REPORT NO: P WMA 12/S00/3008

DEPARTMENT OF WATER AFFAIRS AND FORESTRY
DIRECTORATE OF OPTIONS ANALYSIS

LUKANJI REGIONAL WATER SUPPLY FEASIBILITY STUDY

APPENDIX 1: WATER REQUIREMENTS

FINAL

NINHAM SHAND
CONSULTING SERVICES

January 2006

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

DIRECTORATE OF OPTIONS ANALYSIS

LUKANJI REGIONAL WATER SUPPLY FEASIBILITY STUDY

APPENDIX 1

WATER REQUIREMENTS

SUBMITTED BY

Ninham Shand (Pty) Ltd
P O Box 1347
Cape Town
8000

Tel : 021 - 481 2400
Fax : 021 - 424 5588
e-mail : hydro@shands.co.za

FINAL

January 2006

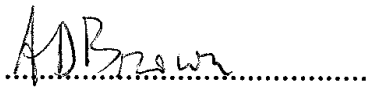
Title	**:**	**Appendix 1 : Water Requirements**
Authors	**:**	**V Jonker and R Blackhurst**
Project Name	**:**	**Lukanji Regional Water Supply Feasibility Study**
DWAF Report No.	**:**	**P WMA 12/S00/3008**
Ninham Shand Report No.	**:**	**10676/3841**
Status of Report	**:**	**Final**
First Issue	**:**	**January 2006**
Final Issue	**:**	**January 2006**

Approved for the Study Team :

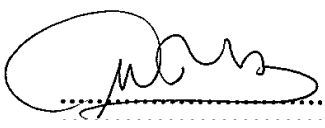
……
M J SHAND
Ninham Shand (Pty) Ltd

DEPARTMENT OF WATER AFFAIRS AND FORESTRY
Directorate : Options Analysis

Approved for the Department of Water Affairs and Forestry by :



A D BROWN
Chief Engineer : Options Analysis (South)
(Project Manager)



L S MABUDA
Director

LUKANJI REGIONAL WATER SUPPLY FEASIBILITY STUDY

WATER REQUIREMENTS

EXECUTIVE SUMMARY

1. INTRODUCTION

The Lukanji Regional Water Supply Feasibility Study, commissioned by the Department of Water Affairs and Forestry (DWAF), commenced in March 2003. The main aim of the study is to review the findings of earlier studies and, taking cognisance of new developments and priorities that have been identified in the study area, to make a firm recommendation on the next augmentation scheme to be developed for the supply of water to the urban complexes of Queenstown and Sada/Whittlesea following the implementation of a suitable water demand management programme. In addition, proposed operating rules will be identified for the existing water supply schemes and the augmentation scheme to provide for the ecological component of the Reserve and the equitable distribution of water between rural domestic and urban water supplies, and irrigators.

In a previous study, the Queenstown Regional Water Supply Feasibility Study (QRWSFS) (DWAF, 1997), the future water requirements of Queenstown and Sada to 2045 were projected from recorded water use to 1995. However, the actual growth in water requirements since 1995 has been significantly lower than predicted.

This document presents updated estimates of the future water requirements of Queenstown, Ilinge, Sada and rural villages that can conveniently be supplied from the town water supply schemes, as well as estimates of the requirements of other water users relying on the same sources of water. The latter estimates are generally those that were made for the QRWSFS, except where new data that justifies changing them has become available since the completion of that study.

2. EXISTING WATER SUPPLY SCHEMES

The existing Lukanji Water Resources System consists of the Black Kei River and its major tributaries, the Klaas Smits River and the Klipplaat River and several dams that are situated on tributaries of the Black Kei River. Run-of-river flow is abstracted from all the rivers for irrigation. In addition, Xonxa Dam on the White Kei River, although not currently part of the system, may well become part of it in the future if it becomes the source of water for augmenting the supply to Queenstown. Therefore, in this study, Xonxa Dam and the main stem of the White Kei River are considered to be part of the System. The Lukanji Surface Water Resources System supplies raw water to the urban areas of Queenstown and Sada, the rural villages of Yonda and Mbekweni, and a number of irrigation schemes.

The town of Ilinge is currently supplied from boreholes, as are many of the rural villages in the area. Supplies to rural villages do not fall within the scope of this study, except where they are situated close to urban areas and can feasibly be included in the urban water supplies.

The water supply schemes that rely on the Lukanji Surface Water Resources System are:

- The Queenstown Water Supply Scheme
- The Sada Water Supply Scheme
- The Upper Klipplaat Irrigation Scheme
- The Klipplaat River Government Water Scheme
- The Zweledinga Irrigation Scheme
- The Oxkraal Irrigation Scheme
- The Nthabethemba and Associated Irrigation Schemes
- The Klaas Smits River Irrigation Scheme
- The Xonxa Irrigation Scheme

3. WATER REQUIREMENTS

The water requirements that affect the Lukanji Water Resources System are :

- Urban and rural domestic requirements supplied from the dams of the System or from run-of-river flow.
- Irrigation requirements, supplied from the dams, run-of-river abstractions and boreholes.
- Afforestation, to the extent that it reduces natural runoff and, hence, the quantity of water available for other users.
- Invasive alien vegetation which has the same effect as afforestation.

The total projected raw water requirements from the urban water supply scheme are summarised in Table 1. It can be seen that the requirements are expected to increase from 12,46 Mm^3/a in 2005 to 15,5 Mm^3/a in 2045.

TABLE 1 PROJECTED WATER REQUIREMENTS FOR QUEENSTOWN AND RURAL VILLAGES

AREA	WATER REQUIREMENTS (Mm^3/a)					
	1990	1995	2003	2005	2020	2045
Queenstown complex	5,58	7,60	7,60	7,85	8,80	10,30
Sada and rural villages	1,23	1,40	2,40	2,41	2,50	3,00
Ilinge and Macibini villages	0,54	0,64	2,18	2,20	2,20	2,20
Totals	**7,35**	**9,64**	**12,18**	**12,46**	**13,50**	**15,5**

The irrigation developments that rely on water from the Lukanji Water Resources System may be categorised as :

- Schemes supplied from dams that are also existing or potential sources of urban supplies.
- Irrigation developments in the catchment areas of the main dams.
- Other irrigation developments.

The estimated field edge irrigation water requirements in these categories are shown in Table 2.

TABLE 2 SUMMARY OF FIELD EDGE WATER REQUIREMENTS FOR IRRIGATION

SOURCE OF SUPPLY	FIELD EDGE WATER REQUIREMENT (Mm^3/a)
Dams with potential for urban water supply	30,3
Surface water in catchments of dams with potential for urban supply	10,8
Dams not used for urban supply and run-of-river flow not affecting main dams	40,4
Groundwater	5,5
Total requirement	**87,0**

4. STREAMFLOW REDUCTION BY AFFORESTATION

There is little indigenous forest in the study area and less than 7 km^2 of the study area is covered by commercial timber plantations. Most of this is along the Amatola mountain range in the catchment of the Klipplaat River. The total reduction in streamflow caused by afforestation is estimated to be 1,24 Mm^3/a.

5. INVASIVE ALIEN VEGETATION

The main occurrence of alien vegetation is in the catchment of Waterdown Dam where an estimated consolidated area of 5,5 km^2 of mainly black wattle is estimated to reduce streamflow by about 0,8 Mm^3/a.

LUKANJI REGIONAL WATER SUPPLY FEASIBILITY STUDY

WATER REQUIREMENTS

CONTENTS

Page No.

CONTENTS

Page No.

TABLES

FIGURES

ABBREVIATIONS

DWAF	Department of Water Affairs and Forestry
QRWSFS	Queenstown Regional Water Supply Feasibility Study
NPV	Net Present Value
m^3	cubic metres
Mm^3/a	Million cubic metres per year
p.a.	per annum
km	kilometre
WASSA	Water and Sanitation Services South Africa
ha	hectare

LUKANJI REGIONAL WATER SUPPLY FEASIBILITY STUDY

WATER REQUIREMENTS

1. INTRODUCTION

The Lukanji Regional Water Supply Feasibility Study, commissioned by the Department of Water Affairs and Forestry (DWAF), commenced in March 2003. The main aim of the study is to review the findings of earlier studies and, taking cognisance of new developments and priorities that have been identified in the study area, to make a firm recommendation on the next augmentation scheme to be developed for the supply of water to the urban complexes of Queenstown and Sada/Whittlesea following the implementation of a suitable water demand management programme. In addition, proposed operating rules will be identified for the existing water supply schemes and the augmentation scheme to provide for the ecological component of the Reserve and the equitable distribution of water between rural domestic and urban water supplies, and irrigators.

In a previous study, the Queenstown Regional Water Supply Feasibility Study (QRWSFS) (DWAF, 1997), several alternative phased schemes were identified to meet the predicted water requirements of Queenstown and Sada/Whittlesea to the year 2045. The future water requirements to 2045 were projected from recorded water use to 1995, and the schemes were compared on the basis of their calculated Net Present Values (NPVs). The scheme with the lowest NPV was found to be one for which the proposed first phase was the construction of a pipeline from Xonxa Dam to Queenstown.

