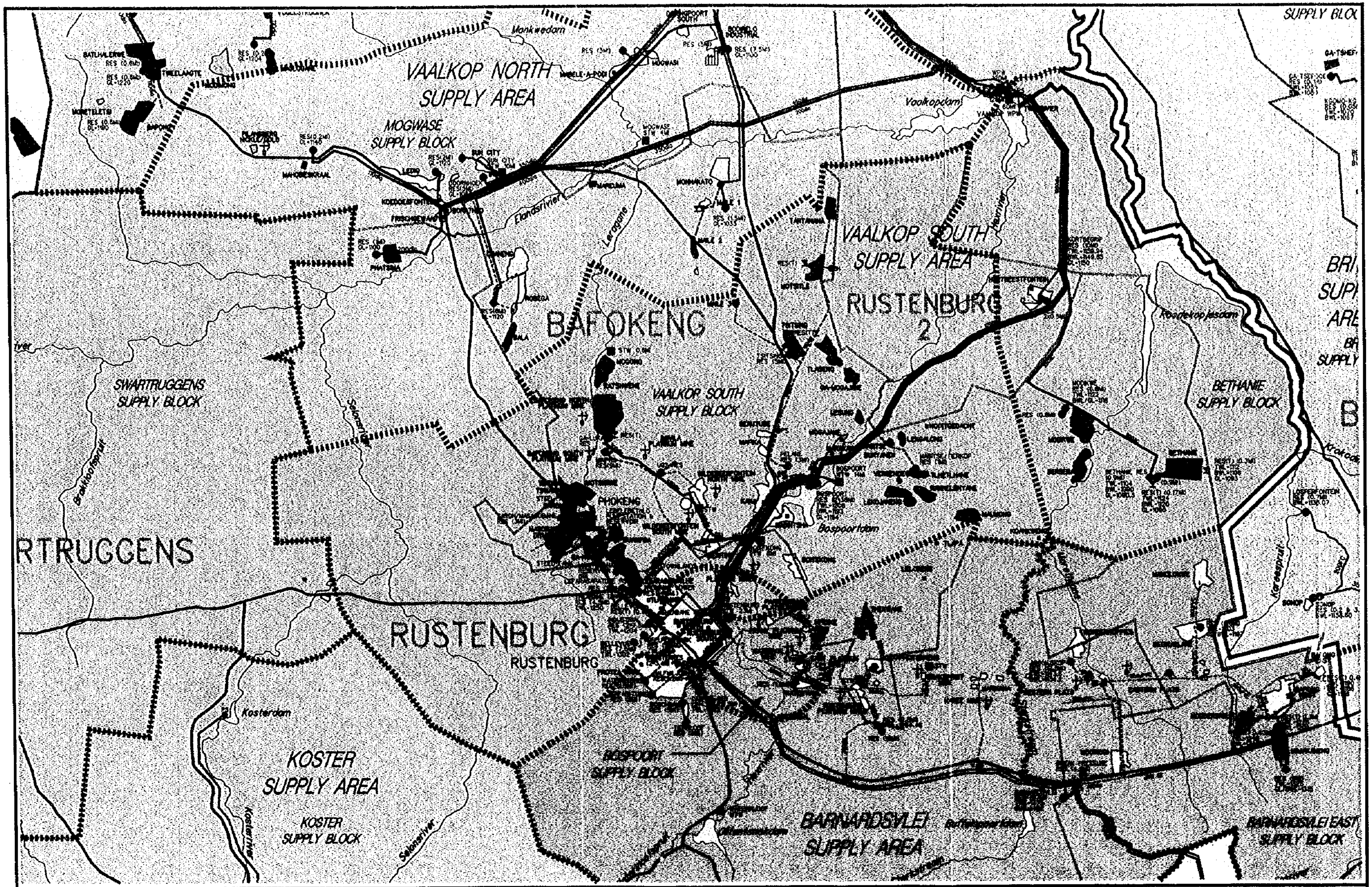
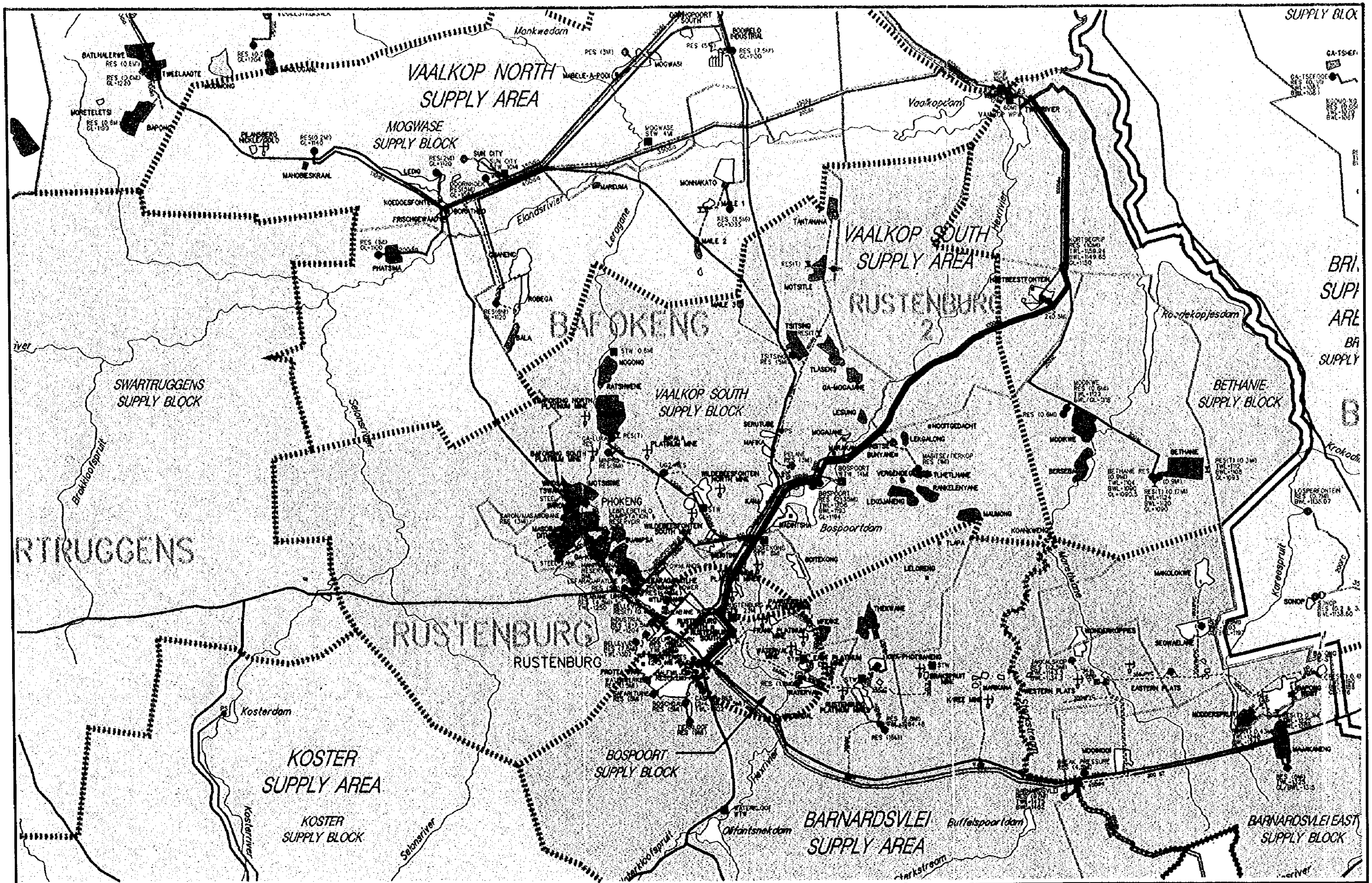
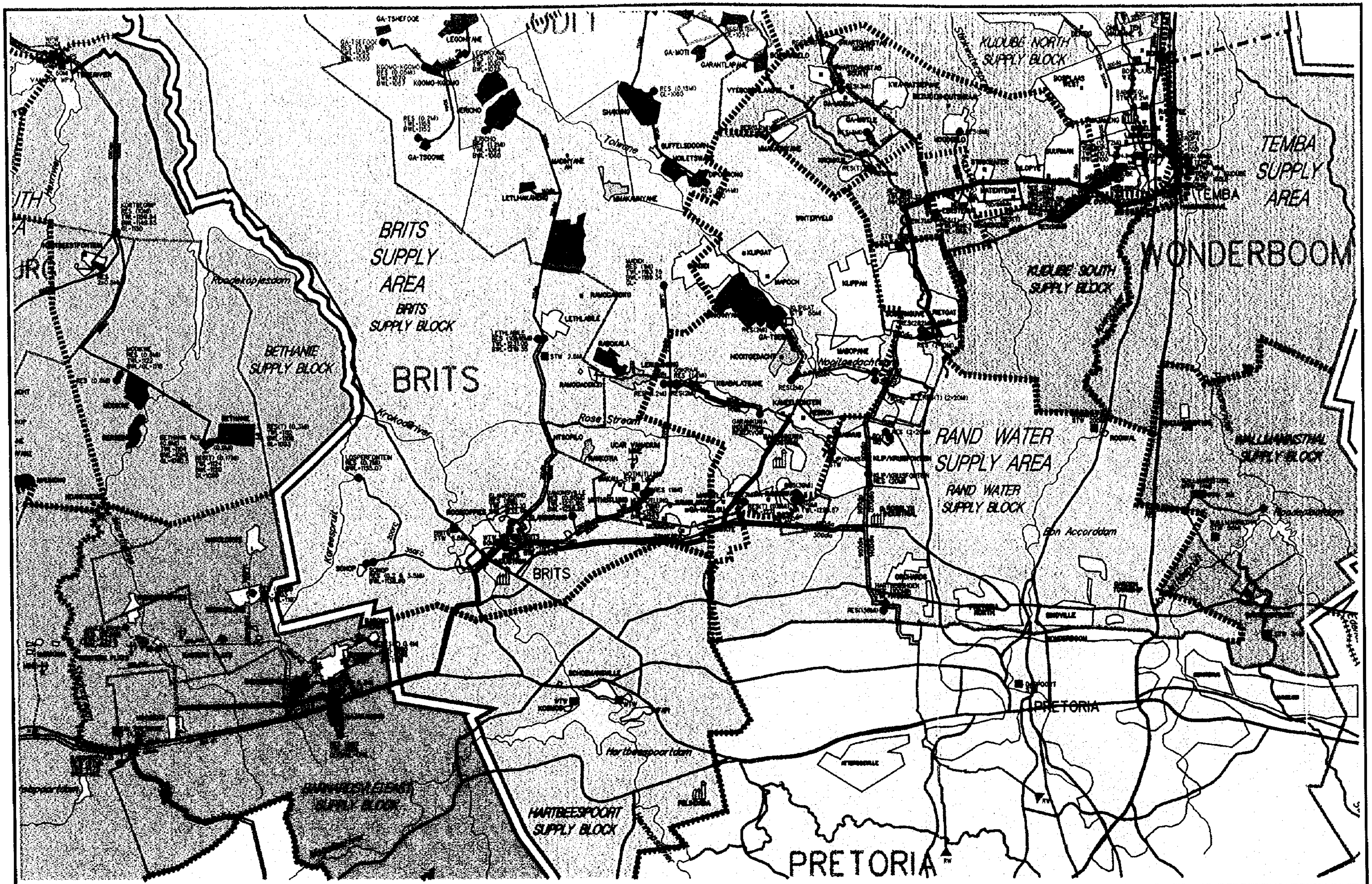


