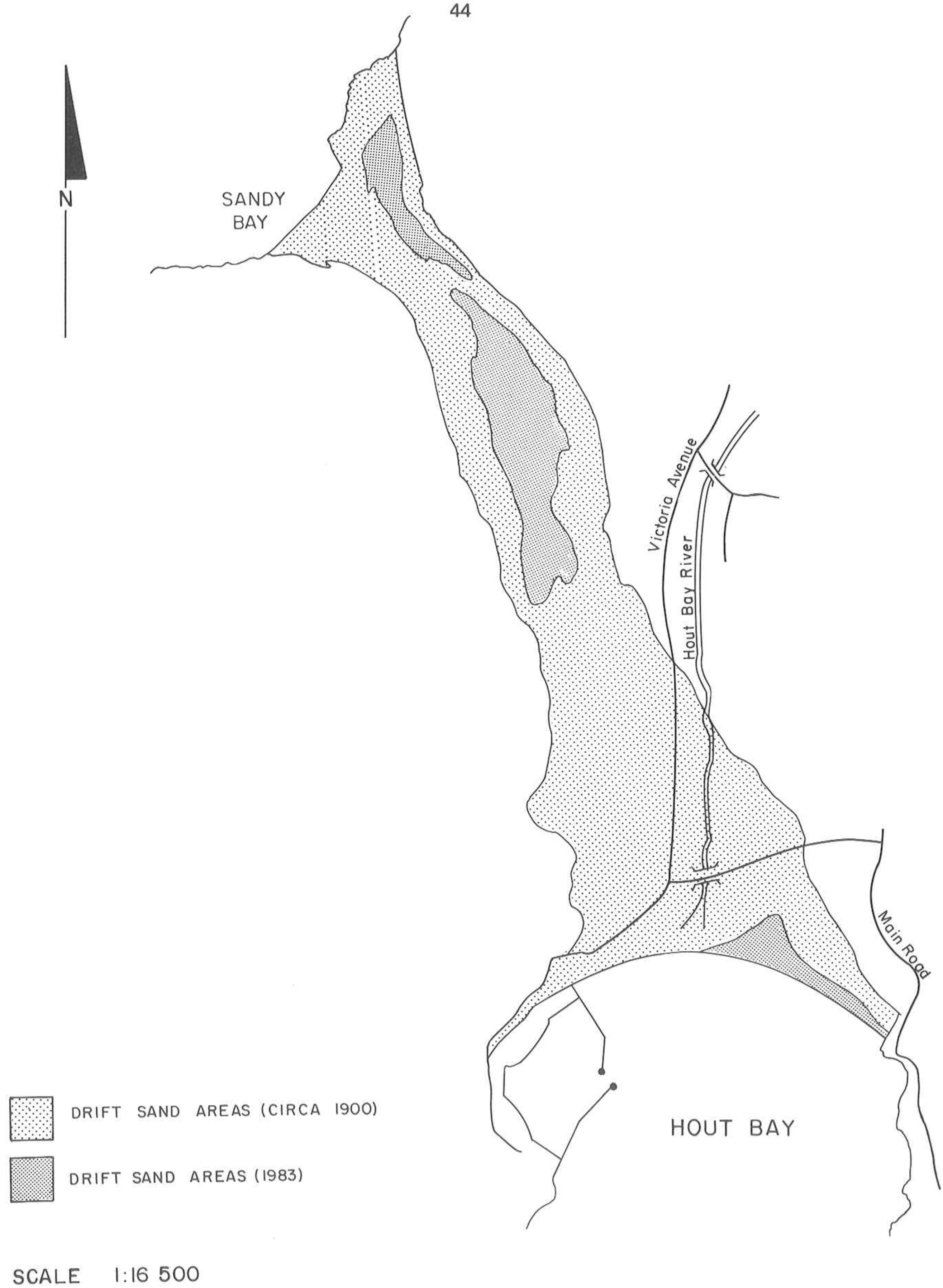


FIG. 39: Reduction of drift sand area (1900 - 1983)
(From Hout Bay Beach Front report HKS, 1984)

Over the last approximately 40 years the characteristics of Hout Bay have been altered significantly insofar that the entire wetland and coastal zone has undergone profound changes from a natural to a predominantly artificial environment. In the lower reaches of the river this has caused large-scale destruction of the flood plains; the river is now forced by levees into a deeply incised channel, which causes erosion in the channel area, and siltation at the river mouth. The construction of harbour works, breakwaters, sea walls, road embankments and the encroachment by residential developments has resulted in an artificial confinement of the Hout Bay beach which has caused a general beach regression. However, because of the configuration of Hout Bay, namely, a deep cove in the shelter of high mountains and rock promontories, the beach seems to have reached relative sedimentary equilibrium (Fromme, 1985).

3.2.3 Beach and Driftsand Strait

The beaches adjacent to the river mouth extend approximately 700m to the west (to the north breakwater of Hout Bay harbour) and 550m to the east, where the beach ends at the Flora Bay rocks. The beach consists of a relatively flat foreshore zone (low water to high water line) which rises more steeply to the beach berm, behind which there is a flatter area forming the backshore zone.

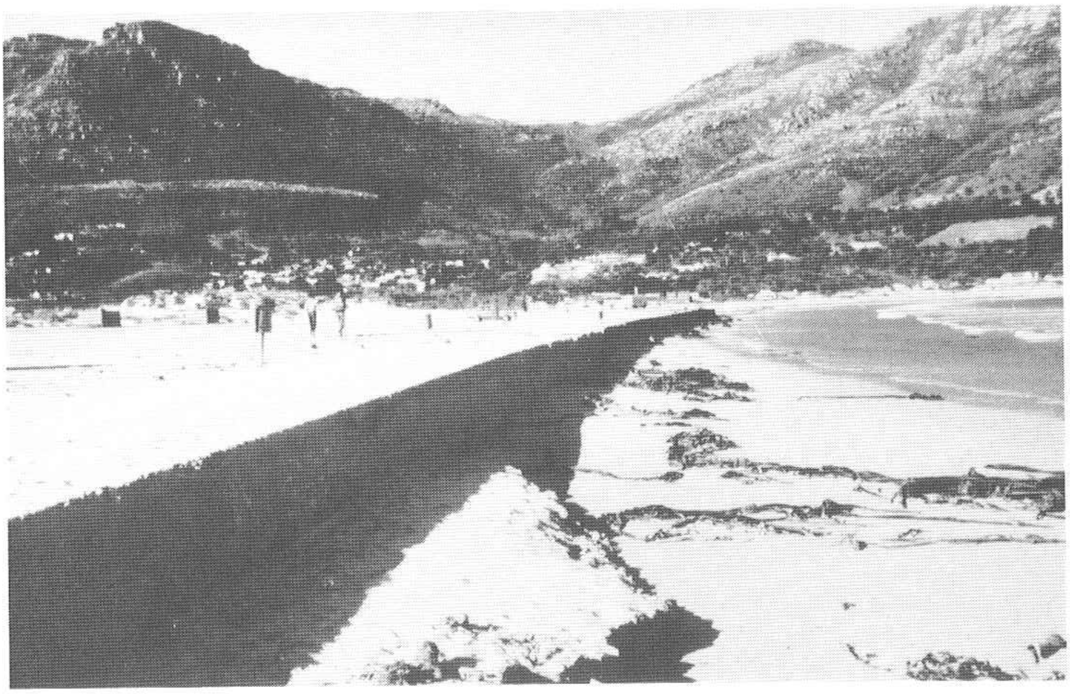


FIG. 40: Sea-wall west of the river mouth with an artificially hardened parking area behind it. (Photo: ECRU, 82-04-19).

The latter is mostly occupied by the small lagoon at the mouth of the Hout Bay River. Another shallow backshore lagoon is formed by the discharge from a stormwater drain at the eastern beach (Beach Crescent). This lagoon, 120m long and 20 to 30m wide, sometimes drains into the mouth channel of the Hout Bay River, 50 to 100m above the mouth.

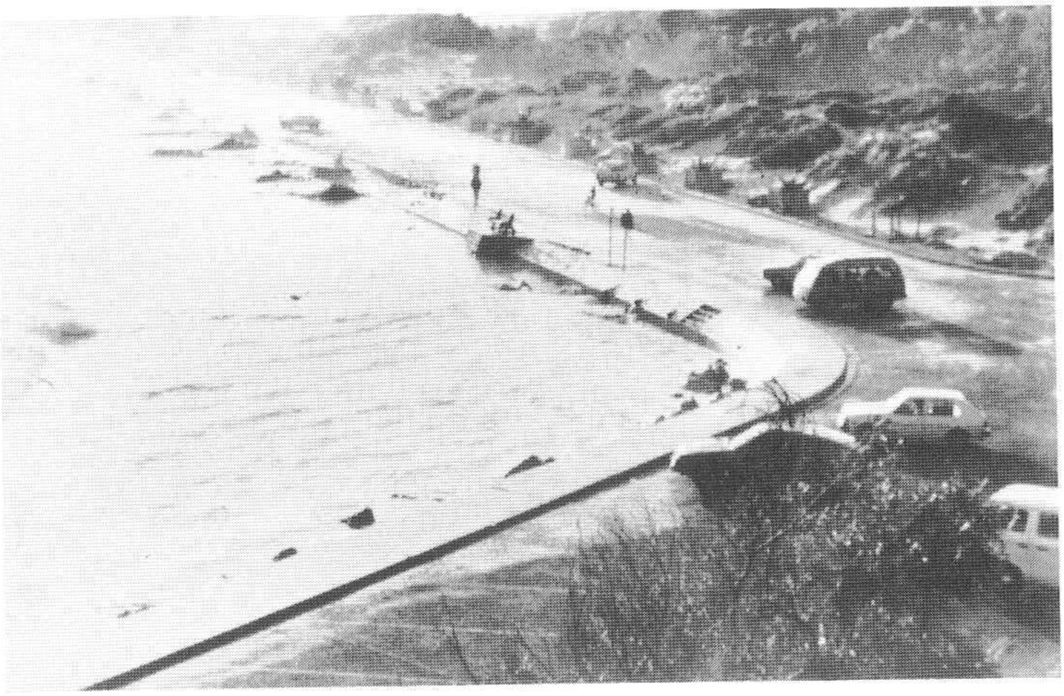


FIG. 41: High seas flooding the beach in front of Promenade Road at the eastern end of the bay. (Photo: ECRU 84-07-03).

