URBAN GROWTH IN METROPOLITAN CAPE TOWN: IMPLICATIONS FOR INLAND AND COASTAL WATERS

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Rapid and poorly planned urban growth in Metropolitan Cape Town is subjecting the inland coastal waters in the region to stress. Increasing extractive demands are being made on inland water systems to provide potable water. Larger volumes of liquid and solid waste, and increased stormwater runoff are impacting negatively on inland and coastal water quality. Urban sprawl is detracting from the aesthetics of river catchments, and is also impacting adversely on river and stormwater quality. An assessment of future urbanisation in terms of major drainage catchments revealed that most will occur in the False Bay north shore catchment. Priority planning concerns identified are: (1) the lack of fundamental scientific information on coastal ecosystems, particularly those of False Bay and Table Bay; (2) the potentially detrimental (health) impact of bacteria and viruses in urban runoff and from treated wastewater discharge on inland water and coastal recreation nodes; (3) the potentially detrimental impact of nutrients in urban runoff and treated wastewater discharge on inland and coastal ecosystems; (4) the potentially negative impact of increased potable water demand on the Berg, Riviersonderend, Breede and Palmiet riverine ecosystems; and (5) the opportunity cost (e.g. water unavailable for agriculture) of increased abstraction of river and groundwater for urban consumption. The paper concludes by emphasising the need for a metropolitan inland and coastal waters management policy to address the lack of coordinated policy and planning within and between local authorities and government departments.

INTRODUCTION

Rapid urban growth is occurring in Metropolitan Cape Town, with the population growth rate during the past decade averaging 4,5 per cent (Republic of South Africa, 1985; 1991). The present population, which is approaching 3 million people is growing at a rate of 2,5 per cent and is predicted to increase to 3,5 million by the year 2000 (Spies and Barridge, 1991). An estimated 30 per cent of the economically active population are currently unemployed, and 60 per cent of blacks, 40 per cent of coloureds and 19 per cent of whites are living below the minimum household subsistence level of R600 per month (Dewar et al., 1990; Bridgeman et al., 1992). Problems of poverty and unemployment are exacerbated by an acute housing shortage, which is in the order of 100 000 units (information from Town Planning Branch, Cape Town City Council).

Increased potable water demand has resulted in the construction of dams and greater abstraction of water from rivers, particularly along the eastern margin of Metropolitan Cape Town (Spies and Barridge, 1991; Department of Water Affairs and Forestry, 1992; in prep. a). Liquid and solid urban wastes are impacting negatively on the False Bay and Table Bay catchments (Quick and Roberts, 1993; Quick, in press). Sprawl, including informal housing settlements, along the edges of the urban area is detracting from the aesthetics of river catchments and also causing a deterioration in the quality of stormwater runoff (Quick, in press).

These developmental issues have serious implications for planning and management in Cape Town, particularly in view of the fact that the future economic growth of the region is dependent on tourism, high technology manufacturing, insurance and finance (Bridgeman et al., 1992). All of these require high standards of environment quality.

Although (Gasson, 1989a and b; 1990) has described the urban demands being made on the natural systems of Metropolitan Cape Town, no detailed information is available on implications of urban growth for inland and coastal waters. This paper, therefore, aims to: (1) describe the characteristics of the major water bodies, rivers and catchments; (2) evaluate the effects of present urbanisation on water quality and water demand; (3) identify areas of potential future urban growth and implications for water quality and water demand; and (4) identify the inland and coastal waters planning and management priorities in Metropolitan Cape Town.

INLAND AND COASTAL WATER SYSTEMS

The inland and coastal waters of Metropolitan Cape Town are summarised in Figure 1. There are three discrete drainage systems, the False Bay catchment, the Table Bay and Atlantic Ocean catchment and in the east of the metropolitan area, the catchments of the Berg, Bree (Riviersonderend and Breede Rivers) and Palmiet.

False Bay and its catchment, have been described in detail by Jackson (1991) and Quick (in press). The catchment is drained by eleven rivers and includes two coastal lakes (Zeekoevlei and Zandvlei) and the Steenbras Dam which supplies 10 per cent of Metropolitan Cape Town's water (Department of Water Affairs and Forestry, 1992). The largest river system is the Eerste/Kuils River which drains a catchment of 710 km^2. The Sand, Zeekoe and Lourens Rivers dominate the remainder of the catchment and drain subcatchments of 93,83 and 140 km^2, respectively. The Cape Flats aquifer is situated on the central northern shore of False Bay. The aquifer is estimated to have a safe yield of 15 - 20 x $10^6 m^3 y^{-1}$ (Gerber, 1981; Vandoolaeghe, 1990; Ninham Shand, 1992a).

The available information on Table Bay has been reviewed by Quick and Roberts (1993). Two major river systems drain into Table Bay, the Diep and the Salt/Black Rivers. A coastal lake, Rietvlei, and a wetland area are situated immediately to the north of