LEGEND : SUPPLY OPTIONS EVALUATED	Supply Options Evaluated in the Rand Water (Hartbeeshoek) Supply Area	SCALE : 1 : 250 000	JICA STUDY TEAM	Figure 2-1



LEGEND : SUPPLY OPTIONS EVALUATED	Supply Options Evaluated in the Rand Water (Hartbeeshoek) Supply Area	SCALE : 1 : 250 000	JICA STUDY TEAM	**Figure 2-1**



LEGEND :

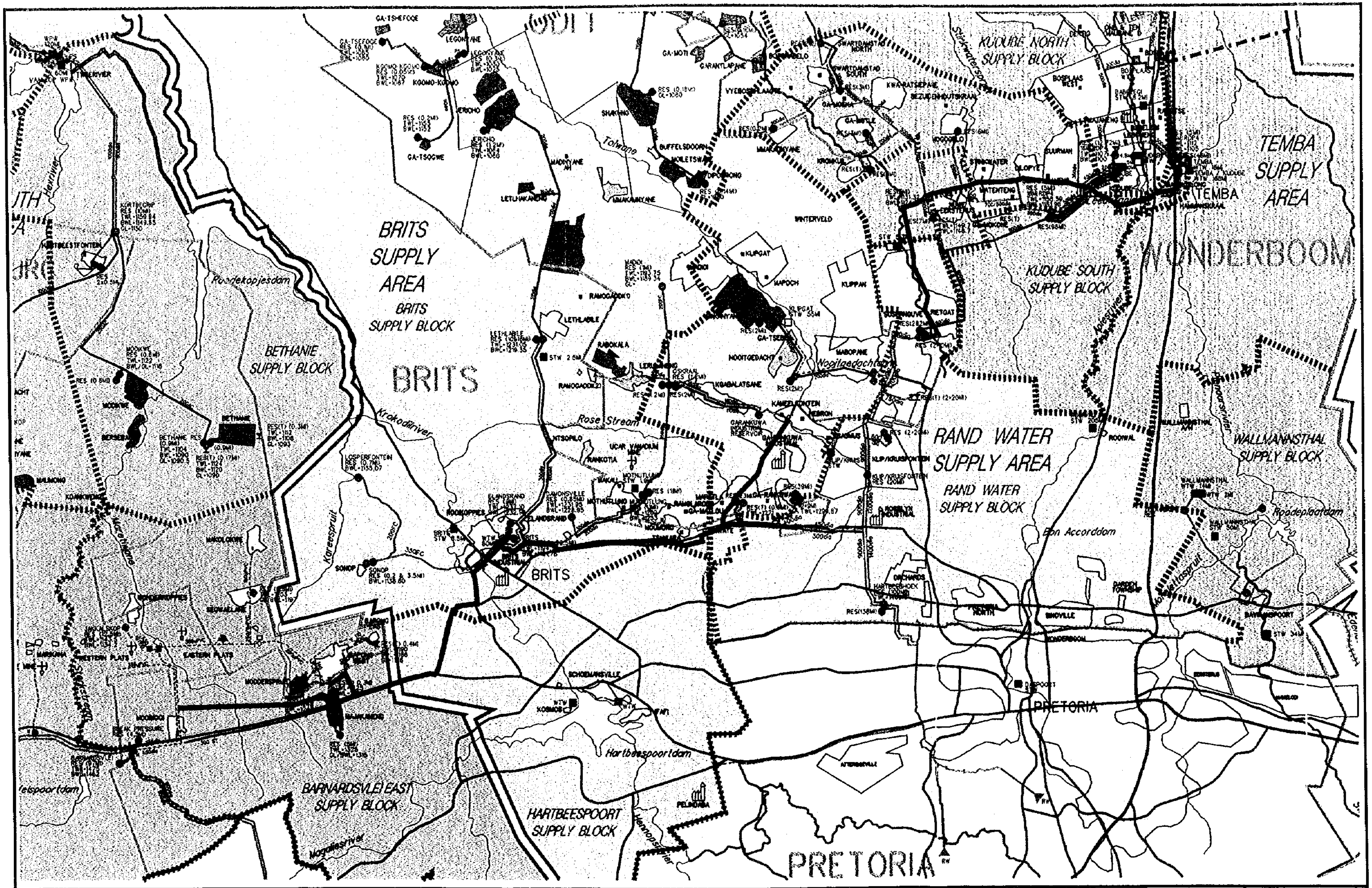
SUPPLY OPTIONS EVALUATED

Supply Options Evaluated in the Barnardsvlei Supply Area

SCALE : 1 : 250 000

JICA STUDY TEAM

Figure 2-2



LEGEND :

SUPPLY OPTIONS EVALUATED

Supply Options Evaluated in the Barnardsvlei Supply Area

SCALE : 1 : 250 000

JICA STUDY TEAM

Figure 2-2

CHAPTER 3

TECHNICAL OPTIONS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 3 TECHNICAL OPTIONS

3.1 Objectives of the Technical Study

As mentioned previous section 2.3 of this report, the existing water supply from RandWater Board to both "Rand Water Supply Area (Hartbeeshoek) and BarnardsvleiWater Supply Area"has sufficient capacity to meet the peak demand of year 2015.

The technical option should therefore be evaluated as "Option for the Replacement of the Exisiting Rand Water Supply Capacity", rather than as "Augmentation Schemes".

According to the information forecasted by the DWAF 1997, the raw water cost in the Vaal river basin will increase significantly due to sharing of high construction cost of new water resource development in and around the basins. Under the above circumstances, stakeholders concerned will require appropriate consideration whether the water supply from RW shall continue to the both area or such water supply shall change partially from Magalies Expansion area instead of existing Rand Water supply infrastructures.

3.2 Overview of the Supply Areas

Rand Water supplies both the Hartbeeshoek and Barnardsvlei reservoirs with water abstracted from Vaal Dam and purified at Zuikerbosch Water Treatment Works.

The Hartbeeshoek Reservoir has a TWL of 1,406.5m and lies on the northern slopes of the Magaliesberg, just south of a suburb named "The Orchards".

