Water as a Constraint on Economic Development

2014-2015 Research Project Progress Report

March 2015

Author:
Helen Seyler

Prepared for:
Department of Economic Development and Tourism
Western Cape Government

Contact:
Chris Millson
Project Manager
chris@green-cape.co.za

Signature page

For the GreenCape Sector Development Agency

Name & Surname: Lauren Basson
Position: Strategic Initiatives Manager

________________________ ________________________

Signature: **Date:**

Name & Surname: Evan Rice
Position: Chief Executive Officer

________________________ ________________________

Signature: **Date:**

Acknowledgements

This project is funded by the Western Cape Department of Economic Development and Tourism. GreenCape would like to acknowledge several groups and individuals who have supported the programme, contributed to critical thinking, or contributed data and information to the programme:

- DED&T including Jim Petrie and Herman Jonker
- Individuals from industry in Saldanha including the IDZ, Arcelor-Mittal, Duferco, and Tronox.
- DEA&DP including Annabel Horn, Joy Leaner, Taryn Dreyer, and Penny Price (ex DEA&DP)
- Isa Thompson (DWS) and Nik Faasen (WCDM)
- SBM including Gavin Williams, Nazeema Durant, and Frank Pronk
- Mark New and Stephanie Midgeley of UCT
- Hannah Baleta and Guy Pegram of Pegasys
- Karen Goldberg and Judy Sikuza of Reos partners
- Nisbert Chimboza, for contributions to the project

Contents

Figures

Tables

Boxes

Acronyms

CBA	Cost – benefit analysis
CCT	City of Cape Town
BRIP	Berg River Improvement Plan
DM	District Municipality
DED&T	Department of Economic Development & Tourism (PGWC)
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAS	Elandsfontein Aquifer System
GDP	Gross domestic product
HEM	Hydro-economic model
IDP	Integrated development plan
IDZ	Industrial Development Zone
LM	Local Municipality
LRAS	Langebaan Road Aquifer System
m^3/a	cubic metres per year (water flow volume, 1 cubic metre = 1000 litres)
Mm^3/a	million cubic metres per year
MAR	mean annual runoff
n/s	not supplied
NDP	National Development Plan
PERO	Provincial Economic Review and Outlook
PGWC	Provincial Government of the Western Cape
RBIG	Regional Bulk Infrastructure Grant
SIC	Standard Industrial Code
SBM	Saldanha Bay Local Municipality
TCTA	Trans-Caledon Tunnel Authority
URV	Unit Reference Value
WARMS	Water Authorisation Registration Management System
WCDM	West Coast District Municipality
WC/WDM	Water Conservation and Demand Management
WCWSS	Western Cape Water Supply System
WEN	Water Exchange Network
WMA	Water Management Area
WRC	Water Research Commission
WWTW	Waste water treatment works
WSA	Water Services Authority
WSP	Water Services Provider

Report Status

Report Title	Water As a Constraint on Economic Development: 2014-2015 Research Project Progress Report
Author(s)	Helen Seyler, Chris Millson
Reviewer(s)	Lauren Basson
Status	Final Draft
This report should be referenced as:	GreenCape, 2015. Water As a Constraint on Economic Development: 2014-2015 Research Project Progress Report. Compiled by H. Seyler, and C. Millson.

1 Background

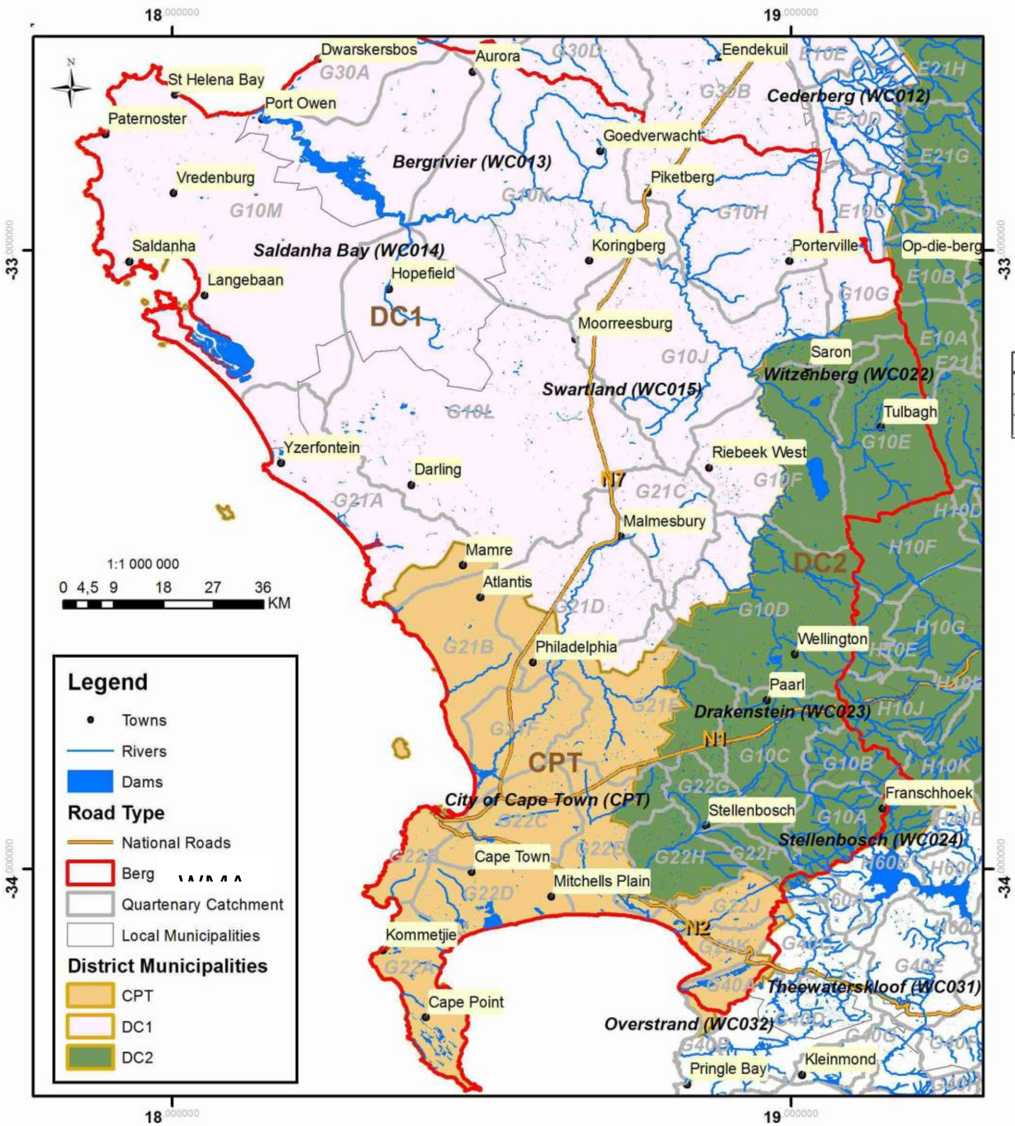
1.1 Project initiation

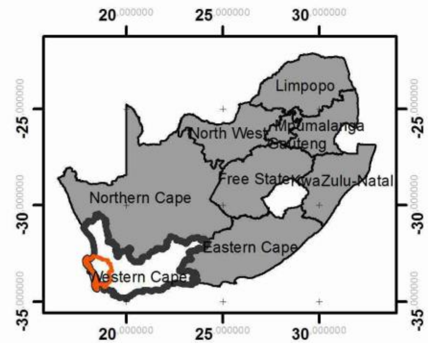
GreenCape is a Special Purpose Vehicle established by South Africa's Western Cape Government with the mandate to support the development of the Green Economy in the Western Cape. Under this mandate GreenCape operates 'sector desks' and undertakes research projects to provide strategic support to various sectors key in the development of a green economy.

The project "Water as a Constraint on Economic Development" commenced in 2013, and received initial funding from the Provincial Department of Economic Development and Tourism (DED&T), for the financial years 2013-2014 and 2014-2015.

The motivation for project establishment was the acknowledgement that the Western Cape is a water-stressed region, and that in order to plan for economic growth, an understanding of how much water is used by the region's economy, and where and how it is used, is required. A particular interest area for the establishment of the project was water requirements and availability for proposed development in Saldanha Bay, and whether and how water pricing could be a mechanism to realise water efficiency. It was recognised that work should commence in a phased approach in order to develop an understanding of water consumption across the economy, and how this consumption is linked to measures of economic productivity. It was also recognized that this understanding would facilitate the identification of critical constraints, and hence the design and ultimate implementation of interventions to alleviate these. Potential constraints include the impacts of water availability and water quality on industry, as well as the industry impacts (in terms of reducing both water availability and quality) on water resources.

Work to date (having successfully completed the first two years of a five year programme) has laid the foundation for further detailed work in this area, to be completed over the next three years. Broadly speaking, the project's aim is to support decision-makers in the field of water resources planning at local and provincial government level, as well as the current and proposed future industry in Saldanha Bay.





DM Code	Name
CPT	City of Cape Town Metropolitan Municipality
DC1	West Coast District Municipality
DC2	Cape Winelands District Municipality

Location: The project focusses on Saldanha Bay, located on the West Coast of South Africa, 140 km north of Cape Town.

Water setting: Saldanha is a coastal town within the Berg Catchment. The Berg River is a heavily utilised system with major transfers into it from the neighbouring Breede River Catchment, and transfers out of it to supply settlements west of the actual river catchment (such as Cape Town). The river is managed over an area similar to that which is serves, an area termed the Berg Water Management Area.

Political Setting: Saldanha Bay town is within Saldanha Bay Local municipality, within the West Coast District Municipality, in the Western Cape Province of South Africa.

Figure 1-1 Location map and details of Saldanha

1.2 Programme Overview

The following key questions broadly shaped an initial scoping assessment of existing work in water resources and economic development in Saldanha Bay, and the wider Berg River Catchment:

1. How much water is used by the region's economy; where and how is it used?
2. How does consumption compare to economic productivity within the main economic sectors and of the largest water users?
3. Which economic activities pose the greatest threats to water resource availability (water quantity and water quality), and in turn to sustainable economic development?
4. In what ways could water resource availability constrain the sustainable economic development of the Berg Catchment?
5. What interventions (including potential water pricing mechanisms) would best enable continued sustainable economic activity, whilst being cognisant of other areas of importance/objectives in these areas?

The key outcome of initial scoping highlighted that economic growth (in Saldanha Bay) *may* be constrained by (the cost of) available water. A five-year "Water as a constraint on Development" programme was thus developed, informed by insights revealed in the scoping exercise (GreenCape, 2013).

The overarching aim of the 5 year programme is to contribute to strategic decision-making for economic development, through answering "What are the 'right' sources of water, at what quality, for the 'right' developments, for the 'right' price?" This question proposes a vision of a new economy in which different sources and qualities of water are sold at different prices, to different users, for different uses. Although the investigation is rooted in Saldanha Bay, the question reflected in the overarching aim is also applicable to economic development in other water-constrained areas. To address the overarching aim and vision, the programme will:

- develop an approach for integrating economic development and water resources planning to promote coordinated infrastructure development; and
- develop decision-support-systems or tools to support strategic decision-making for water resources and economic development planning.

The programme therefore intends to contribute solutions to current development challenges for Saldanha Bay, thus supporting decision-makers at local, provincial and national government, and enabling industry development in Saldanha Bay. In turn the tools developed in this process can be applied in other water-constrained catchments.

1.3 Programme Structure and Activities

Potential solutions to alleviate the constraint posed on economic development by water availability were defined during the scoping assessment. These solutions are shown in Figure 1-2, which also summarises the programme development and includes reference to relevant work carried out by other stakeholders. The project's scoping phase (start of Year 1) included "initiatives mapping" and a "gap analysis" to focus efforts going forward.

A key outcome of the scoping phase was the indication that economic growth might become constrained by the cost of available water. Furthermore, this initial exploratory work highlighted limitations in existing planning processes, which themselves could act as a barrier due to poor integration of water resources and economic development planning. Alleviating constraints to development therefore requires an integrated, systems approach. This approach will need to recognise the interdependent nature of water resources and economic development (item 1 in Figure 1-2). This is described in Section 32.7. As a first step in implementing the required systems approach to economic development and water resources planning, development proposals were collated and their water demands estimated in order to determine implications for development planning and infrastructure (item 2 in Figure 1-2). This is described in Section 4.

Managers of water-constrained catchments should ensure that the currently available resources are allocated for optimal benefit including economic development and job creation ("*SMART* allocation"). For example, this may include allocating water preferentially to a proposed industry based on the fact that it will create significant employment opportunity. During 2014-2015, potential approaches to this type of allocation were considered, laying the foundation for the potential of a cost-benefit approach to be assessed in the next phase of work (item 3 in Figure 1-2). This is described in section 5. However, taking a systems approach (as described above) means that the costs/ benefits of one development or resource supply intervention should be viewed in a broader context. This includes understanding the trade-offs and knock on effects of decisions made on a catchment level. A "Hydro-Economic Model" (HEM) will be developed in future project phases for this purpose. Decision makers will therefore benefit from being able to access a database support system, which spatially portrays the likely impacts of actions taken within various scenarios.

In response to a water availability constraint, one of the first solutions to consider would be to reduce demand through improving water efficiency. Water conservation and demand management (WC/WDM) is under investigation by Saldanha Bay Local Municipality (SBM), and is overseen by the Department of Water and Sanitation (DWS). In addition to traditional WC/WDM measures, a "Water Exchange Network" (WEN) has been considered, in which waters of different qualities are cascaded (used and passed on) between major industrial users. A preliminary investigation into the potential for a WEN in Saldanha Bay was completed during Year 2 of the project (2014-2015), and suggests that a pre-feasibility study is warranted (item 4 in Figure 1-2). This work is described in Section 6.

Beyond the successful reduction of demand through implementation of water efficiency measures, another solution would be to increase supply via often capital intensive infrastructure developments. Saldanha Bay could receive additional water from the Berg River, through various schemes that intend to make more water available to the Berg River's supply system (the Western Cape Water Supply System, or WCWSS). Alternatively, Saldanha Bay could generate local water supply from desalination, groundwater use, or traditional water re-use. These options are currently under investigation by the relevant responsible authorities: City of Cape Town (CCT), SBM, and West Coast District Municipality (WCDM), overseen by the DWS.

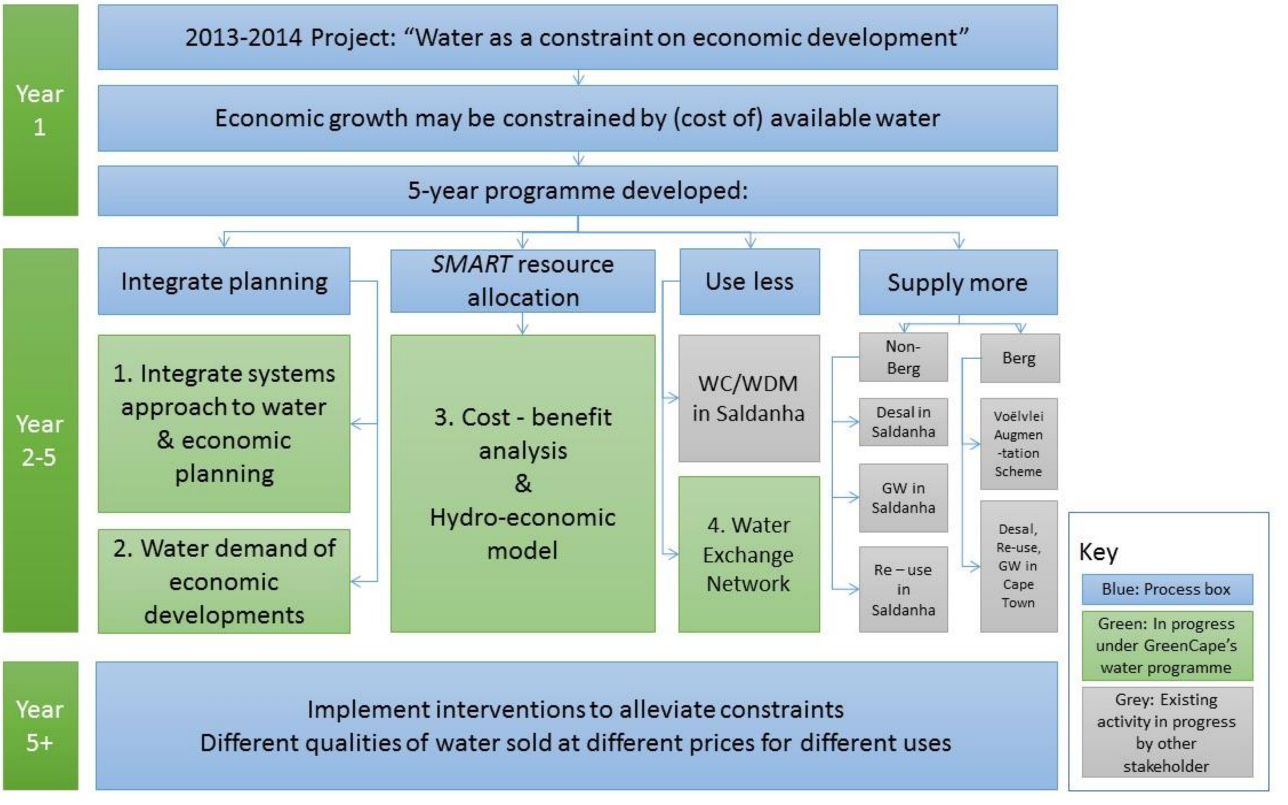


Figure 1-2 Programme activities[1]

[1]Acronyms applied only in Figure 1-2: Desal = desalination, GW = groundwater

1.4 Structure and purpose of this report

This report documents results of programme activities carried out in 2014-2015. Summarised results from the scoping exercise (2013-2014) were documented in a report targeted at the project funders (GreenCape, 2013). The relevant findings from the scoping exercise, including the motivation for the development of a 5-year programme, and the development of the solutions to be investigated under this programme (Figure 1-2), are reincorporated in Section 2 of this report, such that it can be read as a standalone document.

Section 2 (and its appendices) documents the status quo of water resources and economic development in Saldanha and the wider Berg region, incorporating key findings and key insights of the scoping phase. The information provided in the report is linked to what is relevant for the programme, and is not intended to provide a comprehensive description of water and economic situation in Saldanha Bay and the Berg WMA. Furthermore, the information is based on a combination of published reports and information and perspectives collated from discussions and interviews. Given the information is a mix of factual, anecdotal and perspective-based, GreenCape does not take responsibility for any factual errors.

The remaining sections document results of the programme activities listed in Section 1.3. The final section collates findings to date, and outlines the necessary activities for the remainder of the programme.

Italic green text boxes are used throughout the text to document: i) questions that arise from the presented material that warrant further investigation in future phases of the programme or ii) actions recommended to GreenCape, to be included in future programme phases

1.5 Alignment to Existing Policies and Strategies

GreenCape's project is aligned to both national and provincial visions for economic development. Key national documents include the National Development Plan (NDP) and the Green Economy Accord. The NDP refers to the primary challenges for development, which include the fact that "the economy is unsustainably resource intensive" (National Planning Commission, 2011). One of the objectives of the NDP is to ensure that there is enough water for agriculture and industry despite the fact that the country is water scarce. The NDP also recognizes that this scarcity will result in trade-offs in the use of water.

The Green Economy Accord (Department of Economic Development, 2011) documents the commitments of the government to support, promote, and plan for developments in green technology. A green economy can broadly be defined as an economy that "promotes growth while reducing pollution and greenhouse gas emissions, minimizing waste and inefficient use of natural resources, maintaining biodiversity and strengthening energy security" (WRC, 2013a). Growing awareness of water scarcity has meant that the need to address inefficient water use is a priority. This project will assess water use compared to GDP contribution (water productivity as GDP per drop[1]), to highlight water- inefficient industries, in order to inform water 'smart' economic development decisions to be taken.

On a provincial level, the Western Cape government outlines five Provincial Strategic Goals (PSGs, replacing the Provincial Strategic Objectives). GreenCape's project is aligned to PSG1 (creating opportunities for growth and jobs), PSG4 (enabling a resilient, sustainable, quality and inclusive living environment), and PSG5 (improving governance and service delivery through partnerships).