The actual growth in water requirements since 1995 has been significantly lower than predicted and, in addition, the unutilised Oxkraal Dam has become available to augment the supply to existing users. In view of this, it was not certain that a scheme that would entail the construction of the Xonxa Pipeline as its first phase would still be the most advantageous. Consequently, a number of alternative schemes were again investigated, using updated estimates of the future water requirements of Queenstown, Ilinge, Sada and rural villages that can conveniently be supplied from the town water supply schemes.

This document presents the estimates of these water requirements, as well as estimates of the requirements of other water users relying on the same sources of water. The latter estimates are generally those that were made for the QRWSFS, except where new data that justifies changing them has become available since the completion of that study.

2. EXISTING WATER SUPPLY SCHEMES

The existing Lukanji Water Resources System consists of the Black Kei River and its major tributaries, the Klaas Smits River and the Klipplaat River and several dams that are situated on tributaries of the Black Kei River. Run-of-river flow is abstracted from all the rivers for irrigation. In addition, Xonxa Dam on the White Kei River, although not currently part of the system, may well become part of it in the future if it becomes the source of water for augmenting the supply to Queenstown. Therefore, in this study, Xonxa Dam and the main stem of the White Kei River are considered to be part of the System. The Lukanji System is part of the larger Upper Kei System which includes the Doring River Dam and the Lubisi Dam, both on the Indwe River, a major tributary of the White Kei River (see Figure 2.1).

The Lukanji Surface Water Resources System supplies raw water to the urban areas of Queenstown and Sada, the rural villages of Yonda and Mbekweni, and a number of irrigation schemes.

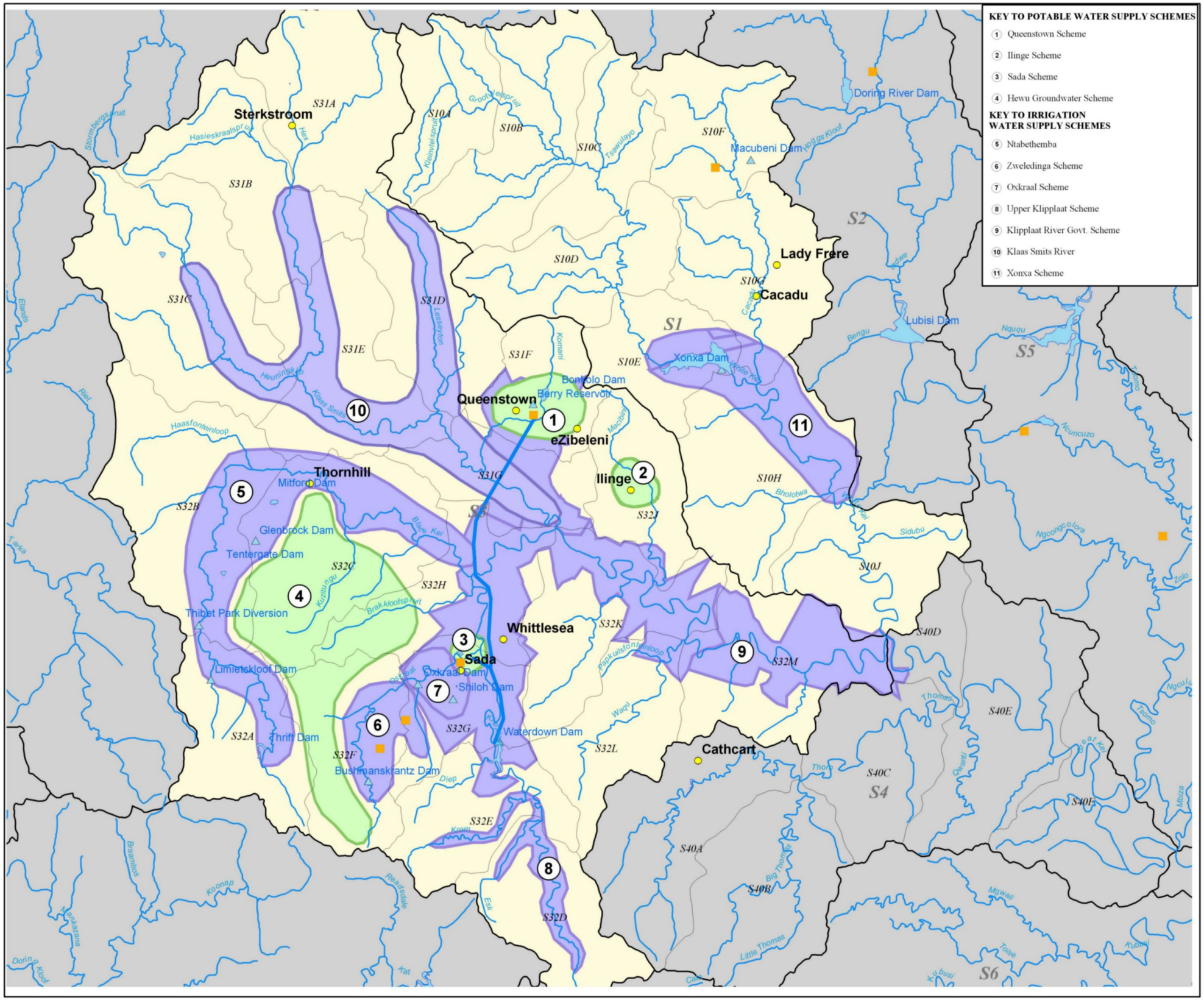
The town of Ilinge is currently supplied from boreholes, as are many of the rural villages in the area. Supplies to rural villages do not fall within the scope of this study, except where they are situated close to urban areas and can feasibly be included in the urban water supplies.

The water supply schemes that rely on the Lukanji Surface Water Resources System are:

- The Queenstown Water Supply Scheme
- The Sada Water Supply Scheme
- The Upper Klipplaat Irrigation Scheme
- The Klipplaat River Government Water Scheme
- The Zweledinga Irrigation Scheme
- The Oxkraal Irrigation Scheme
- The Nthabethemba and Associated Irrigation Schemes
- The Klaas Smits River Irrigation Scheme
- The Xonxa Irrigation Scheme

In addition, as mentioned above, Ilinge is supplied from boreholes. However, this supply has proved to be unreliable in recent years and it is understood that the Lukanji Municipality intends to eventually supply Ilinge from the Queenstown Water Treatment Works.

The supply areas of the different water supply schemes are shown on Figure 2.1 and their main characteristics are summarised in Table 2.1. Their present and expected future water requirements are discussed below.



KEY TO POTABLE WATER SUPPLY SCHEMES

1. Queenstown Scheme
2. Ilinge Scheme
3. Sada Scheme
4. Hewu Groundwater Scheme

KEY TO IRRIGATION WATER SUPPLY SCHEMES

5. Ntabethemba
6. Zweledinga Scheme
7. Oxkraal Scheme
8. Upper Klipplaat Scheme
9. Klipplaat River Govt. Scheme
10. Klaas Smits River
11. Xonxa Scheme

LOCALITY MAP:

LEGEND:		GIS COV:
	WMA Boundaries	Waterman Intp (Amended)
	Towns	Wri500
	Rivers	Ndams
	Dams	Drgnquat
E24D	Quaternary Catchment Number	Drgnquat
	Secondary Catchment	Drgsnd
G3	Secondary Catchment Number	Drgsnd
	Tertiary Catchment	
	Study Area	
	Potable Water Scheme Supply Area	
	Irrigation Scheme Supply Area	
Potable Water Infrastructure		
	Bulk Supply Pipes	
	Water Treatment Works	

PREPARED BY:

NINHAM SHAND CONSULTING SERVICES

CLIENT:

Department: Water Affairs and Forestry
Directorate: Options Analysis

PROJECTION:

ALBERS EQUAL AREA

SCALE : 1:500 000

0 2.5 5 10 Kilometers

TITLE:

LUKANJI REGIONAL WATER SUPPLY FEASIBILITY STUDY

WATER SUPPLY SCHEME

Prepared by:	A Lawrence	**Figure 2.1**
Date:	01/2006	
Data Type:	Fig2_1_waterschemes.mxd	

TABLE 2.1 EXISTING WATER SUPPLY SCHEMES

RIVER	SCHEME NAME	CONSUMERS SUPPLIED		STORAGE DAMS	RECEIVING RIVER
		DOMESTIC	IRRIGATION		
Klipplaat	Upper Klipplaat Irrigation Scheme	-	Lands along the Klipplaat River (700 ha)	-	
Klipplaat	Klipplaat River Irrigation Scheme		Lands along Klipplaat and Black Kei to confluence with White Kei River Lands along Shiloh Irrigation Scheme Lands along Lower Black Kei (1 924 ha)	Waterdown Dam	Klipplaat
Klipplaat	Queenstown Water Supply Scheme	Queenstown eZibeleni	-	Allocation from Waterdown Dam Bonkolo Dam Berry Reservoir	-pipeline-
Klipplaat	Sada-Whittlesea Water Supply Scheme	Sada-Whittlesea	-	Allocation from Waterdown Dam	-pipeline-
Klaas Smits	Klaas Smits River Irrigation Scheme	-	Lands along the Klaas Smits River and its tributaries (2 162 ha)	-	
Oxkraal	Zweledinga Irrigation Scheme	Villages on Upper Oxkraal River	Lands along the Upper Oxkraal River (259 ha originally but not irrigated at present)	Bushmanskrantz Dam	-pipeline-
Oxkraal	Oxkraal Irrigation Scheme	-	Lands along the Lower Oxkraal River (566 ha planned but not implemented)	Oxkraal Dam Shiloh Dam	Oxkraal
Upper Black Kei	Ntabethemba and Associated Irrigation Schemes	-	Lands along the Upper Black Kei River (1 202 ha originally but only 290 ha currently irrigated)	Thrift Dam Limietskloof Dam Thibet Park Diversion Tentergate Dam Mitford Dam GlenbrockDam	Black Kei and its tributaries
White Kei	Xonxa Irrigation Scheme	-	Lands along the White Kei River downstream of Xonxa Dam (1 643 ha originally of which 60 ha currently irrigated).	Xonxa Dam	White Kei

3. WATER REQUIREMENTS

3.1 GENERAL

The water requirements that affect the Lukanji Water Resources System are :

- Urban and rural domestic requirements supplied from the dams of the System or from run-of-river flow.
- Irrigation requirements, supplied from the dams, run-of-river abstractions and boreholes.
- Afforestation, to the extent that it reduces natural runoff and, hence, the quantity of water available for other users.
- Invasive alien vegetation which has the same effect as afforestation.

