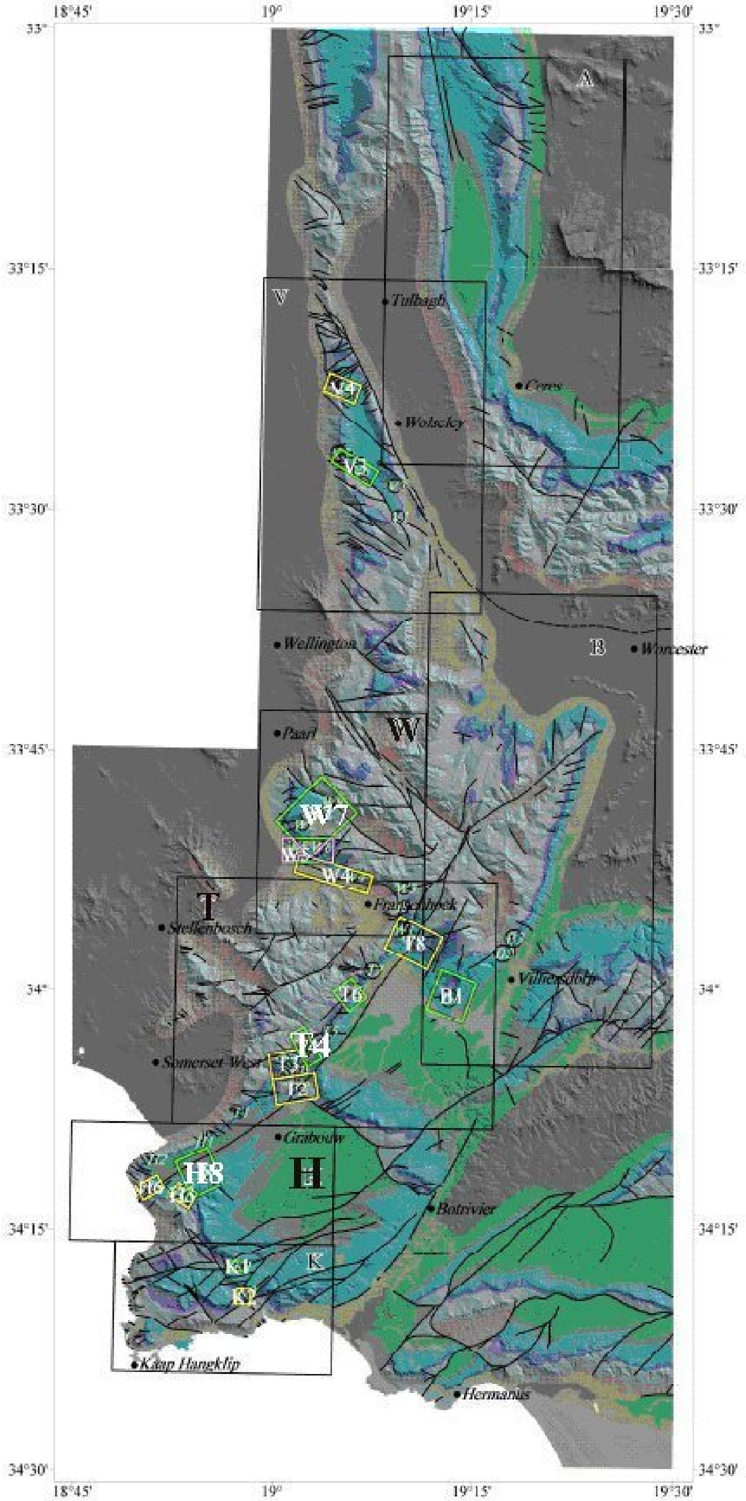
SECTION F

GROUNDWATER DEVELOPMENT OPTIONS

Table Mountain Group Aquifer Introduction

1. SCHEME LAYOUT



2. AVAILABLE INFORMATION

Most of the information on the TMG Aquifer and the various Target Site Areas (TSAs) was taken from: City of Cape Town, CMC Administration (2004). Report 1 : *Hydrogeology Report*. Prepared by the TMG Aquifer Alliance as part of the Preliminary Phase of the TMG Aquifer Feasibility Study and Pilot Project.

Further information regarding the scheme was taken from the following sources:

- City of Cape Town, CMC Administration (2004). Report 4. *Infrastructure Report*. Prepared by the TMG Aquifer Alliance as part of the Preliminary Phase of the TMG Aquifer Feasibility Study and Pilot Project.
- City of Cape Town, CMC Administration (2004). Report 5. *Environmental and Ecological Report*. Prepared by the TMG Aquifer Alliance as part of the Preliminary Phase of the TMG Aquifer Feasibility Study and Pilot Project.
- Ninham Shand. 2004. TMG Aquifer Feasibility Study and Pilot Project: Draft Scoping Report. Report Number 400396/3715.

The TMG Aquifer Feasibility Study identified a number of TSAs for further investigation. The three most promising sites, ranked with high priority and suggested for further investigation at this stage, are the TSAs T4, H8 and W7. These are described in more detail in the following sections of this document.

The other identified TSAs as well as possible targets outside of the study area of the TMG Aquifer Feasibility Study should be considered for future local groundwater supply and augmentation of bulk water supply to the WCWSS.

These further areas include :

