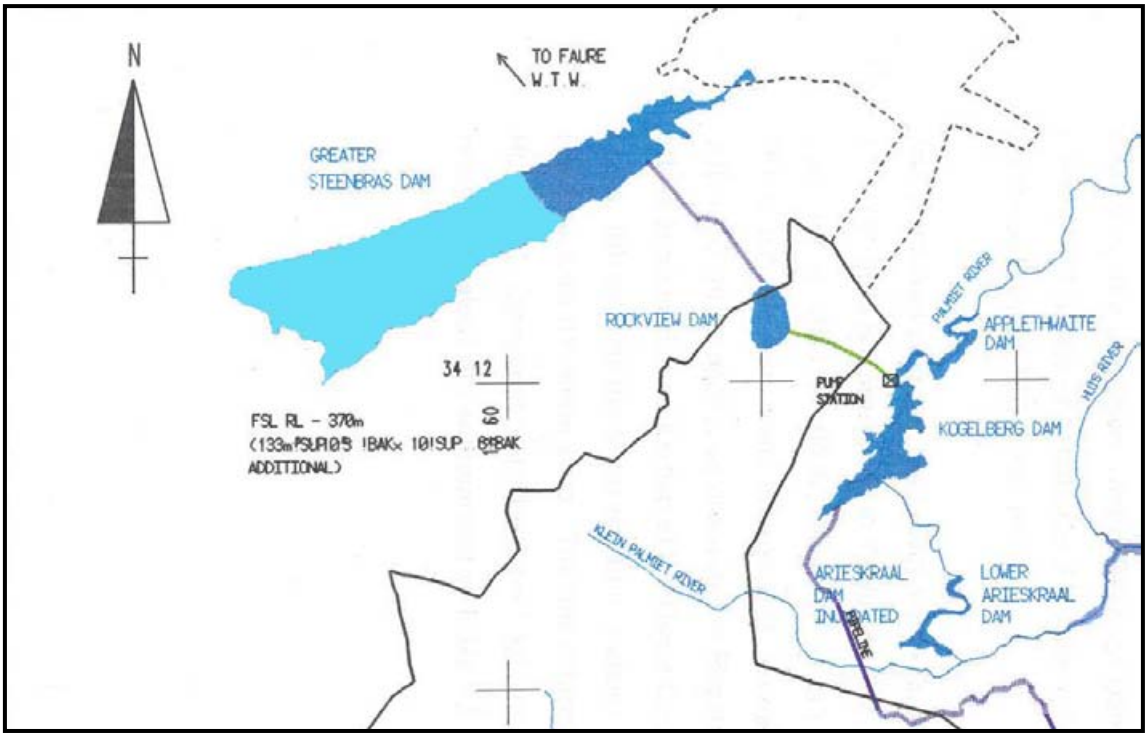
SECTION G

SURFACE WATER DEVELOPMENT OPTIONS

G1.Raising Lower Steenbras Dam

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

The information presented here is taken from the *Assessment of the Instream Flow Requirements for the Palmiet River and the Freshwater Requirements for the Palmiet Estuary,* 2000*.* Cost estimates were based on the 1994 Western Cape System Analysis Report.

This scheme entails the raising of the existing Lower Steenbras Dam by 24 m to the same Full Supply Level as that of the Upper Steenbras Dam (370 masl), effectively creating one Greater Steenbras Dam. The scheme would rely on the existing transfers from the Palmiet Pumped Storage Scheme as well as runoff into the dam from within its own catchment area.

3. SCHEME YIELD

Based on the 2000 Environmental Water Requirement (EWR) study, it was identified that depending on the EWR scenario, an increased yield of between 41 and 49 million m^3/a could be achieved through the raising of Lower Steenbras Dam.

4. UNIT REFERENCE VALUE

The potential financial costs are as follows and are based on escalating the equivalent cost estimates from the 1994 WCSA report:

ITEM	Escalated to 2005 (@ 7% /a) [1]
Capital cost (R million)	258
Annual operating cost (R million) [2]	0
NPV Cost (R million)	258
Unit Reference Value (R/m^3)	**0,89**

1) Using a Discount Rate of 8%
2) Includes raising Steenbras Dam and excludes water treatment costs.

Note: The URV is based on an escalated cost estimate dating back to 1994 (WCSA), when the capital cost for the civil works was estimated to be R107 m. The resulting present day capital cost estimate and URV is considered to be too.

5. ECOLOGICAL

The Desktop Method for determining the EWR for the Steenbras River for a Class A/B yields an EWR of some 44% of the MAR or for a Class B river yields an EWR of 35%.

The raising of the Lower Steenbras Dam would result in some 600 ha of commercial forest plantation being inundated. This impact is deemed to be of low significance. The scheme would operate using the existing conveyance infrastructure.

6. SOCIO-ECONOMIC

Various recreational facilities surrounding the Lower Steenbras Dam would be inundated. The inundation of these recreational areas is likely to have an impact on the public's enjoyment of the amenity and the income generated through entry fees. The significance of this impact is considered to be low.

The inundation of the commercial forest plantation may have an impact on forestry industry and employment in the area. This impact is considered to be of low significance.

7. OTHER ISSUES

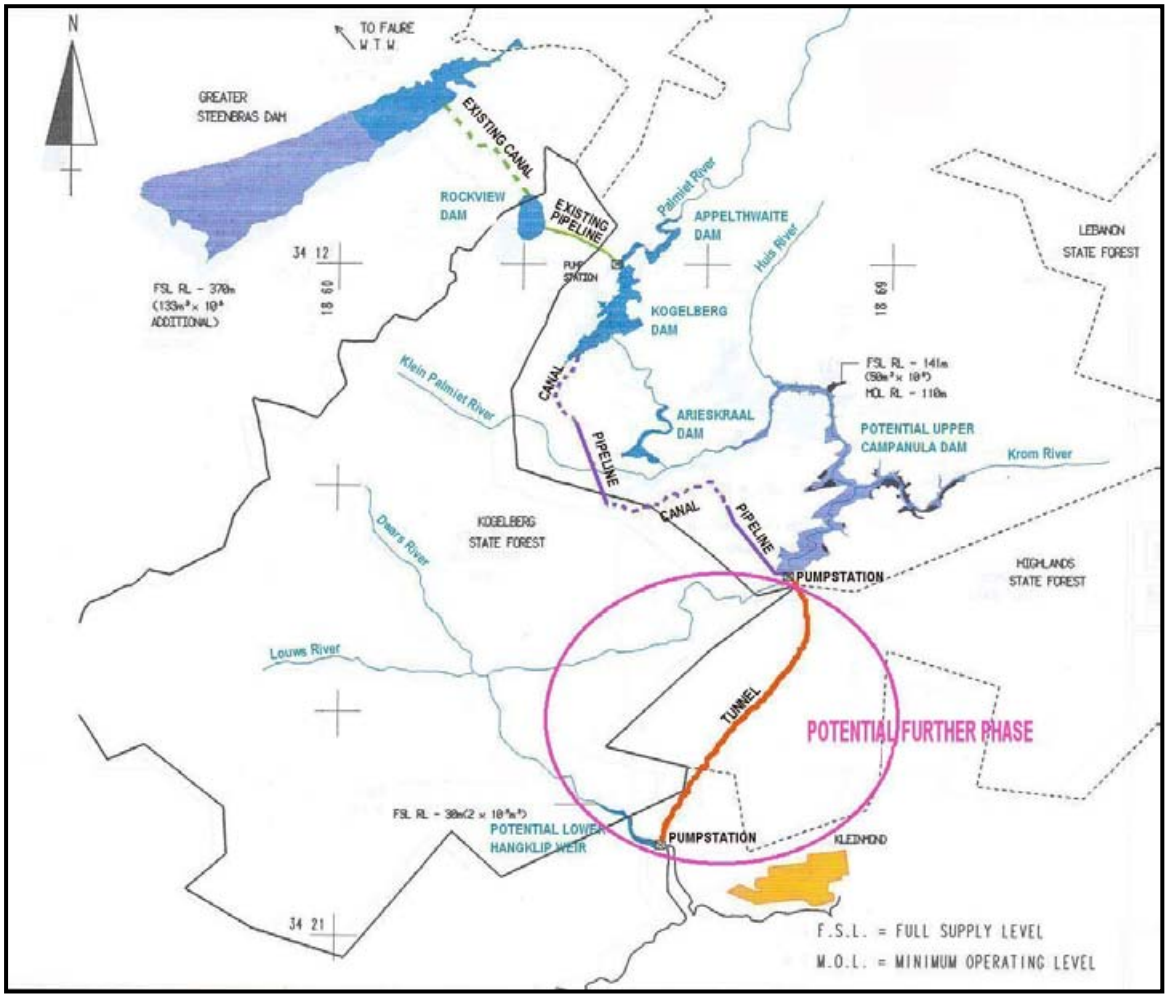
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - Can be integrated into the existing WCWSS;
  - Components of delivery infrastructure are already in place;
  - No encroachment on established irrigated land;
  - Environmental impact of raising Lower Steenbras Dam is considered to be low.

- **Weaknesses**
  - Present day cost estimate seems low.

G2.The Upper Campanula Dam

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

The information for his scheme is taken from the Western Cape System Analysis (1990s) and the *Assessment of the Instream Flow Requirements for the Palmiet River and the Freshwater Requirements for the Palmiet Estuary, 2000.*

Alternative 1

The scheme involves the construction of a small dam (50 million m^3 capacity) on the Lower Palmiet River at the Upper Campanula site, close to the northern boundary of the Kogelberg Biosphere Reserve. This would inundate some existing orchards. To reduce the extent of environmental impact, the main storage component of the scheme would be a raised Lower Steenbras Dam (see Option G1).

Water from Upper Campanula Dam would be conveyed via a pipeline, syphon and two lengths of canal into the existing Kogelberg Dam. Most of this route would be outside of irrigable land. From Kogelberg Dam, the water would be transferred into a raised Lower Steenbras Dam

(additional storage capacity of 133 million m^3/a) via the existing Palmiet Pumped Storage Scheme.

Alternative 2
A further potential phase includes an abstraction weir just upstream of the Palmiet River estuary. This takes advantage of the flow in the tributaries downstream of the Upper Campanula Dam site. Abstracted water would be pumped into Campanula Dam, via a tunnel. The yield of the alternative scheme is based on the WCSA EWR of a minimum regulated flow of 20 million m^3/a into the estuary.

3. SCHEME YIELD

Alternative 1
The EWR assessment suggests a potential yield of 76 million m^3/a from this scheme. This includes raising Lower Steenbras Dam and the existing transfers from the Palmiet River via the Palmiet Pumped Storage Scheme. This is based on the following assumptions :

- The impact of the raised Eikenhof Dam has been taken into account;
- The yield is sensitive to changes in EWR scenarios;
- All suitable privately owned land is assumed to be fully irrigated.

Alternative 2
The yield determined in the WCSA for the overall scheme is 93 million m^3/a.

4. UNIT REFERENCE VALUE

The potential financial costs are as follows and are based on escalating the equivalent 1992 base costs used in the WCSA.

ITEM	Alternative 1 Escalated to 2005 (@ 7% /a) [1]	Alternative 2 Escalated to 2005 (@ 7% /a) [1]
Capital cost (R million)	569	882
Annual operating cost (R million) [2]	5,0	11,3
NPV Cost (R million)	457,0	741,8
Unit Reference Value (R/m^3)	**0,78**	**1,03**

1) Using a Discount Rate of 8%
2) **Alternative 1** includes Campanula Dam, land access, pump stations, canals, pipelines, raising Steenbras Dam. Water treatment costs are excluded. **Alternative 2** further includes Hangklip Weir, tunnel to Upper Campanula Dam and pumping costs between them.

Note: For both options, the URV is based on escalated cost estimates at an annual escalation of 7% per annum, dating back to 1992 base prices (WCSA). The resulting present day capital cost estimates and URVs are considered to be too low.

5. ECOLOGICAL

In terms of the construction impacts on the Kogelberg Biosphere, a dam at Campanula would inundate existing orchards. The pipeline from Campanula to Kogelberg would pass through areas of least environmental sensitivity. Access could be managed to reduce potential impacts by remaining outside of the more environmentally sensitive areas.

In implementing the Reserve, the potential impacts associated with the reduced flow in the Palmiet River, as a result of the dam, can be mitigated.

A potential weir (near the estuary) and a tunnel (from weir to Campanula) would cause significant disruption to the core areas of the biosphere (Alternative 2). The core areas are the most environmentally sensitive. Tunnelling activities such as portal development, removal of spoil material, access and blasting would impact on the core area of the biosphere.

6. SOCIO-ECONOMIC

There would be some loss of existing irrigated land due to inundation. This would have an impact on the farming operation of the affected farms.

7. OTHER ISSUES

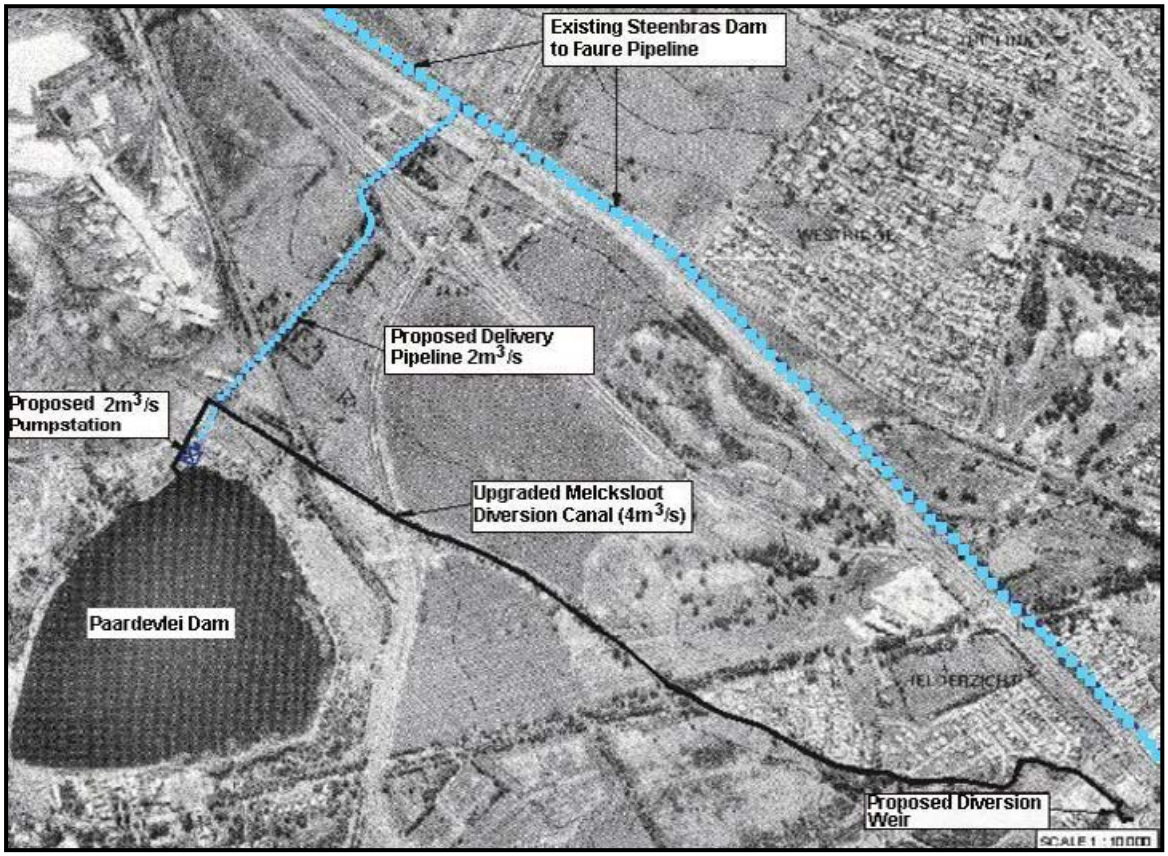
Specific strengths and weaknesses of the scheme include:

- **Strengths**
  - Can be integrated into the existing WCWSS;
  - Large components of infrastructure are already in place;
  - Limited encroachment on established irrigated land;
  - Environmental impact of raising Lower Steenbras Dam is considered to be low.