Each of these categories of water requirements is discussed below in the context of its implications for possible schemes to augment the water supply to Queenstown.

3.2 URBAN AND RURAL DOMESTIC

For the purpose of this investigation, the water requirement projections described below for Queenstown and Sada, as well as rural villages that are also likely to be supplied from the urban water supply scheme, were used.

3.2.1 Queenstown

The population growth rate assumed for Queenstown in the QRWSFS was 3,5% p.a. The more recent demographic studies for the development of the National Water Resource Strategy (DWAF, 2000) have estimated a growth rate for Queenstown of 1,61% p.a. from 1995 to 2005, followed by a growth of 0,87% p.a. from 2005 to 2015 and subsequently a growth rate of 0,61% from 2015 to 2025. Recorded water use statistics for the period March 1997 to January 2003 are included as Appendix 1.1 to this document. These show a decrease in water use over the period. Even after allowing for the possible effects of water conservation and demand management, the statistics suggest that the lower population growth estimates are the more realistic. Therefore, these were used in the current studies to predict future water requirements.

The metered raw water-use in 2002 was 7,3 Mm^3/a. At the end of 2002, a large low cost housing scheme was completed which is estimated by the Town Engineer of Queenstown to have increased water requirements by 0,3 Mm^3/a to 7,6 Mm^3/a. Using the estimates of future population growth rates from the National Water Resource Strategy given above, and assuming the growth rate between 2025 and 2045 to remain at 0,61% p.a., gives a water requirement in 2045 of 10,3 Mm^3/a.

The approximate monthly distribution of water requirements in Queenstown, derived from the data contained in Appendix 1.1, is shown in Table 3.1.

TABLE 3.1 MONTHLY DISTRIBUTION OF QUEENSTOWN WATER REQUIREMENTS

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
%	9,3	9,0	10,0	9,1	8,0	7,9	7,6	7,5	7,5	7,2	8,3	8,6

3.2.2 Sada

The QRWSFS predicted that the water requirements of Sada would grow at 3,36% from 2,03 Mm^3/a in 1995 to 2,42 Mm^3/a in 2000. Thereafter, the growth rate was predicted to decrease to 2,73% p.a., to give a water requirement in 2005 of 2,77 Mm^3/a. It appears that the actual water use in 2003 was 2,4 Mm^3/a. This value was obtained from the Town Engineer of Queenstown. A rough check was performed by subtracting the quantity of water supplied from Waterdown Dam to Queenstown from the total quantity released from the dam into the pipelines to Sada and Queenstown between October 2002 and September 2003. This showed a water use of 2,01 Mm^3 in that twelve month period, which is in reasonable agreement with the value of 2,4 Mm^3 assumed for the 2003 calendar year.

The demographic studies commissioned by DWAF for the development of the National Water Resource Strategy (DWAF, 2000) predicted that the population of Sada would grow at 0,3% p.a. to 2020, and would remain virtually static thereafter. For the purposes of considering possible water augmentation schemes, it has been assumed that the future increases in water requirements will follow these predicted population growth rates. On this basis, water requirements will increase to 2,52 Mm^3/a by 2020, and then remain almost static. However, the village of Zulukama and other rural villages in the vicinity of Sada are likely to be connected to the Sada water supply in the future. Therefore, in consultation with the Town Engineer of Queenstown, a water requirement of 2,40 Mm^3/a in 2003, increasing to 2,50 Mm^3/a by 2020, and 3,0 Mm^3/a by 2045, was assumed.

3.2.3 Ilinge

The small town of Ilinge, situated some 8 km south-east of Queenstown, had a water requirement of 1,38 Mm^3/a in 2002, according to the Town Engineer of Queenstown. This is expected to increase to 1,44 Mm^3/a by 2005, and remain static thereafter.

3.2.4 Rural Villages

The water requirements of rural villages in the immediate vicinities of Ilinge are of interest in this study as the villages are likely to be connected to the urban water supply scheme. If a pipeline were constructed between Xonxa Dam and Queenstown, the possibility of supplying villages along the route with raw water from the pipeline could also be considered.

Estimates of the future water requirements of rural villages in the area vary significantly, as discussed below.

The demographic study conducted for the National Water Resource Strategy indicates rural population growth rates of 0,37% p.a. up to 2005, followed by a negative growth rate of 0,4% p.a. from 2005 to 2015 and a negative growth of 0,85% p.a. from 2015 to 2025. If these rates are used for projecting the water requirements of the rural villages (Macibini Villages) that are situated close to Ilinge, a water quantity of 0,74 Mm^3/a in 2002 decreasing to 0,55 Mm^3/a in 2025 is obtained. Based on recent population figures, a population growth rate of 1,5% p.a. was used for the latest study of the Xonxa Dam Transfer Scheme (Stewart Scott, 2003), and the water requirements of the Macibini Villages were predicted to be about 1,49 Mm^3/a in 2045, based on 1997 water requirements of 0,73 Mm^3/a. For purposes of this study, it has been assumed that the requirements will grow to 0,76 Mm^3/a by 2005 and then remain static.

Xonxa Dam is situated in a valley surrounded by steep hills that limit the number of rural villages upstream of the dam wall that it might be feasible to supply from the dam to fourteen in number. The total number of people living in the villages is about 40 000 according to the figures provided by the National Demographic Study. Five of these villages to the north of Xonxa Dam are supplied or intended to be supplied by the Cacadu Regional Water Supply Scheme. The feasibility of supplying the other villages from the proposed Xonxa Dam to Queenstown pipeline was investigated in detail in 1996 by UWP in a study commissioned by DWAF. The estimated costs of supplying the villages from the proposed pipeline were compared with the estimated costs of groundwater supplies. It was found feasible to supply the six villages listed in Table 3.2, which also shows predicted future populations and estimated water requirements, including those of livestock.

TABLE 3.2 RURAL VILLAGES THAT COULD BE SUPPLIED WITH RAW WATER FROM THE XONXA PIPELINE

VILLAGE NAME	CODE	POPULATION IN YEAR			LIVESTOCK (ELSU)*	WATER REQUIREMENTS** (kℓ/d)		
		1995	2005	2015		1995	2005	2015
Xonxa	E011	7 810	9 384	10 050	4 510	363	406	424
Hatini	E010	1 469	1 765	1 890	1 716	96	104	108
Egcibhala	E012	2 198	2 641	2 828	1 270	102	115	120
Gandu	E013	1 266	1 521	1 629	732	59	66	69
North of Ndenxe	E008	4 348	5 224	5 595	796	146	170	180
Ndenxe	E009	1 068	1 283	1 374	848	58	63	66
Totals		18 159	21 818	23 366	9 872	824	924	967

* ELSU = equivalent large stock unit. Water requirement assumed to be 30 ℓ/d/unit plus 10% losses.
** Human requirement assumed to be 25 ℓ/person/day plus 10% losses.

The village populations in 1995 were taken from the UWP report as they agreed approximately with the values given by the National Demographic Study which were correlated with the 1996 Census figures. Growth in population after 1995 was calculated using the growth rates predicted in the National Demographic Study. Equivalent large stock units were taken from the UWP report and assumed to remain constant, as the area is fully stocked.

It is assumed that water requirements will remain constant after 2015. The requirement of 967 kℓ/day equates to 0,35 Mm^3/a. For pipeline design purposes, a capacity of 970 kℓ/day at a peak factor of 1,5 has been assumed. Thus the additional capacity required in the Xonxa pipeline to serve the rural villages would be a maximum of 16,8 ℓ/s. This requirement would reduce in stages along the pipeline as offtakes for groups of villages were reached.

The QRWSFS predicted that the rural water requirements that could be supplied from the Xonxa pipeline along its route would grow from a negligible quantity in 1990 to 1,2 Mm^3/a in 2045.

UWP (1996) forecast a rural demand of about 0,8 Mm^3/a in 2015, which would increase to 3,5 Mm^3/a in 2045.