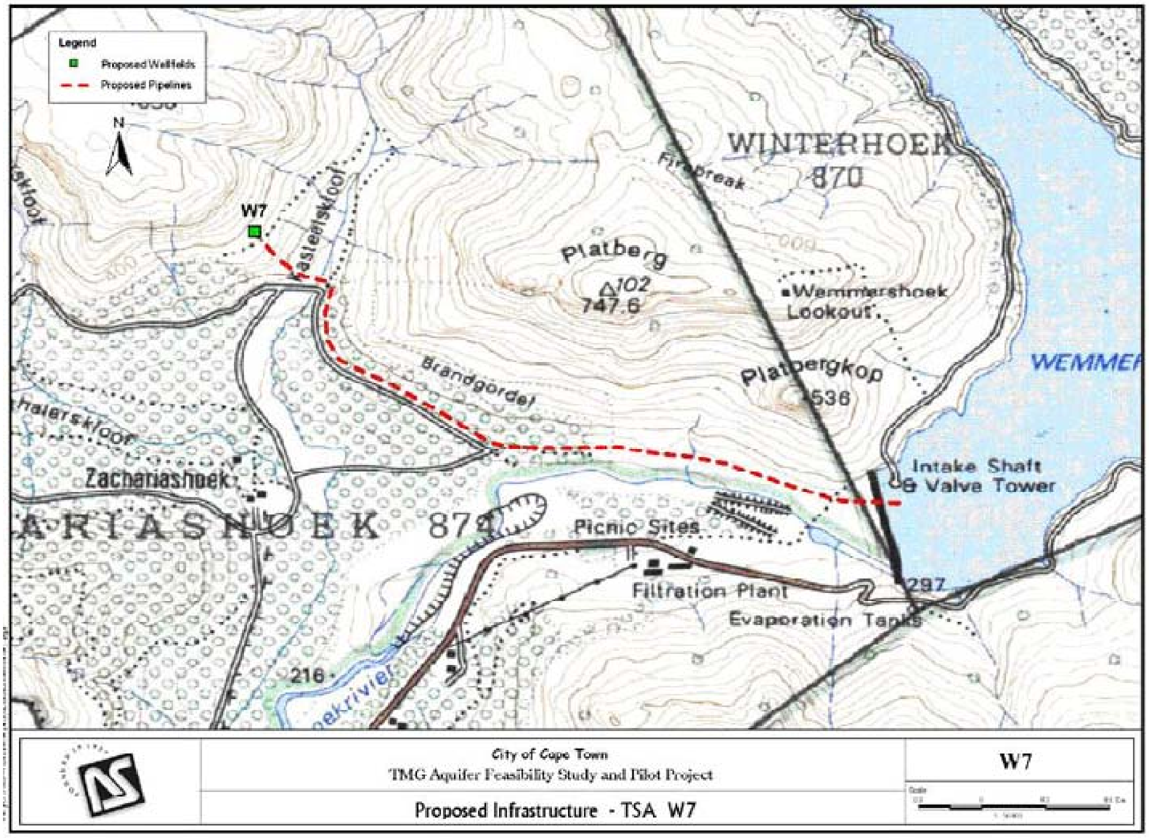
- Agter Witzenberg
- Hexriver Mountains
- Kogelberg
- Hottentots Holland Mountains
- Voëlvlei
- Brandvlei
- Piketberg
- Peninsula

3. SCHEME YIELD

Options outside of the TMG Aquifer Feasibility Study have not been investigated at a feasibility level. Consequently, no scheme yield was determined. However, from other studies a scheme yield of 10 – 20 million m^3/a can be inferred for each of the above schemes. No cost estimates for the different schemes outside of the TMG Aquifer Feasibility Study are currently available.

F1. Table Mountain Group Aquifer TSA W7 - Wemmershoek

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

Three main (W)NW/(E)SE fault structures cross Target Zone W. The La Motte Fault coincides roughly with the southern boundary of the Wemmershoek Mountains. Along the western segment of this boundary, the Skurweberg Formation is downthrown to the north by several hundred metres, and juxtaposed against the basement granite and basal strata of the Peninsula Formation. The Klein Drakenstein Fault downthrows the Skurweberg to the south against the same units along the western side of the Wemmershoek reservoir. The zone of faulting between the Du Toitskloof tunnel area and the upper portion of Stettynskloof, has a similar sense of displacement.

The potential scheme would comprise the following :

- Establishment of 13 production and several monitoring boreholes,
- Equipping the boreholes,
- Construction of a pipe network and pipeline to Wemmershoek Dam.

It is assumed that the existing water treatment facilities can accommodate the additional volume and different quality of the abstracted groundwater.

3. SCHEME YIELD

The scheme yield for the pilot phase is estimated to be 5 million m^3/a. The total yield of the wellfield will be defined after completion of the TMG Aquifer Feasibility Study and Pilot Project. However, it is expected that the final yield will be more than 20 million m^3/a.

4. UNIT REFERENCE VALUE

Currently only cost estimates for the pilot wellfield are available, as given below:

ITEM	Costs escalated to 2005 (@ 7% /a) (1)
	To Wemmershoek Dam
Capital cost (R million)	24.8
Annual operating cost (R million) (2)	1.2
NPV Cost (R million)	?
Unit Reference Value (R/m^3)	0.56

1) Updated URV using a Discount Rate of 8%.
2) Includes conveyance costs from wellfield to dam. Excludes water treatment costs.

5. ECOLOGICAL

The TSAs in Target Zone W – except for W1 and W4 – appear to have no rare species within their boundaries, except on the upper slope of Spitskop in W7.

There is also some concern that large-scale abstraction would affect flows in the Berg River. Some of these effects (in the Berg River) could be off-set through ecological flow releases from Wemmershoek Dam or the Berg River Dam.

The TMG Aquifer Alliance has developed a Monitoring Protocol as part of the TMG Feasibility Study to improve the understanding of potential impacts.

6. SOCIO-ECONOMIC

There are concerns from the public, conservation organisations and existing groundwater and surface water users regarding potential impacts.