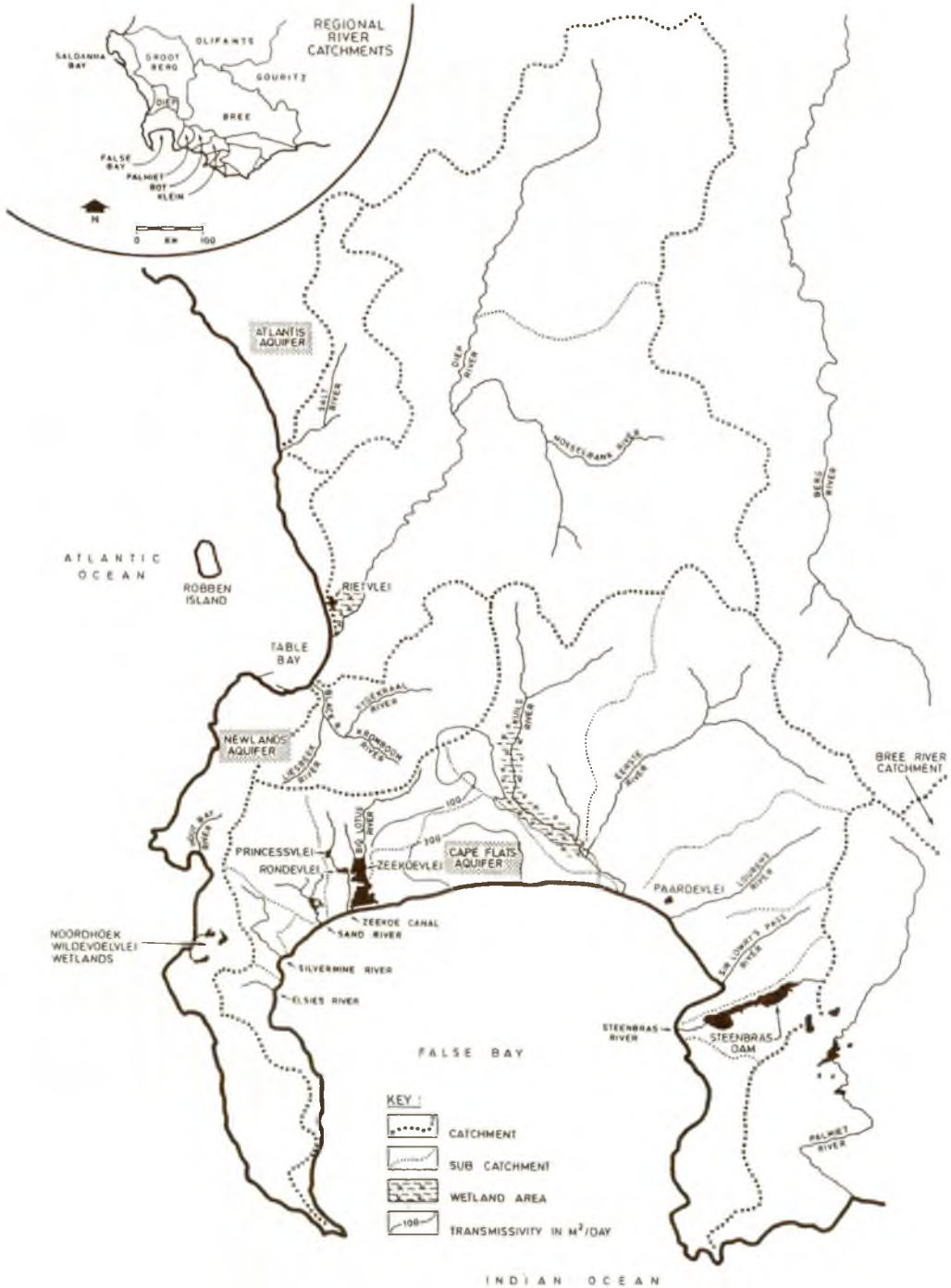

Figure 1. The inland and coastal waters of Metropolitan Cape Town.