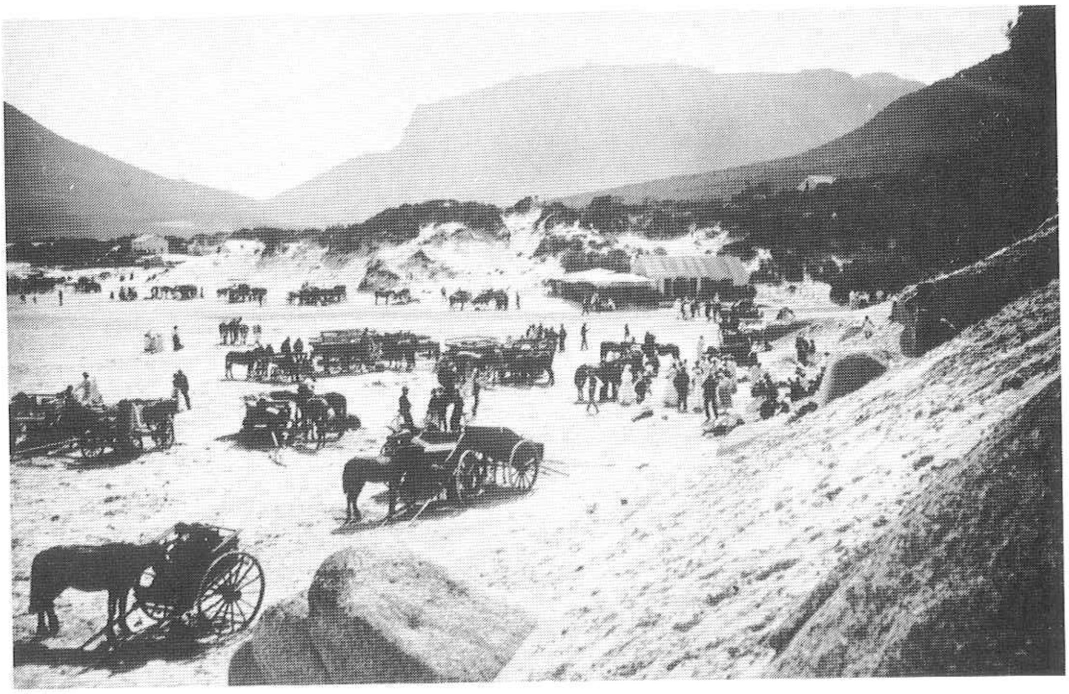


FIG. 42: The eastern end of the beach as it was in *ca*. 1900. Beach regression and the construction of Promenade Road have reduced this wide expanse of beach to a narrow strip. (Photo: Hout Bay Museum).

There are three prominent artificial features which influence the dynamic behaviour of Hout Bay beach:

The first of these is the sea wall west of the river mouth with an artificially hardened parking area behind the wall. Together with the residential encroachment higher up, this wall interrupts the aeolian flow of sand to and from the drift sand strait across the Karbonkelberg/Klein Leeukop ridge and also greatly narrows this section of the beach.

The second is a solid road embankment along the eastern beach (Beach Crescent) and a series of brushwood rows on the upper beach along the embankment, which together confine the beach to an unnaturally small width.

The third is an artificial dune five meter high just east of the river mouth, which is protected by a brushwood line. During the floods of June 1983 this dune was partially washed away, which indicates that it is in the path of major river floods. Opposite this artificial dune is a natural, partly vegetated dune area which was not affected by the floods, but which is the product of increased siltation at the river mouth.

A natural feature of great significance to the Hout Bay area is the conspicuous driftsand strait from Hout Bay to Sandy Bay across a saddle (altitude 127m above MSL) in the ridge between Karbonkelberg (653m) and Klein Leeukop (437m). Originally, this band of driftsand formed a direct connection between Hout Bay and Sandy Bay, but at present it is interrupted by residential developments, encroaching alien vegetation and artificial changes at the Hout Bay beach front.

Considering the small size of the beaches at both extremities of the driftsand strait (Hout Bay and Sandy Bay beaches) it appears to be very unlikely that these beaches could be the source of the sand supply to such a large deposit. In addition, these beaches are surrounded by a rocky coastline which cannot feed much sand to them.

The most likely explanation of the origin of the Karbonkelberg driftsand strait is that it is a residual deposit from the Pleistocene ice-age (1,5 million to 14 000 years ago), when the sea level was more than 100m lower and large sandy surfaces of the continental shelf were exposed to wind erosion (Whitfield *et al.*, 1983).

3.2.4 Physico-chemical Characteristics

Salinity

Salinities of 2 to 4 parts per thousand were measured 100 to 200m upstream (Eagle *et al.*, 1980). The mouth of the Hout Bay River is not, therefore, an estuary *sensu stricto*.

Temperature

Surface temperatures ranged from 13,5°C in July 1983 to 18,5°C in September 1983. Little stratification was found in the shallow estuary waters. The upstream river temperatures were consistently lower than those recorded in the estuary at all seasons, but in summer the surface temperature of Woodhead Reservoir (21,0°C) significantly exceeded that of the estuary (18,5°C).

FIG. 43: The remnant of the driftsand strait on the northeastern slopes of the Karbonkelberg between Hout Bay and Sandy Bay (Photo: ECRU 87-11-01).

pH

Characteristic of water draining from humic sandstone soils, the pH ranged from 4,5 to 6,0, throughout the catchment with the waters of the Woodhead Reservoir and the upper catchment showing a consistently lower pH than the estuary. These measurements fall within the same range (4,3 to 6,1) as those recorded by Harrison and Elsworth (1958) for the upper sampling stations of the Berg River. The estuarine water remained at a pH of 6 during sampling in the summer, winter and spring of 1983.

Nutrients

As might be expected in a well-leached catchment, the nutrient concentrations are low throughout the system (Grindley, 1984). The ammonium (NH4) values are all below 8μmol/l with the higher concentrations found in the waters at Victoria Road bridge and the estuary. These levels are similar to the values recorded at Langrivier (Jonkershoek) by the Eerste River Catchment Study Group, UCT (in prep.).

Nitrate concentrations are mostly low but isolated high values give a wide range (0,1 to 88,5μmol/l). The higher values recorded at the Victoria Road bridge may indicate a fertilizer input to the system.

The low phosphate (P) concentrations might be due to the elevated aluminium and iron levels which would cause the phosphate to precipitate. There is a consistently higher concentration of phosphate just below the bottom outlet pipe from the Woodhead Reservoir, probably due to the presence of higher phosphate levels in the sediment of the dam floor. Surface and bottom water from Woodhead Reservoir showed higher dissolved organic carbon (DOC) levels (10,9 to 19,6 ppm) than the water in the river.

3.2.5 Pollution

Bacteriological and parasitological counts are carried out at irregular intervals by the Water Pollution Control Section of the WCRSC on water samples taken from the Hout Bay River at the Victoria Road and Princess Street bridges. These indicate that the river is at times contaminated, with up to 4 600 faecal coli per 100 ml. High counts have been recorded in spring and autumn, whereas the two lowest were in summer. These results do not suggest that contamination necessarily increases when the flow is low, although low counts at both stations in August 1983 indicate that the flood water had a flushing effect on the entire system. Possible sources of contamination include seepage from septic tanks, livestock grazing in the riparian zone and the squatter community inhabiting the coastal dune area.

High coliform counts have also been recorded by the Water Pollution Control Section in sea water sampled at eight stations between the sewage outfall at Badtamboer in the west, to the eastern end of the bathing beach. Faecal coliforms were found at all the stations on almost every sampling day, but in greatly fluctuating numbers, with no apparent seasonal pattern associated with these fluctuations.

A pollution monitoring survey, carried out by the then National Research Institute for Oceanology, sampled the surface water of the bay and the interstitial water from the beach in March 1977 (Fricke *et al.*, 1979), in November 1979 (Eagle and Bartlett, 1980) and December 1980 (Bartlett, 1981). These samples were analysed for salinity, phosphate, silicate, nitrate, oxidizeable organic matter (OA), dissolved oxygen, pH and trace metals.