- **Weaknesses**
  - Environmental and social impacts associated with inundation upstream of the Upper Campanula Dam;
  - Disturbance to the biosphere, particularly if Alternative 2 were adopted;
  - Possible public resistance to the scheme;
  - Low confidence URV calculation.

G3. The Lourens River Diversion

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

Unless otherwise stated, the information presented for this scheme is taken from the CCT Integrated Water Resource Planning Study of 2002: Report No 3 of 12 – *Lourens River Diversion*.

The Lourens River Diversion Scheme would divert surplus winter water out of the Lourens River via a 1 m high concrete weir of 1000 m^3 storage capacity. The weir would be located at the existing Melcksloot diversion off-take, just downstream of the N2 road. Water would gravitate via an upgraded Melcksloot canal into a raised Paardevlei balancing dam. From the dam, the water would be pumped through a 1,35 km long, 1,2 m dia steel pipeline (of 2 m^3/s delivery capacity) into the existing Steenbras-to-Faure pipeline, and thence to the Faure WTW. The scheme would take 5-6 years to implement and the primary beneficiary would be the CCT.

Following the recent discussions between the CCT and developers of the property surrounding Paardevlei, the CCT has accepted that Paardevlei will not be utilised as part of the Lourens River Diversion Scheme. It is now envisaged that the scheme will comprise a slightly larger weir on the Lourens River immediately downstream of the N2, and a pump station with variable speed drive pumps to deliver a portion of the flow directly to the Faure Water Treatment Works via the existing Steenbras-Faure pipeline. It is envisaged that the cost of this scheme will be similar to that described above, and on which the URV, described below, is based.

3. SCHEME YIELD

The optimum scheme would yield about 19,4 million m^3/a, after allowing for Ecological Water Requirements (EWRs), for a Class "C" river. Without allowance for EWRs, the yield would increase only slightly to about 20,9 million m^3/a.

4. UNIT REFERENCE VALUE

The potential financial costs are as follows :

ITEM	Escalated to 2005 (@ 7% /a) (1)
Capital cost (R million)	45,6
Annual operating cost (R million) (2)	2,3
NPV Cost (R million)	70,5
Unit Reference Value (R/m^3)	0,32

1) Updated URV using a Discount Rate of 8%
2) Excludes water treatment costs.

5. ECOLOGICAL

The overall impact of this scheme is likely to be minimal, given the already severely degraded state of the Lourens River. The construction of a 1 m high weir at the existing Melcksloot diversion will interfere with sediment transport through capturing of floods which move fine sediments through the system. The weir structure is likely to interfere with the migration of indigenous fish to the lower reaches of the river and estuary. Furthermore, the pond-like conditions upstream of the weir could encourage the further spread of alien fish such as carp.

Raising of the Paardevlei Dam would result in the inundation of land surrounding the dam, including habitat for a number of resident and migratory bird species, including a breeding heronry in the willow trees in the south-eastern corner of the dam. This impact is considered to be of low significance, and will not arise if Paardevlei and the diversion canal are omitted from the scheme.

Diverting further water from the Lourens River will result in decreased flows in the lower reaches of the river and the estuary. Since the diversion would only take place during the high flow winter months, this significance of this impact is deemed to be low. Furthermore, run-off from the hardened surfaces of Somerset West will possibly mitigate the winter water high flow abstractions.

6. SOCIO-ECONOMIC

The Lourens River is located within a Protected Natural Environment, and sections of the banks of the river have been designated public open space (POS). The construction of the weir and upgrading of the canal will impact on some portions of the POS and private land, which could affect land value. This impact is considered to be of low significance.

AECI, who owns the Paardevlei Dam and surrounding land, are developing the area surrounding the dam for commercial, office and residential purposes. Raising the dam is likely to have a negative impact on AECI's proposed development. This impact is considered to be of medium significance. Furthermore, the raising of the dam is likely to result in an increase in the level of the water table and flooding of low-lying areas, which could cause damage to a complex of historical buildings to the south-east of the Paardevlei Dam. This is likely to have an impact on land-use and values in the area. This impact is considered to be of low significance, as it is manageable. These impacts will not arise if Paardevlei and the diversion canal are omitted from the scheme.

7. OTHER ISSUES

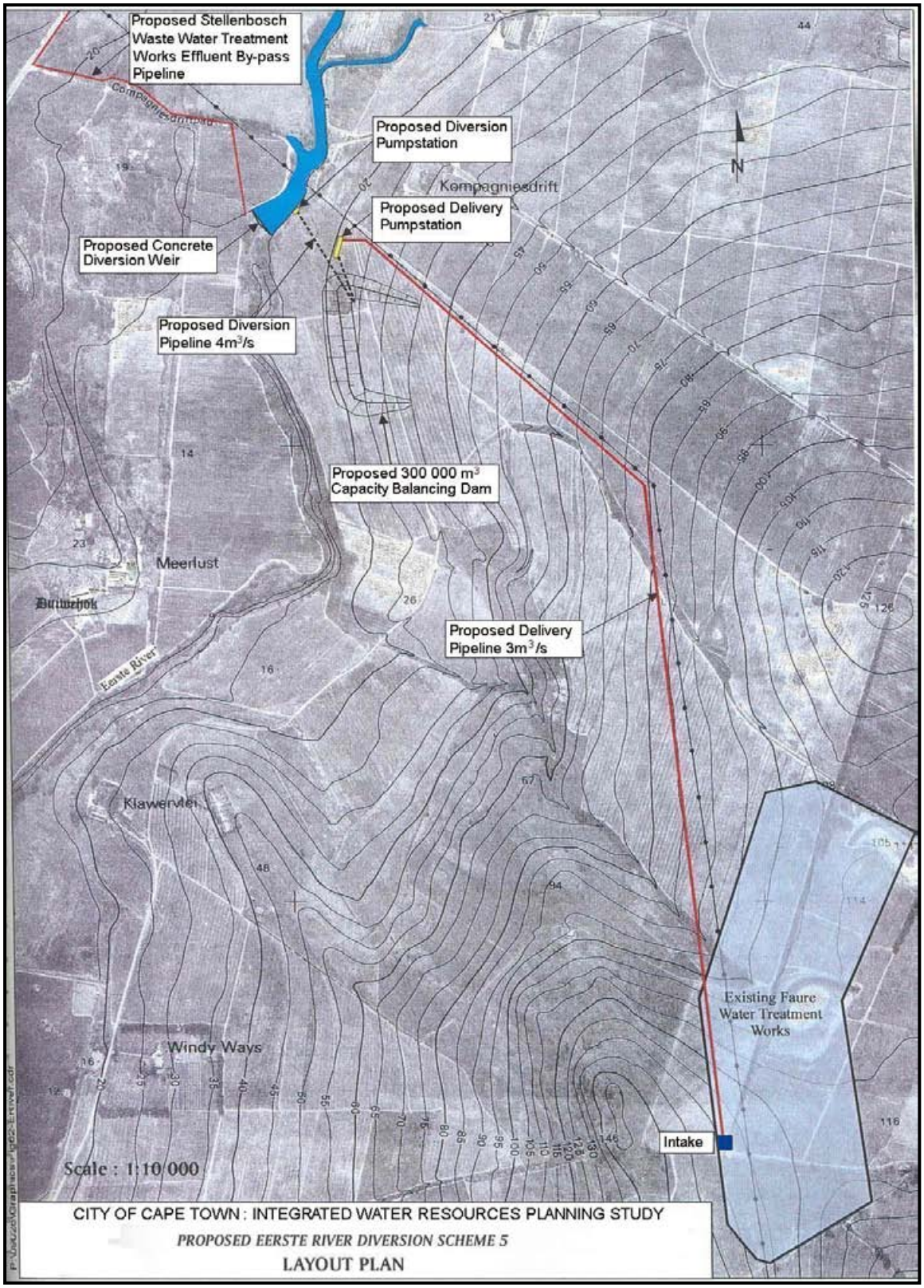
Specific strengths and weaknesses of the scheme include:

- **Strengths**
  - Close proximity to Faure WTW, existing balancing dam, and existing reticulation infrastructure;
  - Easily integrated into the Western Cape Water Supply System (WCWSS);
  - Offers improved carry over storage (winter into summer) in City's bulk storage dams;
  - Short implementation period of 5-6 years.

- **Weaknesses**
  - Potential increased localised flooding due to raising of water table at Paardevlei Dam;
  - Lourens River is susceptible to urban pollution upstream of the diversion weir with resulting water quality concerns;
  - If scheme is also integrated with Eerste River Diversion and/or Cape Flats Aquifer Schemes, available yield may exceed demand at Faure WTW.
  - The ecological impact of the scheme and on the Lourens River Protected Natural Environment.

G4. The Eerste River Diversion

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

Unless otherwise stated, the information presented for this scheme is taken from the City of Cape Town's (CCT's) Integrated Water Resource Planning Study of 2002: Report No 2 of 12 – *Eerste River Diversion*.

The scheme would augment the water supply to the CCT. Surplus winter water would be pumped from a concrete diversion weir (4 m high and of 35 000 m^3 capacity) on the Eerste River into an adjacent off-channel balancing dam, at a rate of 4 m^3/s. From the balancing dam, the water would be pumped to the Faure WTW, via about 2,2 km of rising main, where it would be treated. Other infrastructure requirements include a bypass from the Stellenbosch WWTW, which is situated upstream, to ensure that at least this component of poorer water quality, bypasses the point of diversion.

Specific concerns are primarily water quality related and include the impacts of dense settlements upstream, industrial waste discharge, and effluent water quality discharged at Stellenbosch WWTW.

3. SCHEME YIELD

The optimum scheme would yield about 8,3 million m^3/a, after allowing for Ecological Water Requirements (EWRs), for a Class "D" river.

4. UNIT REFERENCE VALUE

The potential financial costs are as follows :

ITEM	Escalated to 2005 (@ 7% /a) (1)
Capital cost (R million)	101,5
Annual operating cost (R million)	1,9
NPV Cost (R million)	94,9
Unit Reference Value (R/m^3)	1,28 (2)

1) Updated URV using a Discount Rate of 8%
2) Excludes water treatment costs.

5. ECOLOGICAL

The reservoir behind the weir would inundate some 1 200 m of the Eerste River and into the Kompagniesdrift tributary. This would result in the loss of riverine and riparian habitat of moderate environmental importance. The off-channel dam and associated pipeline to the Faure WTW would not have any significant impact on the terrestrial flora or fauna.

The reduction in flow downstream would have a small impact on the lower reaches of the Eerste River, and on the floodplain/pan/wetland system south of the N2. The scheme would not have any significant negative impact on the Eerste River estuary, as the system receives elevated flows throughout the year due to the discharge of large volumes of treated sewage effluent into the Kuils River system, as well as stormwater runoff. The proposed scheme would not have any significant effect on flood peaks, but would reduce the freshets/ within year high flows.

Due to the nature of the scheme (small weir pumping to an off-channel dam in winter), it should be possible to satisfy all components of the Reserve. There may be some water quality concerns associated with the weir and balancing dam, due to the relatively high nutrient loading in the Eerste River.

6. SOCIO-ECONOMIC

The inundation associated with the proposed weir and balancing dam would affect some 3 ha of valuable agricultural land. As the pipeline would be aligned adjacent to existing vehicular tracks, the impact on agricultural land would not be significant. The weir may impinge or inundate the historic ford and access across the Eerste River for the landowner. The infrastructure would not be incompatible with the sense of place of the area and would be unlikely to affect the historical/cultural value of the surrounding farms.

The abstraction of winter water is unlikely to affect the water supply to the Lower Eerste River Irrigation Board, which abstracts from the river downstream.

The proposed sewage effluent bypass pipeline would have to be carefully routed so as to minimise impacts on landowners and users.

7. OTHER ISSUES

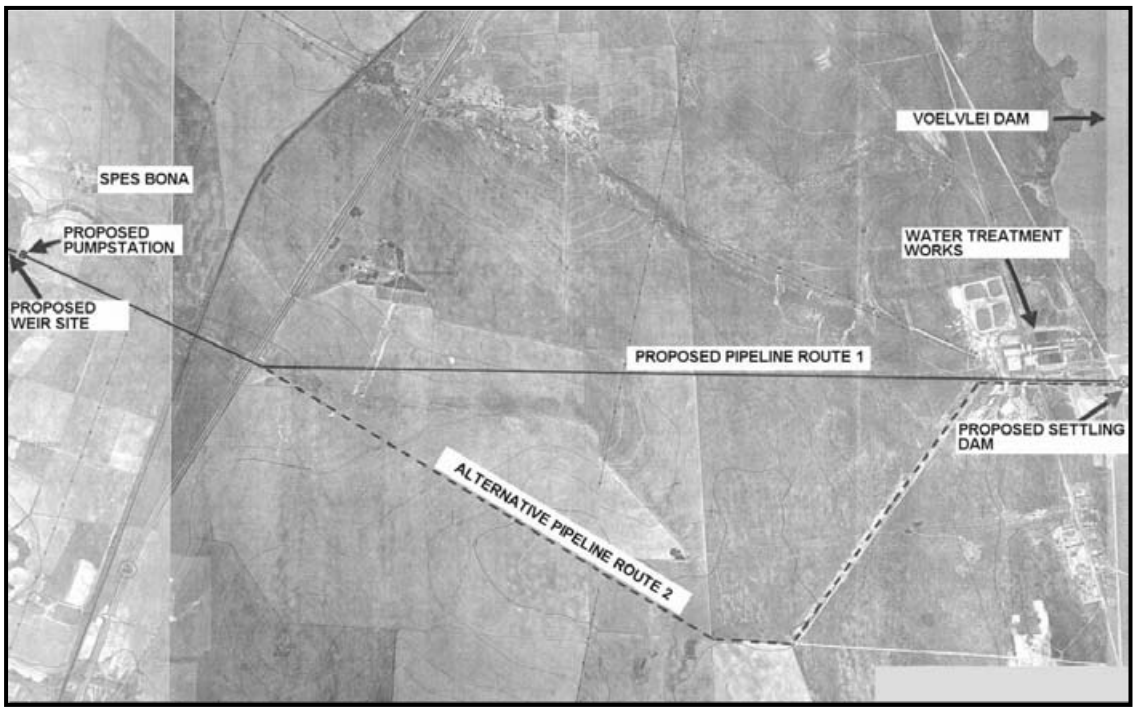
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - Close proximity to Faure WTW and existing reticulation infrastructure;
  - Easily integrated into the Western Cape Water Supply System (WCWSS);
  - Offers improved carry over storage (winter into summer) in City's bulk storage dams;
  - Short implementation period of 4-5 years.

- **Weaknesses**
  - Requires addressing of water quality related issues in the Eerste River;
  - If also integrated with Lourens River and/or Cape Flats Aquifer Schemes, available yield may exceed demand at Faure WTW.

G5.Voëlvlei Augmentation Phase I

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

The information presented is taken from the *CCT, CMA Bulk Water Supply Study - Voëlvlei Augmentation Scheme - Phase I*, Report No. 3245/9531 of 2002.

The scheme entails the abstraction of surplus winter water from the Berg River at Spes Bona. The water would be pumped to the Voëlvlei WTW where it would be treated, either for :

- storage in the existing Voëlvlei Dam, or
- direct delivery to CCT.

The infrastructure requirements for direct treatment and supply to the CCT would be :

- a weir and intake at Spes Bona;
- 3,16 m^3/s pump station
- 1 500 mm dia steel delivery pipeline of up to 5 km long to the existing WTW;
- a desilting facility;
- a pipeline from the desilting facility to the existing Voëlvlei Dam intake;
- alterations to the existing chemical feed arrangements at the WTW.

For storage in Voëlvlei Dam, the last two items above would be replaced by pre-treatment and discharge into Voëlvlei Dam.

The key characteristics of the scheme are :

i) Only surplus winter water would be abstracted;
ii) 20 million m^3/a would be available to take up the spare capacity in the existing Voëlvlei WTW and pipeline to CCT.
iii) Surplus yield (over and above ii) could be used to improve the assurance of supply to other users currently reliant on Voëlvlei Dam (current shortfall of about 30 million m^3/a).
iv) When river flows are too low to permit abstraction, water will be drawn directly from Voëlvlei Dam.