The Western Cape aims to become the "leading green economic hub on the African continent. The "Green is Smart: Green Economy Strategy Framework" (PGWC, 2013a) sets out how this aim can be achieved, including goals, roles and responsibilities. The framework document acknowledges that the Western Cape is particularly vulnerable to climate change impacts. The document highlights a number of approaches, such as improving water efficiency in agriculture and industry. In addition, the document highlights enablers to unlock economic opportunities, such as WC/WDM, development of groundwater resources, reuse of effluent, desalination, and expanded and diversified agriculture. Water pricing is also highlighted as an enabler. In relation to water, the framework document states "it is proposed that the Western Cape public sector review the pricing of all resources, including water… to help identify where it may be able to introduce incentives and disincentives to promote behaviour change to a low-carbon economy". In addition, "Ensuring energy and water efficiency through incentives and pricing" is listed as a responsibility of local municipalities.

The project also aligns with PGWC's Provincial Economic Review and Outlook (PERO), which recognises that the availability of water resources may constrain development (PGWC, 2013b). Also, the Western Cape Sectoral Economic Prospects (DED&T 2011) recognizes the potential constraint of water availability.

In addition to the above, the project is also well aligned with the province's Ministry of Economic Opportunities' Project Khulisa report, which identifies water as a key enabler of economic growth (PGWC, 2014). This study highlights that water can act as a constraint on the development of the oil and gas industry (which is identified as one of the key game changer industries), specifically in Saldanha Bay's Industrial Development Zone (IDZ). Likewise, the agri-processing sector (another priority sector) will not be enabled without the availability of water.

---

[1] *http://data.worldbank.org/indicator/ER.GDP.FWTL.M3.KD*

2 Status Quo

2.1 Water Availability and Use in the Berg WMA

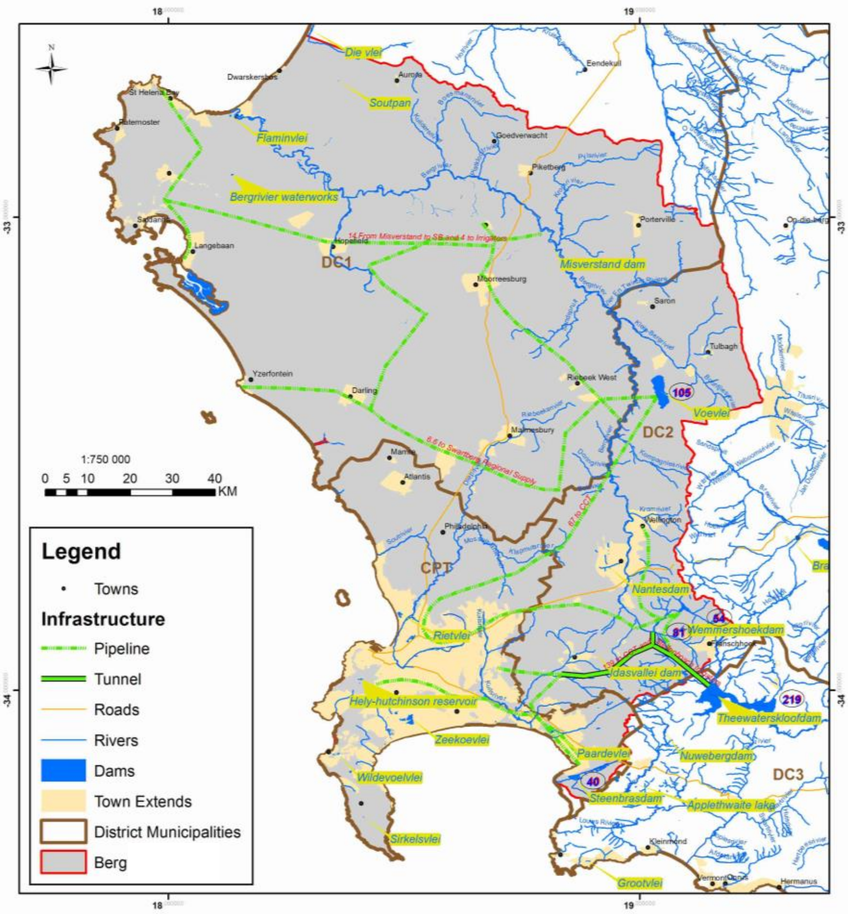
The Department of Water and Sanitation (DWS) previously divided the country into 19 Water Management Areas (WMAs), each containing a large river system (DWAF, 2004a). The Berg River catchment supplies areas outside of its natural boundaries (Cape Town for example), and the boundary of the Berg WMA includes the supply area, and several smaller catchments (Figure 1-1). With the second revision of the National Water Resources Strategy (DWA, 2013) 19 WMAs were reduced to 9, through an amalgamation of areas. As such the Berg no longer constitutes an individual WMA, but is still referred to as such in this report.

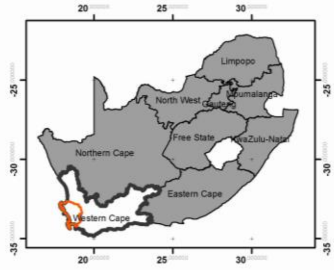
Surface water availability is discussed in two key quantities: the first is the mean annual runoff (MAR) per catchment, which is a sum of all flow in rivers within that catchment. This MAR is either reported as "present day", which is significantly altered by factors that intercept flow (including alien vegetation, rain-fed crops, run-of-river' abstraction), or as 'naturalised' MAR which is an estimate of pre-development MAR based on the hydrology of a catchment. Not all MAR is available for use by the economy, given that a portion must remain within the river system to sustain environmental flows (the Reserve). Also, it would not be possible to capture all MAR. Surface water is impounded in dams, the yield of which is a function of the dam's capacity and the MAR, and the user-defined assurance of supply.

The Berg River is a heavily utilised system. Through a set of five major dams (listed in Table 2-1), the Berg River supplies water to the majority of municipal demands (both domestic and industrial) as well as significant agricultural demands across the Berg WMA. The structure of the supply network, collectively termed the Western Cape Water Supply System (WCWSS, Figure 2-1), enables these dams to be operated in an integrated manner, maximizing efficiency. One of the dams (Theewaterskloof) is located in the neighbouring Breede River catchment, and contributes water to the Berg Catchment and the WCWSS via an inter-basin transfer. The DWS (2014a) point out that the total integrated system yield (at a 98% level of supply assurance for all user categories) is 596 million m^3/a. This figure is deduced from the maximum annual water requirements that the system can supply, before the risk of curtailments become too great.

Table 2-1 Dams of the WCWSS (combined from DWS 2014a, and DWAF 2004b)

Dam	Capacity (million m^3)	Yield (million m^3/a)	Owner	User
Theewaterskloof	432	219		
Voëlvlei	158	105	DWS	CCT / WCDM / Irrigators
Wemmershoek	58	54	CCT	CCT / Drakenstein
Upper Steenbras	30	40	CCT	CCT
Lower Steenbras	34			
Berg River Dam	127	80	TCTA (DWS)	CCT / Others / Irrigators / Overberg
Palmiet		23	DWS / Eskom	CCT/ Eskom
Compensation		38		
Additional yield from integration		11		
Total (firm yield derived from legacy hydrology and using the Water Resources Yield Model)		570		
Total integrated system yield (stochastic yield derived using the Water Resources Planning Model)		596		





The Berg River originates in the mountainous areas to the southeast of the map. It flows north, collecting various tributaries along its course, turning northwest to discharge into the ocean. The dams of the WCWSS are all in the upper mountainous reaches of the river or its tributaries.

Saldanha Bay is in the lower reaches of the catchment and supply system.

Figure 2-1 Dams and major pipelines of the WCWSS

The WCWSS supplies raw water to domestic & industrial users (via municipal supply), and to agricultural users (via Water User Associations and irrigation boards). The major domestic & industrial user is the City of Cape Town, which then supplies to users within the Metropolitan area. The West Coast District Municipality also receives water from the WCWSS and operates smaller schemes to supply West Coast towns and industry, as does the Stellenbosch Local Municipality. The current allocations and recent use from the system are shown in Table 2-2 below. As total allocations were greater than (previous estimates of) total yield (DWAF 2004a) and in response to strain on the system, water use by the agricultural sector has been 'çapped', and no increase in water use by the sector is permitted. The total consumption from the WCWSS has reduced in the last 3 years due to efforts mostly by the City of Cape Town to curb water losses, and decrease domestic water demand (DWS,2014a).

Comparing water allocations to estimates of recent use shows that there is approximately 60 – 86 million m^3/a of un-used water in the WCWSS, with most of this allocated to the City of Cape Town. However, budgeting for the ecological reserve is not fully implemented (releases are currently only accommodated from Berg River Dam, and no other dams on the WCWSS). Once fully implemented, specified water volumes required to sustain ecological health will be released from all dams, thus reducing the total system yield (DWS, 2014).

Depending on the estimate of total yield used, the system is currently somewhere between being over-allocated by 14 million m^3/a, and under-allocated (i.e. an available amount) of 12 million m^3/a. This is likely the cause for the commonly held perception that the Berg is a "fully allocated system", in which any growth in water demand would need to come from other water sources.

Table 2-2 Current allocation and recent use from the WCWSS (million m^3/a) (from DWS, 2014a)

User	Allocation	2012/2013 Use	2013/2014 Use
City of Cape Town	385.90	312.92	306.77
West Coast District Municipality	21.64	25.29	26.86
Stellenbosch LM	3.00	3.00	4.01
Agriculture	173.60	169.00	170.00
Total allocation / use	584.14	510.21	507.65
Total (firm yield derived from legacy hydrology)	570		
Total integrated system yield (stochastic yield)	596		

Note: years are hydrological years, October to September

In addition to the Berg's system yield from these dams, private "off-grid" abstractions also utilise the Berg River (or tributaries within its catchment) mostly for agriculture. Significant aquifers also exist within the Berg WMA. Total (surface) water requirements in the Berg WMA per sector add up to just over 700 m3/ as shown in Table 2-3 below. In the year 2000 the "on grid" demand on the WCWSS (which includes domestic supply and irrigators), was around 500 million m^3/a, implying that "off-grid" demand in 2000 was 200 million m^3/a. Although this old data, it provides an estimate of the total (surface) water demand (use) in the Berg WMA, (i.e. that supplied by the WCWSS, and private "off grid" abstractions).

Table 2-3 Total (Surface) Water Requirements in the Berg WMA (million m^3/a) (DWAF, 2004b)

Water Use Sector	Water Requirement in 2000 (million m^3/a)
Irrigation	301
Urban	389
Rural	14
Afforestation	0
Total	704

Analysis of various datasets, including the water use registrations held within the DWS's Water Authorisiation Registration Management System database (WARMS) was undertaken to determine (1) where and how the ~700 million m^3/a of surface water is used across the Berg, (2) how much groundwater is available and used, and (3) the economic benefit of water used. An inventory of datasets used for the status quo assessment is listed in Appendix 1 (Section 9), and key data and summary insights of the water use and availability assessment are presented in Appendix 2 (Section 10).

Given that the WMA appears to be operating close to capacity (or at least close to the allocated capacity), development planning needs to carefully consider the total amount of water available. This would be the total amount of water available to avoid reaching an environmental limit defined by the responsible authority, and which is available within the WCWSS dams (including that received via inter-basin transfer, plus that available for "off-grid" abstractions from surface water and groundwater). This seemingly simple number is not readily accessible in current literature. A further complication is that the hydrology models used to manage the WCWSS (the Water Resources Yield Model, the Water Resources Planning Model and the Systems Model) do not replicate the physical catchment or the "off-grid" surface or groundwater availability – but focus only on the system yield from dams. There is currently no integrated catchment (surface and groundwater) or system model.

At the moment these WRYM and WRPM are operated and updated by specialized consultants for DWS. Would it be feasible to develop a spatially accurate hydraulically linked surface and groundwater model for the WMA, which incorporates the system model, with a simplified Decision Support System front-end to enable development planners to access this information? Water allocation in the UK is managed with this type of model, the DSS is able to determine the impact of a proposed abstraction, with few more complex cases being referred to specialists.

2.2 Water Availability and Use in Saldanha

The total allocation to the WCDM from the Berg River is 21.64 million m^3/a (Table 2-2), 17.4 million m^3/a of which is allocated to the Withoogte scheme, the rest allocated to its Swartland regional scheme (Table 2-4, referred to as "Misverstand Bulk scheme" and Voëlvlei Bulk scheme respectively in Figure 2-3).

For the Withoogte scheme, raw water is abstracted directly from the Berg River at Misverstand reservoir and pumped to a relatively small off-channel storage reservoir at the Withoogte water treatment plant. The reservoir is located about 17 km to the West of Misverstand at a higher altitude of 175m above sea level. From here the Withoogte's potable water gravitates (mainly) towards the west for distribution mainly in the Saldanha Bay LM and some surrounding areas (Table 2-5).

The abstraction from the Berg River at Misverstand comprises two flow components:

1) Flow in the river due to normal hydrological and geohydrological influences, or so-called "run of river" flow. This component is around 20% of the supply.
2) Artificial river flow in addition to run of river, resulting from releases of water from Voëlvlei dam with the purpose of abstraction for the WCDM at Misverstand reservoir. Although the releases of water from Voëlvlei are intended for abstraction by the WCDM at Misverstand, an unknown volume of the released water is "lost" due to various natural causes and illegal abstraction by farms along this stretch of river. The losses are generally taken as 25% of the release volume (DWAF, 2007a). In turn, Voëlvlei dam, an off channel storage dam, has several sources including diversion canals from the Klein Berg and Vier en Twintig River, and also a diversion of winter flood waters in the Berg River.

What additional yield would be available to Withoogte (this 25% of release volume) if these losses were overcome? By how many years does this delay future reconciliation interventions? How much of the 25% loss is related to illegal abstraction v's evaporation and other factors? And therefore do we invest in curtailing illegal abstraction or in reducing evaporation in this stretch of river (by piping / covering the water)? How does the cost of these interventions compare to other reconciliation options?

In addition to the allocation from the Berg, groundwater is pumped from a wellfield accessing the Langebaan Road Aquifer and added to the Withoogte bulk supply system, with an allocation amount of 1.5 million m^3/a (Table 2-4).

The recent total water use from the system (Table 2-4) shows:

- The total allocation for the WCDM from the WCWSS is 21.64 million m^3/a but this has been exceeded since at least 2008-09, by up to 5.2 million m^3/a.
- This overuse is contributed to by overuse within both the Withoogte and Swartland schemes. The allocation for Withoogte from WCWSS is 17.44 million m^3/a, which has been exceeded in the last three years by up to 2.9 million m3/a.
- Although Swartland exceeds the allocation from WCWSS, the water demand growth rate appears stable and in slight decline. The water demand growth rate at Withoogte is around 5%, and this increase in demand initially translated into an increase in groundwater use from the Langebaan Aquifer (growth rates reached 52% in 2010-11), but has recently been met by increase in use of Berg Water from WCWSS (growth rate of 9% in 2013-14). Groundwater use has declined since 2012. If groundwater had been abstracted at the full allocation (1.35 million m^3/a), total exceedances by the WCDM from the WCWSS would reduce to a maximum 3.87 million m^3/a. (Some comments on increased groundwater use are provided in Section 6)
- Table 2-2 shows that there is currently around 60 – 86 million m^3/a of un-used water in the WCWSS. This implies that there should be no concern over *current* water supply despite the exceedances. As echoed by recent comments by DWS (DWS, 2014b), it is merely an issue of legal allocations.

Table 2-4 Allocation (million m^3/a), recent use (million m^3/a), and growth rates for the WCDM schemes (data from DWS, 2014a)

Scheme Component	Allocation	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Withoogte from Misverstand	17.44	17.49	16.93	16.71	17.53	18.69	20.36
Withoogte from Langebaan Aquifer	1.5 (1.35)+	0.44	0.62	0.97	1.09	0.93	0.00
Swartland from Voëlvlei Dam	4.2	6.66	6.76	6.64	6.59	6.60	6.50
Total for Withoogte	18.79	17.92	17.55	17.68	18.61	19.62	20.36
Total for WCDM	22.99	24.59	24.32	24.31	25.21	26.22	26.86
Total from WC WSS	21.64	24.15	23.69	23.34	24.12	25.29	26.86
Scheme Growth Rate		2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Withoogte from Misverstand	n/a	n/a	-3%	-1%	5%	7%	9%
Withoogte from Langebaan Aquifer	n/a	n/a	42%	56%	12%	-14%	-100%
Swartland from Voëlvlei Dam	n/a	n/a	2%	-2%	-1%	0%	-1%
Total for Withoogte	n/a	n/a	-2%	1%	5%	5%	4%

+ Groundwater abstraction is licensed for 1.5 million m^3/a, however a recent recommendation was made that this be reduced to 1.35 million m^3/a

Table 2-5 Towns served by the Withoogte bulk scheme (DWS, 2014a)

Bulk System	Local Municipality	Towns
Withoogte	Saldanha Bay	Hopefield, Langebaan, Vredenberg, Saldanha, St Helena Bay
	Swartland	Koringberg, Morreesburg
	Bergrivier	Velddrif, Dwarskersbos

Of the ~18 – 20 million m^3/a of water in the Withoogte scheme, approximately 13.5 million m^3/a is sold from the WCDM to the SBM for distribution (number based on billings, WCDM, 2014), the remainder being sold to other LMs from the Withoogte (or comprising losses). Within Saldanha Bay LM, Saldanha town uses 6.75 million m^3/a (52%), 89% of which is for industry (Table 2-6, Figure 2-2). Industry in Saldanha town is therefore the most significant user of the Withoogte scheme.

Of the 6.775 million m^3/a for industry in Saldanha, around 50% is allocated to three major industries, Arcelor-Mittal, Tronox and Duferco, who have allocations of 2.4, 0.5, and 0.4 million m^3/a respectively (information sourced from industry directly).

The water use and availability information for the Berg WMA and Saldanha area is summarized in the schematic graphic in Figure 2-4 below. The roles and responsibilities of the WCDM and SBM with regard to water provision are summarised in Box 2-1.

Table 2-6 Water use in Saldanha Bay for 2012-2013, based on SBMs billings (SBM, 2014)

Town	Total (million m^3/a)	Total (m^3/a)	Residential (m^3/a)	Industrial (m^3/a)	Farms (m^3/a)	Other (m^3/a)
Saldanha	6.75	6,749,565	624,558	6,002,527		122,480
Vredenburg	2.15	2,153,437	1,058,192	107,407	9,973	977,865
St Helena baai	1.09	1,094,379	532,142	516,633	15,255	30,349
Louwville	1.06	1,062,599	975,862	29,527		57,210
Langebaan	0.88	883,486	699,352	98,471	6,838	78,825
Rural	0.55	553,171	3,061	757	149,526	399,827
Hopefield	0.21	213,312	158,214	10,151	11,482	33,465
Long Acres	0.21	214,891	124,710	38,217	51,964	-
Total	12.92	12,924,840+	4,176,092	6,803,690	245,038	1,700,021

+It is assumed that the difference between what is sold to the SBM (13.5 million m^3/a) and what is sold by the SBM (12.9 million m^3/a) reflects un-accounted for water (losses).