The organic content of the beach sand was found to be high in all three surveys as indicated by the low level of dissolved oxygen and the high OA values of the interstitial water and sediments (Bartlett, 1981). The stressed condition of the beach was also indicated by the low number of meiofauna present. It has been suggested that the practice of burying large quantitites of kelp on the beach may have caused these anoxic conditions and the resulting paucity of meiofauna. The lack of a healthy beach fauna community will greatly reduce the ability of this environment to recover from organic pollution.

The nutrient levels in the bay were found to be significantly affected by the extent of upwelling (Bartlett, 1981). Higher marine nutrient levels occur mainly in summer when the wind regime is dominated by south-easterlies which cause upwelling along the west coast of southern Africa. However, the effluent discharge from the fish factories further raised these levels in the surrounding water. Bartlett (1981) noted that the surveys were all conducted outside the peak season for the fish factory operations when the pollution problems could be worse. No evidence of metal pollution was found in the bay (Fricke *et al.*, 1979). However, sediment analysis of the Hout Bay River indicates a very low concentration of trace metals in the estuarine sediments (Grindley, 1984).

4. <u>BIOTIC CHARACTERISTICS</u>

4.1 <u>Flora</u>

(Section contributed by M.E.R. Burns, Coastal Processes and Management Advice Programme, EMA).

4.1.1 Phytoplankton/Diatoms

No data are available.

4.1.2 Algae

Marine algae, sometimes in large quantities, are washed into the estuary and deposited onto the beach. These are mainly the kelps *Ecklonia maxima*, with smaller amounts of *Laminaria pallida* and *Macrocystic angustifolia*.

4.1.3 Aquatic and Semi-aquatic Vegetation

Apart from the extensive reed beds of *Phragmites australis*, which occur on both banks of the river a short distance from the mouth, the contribution by aquatic and semi-aquatic macrophytes to the estuarine vegetation is insignificant. As only isolated patches of such vegetation occur along the river course, it has not been mapped in Figure 44, but a list of some of the contributing species is provided in Appendix I.

The reed beds which, together with stands of *Prionium serratum* (palmiet), no doubt functioned as a filtering or dampening mechanism for floods of various intensities in the past, no longer fulfil this function. Canalization of the river permits only the higher floods to extend into these reed beds and they therefore only periodically retain flood detritus and sediment which is otherwise rapidly lost to the system. Similarly, their importance as a contributor of organic carbon to the trophic processes within the lower reaches of the Hout Bay River is probably now much reduced.

4.1.4 Terrestrial Vegetation

The vegetation of the catchment area of the Hout Bay River is described by Taylor (1978) and Kruger (1979) as Mountain Fynbos and is further differentiated by Moll *et al.*, (1984) into *Mesic* Mountain Fynbos. The latter category is described as occurring on seasonally waterlogged, mesic sites, with the communities having an open to closed canopy cover. The restioid, ericoid and proteoid elements of fynbos are all represented.

Closer to the coast, the vegetation grades into a mosaic of dune fynbos, dune scrub-thicket and dune forest, all of which have been severely invaded by alien plant species, particularly *Acacia cyclops* (rooikrans). The littoral dunes to the east and west of the river mouth have, to a large extent, been stabilized by exotic acacias and *Ammophila arenaria* (marram grass) but indigenous dune species are nevertheless relatively conspicuous, particularly along the seaward margin of these dunes.

A brief description of the various mapping units used in Figure 44 is provided below, while Appendix I lists some of the species and physical features comprising these units.

Acacia cyclops - Tetragonia decumbens Foredune vegetation

The vegetation of this mapping unit has largely became established artificially, due to the stabilization of the dunes by *Ammophila arenaria* and the simultaneous encroachment of predominantly *Acacia cyclops*. Some of the more important indigenous dune species to have established themselves within this area include: *Tetragonia decumbens* (klappiesbrak), *Myrica cordifolia* (waxberry), *Metalasia muricata* (blombos), *Stoebeplumosa* (slangbos) and *Chrysanthemoides monilifera* (bietou). Unless the exotic species are eradicated, the future status of this vegetation is likely to remain unchanged.

Metalasia muricata - Restio eleocharis Dune Fynbos

A well established stand of dune fynbos occurs along the eastern margin of the sand plume which extends across the Karbonkelberg peninsula. In its present state, this vegetation acts as a buffer between the residential area and the mobile sand and its importance in this regard should be recognized. Its future preservation, however, is not adequately ensured due to the physical processes of sand encroachment and erosion along its western margin and the invasive potential of exotic acacias which are already firmly established in the area.

Conspicuous species occurring within this open shrubland vegetation include *Metalasia muricata*, *Passerina vulgaris* (gonna) and *Chrysanthemoides monilifera* in the upper stratum and *Restio eleocharis*, *Ehrharta villosa* (pipe grass) and *Hellmuthia membranacea* in the field layer.

Rhus glauca - Salvia africana lutea Dune Scrub

The vegetation of this mapping unit represents a transition between dune fynbos and dune thicket and possesses floristic and structural characteristics of both of these formations. In Figure 44, it is shown to occur to the west of the Hout Bay River, in a belt around a milkwood thicket, on dunes which have been stabilized for a considerable period of time. Structurally, the vegetation is relatively dense and varies in height between one and four meter. Dominant woody species include *Rhus glauca*, *Euclea racemosa* (sea gwarrie), *Olea exasperata* (coast olive) and *Colpoon compressum* (Cape sumach) while *Salvia africana lutea* (beach salvia), *Psoralea fruticans*, *Nylandtia spinosa* (tortoise berry) and *Restio eleocharis* are common shrub and herbaceous elements. If preserved, this vegetation could progress towards dune thicket.

Sideroxylon inerme - Chionanthus foveolata Dune Thicket

The milkwood thicket indicated in Figure 44 represents a good example of climax vegetation for the Hout Bay dune environment and, as such, should be afforded a high degree of protection. Structurally, the thicket is comprised of a single canopy stratum of approximately eight m in height, with no defined subordinate strata. It is dominated floristically by *Sideroxylon inerme* (white milkwood), with *Chionanthus foveolata* (fine-leaved ironwood) and *Cassine peragua* (bastard saffronwood) as sub-dominants. Occasional large individuals of *Olea europaea* occur around the thicket margin.

4.2 Fauna

4.2.1 Fish

As part of a project on the ecology of the Cape Galaxias the fishes of the Hout Bay River were sampled in 1976, 1977 and 1979 (S McVeigh, Fisheries extension officer, Hout Bay, 1980, pers. comm.; McVeigh, 1977). In the estuary a number of Gobiidae and *Liza richardsoni* (southern mullet) were netted and upstream *Sandelia capensis*, (Cape kurper) *Galaxias zebratus* and *L. richardsoni* were caught with a scoop net. Mr McVeigh, and a Hout Bay resident Mr Willmot, restocked the river with trout in 1976. According to Mr McVeigh the river had already been stocked with bass and trout prior to this, but he was unable to say when this had been done.

An eel (most probably an *Anguilla* sp.) was found in a pool near the boundary of the Orange Kloof Forest Reserve by the forester Mr P le Roux in 1983 when repair work was being carried out on that section of the river after the June flood.