3. SCHEME YIELD

Current estimates suggest that between 35 and 45 million m^3/a could be achieved. The ecological water requirement as determined in 2002 has been allowed for in this estimate. However, the ecological flow requirements of the estuary have not yet been determined. A conservative yield of 35 million m^3/a has therefore been assumed.

4. UNIT REFERENCE VALUE

The URV has been estimated to allow for escalation of 7% p.a. from 2002 to date. The potential financial costs for the scheme are as follows :

ITEM	Escalated to 2005 (@ 7% /a) (1)
Capital cost (R million)	87,0
Annual operating cost (R million) (2)	9,7
NPV Cost (R million)	165,1
Unit Reference Value (R/m)	0,50 (3)

1) URV based on a discount Rate of 8%.
2) Excludes water treatment costs and related WTW upgrade.

The URV would increase to about R0,60/m^3 for the option of pre-treatment and storage in the existing Voëlvlei Dam.

5. ECOLOGICAL

The lower Berg River is in a poor ecological state, however the Berg River estuary is of considerable ecological value and of major importance to birdlife at regional and national levels. Maintenance of the estuary requires that the wetlands are flooded during winter floods.

The requisite weir, some 5 km of large diameter pipeline and a desiliting facility would be constructed to the east of the Berg River, between the river and the Voëlvlei Dam. The proposed weir, with a maximum height of 1 m would have a slight affect on water levels for a distance of 1 km upstream of the weir. This impact is of a low significance. The area between the proposed

weir site and Voëlvlei Dam is located partly within a Provincial Nature Reserve and the Voëlvlei Conservancy. The Reserve contains substantial areas of Renosterveld vegetation, a veld type that has become rare due to the extensive agricultural activities in the area. Furthermore, the Geometric Tortoise, which is endangered, is also found in the Reserve. The impacts associated with the construction of the weir, pipeline and desilting facility in this sensitive environment are considered to be of medium significance, but could be mitigated by optimising the pipeline layout and affording special protection to the tortoises and their eggs during the construction process. Provided that the EFR is met, and since water would be abstracted during the winter, seasonal flow patterns and the ecological functioning of the estuary are unlikely to be affected.

6. SOCIO-ECONOMIC

The construction of a weir on the Berg River is likely to have an impact on the agricultural community and canoeists, the scale of which would be dependent on the size of the weir. This impact is, however, deemed to be of low significance.

With increasing demands being placed on Voëlvlei Dam, the water level in the dam may vary more greatly than in the past, causing an inconvenience to members of the Voëlvlei Yacht Club and other users.

7. OTHER ISSUES

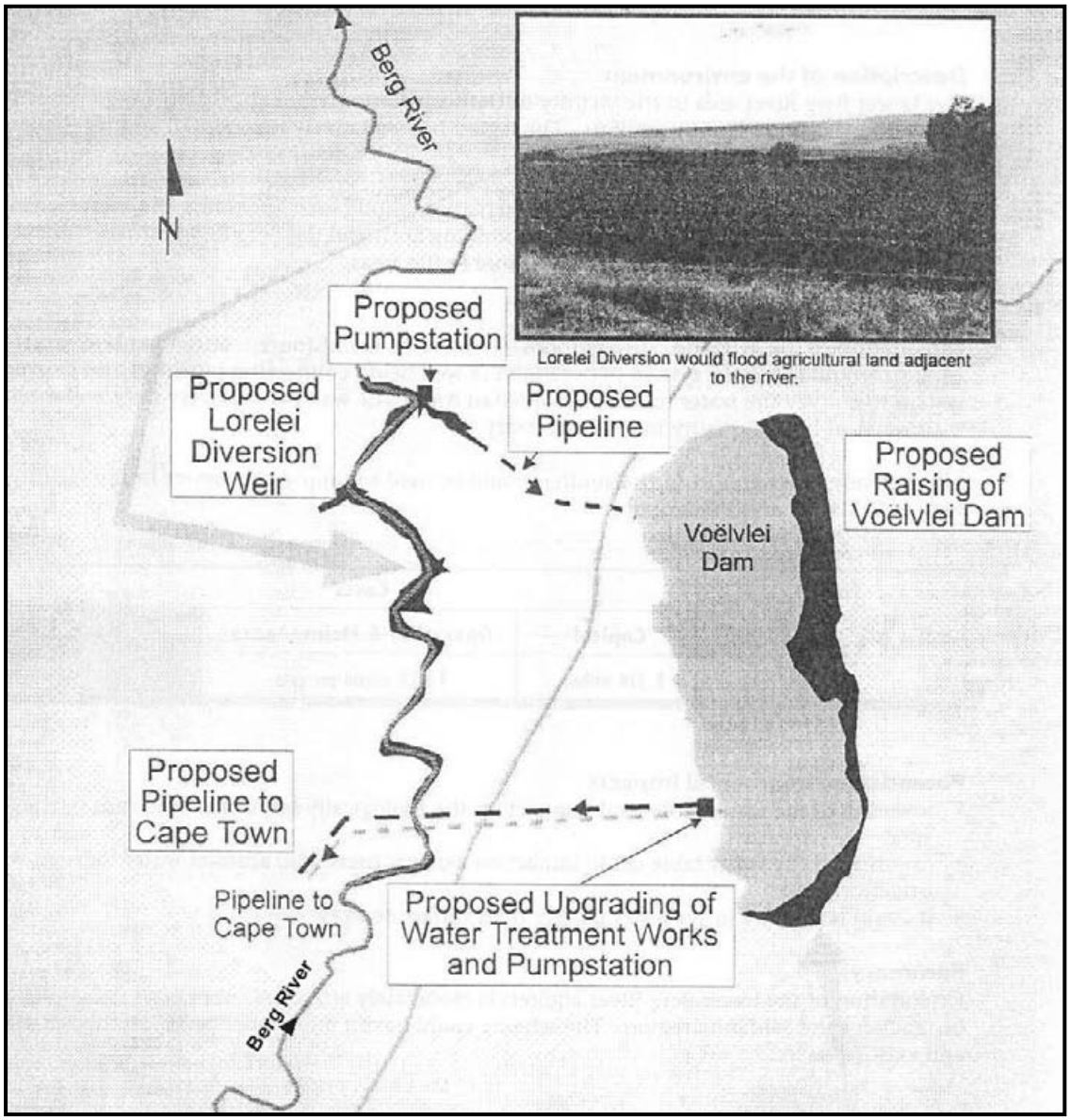
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - Scheme allows for spare capacity in existing CCT infrastructure to be utilised;
  - Offers opportunity to reduce current shortfall on Voëlvlei Dam.

- **Weaknesses**
  - Water quality differences between the Berg River water and water in Voëlvlei Dam necessitates additional water treatment;
  - Scheme yields remain provisional until the Reserve requirements for the Lower Berg River and the estuary are set.

G6.Voëlvlei Augmentation Phase II and III

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

The information presented for this option is taken from the Western Cape System Analysis (1990s). It should be noted that Phases II and III have not been studied further since then. The extent of abstraction from the Berg River was considered to be of high environmental impact on the river and estuary. Phase II and III are nevertheless briefly described as follows :

In addition to the abstractions under Phase I, Phase II involves a 9 m raising of Voëlvlei Dam. Phase III would follow immediately after Phase II with a 7,5 m high weir (4 million m^3 capacity) on the Berg River, inundating about 190 ha. The diversion capacity of $3m^3/s$ (Phase I) would be increased to 20 m^3/s.

Increased pumping and pipeline conveyance capacity to Voëlvlei Dam would be required. Abstraction would be restricted to winter months when EWR has been met. The existing infrastructure would not be sufficient and the WTW would need to be expanded, as well as the pumping capacity of the pump station on the delivery line to Cape Town. A second pipeline to Cape Town would also be required.

3. SCHEME YIELD

Based on the 1990's assessment, Phase II and III would increase the existing Voëlvlei scheme yield (95 million m^3/a) by an additional 110 million m^3/a. Revised Reserve determinations have not yet been taken into account and the ecological flow requirements of the estuary have yet to be determined. These are likely to reduce the yield to some extent through the need to release sufficient flood flows to maintain the estuary.

4. UNIT REFERENCE VALUE

The costs associated with Phase II and III are as follows. These costs are updated from the WCSA, escalated to 2005, at a rate of 7% per annum.

ITEM	ESCALATED TO 2005 @ 7%/A [1]
Capital cost (R million)	1 096
Annual operating cost (R million) [2]	18,7
NPV cost (R million)	1 325
Unit reference value (R/m^3)	0,98

1. Updated URV using a discount rate of 8%
2. Excludes second pipeline to Cape Town and water treatment costs.

An approximate estimate has been made of the costs associated with a new 78 km steel pipeline (1,5 m ID) to Cape Town, pump stations and new 500 Mℓ/d water treatment works at Voëlvlei Dam. This would be required if the yield of 110 million m^3/a were to be realised. The financial implication is that the URV shown above could be expected to approximately double (± R2,1/m^3).

5. ECOLOGICAL

The raising of Voëlvlei Dam would result in the inundation of approximately 130 ha of vegetation, including rare renosterveld and habitat of the rare and endangered geometric tortoise. In Phase III of the project, the construction of a 7.5 m high weir on the Berg River would result in the inundation of up to 190 ha of irrigated farm land, comprising mostly vineyards. These impacts are considered to be of medium significance.

The condition of the lower reaches of the Berg River is poor. Increased abstraction from the river may, however, have a detrimental effect on the floodplain and estuary. While the weir will cause attenuation of some of the annual floods, the EWR study for Skuifraam Dam indicated that there was excess water available for utilisation in the lower reaches of the Berg River, provided that

sufficient flood flows were released to maintain the estuary. The significance of this impact is therefore considered to be low, provided that the EWR is met.

6. SOCIO-ECONOMIC

The raising of the Voëlvlei Dam may inconvenience the yacht and angling clubs, which are based on the dam. Some facilities may be inundated if the full supply level of the dam is raised. This impact is considered to be of low significance.

The construction and subsequent raising of a weir on the Berg River is likely to have an impact on the agricultural community and canoeists, the scale of which would be dependent on the size of the weir and the area inundated. This impact is deemed to be of medium significance.

7. OTHER ISSUES

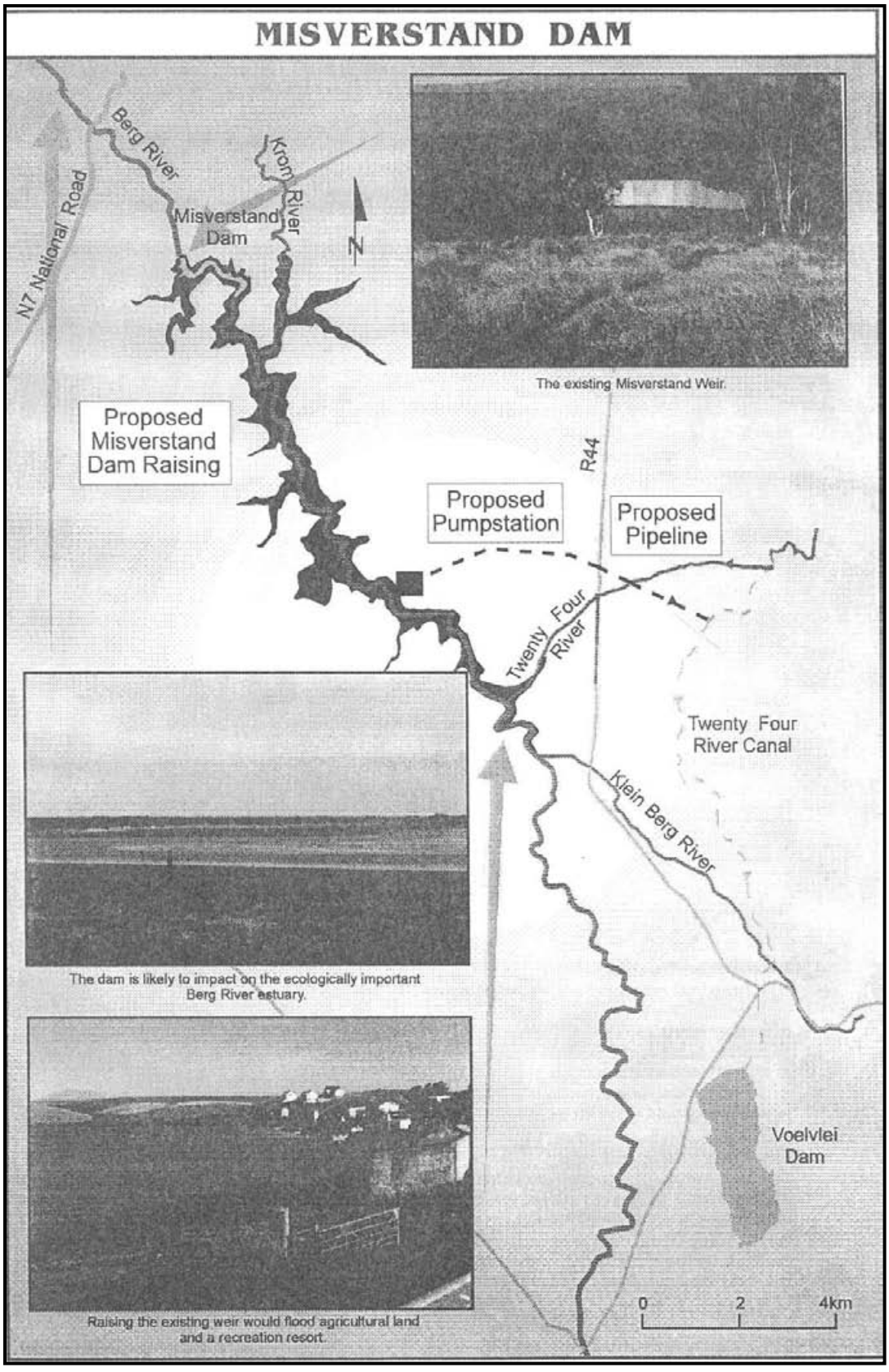
The strengths and weaknesses of the scheme are :

- **Strengths**
  - Offers significant increase in yield.

- **Weaknesses**
  - Significant potential inundation of established agricultural land, 50 ha of nature reserve and important natural heritage sites;
  - Significant potential impact on riverine and estuarine ecology;
  - Scheme was last assessed in 1990s;
  - The estuarine water requirement (not yet determined) is likely to reduce the yield;
  - Additional pipeline to Cape Town required and additional WTW at Voëlvlei Dam;
  - Poor water quality in the Berg River is likely to result in increased eutrophication of Voëlvlei Dam.

G7. A new dam at Misverstand

1. SCHEME LOCATION



2. SCHEME DESCRIPTION

The information presented is drawn from the Western Cape System Analysis (1990s) and the *Pre-Feasibility Study of Potential Water Sources Supplying the West Coast District Municipality,* 2003.

The Misverstand Weir on the Berg River near Piketberg has a storage capacity of 6 million m^3/a. The weir currently provides water to the Vredenburg / Saldanha area via abstractions treated at the Withoogte WTW.

The construction of a new dam in close proximity to the existing weir is an option to meet the growing water demands of the West Coast. Alternatively, the dam could be integrated with Voëlvlei Dam by pumping of water from the potential dam to the Twenty-four Rivers canal, which feeds Voëlvlei Dam. Studies of this scheme undertaken to date have not taken the water quality differences (Berg River vs Voëlvlei Dam) into account.

3. SCHEME YIELD

The Western Cape System Analysis (1990s) indicated that a 27m high dam (280 million m^3 capacity) would yield about 70 million m^3/a, after allowance for EWRs (Ref: WCSA, 1996). Subsequent to that, a further increase in the IFR was included to accommodate the needs (provisional) of the Berg River estuary. This resulted in a further reduction in the yield estimate to 40 million m^3/a.

