

REPORT TO THE WATER RESEARCH COMMISSION

**WATER AND SANITATION IN URBAN AREAS:
FINANCIAL AND INSTITUTIONAL REVIEW**

JUNE 1994

REPORT 2

**OVERVIEW OF THE DEMAND FOR AND COSTS OF WATER
SUPPLY AND SANITATION SERVICES IN SOUTH AFRICA**

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LIST OF REPORTS

Main reports

- Report 1: Overview of Institutional and Financial Arrangements in Water Supply and Sanitation with a focus on the Urban Areas of South Africa. (October 1993)
- Report 2: Overview of the Demand for Costs of Water Supply and Sanitation Services in South Africa. (June 1994)
- Report 3: Meeting the Demand for Water and Sanitation Services: Getting it Right in the Transition. (June 1994)
- Report 4: International Perspectives: Some Lessons for South Africa from England, France, Italy, Brazil and Botswana and some Information on External Funding Agencies. (June 1994)
- Report 5: Macro-economic Sketch: A Sketch of the Macro-economic Implications of Major Investment in the (domestic) Urban Water and Sanitation Sector. (June 1994)
- Report 6: Summary Report. (June 1994)

Working Papers

11. Some Ideas to Inform the Current Tariff Policy Debate for Urban Water and Sanitation Services. (January 1994)
12. Capital Investment in the Urban Water and Sanitation Sector - Some Issues. (April 1994)
13. Institutional Restructuring in the Urban Water and Sanitation Sector: A Review of the Current Debate and Contribution of Some Further Ideas. (February 1994)
14. The Management of Water and Sanitation in Brazil: Some lessons for South Africa. (April 1994)
15. An Investment-Tariff Model for Urban Water Supply. (April 1994)
16. The Management of Water Supply and Sanitation in Botswana: Some lessons for South Africa. (March 1993)
17. Differing Patterns of Water Agencies in Britain, France and Italy. (October 1994)

PREFACE

BACKGROUND

The Water Research Commission (WRC) appointed Palmer Development Group to undertake an institutional and financial review of water supply and sanitation services in the urban areas of South Africa.

OBJECTIVE

The overall objective of this project is:

To present information and analysis that can help relevant community leaders and decision-makers:

- *to guide and promote the extension of services and the reshaping of organisations such as can enable all people living in the (urban) areas of South Africa to have adequate and appropriate water supply and sanitation, and*
- *to facilitate the related processes of financial, institutional, (legislative) and other changes that the adoption and implementation of the above objective will require.*

The specific objectives of the project and working assumptions have been set out in the Draft Project Inception Document.

This report is in fulfilment of Objectives 2 and 3 of the project, namely:

- Estimate how demands for water supply and sanitation services may change in broad terms in the future.
- Estimate total costs of meeting these demands on the basis of alternative levels of service.

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TABLE OF CONTENTS

LIST OF REPORTS	i
PREFACE	ii
1. INTRODUCTION	1
1.1 Scope	1
1.2 Objectives	1
1.3 Data limitations	2
1.4 An investment - tariff model	2
1.5 Externalities and other considerations	2
2. METHODOLOGY	3
2.1 Approach to demographics	3
2.2 Disaggregation of data	4
2.3 Focus on low-income households	5
2.4 Quantification of existing backlog	6
2.5 Quantification of future demand	6
2.6 Cost estimates	7
a) Bulk and internal services	7
b) Upgrading costs	7
c) Note on World Bank data	7
2.7 Presentation of results	7
3. DEMOGRAPHICS	8
4. EXISTING BACKLOG	9
4.1 Definitions	9
4.2 Existing levels of service (total urban population)	10
4.3 Upgrading requirements	11
5. NEW DEMAND	13
6. UNIT CAPITAL COSTS	14
6.1 Internal services costs	14
a) New development	14
b) Upgrading costs	14
6.2 Bulk and connector costs	15
a) New development	15
b) Upgrading	15

7. TOTAL CAPITAL COSTS	16
7.1 Water	16
7.2 Sanitation	17
7.3 Water and sanitation	18
7.4 Discussion	18
8. COMPARISON WITH OTHER STUDIES	20
8.1 Water and Sanitation 2000	20
8.2 Development Bank of Southern Africa	20
9. CLOSURE	21
10. REFERENCES	22

APPENDICES

1. CAPITAL COST SUMMARY
2. DEMAND AND COSTS OF WATER AND SANITATION SERVICES
3. UNIT CAPITAL COSTS
4. ACCESS TO WATER AND SANITATION IN SOUTH AFRICAN URBAN AREAS
5. WITWATERSRAND METROPOLITAN REGION - Demand for and cost of services
6. DURBAN FUNCTIONAL REGION - Demand for and cost of services
7. PORT ELIZABETH METROPOLITAN REGION - Demand for and cost of services

1. INTRODUCTION

1.1 Scope

This analysis aims to provide a more detailed estimate (than is presently available) of possible capital investment demands in the water and sanitation sector and to show how these demands are distributed between metropolitan areas, towns and 'dense settlements'.

All of the services backlog and most of the demand for new services is concentrated in the low-income household sector. It has been assumed that middle- and upper-income households will pay the full costs of new services provided, and the analysis of new household demand for water and sanitation services has therefore focused only on low-income households.

The analysis presented in this report provides an initial basis for testing the cost implications of various policy options regarding the level of service provided to low-income communities.

It should be noted that the costing presented in this report is very preliminary (and was not a major focus of the project). Much more extensive work is currently under way to refine and develop investment and cost scenarios for water and sanitation in both urban and rural areas. This work is being undertaken by and on behalf of the Department of Water Affairs, the Water Research Commission, the Standing Committee on Water Supply and Sanitation (SCOWSAS) and the Development Bank of South Africa (DBSA).

1.2 Objectives

The specific objectives of this report are as follows:

- To quantify the existing backlog in water supply and sanitation services in the urban areas of South Africa, in terms of the number of households and levels of service.
- To quantify, in broad terms, future low-income demand for water and sanitation services, in terms of the number of households.
- To quantify the capital costs of making up the backlog in services and meeting new demand for services, based on estimates of costs per site and bulk infrastructure costs, and assuming various scenarios for the level of service provided.

1.3 Data limitations

It should be noted that, at present, much of the data required for an accurate analysis is not available, or its accuracy is of some doubt. The results presented in this report are therefore largely illustrative in nature, indicating only in broad terms demand and cost scenarios.

As more accurate data becomes available, it would be possible for the estimates presented here to be refined and improved.

1.4 An investment - tariff model

It should be further noted that a comprehensive analysis of water and sanitation demand should include:

- different investment scenarios

How investments are phased has important implications on annual and total investment expenditure.

- an analysis of affordability, willingness to pay and cost-recovery / tariff policy

The extent to which users pay for the costs of services provided will effect the viability of different investment scenarios.

It is not practically feasible to undertake this kind of analysis at a national level due to its complexity, regional specificity and the lack of adequate data.

How such an analysis may be carried out has been illustrated as part of this project and is reported on in Working Paper 15 "An Investment-Tariff model for Water and Sanitation in Urban areas". (Palmer Development Group, 1994a)

1.5 Externalities and other considerations

This report focuses only on the **financial** costs of services provision. Other considerations are also important when making investment decisions for water and sanitation services. Some important **economic** considerations are discussed in Report 5. Other considerations (for example, social and environmental) are discussed in Palmer Development Group (1993a and 1993b).

2. METHODOLOGY

The methodology and key assumptions used in the cost and demand analysis are outlined in this section.

2.1 Approach to demographics

The base demographic data used is that of the Urban Foundation's Demographic Projection Model. Although the 1991 population census provides more recent demographic information, this information has not been used for the following reasons:

- The data is only for the Republic of South Africa, and excludes the TBVC states.
- The data was, at the time that the body of this report was completed, largely 'unprocessed' and analyzed, that is, the data was not in a form which was readily accessible and usable.

Although other 'processed' and well analyzed demographic data exists, for example that of the Development Bank of Southern Africa, the Urban Foundation's model was chosen, based on the following rationale:

- The model provides a macro-demographic framework.
- The model provides a holistic analysis of population growth dynamics taking into account rural-urban migration and the impacts of urbanisation, and includes estimates of population growth rates over the period 1990 to 2000.
- The data is usefully disaggregated by metropolitan area, South African and homeland towns and 'dense settlements'.
- The model has been used as the basis of population growth and housing demand projections by the National Housing Forum and has been accepted by a broad grouping of people as a good basis from which to work.

The analysis pertains to the urban areas in South Africa including the independent and self-governing homelands.

A unique feature of the Urban Foundation's model is its definition of 'dense settlements'. These are "closer" settlements in peri-urban or rural areas (mostly in the "self-governing", "TBVC" or ex-DDA Trust land areas) where people are reliant on the urban economy and a significant proportion of the economically active residents in the settlement commute on a daily or weekly basis.

2.2 Disaggregation of data

The analysis of demand and costs has been disaggregated as follows:

Metropolitan areas

- Pretoria-Witwatersrand-Vereeniging
- Remainder of Region H¹
- Cape Town
- Durban
- Port Elizabeth
- Pietermaritzburg
- Bloemfontein / Botshabelo
- OFS-Goldfields
- East London

Towns (all other proclaimed urban areas, including homeland areas)

Dense settlements (outside of metropolitan areas)

About 70% of the urban population is resident in the **metropolitan areas** and this proportion will almost certainly increase in the future. Each metropolitan area has its own unique characteristics in terms of existing levels of service provision, bulk infrastructure capacity, housing density and spatial location, population growth, unit costs of service provision and the strength of the local economic base. Separate analysis for each of these areas is therefore useful. An additional advantage is that the analysis can easily be modified and improved as better or updated information for each metropolitan area becomes available.

¹ As defined by the Development Bank of Southern Africa. Region H is the 'greater PWV region' and includes parts of Bophuthatswana (Odi I and II, Moretele I and II) and KwaNdebele.

It should be noted that:

- The **Pietermaritzburg** metropolitan area includes Vulindlela. This is probably better classified as peri-urban or rural and should possibly be excluded in the urban service demand estimates.
- The **Bloemfontein** metropolitan area includes Thaba 'Nchu and Botshabelo, and it may be argued that it would be better to treat service demand in these areas separate to Bloemfontein proper.

Approximately 20% of the urban population resides in **towns**, that is, proclaimed urban areas outside the previously identified metropolitan areas. For the purposes of this analysis, this section of the population has been treated as one group. Conditions between towns will obviously vary significantly and each town will need to identify its own demand and cost projections for services, but it is not possible for this diversity to be reflected in this analysis.

The '**dense settlements**' have similarly been treated as one group. Again, conditions will vary significantly between settlements. However, these settlements universally have virtually no local economic base and it is likely that different policy in terms of services provision will be applicable to these areas and it therefore makes sense to treat these settlements as a unit.

2.3 Focus on low-income households

The analysis quantifies backlogs for all households, although it is assumed that all of this backlog exists amongst low-income households.

New demand and costs of services are estimated for low-income households only. It is assumed that other households will pay the full costs of services.

As an approximation, and in the absence of better data, the urban low-income population was assumed to equal in magnitude the urban black (african) population, which accounts for about 70% of the total urban population. The reasons for making this assumption were:

- It is generally a fair approximation of income distribution^{2,3}.

² See for example Wilson and Ramphela (1989, p18) and IMF (1992, p4). The latter report concludes, on the basis of income distribution information presented in the report, that income inequality in South Africa is overwhelmingly the result of income differentials between races (*ibid*).

- It is likely that the new development will be largely focused on the black (african) population (historically, the most disadvantaged by apartheid).
- Relatively good demographic data can be isolated for this sector of the population, compared to that possible if an income cut-off was used.

2.4 Quantification of existing backlog

Estimates of the existing backlog in services were derived from recent studies completed by the University of Cape Town and Palmer Development Group for the Water Research Commission (Palmer Development Group / UCT, 1993a and 1993b). These studies comprised comprehensive surveys of existing levels of service (water supply and sanitation) in the urban areas of South Africa. Comprehensive level of service data is reported in Appendix 4.

The World Bank has recently (June 1993) conducted a preliminary analysis of existing service levels and future demands and costs in the Witwatersrand, Durban and Port Elizabeth⁴. This data is reported but has not been used.

2.5 Quantification of future demand

Population growth projections from the Urban Foundation demographic model were used as the basis for future demand. An average household size of 5.5 was assumed based on the Urban Foundation's income distribution model.

The World Bank analysis of new demand is reported but not used in the analysis.

³ This simplification does, however, produce distortions in areas where there are (proportionately) large low-income populations of other race groups, for example, low-income 'coloured' communities in Cape Town. In most other areas the simplification is tenable because a proportion of the black (african) population will be middle and upper-income, and the low-income populations of other race groups can be 'substituted' for this section of the population.

⁴ The Bank has also, more recently (February 1994) completed a similar analysis for Cape Town. However, this data is not reported here.

2.6 Cost estimates

a) Bulk and internal services

The cost of bulk services and internal services are based on the work of Palmer Development Group (1993d and 1994b). The internal services costs include the cost of the on-site components (for example, the toilet privy). The unit costs used are reported in Appendix 3.

The cost data developed by the World Bank in the three metropolitan areas they analyzed is reported, but not used in the analysis. See Appendices 5, 6 and 7.

b) Upgrading costs

The internal service upgrading costs are based on the World Bank study for the Witwatersrand, Durban and Port Elizabeth.

Upgrading costs for bulk and connector services were assumed to be the differential between the costs for different service levels.

c) Note on World Bank data

All of the World Bank cost data was presented as Rands per hectare costs assuming different densities of development. These costs have been converted to Rands per site, based on the density closest to existing average densities. If significantly higher densities are achieved, then the costs would be lower. More detailed discussion of this is contained in Appendices 5, 6 and 7, which summarise the World Bank studies for the Witwatersrand, Durban and Port Elizabeth respectively.

2.7 Presentation of results

The calculation has been carried out in parallel as follows: (1) aggregated calculation for metropolitan areas and towns respectively, presented in Appendix 1; (2) disaggregated calculation by metropolitan area, for towns and dense settlements, presented in Appendix 2.

The methodologies used for both sets of calculations are identical. The data and results presented in the following sections are based on the calculations in Appendix 2. The results from the two sets of calculations differ slightly (but not significantly), due largely to "rounding errors".

3. DEMOGRAPHICS

The base demographic information used is summarised below.