Water gravitates from the Hartbeeshoek Reservoir to Rosslyn, Klip/Kruisfontein, Mabopane, Klippan, Soshanguve, and Rietgat. A branch at Rosslyn feeds Ga-Rankuwa and the surrounding area.

The Barnardsvlei Reservoir has a TWL of 1,475.4 and is situated on the Magaliesberg just south of the old road from Hartbeespoort Dam to Rustenburg near the village of Mooinooi.

Water gravitates from the Barnardsvlei Reservoir eastwards to supply Western Plats and Eastern Plats mines, and the villages of Mooinooi, Modderspruit, Bapong West, Bapong East, and Majakaneng, and gravitates westwards to supply Rustenburg, Thlabane, Phokeng, Bafokeng, and the surrounding platinum mines. The supply to the Rustenburg area is strengthened by a pipeline from the Bospoort Dam that is situated to the north-east of Rustenburg on the Hex River.

3.3 Availability of Water Resources

The following sources were considered for the local supply options:

(1) Temba Water Treatment Works (formerly Kudube WTW) located on the Apies River (a tributary of the Pienaars River). Temba Reservoir can however also be supplied from Klipdrift WTW (formerly Temba WTW) on the Pienaars River.

(2) Brits Water Treatment Works located on the Crocodile River downstream of Hartbeespoort Dam.

(3) Vaalkop Water Treatment Works located below Vaalkop Dam on the Hex River. The yield of Vaalkop Dam is however dependent on the supply from Roodekoppies Dam on the Crocodile River upstream of Vaalkop and downstream of Brits.

All of the above options source water from the Crocodile or the Pienaars River Systems. The yield of the Crocodile River is heavily dependent on return flows from the Greater Johannesburg area whilst the yield of the Pienaars River is dependent on return flows from the Greater Pretoria Area.

Stochastic hydrological systems modeling of these two river systems was reported on in detail during the Master Plan Study. It was shown that the volume of return flows from the Greater Pretoria and Johannesburg areas will grow at a faster rate than domestic water consumption in the expanded Magalies Area of Supply. The models also show that, as a result of the faster growth in return flows, the local water resources can meet additional demands at a higher level of assurance in the later years of the planning horizon (2015), than at the turn of the century (2000). It was also shown that the Pienaars River will have a greater surplus of water than the Crocodile System in the near future (2000).

The models have operating rules that protect the supply to domestic and industrial consumers at the expense of the supply for irrigation during times of low flow. It is therefore not surprising that the various scenarios analyzed all showed that the domestic and industrial demand is always met, while the risk of failure of supply to irrigators varies, depending on assumptions as to the growth in urban and industrial demand and the availability of return flows.

DWAF has indicated that an updated hydrological analysis of these two river systems will be commissioned soon. One of the purposes of the analysis would be to model diversion of return flows so that they can be optimally directed and utilized.

If it is decided that one or more of the options costed in this section is economically competitive with the RW supply, then DWAF should include such options as scenarios in the further hydrological analysis.

3.4 Capacity of Existing Supply

3.4.1 Rand Water (Hartbeeshoek) Supply Area

During the early part of Phase 1 the Study Team held discussions with RW regarding the capacity of their supply to the Rand Water (Hartbeeshoek) Supply Area. At that time indications were that the RW supply from the Hartbeeshoek Reservoir would be upgraded from the existing capacity of 140 Mld to approximately 300 Mld (both peak day capacity). The total demand for the supply area downstream of Hartbeeshoek is projected to be approximately 340 Mld at the end of the planning horizon (2015). It was therefore projected that, even with the upgraded Rand Water supply, there could be a shortfall of approximately 40 Mld in the supply to the Hartbeeshoek Reservoir Zone. These assumptions were taken through to the subsequent stages of the Master Plan Study.

For the purposes of this Boundary Issues Study, the assumptions underlying the capacity of the RW supply were revisited and further discussions were held with RW.

During mid 1997, RW completed a revised hydraulic simulation analysis of the whole Rand Water Supply Area. Discussions with Rand Water indicated that their supply to the Hartbeeshoek Reservoir can meet a peak demand of approximately 370Mld.

Because the capacity of the supply provided by RW was higher than the previous estimate, the Study Team decided to analyze the hydraulics of the upgraded supply, using a conservative pipeline friction factor. The resulting calculations determined that the supply between the Hartbeeshoek Reservoir and Rosslyn can meet a peak demand of approximately 387Mld and that the supply to the Soshanguve Reservoirs can meet a peak demand of approximately 304Mld. This confirmed the capacities provided by Rand Water. It also confirms RW's statement that the upgraded supply will be able to meet the projected 2015 peak demand of 338Mld below the Hartbeeshoek Reservoir and 254Mld below the Soshanguve Reservoirs once the upgrading has been completed towards the end of 1997.

Rand Water explained that the difference between the current estimates of the supply to the Rand Water Supply Area and previous estimates is because the current RW servitude's are limited. In view of this, a decision had been taken to lay a large diameter pipeline and make full use of the existing servitude's, rather than lay a smaller diameter pipeline that would have to be upgraded in the near future requiring the procurement of additional servitude's.

The pipeline capacity calculations and water demand projections are provided in Annex A and are the summarised water demand is as shown in the following Table 3-1.

Table 3-1 : Reconciliation of Demands in the Rand Water Supply Area

Demand	2015 demand downstream of Hartbeeshoek Reservoir	338 Mld
Supply	RW peak supply to Rand Water Supply Area (ie Hartbeeshoek Reservoir)	370 Mld
Demand	2015 demand downstream of Soshanguve Reservoir	254 Mld
Supply	RW peak supply to Soshanguve Reservoir	304 Mld

3.4.2 Barnardsvlei Supply Area

The RW hydraulic simulation model shows that the supply to the Barnardsvlei Reservoir can meet a peak demand of approximately 150 Mld.

The Study Team analyzed the hydraulics of the existing RW supply to Barnardsvlei using a conservative pipeline friction factor and confirmed the Rand Water capacity estimate.

Bospoort Dam supplies an additional 11 Mld to this supply area.

RW and MW have also agreed that MW should expand the capacity of Vaalkop WTW and construct a 77.9 Mld capacity pipeline from Vaalkop Dam to Rustenburg, via a reservoir near Bospoort Dam.

Once this pipeline from Vaalkop to Rustenburg has been implemented, the supply should be sufficient to meet the year 2015 peak demand of 228 Mld. This is explained in Table 3-2 below.

Table 3-2 : **Reconciliation of Demands in the Barnardsvlei Supply Area**

Demand	**Total Existing Peak Demand**	**228 Mld**
Supply	Existing RW supply to Barnardsvlei Reservoir	150 Mld
	Bospoort Dam supply	11 Mld
	Proposed Vaalkop South pipeline	78 Mld
	Total Peak Supply Capacity	**239 Mld**

3.5 Infrastructure Options

3.5.1 Rand Water (Hartbeeshoek) Supply Area

It has been shown that the existing RW supply to the Rand Water Supply Area has sufficient capacity to meet the peak 2015 demand. The technical options should therefore be evaluated as options for the replacement of the existing RW supply capacity, rather than as augmentation schemes.

The following technical supply options shown schematically in Figure 3-1 are deemed feasible for the Rand Water Supply Area and were evaluated.

- Increase the capacity of Temba WTW and construct a new pipeline to supply the Soshanguve Reservoir.

- Increase the capacity of Brits WTW and construct a new pipeline to supply Ga-Rankuwa and the associated industrial areas.

The results are as follows:

(1) Temba WTW to Soshanguve Reservoir Option

The Temba to Soshanguve option has been sized to meet the Winterveld and Klippan 2015 demand of 47.2 Mld. The pipeline would be approximately 35.2 km in length and water would need to be pumped from Temba (top water level of approximately 1,107m) to the Soshanguve Reservoir (top water level of approximately 1,358m).

Pipelines ranging in size from 600 mm to 1,000 mm diameter were costed in order to determine the optimum size of pipe from an economical viewpoint. The estimated costs, comprising the capital cost of pipes, pumps and treatment works and the energy cost for pumping, for each pipe size are discussed in Chapter 4 of this report.

(2) Brits WTW to Ga Rankuwa Option

The Brits to Ga-Rankuwa option was sized to meet a peak 2015 demand of 44.4 Mld, which includes Ga Rankuwa, Ga Rankuwa Industries, Ga Rankuwa Police Station, and Mapetla. The total pipeline including a branch to Ga Rankuwa Industries would be approximately 30.8 km in length.

Pipelines ranging in size from 600mm to 1,000mm diameter were costed. The estimated costs are provided in the Chapter 4 as for the Temba Option.

3.5.2 Barnardsvlei Supply Area

It has been shown that the existing RW supply, together with the proposed Vaalkop pipeline will have sufficient capacity to meet the 2015 peak demand in the Barnardsvlei Supply Area. All technical options should therefore be evaluated as options for partial replacement for the existing RW supply capacity.