The yield will need to be re-determined once the Reserve for the Lower Berg River and the estuary has been set. For the purposes of this study, a yield of 40 million m^3/a has been assumed.

4. UNIT REFERENCE VALUE

ITEM	Escalated to 2005 (@ 7% /a) [1]
Capital cost (R million)	801,6
Annual operating cost (R million) [2]	17,6
NPV cost (R million)	1131,0
Unit reference value (R/m^3)	2,3

1. Update URV using a discount rate of 8%.
2. Excludes water treatment costs.

5. ECOLOGICAL

The lower Berg River is in a poor ecological state, however, the Berg River estuary is of considerable ecological value and of major importance to birdlife at regional and national levels. Maintenance of the estuary requires that the wetlands are flooded during winter floods.

The construction of a 27 m high dam wall in the vicinity of the Misverstand weir would result in an additional 3000 ha of agricultural land (vineyards and wheat fields) being inundated. The

construction of a transfer pipeline to the Twenty Four Rivers canal would also result in the temporary destruction of productive agricultural land.

6. SOCIO-ECONOMIC

The construction of the new dam at Misverstand would result in large areas of productive agricultural land, infrastructure and a resort being flooded, which is likely to have an impact on the economy, which is considered to be of medium significance.

Canoeing, and most notably the Berg River Canoe Marathon, is likely to be affected by the reduced flows in the lower Berg River. This impact is considered to be of low significance.

7. OTHER ISSUES

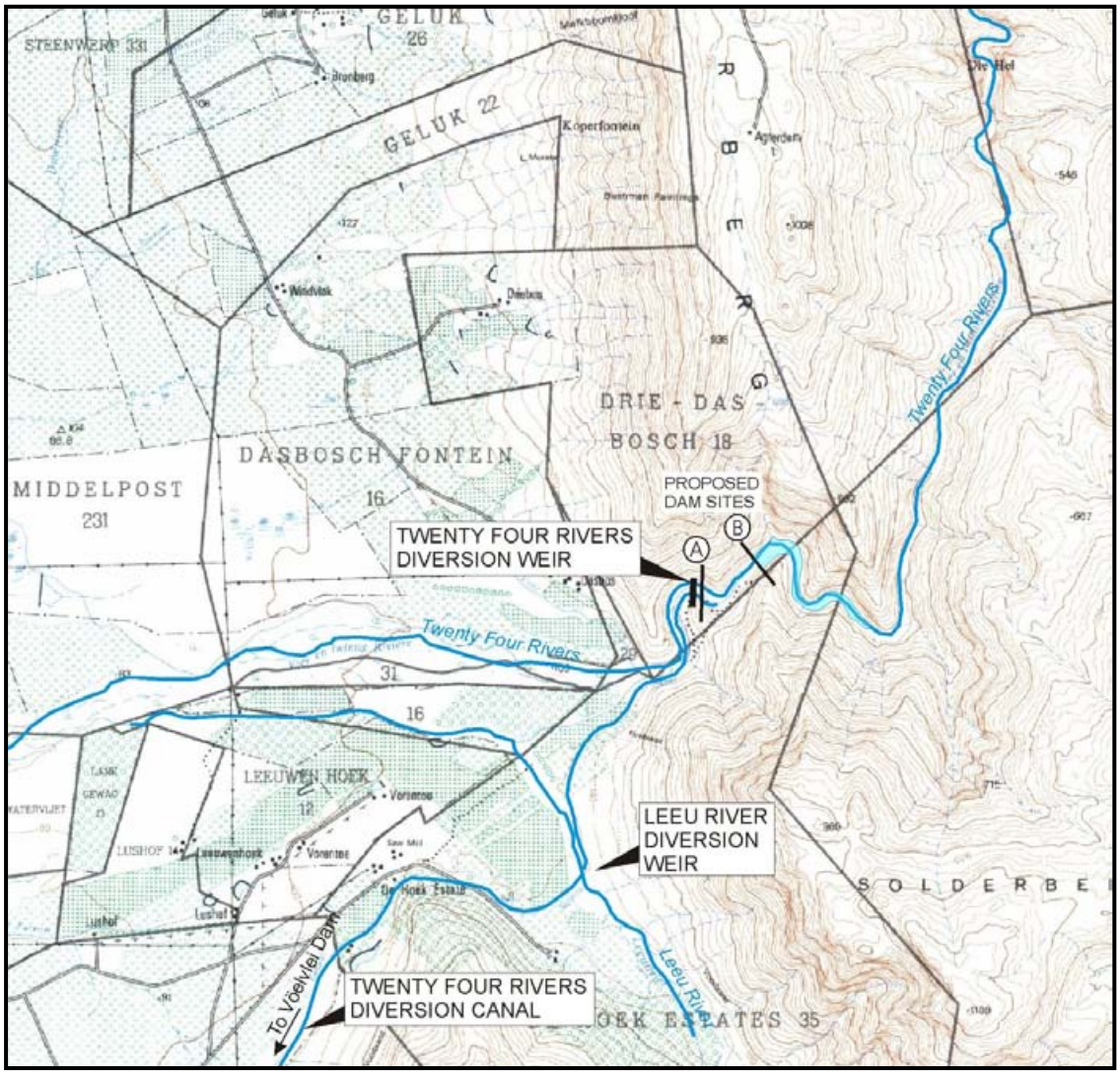
The strengths and weaknesses of the project are :

- **Strengths**
  - The scheme could either be integrated with Voëlvlei Dam or used to supply the West Coast only.

- **Weaknesses**
  - Reducing flow in the Berg River would impact the downstream water quality.
  - There would be inundation of extensive areas of vineyards, wheat fields, homesteads, a resort and recreation facilities.
  - The reduced downstream flows will affect recreational activities such as canoeing.
  - A large dam may have thermal stratification problems.
  - Water in the dam would have slightly elevated salinity levels compared with current abstractions from Misverstand Weir.

G8.Twenty Four Rivers Dam

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

Information presented is drawn from the Kwezi V3 (2003) report, *Pre-feasibility Study of the Potential Water Sources for the area served by the West Coast District Municipality - Phase I* and the currently ongoing Phase II of the same study.

The Twenty Four Rivers Dam would function as a balancing reservoir to improve the efficiency of the current diversions into Voëlvlei Dam. Of the options investigated in the West Coast Study, a 21 m high rockfill dam of 1 million m^3 capacity, located at the existing diversion site, appears to be the most favourable option.

3. SCHEME YIELD

Initial estimates suggested that the balancing storage provided by a 1 million m^3 rockfill dam would increase the yield of Voëlvlei Dam by 4,9 million m^3/a. However, this was based on an EWR of 2,4 million m^3/a (57% of MAR). Subsequently, a desktop Reserve estimate for a Class D river was determined. This indicated a higher EWR (winter low flow scenario = 5 million m^3/a) than previously determined and a resulting yield increase of only 1,8 million m^3/a, which has been assumed for the URV calculation.

4. UNIT REFERENCE VALUES

The potential financial costs for the 1 m^3/s rockfill balancing dam are :

ITEM	2004 COSTS (1)
Capital cost (million)	9,9
Annual operating cost (R million) (2)	0,02
NPV cost (R million)	9,0
Unit Reference Value (R/m^3)	0,63

1. Updated URV using a Discount Rate of 8%.
2. Costs exclude the water treatment costs.

5. ECOLOGICAL

The Twenty Four Rivers downstream of the existing weir is in a poor ecological condition, and is considered to be a D or E category river. Its ecological importance and sensitivity is, however, high.

The proposed dam in the vicinity of the existing weir would inundate some 20 ha of relatively undisturbed river and land, which is likely to support diverse riverine and fynbos communities. This impact is considered to be of a medium significance. Water would be transferred to the Voëlvlei Dam via the existing canal system, thereby requiring no additional disturbance.

The dam is likely to act as a barrier to the migration of fish between the main stem of the river and the upper reaches of the Twenty Four Rivers. The significance of this impact is considered to be low.

6. SOCIO-ECONOMIC

The additional water provided through this scheme would be transferred to the Voëlvlei Dam, from where it will be supplied to the City of Cape Town and the West Coast District Municipality. The provision of additional water is deemed to be of high significance.

7. OTHER ISSUES

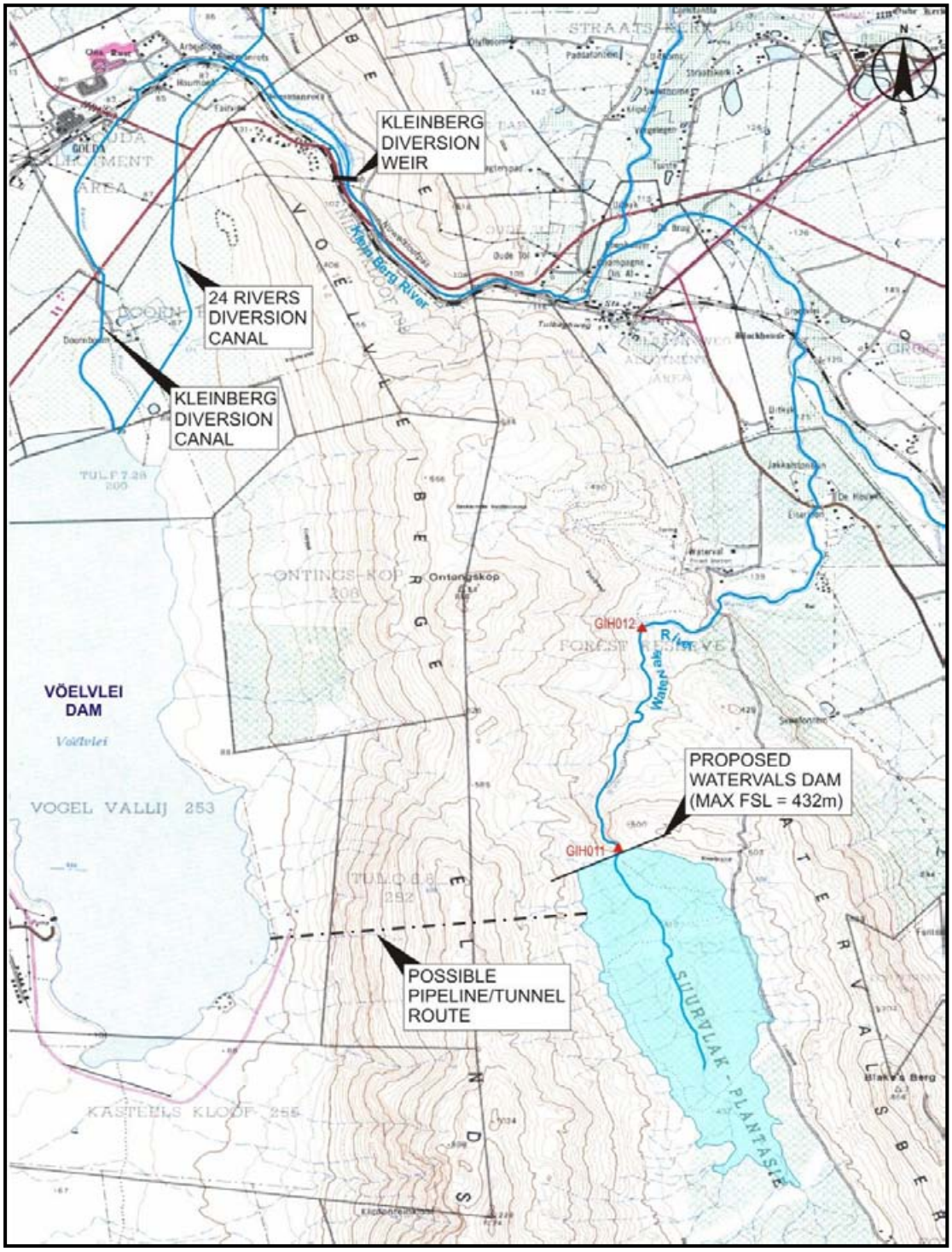
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - Offers potential to either augment the West Coast or CCT;
  - Improved assurance of supply from the Twenty Four Rivers to Voëlvlei Dam.

- **Weaknesses**
  - The yield is sensitive to river classification and this has yet to be set.
  - Water is exposed to canal losses in the existing canal system, estimated to be about 15%.
  - Relatively high ecological impacts associated with inundation.

G9.Watervals River Dam

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

Information presented here is drawn from the Kwezi V3 report (2003) *Pre-feasibility Study of Potential Water Sources for the Areas served by the West Coast District Municipality*.

The Watervals River Dam Scheme would involve the construction of a 12 million m^3 rockfill dam on the Watervals River, a tributary of the Klein Berg River. The maximum full supply level of the 14 m high dam would be 432 m. The water from the proposed Watervals Dam would gravitate underneath the catchment divide via a tunnel into Voëlvlei Dam. This was identified as the preferred option for conveying water from the potential Watervals Dam to Voëlvlei Dam.

3. SCHEME YIELD

It is estimated that the scheme could provide an increase to the firm yield of Voëlvlei Dam of 3,8 million m^3/a. The relatively low yield is attributed to the fact that the dam will reduce the volume of water currently available for diversion into Voëlvlei Dam at the existing Klein Berg River Diversion. The estimated yield does not account for the EWR, which is likely to be significant as the potential dam site lies upstream of a nature reserve. The required EWR releases are likely to further reduce the yield benefit.

4. UNIT REFERENCE VALUES

ITEM	ESCALATED TO **2005 @ 7%/a** (1)
Capital cost (R million)	45,9
Annual operating cost (R million)	0,1
NPV cost (R million)	42,0
Unit reference value (R/m^3)	1,46

1. Update URV using a Discount Rate of 8%.
2. Excludes water treatment costs.

It is likely that much of the yield gain would be to be allocated to meeting the Reserve. Consequently, the URV could be expected to increase significantly once the Reserve is implemented.

5. ECOLOGICAL

The Watervals River is a tributary of the Klein Berg River. The EWR was determined assuming a PES of A/B, as the PES was unknown.

The proposed dam would flood some 160 ha of land, largely comprising the Suurvlak plantation, and some pristine mountain fynbos and high altitude seeps. The requisite transfer tunnel would cross areas of pristine mountain fynbos and renosterbos adjacent to Voëlvlei Dam.

6. SOCIO-ECONOMIC

The impacts on the Suurvlak forestry may result in some socio-economic impacts. However, Mountain-to-Ocean (formerly SAFCOL) proposes to discontinue the Suurvlak Plantation. Therefore, the effects of the proposed dam would be small.