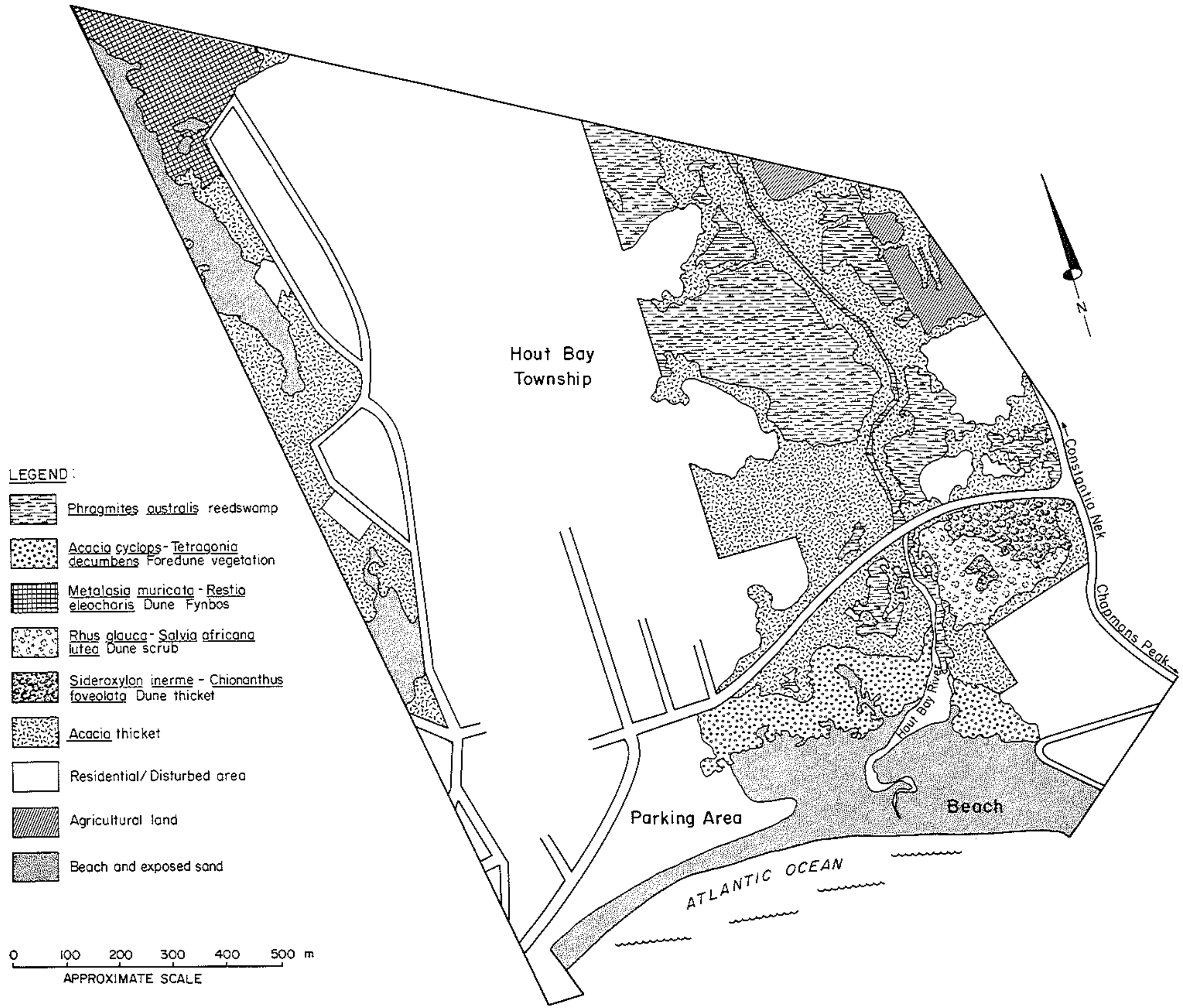


FIG. 44: The vegetation of the lower reaches of the Hout Bay River.

4.2.2 Reptiles and Amphibians

The list of 13 amphibians compiled by the Department of Nature and Environmental Conservation (Appendix II) includes amphibians which have been recorded or are likely to occur in the area. Some of these species may well have disappeared from the Hout Bay Valley as a result of encroaching development causing extensive changes to habitats. Mr John Visser (herpetologist and local resident) records having seen only four riverine species of frog *(Rana grayi, R. fuscigula, Xenopus laevis* and *Bufo pardalis)* with the Table Mountain ghost frog *(Heleophryne rosei)* occurring around the headwaters of the river. He includes the Arum lily frog *(Hypersolius horstockii)* and the sand rain frog *(Breviceps rosei)* in his listing (J Visser, pers. comm.).

The Cape terrapin *(Pelomedusa subrufa)* is common in the river, and two tortoises, the southern padloper and the angulate tortoise are terrestrial residents.

Visser has recorded 15 of the 22 species of snakes listed as likely to occur in the area (Appendix II). Of these, four species (the Cape many-spotted reed-snake *(Amplorhinus multimasculatus)*, puff adder *(Bitis arietans arietans)*, herald snake *(Crotaphopeltis hotamboeia)* and common brown water snake *(Lycodonomorphus rufulus)* frequent riverine habitats.

Of the lizards, only the marbled gecko *(Phyllodactylus porphyreus)* and the Cape dwarf chameleon *(Bradypodium pumilum)* are riverine species. Sixteen species are likely to occur in the area but only seven of these have been recorded by Visser (Appendix II).

4.2.3 Birds

The Hout Bay River catchment is rich in bird life, particularly in the riverine and estuarine areas. Mr G Rudings, a resident of Hout Bay and naturalist, recorded 66 species of which 48 were sighted in the vicinity of the estuary (Appendix III). The birds of the upper catchment are poorly represented in the listing as the area is visited infrequently by Mr Rudings.

Terns, gulls and cormorants frequent the estuarine and beach area, and the estuary is a favoured fishing site for the Pied, Giant and Malachite kingfishers. In 1980 a bird survey was made of the area above the harbour by Mr D Wood, also a local resident and naturalist. Fourteen species were recorded on this occasion, bringing the total for Hout Bay to 72 species.

4.2.4 Mammals

N G Palmer,Cape Department of Nature and Environmental Conservation, *(in litt.)* lists 36 mammal species recorded from, or likely to occur in, the Hout Bay Valley and surrounding mountains (Appendix IV). Amongst these are five exotic species which were either deliberately or accidentally introduced by man. The Himalayan tahr *Hemitragus jemlahicus* has caused considerable damage to the vegetation of Table Mountain and the upper catchment of the Hout Bay River. The tahr, therefore, may have contributed in part to the increased run-off.

It is unlikely that the clawless otter *Aonyx capensis* still occurs in the Hout Bay River since bank erosion and infilling of reedbeds has destroyed habitats which would have protected this animal from predators and human disturbance. As urbanisation of the Hout Bay Valley continues only the smaller mammals will be found in the valley itself. The larger carnivores will be restricted to the upper mountain slopes where they can find adequate refuge.

5. SYNTHESIS AND RECOMMENDATIONS

Present state of the system

Hout bay is a south facing crescentic embayment approximately 22 km from Cape Town. The valley of Hout Bay is surrounded by rugged mountains, with the summit of Table Mountain, Maclear's Beacon (1086m) marking the northernmost point of the catchment. The Hout Bay River rises on Table Mountain and drains the sloping Back Table. The river is typical of the rivers of the fynbos biome being acid, short, steep and fast flowing. The river is difficult to manage because of its erratic flow regime: in winter it is prone to spates whereas in the summer months the flow is so weak that the mouth of the river becomes closed by a sand bar.

The mountainous upper catchment is relatively undeveloped and the streams run through fynbos and the indigenous forests of Orange Kloof. The Cape Town City Council manage this area as a water catchment and forest reserve. However, five reservoirs impound the headwaters of the river (Section 3.1.4). Water is drawn from these reservoirs to augment the city's potable water supply.

Where the valley opens out and the river gradient becomes less steep, severe bank and bed erosion has taken place. This has been exacerbated by agricultural practices and residential developments which have led to the progressive removal of the palmiet swamps. In the past these swamps dissipated the force of the flood waters and held the highly erodible alluvial soil intact. Silt from upstream erosion now causes continuing siltation problems downstream of the Victoria Road bridge and periodic dredging operations are necessary to maintain river flow.

The Hout Bay River emerges from the floodplain of its lower reaches, which are still partially covered by natural reedbeds, into the coastal dunes and onto the beach. There is a small lagoon, approximately half a kilometre long and 20-40m wide which becomes dammed up behind the beach berm during the dry summer months when the flow is weak. During winter, when heavy rainfall causes flooding, the beach berm is breached and the lagoon enters an estuarine phase. However, as the slightly saline water (2 to 4 parts per thousand) seldom reaches more than 100 to 200m upstream, this section of the river is more of a river mouth than a true estuary. Aerial photographs of 1944 show the river flowing through a large triangular sandy embayment extending about one kilometre upstream (Figure 37). This entire highly dynamic sandy area between the sea and the hinterland is now limited to an unnaturally narrow sandy strip, and the lateral movement of the mouth is restricted by hard-surfaced areas (car parks) on both sides.

Hout Bay is an expanding node of development on the Atlantic coast. Its history, natural setting, fishing harbour and the quality of its living environment have made it increasingly popular as a residential area. (At present (1986) the resident population of 10 000 represents 0,53 percent of the population of Metropolitan Cape Town.) As Hout Bay is conveniently close to the city centre, most residents are employed in Cape Town and commute daily to work. There is limited commercial development in the valley and it is unlikely that the area will ever become self sufficient. Hout Bay is, however, one of the most important centres of the fishing industry in the Western Cape, and is becoming increasingly important as a regional and national tourist and recreation attraction

The present condition of the Hout Bay River catchment can be seen as the product of large-scale changes over several centuries. The rate of change has increased significantly in recent times and unless carefully controlled may seriously threaten the high quality of the environment in this unique valley.

Present state of knowledge

The findings of an archaeological excavation at a Late Stone Age cave at Hout Bay are given by Buchanan (1977). Van Riebeeck's Journal (Thom, 1952) gives an early account of the valley, its fauna, flora and indigenous inhabitants, and Raven-Hart (1967) documents the earliest European landings in the bay. The Hout Bay Museum holds a comprehensive collection of letters, photographs and documents which have been used to compile the history of the area (Sections 2.1 and 2.2). These include Borchers (1978) on the early manganese mining in Hout Bay, E Bisschop *(Sentinel News* , June/July 1979) on early farming endeavours, a letter from R.L. Plessis to Mrs Wormser of the Hout Bay Museum (1979) with an account of the first fish factory and the beginnings of the fishing industry, and A Smith *(Sentinel News* , June 1981) on the history of the forts on either side of the bay and at Constantia Nek. The books by Laidler (1926), Green (1957) and Burman (1962) also provide historical information. Bisset (1976) traces some of the early development in Hout Bay and makes proposals for future planning and development, while Callaghan (1982) outlines the current planning policy of the Western Cape Regional Services Council.