Table 1: Key demographic data, 1993 (Urban areas)

	Metro	Town	Dense	TOTAL
Total population, millions	19.1	5.3	2.5	26.9
Low-income population, millions	13.0	3.3	2.5	18.8
Total population growth, % pa	3.7	2.5	4.0	3.5
Low income growth, % pa	5.5	3.5	4.0	5.0
Average low-income household size	5.5	5.5	5.5	5.5
Low-income households, millions	2.4	0.6	0.5	3.4

Source: Appendix 2, Table 1

Discussion

The **total population** in South Africa in 1993 was approximately 39.5 million, and hence about 68% of the total population was living in the urban areas and 48% in the metropolitan areas. The low-income population (assumed equal to the black population) accounted for 70% of the total urban population.

It is possible that the **annual growth rates** estimated by the Urban Foundation for the low-income (black) metropolitan population are too high. However, the World Bank used these high figures for the metropolitan areas studied, therefore, for the sake of consistency, these have been used for the remaining metropolitan areas. The data may therefore represent a "worst case" scenario (which is compatible with the stated intention of the World Bank studies).

The **average household size** has, for the sake of simplicity, been assumed to be equal for all areas.

4. EXISTING BACKLOG

4.1 Definitions

The following categories and definitions of levels of service are used in this report:

Table 2: Level of service definitions

	Water	Sanitation
Minimal	Communal standpipe > 250m, other	Pit, shared toilet
Basic	Communal standpipe < 250m	VIP latrine / on-site "aqua privy"
Intermediate	Yard tap (metered)	Intermediate sanitation
Full	Metered house connection	Conventional waterborne sewerage

Source: World Bank studies (see Appendices 5, 6 and 7).

Comment

- Bucket collection systems are not considered adequate and are included in the minimal service category. (There are about 2 million people served by bucket collection systems in the urban areas in South Africa.)
- Intermediate sanitation includes an aqua-privy linked to a solids-free sewer reticulation system (on which the costing has been based).

It should be noted that an "intermediate" level of sanitation service is practically non-existent in South Africa and it would be consequently unwise to plan a future sanitation strategy incorporating this option until the technology has been further developed and proven under South Africa conditions.

- The full level of service includes conventional septic tank systems. The costing, however, has been based on conventional waterborne sewerage systems.

4.2 Existing levels of service (total urban population)

The percentage of the total urban population with minimal, basic, intermediate and full levels of service are summarised by settlement type below.

Table 3: Existing levels of service in urban areas: percentage

		Min	Basic	Int	Full
Metropolitan	Water	18	13	8	61
	Sanitation	27	3	0	70
Town	Water	5	14	10	71
	Sanitation	26	2	0	72
Dense	Water	46	48	4	2
	Sanitation	98	0	0	2
TOTAL	Water	18	16	8	57
	Sanitation	33	3	0	64

Source: Appendix 2, Table 2.

It should be noted that the level of service definitions used by Palmer Development Group in the case of water supply differed slightly from that used by the World Bank⁵.

⁵

Palmer Development Group defined a basic water supply as a planned standpipe provision at more than 1 per 25 households and/or within 100m. The use of this classification has the effect of over-estimating the population with a minimal level of supply (in terms of the World Bank definition).

Table 4: Existing levels of service: urban population (million)

		Min	Basic	Int	Full
Metropolitan	Water	3.5	2.5	1.6	11.7
	Sanitation	5.1	.6	.0	13.5
Town	Water	.3	.7	.5	3.8
	Sanitation	1.4	.1	.0	3.8
Dense	Water	1.1	1.2	.1	.05
	Sanitation	2.4	.0	.0	.05
TOTAL	Water	4.9	4.4	2.3	15.5
	Sanitation	9.0	.7	.0	17.4

Source: Appendix 2, Table 2.

Comment

- The situation with respect to water supply is better than that for sanitation, although there are still a considerable number of people (about 5 million) with only a minimal water supply.
- The distinction made between a minimal and basic level of water supply is somewhat blurred, depending on both the definition and quality of data available. It is possible that the figures for a minimal water supply are overstated, but the combined minimal and basic level of service figure is likely to be fairly accurate.

4.3 Upgrading requirements

Based on the demographic and existing level of service information already presented, the number of households requiring upgrading can be calculated. The results are shown in the matrix below: (to bring all households to the level stated - basic, intermediate or full)

Table 5: Upgrading requirements - number of households (000's)

	Basic	Intermediate		Full		
	1->2	1->3	2->3	1->4	2->4	3->4
Water						
Metropolitan	635	635	446	635	446	297
Town	48	48	135	48	135	96
Dense	209	209	218	209	218	18
Total	892	892	799	892	799	411
Sanitation						
Metropolitan	936	936	111	936	111	0
Town	250	250	19	250	19	0
Dense	445	445	0	445	0	0
Total	1 632	1 632	130	1 632	130	0

Notes: 1 = minimal level of service
 2 = basic level of service
 3 = intermediate level of service
 4 = full level of service

Source: Appendix 2, Table 3.

5. NEW DEMAND

The number of new households per annum requiring services, based on the demographic assumptions made is summarised below.

Table 6: New low-income household formation

	New households per annum
Metropolitan areas	122 000
Towns	22 000
Dense settlements	20 000
TOTAL	164 000

Source: Appendix 2, Table 1

Discussion

De Loor (1992) estimated total annual "functionally urban" new household formation at 198 000 per annum and hence the above "low-income" demand represents 83% of the De Loor figure.

6. UNIT CAPITAL COSTS

6.1 Internal services costs

a) New development

The average per site new development costs for internal services used in the analysis are summarised below:

Table 7: New development costs - internal services, 1993 Rands per site

	Water			Sanitation		
	Basic	Int	Full	Basic	Int	Full
Metropolitan	620	950	1 100	1 400	1 900	2 500
Town	600	950	1 100	1 100	2 000	2 700
Dense	700	950	1 100	1 100	2 600	3 600

Source: Appendix 2, Table 4a

b) Upgrading costs

Table 8: Upgrading costs - internal services, 1993 Rands per site

	2->3	2->4	3->4
Water			
Metropolitan	360	620	270
Town	500	800	400
Dense	700	1 000	400
Sanitation			
Metropolitan	900	1 700	1 500
Town	900	1 800	1 500
Dense	1 000	2 300	2 300

Source: Appendix 2, Table 4a

Notes: 1 = minimal level of service

3 = intermediate level of service

2 = basic level of service

4 = full level of service

Upgrading from minimal to respective levels of service are assumed to be equal to new development costs.

6.2 Bulk and connector costs

a) New development

Table 9: New development costs - bulk and connector services, 1993 Rands per site

	Water			Sanitation		
	Basic	Int	Full	Basic	Int	Full
Metropolitan	1 600	3 000	4 200	0	1 600	2 100
Town	750	1 500	2 000	0	900	1 200
Dense	1 000	1 800	2 500	0	1 500	2 700

Source: Appendix 2, Table 4b

b) Upgrading

Table 9: Upgrading costs - bulk and connector services, 1993 Rands per site

	Water			Sanitation		
	2->3	2->4	3->4	2->3	2->4	3->4
Metropolitan	1 400	2 600	1 200	1 600	2 100	500
Town	750	1 250	500	900	1 200	300
Dense	800	1 500	700	1 500	2 700	1 200

Source: Appendix 2, Table 4b

Discussion

These are assumed to be the differential costs between service levels, and are therefore largely theoretical. In particular, the bulk upgrade costs from an intermediate to full sanitation service is unlikely to be undertaken and the cost figure is inaccurate. The results of the analysis are, however, not affected by this because the intermediate sanitation service is essentially non-existent in South Africa. If the medium to long term national policy is to provide on-site water supplies to all urban households, then it is likely that water utilities will put in bulk water services to cater for the long term demand (that is, intermediate and full level of service) rather than for a basic level of service. This practice would make the bulk costs for a basic level of service higher, and reduce the upgrade costs in moving to a higher level of service.

7. TOTAL CAPITAL COSTS

7.1 Water

The costs of upgrading **all households** to at least a basic, intermediate or full level of service respectively, and providing new services at the specified target level of service, are summarised in Table 10 below,

Table 10: Water: Total upgrade and new demand costs, 1993 Rands

Service level	Metro	Town	Dense
	R million	R million	R million
All to BASIC			
Upgrade (total)	1 388	65	355
New demand (per annum)	275	30	33
All to INTERMEDIATE			
Upgrade (total)	3 247	287	901
New demand (per annum)	485	55	54
All to FULL			
Upgrade (total)	5 175	512	1 317
New demand (per annum)	652	69	71
REHABILITATION OF FULL	673	144	2

Source: Appendix 2, Table 7

The rehabilitation cost is an estimate of the cost required to rehabilitate the services to households who have a full level of service at present. It is assumed that the existing full levels of service require capital expenditure because of under-capacity in certain cases and the general lack of maintenance over the last number of years. In the case of water supply, rehabilitation of internal services was calculated at 10% of the cost of providing a new

service, and upgrading capacity of bulk services was calculated at 5% the cost of providing new capacity. In the case of sanitation, the respective figures used were 20% and 5%.

7.2 Sanitation

Table 11: Sanitation: Total upgrade and new demand costs, 1993 Rands

Level of service	Metro	Town	Dense
	R million	R million	R million
All to BASIC			
Upgrade (total)	1 355	271	481
New demand (per annum)	168	24	21
All to INTERMEDIATE			
Upgrade (total)	3 529	767	1 824
New demand (per annum)	423	66	81
All to FULL			
Upgrade (total)	4 760	1 035	2 803
New demand (per annum)	563	87	124
REHABILITATION OF FULL	1 485	416	8

Source: Appendix 2, Table 7

7.3 Water and sanitation

Table 12: Water and sanitation: Total upgrade and new demand costs, 1993 Rands

	Metro	Town	Dense
	R million	R million	R million
All to BASIC			
Upgrade (total)	2 743	336	836
New demand (per annum)	443	54	55
All to INTERMEDIATE			
Upgrade (total)	6 776	1 054	2 726
New demand (per annum)	907	120	135
All to FULL			
Upgrade (total)	9 935	1 547	4 120
New demand (per annum)	1 215	157	195
REHABILITATION OF FULL	2 157	560	10

Source: Appendix 2, Table 8

7.4 Discussion

The costs presented in Tables 10, 11 and 12 provide order of magnitude estimates of future water and sanitation services provision in the urban areas of South Africa.

The difference in cost for providing all households with a full as opposed to a basic level of service is significant, of the order of three times.

The scenarios used are simplistic in that they assume all households to be upgraded to a certain minimum service level and all new households to be provided at the specified

minimum level of service. In practice, there will be a mix in the level of services and thus the costs are likely to lie somewhere in between the low and high estimates given in the table.

The costs aggregate internal and bulk services. How the costs are split (shown in the appendices) has important ramifications for how the services are funded. This is discussed in more detail in Working Paper 12 and summarised in Report 3.

Annual investment will depend on the rate at which the backlog in services is eradicated.

It should be noted that the annual expenditure to meet new demand (for each service level, or set mix of service levels) will increase in real terms over time as a result of the expected exponential growth in new household formation over the next 10 years. If the total number of households in South Africa increases at 2.5% per annum, then annual demand for services (as a result of new household formation) will be 28% higher in the year 2004 compared to 1994.

8. COMPARISON WITH OTHER STUDIES

8.1 Water and Sanitation 2000

Water and Sanitation 2000 (1991) provided one of the first cost estimates, which are summarised below. These estimates were made with limited resources in a short period of time.

Table 13: Water and Sanitation 2000 cost estimates (1991 R million)

Total capital cost over 10 years (1990 - 2000)	Water	Sanitation
At current policies (water-borne sanitation)	5 200	10 400
Alternative policies (water vending and VIPs)	3 500	4 900

Source: Water and Sanitation 2000 (1991)

These figures are in the same order of magnitude to those presented in this report.

8.2 Development Bank of Southern Africa

The above estimates were used in turn by the Development Bank of Southern Africa as part of their "Macro-economic policy model for human development in South Africa (1994, draft). Their estimates (framed in a different way to those presented above) are summarised in Table 13.

Table 13: Development Bank of South Africa estimates (1993 Rands)

	Total capital cost R million
Full coverage with water-borne sanitation and treated water throughout country based on current urban demands, over 5 years	37 000
Urban water for 3.2 million households	4 090
Urban sanitation for 3.4 million households	6 140

Source: DBSA (1994)

The paper notes that "a sustainable programme would have to rely on affordable delivery mechanisms, with associated recurrent costs suited to varying income groups: improved water supply to urban settlements is achieved through partially subsidised water vending or piped reticulation for households able to afford recurrent costs, while adequate sanitation would have to rely, depending on area density and income, on suitable pit latrines or waterborne sewerage. Cost-recovery in urban infrastructure development depends on progress with residential development and restoring legitimacy in local government." (DBSA, 1994, draft).

9. CLOSURE

This report has presented an overview of the existing backlog in services provision in the urban areas of South Africa, the estimated future demands for new services, the unit costs of upgrading and providing new services, and an estimate of total investment requirements depending on the level of service provided.

Much of the data is based on preliminary estimates, nevertheless the report does provide a useful starting point for initial investigations into the likely financing requirements needed and possible macro-economic impacts of a large-scale investment programme for water and sanitation. These have been undertaken in Working Paper 12 "Financing Capital Investment in the Urban Water and Sanitation Sector - some issues." and Report 5 "Macro-economic sketch - a sketch of the macro-economic implications of alternative approaches to providing water and sanitation services to the urban areas of South Africa."

The impact of investment policy on operation and maintenance costs cannot be meaningfully analyzed at the national level and has therefore been done separately by means of the development of an "Investment - tariff" model. This is reported on in Working Paper 15 "An investment--tariff model for water in urban areas".