7. OTHER ISSUES

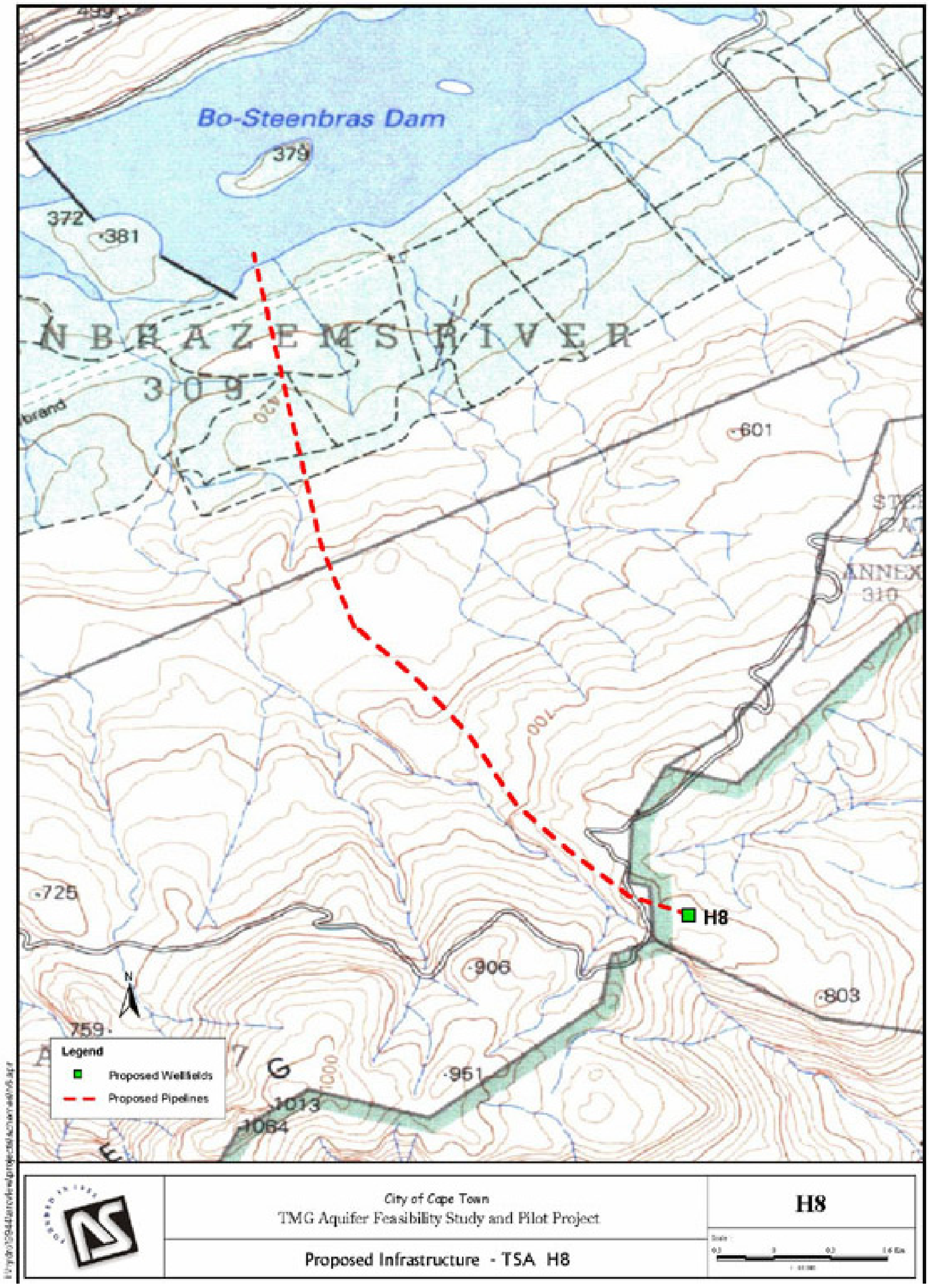
Specific strengths and weaknesses of the potential scheme include :

- **Strengths**
  - Evaporation-free storage within TMG Aquifer
  - High recharge percentage in TMG outcrops
  - High groundwater potential
  - Direct transfer of abstracted water into Wemmershoek Dam
  - Possibility for conjunctive use and optimisation of storage

- **Weaknesses**
  - Feasibility currently unknown.
  - There is a lack of knowledge regarding cost of development and operation, water quality and sustainable yield.
  - Ecological impacts largely unknown. There are concerns regarding possible short and/or long term impacts on seeps and river base flows.
  - Uncertainty regarding the requirement for additional water treatment facilities at Wemmershoek Dam.

F2. Table Mountain Group Aquifer TSA H8 – Steenbras Dam

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

The potential targets in TSA-H8 are both the Skurweberg Aquifer (shallow unconfined) and the Peninsula Aquifer (deep confined) within a moderate to steep, NNW-dipping limb of the Steenbras Syncline, possibly faulted along the main Steenbras-Brandvlei Megafault.

A NW/SE-striking fault, which controls the drainage lines, is one potential hydrotect within the unconfined to semi-confined Skurweberg Aquifer. Most of the exposed trace of the fault in the south-eastern part of H6 falls within an area of Skurweberg recharge, where the aquifer is effectively unconfined. The north-western end of the fault trace displaces the Skurweberg-Rietvlei contact, which is a probable aquitard above the more confined portion of the Skurweberg Aquifer within the main Steenbras Syncline.

The potential scheme would comprise the following :

- Establishment of 13 production and several monitoring boreholes,
- Equipping the boreholes,
- Construction of a pipe network and pipeline to the Upper Steenbras Dam.

It is assumed that the existing water treatment facilities can be extended to accommodate the additional volume and different quality of the abstracted groundwater.

3. SCHEME YIELD

The scheme yield for the pilot phase is estimated to be 5 million m^3/a. The total yield of the wellfield will be defined after completion of the TMG Aquifer Feasibility Study and Pilot Project. However, it is expected that the final yield will be more than 20 million m^3/a.

4. UNIT REFERENCE VALUE

Currently only cost estimates for the pilot wellfield are available, as given below :

ITEM	Costs escalated to 2005 (@ 7% /a) (1)
	To Steenbras Dam
Capital cost (R million)	25.9
Annual operating cost (R million) (2)	1.3
NPV Cost (R million)	?
Unit Reference Value (R/m^3)	0.59

1) Updated URV using a Discount Rate of 6%
2) Includes conveyance costs from wellfield to dam. Excludes water treatment costs.

5. ECOLOGICAL

The eastern shore of the Steenbras Dam is part of the core zone of the Kogelberg Biosphere Reserve, while the western shore is situated in the buffer zone. The ridge top that defines the Steenbras watershed (running roughly NE-SW to end at Kogelberg Peak and partly in TSA H3 and H8) has at least six well-known high altitude rare species, many of which are associated with peaty areas on the upper slopes.

6. SOCIO-ECONOMIC

There are concerns from the public, conservation organisations and existing groundwater and surface water users regarding potential impacts.