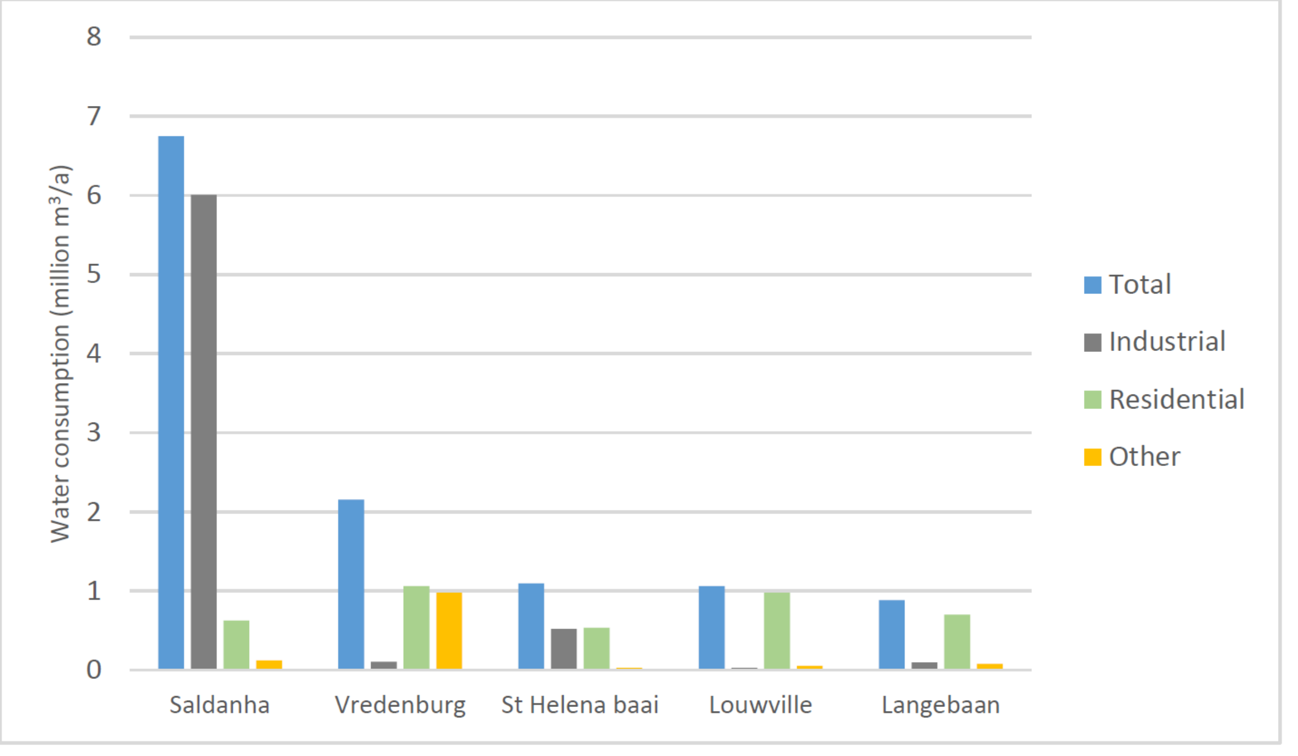


Figure 2-2 Industrial and residential water consumption (2012-2013) for main towns in SBM, from Withoogte scheme

Roles and Responsibilities for Water provision in Saldanha Bay

In the Western Cape, Local Municipalities have the mandated function of Water Services Authorities (WSA) and Water Services Providers (WSP). Saldanha Bay Local Municipality (SBM) acts as the Water Services Authority, but given the regional nature of the supply source, the function of the Water Services Provider has been delegated to the West Coast District Municipality (WCDM).

As the WSA, the Saldanha Bay LM is responsible for providing water services to all people under its jurisdiction, while the WCDM as the WSP is responsible for the bulk water services. In practice this means the WCDM is responsible for physical provision of water (maintenance of infrastructure), and SBM is responsible for ensuring sufficient water is available to for use in this infrastructure (water resources planning, future reconciliation, capital investment for infrastructure to bring new water resources online). The DWS as the custodian of national water resources, is responsible for oversight on these activities, and for licensing all uses of water resources (i.e. abstraction, discharge to a water course etc).

The WCDM has previously been acting as a WSA, undertaking future water resources planning for the Withoogte and other schemes that it operates, yet it has recently been confirmed that it should act solely as a WSP, with the local municipalities retaining WSA status (pers comm Nik Faasen).

For Saldanha this means that *local* water resource interventions to meet future supply (i.e. additional groundwater use or desalination) falls in the responsibility of SBM. Maintenance of infrastructure to meet future demand (i.e. upgrading the pipeline from Misverstand to the LM to cater for greater demand), falls in the responsibility of WCDM.

How does revenue collection from water sales function between the LM and DM? How do these roles and responsibilities impact on development planning? How does the governance structure support or impede a fully integrated approach to economic and water resource planning?

Box 2-1 Water roles and responsibilities between Saldanha Bay LM and WCDM

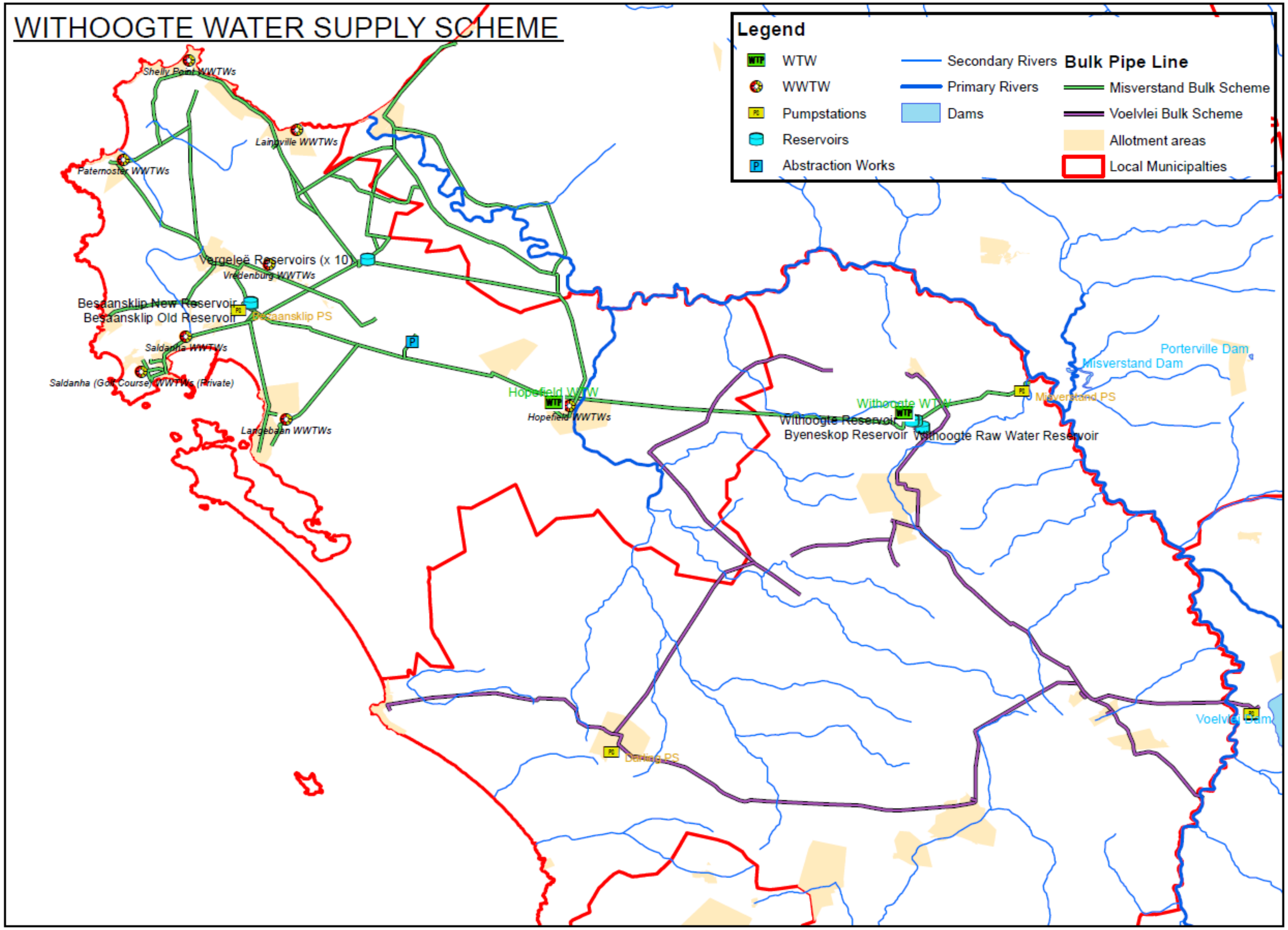


Figure 2-3 Map showing Withoogte Water Supply Scheme Infrastructure (data from GLS Consulting, and WCDM)

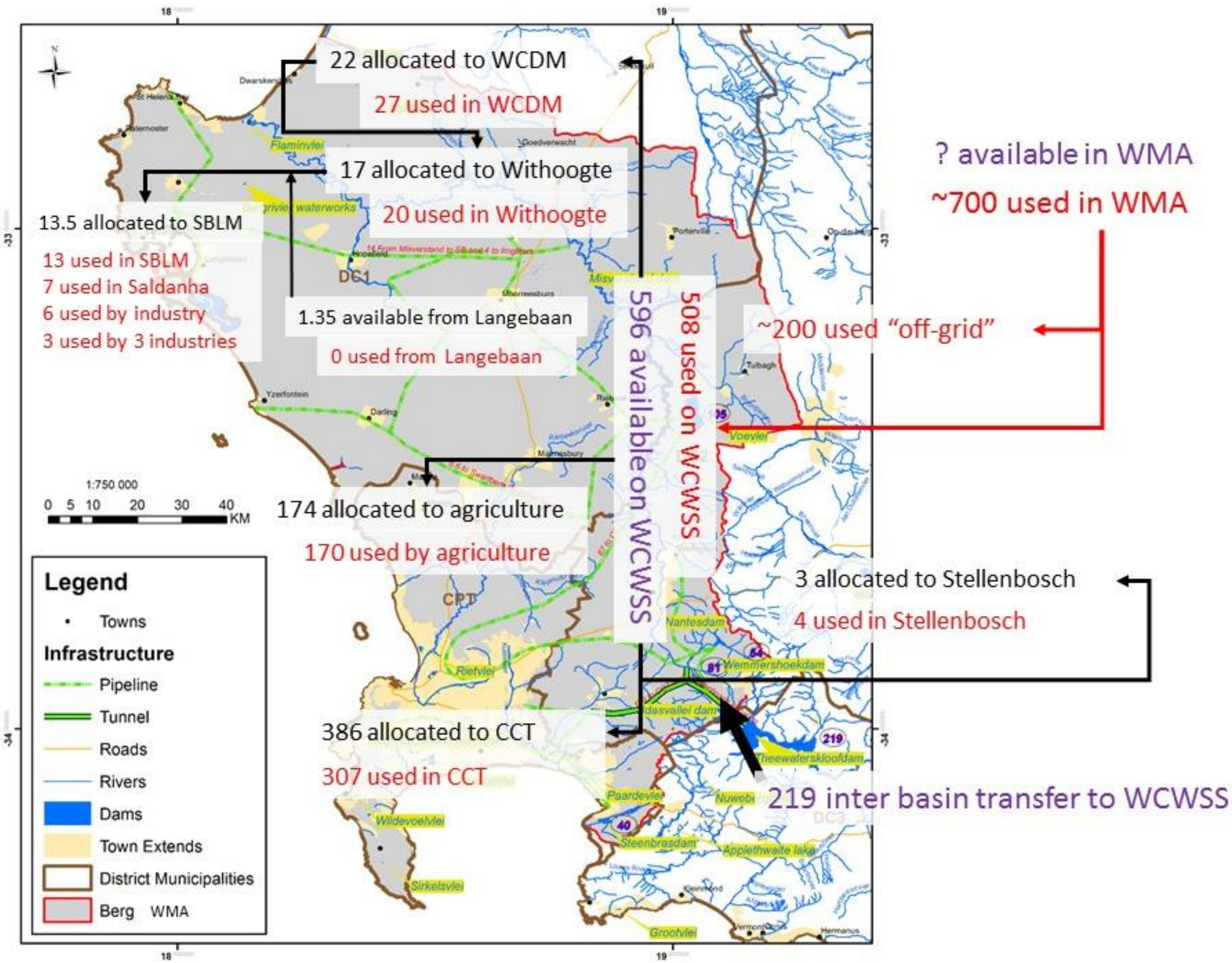


Figure 2-4 **Map of Berg showing schematic representation of current water availability, allocation and use in the Berg, and Saldanha Bay**

2.3 Berg River Water Quality

2.3.1 Chloride concentration

Water quality of the Berg River deteriorates in a downstream direction due to natural geological influences and as a result of human activities, such as agricultural activities (river modifications, water abstractions, and runoff from irrigated soils), urban storm water, discharge from wastewater treatment works (WWTW), and runoff from informal settlements. Water quality is the collective term for the chemical, physical, and biological characteristics the water, and each of these characteristics is impacted differently by a particular activity or pollution source. For example, informal settlements generally contribute micro-biological pollution to water courses whereas the agricultural sector contributes a high nutrient load to water courses causing eutrophication, and agricultural land practices enhance salinisation.

The town of Saldanha Bay, as a user of the Berg River from its lower reaches, is heavily influenced by upstream activities. Although bacteriological contamination may be the most significant water quality risk for the agricultural sector, this can be treated by chlorination in the Withoogte system before reticulation to Saldanha Bay and is not a significant threat to the water users in Saldanha. High salinity levels in the received water do however pose a problem to the steel processing industry. Water with up to 650 mg/l has been supplied, compared to a required concentration of less than 100 mg/l (See Box 2-2), and pre-treatment is required. Water with higher salinity can be re-used fewer times in processing, increasing total consumption of potable water as well as increasing in the amount of treatment chemicals used (Duferco, 2014). The high salinity therefore impacts industrial operating costs and also impacts on production. Industry has called for action from the responsible authorities to curb the increasing salinities (Duferco, 2014).

Chlorides in the Withoogte Water Supply System

The concentration of chloride has been measured in the incoming water at Duferco Steel Processing plant since before 2004 and shows strong seasonal fluctuation (Duferco, 2014):

- Summer levels are stable and return to below 100mg/l reaching a minimum of around 50mg/l
- Chloride levels peak in winter (approximately in August) with slow subsequent decline. Prior to 2006 all chrloride levels were below 200mg/l.
- The magnitude of the winter peaks show a rising trend from winter 2006 to winter 2011, with winter maximum levels rising consistently by ~50mg/l per year, from 400 mg/l in 2006, to 650 mg/l in 2011. Winter 2012 and winter 2013 peaks broke this tend yet remain high (250 mg/l and 400 mg/l respectively)

Box 2-2 Chloride levels in the Withoogte Water Supply System

2.3.2 'Quick fixes' to alleviate constraint on industry

Data for incoming and outgoing water quality at the Misverstand dam show that chloride contents are similar, and that sediment removal methods could not be contributing to the chloride level (pers. comm. Nik Faasen, 16 October 2014). Measures to lower salinity in the water at Misverstand dam are not financially viable for the WCDM, and hence the chloride content is minimised by reducing raw abstraction if incoming chloride spikes are noted. No raw water treatment 'quick fixes' are available to lower the salinity of the water that industries receive from the Withoogte Water Supply System. The West Coast District Municipality believe that the salinity problem can only be tackled via collaboration and coordination between all water users along the length of the Berg River (pers. comm. Nik Faasen, 16 October 2014).

2.3.3 Causes of high salinity

Many of the lower Berg River tributaries are underlain by Malmesbury shales of marine origin and therefore have naturally high salinity concentrations. The shales coupled with agricultural return flows introduce elevated salinities in the middle and lower reaches of the Berg River. If the dominant contribution to salinity was natural (geology), one would expect this to have highest impact in summer, when there is little rainfall to dilute the baseflow to Berg tributaries from shales. However, the seasonal trend is the opposite – a peak is experienced with the start of winter (Box 2-2).

The source of salinity is the topic of much research, which recognises that the expectation in semi-arid winter-rainfall catchments would be that the highest concentration of salts occur in summer when irrigation return flows make a dominant contribution to river flow (Kamish, 2008). Various research efforts show that winter rains mobilise weathering-related salts stored in the unsaturated zone overlying the Malmesbury shale. The pathway may be rising groundwater tables mobilizing salts which decant to baseflow, or interflow which seeps through the unsaturated zone and enters non-perennial rivers (Flugel, 1991, Kamish, 2008, De Clercq 2009). Two non-perennial tributaries in the lower Berg (the Matjies and the Sandspruit, upstream of Misverstand) have the highest salt concentrations, and would therefore contribute significantly to the salinity reaching Misverstand in winter. Dryland agricultural practices enhance the process of salt extraction by clearing deep rooting natural vegetation, thus causing a rise in groundwater tables which flush more unsaturated zone salts (Flugel, 1991). Also reinforcing the seasonal pattern is the fact that summer releases from the Voëlvlei dam (to sustain agricultural irrigation in the lower Berg) will dilute the summer salinity with fresher Berg water (DWAF 2004b).

Weathered Malmesbury Shale could be expected to contribute a range of dissolved ions, causing a high TDS, whereas records show chloride to be specifically elevated, and other salts less so. Only the weathered shale has been found to be enriched in chloride (unweathered shale not particularly enriched), heading to a hypothesis that the enrichment of the weathered shale could be attributed to the inundation of the area by sea water during the Late Tertiary (i.e. 38 to 1.6 million years ago) and the subsequent adsorption of the salt molecules onto the weathered shale or accumulation thereof in the interstitial spaces of the weathered material (Fourie and Görgens, 1977, discussed in Kamish, 2008).

A revised hypothesis is that the chlorides have meteoric (rainwater) origin, from dust transported by prevailing wind and rain depositing salts over millions of years (Fey and De Clercq, 2004 and De Clercq et al., 2009). A critical component of this on-going research work is an attempt to determine the future of the salinity load. If the dryland salinity effects are still intensifying, “the consequences for the management of water quality could be enormous, because any current assessment of the salinity load, on the basis of which impoundment and canalisation schemes may be implemented, could be incorrect for planning purposes” (De Clercq et al., 2009). The work concludes that the current rate of salt discharge could persist for decades or possibly a century or two. The study proposes that methods of decreasing discharge from the salt-contributing catchments should be considered due to the large volumes of water that would need treatment in the case of an end-of-pipe treatment option being used. Follow-up research is currently under way to investigate the impacts of different land uses on salt discharge and water quality, and to recommend the most suitable land uses that would reduce salinization of the Berg River for regulatory purposes (De Clercq et al., 2009).

The cause of the significant rise in winter peak chloride concentration in water in the Withoogte scheme between 2006 and 2011, and why it reduced again in 2013-2014 is uncertain. Establishment of the Berg River Dam over this same timeframe was predicted to cause the concentration and duration of winter salinity peaks to increase (DWAF 2004), presumably due to removal (damming) of some of upstream winter freshwater flush, thus enhancing the relative effect of the geology-derived (and agriculture enhanced) salinity in the lower Berg.

One suggestion for the reduction in salinity in 2013-2014 is related to an upgrade of WWTW upstream of Misverstand, at Drakenstein (pers comm Nik Faasen 16 October 2014), however WWTW's do not specifically contribute chloride (as a dissolved solid) to water courses.

The cause of the short duration spikes in chlorides in the Withoogte scheme (peaks throughout the year of up to 100 mg/l above background) is unknown.

2.3.4 Solutions for high salinity

The Berg Water Partnership (formerly known as the Berg Water Quality Task Team), was established to address pollution issues and to coordinate the various water quality initiatives being implemented. This is a multi-stakeholder task team comprising of a number of different institutions including National, Provincial and Local Government Departments as well as NGOs, academic institutions, Water User Associations and others – all coordinated by the DWS (DWS, 2014). The Berg River Improvement Plan (BRIP) is an initiative feeding into the Berg Water Partnership, and has several tasks under it each targeted at a particular pollution source (including agricultural best practice for nutrient runoff, and WWTW upgrades).

Increasing use of conservation agriculture methods such as no-till farming can reduce the effect that agricultural practices have on salinization (through increasing infiltration rates and decreasing runoff). However, research indicates that the current rate of salt discharge could persist for decades or possibly a century or two (De Clercq et al 2009), hence there is a question over whether existing measures and initiatives are adequate and appropriately directed to specifically address salinity.