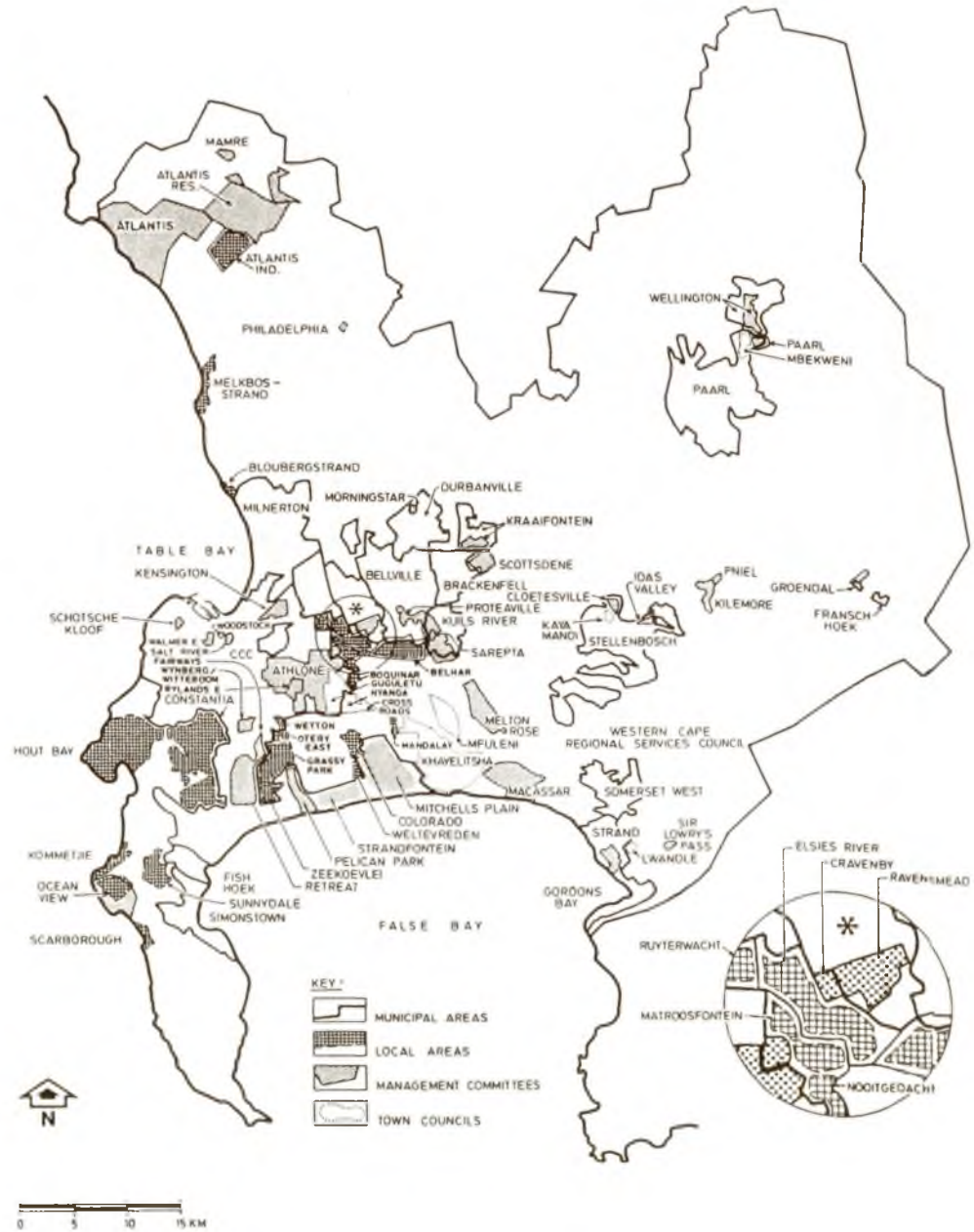

Figure 2. Place names and jurisdictional boundaries in Metropolitan Cape Town.

the Diep River mouth. The Newlands aquifer (about which little is known) is situated in the Salt/Black River catchment. To the north of Rietvlei are the Salt River catchment and the Atlantis aquifer. The Atlantis aquifer is artificially recharged using stormwater and is the potable water resource for Atlantis, supplying approximately 5,1 x $10^6 m^3 y^{-1}$ (Ninham Shand, 1992a). Two small river systems are situated to the south of Table Bay, the Hout Bay River (which drains into Hout Bay) and the Noordhoek Wetland system.

The Berg, Riviersonderend and Palmiet catchments supply most of Metropolitan Cape Town's water. According to the Department of Water Affairs and Forestry (1992), dams on the Berg River system supply 35 per cent (126,4 x 10^8 m^3 y^{-1}) of Cape Town's water allocation, whilst the Riviersonderend catchment supplies approximately 51 per cent (186 x $10^6 m^3 y^{-1}$).

URBANISATION

The jurisdictional boundaries of metropolitan Cape Town are shown in Figure 2, and the extent of urbanisation in Figure 3. A breakdown of the population by catchment is given in Table 1. Most urbanisation has taken place in the Salt/Black, Sand, Zeekoe and Kuils River catchments. The remaining area is dominated by agriculture and mountains. It should be noted that 95 per cent of the informal housing population is in the False Bay catchment, concentrated mainly in the townships of Nyanga, Crossroads (including KTC), Guguletu and Khayelitsha.

Virtually the entire metropolitan coastline is utilized for recreation. Nodes where intensive water-contact recreation occurs are shown in Figure 3. There are only four inland water bodies which are used for water-contact recreation, these are Zandvlei, Zeekoevlei, Milnerton Lagoon and Rietvlei.

Urbanisation and potable water

The water demand for Metropolitan Cape Town during 1991 was estimated to be 260 million $m^3 y^{-1}$ (Water Research Commission, in prep.). Most of this water is utilised for domestic consumption (55-70%) with smaller volumes being consumed by industry (10-15%) and commerce (5-10%; Spies and Barridge, 1991). The present potable water resources being utilised to satisfy urban requirements are summarised in Table 2 and Figure 4.

Table 1: Population by Catchment

Catchment	Population
Atlantic Ocean	
South of Table Bay *1	73 152
Table Bay Harbour *2	42 892
Salt/Black River	897 932
Diep River	98 645
North of Table Bay *3	80 118
Total	*1 192 793*
Eastern Catchment	
Berg River *4	119 107
Total	*119 107*
False Bay	
Peninsula *5	21 364
Northwest shore *6	555 222
Northcentral shore *7	886 624
Northeast shore *8	145 047
Total	*1 608 257*
Grand Total	*2 920 157*

*1 Green Point to Scarborough
*2 Central business area and surrounding suburbs
*3 Bloubergstrand, Melkbosstrand, Atlantis, Philadelphia and Mamre
*4 Paarl/Mbekweni, Wellington, Franschoek/Groendal, Kylemore and Pniel
*5 Kalk Bay to Simonstown
*6 Sand and Zeekoe River catchments and stormwater catchments of Muizenberg, Pelican Park and Strandfontein
*7 Kuils River catchment and stormwater catchments of Weltevreden Valley, Mitchells Plain and Khayelitsha
*8 Sir Lowry's Pass, Lourens and Eerste (excluding Kuils River) River catchments and stormwater catchments of Strand and Gordons Bay

Sources: Cape Town City Council (Town Planning Branch, Surveys and Land Information Branch), and Western Cape Regional Services Council and Republic of South Africa (1985, 1991).

Urbanisation and environmental water quality

False Bay catchment

Rivers, major stormwater outfalls, wastewater treatment works and industrial outfalls discharging directly into False Bay are shown in Figure 5. Potential point sources of pollution in the catchment include 12 wastewater treatment works and 13 sanitary landfill sites (Figure 5; Table 3). Areas of the coast where numerous small stormwater outfalls discharge are also shown as they are of concern with respect to water quality.

The management of water quality in False Bay and its catchment has been

Table 2: Present water resources for urban usage (Department of Water Affairs and Forestry, 1992)

Resource	Yield (x $10^6 m^3 y^{-1}$)
Table Mountain dams and fountains	5.1
Steenbras Dam	36.0
Wemmershoek Dam	56.4
Allocations from Voelvlei Dam	70.0
Paarl and Wellington (Municipal dams and Berg River)	2.0
Stellenbosch (Municipal dams)	5.7
Strand and Somerset West (Lourens River)	3.5
Riviersonderend Scheme (Permanent allocation)	93.0
Riviersonderend Scheme (Temporary allocation)	93.0
Total	364.7

Figure 3. Urbanisation in Metropolitan Cape Town.