It has been proposed (Stewart Scott, 2003) that Ilinge and the Macibini Villages be supplied from the Queenstown Water Treatment Works. The requirements of the villages in the vicinity of the proposed Xonxa pipeline route shown in Table 3.2 have not been included in the analysis of possible augmentation schemes because a recent separate study commissioned by the Chris Hani District Municipality has determined boreholes to be the most economical way of supplying them. Therefore, it is unlikely that they would be supplied from the Xonxa pipeline.

3.2.5 Total Urban and Rural Domestic Requirements

The total projected raw water requirements from the urban water supply scheme are summarised in Table 3.3. It can be seen that the requirements are expected to increase from 12,46 Mm^3/a in 2005 to 15,50 Mm^3/a in 2045.

TABLE 3.3 PROJECTED WATER REQUIREMENTS FOR QUEENSTOWN AND RURAL VILLAGES

AREA	WATER REQUIREMENTS (Mm^3/a)					
	1990	1995	2003	2005	2020	2045
Queenstown complex	5,58	7,60	7,60	7,85	8,80	10,30
Sada and rural villages	1,23	1,40	2,40	2,41	2,50	3,00
Ilinge and Macibini villages	0,54	0,64	2,18	2,20	2,20	2,20
Totals	**7,35**	**9,64**	**12,18**	**12,46**	**13,50**	**15,50**

3.2.6 Potential for Water Conservation and Demand Management

It can be seen from Table 3.3 that the growth in the water requirements of the Queenstown Complex did not increase between 1995 and 2003. In fact, water use decreased in the intervening years to a low of 5,96 Mm^3/a in 2000 but has increased again as low cost housing schemes have been implemented. The decrease between 1995 and 2000 is attributed to the effects of water demand management.

According to figures supplied by the company that operates the Queenstown potable water supply scheme, water losses are about 22% of raw water requirements. Most of the losses occur in the potable water distribution system.

The above statistics suggest that there is little scope for reducing water consumption further by water demand management, but that significant savings could be made by reducing losses. However, this is likely to be a long-term process because of the difficulties of repairing old water reticulation systems. Therefore, any savings that could be achieved have not been allowed for in the estimates of future water requirements shown in Table 3.3.

3.3 IRRIGATION

The irrigation developments that rely on water from the Lukanji Water Resources System are shown in Table 2.1. In terms of their water requirements they may be categorised as :

- Schemes supplied with water from dams that are also existing or potential sources of urban supplies.
- Irrigation developments in the catchment areas of the main dams.
- Other irrigation developments.

The present and expected future water requirements of the schemes in each of these categories are described below, together with water requirements for opportunistic irrigation, both in the catchments of the dams and in other areas.

3.3.1 Schemes Supplied from Dams with Potential for Urban Water Supply

The dams with potential for urban water supply and the irrigation schemes that they supply are :

- Waterdown Dam which supplies the Klipplaat River Government Water Scheme;
- Oxkraal Dam which was constructed to supply the Oxkraal Irrigation Scheme, but can also release water to the river channel to supply the Klipplaat River Government Water Scheme;
- Shiloh Dam which was also constructed to supply a portion of the Oxkraal Irrigation Scheme;

- Bushmanskrantz Dam, which is located upstream of Oxkraal Dam on the same river, and which was built to supply the Zweledinga Irrigation Scheme. Water can be transferred from Bushmanskrantz Dam to Oxkraal Dam by means of river channel releases.

The irrigation schemes are described briefly in Table 2.1. For purposes of considering ways in which the urban water supply can be augmented it has been assumed that :

- The total scheduled area irrigated under the Klipplaat River Irrigation Scheme will, in the near future, be increased to 1 924 ha as a result of the development of an additional 394 ha of land between Waterdown Dam and Oxkraal River. The total irrigation water requirement from Waterdown Dam will then be 14,68 Mm^3/a, including an allowance for conveyance losses of 25% of the allocation.

- An area of 541 ha of land will in the near future be developed for irrigation from Oxkraal Dam as part of the Oxkraal Irrigation Scheme. The quantity of water required from Oxkraal Dam to supply this area will be 4,13 Mm^3/a, including an allowance of 25% of the allocation for conveyance losses.

- As part of the Oxkraal Irrigation Scheme, an additional area of 25 ha of land will, in the near future, be developed for irrigation by means of water supplied from Shiloh Dam. The quantity of water required will be 0,19 Mm^3/a, including an allowance for conveyance losses of 25% of the allocation.

- No water will be required from Bushmanskrantz Dam for the foreseeable future for the defunct Zweledinga Irrigation Scheme. (This assumption is made for purposes of considering alternative operating rules, but in no way precludes the possibility of reviving irrigation below the dam at any time in the future).

- The area of irrigated land to be supplied with water from Xonxa Dam is unlikely to exceed 1 000 ha at any time in the future. The quantity of water required from Xonxa Dam to irrigate 1 000 ha of land would be 11,25 Mm^3/a, including an allowance of 25% of the allocation for conveyance losses.

The assumed quantities of water to be supplied for irrigation from the dams that are possible sources of additional urban water supply are summarised in Table 3.4 and the approximate monthly distribution of releases from Waterdown and Oxkraal Dams to meet the irrigation water requirements of the Klipplaat River Government Water scheme are shown in Table 3.5. The annual quantities of water released from the dams between 1995 and 2003 are shown in Appendix 1.2.

TABLE 3.4 ASSUMED IRRIGATION WATER REQUIREMENTS FROM DAMS THAT ARE POSSIBLE SOURCES OF ADDITIONAL URBAN WATER SUPPLY

SCHEME	DAM	ASSUMED AREA IRRIGATED (ha)	QUOTA (m^3/ha/a)	ALLOWANCE FOR CONVEYANCE LOSSES (m^3/ha/a)	WATER REQUIREMENTS (Mm^3/a)
Klipplaat River Government Water Scheme	Waterdown	1 924	6 100	1 525	14,7
Oxkraal Irrigation Scheme	Oxkraal Shiloh	541 25	6 100 6 100	0,8 0,05	4,1 0,2
Zweledinga	Bushmanskrantz	0	-	-	0
TOTALS IN CATCHMENT OF BLACK KEI RIVER		**2 490**	**-**	**-**	**19,0**
Xonxa Irrigation Scheme	Xonxa	1 000	9 000	2 250	11,3

TABLE 3.5 MONTHLY DISTRIBUTION OF WATER REQUIREMENTS FOR IRRIGATION

SOURCE	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Waterdown Dam %	8,7	10,1	11,1	12,3	13,4	10,0	8,9	6,0	4,2	3,9	4,7	6,7
Oxkraal Dam %	10,7	11,4	11,4	12,9	10,7	9,3	7,9	5,7	5,0	4,3	3,6	7,1

3.3.2 Irrigation Water Requirements in the Catchment Areas of the Main Dams

Irrigation developments in the catchment areas of the main dams reduce the runoff into the dams, and hence, the yields of the dams. Developments falling into this category are :

- The Upper Klipplaat Irrigation Scheme, which is situated in the catchment of Waterdown Dam, and which, for purposes of calculating the yield of Waterdown Dam, has been assumed to abstract 5,1 Mm^3/a by means of farm dams and pumping from rivers.

- Irrigation in the catchment of the Bonkolo River upstream of Bonkolo Dam is assumed to use 0,68 Mm^3/a from surface water resources and 0,5 Mm^3/a from groundwater. The effect of the groundwater use on streamflow has been assumed to be negligible.

- Diffuse irrigation along the Upper White Kei River upstream of Xonxa Dam was estimated in QRWSFS to take place on 557 ha of land and to have a water requirement of 5 Mm^3/a. These values were accepted for the current study. (The Water Resources Situation Assessment Report (DWAF, 2002) gives a water use of 3,67 Mm^3/a, but the higher value given in the QRWSFS is considered more appropriate for this study as it reduces the risk of over-estimating the yield of Xonxa Dam).

The assumed water requirements for irrigation in the catchments are summarised in Table 3.6.

TABLE 3.6 IRRIGATION WATER REQUIREMENTS IN THE CATCHMENTS OF THE MAIN DAMS

IRRIGATION DEVELOPMENT	DAM CATCHMENT AREA	ASSUMED WATER REQUIREMENT (Mm^3/a)
Upper Klipplaat	Waterdown Dam	5,1
Bonkolo River	Bonkolo Dam	1,2 *
Upper White Kei	Xonxa Dam	5,0
Total irrigation water requirement		**11,3**

* 0,5 Mm^3/a is supplied from groundwater.

3.3.3 Other Irrigation Schemes

Other irrigation developments that are of relevance to this study are those along the upper reaches of the Black Kei River, in the catchment of the Klaas Smits River, and opportunistic irrigation in the catchment of the Black Kei River downstream of its confluence with the Klipplaat River. The significance of these developments is that they reduce the quantity of water available from run-of-river flow that can be used on irrigated land that is scheduled under the Klipplaat River Government Water Scheme. As mentioned previously, the quota supplied from Waterdown Dam is less than the optimum for irrigation. When the scheme was first established, the water from the dam supplemented water abstracted from run-of-river flow (DWAF, 1993), but, with the development of additional dams on the Oxkraal River and in the upper reaches of the Black Kei River, the reliability at which the required quantity of water can be abstracted may have decreased. If this were the case, it would be reasonable when considering the future apportionment of water from Waterdown and Oxkraaal Dams, to take into account the possible need to increase the quota for irrigation.