Various national water resources planning projects (by DWS) have assessed engineered solutions to salinity at Misverstand. In 2004 the following measures were recommended (by the Directorate: National Water Resource Planning) as part of a Lower Berg Water Quality Strategy, for implementation by the Regional Offices (existing infrastructure), the Directorate: Options Analysis (feasibility analysis of new infrastructure) and the Directorate: National Water Resource Planning (all planning in the system context):

1. "Investigate options for improved salinity management of water in the middle and lower reaches of the Berg River taking account of the future Berg Water Project and the needs of urban and agricultural users.
2. Determine the extent of reduced salinity that may be achieved if releases of the first winter run-off water (high salinity) from Misverstand Dam were implemented.
3. Investigate the benefit of using alternative abstraction points within Misverstand Dam.
4. Investigate the options of diverting the small local tributaries (Moorreesburgspruit and Nogospruit) around Misverstand Dam, so as to reduce the salinity concentration in the dam itself.
5. Means of managing abstractions from Misverstand Dam to provide water of acceptable salinity for the industrial development at Saldanha Bay should be investigated." (DWAF, 2004b)

The DWS (Directorate: Options Analysis) subsequently carried out salinity modeling to address these recommendations and predict the impact of the Berg Dam and the Voëlvlei Augmentation Scheme (Section 2.4 below) on salinity at Misverstand, and determine engineering solutions. The work tested whether water could only be abstracted from the Berg when Chloride is <300mg/l and supplied from storage through winter peak in Chlorides. The outcomes showed that abstraction would have to continue up to 450mg/l (as otherwise storage reservoir would need to be too large for it to be feasible), and that additional storage is required to bridge the maintain supply when abstraction ceases due to salinity (DWAF 2006, and Kamish, 2008). Presumably as an outcome of this work, an Environmental Impact Assessment (EIA) is currently underway for an additional storage reservoir at Misverstand (pers comm Nik Faasen, 16 October, 2014).

GreenCape needs to feedback this information to the Saldanha industries that have called on the responsible authorities to curb increasing salinities.

What are the predicted salinity levels once the new storage reservoir is installed? Are these acceptable to industry in Saldanha (unlikely)? Are the existing intervention measures and initiatives adequate and appropriately directed to specifically address salinity?

2.4 Supply/demand reconciliation options for the Berg WMA

In the traditional water resources planning approach future water demand is predicted based on recent water demand growth trends, and the expected development of an area (considering economic drivers for growth of an area, using documents such as Integrated Development Plans (IDPs)). A growth percent is determined. Current water availability is assessed, and predicted future demand and current availability are compared. Where future demand exceeds availability, water resource reconciliation interventions are proposed. This occurs following reducing water demand where possible (through water conservation and demand management that addresses overuse, leaks and "unaccounted for water"). Interventions may include new water resource options such as desalination. The feasibility of such interventions is investigated, and generally the most cost effective solution is recommended along with a timeline for required interventions.

Although there is currently an un-utilized volume in the Berg, it is emphasized that this is a temporary situation, given the demand projections for Cape Town. The current un-utilized volume has been generated by bringing the Berg Dam online, by a reduction in water demand of CCT (successful water conservation and demand management measures in recent years), and by the current estimate of WCWSS yield increasing from 570 million m^3/a to 596 million m^3/a. These initiatives are the outcome of the long-term water resources planning for the WCWSS, carried out by the DWS Directorate National Water Resources Planning under the project "Western Cape Water Supply System Reconciliation Strategy Study" (DWAF, 2007b). The project continues on an ongoing basis with 3-year appointments contracted out to specialists to advise the DWS ("Support to the Continuation of the Water Reconciliation Strategy for the Western Cape Water Supply System", DWS 2014a). The project has the mandate to update the reconciliation strategy for the WCWSS (involving updating demand projections and recommendations for interventions), and coordinate all reconciliation interventions that may be implemented by the WSA's (the LMs or the metro).

Current estimates of future water demand from the WCWSS Reconciliation Strategy Study have indicated that the WCWSS water requirements will exceed the current supply in 2022, (applying assumptions of high water requirement growth, 50% success of water conservation and water demand management measures and no impact of climate change on available yields) (DWS 2014a). A new supply intervention needs to be in place by 2022 and due to the time required to bring new water resources online, a decision on which intervention to implement first must be made October 2015 (DWS 2014a). A summary of the currently considered major water supply and demand reconciliation options, their yield, and the investigation status of each is listed in Table 2-7 below, in the order of recommended priority.

Table 2-7 Main water resources intervention options for the WCWSS (planning scenario in DWS 2014a)

Intervention programmes	Investigation by	Year to be implemented	Yield (million m^3/a)	Cost of water (URV)*	Lead time⁺ (years)	Level of investigation completed	Status
Voëlvlei Augmentation Scheme phase 1	DWS Directorate: Options Analysis	2022	23	R1.52 / m^3	7	Feasibility	EIA for phase 1 scheme in process
TMG Scheme (Phase 1, Phase 2)	CCT	2024, 2029	20, 30	n/s	8, 9.5	Pre-feasibility	Continuation of pre-feasibility study required, procurement delays
Re-Use Generic (Phase 1, Phase 2)	CCT	2025,2029	40, 40	n/s	8, 8	Pre-feasibility	Feasibility study in progress (Aurecon for CCT)
Desalination (Phase 1, Phase 2, Phase 3)	CCT	2031, 2033, 2035	50,50,50	n/s	8, 8, 8	Pre-feasibility	Feasibility study in progress (Worley Parsons for CCT)

*the Unit Reference Value is a standard South African costing metric for water resources planning, described in van Niekerk, & du Plessis, 2013

⁺Lead times include the time required for completion of required investigations, construction, water use licensing and EIAs

The Voëlvlei Augmentation Scheme involves the diversion of surplus winter water from the middle Berg River into Voëlvlei dam (DWS, 2014a). The TMG Scheme involves groundwater abstraction from the Table Mountain Group sandstones in the mountainous areas in the upstream reaches of the Berg River. Water re-use in Cape Town is currently being investigated, as well as desalination, both of which have the potential to reduce demand on the WCWSS and Berg River.

2.5 Supply/demand reconciliation options for Saldanha

Water availability and demand calculations carried out in 2011 indicated that shortfalls are already being experienced in Saldanha, but these were likely not apparent due to the balancing between shared users in the system (DWA, 2011). Water demand is currently met through abstraction exceeding the allocation from the Berg River (Section 2.2 above). Demand on the Withoogte system is projected to be around 36 million m^3/a in 2033 (pers. Comm. Nik Faasen WCDM, 4 December 2014), compared to the current total allocation of 18.79 million m^3/a, suggesting a deficit of 17.2 million m^3/a. The projected demand compared to this current allocation (made up by the allocation from the Berg and from groundwater), is shown in Figure 2-5, highlighting graphically that allocation volumes are already being exceeded.

To meet projections of future water demand, water resources interventions were urgently recommended (DWA, 2011). Desalination is currently preferred by the SBM as the water resources intervention option which has highest assurance of supply, and feasibility study (Worley Parsons, 2014) and an EIA (CSIR, 2012) are both currently underway. The construction would proceed in three phases, each of 8.5 Ml/d (3.1 million m^3/a), with the full capacity of 25.5 Ml/d met by 2026. However, an application for funding through DWS's Regional Bulk Infrastructure Grant (RBIG) programme has not yet been successful and SBM may be seeking funds from other sources. The DWS has indicated it will not support SBMs desalination plan, until SBM has demonstrated improvements in water conservation and demand management and reduced its unaccounted for water (from 24% in 2011, DWS, 2011). Additionally, DWS are concerned that desalination has been prematurely favoured without adequate appreciation of alternative sources, including increasing the supply from groundwater, and water reuse. Based on a review of previous water resources reconciliation planning for the area this view is supported by GreenCape (see Section 6). Local industries in Saldanha have indicated that the proposed desalination plant will increase operating costs through the capital levies that will be imposed to fund the plant. Given that current industries believe that these costs are unaffordable, future industrial development in the region may be constrained. Furthermore, as the SBM is as yet unable to source funding for the capital investment required for the desalination works (estimated at R500 million), SBM has begun to indicate to proposed industries that their request for water is dependent on SBM sourcing funds for desalination, also thus potentially constraining industrial development (pers. comm. Hannes Marais, 8 August 2014). The energy requirement for desalination is an additional strain on the system resources.

The potential future supply from desalination is also shown in Figure 2-5. Also, the projected demand was updated in December 2014 (WCDM). However, GreenCape's understanding is that the desalination plant (yields and timing) was planned prior to the update made to the projected demand. The desalination plant no longer meets the (updated) projected demand, with deficits occurring in 2019-2020, and beyond 2023. When compared against current (2013-2014) *use* (rather than allocation), potential shortfalls occur in 2020 (supply >demand by only 0.37 million m^3/a), shortfalls occur in 2025, and beyond 2027. This assumes the over-use compared to allocation of the Berg can continue.

After a significant increase in the projected capital costs for the desalination plant, the WCDM now favours increasing the abstraction of water from the Berg River to meet projected demand across the Withoogte scheme. The WCDM applied to the DWS in December 2013 for an additional 17.199 million m^3/a from the WCWSS, to be developed in 5-year periods over 20 years (i.e. 4.299 million m^3/a every 4 years) (pers. Comm. Nik Faasen WCDM, 4 December 2014). This increased abstraction from the Berg is shown in Figure 2-7, and meets projected demand over the planning period.

Whether the additional 17.199 million m^3/a is to be sourced from un-allocated available water in the WCWSS (up to 12 million m^3/a is unallocated as per section 2.1), or whether it is based on CCT implementing another intervention that alleviates their demand on the Berg is unknown (to the authors). The WCDM is disadvantaged over CCT, with a Raw Water Supply Agreement of April 2003 between the (then) DWAF and CCT earmarking CCT's allocation of water from the WCWSS, such that any possible increased allocation to the WCDM would reduce the CCT allocation (DWS, 2014a). The need to reduce CCT's allocation may be the reason that, although DWS has confirmed there is adequate resources in the Berg for the WCDM to continue to abstract greater than the allocation (DWS, 2014b), the application from WCDM for increased allocation from the Berg River has been a lengthy process as yet without conclusion.

The additional allocation from the Berg appears to be an attractive, relatively simple 'win' for water supply, however as a downstream user the WCDM is also dependent on upstream activities for incoming water quality (return flows, waste water treatment works along the Berg etc.), and the supply has high salinity - which may continue to be high for decades to come (section 2.3). Challenges experienced by industry with regards to water quality are therefore not ameliorated in this plan, and the water supply situation remains dependent on one source, hence without resilience to water shortages. The additional supply would also require an upgrade of >70kms of pipeline, to transport the greater yields from Misverstand to the coastal towns.

Building on the status quo described in this section, water demand projections for the Withoogte Scheme are discussed in greater detail in Section 4, and water resources reconciliation options for the Saldanha area are explored in greater detail in Section 6.

(How) do the water pricing and governance structures of the WSA (SBM) and the WSP (WCDM) influence the preferred water resources intervention options?

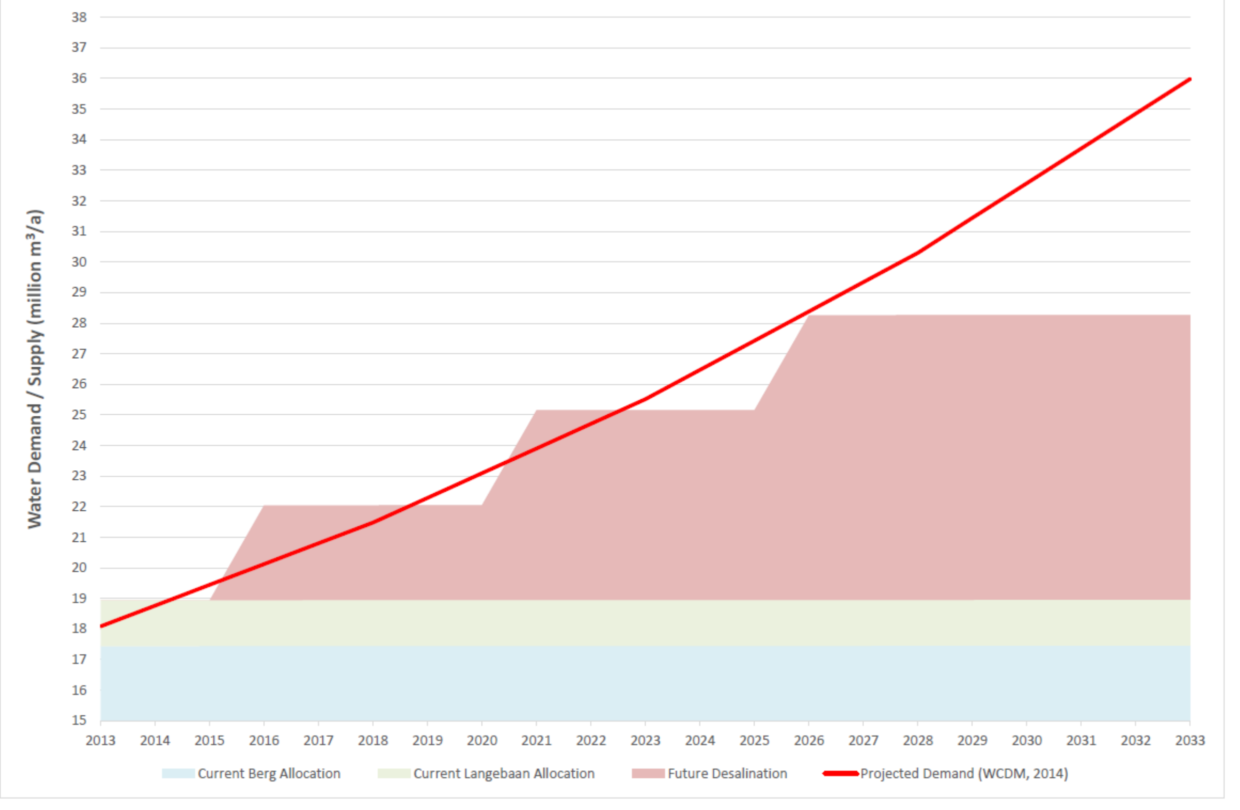


Figure 2-5 **Projected water demand of the Withoogte scheme compared to current <u>allocation</u> and planned desalination plant.**

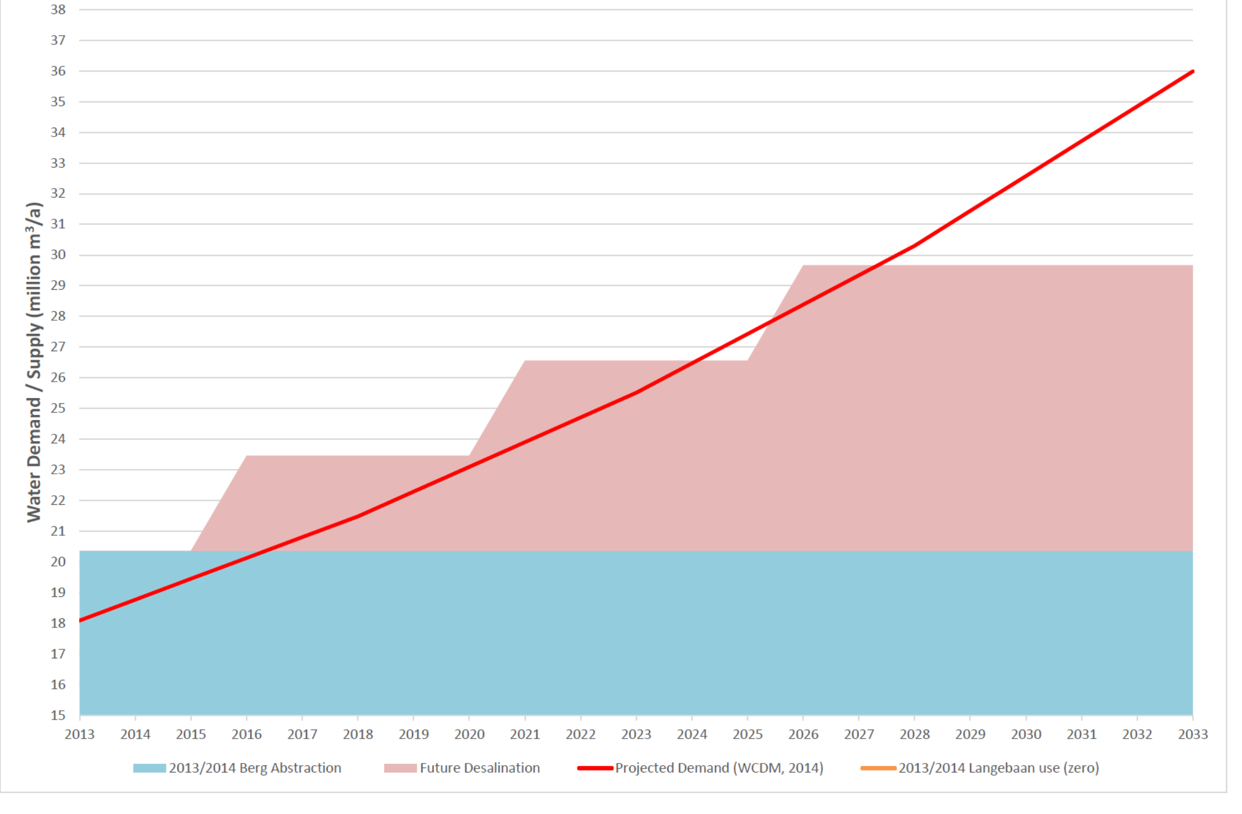


Figure 2-6 **Projected water demand of the Withoogte scheme compared to current <u>abstraction</u> and planned desalination plant.**

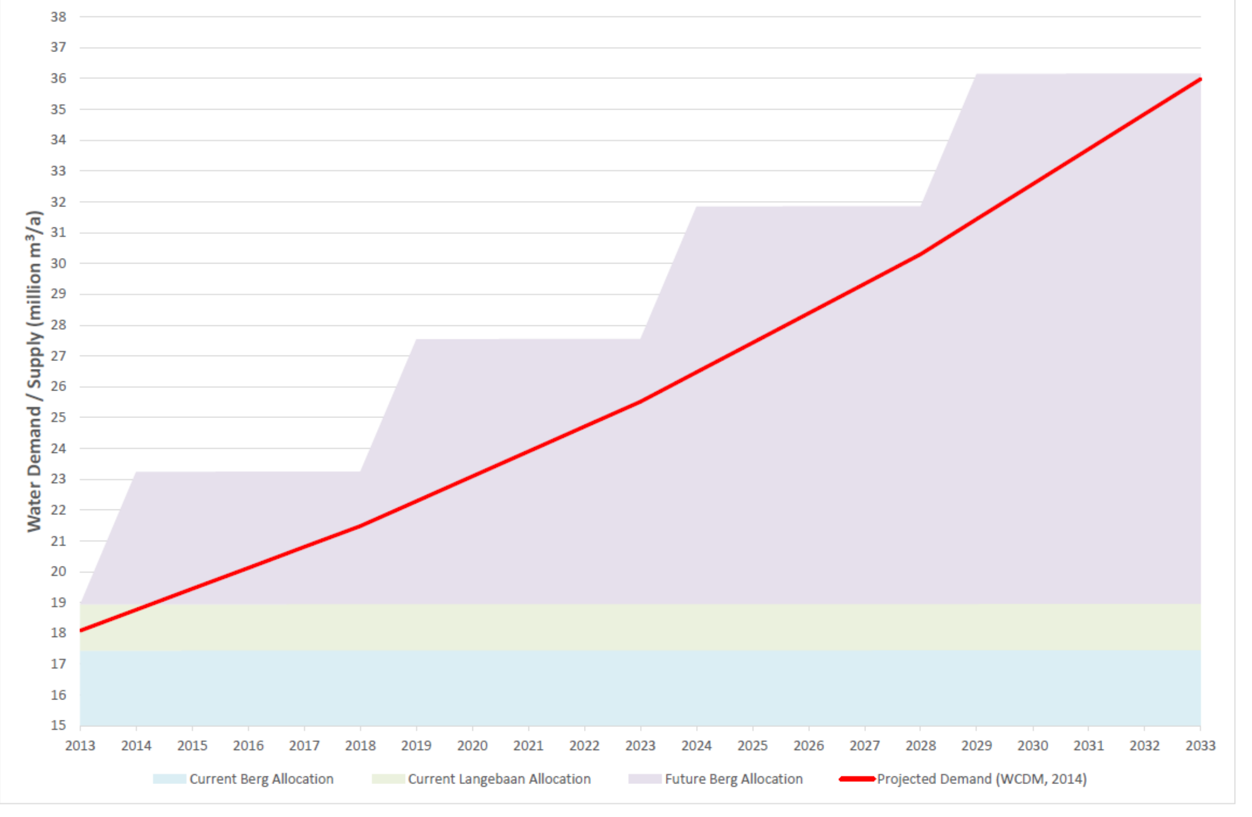


Figure 2-7 Projected water demand of the Withoogte scheme compared to current allocation and planned additional use from the Berg.