The following technical supply options shown schematically in Figure 3-2 are deemed feasible and were evaluated for the Barnardsvlei Supply Area:

- Increase the capacity of Brits WTW and construct a new pipeline to supply the Barnardsvlei East Supply Area.

- Increase the capacity of Vaalkop WTW and construct a new pipeline to supply the Rustenburg Supply Area in addition to the 77.9 Mld pipeline already under consideration.

(1) Brits WTW to Barnardsvlei East Option

The Brits to Barnardsvlei East option was sized to meet a peak 2015 demand of 45 Mld, which includes for Bapong, Segwaelane, Wonderkoppies, Mooinooi, and Western Plats Supply Units. The pipeline would be approximately 32km in total length.

Pipelines ranging in size from 600 mm to 1,200 mm diameter were costed. The estimated costs are provided in the Chapter 4.

(2) Vaalkop WTW to Rustenburg Option

The Vaalkop Dam to Rustenburg option was sized to meet a peak year 2015 demand of 40 Mld, which includes for Rustenburg South, Impala, RPM, Karee, and Diverse consumer Supply Units. The pipeline would be approximately 58.4 km in total length.

Pipelines ranging in size from 600mm to 1,200mm diameter were costed. The estimated costs are provided in Chapter 4.

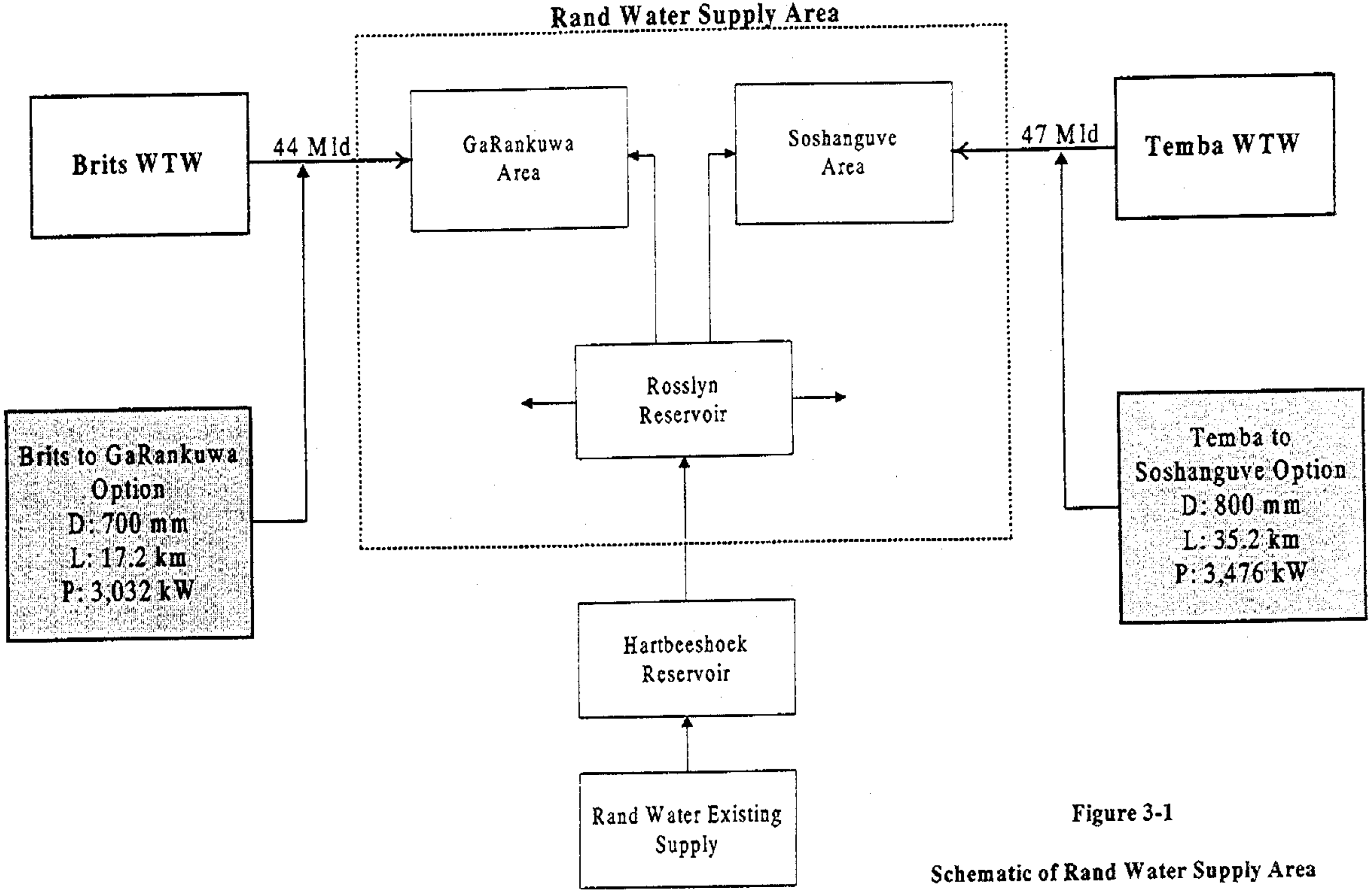