The assumptions made in this study on the water requirements of the various developments are the following :

- The Ntabethemba and associated schemes along the Black Kei River upstream of its confluence with the Klipplaat River are estimated to require 2,16 Mm^3/a of water in their current state (290 ha of irrigated land). In the past, about 1 200 ha of land has been under irrigation, but there has been a drastic decline in irrigation farming, possibly because insufficient water is available at reasonable assurance for the original areas of irrigation. In addition, about 700 ha of diffuse irrigation was supplied from the minor tributaries of the Black Kei River, giving a total irrigated area of approximately 1 900 ha with a water requirement of 12,6 Mm^3/a. It has been estimated (DWAF, 1993) that the 1:10 year yield of the existing dams and the run-of-river flow, after allowing for the 700 ha of diffuse

irrigation, is about 2,5 Mm^3/a, which is sufficient to irrigate about 380 ha of land (i.e. an increase of 90 ha). For purposes of this study, however, the irrigation requirement has been assumed to be the original 12,6 Mm^3/a. This conservative approach has been adopted because irrigation of the original areas of the scheme might be re-instated in the future and this would affect the availability of water for the Klipplaat River Government Water Scheme downstream.

- Opportunistic irrigation in the catchment of the Klaas Smits River is estimated to take place on about 5 250 ha of land, of which 990 ha is irrigated from groundwater. The average field edge water requirement is approximately 5 600 mm/ha/a (DWAF, 1993), giving a water requirement of 29,4 Mm^3/a. Of this, an estimated 5,5 Mm^3/a is supplied from groundwater and 23,9 Mm^3/a from surface water. Part of this requirement (0,7 Mm^3/a from surface water and 0,5 Mm^3/a from groundwater) is in the catchment of Bonkolo Dam. Therefore, the irrigation water requirements in the Klaas Smits River catchment, excluding the catchment of Bonkolo Dam, are estimated to be 23,2 Mm^3/a from surface water and 5,0 Mm^3/a from groundwater.

- Opportunistic irrigation in the catchment of the Black Kei River downstream of its confluence with the Klipplaat River occurs along small tributaries in areas remote from the Black Kei River itself. It is estimated (DWAF, 1993) that some 440 ha of land is irrigated in this way, and that the field edge requirement of the crops grown is approximately 5 400 $m^3/ha/a$, giving a total water requirement of 2,4 Mm^3/a.

The irrigation water requirements assumed in this study for developments that do not affect the yields of the main dams are summarised in Table 3.7.

TABLE 3.7 IRRIGATION WATER REQUIREMENTS THAT DO NOT AFFECT THE YIELDS OF THE MAIN DAMS

IRRIGATION DEVELOPMENT	LOCATION	ASSUMED WATER REQUIREMENT	
		FROM SURFACE WATER (Mm^3/a)	FROM GROUNDWATER (Mm^3/a)
Ntabethemba and associated schemes	Black Kei River catchment upstream of Klipplaat River confluence	12,6	Negligible
Opportunistic irrigation in catchment of Klaas Smits River	Catchment of Klaas Smits River excluding catchment of Bonkolo Dam	23,2	5,0
Opportunistic irrigation in the Lower Black Kei River catchment	Black Kei River catchment downstream of Klipplaat River confluence	2,4	Negligible
Total water requirements		**38,2**	**5,0**

3.3.4 Optimum Irrigation Water Requirements of the Klipplaat River Government Water Scheme

The optimum field edge water requirement of the mix of crops grown on the scheduled land under the Klipplaat River Government Water Scheme has been calculated (DWAF, 1993) to be approximately 7 500 m^3/ha/a along the Klipplaat River and 7 000 m^3/ha/a along the Black Kei River, while the quota supplied from Waterdown Dam is 6 100 m^3/ha/a. Thus, there is a shortfall of 1 400 m^3/ha/a and 900 m^3/ha/a in the quantity of water supplied to the respective areas.

There is normally insufficient water in the Klipplaat River downstream of the dams for the irrigated lands along its banks to be supplied with significant quantities of water from run-of-river flow. Therefore the additional water, if supplied, would have to come from Waterdown Dam or Oxkraal Dam (if supplied from Oxkraal Dam, the water would have to be piped to the 600 ha of land that is located along the Klipplaat River upstream of the Oxkraal/Klipplaat River confluence). The additional water required along the Black Kei River could be abstracted from run-of-river flow in that river at an assurance of at least 1:10 years (see Appendix 4). The quantities of additional water required are shown in Table 3.8.

TABLE 3.8 IRRIGATION WATER REQUIREMENTS OF THE KLIPPLAAT RIVER GOVERNMENT WATER SCHEME IN EXCESS OF THE ALLOCATION FROM WATERDOWN DAM

SECTION OF SCHEME	ALLOCATION (mm/ha/a)	ADDITIONAL WATER REQUIREMENT (mm/ha/a)	SCHEDULED AREA (ha)	TOTAL WATER REQUIREMENT (Mm^3/a)
Klipplaat River	6 100	1 400	915	1,3
Black Kei River	6 100	900	1 009	0,9
Total additional water requirement				**2,2**

3.3.5 Summary of Water Requirements for Irrigation

The irrigation requirements from the various categories of sources of supply are summarised in Table 3.9 where it can be seen that the total field edge water requirement is some 77 Mm^3/a, of which 30 Mm^3/a are supplied from dams which are potential sources of additional urban water supply, and approximately 11 Mm^3/a is abstracted from surface water sources in the catchment areas of the same dams.

TABLE 3.9 SUMMARY OF FIELD EDGE WATER REQUIREMENTS FOR IRRIGATION

SOURCE OF SUPPLY	FIELD EDGE WATER REQUIREMENT (Mm^3/a)
Dams with potential for urban water supply	30,3
Surface water in catchments of dams with potential for urban supply	10,8
Dams not used for urban supply and run-of-river flow not affecting main dams	40,4 *
Groundwater	5,5
Total requirement	**87,0**

* Includes 38,2 Mm^3/a from Table 3.7 and 2,2 Mm^3/a from Table 3.8 that could be supplied from dams.

4. STREAMFLOW REDUCTION BY AFFORESTATION

There is little indigenous forest in the study area and less than 7 km^2 of the study area is covered by commercial timber plantations (DWAF, 1996). Most of this is along the Amatola mountain range in the catchment of the Klipplaat River. The total reduction in streamflow caused by afforestation is estimated to be 1,24 Mm^3/a, from plantations located as shown in Table 4.1.

TABLE 4.1 ANNUAL WATER REQUIREMENTS FOR AFFORESTATION

RIVER CATCHMENT	AFFORESTED AREA (ha)	WATER REQUIREMENT (Mm^3/a)
Upper Klipplaat River	474	1,01
Middle Klipplaat River	20	0,02
Lower Klipplaat River	7	-
Upper Oxkraal River	146	0,21
Lower Oxkraal River	1	-
Total	**648**	**1,24**

5. INVASIVE ALIEN VEGETATION

According to the Water Resources Situation Assessment Report (DWAF, 2002), the main occurrence of alien vegetation is in the catchment of Waterdown Dam where there is reported to be a consolidated area of 5,5 km^2 of mainly black wattle which is estimated to reduce streamflow by about 0,8 Mm^3/a.

REFERENCES

Department of Water Affairs and Forestry, South Africa. 1993. *Upper Kei Basin Study*. Prepared by Kei Basin Consulting Engineers for the Department of Water Affairs and Forestry, the Ciskei Department of Public Works and the Transkei Department of Agriculture and Forestry.

Department of Water Affairs and Forestry, South Africa. 1997. *Queenstown Regional Water Supply Feasibility Study*. Prepared by Kei Basin Consulting Engineers for the Department of Water Affairs and Forestry.

Midgley, D C, Pitman, W V and Middleton, B J. 1994. *The Surface Water Resources of South Africa, 1990*. Volumes 1 to 6. Report to the Water Research Commission, Pretoria.

Stewart Scott (Pty) Ltd. 2003. *Technical Report for the Transfer of Raw Water from Xonxa Dam to Queenstown and the Bulk Potable Water Supply to Macibini Villages*. Prepared for the Lukhanji Municipality.

Uhlmann Withaus and Prins. 1995. Queenstown Regional Water Supply Feasibility Study: *Rural Water Supply: Possibilities using Xonxa Pipeline*. Prepared for the Department of Water Affairs and Forestry.