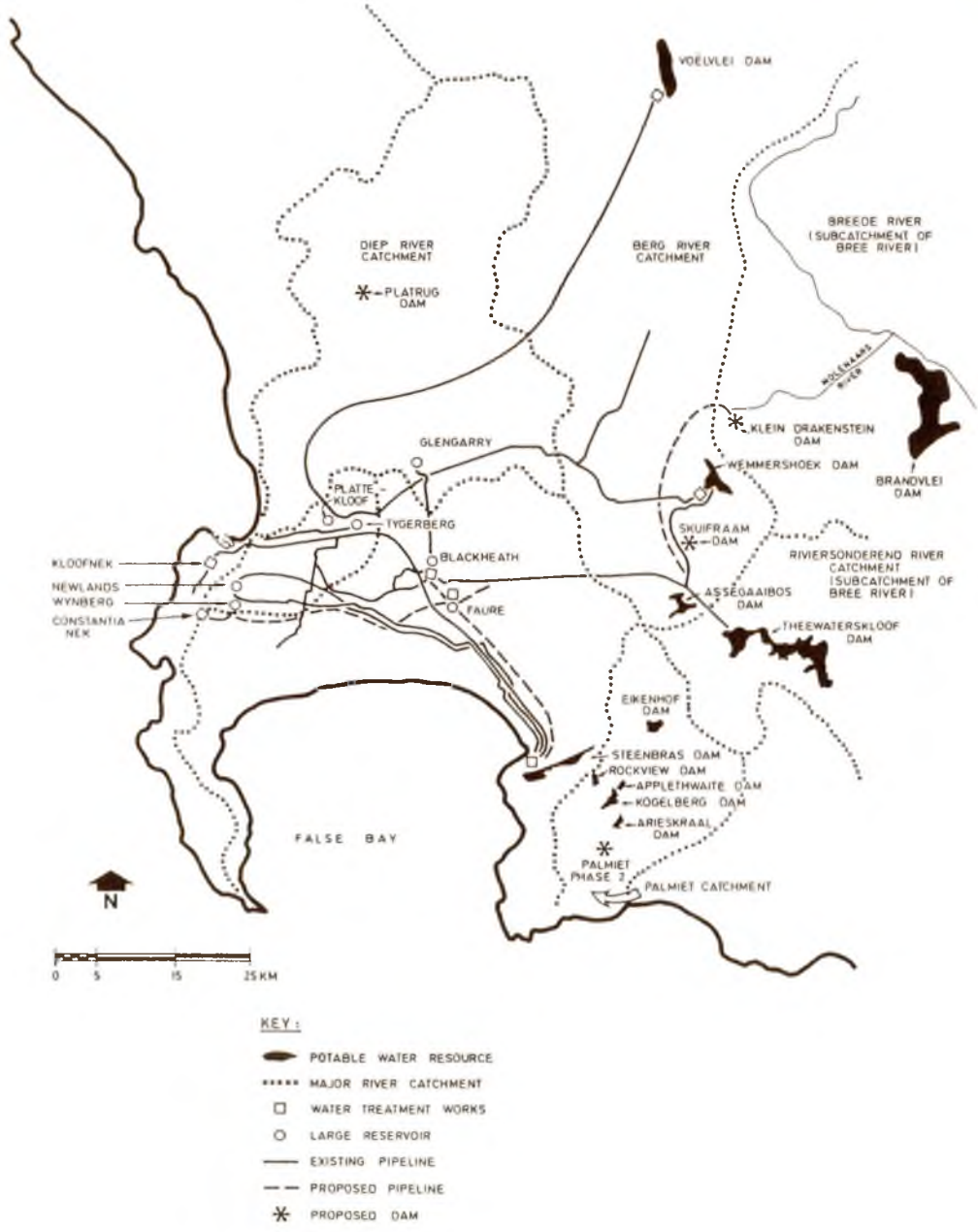

Figure 4. Urban bulk water supply infrastructure and potable water resources for Metropolitan Cape Town.

reported in detail by Quick (in press). According to this study the two primary water quality concerns were: (1) the effect of nutrient loading on both the inland waters and the bay; and (2) the health risk associated with the poor microbiological water quality (bacterial and viral) of rivers, stormwater and treated wastewater outfalls discharging in the vicinity of inland and coastal recreation nodes.

The main sources of both nutrients and bacteria/viruses are runoff from urban and agricultural land (non-point source), and discharges from wastewater treatment works (point source). Nutrient enrichment of inland and coastal water bodies increases the potential for algal and diatom blooms and may also result in the deoxygenation of the bottom water (Harding and Quick, 1992; Quick and Roberts, 1993). Both have negative impacts on ecosystems and on the aesthetic and amenity value of water bodies (Thornton et al., 1989; Quick and Johansson, 1992). A third concern relates to the probable contamination of the Cape Flats aquifer (a potential source of potable water) by the Mitchells Plain Works, Swartklip Sanitary landfill site, Khayelitsha township and Phillipi farming area (Vandoolaeghe, 1990; Ninham Shand, 1992a).

Table Bay and Atlantic Ocean catchment

South of Table Bay two wastewater outfalls, two rivers and numerous small stormwater outfalls discharge into the Atlantic Ocean (Figure 5; Table 3). There is only one treatment works and one landfill site situated in the Noordhoek area. Stormwater from urban areas is discharged through numerous small stormwater outfalls.