Figure 3-1

Schematic of Rand Water Supply Area

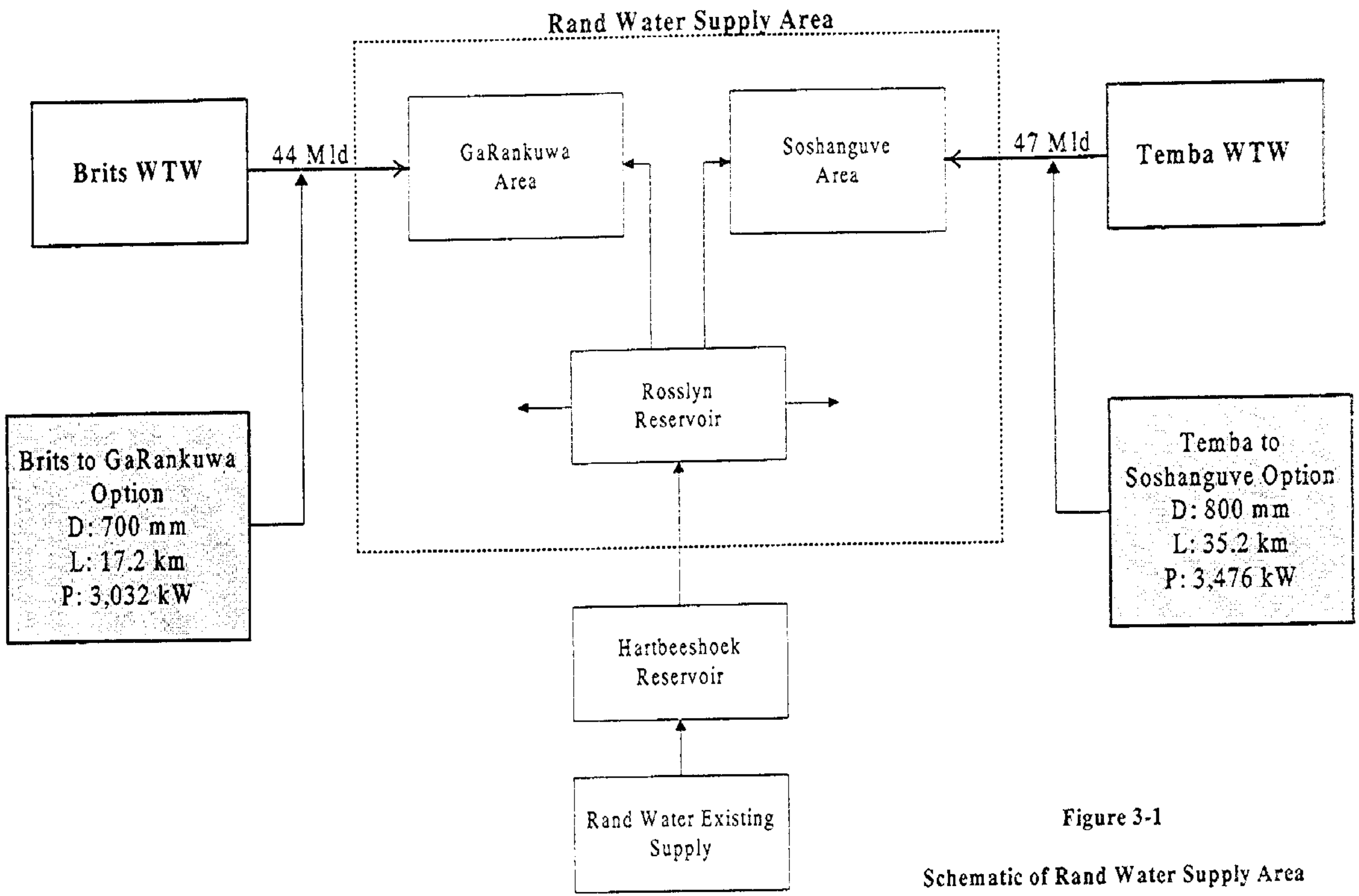


Figure 3-1

Schematic of Rand Water Supply Area

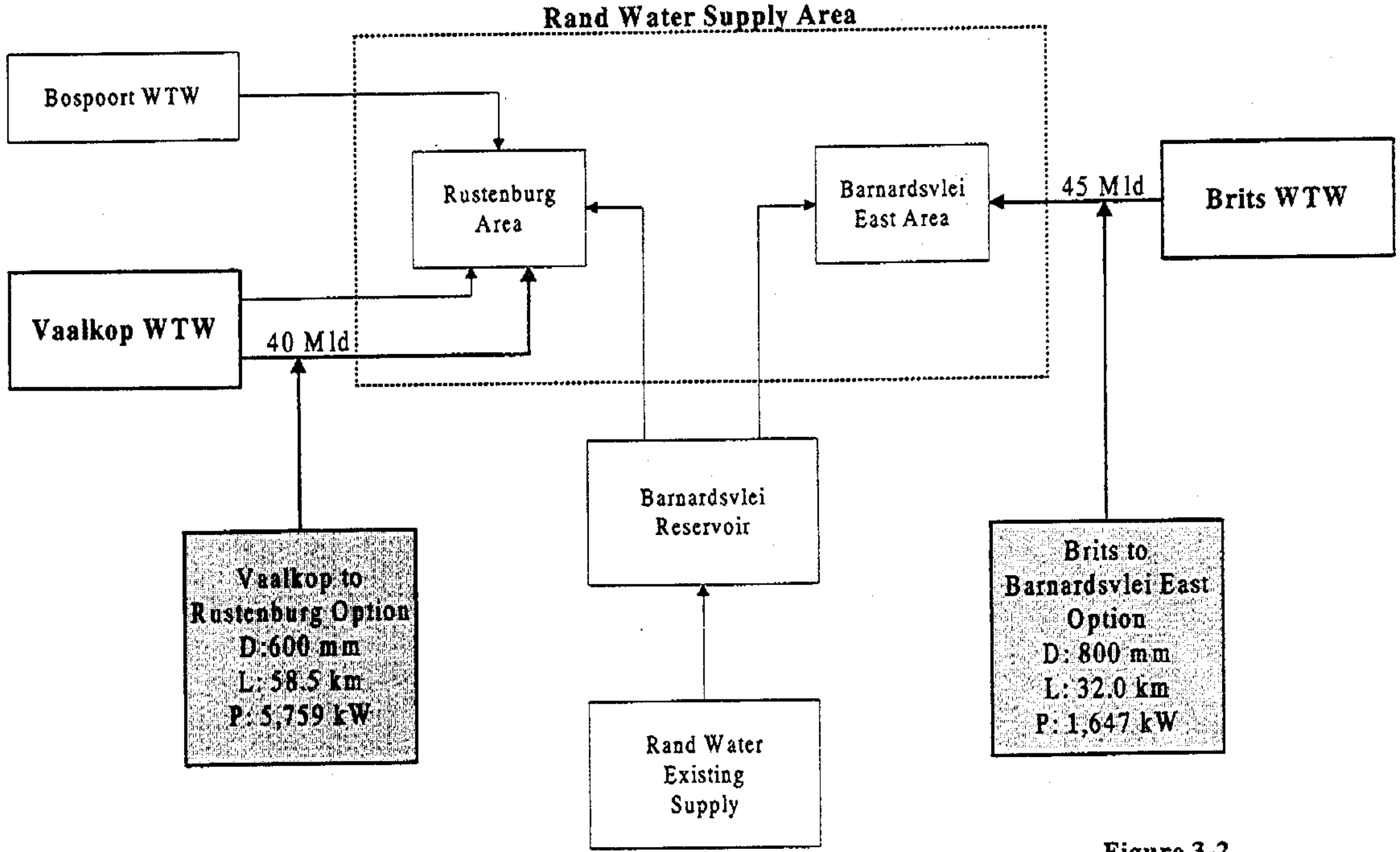


Figure 3-2
Schematic of Barnardsvlei Supply Area

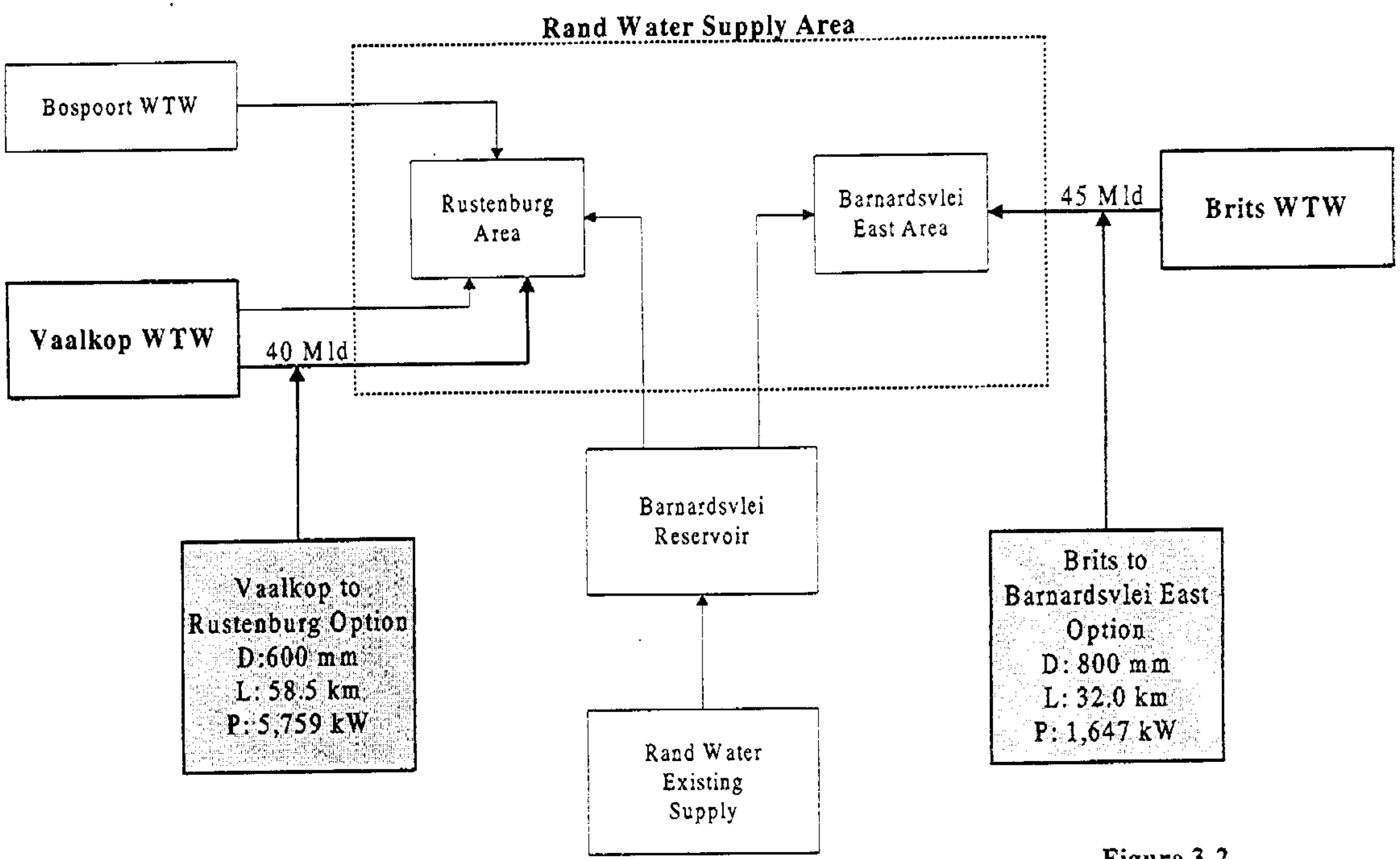


Figure 3-2
Schematic of Barnardsvlei Supply Area

CHAPTER 4

ECONOMIC EVALUATION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 4 ECONOMIC EVALUATION

4.1 General

The economic evaluation was made based on the technical options mentioned in the previous chapter. The economic analysis included an evaluation of all investment costs including the economic viability of investment proposals, which would take into account the possibility of implementing the best option or alternative in the two supply areas.

4.2 Data and Methodology

The data consisted of cost estimates for bulk infrastructure including pipeline costs, the cost of new and / or expanded water treatment works and pumping stations, and O&M costs, energy costs, and purification costs. Input items included the following:

(1) analysis period;
(2) discount rate;
(3) base cost of initial capital cost and replacement of specified works;
(4) energy costs;
(5) engineering costs (15%);
(6) P&G (20%); and
(7) contingencies (10%).