7. OTHER ISSUES

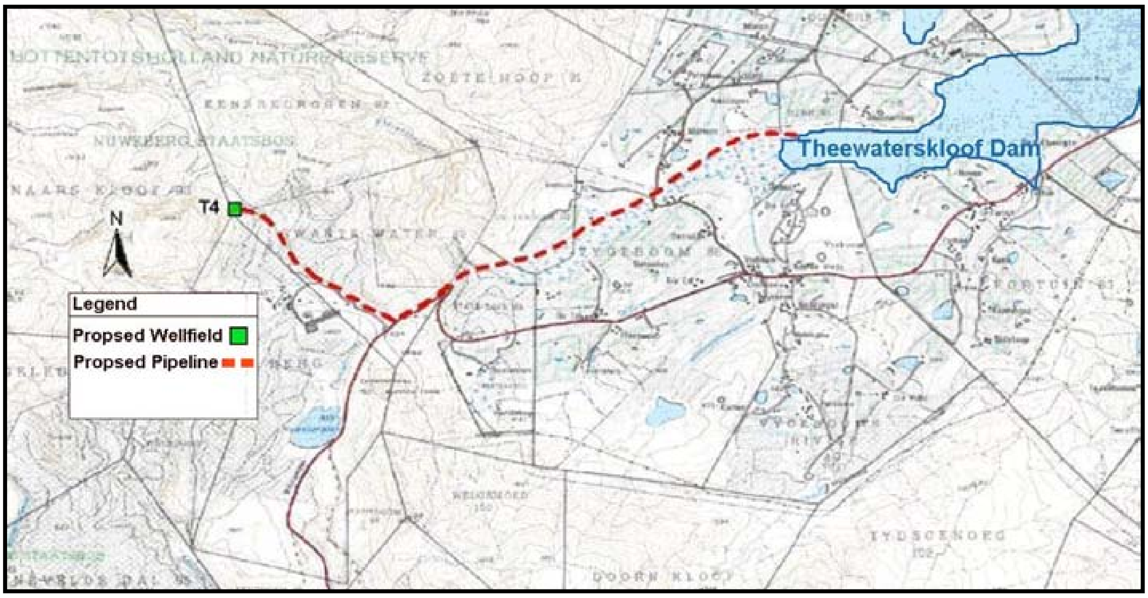
Specific strengths and weaknesses of the scheme include:

- **Strengths**
    - Evaporation free storage within the TMG Aquifer
    - High recharge percentage in TMG outcrops
    - High groundwater potential
    - Direct transfer of abstracted water into Steenbras Dam
    - Possibility for conjunctive use and optimisation of storage

- **Weaknesses**
    - Feasibility currently unknown
    - Environmental impacts unknown
    - Potentially a high level of public opposition due to the location in the buffer zone of the Kogelberg Biosphere Reserve.
    - The cost of water treatment is likely to be higher than from most surface water sources.

F3. Table Mountain Group Aquifer TSA T4 –Theewaterskloof

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

This area contains a convenient transect across the Steenbras-Brandvlei Megafault (SBM), where it crosses the upper Palmiet River close to the Palmiet-Riviersonderend catchment divide. The main target feature is the deep Peninsula Aquifer in the western footwall of the SBM. Production wells and/or aquifer monitoring opportunities also exist in the eastern SBM hanging wall, and in the exposed Peninsula of the northern recharge zone.

Successful groundwater development in the T4 area could naturally extend over time into the adjacent T3 target area. It is also relevant to note that the location of T4 close to the Palmiet-Riviersonderend catchment divide, provides flexibility to the future direction of infrastructure development. Depending upon the success of groundwater exploration results during the present project, the potential for a hydrogeologically motivated tunnel or wide-diameter horizontal directional drilling, along parts of the SBM between T4 and T2 and/or between T4 and T5, is not beyond speculation.

The scheme would comprise the following :

- Establishment of 13 production and several monitoring boreholes,
- Equipping the boreholes,
- Construction of a pipe network and pipeline to Theewaterskloof Dam.

It is assumed that the existing water treatment facilities can accommodate the additional volume and different quality of the abstracted groundwater.

3. SCHEME YIELD

The scheme yield for the pilot phase is estimated to be 5 million m^3/a. The total yield of the wellfield will be defined after completion of the TMG Aquifer Feasibility Study and Pilot Project. However, it is expected that the final yield will be more than 20 million m^3/a.

4. UNIT REFERENCE VALUE

Currently only cost estimations for the pilot wellfield are available, as given below :

ITEM	Costs escalated to 2005 (@ 7% /a) (1)
	To Theewaterskloof Dam
Capital cost (R million)	34.7
Annual operating cost (R million) (2)	1.3
NPV Cost (R million)	?
Unit Reference Value (R/m^3)	0.71

1) Updated URV using a Discount Rate of 8%
2) Includes conveyance costs from wellfield to dam. Excludes water treatment costs.

5. ECOLOGICAL

It can be expected that a number of rare species, associated with wetlands and shale layers, could be found in the TSA.

Most of the potential drill sites are situated on the border between the Hottentots Holland Nature Reserve and agricultural land and forestry. In the existing forestry areas possible drilling effects can easily be mitigated. Existing forest roads and tracks can be used for access. If the borehole sites are required to be located in the nature reserves, impacts due to access and drilling platform preparation can be expected.

Most production and/or monitoring boreholes in the T4 area can be sited on or close to existing forestry road access.

There is some concern that, if large-scale abstraction were to take place, the baseflow in the Palmiet River would be affected. However, these effects could be off-set by the fact that the Palmiet River is already heavily managed and impacted by abstraction, and there are several dams on the system, which can be used to regulate flow, and in particular meet the Ecological Reserve in the lower Palmiet River, where the river is in the best ecological condition.

6. SOCIO-ECONOMIC

There are concerns from the public, conservation organisations and existing groundwater and surface water users regarding potential impacts.