The consulting engineers Hill Kaplan Scott Inc. carried out an investigation of the physical problems of the river after the floods of 1977 and their findings and recommendations are contained in an interim report (HKS, 1979). Further studies have been carried out by them on the Hout Bay beachfront (1984) and the 20- and 50-year flood characteristics of the system (1985).

The vegetation of the upper catchment and Orange Kloof has been studied by various researchers (Cowling, 1976; Glyphis, 1976; McKenzie, 1976) from the University of Cape Town whose papers have been included in the conservation and management report on Table Mountain edited by Moll and Campbell (1976). Shaughnessy's (1980) investigation of the original planting and subsequent spread of alien woody plants around Cape Town includes information on the introduction of some of these pest species into the Hout Bay catchment. King and Grindley (1982) made a preliminary hydrobiological survey of the river, and Grindley and Grindley (1984) prepared an account of the fauna and flora of the coastal dune area.

In 1958 a survey of the fauna of Hout Bay beach was carried out by Brown (1981) who reported it to be "the most sheltered and richest of all the sandy beaches of the Cape Peninsula"; by 1964 he found that the pollution from the fish factories and harbour had virtually eliminated the fauna from the harbour beach and greatly reduced that of the main beach.

Three reports have been published on the pollution of Hout Bay and the meiofauna of the beach (Fricke *et al.*, 1979; Eagle *et al.*, 1980; and Bartlett, 1981); these reports include analyses for heavy metals as well as for nutrients in the coastal waters. An investigation on the proposed Hout Bay sewage outfall was carried out by NRIO for the WCRSC (Hout Bay Outfall Studies, 1986).

Lamming (1962) and Borchers (1979) have written about the geology of the area and Smith-Baillie and Rudman *et al.*, (1976) included Hout Bay in their soil survey of the Cape Peninsula.

From 1944 onwards, aerial photographs of the catchment were taken at irregular intervals and have provided a valuable record of the land-use changes during the last forty years. Maps have been drawn from four sets of these aerial photographs in order to quantify some aspects of these changes, particularly in areas of agriculture, vegetation and residential expansion. (Figure 18).

Problems: present and forseeable

Hout Bay is only 32 per cent developed (1986), in terms of existing development rights, but the rapidly expanding population within Metropolitan Cape Town will inevitably increase the development pressure. The past development has not always shown sensitivity towards the special environmental features of the area nor enhanced its environmental quality for all the residents. Future development pressure in the Hout Bay valley will therefore present a great challenge to those with authority to control and guide its implementation.

Increased development will put stress on the existing infrastructure of Hout Bay, and roads, stormwater drainage and sewage disposal facilities will all need to be upgraded to meet the new demands. Recreation pressure, both by local residents and by people from the greater Cape Town area, on the beach and harbour facilities is increasing rapidly and will require imaginative management if further degradation is to be avoided.

At present traffic congestion is experienced in certain places on Saturday mornings, Sunday afternoons and during peak holiday seasons. When Hout Bay is fully developed severe congestion of both commuter and holiday traffic has been predicted by traffic consultants.

Stormwater run-off from developed areas is likely to increase erosion and flooding problems within the valley, and an increased number of stormwater pipes draining into the river will exacerbate the problems of bank and bed erosion. The problems associated with sewage disposal have been researched at the request of the WCRSC (Hout Bay Outfall Studies, 1986). The health and aesthetic consequences implicit in the handling of increasing amounts of sewerage may pose grave problems for future planners.

From the foregoing, it is clear that the Hout Bay River and its immediate environs are in a degraded condition throughout most of its length. Increased run-off from proposed township developments, exacerbated by the excessive site clearing before building starts, could significantly increase the severity and frequency of the spate conditions in the river. The dumpsites in the reedbeds adjacent to the lower reaches of the river are unsightly and will reduce the flood attenuating function of the area. However, since it is planned to use these infilled areas for sportsfields, there is little likelihood of serious damage or financial loss in the event of a flood bursting the river banks. Damage to the river course (including weirs and bridges), as well as to buildings and private lands could become an increasing source of expense and danger to the local community. Houses constructed in the floodplain are particularly at risk, and every effort should be made to minimise housing development in this vulnerable area.

The divided ownership of the river and its environs militates against the drawing up and implementation of an overall river management plan. Such river-related problems as inappropriate bank stabilization methods, the dumping of debris in the river and trampling of the riverbanks by animals are, therefore, likely to remain in the future. Until the river banks in the erosion zone have been stabilized, siltation of the lower reaches will continue and the dredging operations necessary to maintain flow will be a continuing expense.

Alien vegetation is widespread throughout the valley and its presence will remain a management problem. Along the river, the shallow rooted exotics which have replaced the indigenous riparian vegetation, provide little stability to the river banks and are often uprooted during floods. Alien acacias have encroached onto the sands of the Karbonkelberg dunefield which is thus losing its visual and amenity value.

However, if these acacias within the original plume area are eradicated, blowing sands will again become a natural phenomenon in this area and could become a threat to the adjacent residential areas which have sprung up in the mean time.

The recession of the beach line at the eastern end of the beach (caused by a reduction in the spending (energy-dissipating) area of the beach since the harbour walls were constructed), has not yet established an equilibrium (Hill Kaplan Scott Inc., 1984). All development seaward of this eventual recession line will be at risk, particularly during periods when spring tides and storm conditions coincide. As Figure 41 shows, Promenade Road already experiences storm wave erosion at its base, and this can be expected to worsen as the beach line recedes.

Imaginative planning and development of the beach area is necessary to restore the natural beauty of this part of Hout Bay and to make it a more useful recreation amenity. The parking area at the western end of the beach, originally hardened to protect Beach Estate from drift sand, is a sterile, windswept expanse which is unattractive and of little use to beach users.

RECOMMENDATIONS

Hout Bay can no longer afford to adopt attitudes to environmental management which might have been appropriate to the low-density semi-rural area that it used to be some twenty years ago. It has to be accepted that Hout Bay has become *de facto* an integral suburban part of Cape Town and that the management of the area requires a bold imaginative long-term approach if the quality of life in the valley is to be maintained.

In these times when there are great demands on Government funds to provide basic housing and education for our rapidly increasing population, the relatively affluent will have to contribute more to ensure the maintenance of their life styles. The residents of Hout Bay, therefore will have to come to terms with the fact that, in order to protect the environment which originally attracted them to the area in the first instance, they will have to provide much of the finance to achieve this goal.

There are five major environmental management problems that need urgent attention: the river with particular emphasis on erosion; stormwater drainage; sewage disposal; the beach front including driftsand management; alien vegetation.

The river and stormwater management

Successful management of the river will only be possible if it is undertaken on an integrated basis. The present piecemeal *ad hoc* approach at best provides local solutions but more often compounds the problems. It is essential that the managing authority is granted a public servitude along both banks so that comprehensive protection works can be undertaken. No responsible authority can spend public funds on a patchwork of riverine localities where it is granted access while adjacent possibly ill-managed private areas negate its efforts. Objections to a public servitude raised by riparian owners include the fear that such public areas would intrude upon their privacy and provide access routes for burglars and other undesirables. While accepting that privacy could be affected, household security on the other hand is likely to be improved rather than reduced since, at present, much of the banks are a tangle of alien acacias harbouring squatters and others.

In the lower reaches, particularly between the Victoria Road and Princess Road bridges, the natural function of the *Phragmites* reedswamp should be restored as far as possible and all further infilling should be stopped. This reedswamp could serve as a surge reservoir absorbing flood peaks thereby reducing the risk of flooding.

The Hout Bay River has a history of flooding and the rapid urban development which is taking place within the catchment can only increase the severity of these events. It is therefore vital that the authorities do not allow inappropriate development on the floodplain. To allow houses to be built in areas which have a history of flooding jeopardises both the safety of those residents and the stability of the whole system.

The use of the Hout Bay River as a convenient and, in the short-term, cheap conduit for stormwater from new development should be halted. More effective means of conducting stormwater to the sea from new developments on both sides of the valley should be investigated. To allow new developments to discharge their stormwater into the Hout Bay River will greatly compound the already extensive erosion and flooding problems.

Sewage Disposal

When Hout Bay was a semi-rural area with a low population, sewage disposal by means of septic tanks was entirely suitable. However, the present scale of development precludes such a low technology approach and a sewage treatment plant with, ultimately, a marine outfall is the only reasonable solution to the problem. However, the correct combination of level of treatment and location of the outfall is the subject of debate. In order to reduce operating costs it is logical to site a sewage treatment works at the mouth of the valley so that it is fed by gravity. Unfortunately, the flat valley floor is not considered to be suitable since odours from any sewage works could adversely affect the surrounding residential areas and because land is scarce and expensive. These circumstances have led to the proposal that the sewage receives simple screening, masceration and chlorination before discharge through a pipeline running out to sea beneath the Sentinal. The disadvantages are that, under certain infrequently occurring conditions, the buoyant plume may be visible from Chapmans Peak scenic drive and that under southwesterly wind and swell conditions the effluent, albeit highly diluted, may fetch up on Hout Bay Beach. A longer pipeline than the one proposed may reduce these problems but it is understood that the accompanying costs would escalate considerably. The WCRSC Medical Officer of Health has expressed satisfaction at the diluted state of the effluent reaching the beach area from a public health point of view.