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APPENDIX 1

CAPITAL COST SUMMARY

Contents:

- Table 1: Demographics
- Table 2: Existing service levels
- Table 3: Upgrading requirements
- Table 4: Unit capital costs
- Table 5: Upgrading costs (eliminating backlog and rehabilitation)
- Table 6: New demand
- Table 7: Capital cost summary
- Table 8: Combined summary

Notes:

1. Tables for water and sanitation set out in parallel, that is, Table 2a (water) and Table 2b (sanitation)
2. All money values in 1993 Rands
3. Base data sourced from more detailed tables in Appendix 2
4. The so-called "dense settlements" have been left out of this summary

File = append1.wb1

WATER AND SANITATION

TABLE 1: DEMOGRAPHICS	Metro	Town	Total
Population, 1993 (million)	19.2	5.35	24.55
Growth, %pa	3.5	2.5	
Black population, 1993 (million)	12.69	3.28	15.97
Growth, %pa	4.8	3.5	
Household size (all)	3.6	4.1	
Household size (black, multiple h-hold)	5.5	5.5	
Households, 1993 (million)	5.33	1.30	6.64
Households, 1993, black (million)	2.31	0.60	2.90
New households pa (all)	186 667	32 622	219 289
% low-income (< R16 000 pa)	56	57	56
% mid-income (R16 000 - R40 000 pa)	24	24	24
% high-income (> R40 000 pa)	20	19	20
low-income (n)	104 533	18 595	123 128
mid-income (n)	44 800	7 829	52 629
high-income (n)	37 333	6 198	43 858
New households pa (black, 1993-98)	121 904	22 386	144 290
<i>Source: Appendix 2, Table 1</i>			

WATER

TABLE 2A: EXISTING SERVICE LEVELS	Metro	Town	Total
Percentage of total population:			
Minimal	18%	5%	15%
Basic	13%	14%	13%
Intermediate	8%	10%	8%
Full	61%	71%	63%
Total	100%	100%	100%
Number of people:			
Minimal	3 456 000	267 500	3 723 500
Basic	2 496 000	749 000	3 245 000
Intermediate	1 536 000	535 000	2 071 000
Full	11 712 000	3 798 500	15 510 500
Total	19 200 000	5 350 000	24 550 000
<i>Source: Appendix 2, Table 2</i>			

SANITATION

TABLE 2B: EXISTING SERVICE LEVELS	Metro	Town	Total
Percentage:			
Minimal	27%	26%	27%
Basic	3%	2%	3%
Intermediate	0%	0%	0%
Full	70%	72%	70%
Total	100%	100%	100%
Number of people:			
Minimal	5 184 000	1 391 000	6 575 000
Basic	576 000	107 000	683 000
Intermediate	0	0	0
Full	13 440 000	3 852 000	17 292 000
Total	19 200 000	5 350 000	24 550 000
<i>Source: Appendix 2, Table 2</i>			

WATER

TABLE 3A: UPGRADING REQUIREMENTS	Metro	Town	Total
Number of households to upgrade:			
to BASIC (A)	628 364	48 636	677 000
to INT			
from minimal (A)	628 364	48 636	677 000
from basic (B)	453 818	136 182	590 000
to FULL			
from minimal (A)	628 364	48 636	677 000
from basic (B)	453 818	136 182	590 000
from intermediate (C)	279 273	97 273	376 545
REHABILITATION of FULL level of service			
number of households (D)	2 129 455	690 636	2 820 091
<i>Calculation: Percentage (Table 2) x Total pop. (Table 1) / Household size (black, Table 1)</i>			

SANITATION

TABLE 3B: UPGRADING REQUIREMENTS	Metro	Town	Total
Number of households to upgrade:			
to BASIC (A)	942 545	252 909	1 195 455
to INT			
from minimal (A)	942 545	252 909	1 195 455
from basic (B)	104 727	19 455	124 182
to FULL			
from minimal (A)	942 545	252 909	1 195 455
from basic (B)	104 727	19 455	124 182
from intermediate (C)	0	0	0
REHABILITATION of FULL level of service			
number of households (D)	2 443 636	700 364	3 144 000
<i>Calculation: Percentage (Table 2) x Total pop. (Table 1) / Household size (black, Table 1)</i>			

WATER

TABLE 4A: UNIT CAPITAL COSTS	Metro	Town
New Development	<i>Rands per site</i>	
BASIC: Water - internal	600	600
BASIC: Water - bulk	1 600	750
Total:	2 200	1 350
INT: Water - internal	950	950
INT: Water - bulk	3 000	1 500
Total:	3 950	2 450
FULL: Water - internal	1 100	1 100
FULL: Water - bulk	4 200	2 000
Total:	5 300	3 100
Upgrading		
Internal services:		
From BASIC to INT	360	500
From BASIC to FULL	620	800
From INT to FULL	270	400
Rehabilitation of FULL (% of FULL) (1)	10%	10%
Bulk and connector services: (2)		
From BASIC to INT	1400	750
From BASIC to FULL	2600	1250
From INT to FULL	1200	500
Upgrading capacity of FULL (% of FULL) (3)	5%	5%
Notes:		
1. Assumed		
2. Calculated as (INT - BASIC), (FULL - BASIC), (FULL - INT)		
3. Assumed		
Source: Appendix 2, Table 4		

SANITATION

TABLE 4B: UNIT CAPITAL COSTS	Metro	Town
	Rands per site	
New Development		
BASIC: Sanitation - internal	1 400	1 100
BASIC: Sanitation - bulk	0	0
Total: (a)	1 400	1 100
INT: Sanitation - internal	1 900	2 000
INT: Sanitation - bulk	1 600	900
Total: (b)	3 500	2 900
FULL: Sanitation - internal	2 500	2 700
FULL: Sanitation - bulk	2 100	1 200
Total: (c)	4 600	3 900
Upgrading		
Internal services:		
From BASIC to INT	900	900
From BASIC to FULL	1 700	1 800
From INT to FULL	1 500	1 500
Rehabilitation of FULL (% of FULL) (1)	20%	20%
Bulk and connector services: (2)		
From BASIC to INT	1600	900
From BASIC to FULL	2100	1200
From INT to FULL	500	300
Upgrading capacity of FULL (% of FULL)	5%	5%
Notes:		
1. Assumed		
2. Calculated as (INT - BASIC), (FULL - BASIC), (FULL - INT)		
3. Assumed		
Source: Appendix 2, Table 4		

WATER

TABLE 5A: UPGRADING COSTS	Metro	Town	Total
	<i>R million</i>	<i>R million</i>	<i>R million</i>
TO BASIC (1)			
Internal	377	29	406
Bulk and connector	1 005	36	1 042
Total	1 382	66	1 448
TO INTERMEDIATE (2)			
Internal	760	114	875
Bulk and connector	2 520	175	2 696
Total	3 281	289	3 570
TO FULL (3)			
Internal	1 048	201	1 249
Bulk and connector	4 154	316	4 470
Total	5 202	517	5 720
REHABILITATION / CAPACITY UPGRADE OF FULL SERVICE (4)			
Internal	234	76	310
Bulk and connector	447	69	516
Total	681	145	826
Notes:			
1. <i>(A x unit cost)</i>			
2. <i>(A x unit cost) + (B x unit cost)</i>			
3. <i>(A x unit cost) + (B x unit cost) + (C x unit cost)</i>			
4. <i>(D x unit cost) x factor</i>			

SANITATION

TABLE 5B: UPGRADING COSTS	Metro	Town	Total
	<i>R million</i>	<i>R million</i>	<i>R million</i>
TO BASIC (1)			
Internal	1 320	278	1 598
Bulk and connector	0	0	0
Total	1 320	278	1 598
TO INTERMEDIATE (2)			
Internal	1 885	523	2 408
Bulk and connector	1 676	245	1 921
Total	3 561	768	4 329
TO FULL (3)			
Internal	2 534	718	3 252
Bulk and connector	2 199	327	2 526
Total	4 734	1 045	5 778
REHABILITATION / CAPACITY UPGRADE OF FULL SERVICE (4)			
Internal	1 222	378	1 600
Bulk and connector	257	42	299
Total	1 478	420	1 899
Notes:			
1. <i>(A x unit cost)</i>			
2. <i>(A x unit cost) + (B x unit cost)</i>			
3. <i>(A x unit cost) + (B x unit cost) + (C x unit cost)</i>			
4. <i>(D x unit cost) x factor</i>			

WATER

TABLE 6A: NEW DEMAND	Metro	Town	Total
<i>Number of new black households per annum</i>	121 904	22 386	144 290
	<i>R million pa</i>	<i>R million pa</i>	<i>R million pa</i>
BASIC			
Internal	73	13	87
Bulk	195	17	212
TOTAL	268	30	298
INTERMEDIATE			
Internal	116	21	137
Bulk	366	34	399
TOTAL	482	55	536
FULL			
Internal	134	25	159
Bulk	512	45	557
TOTAL	646	69	715

SANITATION

TABLE 6b: NEW DEMAND	Metro	Town	Total
<i>Number of new black households per annum</i>	121 904	22 386	144 290
	<i>R million pa</i>	<i>R million pa</i>	<i>R million pa</i>
BASIC			
Internal	171	25	195
Bulk	0	0	0
TOTAL	171	25	195
INTERMEDIATE			
Internal	232	45	276
Bulk	195	20	215
TOTAL	427	65	492
FULL			
Internal	305	60	365
Bulk	256	27	283
TOTAL	561	87	648

WATER

TABLE 7A: CAPITAL COST SUMMARY			
	Metro	Town	Total
	<i>R million</i>	<i>R million</i>	<i>R million</i>
BASIC			
Upgrade	1 382	66	1 448
New demand per annum	268	30	298
INTERMEDIATE			
Upgrade	3 281	289	3 570
New demand per annum	482	55	536
FULL			
Upgrade	5 202	517	5 720
New demand per annum	646	69	715
REHABILITATION OF FULL	681	145	826
<i>Notes:</i>			
<i>This table provides order of magnitude figures.</i>			
<i>The figures assume simplistic policies of providing universal coverage at a set level of service.</i>			

SANITATION

TABLE 7b: CAPITAL COST SUMMARY	Metro	Town	Total
	<i>R million</i>	<i>R million</i>	<i>R million</i>
BASIC			
Upgrade	1 320	278	1 598
New demand per annum	171	25	195
INTERMEDIATE			
Upgrade	3 561	768	4 329
New demand per annum	427	65	492
FULL			
Upgrade	4 734	1 045	5 778
New demand per annum	561	87	648
REHABILITATION OF FULL	1 478	420	1 899
<i>Notes:</i>			
<i>This table provides order of magnitude figures.</i>			
<i>The figures assume simplistic policies of providing universal coverage at a set level of service.</i>			

WATER AND SANITATION

TABLE 8: CAPITAL COST SUMMARY		Metro	Town	Total
		<i>R million</i>	<i>R million</i>	<i>R million</i>
BASIC				
Upgrade		2 702	344	3 046
New demand per annum		439	55	494
INTERMEDIATE				
Upgrade		6 841	1 058	7 899
New demand per annum		908	120	1 028
FULL				
Upgrade		9 936	1 562	11 498
New demand per annum		1 207	157	1 364
REHABILITATION OF FULL		2 160	565	2 725
<i>Notes:</i>				
<i>This table provides order of magnitude figures.</i>				
<i>The figures assume simplistic policies of providing universal coverage at a set level of service.</i>				

APPENDIX 2

DEMAND AND COSTS OF WATER AND SANITATION SERVICES

Contents:

- Table 1: Demographics
- Table 2: Level of service data
- Table 3: Upgrading requirements
- Table 4a: Unit cost data - internal services
- Table 4b: Unit cost data - bulk and connector
- Table 5: Upgrading costs (eliminating backlog and rehabilitation)
- Table 6: New demand - annual
- Table 7: Cost summary
- Table 8: Cost summary (water and sanitation)

Notes:

1. These tables contain the detailed estimates by metropolitan region
2. All money values in 1993 Rands
3. Data from World Bank reports (Appendices 5, 6 and 7) reported where relevant
4. More detailed notes given at bottom of each table

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TABLE 1: DEMOGRAPHICS

		THIS STUDY													WORLD BANK STUDY		
		PWV	Dbn	CT	PE	OFS	EL	Bloem	Pmb	Reg-H	Metro	Towns	Dense	TOTAL	Wits	Dbn	PE
Urban Foundation Population - total (000s)	1990	6 812	3 080	2 556	984	468	451	602	497	1 932	17 382	4 920	2 220	24 522			
	1993	7 553	3 415	2 834	1 091	519	497	650	531	2 198	19 287	5 298	2 497	27 083			
	% pa	3.5%	3.5%	3.5%	3.5%	3.5%	3.3%	2.6%	2.2%	4.4%	3.5%	2.5%	4.0%	3.4%			
Population - black (000s)	1990	4 408	2 060	570	580	383	343	470	339	1 873	11 026	2 960	2 220	16 206			
	1993	5 103	2 385	660	671	431	384	544	376	2 137	12 691	3 282	2 497	18 470	4 400	2 300	800
	% pa	5.0%	5.0%	5.0%	5.0%	4.0%	3.8%	5.0%	3.5%	4.5%	4.8%	3.5%	4.0%	4.5%	6.5%	6.0%	8.0%
Household size		5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Black population growth	93-98	5.0%	5.0%	5.0%	5.0%	4.0%	4.0%	5.0%	3.5%	4.5%	4.8%	3.5%	4.0%	4.5%	6.0%	5.0%	7.0%
	98-03	4.7%	4.7%	4.7%	4.7%	3.8%	3.8%	4.7%	3.3%	4.3%	4.5%	3.3%	3.8%	4.2%			
	03-08	4.5%	4.5%	4.5%	4.5%	3.6%	3.6%	4.5%	3.1%	4.1%	4.3%	3.1%	3.6%	4.1%			
Black population (000s)	1993	5 103	2 385	660	671	431	384	544	376	2 137	12 691	3 282	2 497	18 470	4 400	2 300	800
	1998	6 513	3 044	842	857	524	467	694	446	2 664	16 051	3 898	3 038	22 987	5 888	2 935	1 122
	2003	8 194	3 829	1 060	1 078	632	562	874	525	3 288	20 041	4 585	3 661	28 287			
	2008	10 211	4 772	1 320	1 344	754	671	1 089	612	4 019	24 792	5 341	4 369	34 502			
New black households per annum (000s)																	
1994 - 1998		51	24	7	7	3	3	5	3	19	122	22	20	164	54	23	12
1999 - 2003		61	29	8	8	4	3	7	3	23	145	25	23	193			
2004 - 2008		73	34	9	10	4	4	8	3	27	173	27	26	226			