7. OTHER ISSUES

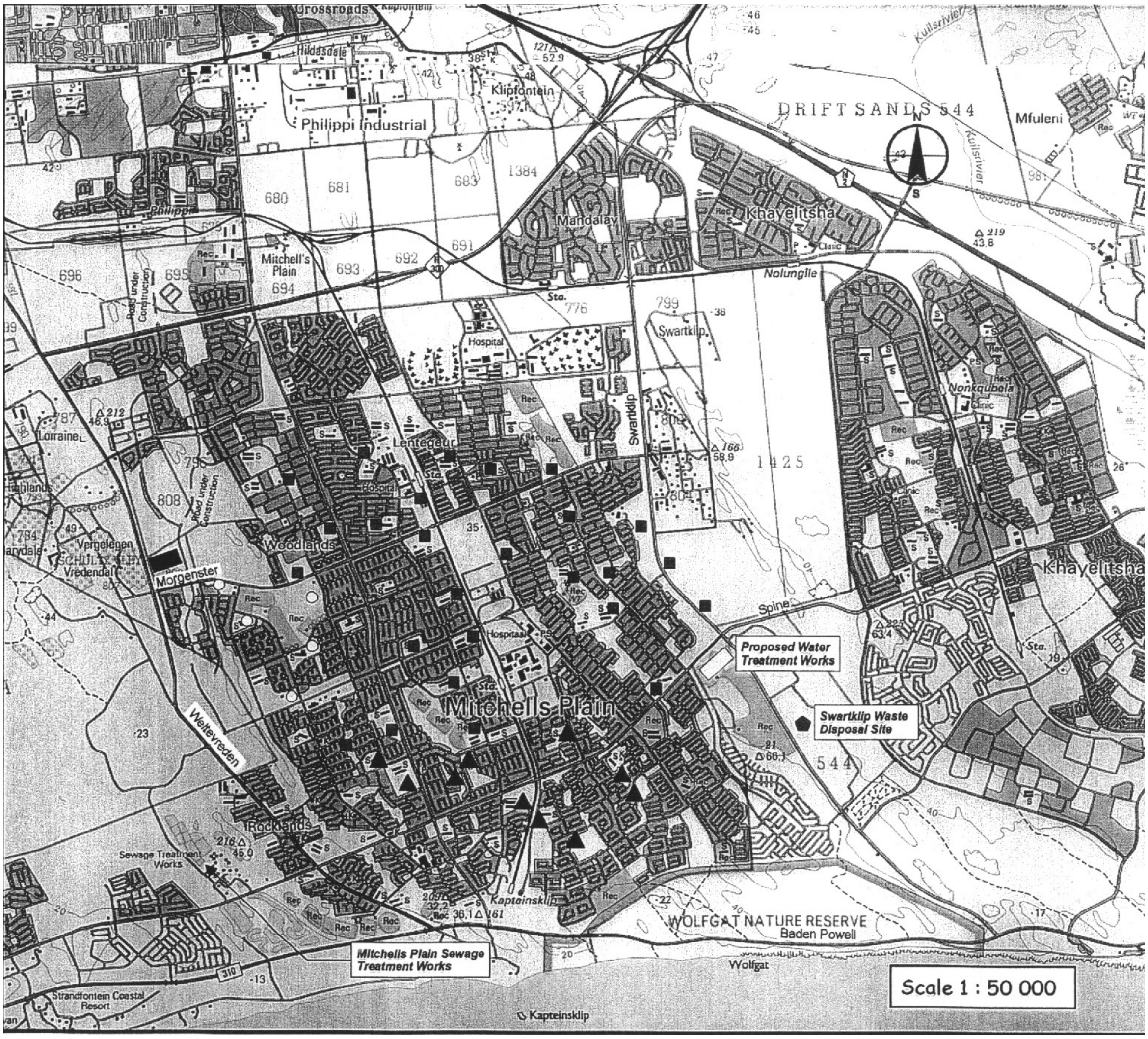
Specific strengths and weaknesses of the scheme include:

- **Strengths**
  - Evaporation-free storage within TMG Aquifer
  - High recharge percentage in TMG outcrops
  - High groundwater potential
  - Direct transfer of abstracted water into Theewaterskloof Dam
  - Possibility for conjunctive use and optimisation of storage

- **Weaknesses**
  - Feasibility currently unknown
  - Environmental impacts unknown
  - The cost of water treatment is likely to be higher than from most surface water sources.
  - Potentially a high level of public opposition due to the location in or adjacent to the Hottenhots Holland Nature Reserve.

F4. Cape Flats Aquifer

1. SCHEME LAYOUT



2. SCHEME DESCRIPTION

Most of the information was taken from Fraser, L, Hay, R, Kleynhans, S H, Luger, M, Weaver, J. (October 2001). *Integrated Water Resource Planning Study – Cape Flats Aquifer,* Ninham Shand. Further information regarding the scheme was taken from the following sources :

- Fraser, L and Weaver, J. (2000). *Cape Flats Aquifer: bulk water for Cape Town now*, Council for Scientific and Industrial Research (CSIR).
- Fraser, L and Weaver, J. (2000). *Groundwater impact scoping for the Cape Flats Aquifer*, Council for Scientific and Industrial Research (CSIR).
- Vandoolaeghe, M A C. (1990). *The Cape Flats Aquifer*.

The Cape Flats Aquifer (CFA) Scheme would comprise the following :

- Establishment of production and monitoring boreholes,
- Equipping the boreholes,

- Construction of a buried pipe network,
- Construction of a 50 Mℓ/d on-site lime softening plant,
- Construction of a 25 Mℓ buffer reservoir, and
- The construction of a pump station to pump water from the buffer reservoir into the distribution network.

Two possible layouts of the scheme could be implemented. However, only one is described in this document due to the other's proximity to the Swartklip Waste Site and Mitchell's Plain Waste Water Treatment Works. In the option described, all production boreholes are sited within public open spaces, parks and school grounds. The boreholes in the eastern zone would be in the north-eastern corner of the high yielding zone. These boreholes would lie upstream of the existing Swartklip Waste Site and also to the east of Swartklip Products. Boreholes in the western zone would be located east, west and north of the Mitchell's Plain WWTW.

The boreholes also need to be at least 500m from the Philippi agricultural area to reduce the impact of pumping.

Typical groundwater from the CFA is high in alkalinity, hardness, salts and iron and is over-saturated in calcium carbonate. Typical treatment required would be :

- Reduction of turbidity,
- Iron removal,
- Oxidation of ammonia,
- Disinfection,
- Reduction in hardness,
- Fluoridation.

Both schemes mentioned above comprise the construction of either an on-site or tertiary 50 Mℓ/d water treatment works.

3. SCHEME YIELD

The scheme yield is estimated to be 18 million m^3/a.

4. UNIT REFERENCE VALUE

Based on a yield of 18 million m^3/a, the URV of the scheme is as follows :

ITEM	Escalated to 2005 (@ 7% /a) [(1)]
Capital cost (R million)	52,9
Annual operating cost (R million) [(2)]	6,2
NPV Cost (R million)	127,5
Unit Reference Value (R/m^3)	0.58

1) URV as given in original cost estimation (2001)
2) Excludes water treatment costs.

5. ECOLOGICAL

River systems

Rivers in the vicinity of the proposed scheme include the Kuils River, Lotus River and Salt River. The Kuils River is the most significant and contributes approximately 0.5 million m^3/a of recharge to the aquifer. The river is upstream of the proposed scheme, which is unlikely to impact on the river.

Seasonal vleis

Several seasonal vleis are found in the Swartklip area. The extent of the cone of depression due to pumping is not expected to extend to more than 1 000 m from the wellfield. There are no seasonal vleis identified of notable ecological importance except for those in the Swartklip area.

Permanent vleis

Zeekoevlei and Rondevlei are important and are situated some 7 km to the west of the proposed scheme. These permanent vleis are located outside the cone of depression and thus are unlikely to be impacted by abstraction.