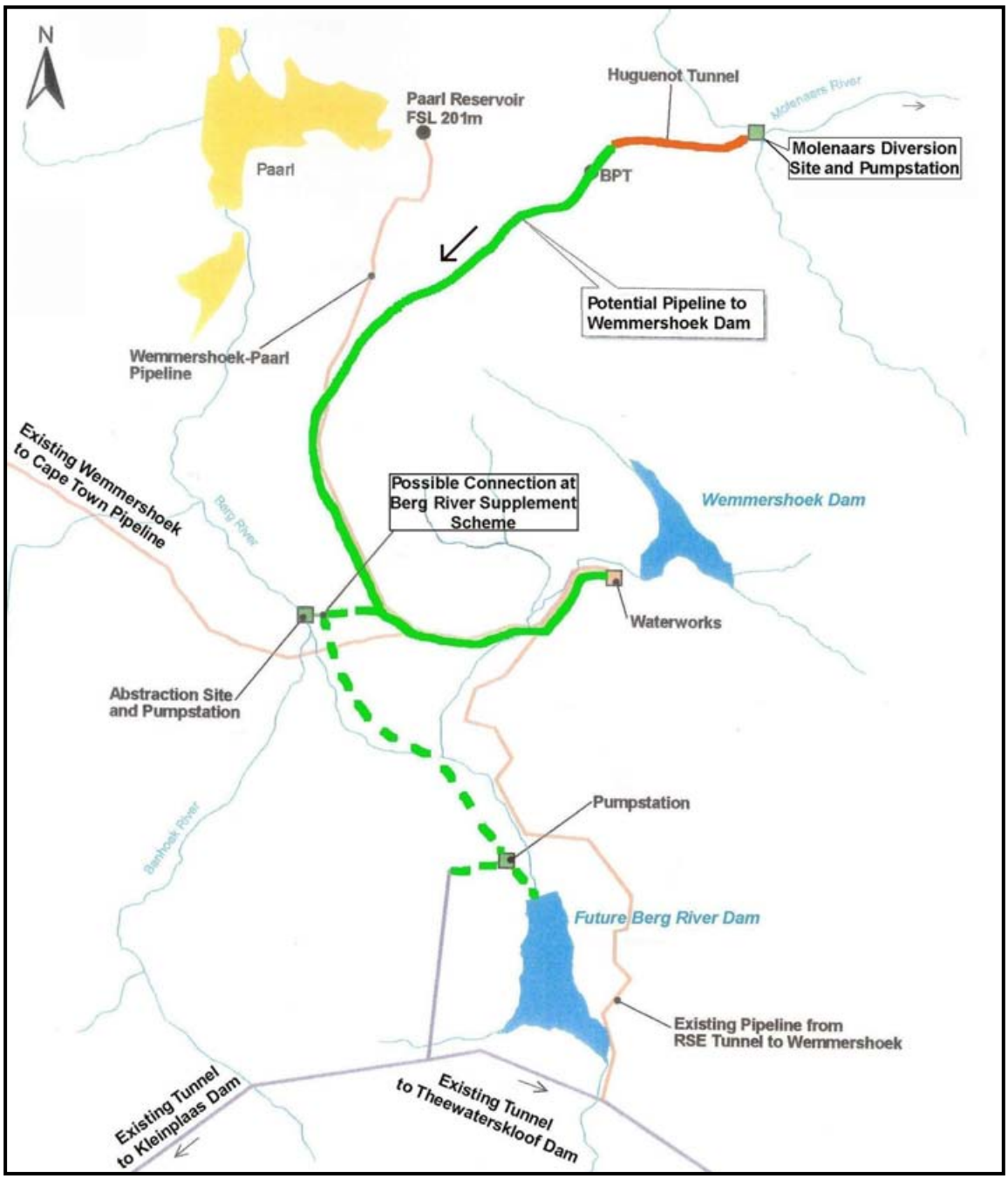
7. OTHER ISSUES

- **Strengths**
  - Scheme can be integrated with Voëlvlei Dam.

- **Weaknesses**
  - Information presented is based on a pre-feasibility study.
  - Further studies beyond this phase may alter the current view of the scheme significantly in terms of yield.
  - Constructing a dam on the Watervals River could significantly impact the downstream water quality.
  - The scheme yield is low and may even reduce after the ERWs are set.
  - From an economic point of view, the Watervals River Dam is expensive, relative to other options for augmenting Voëlvlei Dam.

G10. The Upper Molenaars Diversion

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

Unless otherwise stated, the information presented for this scheme is taken from the DWAF's Breede River Basin Study of 2004: Report No PH 00/00/2702 – *Regional Scheme Development Options and their Environmental Implications;* Report No. 18464USO - *Pre-feasibility Study of Potential Water Sources for the Area Served by the West Coast District Municipality.*

This scheme comprises the construction of a pumping sump in the Molenaars River and adjacent pump station. Winter flows would be pumped to the east portal of the existing Huguenot Tunnel and conveyed under gravity from there through the existing 1,2 m dia. pipeline in the tunnel to the west portal. Thereafter, water would be conveyed under gravity via a new pipeline of approximately 26 km from the west portal to Wemmershoek Dam. The diversion capacity would be 5 m^3/s.

As an alternative, a similar option would be possible for gravitating the water to the Berg River Dam via the Supplement Scheme, either in a new separate pipeline or in a larger supplement scheme pipeline. For the purposes of costing, a separate pipeline has been assumed.

3. SCHEME YIELD

The optimum scheme would yield about 27 million m^3/a, after allowing for Ecological Water Requirements (EWRs), for a Class "B" river at the diversion site.

4. UNIT REFERENCE VALUE

The potential financial costs for the scheme are as follows :

ITEM	Escalated to 2005 (@ 7% /a) (1)	
	To Wemmershoek	*To Berg R Dam*
Capital cost (R million)	298,8	345,21
Annual operating cost (R million) (2)	2,3	2,3
NPV Cost (R million)	156,1	179,0
Unit Reference Value (R/m^3) (3)	1,12	1,28

1) Updated URV using a Discount Rate of 8%
2) Excludes water treatment costs.
3) Does not include the cost of additional pumping capacity required to maintain the yield of Brandvlei Dam.

The URV of the scheme amounts to 1,12 R/m^3. For the alternative conveyance of water to the Berg River Dam, the pipeline length would increase by about 4,5 km, with an estimated URV of about 1,28 R/m^3.

The Molenaars Scheme would have some impact on the existing diversions into Greater Brandvlei Dam and on the potential additional yield of the dam. This impact was not determined during the BRBS or DWAF's study of sources to serve the West Coast District Municipality.

5. ECOLOGICAL

Since the proposed scheme does not require the construction of a dam or weir in the Molenaars River, the impacts on the terrestrial environment due to inundation are likely to be negligible. The requisite pipeline from the Huguenot Tunnel to the Wemmershoek Dam would traverse limited areas of indigenous vegetation, and therefore this impact is likely to be of low significance.

The Molenaars River is rated as Category 1 Ecological Importance and forms part of the 10% core of perennial foothill rivers in the Fynbos Bioregion earmarked for conservation. Furthermore, the Moolenaars River is the only major foothill river in the south-western Cape that is in relatively good condition.

Since the scheme does not result in an in-channel obstruction, the impacts on the Molenaars River should be of a minor significance and mitigatable. The scheme is likely to have a small impact on major floods, and thus on the annual flooding of the Papenkuils Wetlands. This impact is considered to be of low significance. Furthermore, the scheme is unlikely to have any impacts on downstream water quality, due to the small volumes that would be abstracted, provided that the EWR is satisfied.

However, the cumulative impact of the existing and proposed water resource developments on the ecological functioning of the lower reaches of the Breede River and its estuary are of concern.

6. SOCIO-ECONOMIC

The proposed scheme would have no impact on the recreational activities that currently take place on the Molenaars River (trout fishing and white water rafting) since there would be no obstruction to the flow in the river. The sense of place would be slightly affected as the pump sump would comprise a building and pump station but this is close to the road and the Huguenot Tunnel infrastructure.

Due to the operating rules, the proposed abstraction is unlikely to affect current irrigation operations in the Breede River valley. However, the water diversion may foreclose some of the potential further irrigation development in the Breede River Valley. This impact is considered to be of low significance.

The scheme would, however, augment the yield of either the Wemmershoek or the Berg River Dam, which would have a positive impact for the Cape Metropolitan Area and the Berg Water Management Area. This positive impact is considered to be of medium significance.

If the reduced yield in Brandvlei Dam is not reinstated by the provision of additional pumping capacity at the Papenkuils Pump Station then there would have significant adverse impacts on irrigators and their associated communities.

7. OTHER ISSUES

Specific strengths and weaknesses of the scheme include :

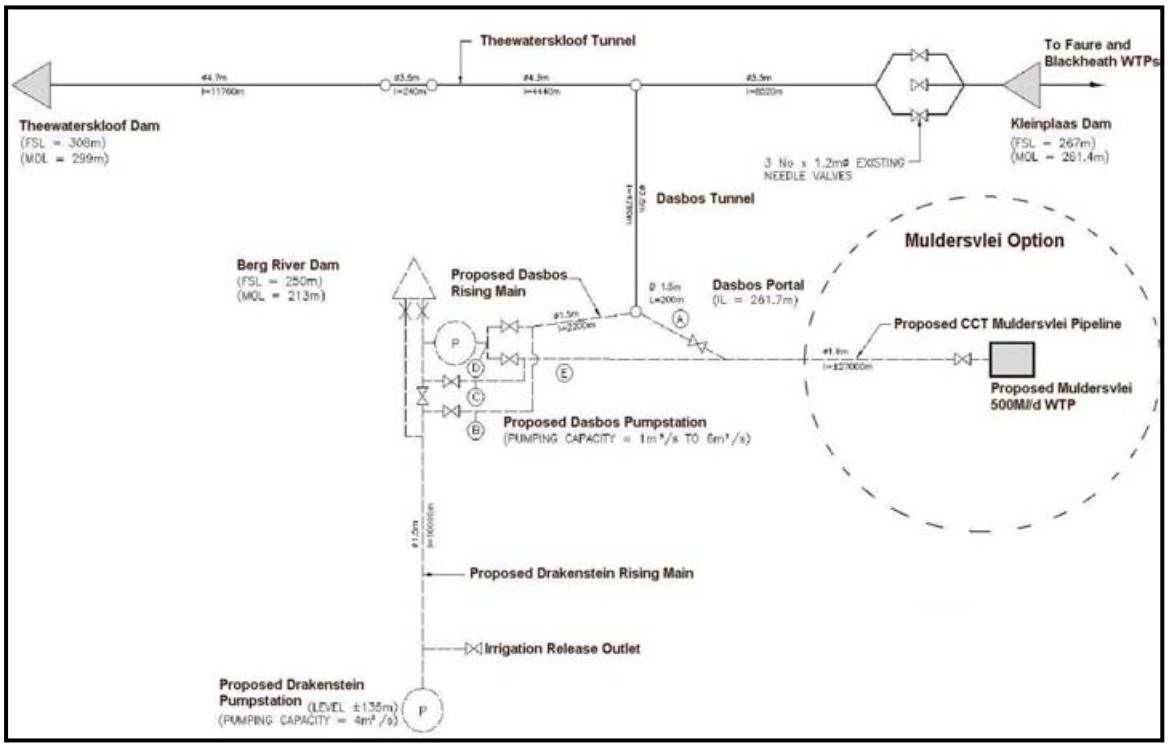
- **Strengths**
  - Pipework through Huguenot Tunnel is already in place;

- Storage in the Wemmershoek or Berg River Dams offers some reduced risk in the event of the RSE tunnel being closed;
- No weir should be required across the Molenaars River.

- **Weaknesses**
  - Some aesthetic impacts in Du Toits Kloof and along the pipeline route;
  - Less water available for existing irrigation from Greater Brandvlei Dam and in the Breede River Valley unless pumping capacity at Papenkuils is increased.

G11. Muldersvlei Optimisation Scheme

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

This option forms part of the potential enhancement of the current Berg Water Project (BWP) and has recently been investigated by the CCT. While it offers no benefit in terms of increasing the BWP yield (81 million m^3/a), it does offer a potential financial saving to the CCT. This would be achieved via the construction of a new 500 Mℓ/day water treatment works at Muldersvlei which would be primarily fed under gravity from the Berg River Dam (BRD). Pumping would only be required when the storage in the BRD drops to about 30% of its Full Supply Capacity. The scheme offers the opportunity to utilise better quality water from the BRD, rather than from Theewaterskloof Dam, with significant savings in water treatment costs.

3. SCHEME YIELD

No additional yield.

4. UNIT REFERENCE VALUE

This has not been determined. It has however been estimated that up to 56 million m^3/a could be supplied from the BRD, with a unit cost water treatment saving of R0,20/m^3. This equates to annual cost saving to the CCT of about R11,0 million/a.

5. ECOLOGICAL

The benefit of this scheme is that it offers the opportunity to avoid having to mix Theewaterskloof water (lower quality) with good quality Upper Berg River water in the BRD. The Theewaterskloof water would be used to supply irrigation by making releases from the tunnel into the Berg River lower downstream. This would however perpetuate the current ecological impacts associated with releasing Theewaterskloof water in summer. The flexibility is however retained in being able to still make irrigation releases from the BRD and to supply the new water treatment works at Muldersvlei, from Theewaterskloof Dam.

The impacts of the pipelines, WTW and storage reservoir are not significant.

6. SOCIO ECONOMIC

Some impacts on landowners and agriculture are anticipated, as well as some visual impacts and impacts on the sense of place in the vicinity of the WTW.

7. OTHER ISSUES

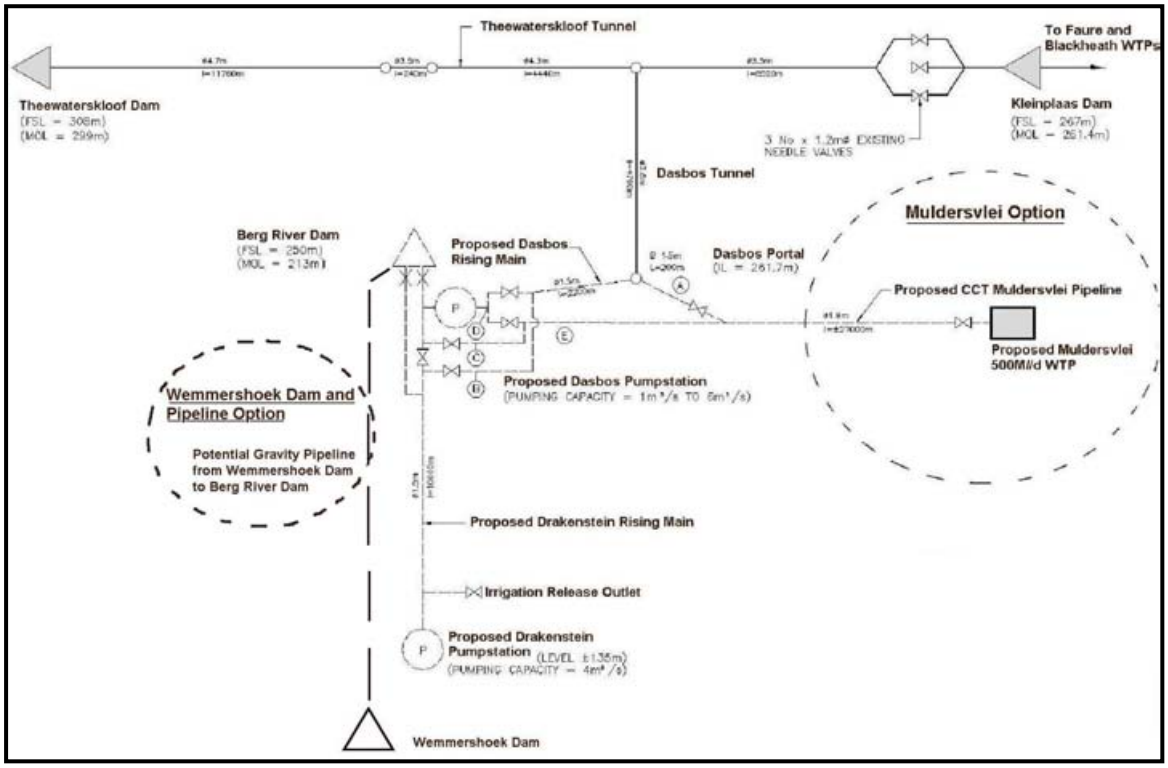
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - Easily integrated into the Western Cape Water Supply System;
  - Is financially attractive;
  - Can be simultaneously implemented with the BWP;
  - Offers operational flexibility in terms of releases and reduces reliance on at least part of the RSE tunnel.

- **Weaknesses**
  - Requires a redesign of the Dasbos Adit pipeline to accommodate increased flow velocities;
  - Has no water quality benefit for the Berg River aquatic ecology or abstractors.

G12. The Wemmershoek Dam and Pipeline

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

This option forms another potential enhancement to the Berg Water Project (BWP) and has been investigated recently by the CCT. It has been identified that an additional yield of 5 million m^3/a is available from within the catchment of Wemmershoek Dam. The dam currently supplies water to Cape Town and to Paarl and Wellington, via a gravity pipeline from the Wemmershoek WTW, situated just downstream of the dam. The WTW is also supplied with water out of Theewaterskloof Dam via a pipeline (Wemmershoek Pipeline) leading from the Riviersonderend-Berg-Eerste Tunnel.

The potential exists to interconnect the Wemmershoek Dam and BRD directly so as to transfer surplus water from Wemmershoek Dam into the BRD, under gravity. In so doing the additional yield of 5 million m^3/a could be utilised.