A single wastewater and two industrial outfalls discharge into Table Bay. The Bay also receives discharges from two rivers and a number of stormwater outfalls. Three treatment works and two sanitary landfill sites are located in the Salt/Black River catchment. In the Diep River catchment there are two wastewater treatment works and four landfill sites (two of which are for hazardous chemicals).

To the north of Table Bay there are discharges of stormwater from Bloubergstrand and Melkbosstrand, and discharges from the Salt River and Koeberg nuclear power station. Two wastewater treatment works and a single sanitary landfill site are located in the Salt River catchment.

Table 3: Wastewater treatment works in Metropolitan Cape Town, volumes of discharge during 1992 and receiving waters (numbers refer to sites shown in Figure 6)

Treatment Works	Discharge Volume M1/day	Receiving water
1. Simonstown	2,0	False Bay
2. Cape Flats	135,0	Zeekoe Canal
3. Mitchells Plain	25,0	False Bay
4. Bellville	40,0	Kuils River
5. Kuils River	1,5	Kuils River
6. Cape Corps	0,5	Kuils River
7. Zandvliet	20,0	Kuils River
8. Macassar	19,0	Eerste River
9. Scottsdene	3,3	Kuils River
10. Elsenberg	0,4	Eerste River
11. Stellenbosch	12,0	Eerste River
12. Gordons Bay	1,5	False Bay
13. Wildevoelvlei	4,1	Wildevoelvlei
14. Athlone	109,0	Salt/Black River
15. Borchards Quarry	29,7	Salt/Black River
16. Parow	0,8	Salt/Black River
17. Milnerton	19,8	Rietvlei/Diep R
18. Kraaifontein	5,5	Kuils River
19. Pniel	0,8	Berg River
20. Paarl	15,1	Berg River
21. Wellington	3,1	Berg River
22. Melkbosstrand	1,5	Salt River
23. Atlantis/Wes Fleur	5,4	Salt River

Information from the Department of Water Affairs and Forestry, Western Cape.

Details on the water quality status in Table Bay are given in Quick and Roberts (1993). They noted the same general water quality concerns for Table Bay and its catchment as those described earlier for the False Bay catchment.

Berg, Bree (Riviersonderend and Breede) and Palmiet catchments

Only a small portion of the Berg, Riviersonderend and Palmiet catchments are included in the metropolitan area, therefore, a detailed discussion of water quality issue affecting their entire catchments is considered beyond the scope of this paper. It is, however, important to note that these catchments supply 86 per cent of Metropolitan Cape Town's potable water allocation. Dams and water abstraction are having a major impact on the hydrology, ecology and aesthetics of these riverine systems (Figure 4; Table 2; and Department of Water Affairs, in prep. a and b; 1992; 1991a).

FUTURE URBAN GROWTH AND IMPLICATIONS

The False Bay catchment is the area which faces the most intense development pressure (Figure 6). Much of the stormwater runoff from these potential developments will impact on water quality and flow in the Zeekoe and Kuils River catchments. Wastewater will impact primarily on the Cape Flats, Mitchells Plain, Zandvliet and Macassar Treatment Works.

Increased runoff from development in the Kuils River catchment will increase the flood risk in the middle and lower reaches of the river (Ninham Shand, in prep.).

Along the Atlantic coastline south of Table Bay the only potential development is in the Ocean View/Noordhoek area. This will impact on the Noordhoek wetlands and beach, and the Kommetjie Beach. In the greater Table Bay catchment potential development areas which will impact on inland coastal waters include: Ysterplaat, Wingfield Acacia Park South, Marconi Beam, Milnerton, Bloubergstrand and