Marine Ecosystem

The *Anaulis australis* occurring in the surf zone of False Bay are reliant on dissolved silica. The silica is derived from groundwater that is discharged into False Bay. The populations of these diatoms are unnaturally high due to the WWTW in the area. A slight decrease in groundwater discharge will have a small effect on their numbers.

Terrestrial Systems

Most of the Cape Flats is covered with alien vegetation. Patches of Sandplain Fynbos, Strandveld and Renosterveld vegetation are found but are not likely to be reliant on groundwater.

6. SOCIO-ECONOMIC

Philippi/Weltevreden Agricultural areas

The farming community is solely dependent on groundwater for irrigation. Abstraction from the wellfield could result in a lowering of the water table in the agricultural area. This could negatively impact on the availability of groundwater. Studies done in the agricultural area indicate that farmers are already over-exploiting the aquifer, which has led to a decrease in yield, with boreholes having to be drilled ever deeper. Abstraction from the proposed wellfield could create the perception that it is affecting the water supply in the Philippi/Weltevreden area.

Human Health

Groundwater abstracted from the CFA will be treated to the same standards as current domestic supply. Possible pollution from solid waste disposal sites and WWTW needs to be monitored. Over-abstraction can lead to seawater intrusion. Proper monitoring and management would reduce the impacts to a negligible risk.

Public acceptability of scheme

The community's acceptability of using groundwater for domestic supply could be significant.

Private Domestic/Garden irrigation
A lowering of the water table will affect local water users, especially wellpoint users. There is a need to conduct a hydrocensus to establish the current extent for domestic/garden irrigation of local groundwater use.

Land subsidence
The lowering of groundwater levels may lead to the compaction of dry sand and the dewatering of clay. This might cause land subsidence, resulting in the possible cracking of foundations to existing buildings. However, this usually happens in deep aquifers and with a lowering of the water table of tens of meters. Land subsidence is not expected to occur and there was no evidence of subsidence during the pilot scheme.

Visual impacts
Infrastructure that may have a visual impact include boreholes, pipelines and the water treatment works. Pipelines will be buried underground and the boreholes will be covered with lockable manholes. The design of the water treatment works needs to consider the visual impact thereof.

Employment opportunities
Approximately 30-40 temporary jobs will be created during the two-year construction phase with only 2-3 long-term jobs for management and maintenance of the wellfield.

7. OTHER ISSUES

Specific strengths and weaknesses of the scheme include:

- **Strengths**
  - 18 million m^3/a yield
  - Minimum environmental problems expected
  - Additional treatment plant would increase CCT treatment capacity
  - Low distribution costs
  - It is possible to abstract the 18 million m^3/a during summer only

- **Weaknesses**
  - Possible pollution
  - Public acceptability
  - No calibrated flow model available

F5. West Coast Aquifer

1. SCHEME LAYOUT

2. SCHEME DESCRIPTION

Several aquifers have been identified in the northern part of the Berg River Catchment between Atlantis and Yzerfontein. These aquifers include the following :

- Adamboerskraal Aquifer
- Langebaan Road Aquifer
- Elandsfontyn Aquifer
- Grootwater Aquifer
- Atlantis: Witsand and Silwerstroom Aquifers

Some of these aquifers, particularly the Langebaan Road and the Elandsfontyn aquifers, have been included in the Saldanha Underground Government Water Control Area. The areas were declared with the intention to preserve these resources for the anticipated industrialisation of the area and expected resultant increased water demand. The Groundwater Report of DWAF West Coast Study provides the most recent information on the West Coast aquifers.

Adamboerskraal Aquifer

This aquifer is situated on the northern bank of the Berg River, approximately 30 km to the north-east of Vredenburg. The short-term and long-term exploitation potentials are estimated at 2,4 million m^3/a and 16 million m^3/a, respectively. The quality of the water is reported to be good. The aquifer was not included in the proclaimed Saldanha Underground Government Water Scheme. It lies adjacent to the ecologically sensitive Berg River estuary at Velddrif.

Langebaan Road Aquifer

The Langebaan Road Aquifer occurs in the Cenozoic deposits situated in the area between the Berg River, Langebaan Lagoon, Darling and Hopefield. Recent studies indicate that the aquifer has a maximum yield of 2,8 million m^3/a with a safe yield of 1,8 million m^3/a. The aquifer was developed in 1999 to partially meet the future water demands of the Berg River - Saldanha System, with an annual allocation of 1,4 million m^3/a. Infrastructure for possible increased future abstraction was installed.

Elandsfontein Aquifer

The Elandsfontyn Primary Aquifer Unit is situated south of the Langebaan Road Primary Aquifer Unit and is connected to it through a low flow boundary stretching from Langebaan to Hopefield. The short-term and long-term exploitation potential of the aquifer have been determined to be 4,80 million m^3/a and 3,20 million m^3/a, respectively. The aquifer is situated adjacent to the ecologically sensitive Langebaan Lagoon, where subterranean outflows from the aquifer occur. This source is potentially extremely environmentally sensitive.

Grootwater Aquifer

The Grootwater Primary Aquifer Unit occurs in the unconsolidated coastal sediments between Yzerfontein in the north and the Modder River to the south. It was proclaimed as a Subterranean Government Water Control Area in 1990. The allocation to properties within the Subterranean Water Control Area totals almost 3 million m^3/a. The exploitation potential of the Grootwater Aquifer was estimated between 2,6 and 3,8 million m^3/a.

Atlantis Aquifer

The Atlantis Aquifer supplies the towns of Atlantis and Mamre and is situated within the Blaauwberg Municipality. Water abstraction from the Atlantis Aquifer system is concentrated from two wellfields, namely, Witzand and Silwerstroom (Fleisher, 1990) and is augmented by artificial recharge using urban storm water (Fleisher and Eskes, 1992). The primary aquifer comprises essentially consolidated sand deposits, overlying greywackes and shales of the Malmesbury Group (Parsons *et al,* 1999). The general groundwater flow is towards the sea and some discharge occurs through springs.

The potential schemes for the West Coast aquifers would involve :

- local abstraction and use for local communities (i.e. domestic and agricultural use).
- artificially recharging the aquifers with treated storm water and/or surplus surface water (i.e. winter floods).

3. SCHEME YIELD

The long-term additional yields of the different aquifers are estimated to be :

- Adamboerskraal Aquifer – 2,4 million m^3/a
- Langebaan Road Aquifer – 2,8 million m^3/a
- Elandsfontyn Aquifer – 4,8 million m^3/a
- Grootwater Aquifer – 3,8 million m^3/a
- Atlantis: Witsand and Silwerstroom Aquifers – fully exploited

4. UNIT REFERENCE VALUE

The cost estimate is based on the complete scheme, including the above-mentioned aquifers (excluding Atlantis). The URV is based on a 1994 cost estimate, escalated at 7% per annum to date.