2.6 A systems view of reconciliation options

Recent research has shown that the cost (URV) of a desalinated water supply in Cape Town reduces if it is operated to meet a base load-type water demand, rather than if used for emergency supply, or as seasonal (summer) addition to the Berg River water in the WCWSS (Blersch and du Plessis, 2014). The research also suggests that capital costs are similar across a range of capacities when considering large desalination plants, i.e. capital costs for a 50 000 m^3/day plant and a 350 000 m^3/day plant are both between R10,000 to R14,000 per m3/day. (Blersch and du Plessis, 2014). This excludes desalination plants built as emergency schemes, which have elevated costs.

There is no (documented) discussion in the existing water resources planning studies that addresses an intuitive implication from this research: is it more cost effective to establish a larger desalination plant in Cape Town with sufficient capacity to meet the city's future shortfall from its allocation from the WCWSS? This scenario sees SBM potentially meeting its future needs from the WCWSS, removing the need for a desalination plant (or any other significant water infrastructure development) in Saldanha Bay. This line of reasoning extends beyond the issue of desalination. If CCT is to invest in infrastructure to generate something like 230 million m^3/a (sum of the yields for interventions local to Cape Town, Table 2-7), it seems likely that it would be most cost effective for these interventions to increase in capacity by another 16 million m^3/a, to also accommodate the projected 2035 shortfall to the Withoogte scheme, thus allowing this volume to be available in the Berg for use in the Withoogte scheme.

Comparing the costs of future reconciliation options across the Berg is part of future phases of the WCWSS Reconciliation Strategy Study (pers comm. Isa Thompson, 2014). However, given the current models do not replicate the integrated surface and groundwater catchment and the water supply systems (Section 2.1), an integrated analysis across the catchment of the trade-offs between various reconciliation intervention options would be a challenge.

Is it more cost effective to establish a desalination plant in Cape Town rather than Saldanha Bay? When assessed as a linked system, how do all the reconciliation options across the Berg WMA compare and what are the most cost-effective solutions?

What governance and water pricing mechanisms would be required for Saldanha to avoid a desalination plant, indirectly benefitting from a larger plant in Cape Town (i.e. transference of Berg River WCWSS allocation from CCT to SBM, which would require payment towards desalination in CCT?)

2.7 Perspectives on water resources and economic development planning

The scoping phase literature review documented above highlights that work is being done to varying degrees on all aspects of the key questions posed at project initiation. Existing work by the DWS certainly addressed how much water is used by the region's economy, and how much is available. An assessment of the virtual water flows through the economy has been explored (WRC, 2013b). Water quality impacts are the key focus of the Berg River Improvement Plan (BRIP) work, under DWS's Water Quality Partnership, in which work has continued for several years. Potential constraints on the economy and wider development is the subject of work such as DWS's Water for Growth and Development Framework (DWA, 2010a), and is also within the Sustainable Water Management Plan (PGWC, 2012). Furthermore, an Action Plan of necessary interventions was delivered within the Sustainable Water Management Plan (PGWC, 2012), and the BRIP is also intervention-orientated. Related to this wealth of existing water and economics work, several stakeholder perspectives gleaned from initial informal conversations suggest that any additional investigation into water/ economics by GreenCape is not necessary (Table 2-8). Conversely, several stakeholders' perceptions reveal gaps in the existing planning frameworks, and numerous stakeholders felt that GreenCape's investigation was necessary (Table 2-8).

Table 2-8 Perspectives of the GreenCape water project, gained in informal stakeholder liaison

Perspectives suggesting no water & economics investigation is necessary by GreenCape
• "The IDZ have covered what your project intends to in their feasibility study"
• "The IDZ has collated development plans and water resource requirements already"
• "The IDP process meets the aims of the GreenCape project"
• "There is no need for this project because the plans have been completed… the funding application is in for the desalination plant…"
Perspectives suggesting there is need for GreenCape's water & economics investigation
• "The IDP process should be meeting the coordinated development aims that this GreenCape project has taken on… but the LM is looking to the IDZ to fulfill this role"
• "We couldn't get information on possible developments so had to make assumptions" [for water resources planning]
• "We are forced to make broad assumptions because there is no clear picture of the planned development" [When planning water resources]
• "We can't get any firmer information from the IDZ or anywhere else on what projects are likely, so I have to apply cautious approach and apply various water demand growth percent's"
• "We need to be assessing the cumulative impact of projects and the viability of development options, and have no mechanism for this … as there is no consolidation of the intended development. Your approach is necessary and wholly supported"
• "There is no tool for strategic assessment of the direction of an area and assessment of a group of developments…. Water Use Licenses, EIAs, are all currently assessed project by project"

- "At the time of the IDZ feasibility studies there was a lot of collaboration and coordination looking at the environmental impact and infrastructure requirements of development…. This effort has fizzled out because the LM now thinks "we'll just put in a desalination plant and all will be well".
- But the LM must take a step back and decide which industries, and then which projects, should go ahead, and start to say "no" based on water availability"

To further investigate stakeholder perceptions and the status quo of integrated water resources and economic development planning in Saldanha, a workshop was hosted on the 24th February 2014 at DWS in Bellville, Cape Town. Attendance was primarily from those in the local, district, provincial and national water, economic, environmental, development and spatial planning space, with representation also from major industries in Saldanha. The objectives of the workshop were the following:

1. Pool collective knowledge for integrated infrastructure development;
2. To develop a common understanding of the "system"; and
3. Further develop relationships and move forward in a collective and collaborative way.

The three framing questions for the workshop were as follows:

1. What are the economic development plans and water resource intervention plans for Saldanha?
2. How are we currently integrating economic development and water resource planning?
3. What are the appropriate sources of water development, at what price?

The workshop highlighted a range of divergent views about the "right" kind of development or actions or plans for the area and the degree to which industry or business should be providing some of its key resources as a "license to operate". Particularly divergent views were also expressed in relation to whether or not water is in fact a constraint to development in the area, given the potential for desalination, and whether or not desalination was an appropriate technology to employ.

Summarizing the literature review, informal stakeholder liaison, and information gleaned from the workshop, the following key insights are drawn on the current water resources and economics baseline situation:

1. The responsible bodies; the Department of Water and Sanitation, the district and the local municipality in Saldanha; carry out significant work for water resources planning. These plans are based on broad assumptions of the annual growth in demand (as a percent) over the planning period (usually the coming 20-40 years). These demand growth percent's are generally developed through an assessment of previous water demand growth trajectories, and take into consideration the general level of economic growth intended for a region, as documented in the Integrated Development Plans (IDPs). However, the IDPs do not define specific projects or developments planned in the municipality, and are generated only on a 5-year basis. There are good reasons for these existing approaches, however, it makes it very difficult to strategically assess a set of development options, such as a group of proposed minerals beneficiation projects for Saldanha, and answer whether there is or is not enough water for these developments.

2. Although work has been done on the potential future cost of water, and the cost per resource intervention or source of water (desalination, water re-use etc.), and on the impact that this cost may have on certain economies, there is no work that addresses a complete cycle for Saldanha: the potential developments, their water demand and the potential source, the potential cost of the provision of the necessary water, and the impact of that cost on the potential development.

3. In the existing work and planning systems, there does not appear to be an explicit feedback loop between the proposed economic developments, the required water, the cost of this intervention, and a strategic decision as to whether this proposed development, or group of developments, is therefore viable, and whether it represents efficient or "smart" use of resources.

4. The strategic decision-making that seems necessary, for a group of developments, or a development direction of an area, is not yet underway as projects are authorized (in environmental impact assessments, in water use licenses), on a project-by-project basis. Stakeholders reflected on the lack of a decision support tool to enable strategic decision-making and quantify competing resource demands.
5. Although work has been done on the economic productivity of various water uses or economic sectors, this had not yet been used to inform the "smart" use of water resources, for the future development options for Saldanha.

Hence, although parts of the project key questions can be answered by various existing interventions, a linked systems analysis of the water and economics situation for Saldanha bay planning is not established in existing work. This results in an inability to answer the following framing question from analysis of the existing literature, and applying existing standard approaches:

What are the "right" sources of water, at what quality, for the "right" developments, for the "right" price?

Several activities and key interventions have been identified as required to respond to this framing question:

1. <u>Integrate systems approach to water & economic planning</u>: Existing planning processes are not optimally integrated, which in itself could allow constraints to develop. Thus one necessity to alleviate constraints to development is to integrate a systems approach, which recognizes the interdependent nature of water resources and economic development, to the existing planning structures.
2. <u>Water Demand of economic developments</u>: As a first step in implementing the required systems approach to economic development and water resources planning, a more explicit link is required between development plans and their water demands. This would be in response to the key insight that future water demands are currently generated from generalized growth percentages. This is due to various reasons including an inability of water resources planners to access information on proposed developments.
3. <u>Cost- benefit analysis</u>: Another necessity for development within a water-constrained catchment is to ensure that available resources are allocated for optimal benefit ("*SMART* allocation"). For example, this may include allocating water preferentially to a proposed industry on account of its employment of a significant number of people. Development of cost-benefit tools, and tools to assess "SMART allocation" of water resources, would respond to the key insights that reflect the lack of a strategic assessment of development options, and a lack of tools for strategic decision-making. Development of appropriate tools could also enable comparison of water resource reconciliation options and economic development scenarios across the Berg.
4. <u>Water Exchange Networks</u>: An alternative approach to using less water to traditional WC/WDM, is a "Water Exchange Network" (WEN) in which water of different qualities are cascaded (used and passed on) between major users, and used for different purposes.

A 5-year programme has been developed to address the above activities, which are sketched in Figure 1-2 showing their alignment with initiatives already underway.

Additional information on the literature reviewed, the existing interventions, stakeholder mapping, and a report from the workshop (Reos, 2014), is included in Appendix 3 Section 11.

The workshop results provide rich information including a large set of stakeholder perspectives related to institutional arrangements for the GreenCape project, water resources, socio-economic development, and planning mechanisms. Perspectives on enablers and barriers to integrated economic development and water resources planning were also collected. These workshop results are incorporated into the key insights here, and the programme activities are designed to take steps towards addressing these key insights. However, there is certainly more material in the workshop results than has been actively incorporated, and it warrants further analysis.

The workshop evaluation forms suggest there is sufficient energy and drive to continue to meet, and that structured multi-stakeholder spaces for discussion/dialogue are generally viewed as central to addressing some of the key barriers to "smart", integrated, "rational" economic development in the area. Such spaces can assist in building an integrated, systemic understanding of and approach to the Saldanha Bay system as well as develop the kinds of relationships that are fundamental to the development and implementation of a "smart", integrated, rational decision-making model based on a clear, collective vision of the future.

The stakeholders who attended the workshop represent the same community with whom the GreenCape project researchers should continue to liaise with whilst taking the programme into the next three years (under the co-funding of the WRC and DED&T). GreenCape should therefore continue to host multi-stakeholder spaces for discussion/dialogue. In preparation for future workshops, it is therefore recommended that GreenCape release a newsletter update of programme activities to all workshop attendees in ~April 2015. Included in this should be a response to questions raised at the workshop.

3 Integrated Water Resources & Economic Development Planning

Purpose: to avoid water constraints on economic development caused by sub-optimal integration of development planning, greater integration is required. Planning needs to incorporate a systems view of resources and the economy. This chapter documents preliminary concepts towards such an approach. It takes the first steps in providing a solution to optimising planning for Saldanha, and a methodology that can be applied in other areas.

Target Audience: the ultimate target audience is those responsible for economic development planning and water resources planning at local, district (or regional offices in the case of water), provincial and national government levels.

3.1 Conceptual Model for Integrated Water & Economics Planning

The framing question reflects the programme vision for Saldanha Bay: the development of a new water economy in which different sources and qualities of water are sold at different prices, to different users, for different uses. It differs from conventional approaches which ask "how much water is needed for development?" or "what economic developments do we need to take into account in water resources projections?" In both of the latter questions, one half of the question is an independent variable i.e. the "proposed development" is a static variable for which enough water must be made available.

In terms of water resources and development, the DWS has been careful to point out that whilst water is essential to development, its availability is not a driver to, nor constraint on, development (DWA, 2010a and DWA 2010b). This position is based on the view that as much water can be made available as is required (via desalination for example). In the case of a catchment where all readily available water is allocated (such as the Berg) a proposed economic development scenario or future would require additional water resources. These in turn require new infrastructure, which comes at a cost. This cost would be borne in part by the economic development in the proposed scenario, via capital levies or direct water charges. If the industries or activities considered in the economic development scenario are unable to bear this cost, then the cost of provision of water becomes a constraint to economic development. Therefore, the ability of these industries or activities to carry the cost of this proposed water infrastructure should be taken into account in determining the viability of the proposed economic development scenario. The cyclic interdependency of economics and water resources therefore needs to be taken into account in development planning.

Through matching water of different quality with different uses and pricing appropriately we aim to recognise this cyclic interdependency of economic development and water, and to accommodate the full complexity of water resources and development planning. The question is therefore transversal across those responsible for water resources planning, and those responsible for economic planning.

A conceptual model showing the approach required to address the framing question, is shown in Figure 3-1. Within this model, economic and water resources planners would need to start with a definition of the development scenario, based on a vision of what level and type of development we want in our future. We would then need to look at the water demand that this development scenario requires. This includes the volume of the required water resource (per year), and also the required water quality. Given that the Western Cape Water Supply System is a fully allocated system, these water requirements need to come from new resource interventions. So, based on the demand of this future development scenario, new resource interventions, and their impact and cost can be assessed. Subsequently, based on the cost and the impact, a strategic decision is required on whether the proposed scenario reflects "smart" use of resources, and should proceed.

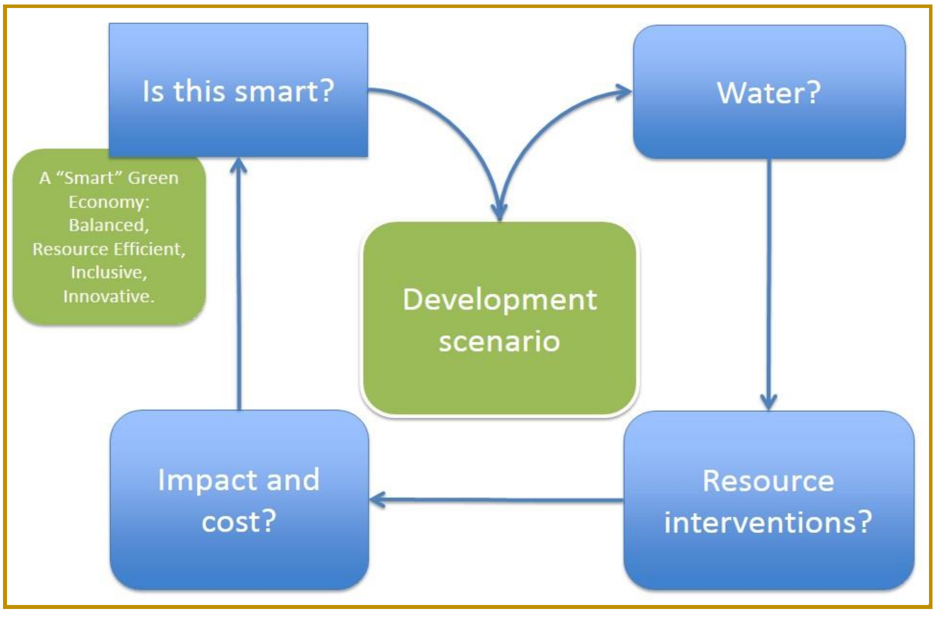


Figure 3-1 Model for integrated water and economic development planning

3.2 Comparison to existing planning processes

This conceptual model can be applied to assess any number of grouped development plans or scenarios, responding to the key insight that projects are currently assessed in isolation (on a project-by-project basis) rather than with strategic oversight. Existing planning mechanisms are not succeeding in applying this cyclic approach (at least in Saldanha), as evidenced by:

- water resources planners reflect having no clear picture of development on which to base projections, and broad water demand assumptions inform resource interventions;
- development planning and water resources planning occurs on different timescales;
- stakeholders feel there is no strategic assessment of a group of developments, with developments authorised on a project-by-project basis;
- the economic productivity of water uses does not inform allocation or development choices; and
- there is no feedback loop from cost of provision, to the development scenario proposed.

The Integrated Development Planning (IDP) process is the key (economic, social) development planning process carried out at local municipal level, which determines the municipal budgets for the coming 5 year period. Simplistically described; the process for IDP development commences with problem definition, and information gathering on *current* available resources (Table 3-1). Based on current problems and available resources, a set of strategies is developed that can address these problems, and new projects are identified, shaped by a vision and objectives. The projects are defined, and planned projects are integrated with other municipal plans, and modified if required. Although there is consultation with stakeholders and other information along the way (such as available water resources under section 1), Figure 3-2 illustrates that IDP development is largely a linear process that commences with problem definitions, and programmes are developed to meet these problems.

The IDP for Saldanha identifies the following key issues relating to the industrial sector, within its Phase 1 analysis section:

- “The capacity of the current harbor and its infrastructure facilities at Saldanha are not sufficient to fulfil the present need or additional exporting needs
- The industrial role and function of Vredenburg and Saldanha are undefined and therefore unstructured industrial development is taking place
- Investigate the possibility to promote an industrial corridor from the port, along the railway line to the existing IDZ area
- There is a conflict of interest between industrial development and conservation of the pristine natural environment in the municipal area
- There is a strategic need for the municipality to reach an agreement with large land owners relating specifically to their land holdings and land release policies
- Industrial land is not accessible/ affordable to previously disadvantaged entrepreneurs
- Heavy industries abstract water from an underground aquifer - the capacity of bulk water for industrial development is unknown
- There is a need to spatially identify and quantify future industrial land needs related to future port expansion, downstream processing and predicted light industrial growth and the ultimate realization of an Industrial Development Zone
- Support systems are needed for SMME’s in the industrial sector” (SBM, 2013)

Although these issues are raised, how they translate to listed projects in the IDP, or which projects aim to address them, is not immediately clear. The IDP incorporates the current status for water resources in Saldanha, through reference to other LM plans (the Water Master Plan, see below).

Natural resources, infrastructure, and development challenges all extend beyond (and are shared between) political boundaries such as the border of an LM. As such there is a need for IDPs to be aligned between LMs, which is a responsibility of the provinces. The “IDP Indabas” are held for the purpose of ensuring that plans are aligned. However, some of those involved have shared the perspective that these have become “tick-box” exercises; in the absence of tools to ensure that strategic planning is possible.

The Water Services Development Plan (WSDP) and Water Master Plan are water-planning processes completed at LM and/or DM level (depending on roles of WSA and WSP). Regarding provision of water and future reconciliation of demand and supply, the Water Master Plan follows the same process as that described in Section 2.4 above. Water demand growth percent’s are applied to inform long term projected water demand, a necessary approach given the different planning timescales (see key insights section 2.7), and given the lack of information from the IDP process (Table 2-8) (WCDM, 2013).

Due to a lack of local surface water resources, nearly all water used in SBM is derived from the municipal system. As part of an EIA, a potential developer must document the anticipated impact on water resources quality and quantity and how the development will source water. Developments in Saldanha with significant water demand therefore apply to the SBM for an allocation during the EIA process. The SBM assesses these developments on a project-by–project basis, and performs a cross-check to determine whether their demand fits within the already planned-for demand (i.e. that derived from growth percent). Planned supply interventions are also taken into account (pers comm Gavin Williams, SBM). This contributes to determining whether or not the proposed development can proceed. If the anticipated demand increase falls outside of the budgeted growth the proposed development is refused until the planned-for growth can be updated. This function is sub-contracted on a retainer basis from the SBM to the same group who completed the LM and DM Water Master Plan. Alternatively, it may be up to a particular development to prove that there is sufficient water in the scheme to supply their needs as part of their application.