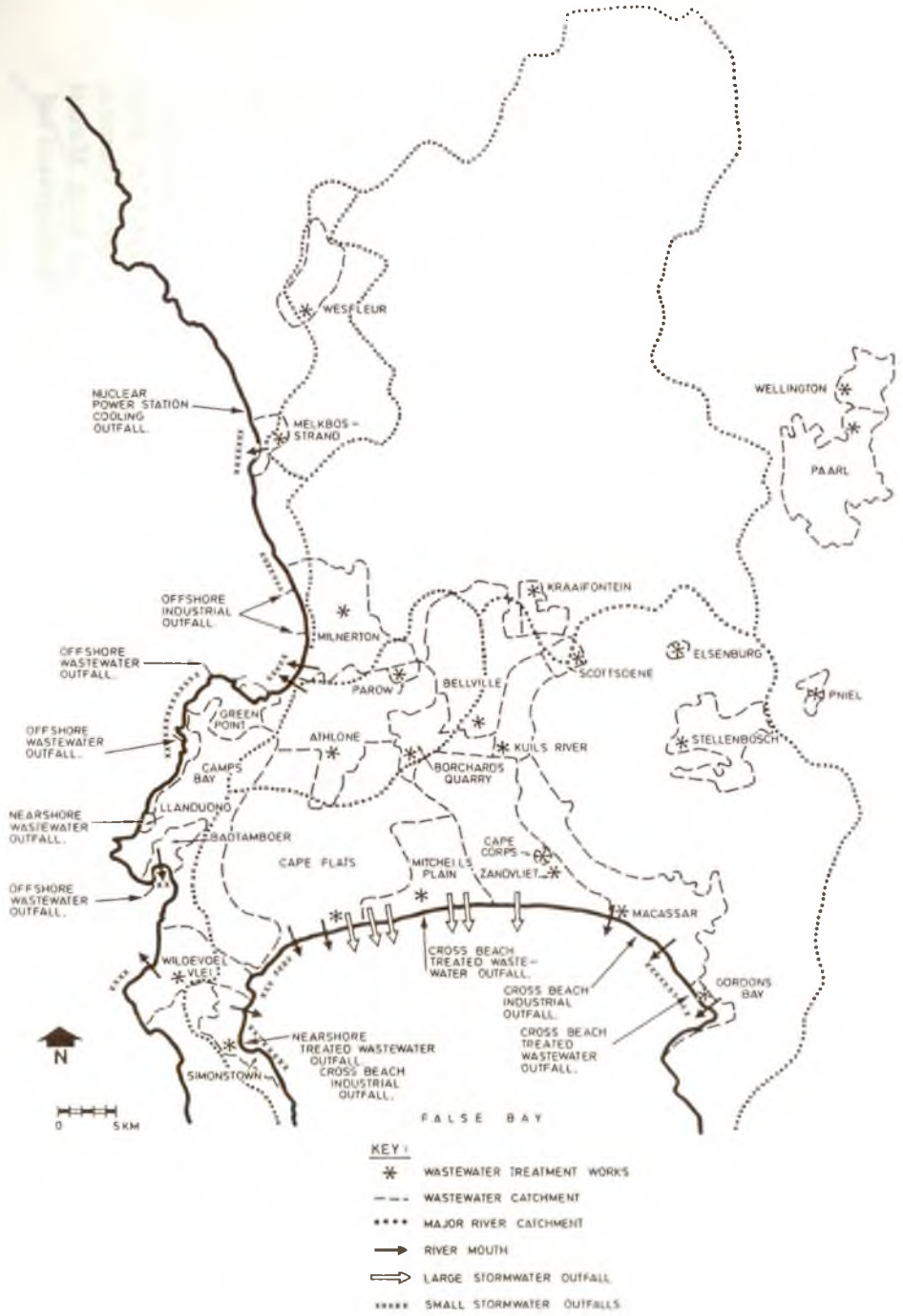

Figure 5. Major river and wastewater catchments, and river, stormwater, wastewater and industrial discharges along the coastline of Metropolitan Cape Town.

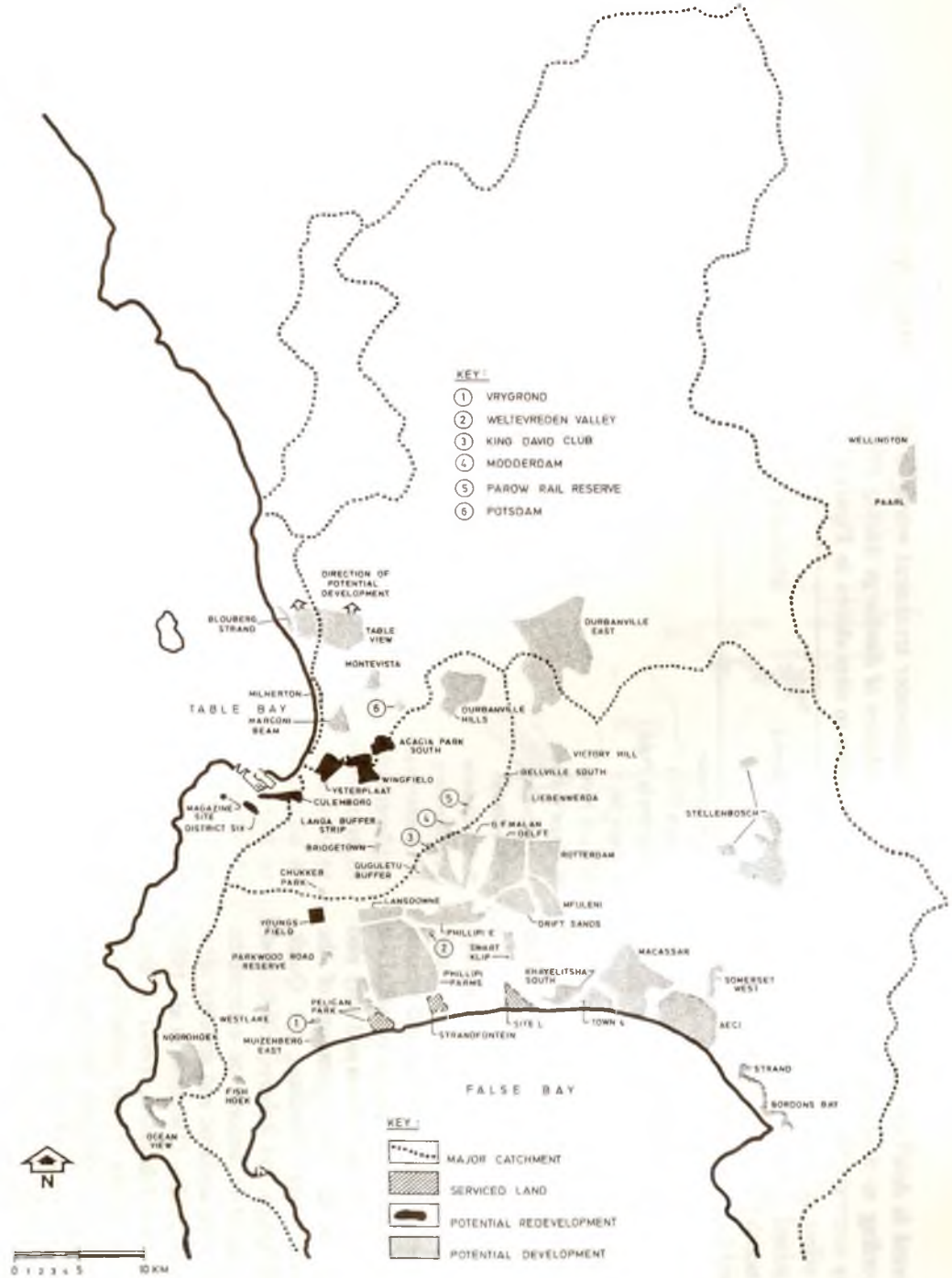

Figure 6. Potential future development and redevelopment in Metropolitan Cape Town.