TABLE 2: LEVEL OF SERVICE DATA

	THIS STUDY														WORLD BANK		
	PWV	Dbn	CT	PE	OFS	EL	Bloem	Pmb	Reg-H	Metro	Towns	Dense	TOTAL	Wits	Dbn	PE	
Existing levels of service	% total population										% low-income population						
Water																	
Minimal	4%	19%	11%	21%	9%	6%	38%	51%	64%	18%	5%	46%	18%	5%	55%	10%	
Basic	10%	27%	5%	8%	14%	5%	11%	13%	14%	13%	14%	48%	16%	32%	6%	4%	
Intermediate	10%	0%	12%	18%	11%	1%	5%	1%	11%	8%	10%	4%	8%	5%	0%	2%	
Full	76%	54%	72%	53%	66%	88%	46%	35%	11%	61%	71%	2%	57%	58%	39%	84%	
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Sanitation																	
Minimal	8%	38%	12%	20%	38%	3%	39%	63%	86%	27%	26%	98%	33%	6%	55%	14%	
Basic	4%	3%	0%	0%	0%	9%	21%	0%	1%	3%	2%	0%	3%	36%	6%	0%	
Intermediate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	
Full	88%	59%	88%	80%	62%	88%	40%	37%	13%	70%	72%	2%	64%	58%	39%	76%	
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Existing levels of service	Total number of people (000s)										Low income people (000s)						
Water																	
Minimal	302	649	312	229	47	30	247	271	1 407	3 493	265	1 149	4 907	220	1 265	80	
Basic	755	922	142	87	73	25	72	69	308	2 452	742	1 199	4 392	1 408	138	32	
Intermediate	755	0	340	196	57	5	33	5	242	1 633	530	100	2 263	220	0	16	
Full	5 740	1 844	2 040	578	342	437	299	186	242	11 709	3 762	50	15 521	2 552	897	672	
Total	7 553	3 415	2 834	1 091	519	497	650	531	2 198	19 287	5 298	2 497	27 083	4 400	2 300	800	
Sanitation																	
Minimal	604	1 298	340	218	197	15	254	334	1 891	5 151	1 378	2 447	8 975	264	1 265	112	
Basic	302	102	0	0	0	45	137	0	22	608	106	0	714	1 584	138	0	
Intermediate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	
Full	6 646	2 015	2 494	873	322	437	260	196	286	13 529	3 815	50	17 394	2 552	897	608	
Total	7 553	3 415	2 834	1 091	519	497	650	531	2 198	19 287	5 298	2 497	27 083	4 400	2 300	800	

Source: Appendix 4

TABLE 3: UPGRADING REQUIREMENTS

Number of households to upgrade ('000s)		THIS STUDY									TOTAL				WORLD BANK		
		PWV	Dbn	CT	PE	OFS	EL	Bloem	Pmb	Reg-H					Metro	Towns	Dense
-> basic	water	55	118	57	42	8	5	45	49	256	635	48	209	892	40	230	15
	sanitation	110	236	62	40	36	3	46	61	344	936	250	445	1 632	48	230	20
-> intermediate min -> int	water	55	118	57	42	8	5	45	49	256	635	48	209	892	40	230	15
	sanitation	110	236	62	40	36	3	46	61	344	936	250	445	1 632	48	230	20
bas -> int	water	137	168	26	16	13	5	13	13	56	446	135	218	799	256	25	6
	sanitation	55	19	0	0	0	8	25	0	4	111	19	0	130	288	25	0
-> full min -> full	water	55	118	57	42	8	5	45	49	256	635	48	209	892	40	230	15
	sanitation	110	236	62	40	36	3	46	61	344	936	250	445	1 632	48	230	20
bas -> full	water	137	168	26	16	13	5	13	13	56	446	135	218	799	256	25	6
	sanitation	55	19	0	0	0	8	25	0	4	111	19	0	130	288	25	0
int -> full	water	137	0	62	36	10	1	6	1	44	297	96	18	411	40	0	3
	sanitation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Rehabilitation of full	water	1 044	335	371	105	62	80	54	34	44	2 129	684	9	2 822			
	sanitation	1 208	366	453	159	58	80	47	36	52	2 460	694	9	3 162			

NOTE:

The table calculates the number of households to upgrade to BASIC, INTERMEDIATE AND FULL respectively
That is, in each categories, it calculates the number of upgrades to bring ALL households up to at least that level of service.

TABLE 4a: UNIT COST DATA - INTERNAL SERVICES (1993 Rands per site) - total construction costs

A: INTERNAL SERVICES		PWV	Dbn	CT	PE	OFS	EL	Bloem	Pmb	Reg-H	Metro	Towns	Dense	TOTAL	Wits	Dbn	PE
NEW DEVELOPMENT COSTS		lo	hi	mid	mid	lo	mid	lo	mid	lo		xxx	mid				
Water	-> basic	450	1 100	700	700	450	700	450	700	450	616	600	700	624	600	1 000	400
	-> int	600	2 100	950	950	600	950	600	950	600	948	950	950	949	800	1 700	800
	-> full	700	2 500	1 100	1 100	700	1 100	700	1 100	700	1 115	1 100	1 100	1 111	1 000	2 100	1 000
Sanitation	-> basic	1 080	2 160	1 620	1 620	1 080	1 620	1 080	1 620	1 080	1 376	1 080	1 080	1 300	1 000	1 800	1 500
	-> int	1 458	3 240	2 025	2 025	1 458	2 025	1 458	2 025	1 458	1 895	2 025	2 600	1 997	1 400	3 000	2 200
	-> full	1 944	4 320	2 700	2 700	1 944	2 700	1 944	2 700	1 944	2 527	2 700	3 600	2 679	1 800	4 200	2 800
UPGRADING COSTS																	
Water = new development	minimal -> basi	450	1 100	700	700	450	700	450	700	450	616	600	700	624	600	1 000	400
	minimal -> int	600	2 100	950	950	600	950	600	950	600	948	950	950	949	800	1 700	800
	minimal -> full	700	2 500	1 100	1 100	700	1 100	700	1 100	700	1 115	1 100	1 100	1 111	1 000	2 100	1 000
ex World Bank	basic -> int	200	700	600	500	200	700	200	700	200	359	500	700	419	200	700	500
	basic -> full	400	1 100	950	800	400	1 100	400	1 100	400	621	800	1 000	691	400	1 100	800
	int -> full	200	400	400	400	200	400	200	400	200	270	400	400	303	200	400	400
Rehabilitation of full	(% of full)	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%			
Sanitation = new development	minimal -> basi	1 080	2 160	1 620	1 620	1 080	1 620	1 080	1 620	1 080	1 376	1 080	1 080	1 300	1 000	1 800	1 500
	minimal -> int	1 458	3 240	2 025	2 025	1 458	2 025	1 458	2 025	1 458	1 895	2 025	2 600	1 997	1 400	3 000	2 200
	minimal -> full	1 944	4 320	2 700	2 700	1 944	2 700	1 944	2 700	1 944	2 527	2 700	3 600	2 679	1 800	4 200	2 800
ex World Bank	basic -> int	800	1 200	1 050	900	800	1 200	800	1 200	800	916	900	1 000	924	800	1 200	900
	basic -> full	1 500	2 300	2 050	1 800	1 500	2 300	1 500	2 300	1 500	1 740	1 800	2 300	1 815	1 500	2 300	1 800
	int -> full	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	2 300	1 596	1 500	1 500	1 500
Rehabilitation of full	(% of full)	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%			

Notes:

1. New development costs from Appendix 3, except for last 3 columns on right which are extracted from World Bank studies (See Appendices 5 to 7). "lo", "mid" and "hi" refer to Appendix 3. XXX denotes figure
2. "lo", "mid" and "hi" refer to Appendix 3. XXX denotes figure in Appendix 3 overridden.
3. Upgrading costs from World Bank studies for Wits, Durban and Port Elizabeth; but upgrading from minimal standard set equal to new development costs.
4. Metropolitan and Total costs shown are weighted averages based on new low-income services demand (ex Table 1)

TABLE 4b: UNIT COST DATA - BULK AND CONNECTOR (1993 Rands per site)

NEW DEVELOPMENT		PWV	Dbn	CT	PE	OFS	EL	Bloem	Pmb	Reg-H	Metro	Towns	Dense	TOTAL
FULL	Water	hi. 5 000	XXX 3 000	XXX 3 500	XXX 4 000	mid 2 500	mid 2 500	XXX 3 500	mid 2 500	hi 5 000	4 220	XXX 2 000	mid 2 500	3 712
	Sewerage	hi 2 700	mid 1 296	mid 1 296	mid 1 296	mid 1 296	lo 432	mid 1 296	mid 1 296	hi 2 700	2 084	XXX 1 200	hi 2 700	2 037
INTERMEDIATE	Water	hi 3 600	XXX 2 100	XXX 2 500	XXX 2 800	mid 1 800	mid 1 800	XXX 2 500	mid 1 800	hi 3 600	3 020	XXX 1 500	mid 1 800	2 667
	Sewerage	hi 2 025	mid 972	mid 972	mid 972	mid 972	lo 324	mid 972	mid 972	hi 2 025	1 563	XXX 900	XXX 1 500	1 465
BASIC	Water	hi 2 000	mid 1 000	mid 1 000	hi 2 000	mid 1 000	mid 1 000	mid 1 000	mid 1 000	hi 2 000	1 631	XXX 750	mid 1 000	1 436
IN-FILL DEVELOPMENT	Water	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
	Sewerage	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
UPGRADING														
Water													lo mid	
From BASIC to INT		1 600	1 100	1 500	800	800	800	1 500	800	1 600	1 389	750	800	1 231
From BASIC to FULL		3 000	2 000	2 500	2 000	1 500	1 500	2 500	1 500	3 000	2 589	1 250	1 500	2 276
From INT to FULL		1 400	900	1 000	1 200	700	700	1 000	700	1 400	1 200	500	700	1 045
Upgrading capacity of FULL (% of FULL)		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Sanitation													lo mid	
From BASIC to INT		2 025	972	972	972	972	324	972	972	2 025	1 563	900	1 500	1 465
From BASIC to FULL		2 700	1 296	1 296	1 296	1 296	432	1 296	1 296	2 700	2 084	1 200	2 700	2 037
From INT to FULL		675	324	324	324	324	108	324	324	675	521	300	1 200	572
Upgrading capacity of FULL (% of FULL)		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

Notes:

1. New bulk costs from Appendix 3. "lo", "mid" and "hi" refer to Appendix 3. XXX denotes figure in Appendix 3 overridden.
2. Upgrading bulk costs taken as differences between new bulk costs.
3. Metropolitan and Total costs shown are weighted averages based on new low-income services demand (ex Table 1)

TABLE 5: UPGRADING COSTS

(All figures in R million)	THIS STUDY (CALCULATED)												
A: INTERNAL SERVICES	PWV	Dbn	CT	PE	OFS-Go	EL	Bloem	Pmb	Reg-H	Metro	Towns	Dense	TOTAL
Water													
-> basic	25	130	40	29	4	4	20	34	115	401	29	146	576
-> int	60	365	69	48	8	8	30	56	165	808	113	351	1 272
-> full	121	479	112	73	13	11	38	68	210	1 125	199	455	1 780
Sanitation													
-> basic	119	510	100	64	39	4	50	98	371	1 355	271	481	2 106
-> int	204	787	125	80	52	15	87	123	504	1 978	525	1 157	3 660
-> full	296	1 062	167	107	70	26	127	164	674	2 693	711	1 602	5 006
Water and sanitation													
-> basic	143	639	140	93	43	8	70	133	486	1 756	299	627	2 682
-> intermediate	265	1 152	195	128	60	24	117	179	669	2 787	638	1 508	4 932
-> full	417	1 541	278	180	83	37	165	232	884	3 818	910	2 057	6 786
B: BULK AND CONNECTOR UPGRADING													
Water													
-> basic	110	118	57	83	8	5	45	49	512	987	36	209	1 232
-> int	417	432	180	129	26	13	132	99	1 010	2 439	173	550	3 163
-> full	879	689	325	241	48	21	196	142	1 509	4 050	313	862	5 225
Sanitation													
-> basic	0	0	0	0	0	0	0	0	0	0	0	0	0
-> int	334	247	60	39	35	4	69	59	704	1 550	243	667	2 461
-> full	445	330	80	51	46	5	92	79	939	2 067	324	1 201	3 592
C: REHABILITATION OF FULL													
Water													
Internal	73	84	41	12	4	9	4	4	3	233	75	1	309
Bulk and connector	261	50	65	21	8	10	10	4	11	440	68	1	509
Total	334	134	106	33	12	19	13	8	14	673	144	2	818
Sanitation													
Internal	470	317	245	86	23	43	18	19	20	1 240	375	7	1 622
Bulk and connector	163	24	29	10	4	2	3	2	7	244	42	1	287
Total	633	340	274	96	27	45	21	22	27	1 485	416	8	1 909

NOTES:

1. Upgrade costs calculated by multiplying unit upgrade costs (Table 4) and number of households to upgrade (Table 3) by category of upgrade
2. Rehabilitation of full level of service = no. of households x new development cost (full) x factor
3. World Bank reported costs extracted directly from their report (See Appendices 5 to 7)
4. World Bank reported figures include rehabilitation of existing infrastructure.