The implications of the existing linear planning mechanisms, and not following the appropriate integrated systems approach include:

- The value of high water demand industries may be discounted without an assessment of the overall cost/ benefit to the system. The DWS has shared the perspective that no ‘wet’ industries should be permitted in a water-constrained area such as Saldanha. However, if the wet industry represents an overall benefit to the system when considered in terms of the cycle presented in Figure 3-1, then these industries should not necessarily be excluded.

- Expensive water resources supply solutions may be proposed without an assessment of the ability of the proposed development to meet these costs: a situation possible for Saldanha given the debate around desalination.

Table 3-1 Phases and outputs of the IDP development (from DWAF, 2007c)

Phases	***Key outputs***	***Time frame***
1 – Analysis	• Assessment of existing level of development; • Priority issues or problems; • Information on causes of priority issues/problems; • Information on available resources.	3 months
2 – Strategies	• The Vision; • Objectives; • Strategies; • Identified Projects	2 months
3 – Projects	• Performance indicators; • Project outputs, targets, location; • Project related activities & time schedule; • Cost & budget estimates	2 months
4 – Integration	• 5-yr financial plan; • 5-yr capital investment programme (CIP); • Integrated Spatial Development framework; • Integrated sectoral programme (LED, HIV, Poverty alleviation, gender equity etc); • Consolidated monitoring/performance management system; • Disaster management plan; • Institutional plan; • Reference to sector plans.	6 weeks (1,5 months)
5 – Approval	• The output of this phase is an approved IDP for the municipality	6 weeks – submission to MEC

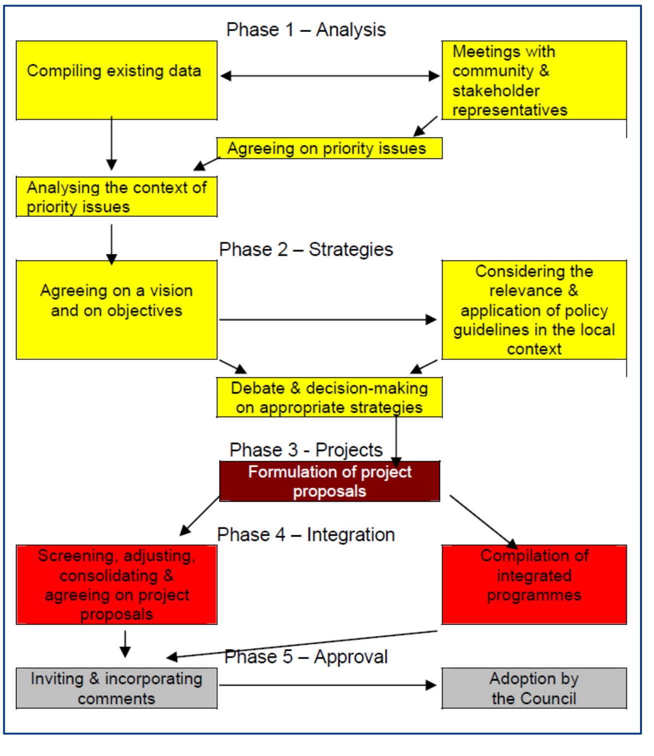


Figure 3-2 Schematic diagram of the IDP methodology process (from DWAF, 2007c)

The discussion above is preliminary and looks at only a few of the planning processes undertaken at LM and DM level. There is a need to review all potentially relevant planning processes (master planning, spatial development planning, local economic development planning, inter alia) and assess how to mainstream the necessary cyclic system planning view into them, and if this isn't possible, to determine how existing processes can be updated.

What changes are needed to the existing governance structures and planning processes (IDPs, IDP indabas and provincial coordination and oversight of IDPs, WSDPs, Water Master Plans, water reconciliation planning amongst others), to enable fully integrated planning? How would these changes be implemented?

Water resources must be planned on 30 year cycles, where as detailed development knowledge focusses on shorter horizons leading to the necessity for water resources planning to make broad assumptions. How do you overcome the different planning timescales to ensure optimized integration?

4 Water Demand for Current Potential Economic Development

Purpose: Responding to stakeholder perspectives that there was no information on development plans to inform water demand planning, and no coordinated picture of development, GreenCape collated existing proposed and potential economic developments in Saldanha Bay and water demand based on these developments, as a preliminary step in enhancing integration between economic development and water resources development planning. This also acts as the first step in applying the cyclic approach to development planning (Figure 3-1).

Target Audience: a collation of proposed developments, and their water demands, was requested from DED&T. The wider target audience includes those responsible for economic development planning and water resources planning at local, district (or regional offices in the case of water), provincial and national government.

4.1 Overview

The first insight listed under section 2.7 above highlights that future water resources interventions are planned based on future water demands generated from generalized growth percent's. Stakeholders indicated that there was no alternative to this because water resources planners could not source, or did not have access to, information on proposed developments (perspectives in Table 2-8). Without a collated view of planned or potential developments, it is not possible to apply the conceptual model for integrated planning as proposed in Figure 3-1. A coordinated view of potential developments is a prerequisite for strategic assessment of development options. Planning water resources interventions from a growth percent also means it is a challenge to then consider a particular development, and determine whether existing water supplies are sufficient: the water demand of the development must be compared to the already planned-for demand to see if what is planned for can meet the development (section 3.2).

As a first step in generating a coordinated view of proposed developments, proposed industrial developments for Saldanha Bay were collated from feasibility reports and environmental impact assessments, from those projects that are known to be "in the pipeline" from DED&T, and direct from major industries. Industrial water demand estimates were generated per development and combined with domestic demand projections to generate a total water demand trajectory. This water demand trajectory was completed during the scoping phase of the project (GreenCape, 2013), and the assumptions and data input to this water demand curve have, where possible, been updated here. This trajectory is compared to current water resources intervention options.

4.2 Methodology

The methodology applied was adapted from that applied by BKS (Pty) Ltd, (now AECOM), in the Bulk Infrastructure Review for Saldanha IDZ (BKS, 2011), that supported the Saldanha Industrial Development Zone feasibility report (Wesgro, 2011). Key components of the methodology applied are:

- *Area included*: The assessment included all potential industrial developments, and other developments that may have significant water demand, in the area served by the Withoogte Water Supply Scheme. It excluded housing developments assuming that the water demand for these would fall under the projected increase in domestic supply.
- *Projects included*: Proposed industrial developments for Saldanha Bay were collated from several sources. Lists for current and recently awarded EIAs in the area were sought from SBM and from DEA&DP (including one list of those assessed by national DoE). Saldanha's major industries were contacted directly for information on future development plans, and parties at DED&T were interviewed for more information regarding large "in the pipeline" developments not yet at EIA stage.

Where a future industrial development was known to be possible for the area, yet was not reflected as an individual project, the development was handled in a hypothetical manner as a group of developments in this industry.

- *Water Demand of developments*: The water demand for each project or industry was taken from feasibility reports and environmental impact assessments where available (ideal), or from values for similar existing industries in Saldanha and literature-derived values (second best). Where there was no other information on which to base an estimate of water demand, a water demand was generated using an estimated value for water use per land area taken up by industrial development, using the area of land for the proposed development in the EIA (an approach applied as a last resort). Values for water use per land area taken up by industrial development were taken from BKS, 2011 and WCDM, 2013.
- *Growth Scenarios*: Three growth scenarios were assessed; low (pessimistic), medium (base case) and high (optimistic), applying the same definitions for these scenarios as those applied by the Saldanha Industrial Development Zone, in their feasibility report (Wesgro, 2011).
    - *High growth (optimistic) scenario*: "An Optimistic Scenario depicts high growth in the various market sectors, optimised statutory and bureaucratic processes, and the most timeous undertaking of solutions to various key challenges and constraints" (Wesgro, 2011).
    - *Medium Growth (base) Scenario:* "Base Scenario depicts an "all things remaining the same" principle where current trends in market potential, competition, the availability of key resources and infrastructure and meeting statutory and bureaucratic processes remain the same" (Wesgro, 2011).
    - *Low Growth Scenario*: "A Pessimistic Scenario depicts a downturn of the market potential and the least timeous undertaking of solutions to addressing key challenges, such as infrastructure provision, skills, environmental management, and the statutory and bureaucratic processes between the various key stakeholders."
- Translating these definitions to the water demand projections: where projects have a range of possible start dates, the earliest would be used in the high growth scenario and the latest for low growth; and where the potential water demand varies, the highest would be used for high growth, lowest for low growth. Where a project's start date and water demand were known with greater certainty, the same data was entered for the low, medium and high growth scenario. It is therefore only projects with uncertainty that generate the difference between projections.
- *Conventional and Green Approach*: In the conventional approach, all water demand is summed with the implicit assumption that all required water is of potable quality and will come from the central supply scheme. A "green" approach was applied, again using the same definition as applied by Wesgro, 2011. In these scenarios the required water quality is taken into account and it is assumed that certain industrial water users would treat their process water, and make use of treated effluent onsite, thus reducing the overall potable demand by some portion (relevant to the industrial process). The reduction was again determined either from information in feasibility reports and environmental impact assessments where available (ideal), or from literature values for similar industries (second best). Where no reduction in demand was deemed possible, the same data was entered for the conventional and green approach.
- *Total water demand*: The current ratio between domestic and industrial demand was assumed to continue in future, in order to scale up the industrial demand to generate a total demand for the existing Withoogte supply scheme.
- *Time horizon*: The information utilised documents projects or project phases commencing in the coming 1-20 years. However other projects will be planned during this time hence the demands cannot be considered representative for the entire 20 year period. The predicted demands taper off around 10 years, reflecting the fact that current plans provide most detail on the coming 10 years only, hence the projected demands are considered to reflect 2013-2025 (cognizant of limitations, below).

The details of each potential development incorporated in the water demand trajectory and additional information on the data used are included in Appendix 4, Section 12.

4.3 Results

The water demand trajectories generated are shown in Figure 4-1 below, compared to the trajectory developed based on a growth percent by WCDM (WCDM, 2014), and compared to existing and planned supply. The water demand trajectories differ significantly between the two approaches (growth percent, and based on actual proposed developments). Furthermore, the trajectories based on planned industrial developments are highly sensitive to individual projects, with a handful of minerals beneficiation and chemical processing projects generating the stepped increases in the trajectories. The analysis shows:

- Should all currently potential developments come into fruition in line with the conventional high demand, or the conventional medium demand, the planned additional supply from the Berg would not be sufficient to meet demand. Supply could not meet demand for a period in 2017 and 2018 for both conventional medium and conventional high growth; permanently after 2019 for conventional high demand, and permanently after 2023 for conventional medium demand. Due to the proposed timing of the increased supply, the supply would not meet the green high demand after 2019.
- The green medium growth scenario and the low growth scenario (both conventional and green) are met by the planned additional supply from the Berg, although with little resilience in the green medium growth scenario around 2017-2018 (i.e. demand within 1 million m^3/a of supply).

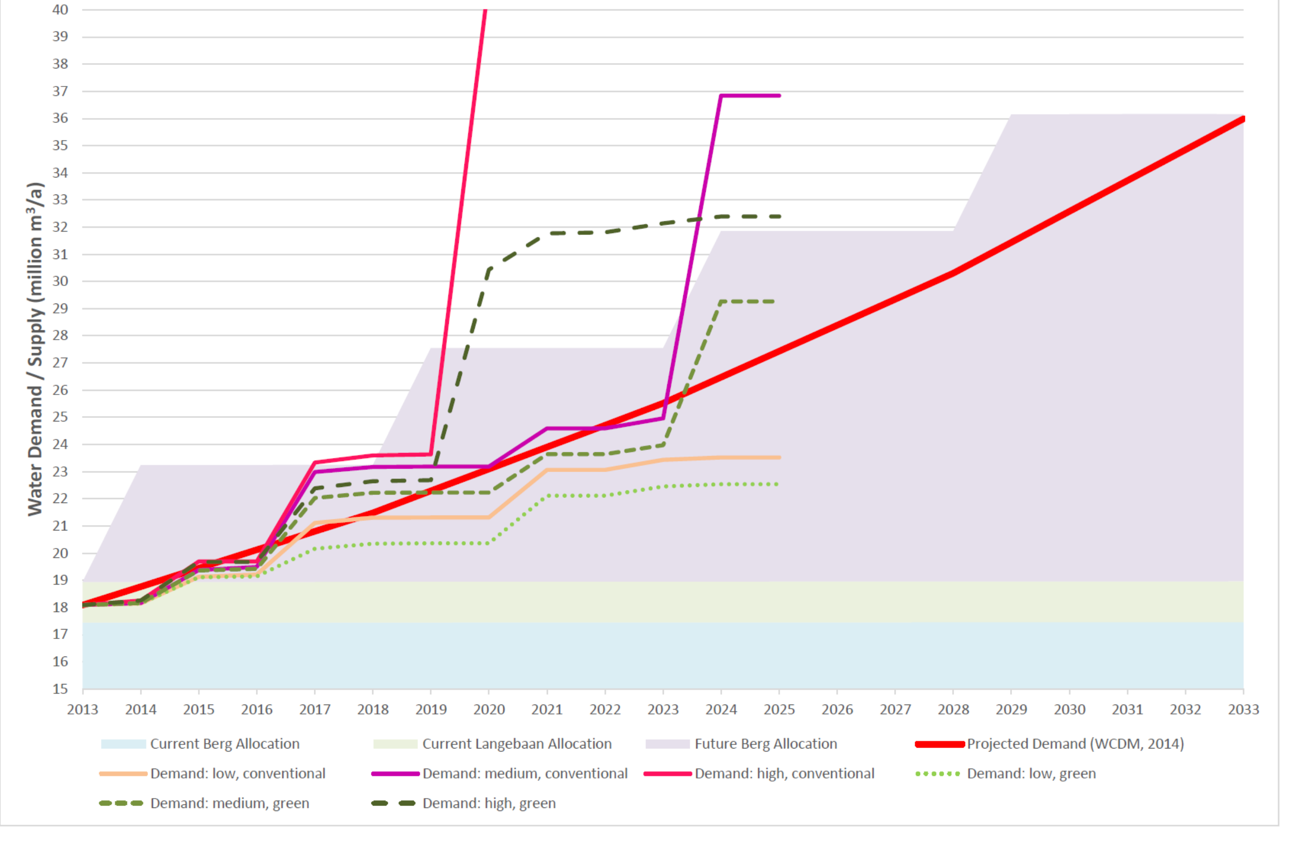


Figure 4-1 Withoogte Scheme Water Demand trajectories based on all potential developments

One proposed project has a very high projected water use and impacts significantly on the water demand projections: the proposed Specialty Metals Complex at Saldanha by Rare Metals Industries Pty Ltd complex (SRK, 2013). Based on conversations with industry leaders in Saldanha, the project is considered unlikely to proceed (at least in Saldanha). Removing this from the demand projection reveals (Figure 4-2):

- The conventional and green high and medium growth scenarios have higher water demand than the planned-for water demand (WCDM 2014), until at least 2021.
- The planned supply from the Berg at the end of the planning phase (2025) is sufficient for the conventional high demand (and therefore all of the demand trajectories), however due to the phased implementation of this supply, shortages are experienced under the conventional high and conventional medium demand scenario, in 2017-2018.
- Again due to the phased implementation of the additional supply from the Berg, at times there is little resilience in the system (resilience to climate induced variability in supply, or infrastructure failures) under the conventional medium and green high demand. In these scenarios demand is within 1 million m^3/a of supply for 2018. These times of potential water shortage cannot be predicted in the water demand trajectory of WCDM, 2014, as the stepped increases in demand are not incorporated.

The large steps in water demand in 2016 and 2020 (Figure 4-2) are generated by two industrial projects, both of which are considered likely to proceed to fruition: Frontier Separation Plant (Ages, 2014), and the associated Chlor-Alkali Plant (MEGA, 2014).

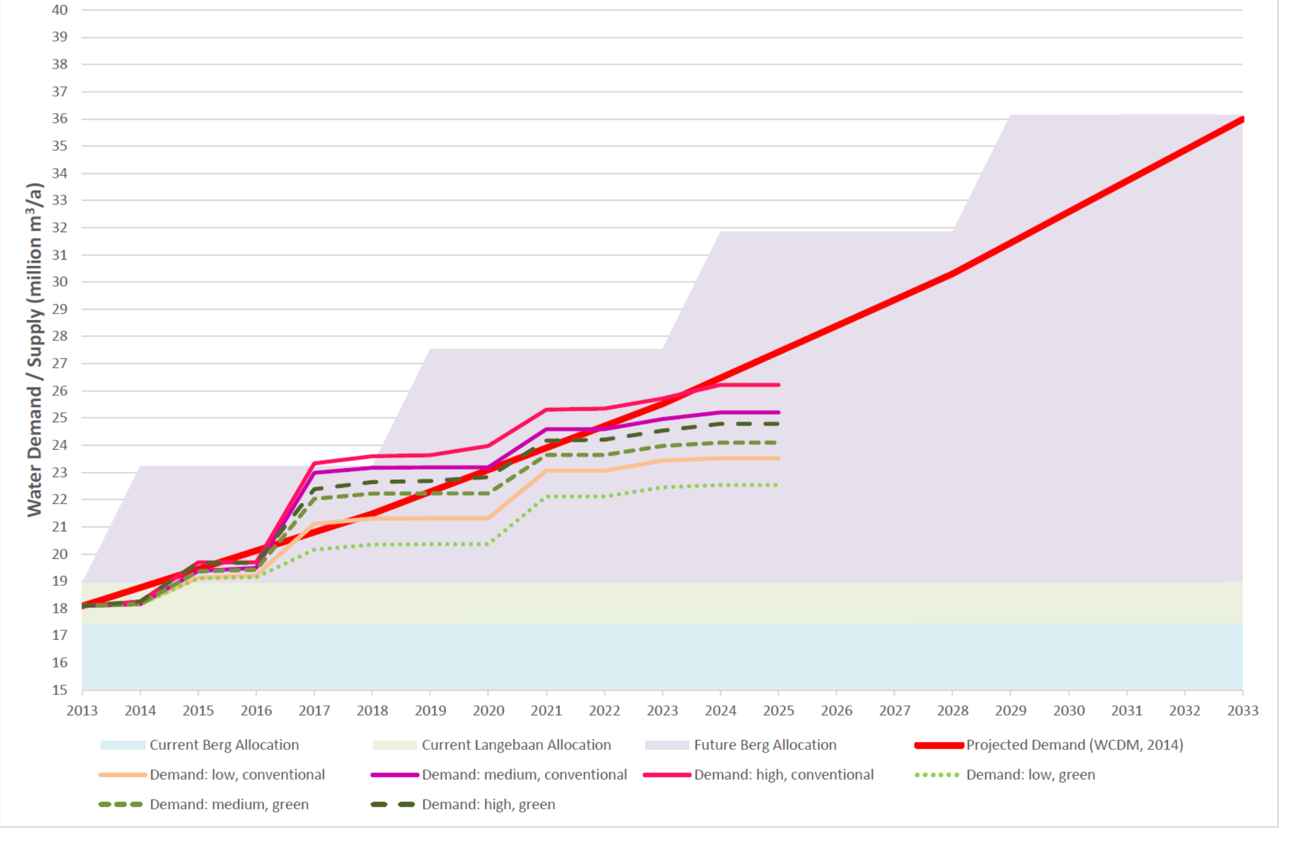


Figure 4-2 **Withoogte Scheme Water Demand trajectories excluding unlikely development**

The above statements of whether projected demand can be met strongly depend of course on the volume and timing of the supply considered. Figure 4-1 and Figure 4-2 above show the current allocations from the

Berg and the Langebaan aquifer, the first of which is routinely breached by over-abstraction, the latter of which is under-utilised (section 2.2). To illustrate the impact that a relatively small yield intervention can have on the resilience of supply, Figure 4.3 shows the same projected demands with the same yields from the Berg, but with total groundwater abstraction increased to 3.8 million ^{3}/a. This volume was recommended in the most recent specialist groundwater investigation (Element Engineers, 2010), which concluded that the sustainable yield for the Langebaan Road Aquifer System (LRAS) was 1.9 million m^3/a, and an additional yield of up to 1.9 million m^3/a was also available in a neighbouring aquifer system (the Elandsfontein Aquifer System, EAS). In Figure 4.3 it is assumed that abstraction at LRAS is immediately increased to 1.9 million m^3/a (as recommended in Element Engineers, 2010), and that development of the EAS wellfield is fast-tracked in 2015 with yields available in 2016. This shows:

- If a higher "base load" is supplied from the current Berg allocation plus enhanced groundwater abstraction, all of the potential demand trajectories are met comfortably by the planned increased and phased abstraction from the Berg.