The capital cost (initial cost plus replacement) was annualized applying an annual amortization rate of 8%. This rate is currently used by the Project Planning Directorate of DWAF to conduct economic analysis and evaluation for project planning purposes. It is also used for project comparison purposes to decide which projects to accept or reject. The replacement cost was valued at the beginning of the year, then annualized, while all other infrastructure costs were annualized and calculated for each of the options in the Rand Water and Barnardsvlei Supply Areas.

Raw water costs have been omitted from all unit cost calculations because of issues related to abstraction rights and withdrawal authorizations which make it extremely difficult to establish a real (true) cost for raw water which is comparable across the various alternatives. Also, in some cases such as the Brits WTW which was funded by DWAF, the cost of raw water is literally miniscule (2.0 c/kl) because capital costs (regarded as sunk cost and already repaid) have been excluded from the raw water tariff. As mentioned in Chapter 3, four different pipeline sizes were used in each of the options in the two supply areas. The annualized capital and recurrent cost of each pipeline was computed and is shown in Tables B-1 to B-16 in the annex. The results are summarized in Tables 4-1 and 4-2. From these results the least costly of the four pipeline sizes in each option was selected. Finally, the unit cost of the least expensive option in each supply area was compared with the projected Rand Water marginal cost. The resulting unit costs (net of raw water costs) were deducted from the projected Rand Water marginal costs and the difference was assumed to be the probable unit cost that each alternative could pay for raw water from DWAF.

Table 4-1 : Economic Analysis for Rand Water Supply Area at 8% Real Interest Rate

Option	Annualized Capital Cost (R x 1,000)	Re-current Cost (R x 1,000)	Total Cost (R x 1,000)	Unit Cost at 1997 Values (R/kl)	Apr-Sep 98 RW Marginal Cost at 1997 Values (R/kl)	Oct 98-Mar 99 RW Marginal Cost at1997 Values (R/kl)	Apr 99-Mar 2000 RW Marginal Cost at 1997 Values (R/kl)
Temba to Soshanguve – 47Mld							
600 mm pipeline	9,935	6,088	16,023	1.16	1.29	1.55	1.65
800 mm	10,957	4,868	15,825	1.15	1.29	1.55	1.65
900 mm	11,540	4,719	16,259	1.18	1.29	1.55	1.65
1,000 mm	12,139	4,654	16,793	1.22	1.29	1.55	1.65
Brits to Ga Rankuwa – 44 Mld							
600 mm pipeline	8,661	10,095	18,756	1.45	1.29	1.55	1.65
700 mm	9,058	9,535	18,613	1.44	1.29	1.55	1.65
800 mm	9,400	9,340	18,739	1.44	1.29	1.55	1.65
1,000 mm	10,275	9,208	19,482	1.50	1.29	1.55	1.65

NB: Rand Water Marginal Cost breakdown is tabulated in Table 4-3

Table 4-1 : Economic Analysis for Rand Water Supply Area at 8% Real Interest Rate

Option	Annualized Capital Cost (R x 1,000)	Re-current Cost (R x 1,000)	Total Cost (R x 1,000)	Unit Cost at 1997 Values (R/kl)	Apr-Sep 98 RW Marginal Cost at 1997 Values (R/kl)	Oct 98-Mar 99 RW Marginal Cost at1997 Values (R/kl)	Apr 99-Mar 2000 RW Marginal Cost at 1997 Values (R/kl)
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800 mm	9,400	9,340	18,739	1.44	1.29	1.55	1.65
1,000 mm	10,275	9,208	19,482	1.50	1.29	1.55	1.65

NB: Rand Water Marginal Cost breakdown is tabulated in Table 4-3

Table 4-2 : Economic Analysis for Barnardsvlei Supply Area at 8% Real Interest Rate

Option	Annualized Capital Cost (R1,000)	Re-current Cost (R x 1,000)	Total Cost (R x 1,000)	Unit Cost At 1997 values (R/kl)	Apr-Sep 98 RW Marginal Cost At 1997 Values (R/kl)	Oct 98-Mar 99 RW Marginal Cost at 1997 Values (R/kl)	Apr 99-Mar 2000 RW Marginal Cost at 1997 Values (R/kl)
Vaalkop to Rustenburg – 40Mld							
600 mm pipeline	11,423	8,057	19,479	1.67	1.39	1.65	1.75
800 mm	13,259	6,868	21,128	1.72	1.39	1.65	1.75
1,000 mm	15,255	6,679	21,934	1.88	1.39	1.65	1.75
1,200 mm	17,281	6,665	23,947	2.05	1.39	1.65	1.75
Brits to Barnardsvlei East – 45Mld							
600 mm pipeline	9,131	12,190	21,322	1.44	1.39	1.65	1.75
800 mm	9,840	11,228	21,068	1.42	1.39	1.65	1.75
1,000 mm	10,846	11,059	21,905	1.48	1.39	1.65	1.75
1,200 mm	11,956	11,037	22,993	1.57	1.39	1.65	1.75

NB: Rand Water Marginal Cost breakdown is tabulated in Table 4-3

Table 4-2 : Economic Analysis for Barnardsvlei Supply Area at 8% Real Interest Rate

Option	Annualized Capital Cost (R1,000)	Re-current Cost (R x 1,000)	Total Cost (R x 1,000)	Unit Cost At 1997 values (R/kl)	Apr-Sep 98 RW Marginal Cost At 1997 Values (R/kl)	Oct 98-Mar 99 RW Marginal Cost at 1997 Values (R/kl)	Apr 99-Mar 2000 RW Marginal Cost at 1997 Values (R/kl)
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NB: Rand Water Marginal Cost breakdown is tabulated in Table 4-3

4.3 Assumptions for Economic Comparison

To be consistent with the methodology used by Magalies Water, the analysis period was based on the 20-year investment period currently used by MW to finance its schemes. The annual discount amortisation rate of 8% currently used by DWAF's Project Planning Directrate in their economic analysis and project planning evaluation was used in the analysis. For bulk supply the pumping cost have been split into two components: civil (65%) and mechanical (35%). The mechanical component of the pumping cost was assumed to be replaceable after 10 years.

Recurrent costs consist of operation costs (including energy / pumping cost), maintenance, and purification cost. In the Rand Water (Hartebeeshoek) Supply Area, the cost of water purification (15.0 c/kl) for the Temba to Soshanguve pipeline was based on the operating costs of Temba WTW owned by MW. Administrative costs were based on 2% of total recurrent expenditure of Temba WTW.

Similarly, in the Barnardsvlei Supply Area, the purification (24.0 c/kl) and administrative costs (10.0 c/kl) for the Vaalkop to Rustenburg pipeline were based on operating costs for Vaalkop WTW which is also owned by MW. It also appears that the cost of administering Vaalkop WTW is expensive relative to Temba WTW.

For both supply areas, the purification costs (46.62 c/kl) and administration (8.0 c/kl) for the pipelines from Brits (Brits to Ga Rankuwa and Brits to Barnardsvlei East) were based on the operating costs of Brits WTW owned by Brits TLC. The high purification cost associated with Brits relative to Vaalkop and Temba is primarily because of the poorer water quality. The current administration and purification costs are summarised in Table 4-3.

Table 4-3 : Current Purification and Administration Cost

(unit:c/kl)

Source of Water	Purification Cost	Administration Cost	Total	Remarks (Raw Water)
Temba WTW	15.00	0.70	17.50	14.70
Brits WTW	46.62	8.00	54.62	2.00
Vaalkop WTW	24.00	10.00	34.00	23.00
RW (Hartebeeshoek)	32.39	17.23	49.62	Vary
RW (Barnardsvlei)	40.47	17.23	57.70	Vary

4.3 Assumptions for Economic Comparison

To be consistent with the methodology used by Magalies Water, the analysis period was based on the 20-year investment period currently used by MW to finance its schemes. The annual discount amortisation rate of 8% currently used by DWAF's Project Planning Directrate in their economic analysis and project planning evaluation was used in the analysis. For bulk supply the pumping cost have been split into two components: civil (65%) and mechanical (35%). The mechanical component of the pumping cost was assumed to be replaceable after 10 years.

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Vaalkop WTW	24.00	10.00	34.00	23.00
RW (Hartebeeshoek)	32.39	17.23	49.62	Vary
RW (Barnardsvlei)	40.47	17.23	57.70	Vary

Table 4-4 provides information regarding the projected marginal cost to RW of supply to the Barnardsvlei and Hartbeeshoek Reservoirs from the Vaal River system. All costs except the raw water charge were based on RW's 1996/97 operating budget, which assumed an average annual water demand for the year of 2,800 Mld. The projected raw water costs were based on proposed increases in the raw water charge levied by DWAF in 1998, 1999 and 2000 and are given in 1997 values discounted at 8% over one year. Also, RW's marginal cost does not include capital cost since all capital expenditure for existing infrastructure has already been spent and is viewed as sunk costs. Rand Water's projected marginal cost in each supply area was compared with the total unit costs of the two options in the same supply areas.