TABLE 6: NEW DEMAND: ANNUAL (during period 1993 - 1998)

(1993 Rands)		Wits	Dbn	CT	PE	OFS-Go	EL	Bloem	Pmb	Reg-H	Metro	Towns	Dense	TOTAL
DEMOGRAPHICS		THIS STUDY												
Number of households per annum (000's)		51	24	7	7	3	3	5	3	19	122	22	20	164
FULL														
Water														
Internal services	R million	36	60	7	7	2	3	4	3	13	136	25	22	183
Bulk services	R million	256	72	23	27	8	8	19	6	96	516	45	49	610
Total	R million	292	132	30	34	11	11	23	9	109	652	69	71	792
Sanitation														
Internal services	R million	100	103	18	18	7	8	11	7	37	309	60	71	440
Bulk services	R million	138	31	9	9	4	1	7	3	52	255	27	53	335
Total	R million	238	135	26	27	11	9	18	10	89	563	87	124	775
INTERMEDIATE														
Water														
Internal services	R million	31	50	6	6	2	3	3	2	11	116	21	19	156
Bulk services	R million	185	50	17	19	6	5	14	5	69	369	34	35	438
Total	R million	215	101	23	25	8	8	17	7	80	485	55	54	594
Sanitation														
Internal services	R million	75	78	13	14	5	6	8	5	28	232	45	51	328
Bulk services	R million	104	23	6	7	3	1	5	2	39	191	20	30	241
Total	R million	179	101	20	20	8	7	13	8	67	423	66	81	569
BASIC														
Water														
Internal services	R million	23	26	5	5	2	2	2	2	9	75	13	14	103
Bulk services	R million	103	24	7	13	3	3	5	3	38	199	17	20	236
Total	R million	126	50	11	18	5	5	8	4	47	275	30	33	338
Sanitation														
Internal services	R million	55	52	11	11	4	5	6	4	21	168	24	21	214
Bulk services	R million	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	R million	55	52	11	11	4	5	6	4	21	168	24	21	214

TABLE 7: COST SUMMARY

(1993 Rands)		Wits	Dbn	CT	PE	OFS-Go	EL	Bloem	Pmb	Reg-H	Metro	Towns	Dense	TOTAL
FULL														
Water														
Upgrade	R million	1 000	1 168	436	314	62	32	233	211	1 719	5 175	512	1 317	7 004
New demand per ann	R million pa	292	132	30	34	11	11	23	9	109	652	69	71	792
Sanitation														
Upgrade	R million	741	1 392	247	159	116	31	219	243	1 613	4 760	1 035	2 803	8 598
New demand per ann	R million pa	238	135	26	27	11	9	18	10	89	563	87	124	775
INTERMEDIATE														
Water														
Upgrade	R million	478	797	250	177	34	22	161	154	1 175	3 247	287	901	4 435
New demand per ann	R million pa	215	101	23	25	8	8	17	7	80	485	55	54	594
Sanitation														
Upgrade	R million	538	1 034	185	119	87	19	156	182	1 209	3 529	767	1 824	6 120
New demand per ann	R million pa	179	101	20	20	8	7	13	8	67	423	66	81	569
BASIC														
Water														
Upgrade	R million	135	248	96	112	12	9	65	84	627	1 388	65	355	1 808
New demand per ann	R million pa	126	50	11	18	5	5	8	4	47	275	30	33	338
Sanitation														
Upgrade	R million	119	510	100	64	39	4	50	98	371	1 355	271	481	2 106
New demand per ann	R million pa	55	52	11	11	4	5	6	4	21	168	24	21	214
REHABILITATION OF FULL														
Water	R million	334	134	106	33	12	19	13	8	14	673	144	2	818
Sanitation	R million	633	340	274	96	27	45	21	22	27	1 485	416	8	1 909

APPENDIX 3: UNIT CAPITAL COSTS

TABLE 1: WATER

Level of service (1993 Rands)	Description	Year	INTERNAL SERVICES COSTS			BULK AND CONNECTOR		
			(Rands per site)			(Rands per site)		
			Low	Mid	Hi	Low	Mid	Hi
Full	House connection	1993	700	1 100	2 500	1 200	2 500	5 000
Intermediate	Yard Tap	1993	600	950	2 100	1 000	1 800	3 600
Basic	Standpipe (1:25 sites)	1993	450	700	1 100	500	1 000	2 000

Source: Palmer Development Group (1994) Working Paper "Cost Analysis of Water Supply Systems" (in preparation)

Notes:

- Bulk and connector service costs are based on volumetric consumptions as follows:
House connection: 250 l/capita/day
Yard tap: 120 l/capita/day
Standpipe: 50 l/capita/day
- Costs are all-in construction costs (incl Vat), they exclude design and indirect costs attributed to the developer
- Base data was for mid-1992 and was escalated by 5%.

TABLE 2: SANITATION

Level of service	Description	Year	INTERNAL SERVICES COSTS			BULK AND CONNECTOR		
			(Rands per site)			(Rands per site)		
			Low	Mid	Hi	Low	Mid	Hi
Full	Waterborne	1992	1 800	2 500	4 000	400	1 200	2 500
		1993	1 944	2 700	4 320	432	1 296	2 700
Intermediate	Aqua-privy + small b	1993	1 458	2 025	3 240	324	972	2 025
Basic	VIP	1992	1 000	1 500	2 000	0	0	0
		1993	1 080	1 620	2 160	0	0	0

Source: Palmer Development Group (1993a) Working Paper B6 "Cost Comparison of Sanitation Systems".

Notes:

- Intermediate sanitation: no representative cost data available.
Internal services and treatment costs assumed to be 75% of full level of service costs.
Bulk and connector costs assumed to be 75% of conventional waterborne sewerage costs.
- Internal services includes toilet superstructure.
- Internal services cost split for internal services component was R1 100 (on-site) and R1 400 (internal reticulation) in 1992 Rands
- 1993 prices based on 1992 cost figures escalated at 8% per annum.
- Costs are all-in construction costs (incl VAT), and exclude design and indirect costs attributed to the developer (planning, overheads)

APPENDIX 4

TABLE 1: ACCESS TO WATER IN THE URBAN AREAS OF SOUTH AFRICA

(Summary of Palmer Development Group Survey conducted in 1992, population base of 1990 used)

Population (1990)						Percentage					
		FULL	INT.	BASIC	MINIMAL	Total	FULL	INT.	BASIC	MINIMAL	Total
Metro	CT	1 843 000	307 000	128 000	282 000	2 560 000	72%	12%	5%	11%	100%
	Bloem	270 020	29 350	64 570	223 060	587 000	46%	5%	11%	38%	100%
	OFS	320 100	53 350	67 900	38 800	485 000	66%	11%	14%	8%	99%
	PE	512 510	174 060	77 360	203 070	967 000	53%	18%	8%	21%	100%
	EL	389 840	4 430	22 150	26 580	443 000	88%	1%	5%	6%	100%
	Durban	1 666 440	0	833 220	586 340	3 086 000	54%	0%	27%	19%	100%
	Pmb	171 850	4 910	63 830	255 320	491 000	35%	1%	13%	52%	101%
	PWV	5 322 000	720 000	708 000	265 000	7 015 000	76%	10%	10%	4%	100%
	H-Bop	179 000	179 000	86 000	790 000	1 234 000	15%	15%	7%	64%	100%
H-KwaN	12 000	12 000	159 000	311 000	494 000	2%	2%	32%	63%	100%	
Total		10 686 760	1 484 100	2 210 030	2 981 170	17 362 000	62%	9%	13%	17%	100%
Town	A	531 700	84 580	41 090	2 130	659 500	81%	13%	6%	0%	100%
	B	256 215	161 595	88 285	6 860	512 955	50%	32%	17%	1%	100%
	C	278 420	110 180	120 000	21 000	529 600	53%	21%	23%	4%	100%
	D	504 876	97 329	182 667	78 028	862 900	59%	11%	21%	9%	100%
	E	712 140	17 940	90 480	37 440	858 000	83%	2%	11%	4%	100%
	F	601 880	22 020	66 060	44 040	734 000	82%	3%	9%	6%	100%
	G	381 560	5 960	49 090	16 390	453 000	84%	1%	11%	4%	100%
	J	527 400	5 900	88 500	47 200	669 000	79%	1%	13%	7%	100%
Total		3 794 191	505 504	726 172	253 088	5 278 955	72%	10%	14%	5%	100%
Dense	B	0	23 160	82 990	82 990	189 140	0%	12%	44%	44%	100%
	C	6 250	6 250	62 500	50 000	125 000	5%	5%	50%	40%	100%
	D	0	0	93 800	40 200	134 000	0%	0%	70%	30%	100%
	F	35 530	33 660	35 530	82 280	187 000	19%	18%	19%	44%	100%
	G	0	0	528 750	327 250	856 000	0%	0%	62%	38%	100%
	J	0	0	60 800	243 200	304 000	0%	0%	20%	80%	100%
Total		41 780	63 070	864 370	825 920	1 795 140	2%	4%	48%	46%	100%
Summary by location											
	Metro	10 686 760	1 484 100	2 210 030	2 981 170	17 362 000	62%	9%	13%	17%	100%
	Town	3 794 191	505 504	726 172	253 088	5 278 955	72%	10%	14%	5%	100%
	Dense	41 780	63 070	864 370	825 920	1 795 140	2%	4%	48%	46%	100%
	Total	14 522 731	2 052 674	3 800 572	4 060 178	24 436 095	59%	8%	16%	17%	100%
Summary by region											
	Region A	2 374 700	391 580	169 090	284 130	3 219 500	74%	12%	5%	9%	100%
	Region B	256 215	184 755	171 275	89 850	702 095	36%	26%	24%	13%	100%
	Region C	874 790	199 130	314 970	332 860	1 721 750	51%	12%	18%	19%	100%
	Region D	1 407 226	275 819	375 977	347 878	2 406 900	58%	11%	16%	14%	100%
	Region E	2 550 430	22 850	987 530	879 100	4 439 910	57%	1%	22%	20%	100%
	Region F	637 410	55 680	101 590	126 320	921 000	69%	6%	11%	14%	100%
	Region G	381 560	5 960	577 840	343 640	1 309 000	29%	0%	44%	26%	100%
	Region H	5 513 000	911 000	953 000	1 366 000	8 743 000	63%	10%	11%	16%	100%
	Region J	527 400	5 900	149 300	290 400	973 000	54%	1%	15%	30%	100%
	Total	14 522 731	2 052 674	3 800 572	4 060 178	24 436 155	59%	8%	16%	17%	100%
PWV breakdown (for black townships only)											
	Central Wits	980 510	165 720	165 720	69 050	1 381 000	71%	12%	12%	5%	100%
	East Rand	837 900	266 000	133 000	93 100	1 330 000	63%	20%	10%	7%	100%
	Pretoria & N	428 930	36 350	261 720	0	727 000	59%	5%	36%	0%	100%
	Vaal triangle	163 710	93 090	51 360	12 840	321 000	51%	29%	16%	4%	100%
	West Rand	293 400	68 460	63 570	63 570	489 000	60%	14%	13%	13%	100%
	Total	2 704 450	629 620	675 370	238 560	4 248 000	60%	14%	13%	13%	100%

Notes:

Full = House connection (metered)

Int. = Yard tap

Basic = communal standpipe / kiosk (planned provision)

Minimal = emergency supply, unplanned provision, source > 100m or more than 25 households per tap
(there is great uncertainty in the data regarding the distinction between basic and minimal water supply)

References:

Palmer Development Group (1993) "Urban Water Evaluation" - Working Papers

File = append4.wb1

TABLE 2: ACCESS TO SANITATION IN THE URBAN AREAS OF SOUTH AFRICA

(Summary of Palmer Development Group Survey conducted in 1992, population base of 1990 used)

		Population (1990)					Percentage				
		FULL	INT.	BASIC	MINIMAL	Total	FULL	INT.	BASIC	MINIMA	Total
Metro	CT	2 243 000	0	3 000	310 000	2 556 000	88%	0%	0%	12%	100%
	Bloem	242 000	0	128 000	232 000	602 000	40%	0%	21%	39%	100%
	OFS	290 000	0	0	177 000	467 000	62%	0%	0%	38%	100%
	PE	778 000	0	0	189 000	967 000	80%	0%	0%	20%	100%
	EL	443 000	0	47 000	15 000	505 000	88%	0%	9%	3%	100%
	Durban	1 813 000	0	102 000	1 169 000	3 084 000	59%	0%	3%	38%	100%
	Pmb	182 000	0	1 000	308 000	491 000	37%	0%	0%	63%	100%
	PWV	6 182 000	0	287 000	547 000	7 016 000	88%	0%	4%	8%	100%
	H-Bop	168 000	0	0	1 066 000	1 234 000	14%	0%	0%	86%	100%
	H-KwaN	56 000	0	9 000	430 000	495 000	11%	0%	2%	87%	100%
Total		12 397 000	0	577 000	4 443 000	17 417 000	71%	0%	3%	26%	100%
Town	A	454 000	0	10 000	85 000	549 000	83%	0%	2%	15%	100%
	B	253 000	0	8 000	252 000	513 000	49%	0%	2%	49%	100%
	C	297 000	0	3 000	197 000	497 000	60%	0%	1%	40%	100%
	D	533 000	0	21 000	362 000	916 000	58%	0%	2%	40%	100%
	E	660 000	0	45 000	76 000	781 000	85%	0%	6%	10%	100%
	F	548 000	0	1 000	160 000	709 000	77%	0%	0%	23%	100%
	G	373 000	0	0	3 000	376 000	99%	0%	0%	1%	100%
	J	494 000	0	6 000	168 000	668 000	74%	0%	1%	25%	100%
	Total	3 612 000	0	94 000	1 303 000	5 009 000	72%	0%	2%	26%	100%
Dense	B	0	0	0	193 000	193 000	0%	0%	0%	100%	100%
	C	30 000	0	8 000	117 000	155 000	19%	0%	5%	75%	100%
	D	0	0	0	81 000	81 000	0%	0%	0%	100%	100%
	F	0	0	0	202 000	202 000	0%	0%	0%	100%	100%
	G	0	0	0	933 000	933 000	0%	0%	0%	100%	100%
	J	0	0	0	304 000	304 000	0%	0%	0%	100%	100%
Total		30 000	0	8 000	1 830 000	1 868 000	2%	0%	0%	98%	100%
Summary by location											
Metro		12 397 000	0	577 000	4 443 000	17 417 000	71%	0%	3%	26%	100%
Town		3 612 000	0	94 000	1 303 000	5 009 000	72%	0%	2%	26%	100%
Dense		30 000	0	8 000	1 830 000	1 868 000	2%	0%	0%	98%	100%
Total		16 039 000	0	679 000	7 576 000	24 294 000	66%	0%	3%	31%	100%
Summary by region											
Region A		2 697 000	0	13 000	395 000	3 105 000	87%	0%	0%	13%	100%
Region B		253 000	0	8 000	445 000	706 000	36%	0%	1%	63%	100%
Region C		859 000	0	139 000	723 000	1 721 000	50%	0%	8%	42%	100%
Region D		1 754 000	0	68 000	647 000	2 469 000	71%	0%	3%	26%	100%
Region E		2 655 000	0	148 000	1 553 000	4 356 000	61%	0%	3%	36%	100%
Region F		548 000	0	1 000	362 000	911 000	60%	0%	0%	40%	100%
Region G		373 000	0	0	936 000	1 309 000	28%	0%	0%	72%	100%
Region H		6 406 000	0	296 000	2 043 000	8 745 000	73%	0%	3%	23%	100%
Region J		494 000	0	6 000	472 000	972 000	51%	0%	1%	49%	100%
Total		16 039 000	0	679 000	7 576 000	24 294 000	66%	0%	3%	31%	100%

Notes:

Full = Waterborne and standard septic tanks

Int. = "intermediate" = "aqua-privy" + solids-free sewerage

Basic = VIP latrine or "aqua-privy" with on-site soakaway ("other" category in survey)

Minimal = unimproved pit, bucket, none

References:

Palmer Development Group (1993) "Urban Sanitation Evaluation" - summary report and working papers.