ITEM	Costs escalated to 2005 (@ 7% /a) [(1)]
Capital cost (R million)	703.02
Annual operating cost (R million) [(2)]	22.94
NPV Cost (R million)	
Unit Reference Value (R/m^3)	0.6

1) URV as stated in original cost estimation (1994)
2) Excludes water treatment costs.

The URV needs to be re-determined as the potential yields presented above are significantly less than the yields used in the 1994 cost estimate.

5. ECOLOGICAL

The development and utilisation of the Atlantis Aquifer provides an indication of the ecological impacts that can arise from the development of similar primary aquifers.

Atlantis Aquifer

Groundwater levels in the vicinity of the Witsands and Silwerstroom areas have dropped 5-7 m over a period of 20 years, indications are that this has stabilised (Parsons *et al,* 1999). This gradual lowering of the water level has not, however, resulted in any apparent negative ecological impacts.

No visible signs of any impact caused by groundwater abstraction are currently visible. Silwerstroom spring is still flowing in spite of continual groundwater abstraction from the wellfield for the past 22 years (Parsons *et al,* 1999). Prolonged pumping in the Silwerstroom wellfield has, however, affected the natural flow regime of the aquifer and has caused an increase in salinity in the pumped water.

Interference with the natural regime of the Atlantis aquifer occurs on the basis of :

1. artificial recharge of the aquifer through urban storm water, particularly at the Witsand area
2. diversion of inferior quality water into the coastal region of the aquifer, and
3. the percolation of water from the maturation ponds situated at the Atlantis waste water treatment works into the aquifer.

The maturation ponds located at the Atlantis WWTW extends over an area of 50 000 - 70 000 m^2 (Fleisher and Hon, 1991). Although lined, unknown quantities of water percolate out of the ponds and can be seen in seepages below the ponds and flooding of low-lying land nearby. Chemical quality of the percolated water has, however, been found to be better than the water from the aquifer (Fleisher and Hon, 1991).

Brackish water occurs in the area of the Silwerstroom wellfield (north and north east), the southern regions of the Atlantis aquifer and downstream of the coastal recharge areas. Salinity levels do not yet exceed the 4 000 mg/ℓ Cl established level.

The thin thickness of the aquifers along with the fine grain lithology of the aquifer indicates that unfavourable conditions for water abstraction exist for large sections of the aquifer (Fleisher and Hon, 1991). Boreholes situated within these areas are relatively low yielding. Special care will be required in borehole design and gravel packing.

Other West Coast Aquifers
The CSIR has investigated the impacts that exploitation of the Langebaan Road Aquifer will have on groundwater seepage which may support plant communities next to the Berg River. Similar environmental concerns have been raised about the exploitation of the other West Coast aquifers.

6. SOCIO-ECONOMIC

Associated costs
The thin thickness of the aquifers along with the fine grain lithology of the aquifer indicates that unfavourable conditions for water abstraction exist for large sections of the aquifer (Fleisher and Hon, 1991). Boreholes situated within these areas are relatively low yielding. Special care will be required in borehole design and gravel packing.

Health impacts
No health hazards will be involved in the utilisation of groundwater by pumping it at a distance beyond 70 m from the maturation ponds (Fleisher and Hon, 1991). However, the quality of some of the aquifer formation contains water of high salinity or high chloride levels not suitable for potable use.

Political and institutional considerations

Future abstraction will have to be distributed correctly to include factors such as the thin thickness of the aquifer, the decline of the groundwater level at the Witsand aquifer and the further development of the wellfields. If not, the local depression in Witsand will deepen, resulting in decreasing yields in the individual production boreholes.

7. STRATEGIC ISSUES

Specific strengths and weaknesses include :

- **Strengths**
  - o Potential to extend the wellfields to exploit the full potential of groundwater abstraction, particularly for the Witsand area;
  - o Conjunctive use of groundwater and surface water;
  - o Artificial recharge with surface water surplus (winter floods) to enhance groundwater potential;
  - o Wellfield model can serve as a tool for optimising and subsequent management of the wellfields.

- **Weaknesses**
  - o Decline of water levels in the semi-confined aquifer will have an impact on the yields of individual boreholes;
  - o A natural constraint exists within the thin thickness of the aquifer;
  - o Outdated URV estimates.

F6. Newlands Aquifer

1. SCHEME LAYOUT

Refer to locality maps in Introduction to this document.

2. SCHEME DESCRIPTION

Most of the information was taken from :

- City of Cape Town (1992). Western Cape System Analysis: *Utilisation of Less Conventional Water Sources*. Ninham Shand.
- Western Cape System Analysis. Evaluation of the Options Conference, 28 to 30 April 1996. Information Pack for Delegates.
- City of Cape Town (1994). Western Cape System Analysis: *Options for the Supply of Water in the Western Cape*. Ninham Shand.
- *Water Resources and Water Resource Planning*: City of Cape Town. 2001.

Several springs exist in the Newlands area. Most of these springs are privately used. One spring is currently used by the City of Cape Town (1.5 million m^3/a). It is proposed to use the aquifer by means of boreholes and abstract up to 10 million m^3/a of groundwater.

The scheme would comprise the following :

- Establishment of production and monitoring boreholes,
- Equipping the boreholes,
- Construction of a buried pipe network.

3. SCHEME YIELD

The potential scheme yield is estimated to be 10 million m^3/a, while the safe yield was previously set at 7 million m^3/a.

4. UNIT REFERENCE VALUE

ITEM	Escalated to 2005 (@ 7% /a) (1)
Capital cost (R million)	5.51
Annual operating cost (R million) (2)	0.551
NPV Cost (R million)	?
Unit Reference Value (R/m^3)	0.53

1) URV as given in 1996 for 7 million m^3/a
2) Excludes water treatment costs.

5. ECOLOGICAL

Baseflow to the Liesbeeck River could be reduced with accompanying impacts on aquatic ecosystems. The lowering of the water table could impact on the natural environment.

6. SOCIO-ECONOMIC

Lowering of the water table will affect local water users, especially wellpoint users. There is a need to conduct a hydrocensus to establish the extent of local groundwater use in this area.