Water from Wemmershoek Dam to the Berg River Dam would either be transferred by reversing the flow in the Wemmershoek pipeline or via a new pipeline about 12 km long. The periods of transfer are estimated to be about one or two months respectively for these options, but would also depend on the respective water levels in the two dams.

3. SCHEME YIELD

The scheme would yield 5 million m^3/a.

4. UNIT REFERENCE VALUE

(Not determined). The URV is expected to be low due the gravitational feed between Wemmershoek Dam and the BRD, with low associated operating costs.

5. ECOLOGICAL

From a water quality perspective, the scheme allows for water of similar quality to be transferred into the BRD from Wemmershoek Dam. The impacts of the additional pipeline are unlikely to be significant.

6. SOCIO ECONOMIC

Not assessed but expected to be insignificant.

7. OTHER ISSUES

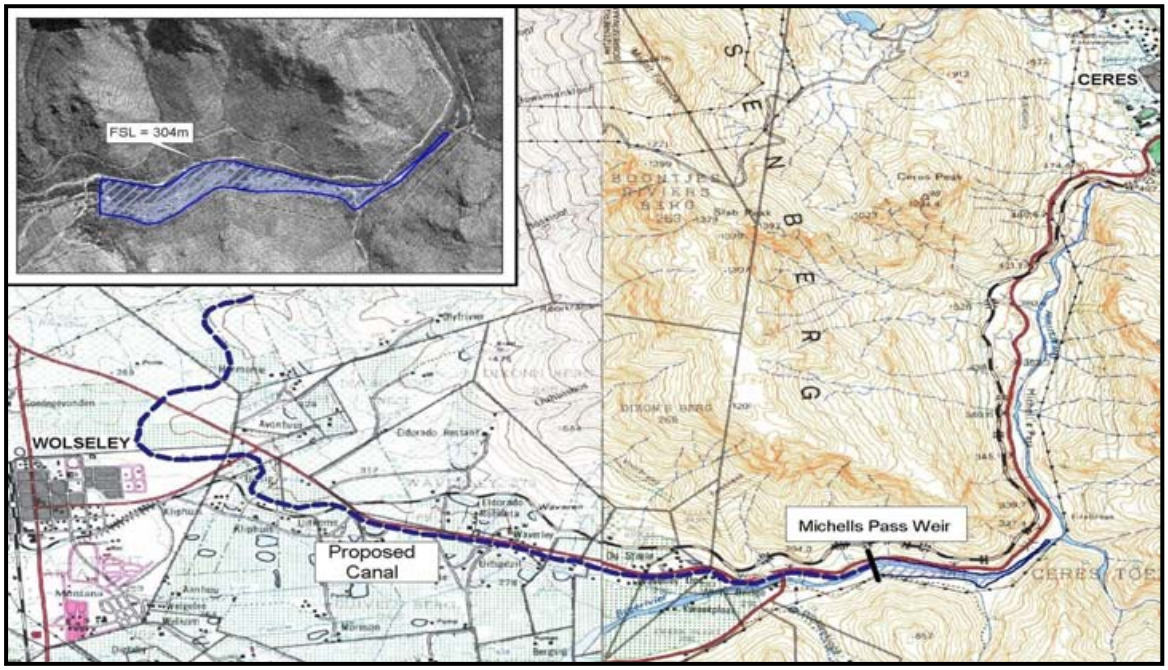
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - The scheme operation (gravity) is cost effective;
  - It can be implemented without impacting on the design of the BRD supplement scheme.

- **Weaknesses**
  - Not determined.

G13. The Michell's Pass Diversion

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

The information presented for this scheme is taken from two sources, namely :

- DWAF's Breede River Basin Study (BRBS) of 2004: Report No PH 00/00/2702 – *Regional Scheme Development Options and their Environmental Implications*.
- DWAF's *Pre Feasibility Study of Potential Water Sources For the Area Served by the West Coast District Municipality.* Report No 18464USO.

A 10 m high weir on the Dwars River (Upper Breede) would divert winter water via a 9 km canal across the catchment divide, into a tributary of the Klein Berg River. The existing Klein Berg diversion weir and canal would then divert the water into Voëlvlei Dam. The BRBS assessed three diversion capacities at Michell's Pass, namely 4, 8 and 12 m^3/s. The scheme could alternatively also supply the West Coast area through a sharing of the resource.

3. SCHEME YIELD

The BRBS investigated the following scheme yields for the Michell's Pass diversion.

- 4 m^3/s diversion - 36 million m^3/a
- 8 m^3/s diversion - 52 million m^3/a
- 12 m^3/s diversion - 60 million m^3/a

The yields take account of the requirements of existing downstream users, and to at least maintaining present day flows for meeting EWRs. However, the effects on the diversion into Brandvlei Dam would be significant, as discussed below. The potential cost of a second pipeline to Cape Town from Voëlvlei Dam has not been taken into account. It is considered that the yield could be fully utilised (within existing infrastructure) by Cape Town, the growing West Coast regions and the current shortfalls on Voëlvlei Dam.

The West Coast Study investigated a 1m^3/s pumping diversion at Michell's Pass and found the effective increased yield from Voëlvlei Dam (11 million m^3/a) to be adequate to meet the projected West Coast District Municipality's water demands (up to 2022).

For a 1 m^3/s diversion at Michell's Pass, the following impacts on the yield of Greater Brandvlei Dam could be expected.

- A yield reduction of 6 million m^3/a (assuming the existing 5 m^3/s Papenkuils abstraction), which could be recovered by increasing the Papenkuils Diversion capacity from 5 to 6,4 m^3/s.
- A yield reduction of 11 million m^3/a (assuming the potential 20 m^3/s Papenkuils abstraction), which could be recovered by increasing the potential diversion capacity from 20 to 23,7 m^3/s, without providing additional storage.

4. UNIT REFERENCE VALUE

The potential financial costs for the 8 m^3/s Michell's Pass diversion scheme (yield of 52 million m^3/a) are as follows :

ITEM	Escalated to 2005 (@ 7% /a) (1)
Capital cost (R million)	77,3
Annual operating cost (R million) (2)	0,2
NPV Cost (R million)	38,2
Unit Reference Value (R/m^3)	0,15 (3)

1) Updated URV using a Discount Rate of 8%
2) Excludes water treatment costs.
3) Excludes the cost of additional pumping capacity into Brandvlei.

The URV of the 8 m^3/s diversion scheme amounts to 0,15 R/m^3, assuming present day river classes downstream and excludes water treatment.

5. ECOLOGICAL

The present ecological status of the Breede River in the vicinity of the weir is a Category D/E. However, the river in the vicinity of Michell's Pass is an example of a rare foothill rejuvenation zone. The weir is unlikely to have an effect on the downstream environment, due to its small capacity, but lotic habitat would be created upstream of the weir for some 1.5 km. This may

create habitat for the small-mouthed bass, threatening survival of the indigenous fish. This impact is however considered to be of low significance. Furthermore, the scheme is unlikely to have an impact on the Breede River estuary, as the volume of water to be abstracted is very small.

The construction of a 10 m high weir is likely to flood an area of some 15 ha. The area consists of fynbos that is recovering after the removal of alien vegetation. The construction of the transfer canal is likely to disturb some 130 ha of land, which is not considered to be of ecological importance. Therefore the significance of this impact is considered to be low.

The Breede River valley is heavily utilised as a source of water for irrigation and domestic consumption. The lower reaches of the Breede River have poor water quality along its middle and lower reaches due to irrigation return flows during the summer, but water quality is good during the winter months when the diversion would take place. Abstraction at the weir may result in further elevated phosphate and salinity levels. However, provided that the EWR is satisfied, the significance of this impact is likely to be low.

The effects of the scheme may be greater for the receiving environment, since the transfer of water will result in elevated winter flows in the Klein Berg River. Furthermore the scheme may result in the transfer of organisms into the Berg River catchment.

6. SOCIO-ECONOMIC

The construction of the canal would result in crossings of various access tracks and footpaths. The scale of this impact is, however, small and is deemed to be of low significance. The weir is likely to lead to the inundation of an old road into the Tierhoekkloof tributary. The importance of the road is unknown, and the significance of the impact is considered to be low.

The land surrounding the weir site is presently uncultivated, and the canal would lead to the loss of some productive land. However, existing agricultural users would not be impacted by the abstraction of water. The impact to agriculture is expected to be of low significance.

There are currently no recreational activities taking place at the proposed weir site. However, the construction of the weir may result in opportunities for fishing. Furthermore, the proposed scheme would increase the amount of water available in the Berg Water Management Area, and would allow for increased transfers from Voëlvlei Dam to Cape Town or to the West Coast area. This impact is considered to be of a high significance.

If the reduced yield of Brandvlei Dam is not reinstated by the provision of additional pumping capacity at the Papenkuils Pump Station, then this would have significant adverse impacts on irrigators and their associated communities.

7. OTHER ISSUES

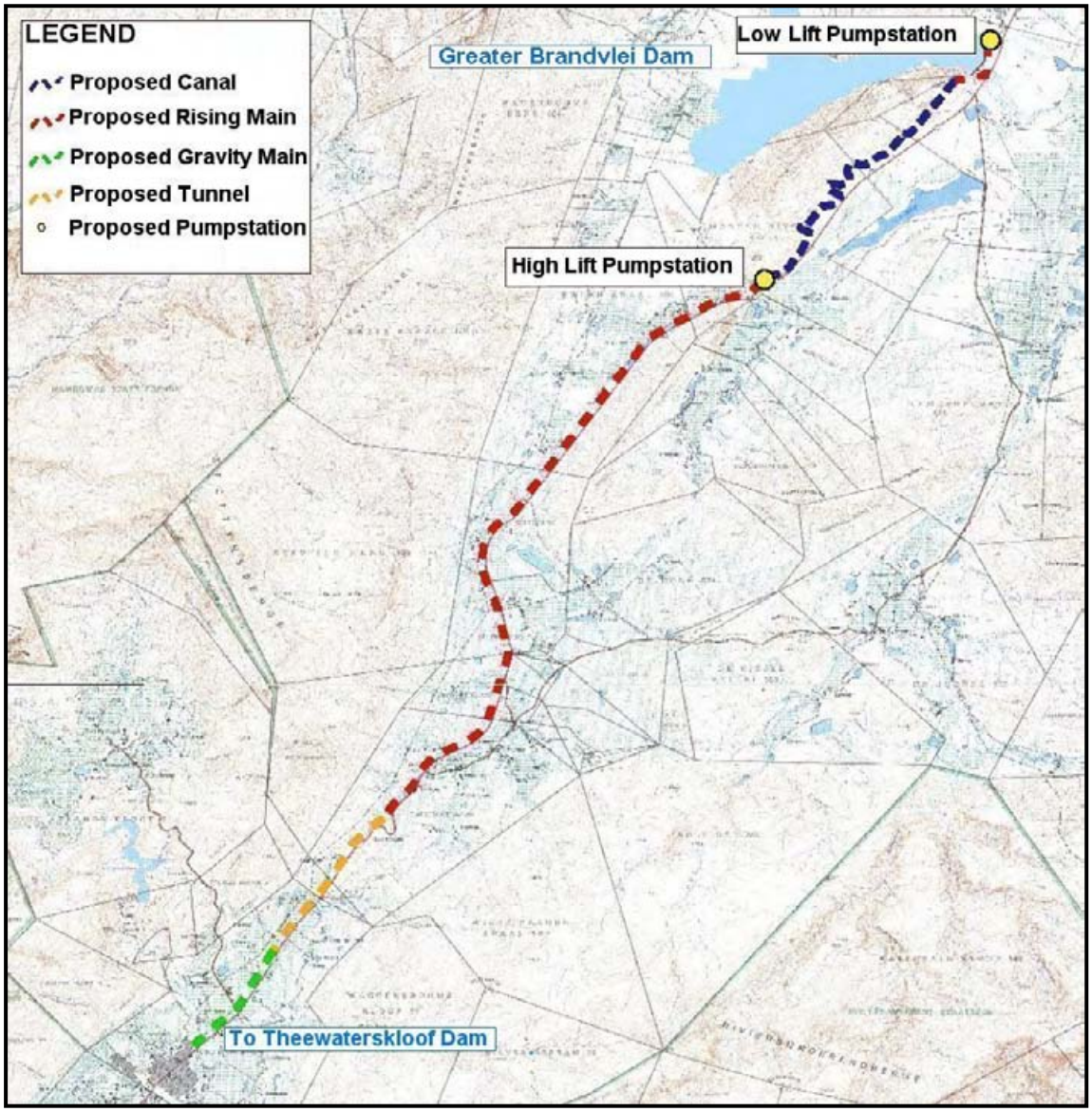
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - Versatile in terms of augmenting supply to Cape Town, the West Coast or both;
  - Scheme can be integrated into the WCWSS;
  - Water quality is good;
  - Potential to augment stressed local supply schemes at Wolseley and Tulbagh.

- **Weaknesses**
  - o May require additional pipeline to Cape Town;
  - o Existing diversion infrastructure on Klein Berg River will re-quire upgrading;
  - o Impacts of diversions > 1 m^3/s on the yield of Greater Brandvlei Dam are not yet assessed, but would adversely affect existing irrigation unless pumping capacity at Papenkuils is increased;
  - o Diversion capacity is limited to prevent inundation of the Witels River, upstream of the diversion weir;
  - o Risks to the Berg River system due to the transfer of excessive water and organisms;
  - o Severe impact on further irrigation development out of Brandvlei Dam.

G14. Linking Brandvlei Dam to Theewaterskloof Dam for transfer

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

The information presented for this scheme is taken from DWAF's Breede River Basin Study (BRBS) of 2004: Report No PH 00/00/2702 – *Regional Scheme Development Options and their Environmental Implications*.

This scheme is based on the potential transfer of water from Greater Brandvlei Dam (GBD) to Theewaterskloof Dam (TWK), via a combination of pipelines, a canal and a tunnel. The scheme relies on the augmentation of GBD, of which the option to increase abstraction into the dam from the Papenkuils run-of-river abstraction site appears to be the most economical. After supplying

the demand of existing GBD users, spare water would be transferred to Theewaterskloof for direct transfer from Theewaterskloof to the CCT.

A delivery rate of 2 m^3/s was adopted in the BRBS.

3. SCHEME YIELD

The incremental yield of this scheme is estimated to be 41 million m^3/a. This takes into account the compensation flows (5 m^3/s) required downstream of the abstraction site, as well as any additional releases from GBD required to meet the EWRs of the closest downstream IFR site (Le Chasseur). The current EWRs for the Lower Breede River (Class "C") and its estuary (Class "B") are almost entirely met through present day flow conditions.

4. UNIT REFERENCE VALUE

The BRBS did not take water treatment costs into account when assessing the URV. The potential financial costs (including the costs associated with the Papenkuils Pump Station) are as follows :

ITEM	Escalated to 2005 (@ 7% /a) (1)
Capital cost (R million)	426,8
Annual operating cost (R million) (2)	15,2
NPV Cost (R million)	282,9
Unit Reference Value (R/m^3)	1,40

1) Updated URV using a Discount Rate of 8%
2) Excludes water treatment costs.

5. ECOLOGICAL

Raising of the Papenkuils weir would directly affect the Papenkuils wetlands, by exacerbating the impact of abstraction and storage in the Greater Brandvlei Dam (GBD). This may result in a change to plant communities and species phenological responses downstream of the weir. These are considered to be significant impacts. The construction of the pipelines and canals may impact on the rare coastal Renosterveld and Sand Fynbos. These impacts are, however, deemed to be of low significance.

A major concern of the proposed scheme would be the impacts associated with the inter-basin transfer (IBT). Impacts associated with the IBT include, *inter alia,* differences in water quality between the GBD and Theewaterskloof Dam and the risk of transferring fauna and flora to the Theewaterskloof Dam and conceivably into the upper reaches of the Berg River. Plant species of concern include propagules of the exotic Kariba weed. Furthermore, the discharge of up to 2 m^3/s of water into the Elands River is likely to result in erosion of the existing channel, with further impacts on the degraded riverine ecosystem. The impacts for the receiving environment are deemed to be of medium to high significance.