File = append4.wb1

APPENDIX 5

Witwatersrand Metropolitan Region

Demand for and cost of water and sanitation services

5.1 Introduction

The aim of this appendix is to outline scenarios for the future demand and costs of water and sanitation services in the Witwatersrand Functional Region and to examine, in a preliminary way, the financial implications of these on the water sector.

The information for this section is derived primarily from the World Bank Aide Memoir dated 14 June 1993. Supplementary demographic information is quoted from the Urban Foundation Demographic and Income Distribution models.

The appendix is structured as follows:

- 5.2 Demographics
- 5.3 Level of service definitions
- 5.4 Existing levels of service
- 5.5 Unit infrastructure costs
- 5.6 Total investment costs - World Bank
- 5.7 Investments per site - World Bank
- 5.8 Sensitivity of investment requirements
- 5.9 Operation and maintenance costs
- 5.10 Financial implications for sector

5.2 Demographics

The World Bank adopted the following demographic estimates as the best available:

Population in low-income settlements, 1993	± 4.4 million people
Population growth rate	6.3%
Additional low-income population, 1998	1 600 000

- Notes:
1. Figures refer to the population within West-Rand, East-Rand and Central Wits RSC areas.
 2. The source of population information used by the World Bank was from local authorities and was not cross-checked with the 1991 population census. There is a distinct tendency for local authorities to over estimate population. For example, in KwaThema, the Town Council population estimate is 230 000, based on occupancies of 10 - 12 persons per house and 6 people to backyard shack. The 1991 Census figure was 81 000. A random survey of 50 houses and backyard shacks showed an average occupancy of 6.3 people per house and 3 people per backyard shack, which would indicate a total population of about 130 000.
 3. See Urban Foundation Demographic Figures provided below for comparison.

5.2

Based on the above information and assuming an average household size of 5.5 (Urban Foundation), the following household and population information has been derived:

Household formation	
Annual increase in black population: 1993 - 2000	290 000
Average black household size	5.5
Number of new black households per annum	52 700
New black households: 1993 - 1998	263 500
New black households: 1993 - 2003	527 000

Data from the Urban Foundation is summarised below:

Population	1990	1993	2000
White	1 351 000		
Coloured	209 000		
Asian	215 000		
Black	3 201 000	3 706 000	5 214 000
TOTAL	4 861 000	5 515 000	7 406 000

Note: Model assumes 1990 - 2000 growth rate to be 4.3% per annum for the whole of the PWV area. Black population growth rate assumed to be 5% per annum.

The model therefore gives a low-income (black) population figure of 3.7 million, compared to the World Bank figure of 4.4 million (almost 20% higher).

5.3 Definitions of levels of service

The World Bank used the following definitions for levels of service when calculating investment scenarios:

Standard	Water	Sanitation
Minimal	communal standpipe	bucket / community toilet
Basic	water within 250 m	on-site sanitation
Intermediate	yard tap	intermediate sewerage
Full	metered house connection	conventional sewerage

Comment:

The World Bank's new development cost figures for a basic level of sanitation were for an "on-plot latrine or similar". "Intermediate sewerage" was not further defined.

5.4 Existing levels of service

World Bank:

Level of service		Millions of people
Minimal	communal standpipe > 250m	0.24
	bucket, shared toilet	0.29
Basic	communal standpipe < 250m	1.4
	on-site sanitation (pit or "aqua-privy")	1.6
Intermediate	yard tap	0.24
	intermediate sewerage	0
Full	metered house connection	2.6
	conventional sewerage	2.6
TOTAL	All service levels	4.5

Water Research Commission figures: (Palmer Development Group, 1993)
(1990 figures escalated at 5% per annum)

Level of service		Millions of people
Minimal	Communal standpipe > 250m	0.27
Basic	communal standpipe < 250m	0.40
Intermediate	yard tap	0.58
Full	metered house connection	2.44
TOTAL	All service levels	3.7

Note: Water Research Commission figures were reconciled with the Urban Foundation macro-demographic model. The World Bank figures are sourced directly from the local authorities and, as noted above, are probably over-estimated.

5.5 Unit Costs

New development costs

New development costs (1993 Rands / plot):

		Density of development		
		25 plot/ha	40 plot/ha	60 plot/ha
Water Supply				
Basic	standpipe < 250m	800	575	430
Inter- mediate	yard tap	1 000	720	540
Full	metered house connection	1 200	860	650
Sanitation				
Basic	on-site sanitation	1 000	720	540
Inter- mediate	intermediate sewerage	1 680	1 210	910
Full	Conventional waterborne	2 400	1 725	1 300

Source: World Bank, 1992

- Notes:
1. The costs include internal bulk services.
 2. Costs exclude land costs.
 3. Assumed to be total construction costs (but this is not explicitly stated in aide memoir).

Comment:

These costs are significantly lower than for the Durban Functional Region (see Appendix 6). This is to be expected, because of the flatter topography. However, there appear to be two problems with these figures:

- It is difficult to imagine why on-site sanitation systems would cost less if the density of development is higher.
- The costs appear to be on the low side. Based on existing project information, R1 000 for a constructed VIP is too little, and R 540 is certainly unrealistic. The figure of R1 300 for conventional waterborne sanitation, indicates that it is probable that the privy superstructure is excluded from the cost and hence the costs are not strictly comparable.

Upgrading costs

Upgrading costs (1993 Rands per plot):

		Density of development		
		25 plot/ha	40 plot/ha	60 plot/ha
Water Supply				
Basic to intermediate		250	180	135
Basic to full		500	360	270
Intermediate to full		250	180	135
Sanitation				
Basic to intermediate		850	580	1 040
Basic to full		1 750	1 260	950
Intermediate to full		***	***	***

Source: World Bank, 1993

- Notes:
1. Upgrading from minimal level of service to basic, intermediate and full level of service is assumed equivalent to the new development costs already provided.
 2. Costs exclude land and internal bulk services.
 3. It is assumed that the costs are total construction costs, however, this is not explicitly stated in the aide memoire.

*** not considered viable

Comment:

The unit upgrading costs were based on a composite of figures obtained from local and regional authorities and infrastructure/housing development organisations. No primary data is referenced, however, and it is therefore to cross-check the accuracy of the quoted figures.

Some of the figures appear to be questionable. For example the upgrading cost from on-site to full waterborne sanitation at a density of 60 plots per hectare for only R 950 per plot would appear to be too low. The water upgrading costs (from communal standpipe to yard tap) also appear to be too low.

5.6 Total Costs

The World Bank estimated the following total investment requirements for water and sanitation: (R million, 1993)

Total investment costs, R million (mid-1993)			
	Basic	Intermediate	Full
Water			
Upgrading	27	43	284
New sites	120	150	180
Sub-total	147	193	464
Bulk	1 500	1 500	1 500
Sanitation			
Upgrading	58	138	739
New sites	150	252	360
Sub-total	208	390	1 099
Bulk	827	827	827
TOTAL			
Internal	355	583	1 563
Bulk	2 327	2 327	2 327
Total	2 682	2 910	3 890
PER ANNUM	536	582	778

These calculations are based on the following assumptions:

1. Eradication of backlog and catering for new demand over the next 5 years.
2. Of the 1.6 million new people living in the Witwatersrand area, over the next 5 years, 1 million will move to newly developed plots/housing on vacant land (at an average of 6 people per plot, therefore = 167 000 plots), with the remaining ±600 000 densifying existing black and white settlements.
3. Bulk costs are based on a 'shopping list' of bulk service agencies' capital development plans. The bulk costs assume the provision of capacity for the highest level of service. No assessment of the appropriateness, efficacy and efficiency of these investments has been done.

Comments on assumptions

Densities: The density of both new development and upgrading is worked out according to a model with the distance to the CBD a key parameter:

The average density of new development is about 240 people per hectare, or about 40 plots per hectare (6 people per plot). The infrastructure is designed to tolerate a density of 450 people per hectare and thus accommodate subdivision. The density ranges from 300 people per hectare at 5 km from the CBD to 130 people per hectare at 35 km from the CBD.

It may be argued that the model is simplistic and that distance from the CBD should not be the key parameter, and that proximity to transport corridors may be a more important locational parameter.

The average gross density in existing low income settlements is 158 people per hectare.

Densification / new development split: The extent to which additional people are accommodated in existing settlements will have a key impact on overall investment costs.

Inaccuracies in cost estimates: The cost estimates included in the document are preliminary and therefore uncertain. It is possible that these costs could be underestimated, having an important effect on overall investment requirements.

Bulk costs: The bulk infrastructure costs are based on a 'shopping list' of needs / plans of the 'regional supply authorities'. These costs are assumed to be constant, irrespective of the level of service provided. Furthermore, no analysis on the appropriateness, efficacy and efficiency of the bulk infrastructure capital development plans has been done. The bulk costs therefore distort the overall investment scenario. For example, the implementation of a basic level of service could require a much reduced bulk infrastructure investment compared to a full level of service, and therefore the total investment figure of 2.7 billion for a basic level of service is misleading because 87% of this investment is for bulk infrastructure (VIPs, for instance, require minimal bulk infrastructure). It is also doubtful that the bulk costs shown represent the actual full costs that would be incurred in providing a full level of service to all households in the Witwatersrand Region.

Time period for eradication of backlogs and analysis: A five year implementation period is assumed in which time the full backlog is eradicated. From a financial impact point of view, year 6 is regarded by the Bank as the critical year. No allowance is made for additional investment requirements after the five years. At this point there could be an additional 53 000 households per annum in the Witwatersrand region, requiring a significant ongoing housing investment and an additional financial burden over and above that to be borne from year 6 onwards (assuming borrowing for investment requirements).

A five year programme to accomplish the eradication of the backlog in services, and to simultaneously adequately cater for new demand, is probably unrealistic. A similar five year programme in Botswana, taking place in a strong and stable institutional and financial environment, is in its 8th year of implementation at present. Extending the period of implementation to 8 to 10 years would be more realistic and would have implications for the total investment requirements and financial impact of the investments.

5.7 Investment per site

The following investments per site were calculated:

Investment per site - Rands (mid-1993)			
	Basic	Intermediate	Full
Water			
Upgrading	32	52	342
New sites	720	900	1 080
Bulk	1 500	1 500	1 500
Sanitation			
Upgrading	70	170	890
New sites	890	1 510	2 155
Bulk	827	827	827
TOTAL	2 682	2 730	3 935

Source: Derived from World Bank data

- Notes:
1. No. of new sites: 167 000 (World Bank)
 2. No. of people on new sites: 1 000 000
 3. Occupancy: 6 people per site (World Bank)
 4. Density: ± 40 plots/ha, ± 240 people per hectare (derived)
 5. Number of existing households to upgrade: 730 000 (4.4 million / 6)
 6. Number of new households to be accommodated in existing settlements: 100 000
 7. New bulk infrastructure to cater for 1 000 000 households.

7. Upgrading costs calculated on the basis of 230 000 households per site

5.8 Sensitivity of investment requirements

Dominance of bulk infrastructure costs: The bulk infrastructure costs shown dominate the overall investment costs, accounting for 60%, 85% and 87% for full, intermediate and basic levels of service respectively. Changes in these costs will therefore have a marked effect on the overall investment scenario. Unfortunately, these costs have received little investigative attention from the World Bank.

The bulk infrastructure requirements for providing a basic and intermediate level of service should be much less than those needed for a full level of service, and therefore it is probable that the figures presented do not represent an accurate reflection of the real costs that would be incurred for different level of service options. [See 'bulk costs' under 'comment on assumptions' above.]

Period of eradication of backlog: Eradication of the backlog over 10 years as compared to 5 years would reduce the annual investment requirement. The extent of the reduction is, however, difficult to independently quantify as it depends to a large extent on assumptions about the extent of densification of existing low-income settlements. All other things being equal, the annual upgrading requirement should, in theory, halve, reducing the annual investment requirement from R 778 million to about R 676 million (13% reduction) in the case of full service provision. The actual reduction in investment requirement will, however, probably be less than this.

Density of infrastructure: Water and sewer reticulation costs are strongly dependent on the density of development. Developing at a density of 25 plots per hectare compared to 40 plots per hectare will result in an increase in unit costs of almost 40% for a full level of service. Assuming a 20% increase in unit development costs as a result of not achieving the stated densities would result in the overall investment requirement increasing by 5% from 3 890 million to 4 085 million in the case of full service provision. On the other hand, on-site sanitation costs are largely independent of development density.

5.9 Operation and maintenance costs

The World Bank approach:

The World Bank reports that accurate operation and maintenance costs for the provision of services in low-income settlements are not available. It further comments, noting anecdotal evidence, that the cost of service provision in these settlements may be significantly higher than the rendering of services in high income areas. The Bank therefore adopted the following approach to the operation and maintenance

implications of the illustrative capital investment programme put forward:

Operations and maintenance costs of new capital investment (both new services and upgrading) =

Basic level: 10% of cumulative capital investment
Intermediate: 5%
Full: 5%

This approach yields the following costs at year 6 (1993 prices):

Basic: R 460 million per annum
Intermediate: R 275 million per annum
Full: R 462 million per annum

The costs are for all services (roads, stormwater, water, sewerage, electricity and refuse removal) and assume that water and electricity consumption is paid for by the user. Nevertheless, these costs are counter intuitive because it is difficult to imagine that it is as expensive to maintain a basic level of service (VIP pit latrines, communal standpipes, high mast lighting, gravel roads and partially lined open stormwater channels) than a full level of service (conventional waterborne sewerage and treatment works, metered water and electricity house connections, paved roads and piped stormwater).

Taking this approach further, by applying it only to the water and sanitation components of the investment, allows a comparison with alternative operation and maintenance cost estimates:

Basic: R 35 million per annum
Intermediate: R 29 million per annum
Full: R 78 million per annum

An alternative approach:

Actual operating and maintenance costs of upgraded and newly provided services are likely to be:

(1993 Rands per month per site)

	water	sanitation	total
Basic:	5 - 10	5 - 10	10 - 20
Intermediate:	10 - 20	10 - 20	20 - 40
Full:	15 - 40	15 - 40	30 - 80

The costs are based on:

Water: A water tariff of 130 c/kl, average water consumptions of 130 - 260 l/house/day (basic), 260 - 520 l/house/day (intermediate) and 390 - 1040 l/house/day (full). The 130 c/kl is assumed to cover full costs, that is, full 'bulk' water costs and maintenance of water reticulation (capital component for internal services not included).