7. OTHER ISSUES

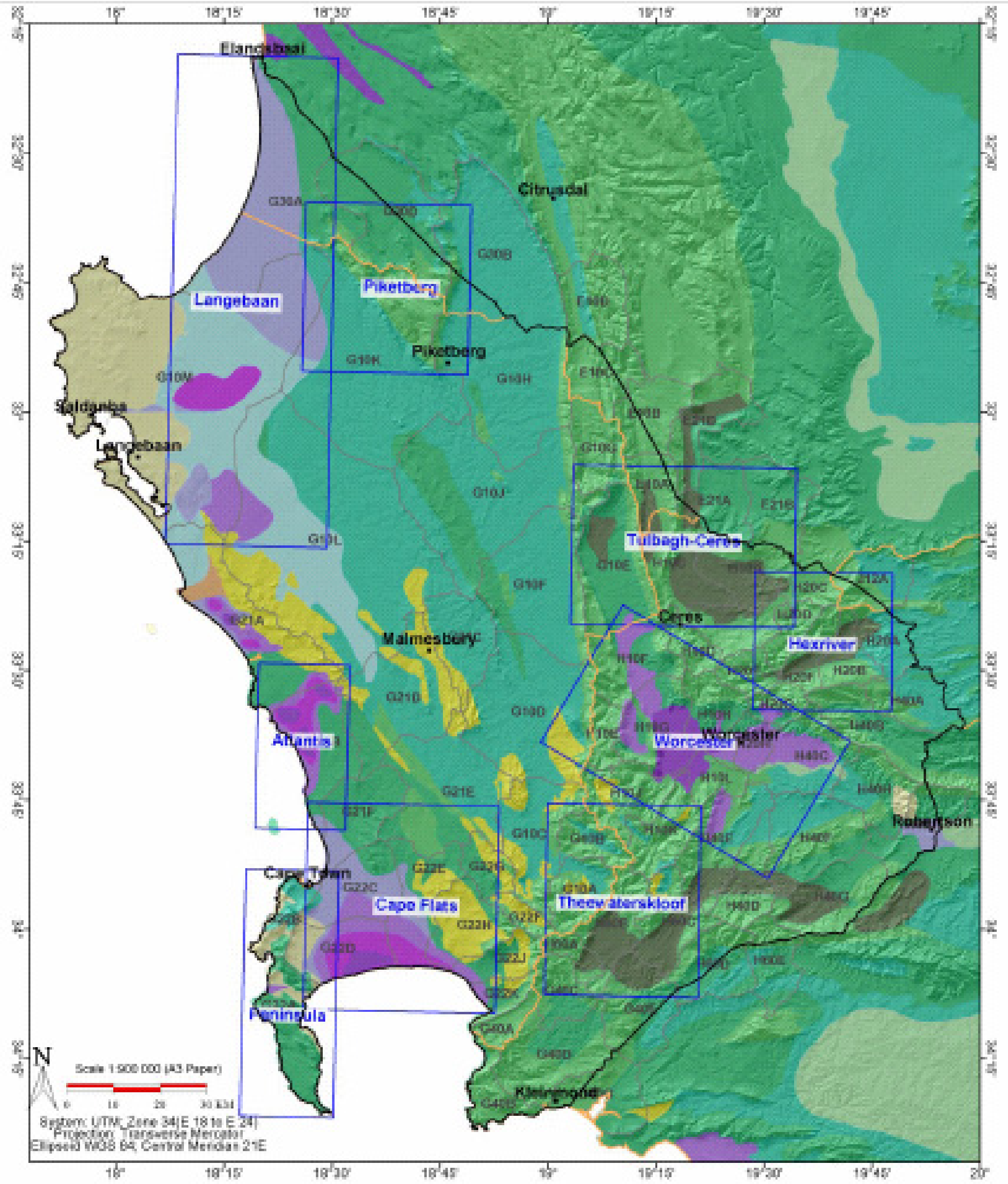
Specific strengths and weaknesses of the scheme include :

- **Strengths**
  - Financially attractive
  - Located within users location will save on distribution costs

- **Weaknesses**
  - Small yield
  - Possible operational difficulties

F7. Conjunctive use options

1. SCHEME LAYOUT



2. SCHEME DESCRIPTIONS

Conjunctive use can be grouped into two main options :

- Injection of surplus surface water into aquifers for evaporation free storage and later use (called Aquifer Storage and Recovery [ASR] scheme); and
- Pumping of groundwater into surface water storage facilities in times of drought, or to supplement the surface water during periods of shortfall.

The following table summarises the possible conjunctive use options for the various aquifers in the study area.

Aquifer	Aquifer interaction	SW - GW interaction	Potential / Scenarios
Coastal Aquifers			
Cape Flats	Partly fed by TMG Aquifer, via Newlands Aquifer	Baseflow, vleis	Flood management; Blending with surface water
Atlantis	Underlying bedrock	Baseflow	Artificial recharge, ASR; Supply
Darling	Underlying bedrock	Baseflow	Artificial recharge, ASR; Supply
Langebaan	Underlying bedrock and TMG	Baseflow, wetlands	Artificial recharge, ASR; Supply
TMG Aquifers			
Theewaterskloof	Local alluvium	Springs and gaining streams (via alluvium)	Augmentation; Conjunctive use with Theewaterskloof Dam or Wemmershoek Dam
Tulbagh – Ceres	Local alluvium	Springs and gaining streams (via alluvium)	Current use; Conjunctive use with transfer scheme
Hexriver Mtn	Local alluvium	Springs and gaining streams (via alluvium)	Current use; Conjunctive use with farm dams
Worcester	Underlying TMG	Baseflow of Upper Breede River	Augmentation; Conjunctive use with Brandvlei Dam
Peninsula	Local alluvium and outflow to Newlands springs	Springs	Augmentation; Conjunctive use with dams on Table Mountain and Simon's Town
Piketberg	Connection to Langebaan / Die Vlei Aquifer	Springs	Conjunctive use with farm dams; Augmentation to Aurora

3. SCHEME YIELD

These schemes are not investigated further and therefore, no scheme yield was established.

4. UNIT REFERENCE VALUE

No cost estimation for the schemes is currently available.

5. ECOLOGICAL

Not investigated.

6. SOCIO-ECONOMIC

Not determined.

7. OTHER ISSUES

Specific strengths and weaknesses include :

- **Strengths**
  - Conjunctive use of surface water and groundwater to optimise water demand and supply
  - Evaporation free storage within the subsurface

- **Weaknesses**
  - Currently not investigated