Alternative water resources interventions are discussed further in section 6.

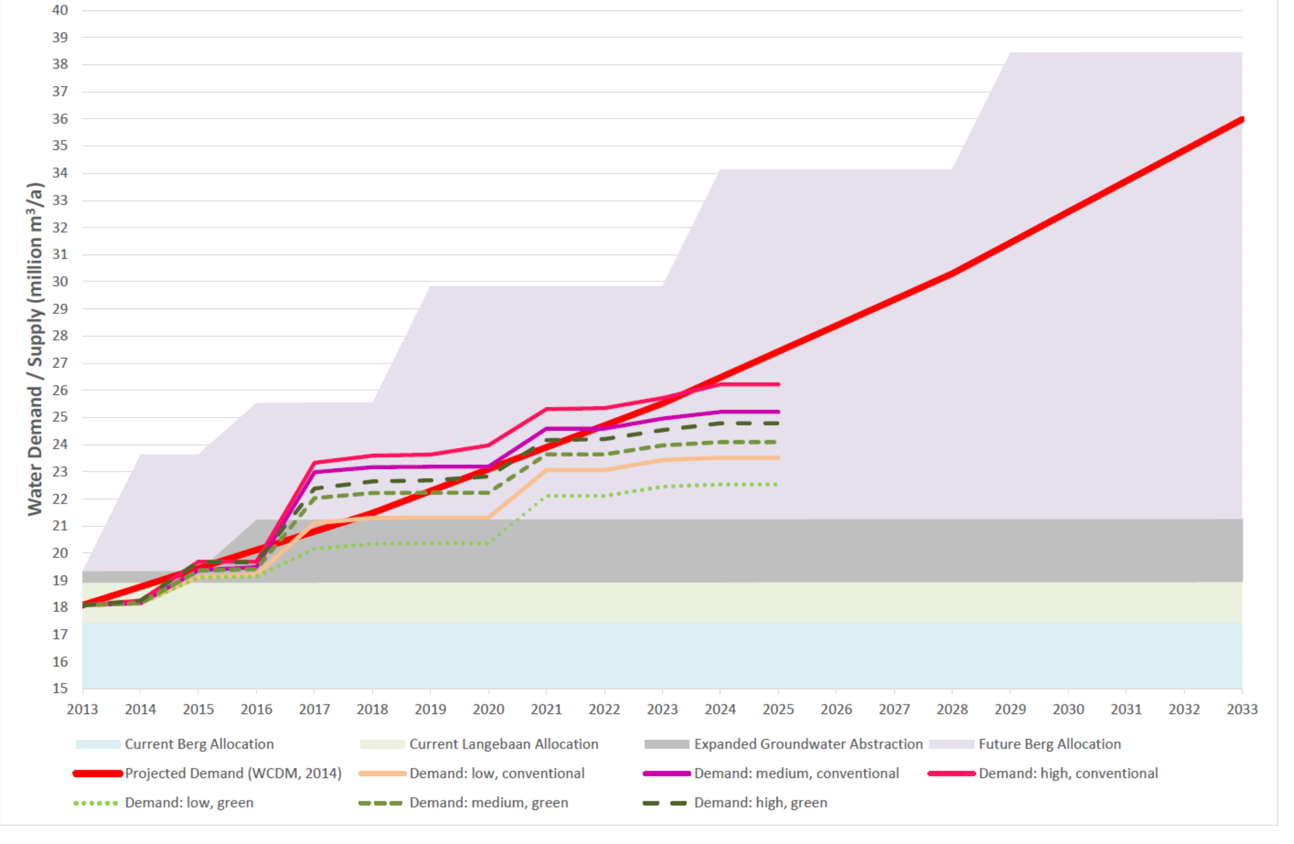


Figure 4-3 Withoogte Scheme Water Demand trajectories excluding unlikely development, shown with enhanced groundwater supply

The timing of the planned stepped implementation of the additional supply from the Berg has a dominant effect on whether supply can be met.

The reasons for the stepped increase in allocation require investigation to determine whether these timings are fixed (possible if yield timing is related to other interventions coming online in CCT freeing up water resources to Saldanha, or if the yield timing is related to required infrastructure upgrades in the Withoogte), or can be flexible (there is an utilized volume in the Berg so the actual water resource is available). If flexible, and certain projects come online quicker than incorporated in the above demand projections (or other projects come online that are not yet in planning documents), then there is more flexibility in the system and constraints on these projects and others getting off the ground are somewhat alleviated.

4.4 Limitations

The methodology applied to derive the water demand trajectories has the following limitations:

- Most significantly, the water demand trajectories cannot represent all potential developments up to 2025, as new projects will come online within this time i.e. planned in 2016 for commencement in 2018. This factor contributes to the water demand trajectories flattening in the latter part of the projection (visible in Figure 4-2), and means the trajectories are under-estimates for anything beyond the coming 5 years. There is little that can be adjusted in the methodology to address this limitation.
- Also significant is that the methodology sums all potential projects, and not all projects will go ahead (due to project funding withdrawn, shifts in economic climate impacting development plans, EIA's being rejected, amongst other factors) so the demand may be over-estimated. Incorporating a "likelihood factor" can go some way to managing this over-estimate (see recommendations).
- Several assumptions are involved in those projects for which water demand is not currently known.

4.5 Implications and Recommendations

The results above show the impact of large industrial developments on water demand, which generate a stepped increase in water demand compared to the gradual growth projected in the traditional approach to water demand planning. In several scenarios the demand based on industrial developments exceeds the existing demand projections based on the traditional approach, and reveals that demand may exceed supply in 2017-2019, caused largely by two particular industrial developments (the Frontier Separation Plant and the Chlor-Alkali Plant). This result suggests that:

i) A closer analysis of the demand / supply for the coming 5 years may be warranted to verify this result.
    - The Frontier Separation Plant and the Chlor-Alkali Plant have both assessed their impact on water demands in detail as part of their EIA processes (following the process described in section 3.2), (AGES, 2014 and MEGA 2014 respectively). Frontier Separation (Pty) Ltd was instructed by SBM to contract the same engineering consultants who developed the water master plan for SBM and WCDM, to demonstrate that there was sufficient water for the development, and Chlor-Alkali Holdings (Pty) Ltd carried out a specialist water supply study as part of the EIA (Mega, 2014 – Appendix C). Each project has secured a water supply from SBM, so it can be deduced that the SBM and WCDM have gone through a similar (but more rigorous) planning process to that included here, yet came to a different conclusion. The intention here is not to determine the viability of individual projects, as this requires a more in-depth analysis (capacity of local supply infrastructure in addition to total scheme demand). The demand trajectories were compiled for a regional picture of the impact of potential developments on water demand, and to understand whether development at broader scale is constrained.

ii) There appears to be merit in applying the method tested here for detailing short term water demand trajectories, in combination with long term forecasts based on growth percent's.

- It seems counter-intuitive for the standard approach to water demand planning to apply a growth percent and then assess developments on a project by project basis to determine whether they 'fit' into the trajectory, and also for each development to undertake its own detailed water supply/ demand assessment.
- It is recommended that SBM (and other water resources planners) apply a combination of water demand projections based on growth %, and projections based on planned potential developments depending on the time frame under consideration.

In support of this recommendation, it is recommended that GreenCape interrogate the local level planning processes and decisions in greater detail to determine whether there is merit in the SBM &/ DED&T adopting and routinely maintaining the development-based water demand curve generated here. If there is merit, the tool and data can be handed over, and ideally made available online for developers and decision-makers. Prior to handover the following updates are recommended by GreenCape:

- *Data updates:*
  - *A verification exercise is necessary with DED&T to ensure all potential developments are captured.*
  - *Determine criteria for likelihood, and amend projections based on the likelihood of projects.*
  - *Some of the base data used for the projections was 2012/2013 water use data from SBM. As new water use data becomes available annually, the projections can be compared to actual, and updated.*
- *Tool updates*
  - *A VBA coded macro-model was developed to generate the water demand projections, which reads basic project information input to user-friendly input sheets, and develops the water demand curves. It is recommended that the model be tabled with relevant stakeholders and depending on a more detailed user-needs assessment, the model could be updated and made available (i.e. online).*
  - *A simple user-manual needs to be written*
  - *The model could be updated to group development scenarios (i.e. separating green economy industries, minerals beneficiation etc.), generating sums per industry group, and to incorporate likelihood, enabling a user to plot up various combinations of industry groups & likelihood.*

5 'Smart' water allocation

Purpose: Stakeholder perspectives reflect that there are no tools for strategic assessment of a group of developments (rather than project-by-project assessment), and that the relative benefit of water use is not being taken into account in allocation of scarce resource. In response, tools for linking water use and economic value were investigated, and work commenced on a water related cost benefit analysis of potential developments for Saldanha. Once completed, it is intended that the final results can guide decision-making in Saldanha Bay, and assist DWS in an illustration of what can be taken into account in allocation.

Target Audience: The DWS is responsible for water allocation decisions, and hence the results have the potential to be directly useful. The wider target audience is those responsible for economic development planning and water resources planning at local, district (or regional offices in the case of water), provincial and national government.

5.1 Overview

The conceptual planning model developed in Figure 3-1 to respond to the framing question [*What are the "right" sources of water, at what quality, for the "right" developments, for the "right" price?*] requires that a development scenario and its associated water demand and cost of provision of that water, be assessed to determine whether, on balance, it is resource efficient, balanced, inclusive, and innovative i.e. whether it represents 'smart' water resource use. When this associated water demand initiates new water resources to be developed with associated cost, this 'smart assessment' must include whether the development can afford the water cost, and whether the benefits of the development warrant the expense of the water resources intervention. Where new development will be supplied from an existing but constrained resource, and in order to promote the most beneficial resource use, this resource should be allocated to the development that represents the greatest social, economic and environmental benefit. However, stakeholder perspectives reflect that there are no tools for strategic assessment of a group of developments (rather than project-by-project assessment), and that the relative benefit of water use is not being taken into account in allocation of scarce resource.

Various methodologies were assessed for their usefulness in linking water use and economic productivity. Three methods were analysed, a summary of which is provided in Section 5.2 below:

1. Statistical water accounting on a macroeconomic level and as input-output analysis
2. Water Footprint Assessment (WFA)
3. Water efficiency and economic productivity indicators.

A water-related cost benefit analysis was initiated for future development plans for Saldanha, to investigate the potential for the approach to inform resource allocation for greatest social, economic and environmental benefit, and is described in Section 5.3.

5.2 Tools for an integrated water & economics investigation

5.2.1 Statistical water accounting

The growing need to understand how water resources are used in the economy has seen the development of Integrated Environmental and Economic Accounting (IEEA) by the United Nations (UN). The aim of IEEA is to develop natural resources-specific accounts as part of the Systems of National accounts (SNA) (UN, 2005). In South Africa it is the responsibility of Stats SA to compile Water Resources Accounts (WRA) as part of the national accounts. These integrate water resources information from DWS and economic data from Statics South Africa (Stats SA). Figure 5-1 below illustrates the WRA framework.

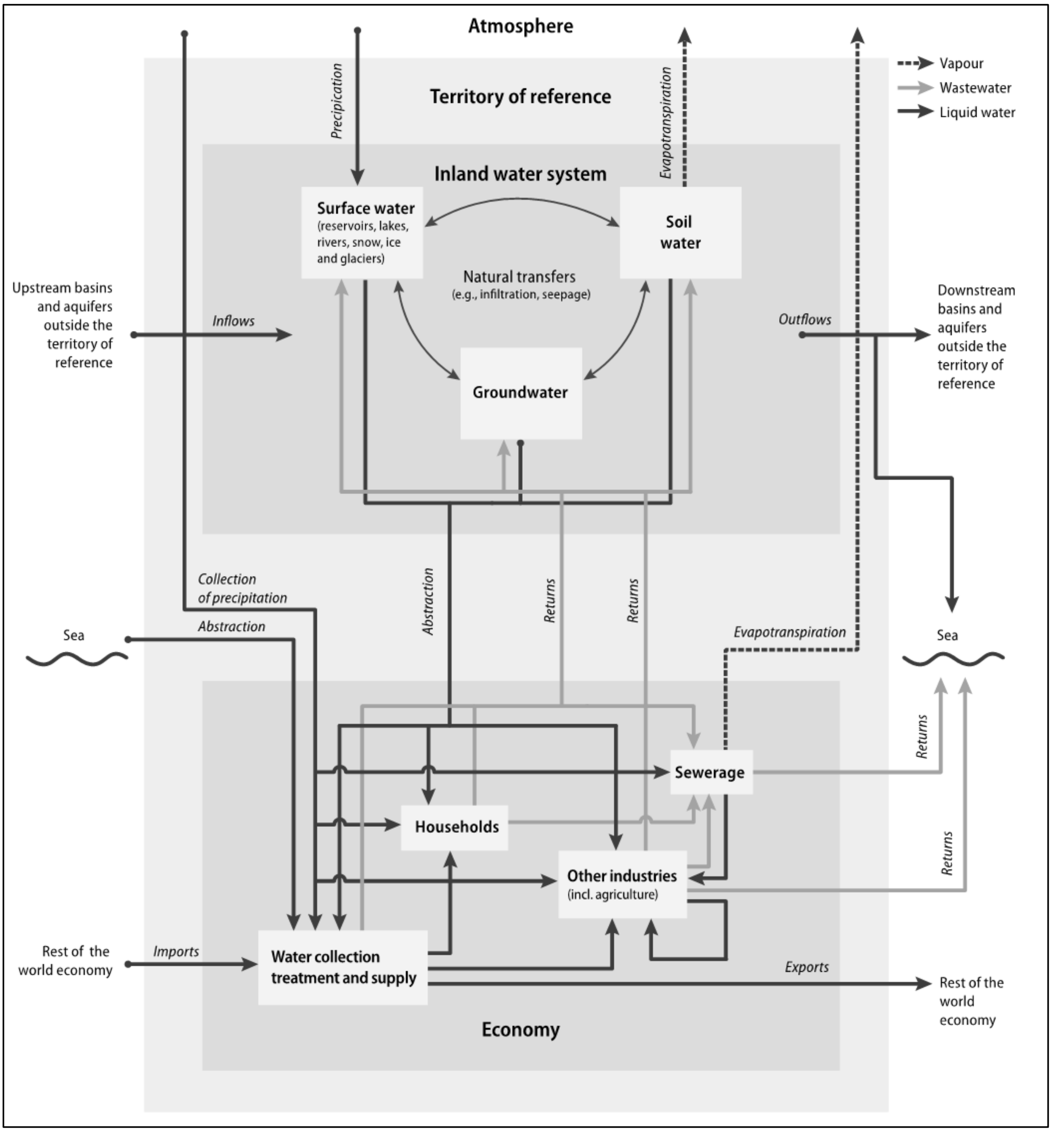


Figure 5-1 **Water accounting framework (UN 2005).**

Statistical water accounting was carried out for the Berg through completing an input-output (or stocks-and-flows) analysis, updating that previously carried out by StatsSA (StatsSA, 2003). The results, shown visually in Figure 5-2, raise several uncertainties related to the base data used (largely the WARMS database). At minimum the approach provides an alternative illustration of water flows than that provided by the standard water balance approach implemented in the water sector.

The result is also incomplete as the "virtual water" of a product does not end in those units shown on the right hand side of the diagram, but continues to move into other economic units, just as the economic value moves. The challenge of mapping both of these -water flows and economic flows- is that water use data is only categorised and registered (in WARMS) to the macroeconomic level. Water use data is registered as 10 "water use sector" classes, while economic data is segregated to 23 classes following the Standard

Industrialisation Classification (SIC) codes (refer to Table 5-1 below). It could be feasible to group SIC codes to roughly match the 10 water use sector classes, to compare economic productivity per water class (section 5.3), however this unfortunately loses economic detail, and some water use classes simply do not have a SIC code equivalent and vice versa.

Challenges aside, in combination with other analyses it is recommended that this method for representation of water and economics information be further tested. The information in the WARMS database will be soon updated once the DWS Validation & Verification study is completed and available to all. Landuse maps are also currently being updated by various parties. Once accurate coordinates for water use are known, through linking these to detailed landuse information, an economic SIC code for that water use can be ascribed.

If the water uses shown in the statistical water accounting assessment can be linked to economic uses, and the stocks-and-flows tables generating the diagram be coded into a "live" system, then it may be feasible to test large-scale water resources interventions in this model – thus providing a simplified decision support tool (see recommendations).

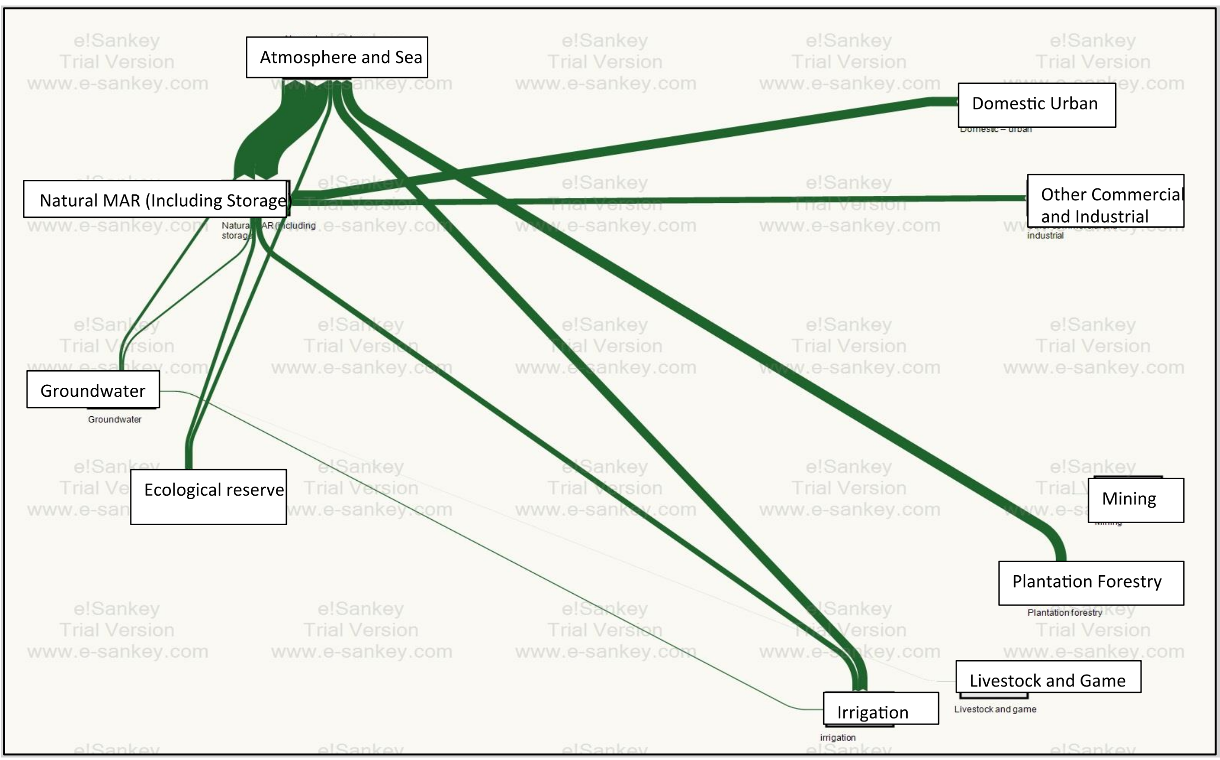


Figure 5-2 Diagram showing stocks and flows of water through the natural and economic system

Table 5-1: Table showing comparison of water use classes to industrial statistics classes

Number	Water Use Sector Classes (DWS)
1	Agriculture: Aquaculture
2	Agriculture: Irrigation
3	Agriculture: Watering Livestock
4	Industry (Non-Urban)
5	Industry (Urban)
6	Mining
7	Recreation
8	Schedule 1
9	Urban (Excluding Industrial &/Or Domestic)
10	Water Supply Service
Number	**Standard Industrial Classification Codes**
1	Agriculture, forestry and fishing
2	Mining and quarrying
3	Food, beverages and tobacco
4	Textiles, clothing and leather goods
5	Wood, paper, publishing and printing
6	Petroleum products, chemicals, rubber and plastic
7	Other non-metal mineral products
8	Metals, metal products, machinery and equipment
9	Electrical machinery and apparatus
10	Radio, TV, instruments, watches and clocks
11	Transport equipment
12	Furniture and other manufacturing
13	Electricity
14	Water
15	Construction
16	Wholesale and retail trade
17	Catering and accommodation services
18	Transport and storage
19	Communication
20	Finance and insurance
21	Business services
22	Community, social and personal services
23	General government

5.2.2 Water footprint

Green and blue water footprints[2] were calculated for the primary sector across the Berg. The investigation illustrated that the conceptual approach to water footprints is fundamentally different to that of water resources quantification and allocation carried out by DWS. A water footprint analysis intends to quantify all water used (consumed in green and blue footprints, or required to assimilate a pollution load in grey water footprints), in the development of a product, whereas in the current approach to water resources planning and allocation, the volume of blue water used is essentially ignored. This water use is not quantified and not licensed to agricultural users. The water resources yield models and the systems

The applicability of a water footprint approach should be assessed in greater detail as the smart water assessment task is taken forward in the next phase of the programme.