Table View. Milnerton, Bloubergstrand and part of Table View drain directly into the surf zone. The remaining potential developments drain into the lower reaches of the Diep River (including Rietvlei and Milnerton Lagoon), which in turn will impact on Table Bay in the vicinity of discharge into the ocean.

A range of future water demand scenarios are shown graphically in Figure 7. The most likely scenario according to Spies and Barridge (1991), assumes the 1970-1990 pattern of growth (10 years of fair economic growth followed by 10 years of stagnation), in which water use increases at one and a half times the population growth. Using this scenario the Water Research Commission (in prep.) predicted that in order to meet both the irrigation and urban water demand additional resources would be needed by 1995. Potential future water resources are summarised in Table 4.

Increased potable water demand in Metropolitan Cape Town will impact primarily on the riverine ecosystems of the Berg, Bree and Palmiet catchments. Because the negative impacts of water abstraction, dams and inter-basin transfer of water on riverine ecosystems have been well documented nationally and internationally (Davies and Day, 1986; Moss 1992; Wetzel, 1992) the Department of Water Affairs and Forestry has been conducting impact assessments on the Berg and Palmiet Rivers. Their primary objective is to determine the quantity and quality of water required to maintain the desired status of the ecology in dimensions of time and space (Department of Water Affairs and Forestry, in prep. b).

To this end a number of studies have been conducted, and are continuing, on the Palmiet and Berg Rivers. These studies cover a broad range of topics, which include hydrology, terrestrial and aquatic ecosystems and socio-economic concerns (CSIR, in prep.; Department of Water Affairs and Forestry, in prep. a and b, 1991a; Ninham Shand, in prep., 1992b). Little information is available on the Breede and Riviersonderend Rivers.

Management concerns for False Bay and catchment

- The direct effects of present and future urbanisation (particularly low cost and informal housing) and proposed densification in the Cape Flats on stormwater/wastewater/river micro-biological and nutrient water quality.
- The direct effects of above urbanisation on flooding in the lower reaches of the Kuils River.
- The direct and indirect (secondary) effects of poor micro-biological water quality on recreation in lakes (Zeekoevlei and Zandvlei) and in the vicinity of river mouths, and stormwater and treated wastewater outfalls along the north shore coast.
- The direct and indirect (secondary) effects of increased nutrient loading on river, surf zone and Bay ecosystems.
- The direct and indirect (secondary) effects of low income housing development, agriculture, Mitchells Plain Wastewater Treatment works and the Swartklip sanitary landfill site on the future use of the Cape Flats aquifier as a potable water resource.
- The need to improve our information base on the options for managing the water quality of stormwater runoff, the loading of nutrients entering the Bay and implications for the Bay ecosystems, the mixing dynamics of outfalls and rivers flowing into the surf zone, and the circulation and flushing of False Bay.
- The need for an officially constituted body, with representatives from local and government authorities, the users of the Bay, and affected communities to manage False Bay.

Management concerns for Table Bay and Atlantic catchment

- The direct effects of urbanisation (particularly informal housing at the Marconi Beam site) on microbial and nutrient quality of stormwater, and indirect (secondary) effect on the Rietvlei ecosystem, and recreation in Diep River lagoon and mouth area.
- The direct effects of potential future development at the Marconi Beam site, along the Milnerton coast, and at Ysterplaat, Wingfield, Acacia Park South, Bloubergstrand and Table View on microbial and nutrient quality of stormwater, and loading of wastewater to the Milnerton Works. The secondary impacts of these potential developments on water contact recreation (Rietvlei, Milnerton Lagoon, Table Bay coastline) and river, estuarine and marine ecosystems (in close proximity to rivers and outfalls) should also be assessed.
- The direct effects of potential future urbanization on microbial and nutrient quality of stormwater

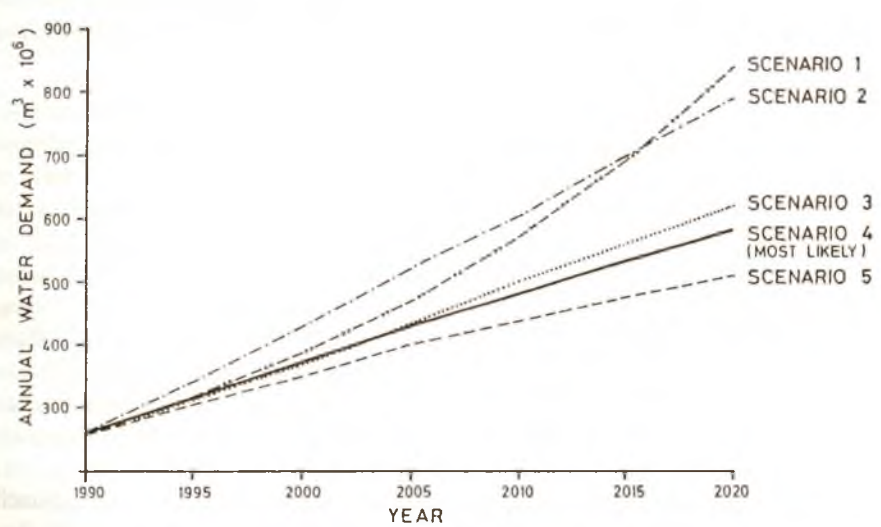

Figure 7. Future water demand scenarios for Metropolitan Cape Town. 1 = 4% growth; 2 = return to the 1960's, high economic growth, little informal housing, water use increases at just over double the population growth; 3 = third world future, population growth dominated by rapidly expanding poor population, increased water use follows the pattern of the 1980's; 4 = second world future, assumes 1970 to 1990 pattern of growth (10 years economic growth, 10 years economic stagnation), water use increases at 1,5 times the population growth; and 5 = forecasts provided by local authorities (source: Spies and Barridge, 1991).