ADDENDUM 1.1

Queenstown Water Use
1997 to 2002

QUEENSTOWN VOLUMES

1997

MONTH			Mar-97	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	
DAYS			31	30	31	30	31	31	30	31	30	31	
VOLUME DATA							**ACTUAL**						
VOLUME IN Kl			Mar-97	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	**TOTAL**
RAW WATER IMPORTATION	790877	798770	576047	601804	568498	602911	562182	554218	700849	565249	566010	651786	**7539201**
RAW WATER INTO WTW			576047	592804	566500	590000	554000	532965	700767	553056	563382	664977	
TREATED WATER			543172	577731	534444	553325	#N/A	512200	679200	549080	558910	644180	
WATER SOLD			441249	466425	447751	450017	439664	487621	535176	562028	500833	558591	
QUEENSTOWN			193693	191629	159911	184312	173258	190050	222628	215000	219841	252439	
MLUNGISI			138057	156816	166468	149014	149887	177100	176590	204290	160370	178048	
eZEBELENI			109499	117980	121372	116691	116519	120471	135958	142738	120622	128104	
SEWAGE TREATED			352333	413657	398006	385435	#N/A	282785	419887	339936	319492	374769	
WATER BALANCE							**ACTUAL**						
VOLUME IN Kl			Mar-97	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	
RAW WATER IMPORTATION ACTUAL			576047	601804	568498	602911	#N/A	554218	700849	565249	566010	651786	
WATERDOWN			517247	601804	403823	432211	#N/A	394618	420849	393749	514910	651786	
BONGOLA			58800	0	164675	170700	#N/A	159600	280000	171500	51100	0	
WATERDOWN DAM CAPACITY			100%	100%	100%	100%	#N/A	100%	100%	100%	100%	100%	
BONGOLA DAM CAPACITY			65%	60%	60%	53%	#N/A	52%	48%	42%	42%	40%	
BERRY DAM CAPACITY			100%	100%	100%	100%	#N/A	83%	78%	50%	25%	50%	
RAW WATER SOLD													
RAW INTO WTW (BERRY) ACTUAL			576047	592804	566500	590000	554000	532965	700767	553056	563382	664977	
TREATED WATER ACTUAL			543172	577731	534444	553325	#N/A	512200	679200	549080	558910	644180	
LOW LEVEL			36785	38533	38709	41182	#N/A	35150	43780	33160	35520	44790	
HIGH LEVEL (300)			174600	176522	145000	174900	100000	120000	165000	110000	130000	180000	
FINCHAMS NEK			59590	66828	67984	98592	#N/A	55640	70790	66130	69150	81580	
eZEBELENI			134778	144328	135729	125928	124000	143350	193880	144500	157880	146120	
MLUNGISI			137419	151520	147022	112723	#N/A	158060	205750	195290	166360	191690	
WATER SOLD ACTUAL			441249	466425	447751	450017	439664	487621	535176	562028	500833	558591	
QUEENSTOWN			193693	191629	159911	184312	173258	190050	222628	215000	219841	252439	
MLUNGISI - BULK			138057	156816	166468	149014	149887	177100	176590	204290	160370	178048	
eZEBELENI - BULK			109499	117980	121372	116691	116519	120471	135958	142738	120622	128104	
MLUNGISI - METERED													
eZEBELENI - METERED													
LOSS IN WTW			6%	3%	6%	6%	#N/A	4%	3%	1%	1%	3%	
LOSS UPTO WTW			6%	4%	6%	8%	#N/A	8%	3%	3%	1%	1%	
LOSS IN NETWORK (HL & LL & FN)			34%	37%	35%	36%	#N/A	11%	39%	-6%	21%	25%	
LOSS TOWN RUNNING AVE (3 mths)			#N/A	#N/A	35%	36%	#N/A	#N/A	#N/A	15%	18%	13%	
LOSS IN MLUNGISI													
LOSS IN EZIBELENI													
TOTAL LOSS			23%	22%	21%	25%	#N/A	12%	24%	1%	12%	14%	

QUEENSTOWN VOLUMES 1998

1998

MONTH	Jan-98	Feb-98	Mar-98	Apr-98	May-98	Jun-98	Jul-98	Aug-98	Sep-98	Oct-98	Nov-98	Dec-98	
DAYS	31	28	31	30	31	30	31	31	30	31	30	31	
VOLUME DATA													
VOLUME IN Kl	Jan-98	Feb-98	Mar-98	Apr-98	May-98	Jun-98	Jul-98	Aug-98	Sep-98	Oct-98	Nov-98	Dec-98	
RAW WATER IMPORTATION	669071	675749	487328	571851	491802	584005	544553	518247	585092	570829	545090	514839	**6758456**
RAW WATER INTO WTW	638918	610751	523865	569467	568027	634425	544553	542314	520814	559820	526114	505000	
TREATED WATER	619310	618600	494000	562116	582950	574030	510262	527930	507590	552979	535950	513560	
WATER SOLD	606974	546764	477000	488029	430468	478624	368034	384550	352472	405151	403442	404965	
QUEENSTOWN	264542	233279	229000	212534	169544	219532	192760	209564	221446	231921	217788	228617	
MLUNGISI	207490	188910	158000	174000	167000	166509	117640	108330	101470	109980	126710	123370	
eZEBELENI	134942	124575	90000	101495	93924	92583	94388	102471	83646	106320	116700	88280	
SEWAGE TREATED	360287	380880	378137	401829	370764	386580	386580	346813	311448	276602	312621	281965	
WATER BALANCE													
VOLUME IN Kl	Jan-98	Feb-98	Mar-98	Apr-98	May-98	Jun-98	Jul-98	Aug-98	Sep-98	Oct-98	Nov-98	Dec-98	
RAW WATER IMPORTATION ACTUAL	669071	675749	487328	571851	491802	584005	544553	518247	585092	570829	545090	514839	
WATERDOWN	669071	675749	487328	571851	491802	584005	544553	518247	585092	570829	545090	514839	
BONGOLA	0	0	0	0	0	0	0	0	0	0	0	0	
WATERDOWN DAM CAPACITY	81%	77%	87%	92%	91%	87%	86%	83%	100%	100%	93%	95%	
BONGOLA DAM CAPACITY	39%	37%	41%	48%	47%	46%	46%	45%	45%	43%	43%	52%	
BERRY DAM CAPACITY	63%	100%	88%	75%	100%	88%	97%	100%	97%	100%	100%	98%	
RAW WATER SOLD							2082	2100	2678	2480	2453	2155	
RAW INTO WTW (BERRY) ACTUAL	638918	610751	523865	569467	568027	634425	544553	542314	520814	559820	526114	505000	
TREATED WATER ACTUAL	619310	618600	494000	562116	582950	574030	510262	527930	507590	552979	535950	513560	
LOW LEVEL	54300	54720	47320	45290	49660	53170	43089	49420	47890	39250	41000	35540	
HIGH LEVEL (300)	150000	162700	106900	111756	118800	127800	155100	163200	155000	177039	149000	141229	
FINCHAMS NEK	73540	80510	69560	88320	95560	94510	92230	85160	85770	88270	80060	70510	
eZEBELENI	153770	139260	124410	147600	130600	141610	98163	121820	117460	138440	139180	118610	
MLUNGISI	187700	181410	145810	169150	188330	156940	121680	108330	101470	109980	126710	147671	
WATER SOLD ACTUAL	606974	546764	477000	488029	430468	478624	368034	384550	352472	405151	403442	404965	
QUEENSTOWN	264542	233279	229000	212534	169544	219532	192760	209564	221446	231921	217788	228617	
MLUNGISI - BULK	207490	188910	158000	174000	167000	166509	117640	108330	101470	109980	126710	123370	
eZEBELENI - BULK	134942	124575	90000	101495	93924	92583	94388	102471	83646	106320	116700	88280	
MLUNGISI - METERED							96350	105657	54766	88279	89142	93822	
eZEBELENI - METERED							78924	69329	76260	84951	96512	82526	
LOSS IN WTW	3%	-1%	6%	1%	-3%	10%	6%	3%	3%	1%	-2%	-2%	
LOSS UPTO WTW	7%	8%	-1%	2%	-19%	2%	0%	-5%	11%	2%	3%	2%	
LOSS IN NETWORK (HL & LL & FN)	4%	24%	7%	26%	36%	20%	34%	30%	23%	24%	19%	18%	
LOSS TOWN RUNNING AVE (3 mths)	17%	18%	12%	19%	23%	27%	30%	28%	29%	26%	22%	20%	
LOSS IN MLUNGISI							18%	n/a	46%	20%	30%	24%	
LOSS IN EZIBELENI							16%	32%	n/a	20%	17%	7%	
TOTAL LOSS	9%	19%	2%	15%	12%	18%	32%	25%	39%	29%	26%	21%	