Options, therefore, are: simple treatment and discharge through a marine outfall; treatment to a higher (General) standard and then a discharge to the sea; or pumped transfer to the Cape Flats sewage works. The options with their financial and environmental implications should be presented to the residents of Hout Bay who having contributed to the decision-making process will have to live with the consequences of the final choice.

The Beachfront

The original sediment transport regime has been severely disrupted by various forms of development thus giving rise to a situation requiring constant maintenance. Once again, a bold imaginative approach is required in order to upgrade the entire beachfront to accommodate the consequences of the disruption of the natural processes and the increasing human pressure. Such a plan should provide for attractive beach amenities which would be in keeping with stabilization requirements for mobile sand and reduction of maintenance requirements to a minimum. The present piecemeal approach has resulted in generally unsatisfactory, aesthetically unpleasing conditions.

It would be realistic to seek financial assistance from the state or CPA for such a beachfront improvement scheme since Hout Bay is a recreation area for people from throughout the Cape Peninsula and even further afield.

Alien Vegetation

Much of the Hout Bay valley is infested with various alien plant species. Removal of alien acacias from the banks of the Hout Bay River should be a fundamental component of any management scheme. Alien acacias have encroached extensively upon the formerly mobile sand corridor on the west side of the valley. Prior to human interference this corridor used to link Hout Bay with Sandy Bay. Removal of these alien plants would, however, re-mobilize the sand and this could prove a nuisance to properties bordering the sand bypass. Any eradication scheme would therefore have to be accompanied by a re-vegetation scheme using indigenous species.

In conclusion, the ultimate beneficiaries or victims of the management options adopted for the various components of Hout Bay are the residents themselves. It behoves the managing authorities to take these people into their confidence, present the options for solving the various problems in the form of cost/benefit analyses (both financial and environmental) and then put the options to the vote. The results would serve as an invaluable guide to the managing authorities.

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Aerial Photography

Date	Job No.	Photos Nos.	Scale	Colour	Source
1944	61/44	315-17,340-42, 1320 - 25	18 000	B & W	Trig. Survey
1958	424	7046,47	30 000	B & W	Trig. Survey
1960	454	7592	36 000	B & W	Trig. Survey
1977	786	1474,75	50 000	B & W	Trig. Survey
1979	326	392/3 - 95/3	10 000	Col	Univ. of Natal
1980	348	51	20 000	B & W	Univ. of Natal
1983	-	255 - 292	6 000	B & W	WCRSC
1983	-	338 - 351	4 000	B & W	WCRSC
1983	-	312 - 320	4 000	B & W	WCRSC
1987	-	259 - 64	10 000	Col	EMA/CSIR
1988	-	-	10 000	Col	EMA/CSIR

8. 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: orginating 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 the 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.

EDDY: 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.

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 saline 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.

ISOBATH: a line joining points of equal depth of a horizon below the surface.

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 to the shore.

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.

MEIOFAUNA: microscopic or semi-microscopic animals that inhabit sediments but live quite independently of the benthic macrofauna.

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^{o}, 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.

OLIGOTROPHIC: poor in nutrients and hence having a paucity of living organisms.

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.

PERIPHYTON: plants and animals adhering to parts of rooted aquatic plants.

PHOTOSYNTHESIS: the synthesis of carbohydrates in green plants from carbon dioxide and water, using sunlight energy.

PHYTOPLANKTON: plant component 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 silica. 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.

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.

WAVE HEIGHT (average energy wave height): an index which reflects the distribution of average incident wave energy at inshore sites along the coast presented as a wave height.

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 component of plankton.

References:

DAY, J.H. (ed.)(1981). Estuarine ecology with particular reference to Southern Africa. Cape Town, A.A. Balkema.

SOUTH AFRICAN TIDE TABLES (1980). Retreat C.P. The Hydrographer. South African Navy.

APPENDIX I: Plant species and physical features of the Hout Bay vegetation mapping units used in Figure 44.

Mapping unit	Area (m^2)	% Area	Cover (%)	Height (m)
Phragmites australis reed swamps	171 500	10	100	4
Acacia cyclops - *Tetragonia decumbens* Foredune vegetation	56 000	3,3	25	0,5-3
Metalasia muricata - *Restio eleocharis* Dune fynbos	46 500	2,7	25	0,5-2
Rhus glauca - *Salvia africana lutea* Dune scrub	25 000	1,5	50	1-4
Sideroxylon inerme - *Chionanthus foveolata* Dune thicket	19 500	1,1	80	8
Acacia Thicket	311 500	18,1	80	3-5
Residential/Disturbed area	1 066 500	62		
Agricultural land	24 500	1,4		
Total	1 721 000			

Phragmites australis Reed swamp
Phragmites australis (5)

Acacia cyclops - Tetragonia decumbens Foredune vegetation
Acacia cyclops (3); *A. saligna* (r); *Agropyron distichum* (+); *Ammophila arenaria* (2) ; *Arctotheca populifolia* (r) ; *Chrysanthemoides monilifera* (r) ; *Ficinia lateralis* (+); *Metalasia muricata* (+); *Myrica cordifolia* (+); *Nylandtia spinosa* (r); *Pelargonium* sp (r); *Salvia africana lutea* (+); *Senecio elegans* (+) *Senecio littoreus* (+) ; *Solanum guineense* (1) ; *Stoebe plumosa* (+) ; *Tetragonia decumbens* (1); *Trachyandra divaricata* (+).

Metalasia muricata - Restio eleocharis Dune fynbos
Acacia cyclops (1) ; *A. saligna* (1) ; *Ammophila arenaria* (1) ; *Carpobrotus acinaciformis* (1); *Chrysanthemoides monilifera* (1); *Cliffortia* sp (+); *Colpoon compressum* (+); *Ehrharta villosa* (+); *Hellmuthia membranacea* (+); *Leptospermum laevigatum* (r); *Metalasia muricata* (2); *Muraltia* sp (+); *Myoporum serratum* (r); *Myrica cordifolia* (+) ; *Nylandtia spinosa* (+) ; *Passerina vulgaris* (1) ; *Pelargonium capitatum* (+) ; *Psoralea fruticans* (+) ; *Restio eleocharis* (2) ; *Rhus glauca* (+); Rhus laevigatus (+); *Senecio elegans* (+); *Stoebe plumosa* (+); *Sutherlandia frutescens* (+) ; *Trachyandra divaricata* (r).

Rhus glauca - Salvia africana lutea Dune scrub
Colpoon compressum (1); *Euclea racemosa* (1); *Maytenus heterophylla* (+); *Maytenus lucida* (+); *Metalasia muricata* (+); *Nylandtia spinosa* (1); *Olea exasperata* (1); *Psoralea fruticans* (1); *Restio eleocharis* (2); *Rhus glauca* (2); *Salvia africana lutea* (1).

Sideroxylon inerme - Chionanthus foveolata Dune thicket
Cassine peragua (+); *Chionanthus foveolata* (1); *Olea europaea* (+); *Sideroxylon inerme* (4).

APPENDIX I: (continued)

Acacia Thicket
Acacia cyclops (3) ; *A. longifolia* (1) ; *A. melanoxylon* (1) ; *A. saligna* (3) ; *Albizia lophantha* (1) ; *Eucalyptus* spp (+) ; *Manulea tomentosa* (+) ; *Pennisetum clandestinum* (1); *Protasparagus capensis* (+) ; *Psoralea fruticans* (+) ; *Solanum quadrangulare* (+) ; *Stenotaphrum secundatum* (1) ; *Tetragonia fruticosa* (+) ; *Zantedeschia aethiopica* (+).

Riparian species*
Chenopodium sp (+) ; *Juncellus laevigatus* (+) ; *Juncus kraussi* (+) ; *Mariscus conjestus* (r) ; *Paspalum paspaloides* (1) ; *Phragmites australis* (+) ; *Polygonum salicifolium* (+) ; *Pycreus polystachys* (+) ; *Scirpus nodosus* (+) ; *Sporobolus virginicus* (+) ; *Typha capensis* (+).

* Not mapped in Figure 44.

Note: The symbols in brackets following each species' name represent adapted Braun-Blanquet Cover-Abundance Classes as follows:

r = 1/few individuals, cover less than 0,1 percent of area.
+ = occasional plants, cover less than 1 percent of area.
1 = abundant, cover 1-5 percent of area.
2 = any number, cover 6-25 percent of area.
3 = any number, cover 26-50 percent of area.
4 = any number, cover 51-75 percent of area.
5 = any number, cover 76-100 percent of area.

APPENDIX II: Reptiles and Amphibians

The following reptiles and amphibians have either been recorded or are likely to occur in this area. Some of these species may well have disappeared from the Hout Bay Valley as a result of the extensive development taking place there. Literature records, sight records and Cape Department of Nature and Environmental Conservation specimen records were used for compiling this list. Species marked with an * are only found, or likely to be found, in the upper reaches of the catchment (that is, the higher mountain streams, slopes or peaks). Species marked with a + have been recorded by Mr John Visser of Hout Bay.