6. SOCIO-ECONOMIC

Additional water sent to Theewaterskloof Dam would be transferred directly to the Western Cape Water Supply System. This positive impact is considered to be of a medium to high significance.

The volume of water to be abstracted is small and water would only be transferred to Theewaterskloof Dam once the demands of existing users of the GBD have been met. Therefore, the impact on existing users is negligible, and this impact is deemed to be of low significance.

Recreational activities on the Brandvlei Dam may be affected by the increased fluctuation of water levels in the dam, due to the proposed scheme.

The implementation of this scheme would preclude further irrigation development out of GBD in the Breede River catchment. The Breede ISP has suggested that this scheme not be considered as a transfer option, but that GBD continue to serve the users in the Breede River catchment.

7. OTHER ISSUES

Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - Scheme can be integrated into the WCWSS with no additional infrastructure requirements;
  - Scheme utilises the significant storage capacity available in both Brandvlei and Theewaterskloof Dams.

- **Weaknesses**
  - Theewaterskloof water quality will be impacted by higher colloidal bearing water from Greater Brandvlei Dam;
  - More cost effective potential surface water schemes are possible;
  - Scheme has a high operating cost component;
  - Severe impacts on further irrigation development out of Greater Brandvlei Dam;
  - Significant impacts on the Papenkuils wetland;
  - Risks of transferring organisms to the Theewaterskloof Dam, Riviersonderend River and the Berg River systems.

G15. Raising Theewaterskloof Dam

1. SCHEME LAYOUT

2. SCHEME DESCRIPTION

Theewaterskloof Dam on the upper reaches of the Riviersonderend River (Breede WMA) is owned by DWAF. It has a storage capacity of 434 million m^3/a (Ref: Breede River Basin Study) and is the largest storage dam within the Western Cape Water Supply System. The dam forms the heart of the Riviersonderend-Berg-Eerste (RSE) Government Water Supply System. It stores runoff from its own catchment as well as water transferred into the dam from the Upper Berg River catchments (Banhoek and Wolwekloof) and will be operated conjunctively with the Berg Water Project. The RSE scheme has a 1 in 50 year yield of 234 million m^3/a, of which about 161 million m^3/a is transferred into the Berg WMA. The remaining yield supplies irrigators along the Riviersonderend River via releases made from the dam. The Overberg Rural Water Supply Scheme (Overberg Water) is also supplied via releases, abstracted from the Riviersonderend River. There are no environmental releases from the dam.

The dam's capacity is equivalent to 1,7MAR. As such there is little benefit in raising it in terms of its own incremental runoff. From a water resource perspective, a raised Theewaterskloof Dam would add storage to the Western Cape System. However, transfers into the dam from potential schemes (such as the Brandvlei to Theewaterskloof Transfer), could be managed without a raising, by making transfers when there is spare capacity in Theewaterskloof and utilising those transfers immediately. Nevertheless, additional storage in the WCWSS will be required to balance seasonal supply and demand, and for drought carry-over, as many proposed schemes involve diversions with no additional storage by Lourens, Eerste, Molenaars, Michell's Pass, Voëlvlei Phase 1, etc.

It was recommended in the Breede River Basin Study (2003) that the potential raising of the dam should not be investigated in any detail due the significant extent of developed land and expropriation that would be required.

3. SCHEME YIELD

There would be no significant yield increase from the runoff within the catchment of the dam. Any potential yield increase would be dependant on the size of the potential transfer scheme/s delivering water from elsewhere into the WCWSS. Evaporation losses from the increased surface are would be significant.

4. UNIT REFERENCE VALUE

Not assessed.

5. ECOLOGICAL AND SOCIO-ECONOMIC

The raising of Theewaterskloof Dam would have a significant social impact due to the extent of land expropriation and potential water logging of adjacent areas. Specific concerns associated with a raising are:

- loss of wetlands upstream of the dam;
- the impacts on the riparian properties and structures on those properties;
- the social and economic impacts resulting from the loss of high value fruit crops;
- the effect of waterlogging on deciduous fruit trees located on riparian farms;

It was estimated in 1997 that the potential loss of foreign income as a direct result of a 1m raising would be in the order of R9 million per annum. Escalated at 7% per annum this equates to a current estimate of R16 million per annum, without taking fluctuations in foreign currency into account.

6. OTHER ISSUES

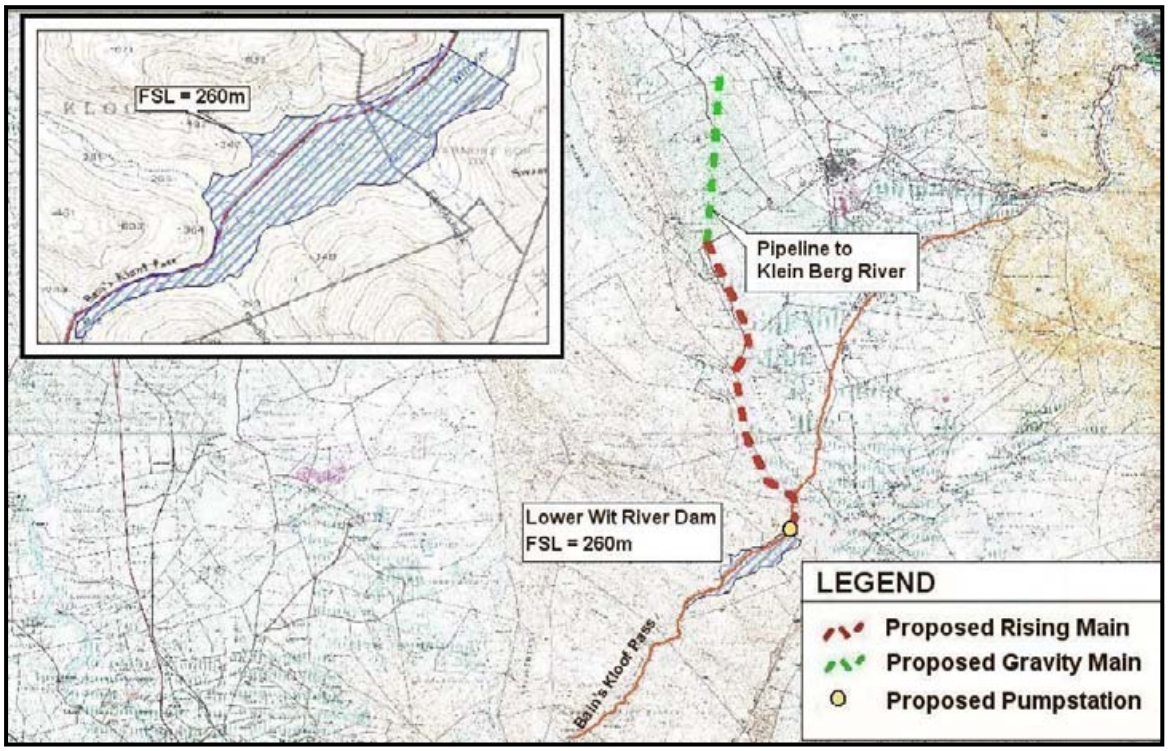
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - The spillway is of short crest length (75 m) and could be easily raised using a spillway gated system;
  - Raising would increase the storage availability within the System;
  - No significant ecological impacts.

- **Weaknesses**
  - Increased evaporation losses;
  - Severe socio-economic impacts (expropriation of high value crops);
  - Potential water logging of surrounding areas.

G16. Lower Wit River Dam

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

The information presented for this scheme is taken from DWAF's Breede River Basin Study (BRBS) of 2004: Report No PH 00/00/2702 – *Regional Scheme Development Options and their Environmental Implications*.

This scheme entails the construction of a rockfill dam at the bottom of Bain's Kloof on the Lower Wit River. To augment the WCWSS, water would be pumped through a static head of 23 m, at a rate of 1,2 m^3/s, via a rising main of 13 km, across the catchment divide. From the watershed to the point of discharge (the Brakkekloof River tributary of the Klein Berg River), it would be conveyed via a 6,5 km gravity pipeline (700mm dia) with available static head of 100 m. From here the water would flow into the Klein Berg River and be diverted into Voëlvlei Dam. The Lower Wit River Dam would store surplus winter water only, with inflow being released in summer for downstream users.

The BRBS investigate four potential dam capacities, ranging between 12 and 86 million m^3. It concluded that for this scheme, a dam of 24 million m^3 capacity appeared the most favourable option. The dam wall height would be 28 m and have a crest length of 737 m.

Approximately 7 km of the R43 through Bain's Kloof would have to be relocated, with the need for new bridges over both the Wit and Breede Rivers.

3. SCHEME YIELD

The EWRs at the closest downstream IFR site (Le Chasseur) would be maintained in accordance with present day flows for the existing "Class C/D" river at that site. For a 24 million m^3 capacity dam, the yield available via the potential transfer scheme would be about 29,5 million m^3/a.

The impact of the scheme on the pumping requirement at Brandvlei Dam was not assessed during the Breede River Basin Study, but should be taken into account.

4. UNIT REFERENCE VALUE

The BRBS did not take water treatment costs into account when assessing the URV. The potential financial costs are as follows :

ITEM	Escalated to 2005 (@ 7% /a) (1)
Capital cost (R million)	333,6
Annual operating cost (R million) (2)	3,0
NPV Cost (R million)	176,1
Unit Reference Value (R/m^3) (3)	1,17

1) Updated URV using a Discount Rate of 8%
2) Excludes water treatment costs.
3) Does not include the cost of additional pumping capacity to be provided at Papenkuils.

5. ECOLOGICAL

The construction of the proposed dam would inundate some 232 ha of pristine indigenous mountain fynbos, which would permanently displace a suite of mammals, reptiles and birds. The broader area is known to be inhabited by various Red Data species. Furthermore, the requisite pipeline and canal would impact on further areas indigenous vegetation and the canal would form a barrier to the movement of certain animals. These impacts are considered to be of medium significance.

The Wit River hosts three indigenous fish species namely the Burchell's redfin, the Cape Galaxias and the Cape Kurper. Furthermore, the Wit/Breede Rivers form an important migratory route for an eel species. The proposed dam would pose a barrier to the migration of the eel and the witvis, which migrate between marine and freshwater systems during their lifecycles. The impacts on the aquatic ecology are considered to be of high significance.

All of the ecological impacts associated with the transfer of water, described in the Michell's Pass Diversion option will apply.

6. SOCIO-ECONOMIC

The proposed dam is likely to impact on the recreational activities taking place in the Bain's Kloof valley, such as hiking and fishing. A number of tourism establishments would be inundated. This impact is considered to be of medium significance.

The dam would inundate portions of the Bain's Kloof Pass, a National Monument and other sites of cultural and archaeological significance. This impact is considered to be of medium significance.

The dam would inundate some agricultural areas, mainly vineyards. Small areas of agriculture would be lost due to the canal. Furthermore, some homesteads, resorts, farm roads, power lines and telephone lines would have to be relocated due to inundation.

The dam would change the aesthetics and sense of place of the Bain's Kloof Pass and valley. The relocation of the abovementioned infrastructure would further contribute to the visual impact of the scheme. This impact is considered to be of medium significance.

7. OTHER ISSUES

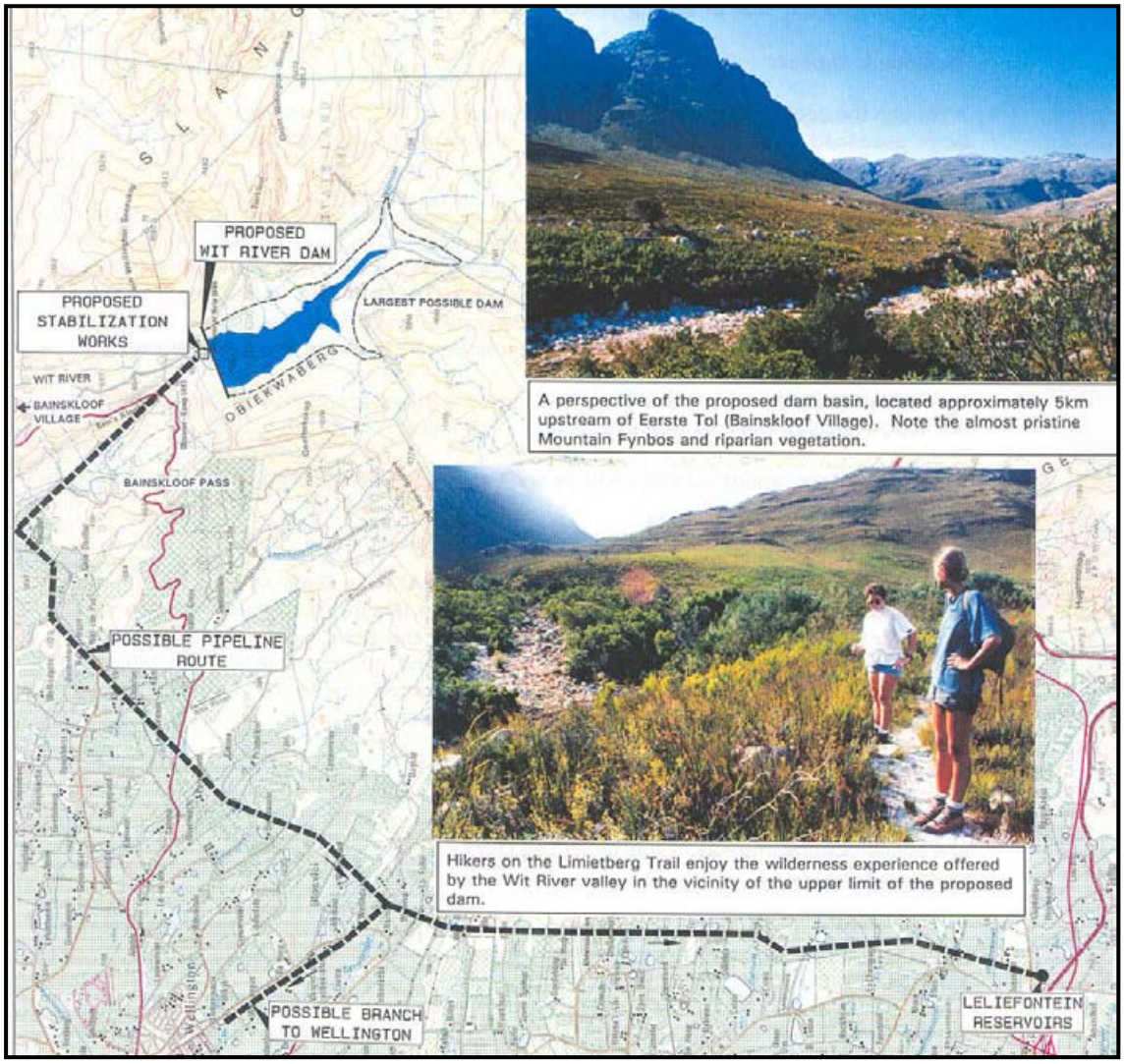
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - Scheme can be integrated into the WCWSS;
  - Water quality of source is high.

- **Weaknesses**
  - Significant relocation of infrastructure and new bridge construction;
  - High ecological impacts;
  - High socio-economic impacts;
  - Impacts on recreational activities and National Monument.

G17. The Upper Wit River Dam

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

The information presented for this scheme is taken from the 1995 report by Ninham Shand entitled *The Upper Berg River Valley Water Supply*, (Report No: 2243/5794) and the Western cape System Analysis of 1994.

This local supply scheme could augment the supply to Paarl and Wellington, as well as irrigators in the Wellington area and along the Berg River. The scheme would relieve the pressure for additional water for Paarl and Wellington from the CCT's Wemmershoek Dam. The potential Upper Wit River Dam site is located 5 km upstream of Bainskloof Village (Eerste Tol). A 32 m high rockfill dam would have a crest length of 650 m, and would inundate 72 ha. This dam size was determined as being adequate to meet the projected water demands of Paarl and Wellington. The dam would store surplus winter that would be stabilised at the site, and then conveyed via a 500 mm dia, 17,5 km steel pipeline to Paarl's existing Leliefontein reservoirs. A 3 km long, 200 mm dia branch pipeline, would deliver water to Wellington.