QUEENSTOWN VOLUMES 1999

MONTH	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99	
DAYS	31	28	31	30	31	30	31	31	30	31	30	31	
VOLUME DATA													
VOLUME IN KI	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99	**TOTAL**
RAW WATER IMPORTATION	487460	521377	520170	524871	518798	523754	498745	516707	593695	575072	602652	635529	**6518830**
RAW WATER INTO WTW	485000	498000	500000	510000	504000	499822	497000	470087		474000		520247	
TREATED WATER	479810	478336	462914	473391	464349	460500	478385	467678	565159	471231	579874	534024	
WATER SOLD	389377	371029	365000	440243	345148	326272	345948	361294	405982	370303	509373	450616	
QUEENSTOWN	217743	193879	198000	214101	191489	172464	192289	202138	232777	217583	307156	254009	
MLUNGISI	141320	127640	116490	128530	113460	118030	105280	114200	123210	111980	124790	95848	
eZEBELENI	115040	90440	81850	95450	84250	92190	85720	94260	101790	104620	126000	100759	
SEWAGE TREATED	269868	300937	281015	273405	259008	248134	233872	242888	278296	262127	280048	309302	
WATER BALANCE													
VOLUME IN KI	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99	
RAW WATER IMPORTATION ACTUAL	487460	521377	520170	524871	518798	523754	498745	516707	593695	575072	602652	635529	
WATERDOWN	487460	486377	520170	384871	328798	523754	498745	516707	593695	575072	602652	635529	
BONGOLA	0	35000	0	140000	190000	0	0	0			0	0	
WATERDOWN DAM CAPACITY	89%	84%	80%	77%	73%	68%	65%	61%	57%	66%	56%	56%	
BONGOLA DAM CAPACITY	50%	55%	55%	56%	53%	52%	52%	52%	50%	46%	42%	69%	
BERRY DAM CAPACITY	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	95%	100%	
RAW WATER SOLD	2363	2420	2000	2407	2033	2695	2030	3880	5082	3233	2457	3152	
RAW INTO WTW (BERRY) ACTUAL	485000	500000	500000	510000	504000	499822	497000	505000	582638	508929	590721	562202	
TREATED WATER ACTUAL	479810	478336	462914	473391	464349	460500	478385	467678	565159	471231	579874	534024	
LOW LEVEL	42270	47110	44670	47150	46910	44810	46160	46040	53860	48550	55500	47540	
HIGH LEVEL (300)	130000	108446	122174	119841	125949	125950	131345	128468	171809	134451	175764	144274	
FINCHAMS NEK	68830	69780	66000	67830	66640	61730	67550	63920	79730	62090	80760	77780	
eZEBELENI	106000	125660	111960	115800	112680	116360	119470	115300	132400	119690	143060	139570	
MLUNGISI	132710	127340	118110	122770	112170	111650	113860	113950	127360	106450	124790	124860	
WATER SOLD ACTUAL	389377	371029	365000	440243	345148	326272	345948	361294	405982	370303	509373	450616	
QUEENSTOWN	217743	193879	198000	214101	191489	172464	192289	202138	232777	217583	307156	254009	
MLUNGISI - BULK	141320	127640	116490	128530	113460	118030	105280	114200	123210	111980	124790	124860	
eZEBELENI - BULK	115040	90440	81850	95450	84250	92190	85720	94260	101790	104620	126000	113640	
MLUNGISI - METERED	89336	91726	90000	141982	85647	80997	85647	83894	94258	76761	103094	95848	
eZEBELENI - METERED	82298	85424	77000	84160	68012	72811	68012	75262	78947	75958	99123	100759	
LOSS IN WTW	1%	4%	7%	7%	8%	8%	4%	7%	3%	7%	2%	5%	
LOSS UPTO WTW	1%	4%	4%	3%	3%	5%	0%	2%	2%	12%	2%	12%	
LOSS IN NETWORK (HL & LL & FN)	6%	26%	25%	16%	29%	33%	31%	22%	31%	16%	7%	14%	
LOSS TOWN RUNNING AVE (3 mths)	14%	16%	19%	22%	23%	26%	31%	29%	28%	23%	18%	12%	
LOSS IN MLUNGISI	37%	28%	23%	-10%	25%	31%	19%	27%	23%	31%	17%	23%	
LOSS IN EZIBELENI	28%	6%	6%	12%	19%	21%	21%	20%	22%	27%	21%	11%	
TOTAL LOSS	20%	28%	29%	16%	33%	37%	30%	29%	31%	35%	15%	29%	

QUEENSTOWN VOLUMES 1998 2000

MONTH	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	
DAYS	31	29	31	30	31	30	31	31	30	31	30	31	
VOLUME DATA													
VOLUME IN KI	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	
RAW WATER IMPORTATION	476335	498493	474813	498804	460063	457908	451341	488616	526018	514433	540586	553873	**5941283**
RAW WATER INTO WTW	506000	495000	459000	473169	443765	441398	392097	466348	509353	508169	518394	543183	
TREATED WATER	496802	485050	443748	466390	418037	435679	427873	466587	497268	497639	489152	522174	
WATER SOLD	408291	341512	384756	325951	333934	341559	394767	341829	373526	424645	407325	414045	
QUEENSTOWN	218217	195587	211608	176839	177337	202072	230141	201915	227894	265349	237736	263439	
MLUNGISI	114750	117140	109790	111690	101450	107030	100900	111510	116480	116720	120920	125380	
eZEBELENI	103300	98650	81270	97200	80130	83890	80380	86480	90800	88890	88090	99355	
SEWAGE TREATED	328935	337666	345955	462012	283093	264750	261299	278070	310457	280417	371203	366355	
WATER BALANCE													
VOLUME IN KI	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	
RAW WATER IMPORTATION ACTUAL	476335	498493	474813	498804	460063	457908	451341	488616	526018	514433	540586	553873	
WATERDOWN	476335	469093	18813	258804	385063	415908	391341	296616	336018	374433	380586	433873	
BONGOLA	0	29400	456000	240000	75000	42000	60000	192000	190000	140000	160000	120000	
WATERDOWN DAM CAPACITY	72%	81%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
BONGOLA DAM CAPACITY	72%	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
BERRY DAM CAPACITY	100%	100%	100%	100%	100%	80%	80%	80%	80%	80%	85%	90%	
RAW WATER SOLD	2980	3152	8971	7948	3527	8101	4203	4203	2526	1620	2699	5587	
RAW INTO WTW (BERRY) ACTUAL	506000	495000	459000	473169	443765	441398	392097	466348	509353	508169	518394	543183	
TREATED WATER ACTUAL	496802	485050	443748	466390	418037	435679	427873	466587	497268	497639	489152	522174	
LOW LEVEL	45360	46520	43090	47500	46460	46950	45790	47970	49700	50760	55650	55350	
HIGH LEVEL (300)	133622	110220	101038	96670	95977	105539	102133	117797	127738	124739	106982	126574	
FINCHAMS NEK	70030	82500	74470	83410	71770	74860	77150	84000	97770	94380	95090	97470	
eZEBELENI	133040	128670	115360	127120	102380	101300	101900	105310	105580	111040	110510	117400	
MLUNGISI	114750	117140	109790	111690	101450	107030	100900	111510	116480	116720	120920	125380	
WATER SOLD ACTUAL	408291	341512	384756	325951	333934	341559	394767	341829	373526	424645	407325	414045	
QUEENSTOWN	218217	195587	211608	176839	177337	202072	230141	201915	227894	265349	237736	263439	
MLUNGISI - BULK	114750	117140	109790	111690	101450	107030	100900	111510	116480	116720	120920	125380	
eZEBELENI - BULK	103300	98650	81270	97200	80130	83890	80380	86480	90800	88890	88090	99355	
MLUNGISI - METERED	107074	75457	94507	81286	98616	82989	92147	79210	76672	88634	84763	86716	
eZEBELENI - METERED	83000	70468	78641	67826	57981	56498	72479	60704	68960	70662	84826	63890	
LOSS IN WTW	2%	2%	3%	1%	6%	1%	-9%	0%	2%	2%	6%	4%	
LOSS UPTO WTW	-6%	1%	1%	4%	3%	2%	12%	4%	3%	1%	4%	1%	
LOSS IN NETWORK (HL & LL & FN)	22%	27%	16%	31%	25%	17%	7%	25%	21%	9%	15%	11%	
LOSS TOWN RUNNING AVE (3 mths)	14%	21%	22%	25%	24%	25%	16%	16%	18%	18%	15%	12%	
LOSS IN MLUNGISI	7%	36%	14%	27%	3%	22%	9%	29%	34%	24%	30%	31%	
LOSS IN EZIBELENI	20%	29%	3%	30%	28%	33%	10%	30%	24%	21%	4%	36%	
TOTAL LOSS	14%	31%	17%	33%	27%	24%	12%	29%	29%	17%	24%	24%	

QUEENSTOWN VOLUMES **2001**

MONTH	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	
DAYS	31	28	31	30	31	30	31	31	30	31	30	31	
VOLUME DATA													
VOLUME IN KI	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	**TOTAL**
RAW WATER IMPORTATION	649838	623631	588855	579507	579534	579561	558473	566408	620212	577689	649113	617993	**7190814**
RAW WATER INTO WTW	636967	612990	581451	568913	567750	569172	552097	550572	596506	549131	647198	614000	
TREATED WATER	618145	586860	553406	556039	557954	572669	497040	531535	584167	542571	630413	612888	
WATER SOLD	512407	445780	489058	446837	445269	402324	414449	476751	453028	417541	437403	456446	
QUEENSTOWN	307574	270754	300124	273922	247872	211530	222604	216774	248163	232507	241951	264202	
MLUNGISI	140410	132020	119010	128230	127470	127850	120780	121740	124100	107690	133360	131460	
eZEBELENI	110905	110350	97440	108220	102190	103420	91430	100210	115010	107960	123420	128960	
SEWAGE TREATED	338217	384766	346880	390003	330349	319141	293587	294081	310746	304917	372809	425987	
				30	31	30	31	31	30	31	31	245	
				11515	10784	10772	10435	10497	11507	10087	10455	2633819	