Table 4-4: Composition of Projected Rand Water Marginal Costs

Component	RW (Hartebeeshoek) Supply Area			Barnardsvlei Supply Area		
	Apr 98-Sept 98 (c/kl)	Oct 98-Mar 99 (c/kl)	Apr 99-Mar 2000 (c/kl)	Apr 98-Sept 98 (c/kl)	Oct 98-Mar 99 (c/kl)	Apr 99-Mar 2000 (c/kl)
Raw water (from Vaal River)	79.55	105.45	115.62	79.55	105.45	115.62
Energy (electricity)	13.72			19.64		
Pump, maintenance, operational overheads, purification, etc.	16.77			20.83		
Pro-rata administration	17.23			17.23		
Total	**127.27**	**153.17**	**163.34**	**137.25**	**163.15**	**173.32**
Water Research Commission levy	1.90			1.90		
Total Marginal Cost	**129.17**	**155.07**	**165.24**	**139.15**	**165.05**	**175.22**

DWAF currently charges RW 55 c/kl for raw water purchases which includes a levy for the Lesotho Highlands Water Project (LHWP). Current projections by DWAF show that the raw water tariff from the Vaal River system will increase to 114 c/kl (in constant 1997 prices) over the next two years to provide for cost requirements of the present Vaal River System schemes, LHWP Phase 1A, and future augmentation schemes for the Vaal River System. DWAF also announced on 2 July 1997 the proposed increases in the Vaal River raw water tariff for the next five years, assuming 10% inflation. The expected trend in the raw water tariff shown in Table 4-4 and Figures 4-1 and 4-2 could have a significant escalating effect on RW's marginal cost and its bulk water tariff in the future.

Table 4-4 provides information regarding the projected marginal cost to RW of supply to the Barnardsvlei and Hartbeeshoek Reservoirs from the Vaal River system. All costs except the raw water charge were based on RW's 1996/97 operating budget, which assumed an average annual water demand for the year of 2,800 Mld. The projected raw water costs were based on proposed increases in the raw water charge levied by DWAF in 1998, 1999 and 2000 and are given in 1997 values discounted at 8% over one year. Also, RW's marginal cost does not include capital cost since all capital expenditure for existing infrastructure has already been spent and is viewed as sunk costs. Rand Water's projected marginal cost in each supply area was compared with the total unit costs of the two options in the same supply areas.

Table 4-4: Composition of Projected Rand Water Marginal Costs

Component	RW (Hartebeeshoek) Supply Area			Barnardsvlei Supply Area		
	Apr 98-Sept 98 (c/kl)	Oct 98-Mar 99 (c/kl)	Apr 99-Mar 2000 (c/kl)	Apr 98-Sept 98 (c/kl)	Oct 98-Mar 99 (c/kl)	Apr 99-Mar 2000 (c/kl)
Raw water (from Vaal River)	79.55	105.45	115.62	79.55	105.45	115.62
Energy (electricity)	13.72			19.64		
Pump, maintenance, operational overheads, purification, etc.	16.77			20.83		
Pro-rata administration	17.23			17.23		
Total	**127.27**	**153.17**	**163.34**	**137.25**	**163.15**	**173.32**
Water Research Commission levy	1.90			1.90		
Total Marginal Cost	**129.17**	**155.07**	**165.24**	**139.15**	**165.05**	**175.22**

DWAF currently charges RW 55 c/kl for raw water purchases which includes a levy for the Lesotho Highlands Water Project (LHWP). Current projections by DWAF show that the raw water tariff from the Vaal River system will increase to 114 c/kl (in constant 1997 prices) over the next two years to provide for cost requirements of the present Vaal River System schemes, LHWP Phase 1A, and future augmentation schemes for the Vaal River System. DWAF also announced on 2 July 1997 the proposed increases in the Vaal River raw water tariff for the next five years, assuming 10% inflation. The expected trend in the raw water tariff shown in Table 4-4 and Figures 4-1 and 4-2 could have a significant escalating effect on RW's marginal cost and its bulk water tariff in the future.

Figure 4-1 : Projected Rand Water Marginal Cost - Rand Water (Hartbeeshoek) Supply Area

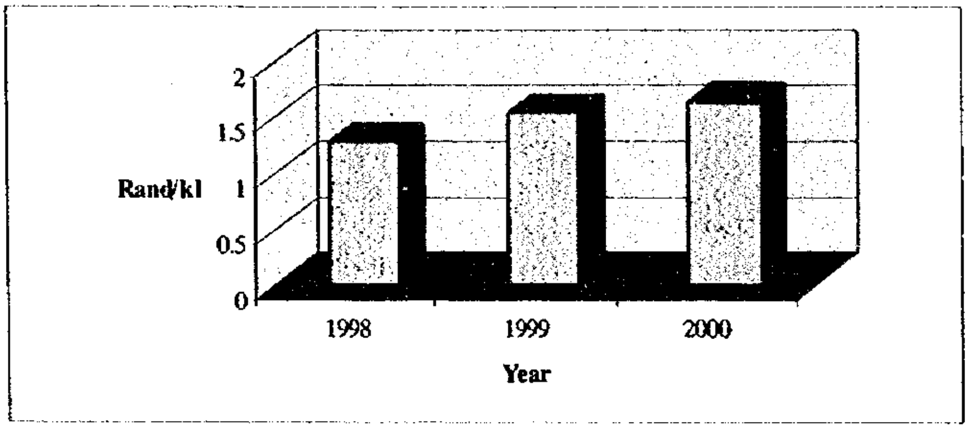
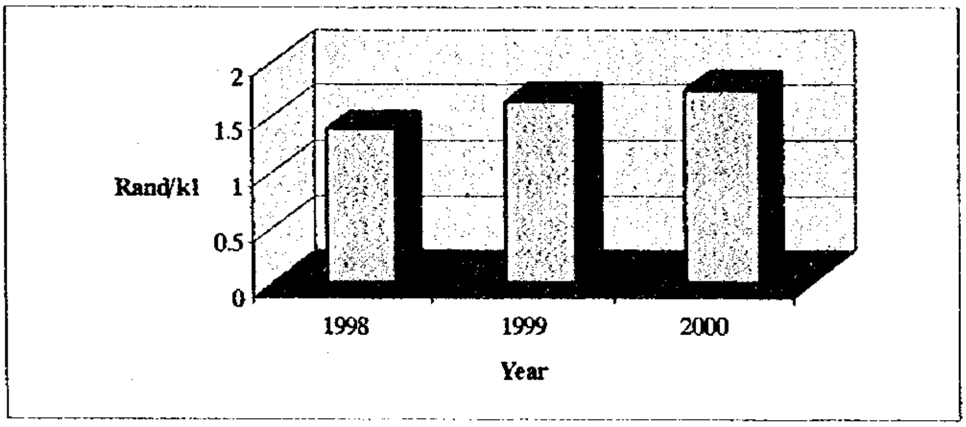


Figure 4-2 : Projected Rand Water Marginal Cost - Barnardsvlei Supply Area



4.4 Analysis and Results

4.4.1 Rand Water Supply Area

Summarized results of the unit cost (excluding raw water) of four pipelines sizes for each of the two alternatives are shown in Table 4-5 below.

Table 4-5: Total Unit Cost (R/kl) for Rand Water Supply Area

Temba to Soshanguve	Pipe Diametes (mm)	600	800	900	1000
	Unit Cost (R/kl)	1.16	1.15	1.18	1.22
Brits to Ga Rankuwa	Pipe Diametes (mm)	600	700	800	1,000
	Unit Cost (R/kl)	1.45	1.44	1.44	1.50

The above costs are based on the annualized capital costs at 8% and re-current costs for each of the pipeline sizes. The results shown in the Table 4-6 indicate the following:

(1) The unit cost of utilizing an 800 mm pipeline is the least costly for the Temba to Soshanguve option while a 700 mm main is the least costly for the Brits to Ga Rankuwa option.

(2) The unit cost of Temba to Soshanguve is the cheaper of the two options ranging in unit cost from R1.16/kl to R1.22/kl.

Table 4-6 shows the difference between total unit cost (excluding raw water) and the projected RW marginal cost for 1998, 1999 and 2000. The difference (gap) is assumed to be the probable cost of raw water from Temba to Shoshanguve. More specifically, the difference is what the price of raw water could be from Temba to Shoshanuve. The probable cost of raw water from Temba to Shoshanguve is likely to be 14.17 c/kl in 1998, rising to 40.07c/kl and 50.24 c/kl in 1999 and 2000 respectively. If the present raw water cost of Temba is no substatial change, RW marginal cost becomes higher than that of Temba tariff in near future.

Table 4-6 : Probable Raw Water Cost for Temba to Shoshanguve

(unit:c/kl)

Unit Cost	1997	1998	1999	2000
Rand Water marginal cost	89.92	129.17	155.07	165.24
Unit cost of Temba WTW	115.00 (129.70)	115.00※ (129.70)	115.00 (129.70)	115.00 (129.70)
Gap (difference)	-25.08 (-39.78)	14.17 (-0.53)	40.07 (25.37)	50.24 (35.54)

※ Figures in parenthesis include 14.7c/kl of present raw water cost of Temba WTW.