The existing diversion weir at the dam site diverts about 5 million m^3/a during summer into the Berg WMA for irrigators near Wellington ("Gawie-se-Water scheme"). Compensation releases from the potential dam would be necessary to supply those farmers with established water allocations.

3. SCHEME YIELD

A 32 m high dam of 9 million m^3 capacity would yield about 12 million m^3/a. Whilst the scheme is based on the storage of surplus winter water, the extent of the surplus would need to be reassessed, taking the winter Reserve components into account. Summer flows in the river are currently reduced by diversions at the "Gawie-se-Water" abstraction site.

4. UNIT REFERENCE VALUE

The dam and pipeline are included in the URV calculation. The URV has been re-estimated to allow for escalation at 7% per annum.

ITEM	Escalated to 2005 (@ 7% /a) (1)
Capital cost (R million)	100,3
Annual operating cost (R million) (2)	0,8
NPV Cost (R million)	110,0
Unit Reference Value (R/m^3)	0,75

1) Updated URV using a Discount Rate of 8%
2) Excludes water treatment costs.

5. ECOLOGICAL

The dam would inundate 72 ha of pristine indigenous fynbos and would permanently displace the associated animals, reptiles and invertebrates. The dam would also act as a barrier to the habitat of the indigenous fish species, namely *Burchell's redfin*, the *Cape bolaxas* and the *Cape Kurper* and could result in the introduction of black bass with adverse consequences. The barrier effect would also prevent the migration of eels and the witvis.

6. SOCIO-ECONOMIC

The dam basin would inundate the existing hiking tail and would have a significant impact on the sense of place of this pristine area.

The dam would inundate areas owned by Wellington Municipality and the Mountain Club.

7. OTHER ISSUES

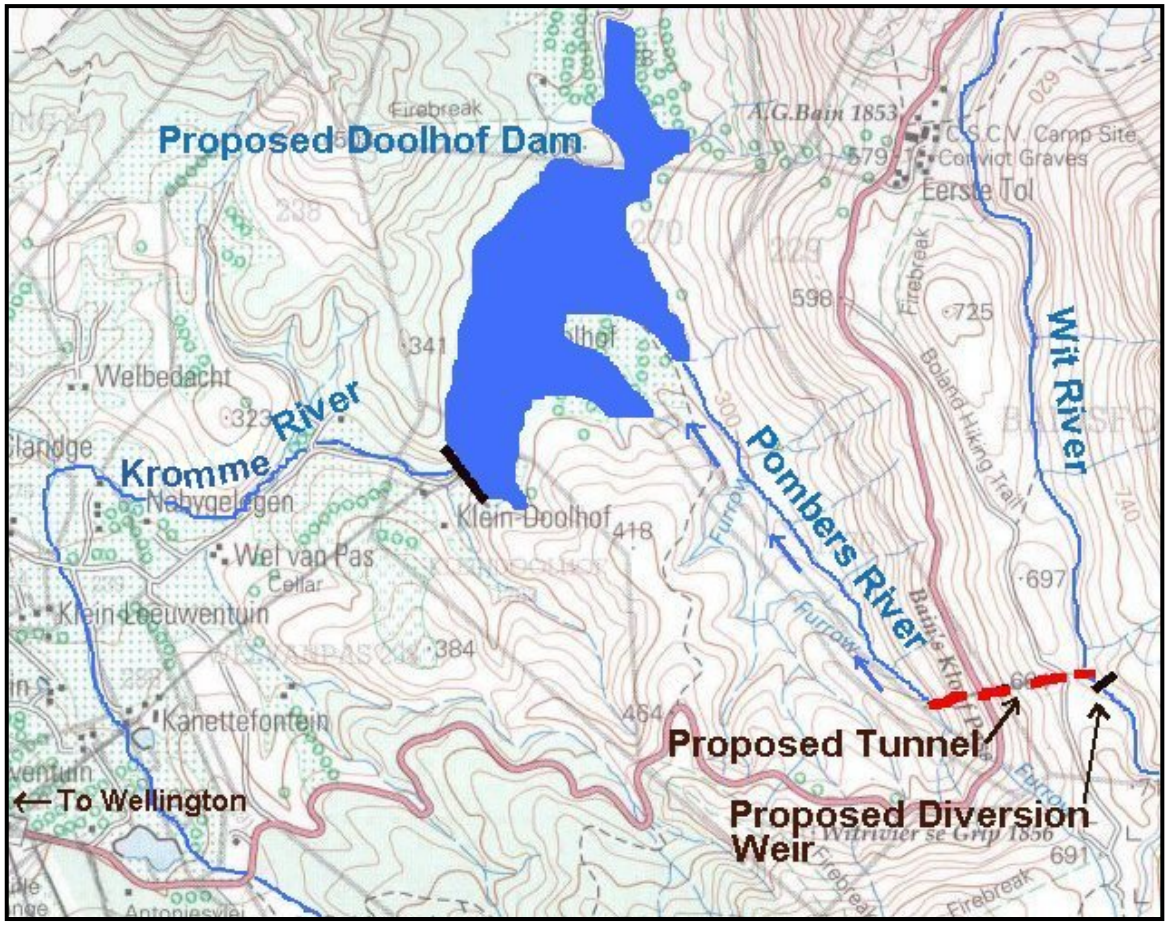
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - The scheme offers an alternative source of supply to Paarl and Wellington;
  - Water quality of the source is high, with only stabilisation required in terms of treatment.
  - For a larger dam, surplus water (over and above Paarl and Wellington's requirements) could be delivered into Wemmershoek Dam, via reversing the direction of pumping in the existing Wemmershoek to Paarl pipeline.
  - The scheme is likely to attract considerable public opposition.

- **Weaknesses**
  - The dam site is located in a pristine mountain fynbos area and the Wit River is of high conservation status.
  - Inundation upstream of the dam wall would result in the loss wilderness areas, cultural heritage sites and will impact on angling and hiking in the area.

G18. The Upper Wit River Diversion

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

This scheme serves as an alternative option to a dam on the upper Wit River Dam. The scheme would comprise a low weir on the Wit River and one of the following alternatives :

- Enlargement of the Gawie se Water diversion channel which was originally constructed in about 1900 and diverts water across the divide into the Kromme River tributary of the Berg River;
- A new diversion channel constructed adjacent to the original channel if it is decided that the existing channel should be preserved as a heritage site;
- Construction of a tunnel through the mountain to divert flow in excess of the Reserve from the Wit River into the Kromme River. This alternative has been costed. The diverted water would be stored in a dam to be constructed on the Kromme River at a site on the farm Doolhof. The water would be treated and pumped to Wellington and back to Paarl, reversing the flow in the existing pipeline as outlined for the Upper Wit River Dam Scheme. Water could also be reversed into the pipeline from Wemmershoek Dam to the city.

3. SCHEME YIELD

The yield of the scheme would be approximately 10 million m^3/a.

4. UNIT REFERENCE VALUE

The weir, tunnel, dam, pipeline and land acquisition are included in the URV calculation. The cost of pumping is also included.

ITEM	Escalated to 2005 (@ 7% /a) (1)
Capital cost (R million)	40
Annual operating cost (R million) (2)	2
NPV Cost (R million)	64,8
Unit Reference Value (R/m^3)	0,54

1) Discount rate of 8% used for the URV calculation.
2) Excludes the costs of water treatment.

5. ECOLOGICAL

The proposed weir on the Wit River would be similar to the existing gauging weir and therefore would not be a major obstacle to the migration of fish up the river.

The Reserve requirements of the Wit River would be met with little or no impact on floods. The flow in the Kromme River would be increased but in accordance with the normal seasonality. The dam on the Kromme River would act as a barrier and releases would be required to meet the Reserve.

Most of the area inundated by the Doolhof Dam is current cultivated land and therefore the environmental effect would not be significant.

6. SOCIO ECONOMIC

The socio-economic effect on the hiking trail next to the Wit River would be small, although the construction of the tunnel and the disposal of soil could prove unsightly.

The dam at Doolhof would inundate most of the existing farm, including the homestead and outbuildings. Therefore people would be displaced and the farm workers are likely to lose their source of employment. Therefore this impact is rated as significant.

7. OTHER ISSUES

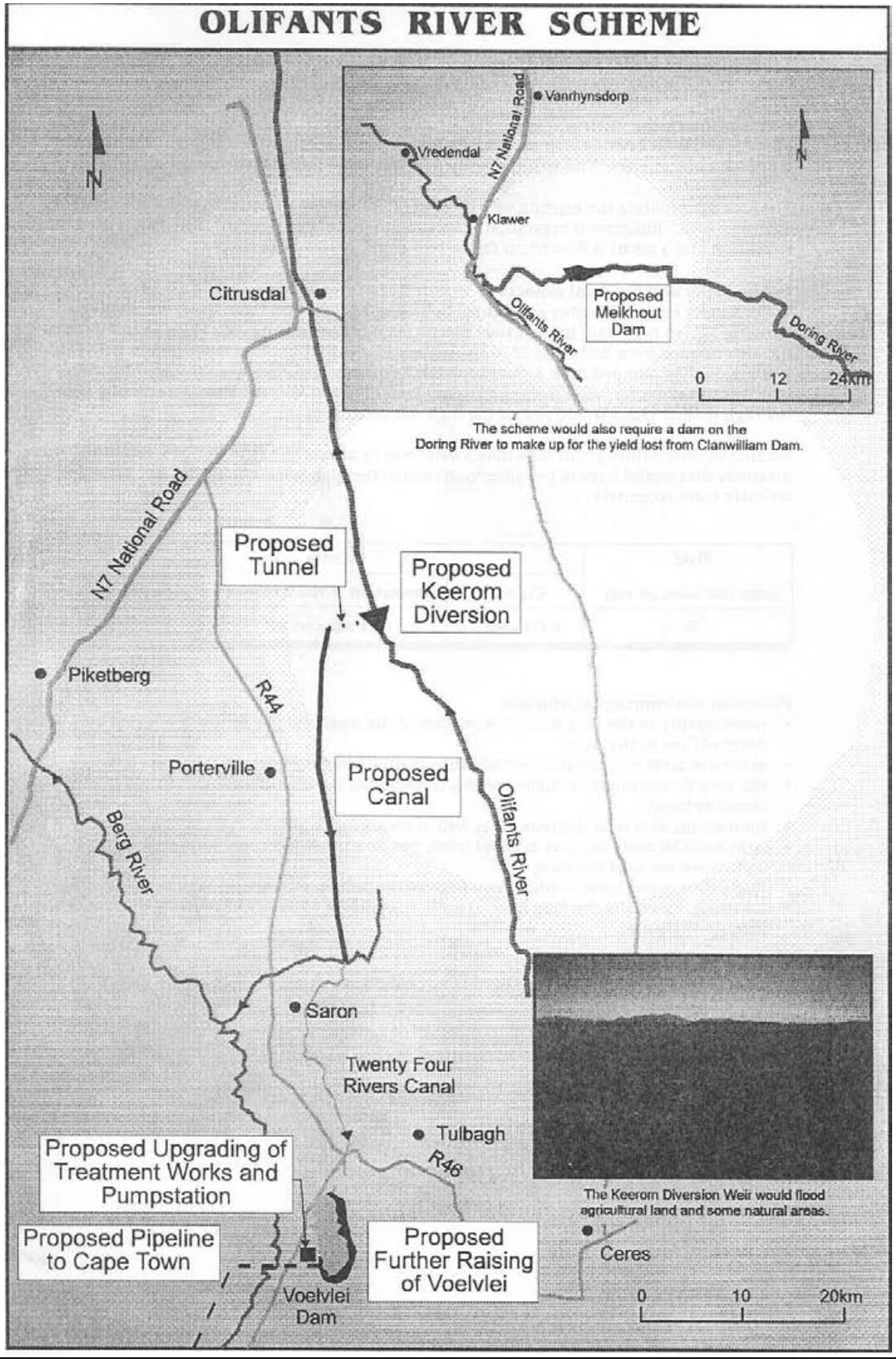
Specific strengths and weaknesses of the scheme included :

- **Strengths**
  - The scheme would require no storage on the Wit River;
  - The diversion would not compromise the Reserve and affect the flood plains.
  - The scheme would inundate very little indigenous natural fynbos.

- **Weaknesses**
  - The dam on the Kromme River would inundate the farm buildings and attenuated lands.
  - The displaced farmer and farm workers would lose their homes and their source of employment.
  - The yield of Brandvlei Dam would be reduced unless the pumping capacity at Papenkuils is augmented.

G19. The Olifants River Diversion

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

The information for this option is taken from the Western Cape System Analysis (1990s). The diversion would entail a 5 m high weir (1 million m^3 capacity) at the Keerom site on the Upper Olifants River. A tunnel of 34 m^3/s capacity would transfer winter water (120 million m^3/a) into the Berg WMA, where it would be conveyed via a new canal linking into the existing Twenty Four Rivers Canal, feeding into Voëlvlei Dam. Voëlvlei Dam would need to be raised if full advantage of the potential scheme yield were to be taken. A second pipeline from Voëlvlei Dam to Cape Town would also be required, as well as an additional water treatment works.

Furthermore, to recover the impact on the yield of Clanwilliam Dam, new sources of supply would be required from within the environmentally sensitive Doring River catchment. This would be necessary to ensure existing levels of supply to those irrigators downstream of the Olifants/Doring River confluence, currently supplied out of Clanwilliam Dam.

DWAF are currently investigating the feasibility of Raising Clanwilliam Dam. This appears a favourable option for augmenting the supply of water to irrigators in the Lower Olifants River catchment. If the Clanwilliam Dam-raising were to go ahead, the diversion of water out of the Upper Olifants River for transfer into the Berg WMA will become even less favourable.

3. SCHEME YIELD

The Olifants Diversion Scheme could yield about 90 million m^3/a after allowance for the EWRs (as estimated in the early 1990s). The yield would need to be revised once the Reserve for the Olifants River and estuary has been set.

4. UNIT REFERENCE VALUE

The WCSA determined a URV of R1,03/m^3 (1996) for a scheme yielding 90 million m^3/a. However, that cost estimate did not take the following into account:

- a potential new dam on the Doring River to offset the impact on the yield of Clanwilliam Dam;
- the raising of Voëlvlei Dam;
- the additional WTW infrastructure required at Voëlvlei Dam;
- water treatment costs;
- the cost of a second pipeline to Cape Town;

From the outset, this scheme does not appear favourable and as such no attempt has been made to update the URV, which would be significant.

5. ECOLOGICAL

The Olifants River Basin contains unique natural features that are important for conservation, such as the eight endemic fish species supported by the river system. The Ecological Importance and Sensitivity is rated as high, in the upper reaches of the Olifants River, in the

vicinity of the proposed weir. Abstraction of winter water from the Olifants River would have a negative effect on the riverine ecosystem, which is already stressed.

The weir would flood some 50 ha of natural vegetation, including partial inundation of the Olifants River gorge, an important feature because of its geological and biological links to Gondwanaland. The significance of this impact is considered high. Furthermore the weir is likely to obstruct the movement of endemic fish to the upper reaches of the Olifants River. The construction of the canals would also result in a loss of some agricultural land. The significance of this impact is considered to be low.

The Doorn River is currently free of impoundments and is therefore important for conservation. The proposed scheme would require a dam to built on the Doorn River to supply water to irrigators in the lower reaches of the Doring River, which is likely to affect some 300 ha of natural vegetation, the migration of endemic fish and the conservation status of the river. This impact is considered to be of medium to high significance.

The impacts associated with raising Voëlvlei Dam are described in Voëlvlei Augmentation Phase II and III (Option G6).

6. SOCIO-ECONOMIC

The Olifants River gorge is deemed to be of great importance due to its geological and biological links to Gondwanaland, and inundation of the gorge was deemed to be unacceptable in previous studies. Consequently, the significance of this impact is considered high.

The construction of the canal would impact on farmers through loss of land and by reducing access to parts of farms. This impact is deemed to be of low significance.

7. OTHER ISSUES

Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - Potential to supply significant additional yield.

- **Weaknesses**
  - Significant ecological impacts;
  - Likely to attract very significant public opposition;
  - High financial costs.