AMPHIBIANS
Xenopus laevis (common platanna)+
Heleophryne rosei (Table Mountain ghost frog)*
Bufo angusticeps (sand toad)
Bufo pardalis (leopard toad)+
Breviceps montanus (Cape mountain rain frog)*
Breviceps rosei (sand rain frog)+
Tomopterna delalandii (Cape sand frog)
Rana fuscigula (Cape river frog)+
Rana montana (Cape grass frog)*
Cacosternum boettgeri (common caco)
Arthroleptella lightfooti (Cape chirping frog)*
Hyperolius horstockii (Arum lily frog)+

APPENDIX II: (continued)

TORTOISES/TERRAPIN
Chersina angulata (angulate tortoise)+
Homopus areolatus (southern padloper)+
Pelomedus subrufa (Cape terrapin)+

SNAKES
Typhlops lalandei (Delalande's blind snake)+
Leptotyphlops nigricans (black worm snake)
Lycodonomorphys rufulus (common brown water snake)+
Lamprophis fuscus (yellow-bellied house snake)
Lamprophis aurora (aurora house snake)+
Lamprophis inornatus (olive house snake)+
Duberria lutrix (southern slug-eater)+
Pseudaspis cana (mole snake)+
Amplorhinuus multimaculatus (Cape many-spotted reed snake)+
Psammophylax rhombeatus (rhombic skaapsteker)+
Psammophis notostictus (whip snake)+
Psammophis crucifer (cross-marked grass snake)+
Homoroselaps lacteus (spotted harlequin snake)+
Crostaphopeltis hotamboeia (herald snake)+
Dispholidus typus (boomslang)
Dasypeltis scabra (common eggeater)+
Hemachatus haemachatus (rinkhals)
Aspidelaps lubricus (coral snake)
Naja nivea (Cape cobra)+
Bitis cornuta (many-horned adder)
Bitis atropos (Cape mountain adder)
Bitis arietans (puff adder)+

LIZARDS
Pachydactylus geitjie (ocellated gecko)
Phyllodactylus porphyreus (marbled gecko)+
Bradypodion pumilum (Cape dwarf chameleon)+
Agama atra (rock agama)
Tropidosaura montana (green-striped mountain lizard)*
Tropidosaura gularis (yellow-striped mountain lizard)*
Meroles knoxii (Knox's ocellated sand lizard)
Acontias meleagris (golden sand lizard)+
Scelotes bipes (silver sand lizard)+
Mbuya capensis (three-striped skink)+
Mabuya homalocephala (Cape speckled skink)+
Chamaesaura anguina (Cape snake lizard)*
Pseudocordylus microlepidotus (crag lizard)*
Cordylus cordylus (common girdles lizard)+
Tetradactylus seps (short-legged plated lizard)
Tetradactylus tetradactylus (long-tailed seps)

APPENDIX III: Birds of Hout Bay Valley and Estuary (G E Rudings (1980-1985) and D Wood (1980) pers. comm.).

Old Roberts No.	Species	Habitat	New * Roberts No.
47	White-breasted Cormorant	Beach	55
48	Cape Cormorant	Beach	56
50	Reed Cormorant	Estuary and River	58
59	Little Egret	Estuary and River	67
61	Cattle Egret	River	71
72	Hamerkop	River	81
85	Spoonbill	Flying over	95
89	Egyptian Goose	River	102
96	Yellow-billed Duck	River	104
130	Black-shouldered Kite	Estuary and River	127
154	Steppe Buzzard	River/Hunting	149
155	Forest Buzzard	River	150
181	Cape Francolin	River	195
192	Helmeted Guineafowl	River	203
210	Moorhen	River/Estuary	226
235	White-fronted Plover	Estuary/Beach	246
245	Blacksmith Plover	River	258
275	Spotted Dikkop	River	297
287	Kelp Gull	Beach/Estuary/River	312
288	Grey-headed Gull	Beach/Estuary	315
289	Hartlaub's Gull	Beach/Estuary	316
290	Caspian Tern	Beach/Estuary	322
291	Common Tern	Beach/Estuary	327
198	Swift Tern	Beach/Estuary	324
296	Sandwich Tern	Beach/Estuary	326
311	Rock Pigeon	River	349
314	Redeyed Dove	River	352
316	Cape Turtle Dove	River	354
317	Laughing Dove	River	355
343	Red-crested Cuckoo	River	377
351	Klaas's Cuckoo	River	385
357	Burchell's Coucal	River	391
380	Black Swift	Estuary/River (air space)	412
383	White-rumped Swift	Estuary/River (air space)	415
385	Little Swift	Estuary/River (air space)	417
386	Alpine Swift	Estuary/River (air space)	418
390	Speckled Mousebird	River	424
391	White-backed Mousebird	River	425
394	Pied Kingfisher	Estuary/River	428
395	Giant Kingfisher	Estuary	429
397	Malachite Kingfisher	Estuary	431
432	Pied Barbet	Estuary/River	465
493	European Swallow	Estuary/River	518
502	Greater Striped Swallow	Estuary/River	526
506	Rock Martin	Estuary/River	529
509	Brown-throated Martin	Estuary/River	533

APPENDIX III: (Cont.)

Old Roberts No.	Species	Habitat	New * Roberts No.
511	Black Sawwing Swallow	Estuary/River	536
524	White-necked Raven	Beach/Estuary/River	550
543	Cape Bulbull	River	566
581	Cape Robin	Estuary/River	601
604	Cape Reed Warbler	Estuary	635
609	African Sedge Warbler	Estuary/River	638
618	Grassbird	River	661
637	Neddicky	River	681
646	Le Vaillant's Cisticola	River	677
651	Spotted Prinia	River	686
672	Cape Batis	River	700
682	Paradise Flycatcher	Estuary/River	710
686	Cape Wagtail	River	713
707	Fiscal Shrike	Estuary/River	732
709	Southern Boubou	River	736
722	Bokmakierie	Estuary/River	746
733	European Starling	Esatuary/River	757
745	Red-winged Starling	Estuary/River	769
751	Malachite Sunbird	Estuary/River	775
760	Lesser Double-collard Sunbird	Estuary/River	783
775	Cape White Eye	Estuary/River	796
786	Cape Sparrow	Estuary/River	803
799	Cape Weaver	Estuary/River nesting	813
810	Yellow-rumped Widow	Estuary/River	827
843	Common Waxbill	Estuary/River	846
857	Cape Canary	Estuary/River	872
872	Cape Bunting	River	885

* New Roberts numbers from Maclean, 1985

APPENDIX IV: Mammals recorded from or likely to occur in the Hout Bay valley and surrounding mountains (N G Palmer, CDNEC, *in litt*).

Common name	Scientific name
Cape golden mole	*Chrysochloris asiatica*
Giant musk shrew	*Crocidura flavescens*
Forest shrew	*Myosorex varius*
Egyptian fruit bat	*Rousettus aegyptiacus*
Cape horseshoe bat	*Rhinolophus capensis*
Geoffroy's horseshoe bat	*Rhinolophus clivosus*
Cape serotine bat	*Eptesicus capensis*
Chacma baboon	*Papio ursinus*
Grey squirrel X	*Sciurus carolinensis*
Grey pygmy climbing mouse	*Dendromus melanotis*
Brant's climbing mouse	*Dendromus mesomelas*
Krebs' fat mouse	*Steatomys krebsii*
Cape Spiny mouse	*Acomys subspinosus*
Pygmy mouse	*Mus minutoides*

APPENDIX IV: (Cont.)

* House mouse	*Mus musculus*
Verreaux's mouse	*Praomys verreauxii*
* Brown rat	*Rattus norvegicus*
* House rat	*Rattus rattus*
Vlei rat	*Otomys irroratus*
Saunders' vlei rat	*Otomys saundersiae*
Porcupine	*Hystrix africaeaustralis*
Cape dune molerat	*Bathyergus suillus*
Cape molerat	*Georychus capensis*
Clawless otter	*Aonyx capensis*
Striped polecat	*Ictonyx striatus*
Water mongoose	*Atilax paludinosus*
Cape grey mongoose	*Herpestes pulverulentus*
Small-spotted genet	*Genetta genetta*
Large-spotted genet	*Genetta tigrina*
Caracal	*Felis caracal*
Wild cat	*Felis lybica*
Cape fur seal	*Arctocephalus pusillus*
Rock dassie	*Procvia capensis*
Grysbok	*Raphicerus melanotis*
* Himalayan tahr	*Hemitragus jemlahicus*
Grey rhebok	*Pelea capreolus*