WATER BALANCE													
VOLUME IN KI	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	
RAW WATER IMPORTATION ACTUAL	649838	623631	588855	579507	579534	579561	558473	566408	620212	577689	649113	617993	
WATERDOWN	349838	203631	278855	345452	334308	323164	323473	325408	345212	312689	324113	309993	
BONGOLA	300000	420000	310000	234055	245226	256397	235000	241000	275000	265000	325000	308000	
WATERDOWN DAM CAPACITY	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
BONGOLA DAM CAPACITY	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
BERRY DAM CAPACITY	70%	100%	90%	90%	80%	100%	100%	100%	70%	70%	100%	100%	
RAW WATER SOLD	2420	1511	1944	1710	2278	2846	630	622	633	39	75	81	
RAW INTO WTW (BERRY) ACTUAL	636967	612990	581451	568913	567750	569172	552097	550572	596506	549131	647198	614000	
TREATED WATER ACTUAL	618145	586860	553406	556039	557954	572669	497040	531535	584167	542571	630413	612888	
LOW LEVEL	59070	59690	54990	55630	60090	61940	36550	37310	64690	60820	73600	85760	
HIGH LEVEL (300)	160935	145870	147846	125119	135634	146149	123430	141175	158767	140041	153533	127378	
FINCHAMS NEK	116910	116790	73450	68720	70300	105220	95870	99940	102650	97010	115000	109670	
eZEBELENI	140820	132490	158110	178340	164460	131510	120410	131370	133960	137010	154920	158620	
MLUNGISI	140410	132020	119010	128230	127470	127850	120780	121740	124100	107690	133360	131460	
WATER SOLD ACTUAL	512407	445780	489058	446837	445269	402324	414449	476751	453028	417541	437403	456446	
QUEENSTOWN	307574	270754	300124	273922	247872	211530	222604	216774	248163	232507	241951	264202	
MLUNGISI - BULK	140410	132020	119010	128230	127470	127850	120780	121740	124100	107690	133360	131460	
eZEBELENI - BULK	110905	110350	97440	108220	102190	103420	91430	100210	115010	107960	123420	128960	
MLUNGISI - METERED	106867	98094	108204	103592	124966	118363	116940	186486	117513	110356	109434	109346	
eZEBELENI - METERED	97966	76932	80730	69323	72431	72431	74905	73491	87352	74678	86018	82898	
LOSS IN WTW	3%	4%	5%	2%	2%	-1%	10%	3%	2%	1%	3%	0%	
LOSS UPTO WTW	2%	1%	1%	2%	2%	1%	1%	3%	4%	5%	0%	1%	
LOSS IN NETWORK (HL & LL & FN)	16%	21%	11%	14%	24%	38%	22%	30%	28%	29%	35%	25%	
LOSS TOWN RUNNING AVE (3 mths)	14%	16%	16%	16%	17%	26%	28%	30%	27%	29%	31%	30%	
LOSS IN MLUNGISI	24%	26%	9%	19%	2%	7%	3%	-53%	5%	-2%	18%	17%	
LOSS IN EZIBELENI	12%	30%	17%	36%	29%	30%	18%	27%	24%	31%	30%	36%	
TOTAL LOSS	21%	28%	17%	23%	23%	30%	26%	16%	27%	28%	33%	26%	

QUEENSTOWN VOLUMES 1998 **2002**

MONTH	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	
DAYS	29	28	31	30	31	30	**31**	32	30	30	30	28	
VOLUME DATA													
VOLUME IN KI	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	**TOTAL**
RAW WATER IMPORTATION	621098	689063	609184	635000	617758	606104	563112	571499	538932	615910	627047	593507	**7288214**
RAW WATER INTO WTW	621057	674970	603156	626985	614368	569518	563322	575529	536619	612276	627047	593507	
TREATED WATER	624262	684777	627290	650725	594477	590618	578290	583060	542094	582644	647798	596427	
WATER SOLD	508661	464774	463777	524767	501202	444344	413834	472962	414776	445247	443515	513887	
QUEENSTOWN	272355	266284	246829	309128	296669	246566	229917	258082	226321	250468	246711	279142	
MLUNGISI	129970	140980	132590	144510	119570	129900	132660	126510	119460	125020	130030	137610	
eZEBELENI	132390	134740	116780	120300	115380	151381	151675	153680	153661	154927	156675	155914	
SEWAGE TREATED	341652	397716	339410	343588	290706	336942	342372	351263	324347	302279	296503	281295	
	10750		4000557										

WATER BALANCE												
VOLUME IN KI	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02
RAW WATER IMPORTATION ACTUAL	621098	689063	609184	635000	617758	606104	563112	571499	538932	615910	627047	593507
WATERDOWN	301098	303063	452584	454716	327758	358104	318112	321499	297932	275311	312190	269607
BONGOLA	320000	386000	156600	180284	290000	248000	245000	250000	241000	340599	314857	323900
WATERDOWN DAM CAPACITY	100%	100%	100%	95%	95%	90%	90%	90%	95%	95%	95%	95%
BONGOLA DAM CAPACITY	100%	100%	100%	90%	90%	90%	90%	90%	90%	90%	90%	90%
BERRY DAM CAPACITY	100%	100%	100%	100%	100%	100%	95%	95%	100%	100%	100%	95%
RAW WATER SOLD	87	88	78	106	106	57	57	82	77	76	68	68
RAW INTO WTW (BERRY) ACTUAL	621057	674970	603156	626985	614368	569518	563322	575529	536619	612276	627047	593507
TREATED WATER ACTUAL	624262	684777	627290	650725	594477	590618	578290	583060	542094	582644	647798	596427
LOW LEVEL	80820	84430	78400	82080	78250	82710	78070	75770	76830	76240	70660	57890
HIGH LEVEL (300)	137052	163577	159040	166485	142327	139218	134270	144560	110464	136934	177568	148677
FINCHAMS NEK	110310	125110	109950	106640	109920	101920	98700	104620	109530	101700	115500	108300
eZEBELENI	166110	170680	147310	151010	144410	136870	134590	131600	125810	142750	154040	143950
MLUNGISI	129970	140980	132590	144510	119570	129900	132660	126510	119460	125020	130030	137610
WATER SOLD ACTUAL	508661	464774	463777	524767	501202	444344	413834	472962	414776	445247	443515	513887
QUEENSTOWN	272355	266284	246829	309128	296669	246566	229917	258082	226321	250468	246711	279142
MLUNGISI - BULK	129970	140980	132590	144510	119570	129900	132660	126510	119460	125020	130030	137610
eZEBELENI - BULK	132390	134740	116780	120300	115380	151381	151675	153680	153661	154927	156675	155914
MLUNGISI - METERED	132648	109664	123841	131576	118598	118031	108303	126696	116071	114129	110200	131491
eZEBELENI - METERED	103658	88826	93107	84063	85935	79747	75614	88184	72384	80650	86604	103254
LOSS IN WTW	-1%	-1%	-4%	-4%	3%	-4%	-3%	-1%	-1%	5%	-3%	0%
LOSS UPTO WTW	0%	2%	1%	1%	1%	6%	0%	-1%	0%	1%	0%	0%
LOSS IN NETWORK (HL & LL & FN)	25%	35%	35%	20%	17%	20%	22%	15%	16%	17%	32%	8%
LOSS TOWN RUNNING AVE (3 mths)	28%	28%	31%	30%	24%	27%	27%	26%	25%	25%	25%	23%
LOSS IN MLUNGISI	-2%	22%	7%	9%	1%	9%	18%	0%	3%	9%	15%	4%
LOSS IN EZIBELENI	22%	34%	20%	30%	26%	47%	50%	43%	53%	48%	45%	34%
TOTAL LOSS	18%	33%	24%	17%	19%	27%	26%	17%	23%	28%	29%	13%

ADDENDUM 1.2

Releases from Dams
for Irrigation and Urban Supply Purposes

RELEASES OUT OF DAMS FOR IRRIGATION PURPOSES : 1995 TO 2003

DATE	WATERDOWN DAM m^3		OXKRAAL DAM m^3	BUSHMANSKRANTZ DAM m^3	THRIFT DAM m^3	LIMIETSKLOOF DAM m^3	XONXA DAM m^3	TOTAL FOR ALL THE DAMS m^3
	Irrigation Releases	Domestic Releases	Irrigation Releases	Irrigation Releases	Irrigation Releases	Irrigation Releases	Irrigation Releases	Irrigation Releases
1995	13 878 107	7 702 279	0	0	0	0	0	21 580 386
1996	16 213 041	7 375 715	0	0	0	0	0	23 588 756
1997	17 950 038	7 704 849	0	0	0	0	0	25 654 887
1998	13 377 882	8 851 051	0	0	0	0	0	22 228 933
1999	13 092 498	8 302 161	5 245 838	0	0	0	0	26 640 497
2000	6 015 923	6 411 962	0	0	0	0	0	12 427 885
2001	1 166 752	6 205 334	4 019 448	0	0	0	0	11 391 534
2002	908 956	6 413 534	5 047 416	0	0	0	0	12 369 906
2003	181 896	2 712 612	4 324 749	0	0	0	0	7 219 257
TOTAL	**82 785 093**		**18** 637 **451**	**0**	**0**	**0**	**0**	**163 102 041**

Source : DWAF Eastern Cape Region

Note : Domestic releases from Waterdown Dam are for the water supplies to Queenstown and Sada.