Table 4: Summary of potential future conventional sources of potable water in Metropolitan Cape Town - refer also to Figures 1 and 4 (sources: Department of Water Affairs and Forestry, 1992; in prep. a; Water Research Commission, in prep.)

Resource	Estimated Yield * ($\times 10^6 M^3 Y^{-1}$)
High probability of development	
° Palmiet Phase 1 (aqueduct from Rockview Dam to Steenbras, and pipeline to Faure treatment works)	36
° Lower Berg River: Voelvlei/Lorelei 1 (pipeline from Berg River to Voelvlei Dam)	15
° Upper Berg River: Skuifraam Dam	80
Further evaluation needed	
° Klein Drakenstein diversion (dam in Elands River, Breede system, and pipeline to Riviersonderend Scheme)	35
° Eerste and Lourens River diversions (direct diversion of high water flows to Faure treatment works)	15
° Cape Flats Groundwater	18
° Newlands Groundwater	10-15
° Lower Berg River: Voelvlei/Lorelei Phase II & III	110
° Lower Berg River: Raising of Misverstand Dam wall	110
° Lower Berg River Groundwater	78
° Breede River (pumping of water from Brandvlei Dam to Theewaterskloof Dam)	100
° Olifants River (diversion to Berg River catchment)	90
° Diep River (Platrug Dam)	12
° Palmiet Phase II (Damming of lower Palmiet River)	44-106
° Sewage effluent - direct re-use after reclamation	80 - 100
- exchange for irrigation water	20

* The entire yield of each of these resources as given above will not necessarily be available to the metropolitan area as environmental and/or local demands may receive priority.

and loading of wastewater to the Wildevoëlvlei Works, and secondary effects on the Noordhoek Wetland and Atlantic coastline ecosystems, and water-contact recreation on Noordhoek and Kommetjie Beaches.

- The direct effects of urbanisation on nutrient loading into Table Bay and potential indirect (secondary) effect on the Bay ecosystem.
- The need for a water quality monitoring programme in the Harbour area.
- The need for research to determine the pollution status (particularly with regard to nutrients) of the whole of Table Bay.
- The need for a management committee which includes local authorities, government bodies and the users of Table Bay.

Management concerns for the Berg, Bree and Palmiet catchments

- The need to fully assess, on a regional scale, the environmental, social, economic and opportunity costs of utilising conventional potable water resources.
- The need to investigate the feasibility of utilising unconventional potable water resources such as: treated wastewater, sea water desalination, icebergs, importation by tanker and a dual reticulation system.
- The need to investigate implementing water demand management including water efficient plumbing, water efficient gardening, leak detection and prevention, tariffs, rainwater tanks, bathwater tanks, restrictions and universal metering.
- The need to collate information and initiate relevant research on the Riversonderend and Breede Rivers.

Please note that many of these issues are currently being investigated by the Department of Water Affairs and Forestry (Department of Water Affairs and Forestry, in prep. a).

CONCLUSION

There are three key problems relating to the present management of the inland and coastal waters of Metropolitan Cape Town. Firstly, there is a lack of essential research information. Research priorities identified were: (1) the need to improve our information base on the options for managing the quality (both nutrient and bacterial/viral) of stormwater runoff entering rivers and discharging into the coastal zone; (2) the need to determine the potential effect of nutrient loading on coastal zone and bay ecocystems; and (3) the need to collate information and initiate research on the Riviersonderend and Breede Rivers.

Secondly, there is a lack of co-ordinated policy and planning within, and between, the numerous different local and government authorities in Metropolitan Cape Town. Thirdly, no single authority is responsible for the control of marine pollution. The responsibility has been fragmented between several government Departments including the Departments of Transport, Water Affairs, Environment Affairs and National Health and Population Development, and Provincial and Local authorities (Lusher and Ramsden, 1992).

Despite the problems noted above, there is cause for optimism. Central government is aware of the lack of coordination and fragmentation of environmental management and is taking steps to address these issues (Council for the Environment, 1989a, b and c; Department of Water Affairs and Forestry, 1991b; Presidents Council, 1991). Positive developments are also occurring at the metropolitan scale in Cape Town. The two major local authorities (Cape Town City Council and the Western Cape Regional Services Council) began working toward a Metropolitan Development Framework in February 1991 (City of Cape Town, 1992).

In addition, a number of coordinated metropolitan/regional planning forums have been initiated, all of which recognise the need to include all the major stakeholder groups. These include the Western Cape Economic Development Forum, the Transportation Forum, the Electricity Forum and others. Significant developments with regard to the management of water quality include the formation of the False Bay and Table Bay Water Quality Committees and the False Bay Forum.

The next step should be the formulation of a metropolitan inland and coastal waters management policy which forms part of a larger environmental management policy for Metropolitan Cape Town. It is essential that future environmental policy take cognisance of the planning priorities in developing cities, which have been identified by Stren and White (1989), Bartone (1991), Clark (1991), World Bank (1991), Hardoy et al. (1992) and Stren et al. (1992): (1) the promotion of economic growth and development to create optimum employment opportunities; (2) the facilitation of equitable access to urban facilities/opportunities (particularly employment); (3) the facilitation of affordable, appropriate and accessible housing/shelter by the private and public sector; (4) the provision of essential services, notably potable water and waste/wastewater removal; (5) the promotion of efficient, equitable and sustainable use of resources (financial, human, land etc.) by local government, private sector, non-government organisations and individuals; (6) the integration of appropriate environmental policy, planning and management, based on sustainable development, in the overall urban planning process; and (7) the provision of co-ordinated, accountable, metropolitan/regional planning and management.

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