* - Exotics

APPENDIX V: Guide to available information

ESTUARY / RIVERMOUTH / LAGOON: HOUT BAY

Guide to available information

Section	Group	Item	Acocks	Bartlett	Bisset	Borchers	Brown	Buchanan	Burman	Callaghan	Cape Of Good Hope Act 34, 1987	Cape Of Good Hope Act 35, 1987	Cape Metroplitan Draft Plan	Cape Of Good Hope Ordinance, 1985	Clark	Council On Environmental Quality	Eagle, Bartlett and Henning	Eerste River Catchment Study	Ferrario	Fricke
MANAGE-MENT		Historical			*			*	*											
		Conservation/Utilization														*				
		Management/Planning								*			*		*				*	
		Legislation									*	*		*						
		Water																*		
BIOTIC		Food webs/Ecosystems																		
	Fauna	Mammals																		
		Birds																		
		Reptiles																		
		Amphibians																		
		Fish																		
		Molluscs																		
		Crustaceans																		
		Other aquatic invertebrates					*													
		Terrestrial invertebrates																		
		Zooplankton																		
	Flora	Terrestrial vegetation	*																	
		Semi-aquatic vegetation																		
		Aquatic vegetation																		
		Algae																		
		Phytoplankton																		
		Microbiology																		
ABIOTIC	Chemistry	Pollution		*													*			*
		Eutrophication																		
		General Chemistry		*													*			*
		Salinity															*			*
	Physics	Circulation and mixing																		
		Hydrology / Flood regime																		
		Oceanography																		
		Climate																		
	Geology	Sedimentology																		
		Palaeoenvironment																		
		Geology				*														
	Physiography	Morphology																		
		Dams/Obstructions																		
		Catchment characteristics																		
YEAR (DATE OF INFORMATION)			1975	1981	1976	1979	1971	1977	1962	1982	1887	1887	1984	1985	1986	1981	1980	in prep	1978	1979

Sources of information

APPENDIX V: (Continued)

ESTUARY / RIVERMOUTH / LAGOON: HOUT BAY

Guide to available information

Category	Sub-category	Topic	Fromme	Fuggle	Great Britain Water Act	Green	Grindley	Grindley and Grindley	Harrison and Elsworth	Hewlett	Heydorn and Tinley	Hill Kaplan Scott Inc.	Hill Kaplan Scott Inc.	Hill Kaplan Scott Inc.	Hout Bay Beach Front	Hout Bay Outfall Studies	Howard Williams	King and Grindley	Kruger	Laidler
YEAR (DATE OF INFORMATION)			1985	1981	1973	1957	1984	1984	1958	1982	1980	1979	1984	1985	1980	1986	in press	1982	1979	1926
MANAGEMENT		Historical				*	*													*
MANAGEMENT		Conservation/Utilization					*				*		*		*		*	*		
MANAGEMENT		Management/Planning			*		*				*	*	*		*		*	*		
MANAGEMENT		Legislation										*			*					
MANAGEMENT		Water			*		*				*	*					*			
BIOTIC		Food webs/Ecosystems																		
BIOTIC	Fauna	Mammals																		
BIOTIC	Fauna	Birds																		
BIOTIC	Fauna	Reptiles																		
BIOTIC	Fauna	Amphibians																		
BIOTIC	Fauna	Fish																		
BIOTIC	Fauna	Molluscs																		
BIOTIC	Fauna	Crustaceans																		
BIOTIC	Fauna	Other aquatic invertebrates							*									*		
BIOTIC	Fauna	Terrestrial invertebrates																		
BIOTIC	Fauna	Zooplankton																		
BIOTIC	Flora	Terrestrial vegetation					*	*											*	
BIOTIC	Flora	Semi-aquatic vegetation																		
BIOTIC	Flora	Aquatic vegetation																		
BIOTIC	Flora	Algae																		
BIOTIC	Flora	Phytoplankton																		
BIOTIC		Microbiology																		
ABIOTIC	Chemistry	Pollution														*				
ABIOTIC	Chemistry	Eutrophication																		
ABIOTIC	Chemistry	General Chemistry					*													
ABIOTIC		Salinity																		
ABIOTIC	Physics	Circulation and mixing														*				
ABIOTIC	Physics	Hydrology / Flood regime	*				*		*	*		*	*	*						
ABIOTIC	Physics	Oceanography																		
ABIOTIC	Physics	Climate		*																
ABIOTIC	Geology	Sedimentology	*											*						
ABIOTIC	Geology	Palaeoenvironment	*																	
ABIOTIC	Geology	Geology					*					*								
ABIOTIC	Physiography	Morphology																		
ABIOTIC	Physiography	Dams/Obstructions					*					*								
ABIOTIC	Physiography	Catchment characteristics					*					*	*	*				*		

Appendix V:(Continued)

ESTUARY / RIVERMOUTH / LAGOON: HOUT BAY

Guide to available information		Lamming	Mabbutt	MacDonald, Jarman and Beeston	Macivar	Maclean	McVeigh	McVeigh	Moll and Campbell	Moll	Pitman	Raven-Hart	Roberts	Shaughnessy	Smith-Baillie	Snow	Taylor	Thom	Whitfield, Allanson and Heinecken
YEAR (DATE OF INFORMATION)		1962	1952	1985	1977	1985	1977	1980	1976	1984	1973	1967	1978	1980	1976	1985	1978	1952	1983
MANAGE-MENT	Historical											*						*	
	Conservation / Utilization			*															
	Management / Planning			*															
	Legislation																		
	Water																		*
BIOTIC	Food webs / Ecosystems																		
BIOTIC: Fauna	Mammals																		
	Birds					*							*						
	Reptiles																		
	Amphibians																		
	Fish						*	*											
	Molluscs																		
	Crustaceans																		
	Other aquatic invertebrates																		
	Terrestrial invertebrates																		
	Zooplankton																		
BIOTIC: Flora	Terrestrial vegetation			*					*	*				*		*	*		
	Semi-aquatic vegetation																		
	Aquatic vegetation																		
	Algae																		
	Phytoplankton																		
BIOTIC	Microbiology																		
ABIOTIC: Chemistry	Pollution																		
	Eutrophication																		
	General Chemistry																		
ABIOTIC	Salinity																		
ABIOTIC: Physics	Circulation and mixing																		
	Hydrology / Flood regime										*								*
	Oceanography																		
	Climate		*																
ABIOTIC: Geology	Sedimentology																		
	Palaeoenvironment																		
	Geology	*	*		*										*				
ABIOTIC: Physiography	Morphology				*														
	Dams/Obstructions																		
	Catchment characteristics																		

POSTSCRIPT

Amongst the recommendations contained in this report it is stated that a "bold imaginative approach is required to upgrade the entire beachfront" (see p59). Since that recommendation was made the Western Cape Regional Services Council has commissioned a detailed study of the beachfront. The study aims to produce a plan for the Hout Bay beach which will provide an aesthetically attractive, economically maintained , recreation environment. Careful consideration is to be given to the natural processes acting in the area so that the final design is in as close harmony with these processes as possible. The WCRSC is to be applauded for taking this action and it is hoped that the consultants' recommendations will be implemented in the very near future.

Notwithstanding some of the administrative and legal problems that exist, it is hoped that a similar planning study for the Hout Bay River will be commissioned in the near future.

ERRATUM

Errors in Figures 24, 25 and 26

Note : During the above mentioned beach front study, the following errors were detected in the maps used in Figures 24, 25 and 26 :

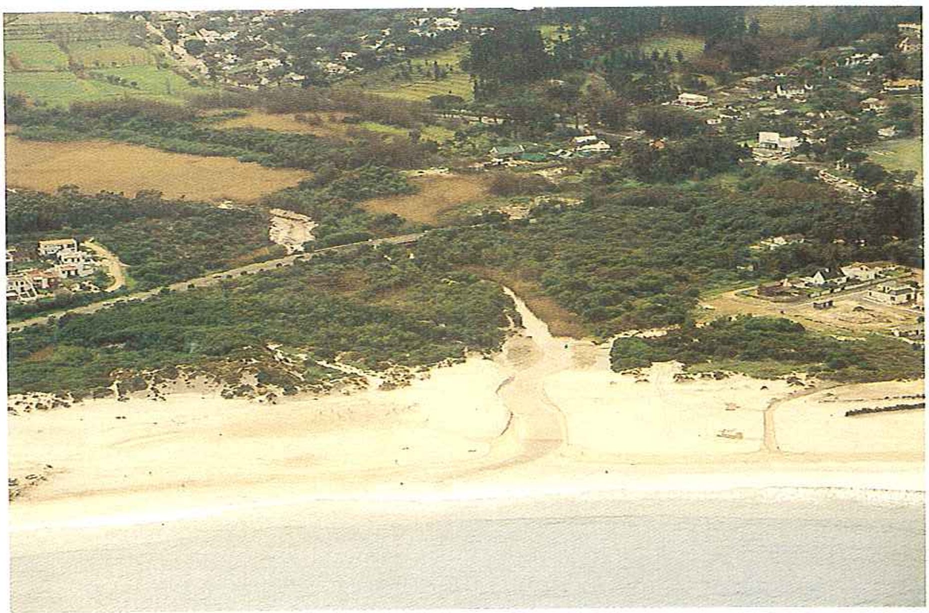
i) Scale is incorrect
ii) Location of Madeira Restaurant and Yacht Club incorrect
iii) Length of harbour wall incorrect

The Editors
April 1989.

PLATE I:
Hout Bay: the valley with its head on the back slopes of Table Mountain (background) widening towards the sea (foreground). (Photo: ECRU 88-05-31).

PLATE II:
Urban development of the Hout Bay valley: note the houses extending from the valley floor up the lower slopes of the surrounding mountains. (Photo: ECRU 88-05-31).

PLATE III:
The shallow lower reaches of the Hout Bay River meandering across the broad beach. Note the *Phragmites* reed-beds in the left background. (Photo: ECRU 88-05-31).



LIST OF REPORTS PUBLISHED BY ECRU TO DATE

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Estuaries of the Cape Part II. Synopses of available information on individual systems.

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* Out of print.