Sanitation: PDG/UCT (1993) Urban Sanitation Evaluation, Working Paper B6. Includes maintenance of on-site structure, pit emptying, reticulation maintenance, treatment and capital redemption component for bulk infrastructure.

Assume the following average costs:

(1993 Rands per month / site)

	water	sanitation	total
Basic:	8	7	15
Intermediate:	15	15	30
Full:	25	25	50

The total operating and maintenance costs (including water consumption) for low-income households are likely to be in the following order of magnitude in year 6 (1993 prices)

Number of sites:

Upgraded:	100 000	(new households in area only)
New:	167 000	
TOTAL:	267 000	

Annual Operating Cost, 1999 (R million, 1993 Rands)			
	Water	Sanitation	Total
Basic	26	22	48
Intermediate	48	48	96
Full	80	80	160

These figures are significantly higher than those derived by the Bank and it is therefore possible that their figures are under estimated. It is not possible to draw further conclusions because of the different methodologies employed in deriving these estimates.

5.10 Financial implications for sector

If a full level of service is to be provided to low-income residents in the Witwatersrand, then, based on the data previously presented, and financial data for the white local authorities summarised overleaf:

- The annual investment requirement of R 778 million (over 5 years is about one and a half times the total revenue received by white local authorities in their water trading accounts, and about 15 times the water trading surplus (if assumed to be 10% of R 500 million).
- The annual operating and maintenance requirement for the low-income settlements (of the order of R 160 million) for a full level of service is about one third of the current expenditure in white local authorities for water supply.

Rand Water Board

Rand Water Board's operating revenue and expenditure for 1991/92 were as follows:

Income:	R 612 million
Expenditure:	R 563 million
Surplus:	R 49 million

Financial Data from white local authorities

Aggregate financial data for white local authorities in the Witwatersrand.

White Local Authorities - Rand per annum (nominal)					
	88/89	89/90	90/91	91/92	92/93
Water					
Income	253	347	423	488	525
Expenditure	253	315	390	469	479
Surplus	-0.9	31.9	32.5	18.8	46.1
Sewerage - TA					
Income	26.4	48.6	56.9	59.8	65.2
Expenditure	45.8	70.1	85.6	101.4	114.5
Surplus	-19.4	-21.5	-28.8	-41.6	-49.3
Sewerage - RA					
Income	129	172	212	250	288

Note: TA = Trading account, RA = Rates account

White Local Authorities - monthly per household data					
	88/89	89/90	90/91	91/92	92/93
Population	2.42	2.59	2.61		
Households - @4	605 000	647 000	652 000		
Households - @5	484 000	518 000	522 000		
Water					
Income	35 - 44	45 - 56	54 - 67		
Expenditure	35 - 44	40 - 50	50 - 62		
Surplus	0	5	5		

APPENDIX 6

Durban Functional Region

Demand for and cost of services

6.1 Introduction

The aim of this appendix is to outline scenarios for the future demand and costs of water and sanitation services in the Durban Functional Region and to examine, in a preliminary way, the financial implications of these on the water sector.

The information for this section is derived primarily from the World Bank Aide Memoire dated 14 June 1993. Supplementary demographic information is quoted from the Urban Foundation Demographic and Income Distribution models.

The appendix is structured in the same way as Appendix 5:

- 6.2 Demographics
- 6.3 Level of service definitions
- 6.4 Existing levels of service
- 6.5 Unit infrastructure costs
- 6.6 Total investment costs
- 6.7 Investments per site
- 6.8 Sensitivity of investment requirements
- 6.9 Operation and maintenance costs
- 6.10 Financial implications for sector

6.2 Demographics

The World Bank adopted the following demographic estimates as the best available:

Population in low-income settlements, 1993	± 2.3 million people
Population growth rate	5%
Additional low-income population, 1998	800 000

Data from the Urban Foundation is summarised below:

Population	1990	1993	2000
White	354 000		
Coloured	596 000		
Asian	70 000		
Black	2 060 000	2 390 000	3 355 000
TOTAL	3 080 000	3 470 000	3 560 000

6.2

Based on the above information and assuming an average household size of 5.5 (Urban Foundation), the following household and population information has been derived:

Household formation	
Annual increase in black population: 1993 - 2000	135 000
Average black household size	5.5
Number of new black households per annum	24 500
New black households: 1993 - 1998	122 500
New black households: 1993 - 2003	245 000

The Urban Foundation gives a black population of 2.4 million for 1993, compared to the 2.3 million assumed by the World Bank, and there is thus fair agreement. However, the model predicts an increase in the black population of 135 000 per annum, whereas the World Bank assumed an annual increase of 160 000, which is about 20% higher.

6.3 Level of service definitions

The World Bank used the following definitions for levels of service when calculating investment scenarios:

Standard	Water	Sanitation
Minimal	communal standpipe	bucket / shared toilet
Basic	water within 250 m	on-site VIP
Intermediate	yard tap	intermediate sewerage (septic tank with low flush toilet)
Full	metered house connection	conventional sewerage

6.4 Existing levels of service

World Bank:

Level of service		Millions of people
Minimal	Communal standpipe > 250m, bucket, pit, shared toilet	1 250 000
Basic	communal standpipe < 250m, VIP latrine	140 000
Intermediate	yard tap, intermediate (on-site) sewerage	few
Full	metered house connection, conventional sewerage	900 000
TOTAL		2 290 000

Comparison with other estimates:

Data available from the Water research commission (Palmer Development Group, 1993), based on a national survey of local authorities, estimates that there are 1.4 million people in the DFR with a minimal and/or basic level of water service. This compares well with the World Bank figure of 1.39 million. However, the split between minimal and basic is quite different for the two sources of data. The Water Research information shows roughly a 50:50 split between minimal and basic levels of service, whereas the World Bank figures estimate a 90:10 split.

Corresponding data for sanitation shows a closer correspondence: 1.2 million people with minimal sanitation and 100 000 with a basic level of sanitation (VIP latrines). These figures compare closely with the World Bank figures of 1.25 million and 140 000.

6.5 Unit Costs

New development costs

New development costs: (1993 Rands / plot)

		Density of development		
		15 plot/ha	24 plot/ha	45 plot/ha
Water Supply				
Basic	Standpipe < 250m	1 300	960	580
Int.	Yard tap	2 300	1 700	1 000
Full	metered house connection	2 900	2 100	1 300
Sanitation				
Basic	VIP	1 800	1 800	1 800
Int.	Low-flush on-site septic	3 000	3 000	3 000
Full	Conventional waterborne	5 800	4 200	2 500

Source: World Bank, 1992

- Notes: 1. Raw construction costs, excludes land, bulk infrastructure, P+Gs, design and overheads.
2. Includes "internal bulk" services.

Upgrading costs

Upgrading costs (1993 Rands per plot)

Upgrading Costs (1990 Rupees per plot)				
		Density of development		
		15 plot/ha	24 plot/ha	45 plot/ha
Water Supply				
Basic to intermediate		320	710	430
Basic to full		1600	1100	680
Intermediate to full		580	420	250
Sanitation				
Basic to intermediate		1 200	1 200	1 200
Basic to full		4 000	2 300	700
Intermediate to full		2 800	1 000	(not viable)

Source: World Bank, 1992

- Notes:
1. Raw construction costs, excludes land, bulk infrastructure, P+Gs, design and overheads.
 2. Excludes costs of rehabilitation and expansion of capacity of "internal bulk" services.
 3. Upgrading from minimal level of service to basic, intermediate and full services is assumed equivalent to new development costs.

Comment:

The same general comments made in Appendix 5 are applicable here. Some of the specific figures appear to be questionable: for example, the upgrading cost from a VIP to full waterborne sanitation at a density of 45 plots per hectare for only R 700 per plot compared to a new development cost of R 2 500 per plot. The water upgrading costs (from communal standpipe to yard tap) also appear to be inconsistent between the densities and too low.

6.6 Total Costs

The World Bank estimated the following total investment requirements for water and sanitation: (R million, 1993)

Total investment costs, R million (mid-1993)			
	Basic	Intermediate	Full
Water			
Upgrading	145	201	237
New sites	32	56	70
Bulk	267	267	267
TOTAL	444	524	574
Sanitation			
Upgrading	204	277	426
New sites	44	73	140
Bulk	142	142	142
TOTAL	390	492	708
TOTAL	834	1016	1282
PER ANNUM	167	203	256

These calculations are based on the following assumptions:

1. Eradication of backlog and catering for new demand over the next 5 years.
2. Of the 800 000 new people living in the Durban Functional Region (DFR) over the next 5 years, 242 000 will move to 30 250 newly developed plots/housing on vacant land (8 people per plot), with the remaining ±550 000 densifying existing black and white settlements.
3. Bulk costs are based on a 'shopping list' of regional bulk supply agencies' capital development plans. The bulk costs assume the provision of capacity for the highest level of service. No assessment of the appropriateness, efficacy and efficiency of these investments have been done.

Comments on assumptions

Densities: The new development costs assume an average occupancy of 8 people per plot. The actual development density is not explicitly stated, but would appear to be in the region of 20 to 24 plots per hectare, giving a gross density of 160 to 200 people per hectare. The average gross density in existing low income settlements is 81 people/hectare, and it is therefore questionable whether these densities are achievable, given Durban's topography. There are significant cost implications, depending on the density achieved. For example, for a full level of service, development at 15 plots/ha compared to 24 plots/ha is almost

40% more expensive.

Densification / new development split: The actual split that occurs will have a significant impact on development costs. The World Bank assumes that a further 550 000 can be accommodated through increasing the density of existing settlements. Yet their upgrading cost analysis make provision for an additional 280 000 people within these areas (using their project densities for 1998), and it is not clear where / how the remaining 270 000 people will be accommodated. Providing new services for these people at a full level of service will require at least an additional investment of about R 210 million.

Upgrading costs: Upgrading costs are highly uncertain and based on minimal data. It is possible that these costs could be significantly under-estimated. The upgrading costs account for a significant proportion of the total investment costs (52% in the case of upgrading to a full level of service), and hence an under-estimate of 20%, for example, could require an additional investment of R 130 million (10% of total investment requirements).

Exclusion of overheads: The internal infrastructure upgrading costs are raw construction costs and exclude design, supervision, survey, preliminary and general and project management. These costs typically account for between 15% and 25% of raw construction costs, but may even exceed 25%. The World Bank argued that their inclusion would distort the picture because, in the light of international experience and practice, these costs should be much lower. Additional costs excluded are those of escalation and contingency allowances. Inclusion of these costs could increase the overall investment requirements by 10% or more.

Bulk costs: See Appendix 5.

Time period for eradication of backlogs and analysis: See Appendix 5.

6.7 Investment per site

The following investments per site were calculated:

Investment per site - Rands (mid-1993)			
	Basic	Intermediate	Full
Water			
Upgrading	675	935	1 102
New sites	1 060	1 850	2 310
Bulk	1 090	1 090	1 090
TOTAL	1 810	2 140	2 345
Sanitation			
Upgrading	950	1 290	1 980
New sites	1 455	2 415	4 630
Bulk	580	580	580
TOTAL	1 590	2 010	2 890
TOTAL	3 404	4 150	5 235

Source: World Bank, 1992

- Notes:
1. Number of new sites: 30 250 (World Bank)
 2. Number of people on new sites: 242 000
 3. Occupancy: 8 people per site (World Bank)
 4. Density: ± 20 plots/ha; ± 160 people per hectare (derived)
 5. Number of existing households to upgrading: 214 900 (World Bank)
 6. Number of people to be accommodated within existing developed areas (1993 - 1998): 280 000
 7. Number of people within existing settlements in 1993: 2 290 000 at 81 p/hectare and 10.6 people per plot (World Bank).
 8. Number of people within existing settlements in 1998: 2 270 000 at 91 p/hectare (World Bank).
 9. It is assumed that new serviced sites within the existing areas will be created, but it is not explicitly stated how many. The upgrading cost / site is therefore based on initial number of plots in existing low-income (black) settlements.
 10. Unit bulk service costs calculated on the basis of 245 000 plots.

6.8 Sensitivity of investment requirements

Period of eradication of backlog: Eradication of the backlog over 10 years as compared to 5 years would reduce the annual investment requirement. The extent of the reduction is, however, difficult to independently quantify as it depends to a large extent on assumptions about the extent of densification of existing low-income settlements. All other things being equal, the annual upgrading requirement should, in theory, halve, reducing the annual investment requirement from R 256 million to about R 200 million (20% reduction) in the case of full service provision. The actual reduction in investment requirement will, however, probably be less than

this.

Density of infrastructure: Water and sewer reticulation costs are strongly dependent on the density of development. Developing at a density of 15 plots per hectare compared to 24 plots per hectare will result in an increase in unit costs of almost 40% for a full level of service. Assuming a 20% increase in unit development and upgrading costs as a result of not achieving the stated densities would result in the overall investment requirement increasing by 14% from 1 282 million to 1 457 million. On the other hand, on-site sanitation costs are largely independent of development density.

Actual versus raw construction costs: If actual upgrading costs are 20% higher than raw construction costs, the total investment would increase by 130 million (10%).

Bulk infrastructure costs: See Appendix 5.

6.9 Operation and maintenance costs

The World Bank approach: (See Appendix 5)

This approach yields the following costs at year 6 (1993 prices):

Basic:	R 246 million per annum
Intermediate:	R 147 million per annum
Full:	R 188 million per annum

Taking this approach further, by applying it only to the water and sanitation components of the investment, allows a comparison with alternative operation and maintenance cost estimates:

Basic:	R 84 million per annum
Intermediate:	R 51 million per annum
Full:	R 64 million per annum

An alternative approach: (See Appendix 5)

The total operating and maintenance costs (including water consumption) for low-income households are likely to be in the following order of magnitude in year 6 (1993 prices)

Number of sites:

Upgraded:	215 000
New:	30 000
TOTAL:	245 000

Annual Operating Cost, 1999 (R million, 1993 Rands)			
	Water	Sanitation	Total
Basic	23.5	20.6	44.1
Intermediate	44.1	44.1	88.2
Full	73.5	73.5	147.0

These figures, while in the same order of magnitude, show an opposite trend to those assumed by the Bank. Further deductions beyond this cannot be made because of the different assumptions used in compiling the figures.