4.4.2 Barnardsvlei Supply Area

The results of the unit cost calculation for the four pipeline sizes in the Barnardsvlei East Zone are presented in Table 4-7.

Table 4-7: Total Unit Cost (R/kl) for Barnardsvlei Supply Area

Option	Pipe Diameter (mm)			
	600	800	1000	1200
Vaalkop to Rustenburg (R/kl)	1.67	1.72	1.88	2.05
Brits to Barnardsvlei East (R/kl)	1.44	1.42	1.48	1.57

The data is based on the annualized capital cost and re-current cost for each of the pipeline sizes. Again, results in the table indicate the following:

(1) The unit cost of the 600 mm pipeline is the least costly for the Vaalkop to Rustenburg option while the 800 mm pipeline is the cheapest for the Brits to Barnardsvlei East option.

Table 4-6 : Probable Raw Water Cost for Temba to Shoshanguve

(unit:c/kl)

Unit Cost	1997	1998	1999	2000
Rand Water marginal cost	89.92	129.17	155.07	165.24
Unit cost of Temba WTW	115.00 (129.70)	115.00※ (129.70)	115.00 (129.70)	115.00 (129.70)
Gap (difference)	-25.08 (-39.78)	14.17 (-0.53)	40.07 (25.37)	50.24 (35.54)

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The data is based on the annualized capital cost and re-current cost for each of the pipeline sizes. Again, results in the table indicate the following:

(1) The unit cost of the 600 mm pipeline is the least costly for the Vaalkop to Rustenburg option while the 800 mm pipeline is the cheapest for the Brits to Barnardsvlei East option.

(2) The unit cost of Brits to Barnardsvlei East is the cheaper of the two options.

The results shown in Table 4-8 indicate the following:

The probable cost of raw water from Brits to Barnardsvlei East is likely to be R2.85 c/kl more than RW marginal cost in 1998 but, R23.05 c/kl in 1999 and R33.22 c/kl in 2000. As mentioned in Rand Supply Area, water cost of this area becomes also same tendency in near future.

Table 4-8 : Probable Raw Water Cost for Brits to Barnardsvlei East

(unit:c/kl)

Unit Cost	1997	1998	1999	2000
Rand Water marginal cost	98.00	139.15	165.05	175.22
Unit cost of 800mm pipeline	142.00	142.00	142.00	142.00
Gap (difference)	(144.00) -44.00 (-46.00)	(144.00) -2.85 (-4.85)	(144.00) 23.05 (21.05)	(144.00) 33.22 (31.22)

※ Figure in parenthesis include 2c/kl of present raw water cost of Brits WTW.

4.5 Conclusions

4.5.1 Rand Water Supply Area

As shown in Figure 4.3 the gap (difference) between the unit cost of Temba to Shoshanguve and the Rand Water marginal cost is smaller in 1998 (14.17 cents/kl), but starts to widen in 1999 (by 40.07 cents) and 2000 (by 50.24 cents/kl).

If the probable cost of raw water from Temba to Shoshanguve is 14.17 c/kl or less in 1998, then Temba to Shoshanguve is competitive with Rand Water. However, if the probable cost of raw water exceeds 14.17 c/kl, the unit cost of Temba to Shoshanguve becomes prohibitive and the Rand Water option becomes the better of the two options. It is not possible at this stage to project what the actual raw water charge from Temba to Shoshanguve could be. The numbers quoted above are only probabilities. What is clear however is that capital costs are excluded from the RW marginal cost. If these costs were included, the marginal cost of the RW supply would be extremely prohibitive and uneconomical.

(2) The unit cost of Brits to Barnardsvlei East is the cheaper of the two options.

The results shown in Table 4-8 indicate the following:

The probable cost of raw water from Brits to Barnardsvlei East is likely to be R2.85 c/kl more than RW marginal cost in 1998 but, R23.05 c/kl in 1999 and R33.22 c/kl in 2000. As mentioned in Rand Supply Area, water cost of this area becomes also same tendency in near future.

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Unit Cost	1997	1998	1999	2000
Rand Water marginal cost	98.00	139.15	165.05	175.22
Unit cost of 800mm pipeline	142.00	142.00	142.00	142.00
Gap (difference)	(144.00) -44.00	(144.00) -2.85	(144.00) 23.05	(144.00) 33.22
	(-46.00)	(-4.85)	(21.05)	(31.22)

※ Figure in parenthesis include 2c/kl of present raw water cost of Brits WTW.

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4.5.2 Barnardsvlei Supply Area

Figure 4-4 shows the marginal cost of Rand Water supply starting off more economical than Brits to Barnardsvlei in 1998. However, the gap (difference) begins to widen in 1999 (by 23.05 c/kl) and 2000 (by 33.22 c/kl). What the analysis shows is that the probable cost of raw water from Brits to Barnardsvlei East is more costly than Rand Water marginal cost in 1998. But, the probable cost of raw water from Brits to Barnardsvlei East is less than the Rand Water marginal cost in 1999 (by 23,05 c/kl) and 2000 (by 33.22 c/kl). It would seem that clearly, Brits to Barnardsvlei East is the better of the two alternatives. Again it is not possible to project what the raw water charge from Brits to Barnardsvlei East could be. The numbers quoted above are only probabilities. As stated earlier, capital costs are excluded from the RW marginal cost. If these costs were included, the marginal cost of the RW supply would be extremely prohibitive and uneconomical.

As was shown in Table 4-4, by the year 2000 the RW marginal cost will have increased significantly as a result of the planned increases in the cost of raw water levied by DWAF. If capital costs were included in RW's marginal cost calculation, the RW marginal cost would be even higher. In closing, the projected marginal costs of the RW bulk supply to the two supply areas are likely to become more expensive in the long run than the cost of the alternative local sources of supply considered for each of the two areas considered in this study.

4.5.3 General

The Boundary Issues Study has considered technical alternatives to the existing Rand Water supplies to the two areas and the economic implication of these options. The final decision on long term strategy for water supply to these areas must also be based on political will and institutional aspects (such as the existing customer base of the boards concerned) which were outside the scope of this study.

The analysis indicated that there is a need to formulate appropriate public policy towards water supply sources in the two zones in near future. There are economic and political incentives for DWAF policy makers to consider the implications of these alternatives. Future public policy towards water supply in these two areas should be designed around those incentives.

In order to accurately reflect the true cost of water it is important that there is a consistent strategy and policy regarding raw water tariffs. At present there do appear to be some anomolies (such as the very low cost of raw water purchased by Brits TLC) that could be addressed.

It is important that a clear long term policy is developed by DWAF to enable long term coherent planning to take place and to provide a sufficient level of confidence to allow large scale infrastructure to be developed where necessary. Once decided such policy will impose binding constraints of bulk supply stakeholders in the two areas of supply and significantly affect their business development. The choice of alternatives in the long-term must be in the overall economic interest of the country as a whole.

Figure 4-3 : Unit Cost of Rand Water Supply Area (Temba to Soshanguve)

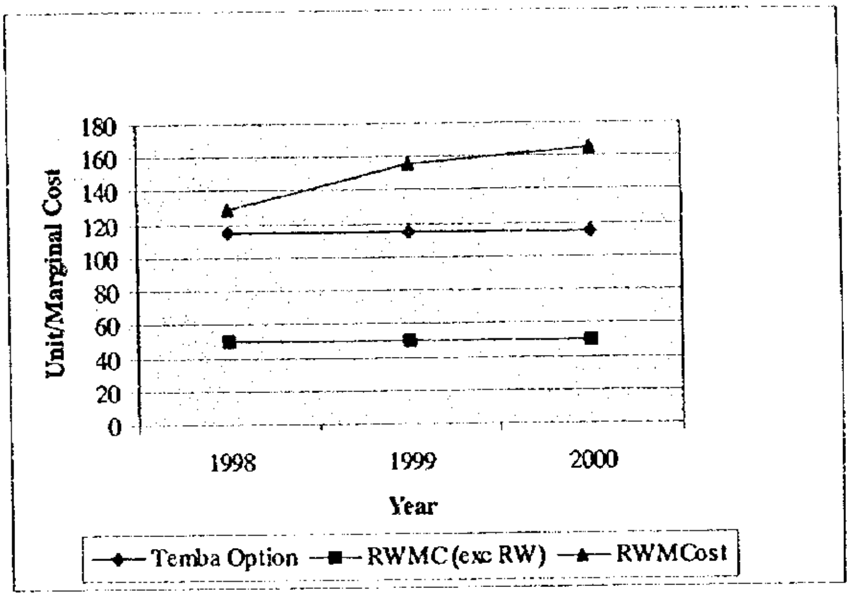

Figure 4-4 : Unit Cost of Barnardsvlei Supply Area (Brits to Barnardsvlei)