6.10 Financial implications for sector

If a full level of service is to be provided to low-income residents in the Durban Functional Region, then, based on the data previously presented and financial data for the white local authorities summarised overleaf:

- The annual investment requirement of R 256 million (over 5 years is more than double the total revenue received by white local authorities in their water trading accounts, and about 25 times the average surplus of approximately R 10 million obtained in this account in the period 1988/89 to 1991/92.
- The annual operating and maintenance requirement for the low-income settlements (of the order of R 147 million) is of the same order of magnitude as the existing total expenditure in the water trading accounts.

Comparison with other estimates

Jackson (1992) estimated that between R 4 billion and R 7 billion in total investment (1992 prices) was required to provide everybody living in the DFR with a lower and higher level of service respectively by the year 2000 and that this would require an annual subsidy requirement (based on current payment practices and a subsidy of R 65 per site per month) of between R 314 million and R 679 million. These figures are based on a 2.5% population growth rate and cost figures supplied by van Wyk and Louw. These figures are about 3 to 4 times higher than the World Bank projections for a full level of service when compared on an annualized investment basis. Although Jackson's figures are admittedly only a ball-park estimate, they do suggest caution in assessing overall investment requirements, in that an ambitious programme may end up providing a high level of service for some, but not being able to deliver the same high level of service to everybody.

Financial Data from white local authorities:

Aggregate financial data for Durban, Durbanville, Ballito, Hillcrest, New Germany, Tongaat, Kloof, Westville, Queensburgh, Stanger, Pinetown is summarised below:

White Local Authorities - Rand per annum (nominal)					
	88/89	89/90	90/91	91/92	92/93
Water					
Income	119	139	155	171	190
Expenditure	112	127	148	160	191
Surplus	7.1	12.2	7.2	10.8	-0.5
Sewerage					
Income	4.2	4.4	4.9	5.9	6.8

White Local Authorities - monthly per household data					
	88/89	89/90	90/91	91/92	92/93
Population	920000	930000	983000	1047000	1123000
Households - @4	230000	232500	246000	261800	280800
Households - @5	184000	186000	196600	209400	224600
Water					
Income	43 - 54	50 - 63	53 - 66	54 - 68	56 - 70
Expenditure	40 - 51	46 - 59	50 - 63	51 - 64	57 - 70
Surplus	3	4	3	3	0

Operating income and expenditure - Umgeni Water (1992/93)

Income: R 243 million
 Expenditure: R 231 million
 Surplus: R 12 million

APPENDIX 7

Port Elizabeth Metropolitan Area

Demand for and cost of services

7.1 Introduction

The aim of this appendix is to outline scenarios for the future demand and costs of water and sanitation services in the Port Elizabeth Metropolitan area and to examine, in a preliminary way, the financial implications of these on the water sector.

The information for this section is derived primarily from the World Bank Aide Memoir dated 14 June 1993. Supplementary demographic information is quoted from the Urban Foundation Demographic and Income Distribution models.

The appendix is structured as follows:

- 7.2 Demographics
- 7.3 Level of service definitions
- 7.4 Existing levels of service
- 7.5 Unit infrastructure costs
- 7.6 Total investment costs - World Bank
- 7.7 Investments per site - World Bank
- 7.8 Sensitivity of investment requirements
- 7.9 Operation and maintenance costs
- 7.10 Financial implications for sector

7.2 Demographics

The World Bank adopted the following demographic estimates as the best available:

Population in low-income settlements, 1993	± 800 000 people
Population growth rate	6% per annum
Additional low-income population, 1998	330 000 people

- Notes:
- 1. Figures refer to the population within Port Elizabeth and Uitenhage/Despatch.
 - 2. The source of population information is from local authorities and has not been cross-checked with the population census. There is a distinct tendency for local authorities to over estimate population.
 - 3. See Urban Foundation Demographic Figures provided below for comparison.

Based on the above information and assuming an average household size of 5.5 (Urban Foundation), the following household and population information has been derived:

Household formation	
Annual increase in black population: 1993 - 2000	66 000
Average black household size	5.5
Number of new black households per annum	12 000
New black households: 1993 - 1998	60 000
New black households: 1993 - 2003	120 000

Data from the Urban Foundation is summarised below:

Population	1990	1993	2000
White	194 000		
Coloured	201 000		
Asian	9 000		
Black	580 000	671 000	945 000
TOTAL	984 000	1 097 000	1 416 000

Note: Model assumes 1990 - 2000 growth rate to be 3.7% per annum for the whole of the PE metropole and 5% per annum for the black population.

The model therefore gives a low-income (black) population figure of 671 000 people, compared to the World Bank figure of 800 000 (almost 20% higher).

7.4 Level of service definitions

The World Bank used the following definitions for levels of service when calculating investment scenarios:

Standard	Water	Sanitation
Minimal	communal standpipe	bucket / community toilet
Basic	standpipe within 250 m	on-site sanitation
Intermediate	yard tap	aquaprivy with intermediate sewerage
Full	metered house connection	conventional sewerage

7.4 Existing levels of service

World Bank:

Level of service		Millions of people
Minimal	Communal standpipe > 250m	77 000
	Bucket, shared toilet	112 000
Basic	communal standpipe < 250m	33 000
	on-site sanitation	0
Intermediate	yard tap	17 000
	intermediate sewerage	77 000
Full	metered house connection	663 000
	conventional sewerage	603 000
TOTAL	All service levels	790 000

Water Research Commission Figures:

Water supply:

Level of service		Millions of people
Minimal	Communal standpipe > 250m	242 000
Basic	communal standpipe < 250m	24 000
Intermediate	yard tap	80 000
Full	metered house connection	350 000
TOTAL	All service levels	695 000

Note: 1990 figures escalated at 5% per annum

Sanitation:

Level of service		Millions of people
Minimal	Bucket	200 000
Full	Conventional sewerage	495 000
TOTAL	All service levels	695 000

Note: 1990 figures escalated at 5% per annum

Discussion

There is a fairly large discrepancy between figures derived by the World Bank and that obtain from the Water Research Commission survey. The latter figures show a lower level of service generally than do the World Bank figures. However, the World Bank overall low-income population figures are significantly higher.

7.5 Unit Costs

New development costs

New development costs: (1993 Rands / plot)

		Density of development		
		26 plot/ha	42 plot/ha	63 plot/ha
Water Supply				
Basic	SP < 250m	390	290	220
Inter- mediate	Yard tap	850	620	480
Full	metered house connection	1 230	880	670
Sanitation				
Basic	VIP	1 500	1 500	1 500
Inter- mediate	Low-flush on-site septic tank	2 500	2 200	2 030
Full	Conventional waterborne	3 390	2 810	3 000

Source: World Bank, 1992

- Notes: 1. Includes internal bulk infrastructure
2. Excludes land and overheads costs ("fees")

Comment on costs

1. It is not clear why conventional sewerage costs are lower for new development at 42 plots/ha compared to 63 plots/ha, and there might be a mistake in either figure.
2. It would seem that the costs of a basic level of water supply are too low. For example, equivalent costs in the PWV range from R430 to R800 per site depending on density.

Upgrading costs

Upgrading: (1993 Rands per plot)

		Density of development		
		25 plot/ha	40 plot/ha	60 plot/ha
Water Supply				
Basic to intermediate		575	420	320
Basic to full		1 060	745	555
Intermediate to full		480	320	240
Sanitation				
Basic to intermediate		1 250	860	675
Basic to full		2 360	1 640	1 885
Intermediate to full		***	***	***

Source: World Bank, 1992

- Notes:
1. Upgrading from minimal level of service to basic, intermediate and full services is assumed equivalent to new development cost provided above.
 2. Costs exclude rehabilitation / expansion of internal bulk infrastructure.
 3. The report does not state whether the costs include overheads.
- *** not viable

Comment on upgrading costs

The same general comments made in Appendix 5 are applicable here. Some of the specific figures appear to be questionable, for example, the cost of upgrading from on-site sanitation to full waterborne sanitation at a density of development of 60 plots per hectare appears too low. The equivalent figure for the PWV is R 950, but even this figure would seem to be too low. It should be noted, however, that these costs exclude on-site super-structures.

7.6 Total Costs

The World Bank estimated the following total investment requirements for water and sanitation: (R million, 1993)

Total investment costs, R million (mid-1993)			
	Basic	Intermediate	Full
Water			
Upgrading	2.8	6.9	11.4
New sites	13.0	28.6	41.6
Sub-total	15.8	35.5	53.0
Bulk	49.5	49.5	49.5
Sanitation			
Upgrading	20.0	28.0	16.8
New sites	50.7	84.5	114.4
Sub-total	70.7	112.5	131.2
Bulk	108.6	108.6	108.6
TOTAL			
Internal	86.5	148.0	184.5
Bulk	158.1	158.1	158.1
Total	244.6	306.2	342.6
PER ANNUM	48.9	61.2	68.5

These calculations are based on the following assumptions:

1. Eradication of backlog and catering for new demand over the next 5 years.
2. Of the 330 000 new people living in the Port Elizabeth area over the next 5 years, 110 000 will move to newly developed plots/housing on vacant land, 165 000 densifying settlements identified in the report and the remaining 55 000 settling in other existing black and white formal settlements. The density of new development is not explicitly stated in the report, but is thought to be at an average of 130 people per hectare (about 26 plots per hectare and therefore a total of about 22 000 new sites)
3. Bulk costs are based on a 'shopping list' of local authorities capital development plans. The bulk costs assume the provision of capacity for the highest level of service. No assessment of the appropriateness, efficacy and efficiency of these investments have been done.
4. The figure for upgrading to a full level of sanitation service (16.8 million) appears to be anomalous, as it is difficult to imagine why this should be less than upgrading to an intermediate level of sanitation service (28 million).

Comments on assumptions

Densities: See Appendix 5.

Densification / new development split: The extent to which additional people are accommodated in existing settlements will have a key impact on overall investment costs.

Inaccuracies in cost estimates: The cost estimates included in the document are preliminary and therefore uncertain. It is possible that these costs could be under estimated, having an important effect on overall investment requirements.

Bulk costs: See Appendix 5.

The total investment figure of 244 million for a basic level of service is misleading because 65% of this investment is for bulk infrastructure (VIPs, for instance, require minimal bulk infrastructure). It is also doubtful that the bulk costs shown represent the actual full costs that would be incurred in providing a full level of service to all households in the Port Elizabeth Metropolitan Region.

Time period for eradication of backlogs and analysis: See Appendix 5.

7.7 Investment per site

The following investments per site were calculated:

Investment per site - Rands (mid-1993)			
	Basic	Intermediate	Full
Water			
Upgrading	85	210	345
New sites	590	1 300	1 890
Bulk	900	900	900
Sanitation			
Upgrading	600	850	510
New sites	2 300	3 840	5 200
Bulk	1 975	1 975	1 975
TOTAL			
	4 450	5 560	5 910

Source: World Bank, 1992

- Notes:
1. Number of new sites: 22 000 (World Bank)
 2. Number of new people: 110 000
 3. Occupancy: 5 people per site (World Bank)
 4. Density: ± 26 plots/ha; ± 130 people per hectare (derived)
 5. Number of households to upgrade: 33 000 (World Bank)
 6. Number of people to upgrade: 165 000 (derived)
 7. Household size: 5
 8. Unit bulk service costs calculated on the basis of 245 000 sites.

7.8 Sensitivity of investment requirements

Bulk infrastructure costs: The bulk infrastructure costs given represent a significant share of the overall investment costs, accounting for 49%, 52% and 65% for full, intermediate and basic levels of service respectively. See Appendix 5.

Period of eradication of backlog: Eradication of the backlog over 10 years as compared to 5 years would reduce the annual investment requirement. The extent of the reduction is, however, difficult to independently quantify as it depends to a large extent on assumptions about the extent of densification of existing low-income settlements. All other things being equal, the annual upgrading requirement should, in theory, halve, reducing the annual investment requirement from R 68 million to about R 65 million (5% reduction) in the case of full service provision.

7.9 Operation and maintenance costs

The World Bank approach: (see Appendix 5)

This approach yields the following costs at year 6 (1993 prices):

Basic:	R 44 million per annum
Intermediate:	R 32 million per annum
Full:	R 49 million per annum

Taking this approach further, by applying it only to the water and sanitation components of the investment, allows a comparison with alternative operation and maintenance cost estimates:

Basic:	R 24 million per annum
Intermediate:	R 15 million per annum
Full:	R 16 million per annum

An alternative approach: (see Appendix 5)

The total operating and maintenance costs (including water consumption) for low-income households are likely to be in the following order of magnitude in year 6 (1993 prices)

Number of sites:

Upgraded: 33 000

New: 22 000

TOTAL: 55 000

Annual Operating Cost, 1999 (R million, 1993 Rands)			
	Water	Sanitation	Total
Basic	5.3	4.6	9.9
Intermediate	9.9	9.9	19.8
Full	16.5	16.5	33.0

These figures are of the same order of magnitude as the World Bank assumed figures, however the direction of increasing cost is opposite, with a full level of service costing more to operate than a basic level.

7.10 Financial implications for sector

If a full level of service is to be provided to low-income residents in the Port Elizabeth area, then, based on the data previously presented and financial data for the white local authorities summarised overleaf:

- The annual investment requirement of R 65 million (over 5 years is about 15% more than the total current expenditure by Port Elizabeth municipality on its regional water supply function.

Should the total capital requirement be borrowed over a 15 year period at a real interest rate of 5%, then annual payments on the investment in water and sanitation would be ***, equivalent to *** % of total expenditure in the water sector at present.

- The annual operating and maintenance requirement (of the order of R 33 million per annum) for the new investment in low-income settlements represents about 60% of total current expenditure in white local authorities.

Financial Data from Port Elizabeth Municipality

White Local Authorities - Rand per annum (nominal)					
	88/89	89/90	90/91	91/92	92/93
Water					
Income					
Expenditure ^a		37.4	44.5	49.2	57.2
Surplus	-0.8	-5.7	-1.0	0.05	-0.2
Sewerage - TA^b					
Income				1.2	1.5
Expenditure				1.2	1.3
Surplus				0	0.2
Sewerage - RA^c					
Income	3.5	4.6	4.7	5.8	6.3

- Note: a. Total expenditure on bulk water supply and distribution.
 PEM has regional responsibility for water.
 b. TA = Trading account
 c. RA = Rates account

Port Elizabeth Municipality - monthly per household data					
	88/89	89/90	90/91	91/92	92/93
Population	0.291	0.295	0.299	0.321	0.340
Households - @4	72 800	73 800	74 800	80 300	85 000
Households - @5	58 200	59 000	59 800	64 200	68 000
Water					
Income					
Expenditure					
Surplus					