[2] *Green water footprint refers to consumption of rainwater. Blue water footprint refers to the consumption of surface water and groundwater. (Hoekstra et al, 2011)*

model only consider runoff that enters rivers and dams (section 2.1). However, for a complete or systemic view of assessment of water resource availability and the beneficial use of water, this water use should be quantified, in terms of the trade-offs between using the water prior to entering the river for agriculture, and therefore not being available for other users. Maps of the water footprint data generated are incorporated in Appendix 2, Section 10.

5.2.3 Water productivity and efficiency

The difference between water use productivity (product units/m^3 water) and water-use efficiency (m^3/product units) is one of scale. Water-use efficiency has a micro-level focus on the output of processes and products, while water productivity is relevant for a macro-economic and resources planning view, relating water to GDP or other larger scale indices. The GDP generated per unit volume (m^3) of water used (per macro scale water use sector) has been calculated to rate the economic value of water nationally (DWAF, 2010a). This shows that the economic productivity of the "Urban sector: commercial and industrial users" in terms of GDP per drop and jobs per drop far outweighs other water use sectors (Table 5-2). Nevertheless, the jobs per drop generated by the agricultural sector in the "commercial irrigation" water use class may be locally significant. These concepts were also explored for the Western Cape within WRC 2013b.

Table 5-2 Economic productivity of various water use sectors (from DWAF, 2010a)

Sector	Gross Domestic Product per water unit (Rand /m^3)	Employment per water unit (number / million m^3)
Urban sector: commercial and industrial consumers	R498.8	1746
Rural – subsistence agriculture	R0.9	22
Commercial irrigation	R2.8	134
Commercial forestry	R2.0	57

As an illustration of the spatial variability in water use productivity, and the difference in water use productivity between sectors, the GDP and jobs 'per drop' was mapped for the primary and tertiary sector across the Berg (the maps are incorporated in Appendix 2, Section 10). The results are generally as expected: for example the tertiary sector has highest GDP per million m^3/a water used around the City of Cape Town area. The primary sector GDP per million m^3/a water used is highest in the Saldanha Bay area, which appears to have incorporated the steel processing and other heavy industries. Although the primary sector agriculture is significant in the Cape Winelands areas, the GDP per million m^3/a water used is lowest: the GDP produced is low for an activity that requires significant water use.

5.3 Water-related Cost-Benefit Analysis Method

A water-related cost-benefit analysis was initiated to assess the most beneficial use of water resources out of the planned developments for Saldanha, incorporating a desktop review of cost/benefit analysis (CBA) methodology, and the application of this approach to supporting decision-making in water resources.

Cost/benefit analysis (CBA) provides a method to evaluate spending priorities. In the context of this approach, the "cost" is taken as the expected number of liters of water consumed by the development in question. "Benefits" include the expected revenue generated by the development as well as the number of jobs that the development is expected to create. The initial aim of the project will be to rank the proposed developments not only according to metrics such as "jobs per drop" and "revenue per drop".

However, the standard CBA method results in the exclusion of some parameters that cannot be expressed in monetary terms (e.g. well-being). Reliance on GDP introduces a number of analytical biases. GDP and mean GDP per capita are poor proxies for human welfare in economies defined by high levels of inequality and subsistence economic activity. In addition, lack of economic data, high levels of economic informality and inequality makes it difficult to link economic development options to positive GDP impact.

An alternative CBA method has been developed that placed people and their well-being at the centre of the various options being assessed, using a set of criteria to evaluate projects (Cartwright, et al., 2013). This alternative method manages to circumvent the limitations of the use of GDP as indicator for economic growth with regards to informal economic activities and environmental value. Through selection of assessment criteria that are linked to water resources, the project will develop a CBA framework to compare the water related cost and benefit of economic development options in Saldanha Bay. The cost benefit analysis will result in indices, such as "wellbeing per drop", to highlight the most (overall) appropriate use of water. These results will directly support decision-making in water allocation and licensing.

A "cost effectiveness analysis" (CEA) will also be applied to the water resources intervention options, to attempt to fully incorporate the financial costs of resources infrastructure, the environmental costs, the cost to the users, and the perceived benefit of various options. Most importantly, to overcome the current challenges and disconnect between economic developments and the required water resources interventions, the research will attempt to link the two sets of indices (CBA of economic development and CEA of water resources interventions). The outcome can indicate the most appropriate water resources infrastructure for the most appropriate development scenarios.

5.4 Regional hydro-economic model

In the same way that potential developments should be assessed for 'smartness', via a CBA or similar, so should various water resources reconciliation intervention options. Included in this is considering the system as a whole, for example assessing trade-offs between establishing larger desalination in Cape Town rather than in Cape Town and in Saldanha. With a lack of integrated catchment and systems model in the Berg, the existing water resources planning tools do not readily allow for such comparison (Section 2.1 and 2.7), nor for the detection of competing demands on the total water resources from different development plans. The following kind of questions are therefore not readily answerable in the current models or tools:

- Is it more cost effective to establish a desalination plant in Cape Town rather than Saldanha Bay? When assessed as a linked system, how do all the reconciliation options across the Berg WMA compare and what are the most cost-effective solutions?
- What additional water resources are required to realise optimal development of the agri-processing industry across the Berg catchment? What are the trade-offs (or relative socio-economic-environmental impacts and benefits) between allocating water resources to agri-processing verses other uses, for example enhanced water use downstream in Saldanha Bay for minerals beneficiation?
- Several municipalities in the Berg catchment record water losses above an acceptable level. If all these municipalities could bring water losses to within an acceptable range, what water volume would be saved, for what cost, and what development may this enable and where?
- The re-use of treated effluent is gaining importance. If effluent was re-used at all the upstream WWTW on the Berg River (rather than being returned to the river) what would the downstream impact be on flow, and therefore also on agricultural users who abstract directly from the river and rely in part on these return flows? Given the impact on flow, what are trade-offs between re-use for a certain purpose at source of WWTW, and agricultural use of return flows (essentially re-use downstream)?
- Alien vegetation and its impact on available water resources is also receiving greater attention as water resources become constrained. If all (or maximized) alien vegetation was cleared what would be the impact on water resources, what economic benefit could this water be used for and where, and how does that compare with the economics of alien removal?

Many of the above questions require spatial hydrologic analysis to characterise water availability in response to abstraction scenarios, throughout the catchment. In addition an economic link is required to translate the water use into relative benefit. These questions cannot all be answered by the same kind of model process. Nevertheless, the development of a hydro-economic model to explore these questions, and quantify regional trade-offs and competing resources in development is planned for 2015-2018 under the GreenCape WRC-DED&T funded programme continuation.

6 Water Exchange Network

Purpose: Responding to industry's perspectives that the capital levies for the proposed desalination plant would be unaffordable, and industry's willingness to make use of treated effluent, GreenCape reviewed water resources interventions that have been investigated to date. It appears that desalination was favoured without adequate appreciation of alternative sources including increasing the supply from groundwater, and water reuse. GreenCape therefore tested the concept of a Water Exchange Network to cascade water between users. This preliminary investigation has shown that a Water Exchange Network pre-feasibility study is worthwhile.

Target Audience: The primary target audience would be industry and SBM, the two would be required to implement a Water Exchange Network. The wider target audience is all those responsible for economic development planning and water resources planning at local, district (or regional offices in the case of water), provincial and national government.

6.1 Motivation

Desalination is currently the preferred water resources intervention by SBM, and the additional water from the Berg is favoured by WCDM. Previous water resources planning work carried out for the Saldanha Bay region was reviewed to understand the work that has underpinned these recommendations, and understand what led to SBM favouring desalination. Summary findings of this review are provided in Table 6-1 below.

The industries currently operating in Saldanha generate significant effluent volumes. Based on the current status quo for water resources in Saldanha (section 2), on the knowledge that energy scarcity is also a constraint for Saldanha Bay, and on the insights raised in Table 6-1, (specifically the conclusions of the Element Engineering 2010 Summary report), GreenCape believes there is merit in re-assessing the potential for water re-use as an intervention option, prior to significant investment in desalination.

Table 6-1 Summary review of previous Water Resources Planning Studies for Saldanha Bay Area

Report:	Key content

Title
Pre-feasibility study of potential water sources for the area served by the West Coast District Municipality.
 	
Completed by:
Kwezi V3
(in association with Ninham Shand for integration with the WCWSS, and with SRK for groundwater pre-feasibility section)
 	
Completed for:
DWAF Directorate: Options Analysis
 	
Date:
2007
 	
(DWAF 2007a)
	Report Summary:
	Considered area supplied by the WCDM, including Withoogte and Swartland scheme.
	Study carried out 2 phases:
	• Phase 1 screening of options
	• Phase 2 Pre-feasibility (with report volumes 1 to 3, and volume 4 summary
	Provided water status quo: water sources and supply, demand, water quality constraints
	Investigated and recommended preliminary implementation measures to alleviate constraints including:
	• Alien vegetation clearing, adjustments to supply system (increasing storage, optimizing operation at Misverstand, changing the type of pumps used).
	Investigated potential additional water sources including:
	• Groundwater: Elandsfontein aquifer system, Adamboerskraal Aquifer System, Papkuils Aquifer System
	• Twenty Four Rivers
	• Inter Basin Transfer from Breede River via Mitchells pass diversion
	The water quality task included ting various scheme options in the ACRU salinity model to assess best options for management of salinity in the Middle and Lower Berg, and at Misverstand Wier, and investigating various options for providing water to Saldanha Steel. The modelling showed that maintaining TDS<300mlg/l was considered too costly to include (due to size of storage reservoir required for mixing).
	Pre-feasibility level findings:
	• Groundwater:
	  o Elandsfontein aquifer system: pre-feasibility results were positive, therefore delineated target zones, and provided costs for a necessary pilot abstraction scheme. However, did not provide a potential yield and a URV for equal comparison with other (surface water) options, reporting these would be available after pilot study.
	  o Adamboerskraal Aquifer System: pre-feasibility stage hydrocensus detected salinity of groundwater "unacceptably high" and based on this, the option wasn't assessed further
	  o Papkuils Aquifer: screening phase showed positive results (potentially high yield) but there was little information on which to base the pre-feasibility study, as a hydrocensus was not conducted (scope / budget reasons?).
	• Twenty Four Rivers
	  o Investigated the potential of increasing the yield at Voelvlei dam through addition of storage (potential dam sites identified) on Twenty Four river. Provided cost and yields, however noted environmental flow requirements could not be met with a dam that provides any significant additional yield to the system.
	• Mitchells Pass
	  o Investigated the potential to divert winter flows from the Upper Breede, through Mitchells Pass to Voelvlei. The diversion would make use of the (pre-existing) Klein Berg River Diversion, and it's capacity to house the additional winter flows was assessed,

Report:	Key content
	finding that 96% of the diverted water would reach Voelvlei (the rest spilling). The net additional yield to Voelvlei dam (taking into account evaporation losses) was calculated at 10.9 million m^3/a. Report recommendations: • Report provided priorities for the preliminary implementation measures. • With regard to the potential additional water sources, the pre-feasibility report recommended that the Twenty Four Rivers Scheme, the Mitchells Diversion, and the Elandsfontein and Papkuils Aquifer all be taken to feasibility level study with immediate commencement for all three options. For the Elandsfontein Aquifer this recommendation includes immediate establishment of a pilot wellfield, with details for this wellfield provided (siting, costs). The recommendation for groundwater is confident and clear: "Because the potential yield from both sources are considered to be extensive, the processes required to bring them to full production have to be commenced immediately after commissioning of the primary implementation options". Discussion of Report Findings • Some augmentation options did not pass the screening phase and are therefore excluded from the summary report, because easier readily available options were to be assessed first. **The report notes that these discounted options may become viable in future with technology advances. The re-use of water**, desalination, **and increased groundwater use (and possibly via artificial recharge) were all in this category**. • The pre-feasibility results were positive for Papkuils & Elandsfontein Aquifer and **it is not clear why the recommendation for a feasibility study pilot wellfield was not implemented during feasibility stage (below).**
Title: **Investigation into Alternative water sources for the West Coast District Municipality: Water Study Report:** **Draft Volumes 1 – 4** **And Final Condensed Executive Summary** **Completed by:** **Element Engineers** **Completed for:** **WCDM**	The scope for the study was to assess: • Optimization of existing sources, and update water use/demand/balance projections to feed into feasibility of alternative sources • Investigation of the following options for alternative sources: Basin transfer from Breede, Seawater desalination, reclamation, artificial recharge of groundwater • Reclamation was to be included in Volume 2: Optimization of existing sources • Basin transfer, desalination and groundwater was to be included in Volume 3: Alternative sources. Findings for groundwater feasibility include (from Volume 2: Optimisation of existing sources): • No intrusive ground investigations were carried out. The hydrogeological information from pre-feasibility study was incorporated into a numerical model, and following model simulations, conclusions were drawn on exploitation potential. The results show: • **Abstraction at the existing WCDM wellfield at Langebaan Road Aquifer System (LRAS) can sustainably be increased to 1.9 million m3/a, and expansion of the wellfield is recommended.** • **The Elandsfontein Aquifer System (EAS) could supply 1.45 million m3/a to 1.9 million m3/a and development of a pilot wellfield is recommended**. Furthermore it is recommended that the calibrated model be updated routinely to manage the aquifer and abstraction. • Summarising the optimization of existing sources, the report states that prior to new sources, an additional 2.45 million m^3/a can be made available from transfer of water rights from other users (2 million m^3/a), and increasing groundwater abstraction at LRAS (0.45 million m^3/a, i.e. from existing 1.45 million m^3/a to the recommended 1.9 million m^3/a). Findings for water re use feasibility: (Volume 2 and Volume 3) • In discussion of existing sources (Volume 2) it is stated that 7183m^3/d or 2.62 million m^3/a of semi-treated effluent available for re-use from the 6 WWTW in the Saldanha Bay Regional Scheme. The summary report states: "Although Reclamation seems a viable solution,

Report:	Key content
Date: **Volume 1-4: Jun 2009** **Final Condensed Executive Summary: October 2010**	the current status pertaining to available semi-treated effluent is such that very little surplus effluent is available as it is already contracted out to industry and other uses e.g. golf estates and agriculture." However, the available effluent volumes are based on 2008 data and would increase in future as use increases. An options analysis or cost benefit analysis was carried out (Volume 4): • Following the assessment of new sources, 6 water resources intervention scenarios were selected for consideration in an optimization process. These scenarios included various combinations of desalination, basin transfer from Breede River, Traded water from Berg area, reclamation of treated effluent. These scenarios are for meeting the predicted demand shortfall that remains after the optimization of existing sources has been implemented. • **However, the use of the recommended additional 1.45 to 1.9 million m3/a available from the EAS is not considered in the scenarios, and is not listed as an additional potential source in the summary document.** • An economic cost – benefit analysis was carried out, and the 6 scenarios were compared based on total capital cost, unit water costs, Nett present value, internal rate of return, benefit/cost ratio, unit reference values. • Scenarios that included basin transfer and water trading (surface water schemes) were most favourable in all economic indices. Given that basin transfer requires significant public participation and regulatory processes, **scenario 4 (immediate water trading to alleviate constraints, followed by basin transfer in a future phase 2 allowing time for the necessary liaison) was recommended for implementation**. The report notes that should basin transfer not be viable in future, the second phase can be reconsidered and basin transfer can be replaced by one of the other options (reclamation or desalination). Study Conclusions (Summary report) • In the summary report the recommendation for surface water interventions made in Volume 4 Cost Benefit Analysis (above) is not repeated: surface water scenarios (basin transfer and water trading) are now because transfer from the Breede would be unlikely and require significant liaison with IAPs / other catchments etc. • The next economically favourable scenarios from the cost benefit analysis (those including reclamation) are not incorporated in any way in the summary report. The report states "**taking into account the acute existing water need in the WCDM area, as well as other cost- beneficial evaluation criteria, it was decided to recommend the desalination of seawater as preferred alternative**" Discussion of Report Findings • The feasibility study intended to include assessing the feasibility of groundwater, however only a desktop study was carried out, essentially repeating the pre-feasibility study. However a clear recommendation of the previous pre-feasibility was to develop a pilot wellfield in the EAS. Furthermore, groundwater was not considered in volume 4 cost benefit of sources, yet it had been recommended as a potential additional source (as well as an optimisation source) in Volume 2. • The **recommendation for desalination made in the summary report is not supported by the findings of the cost benefit analysis, volume 4, in which a clear recommendation is made for surface water options, and in which reclamation scenarios are more economically favourable than desalination.**
Report Title **All Towns Reconciliation Strategy Study:**	The All Towns Reconciliation Strategy Study was initiated by (the then) DWA to enable DWS's oversight on the provision of domestic water supply by Water Services Authorities. Strategies describing the status quo of water supply, and providing recommendations for future reconciliation of water supply and demand, were completed for all population centres. The strategy for Saldanha Bay provides a comprehensive

Report:	Key content

Reconciliation Strategy for Saldanha
 	
Completed by Umvoto Africa
 	
Completed for: DWAF Directorate: National Water Resources Planning
 	
Date: **June 2011**
	yet concise, accurate, and most up to date coordination of all aspects of water supply for Saldanha Bay Town (not to the Withoogte Scheme, which would have to be summed from the various individual strategies). Key contents include:
	Information on the current situation including:
	• Status quo of water services: provides numbers for the consumer profile, economic drivers for growth in the demand, information on the level of services supplied, and on unaccounted for water (UAW).
	• Water resources: provides a description of the current resources supplying the scheme, and their yields.
	• Bulk and reticulation infrastructure: provides a description of the infrastructure including raw water abstraction and mains (reservoirs, pipeline diameters), water treatment works (capacity, compliance with standards), reticulation network (reservoirs, pipeline diameters and network), and waste water treatment works (capacity, compliance with standards).
	• Legal agreements and institutional arrangements.
	Information on future water requirements, and recommendations for water resource intervention:
	• Predicted various future water demands based on percent growth rates for low, medium and high growth scenarios.
	• Using predicted water demands and currently available water resources, provided water balances. For medium growth scenario, Saldanha Bay is predicted to be 3.6 million m^3/a short of water by 2020, increasing to 11 million m^3/a by 2035. After a recommended improvements in WC/WDM, this 2035 projection is reduced to 10.5 million m^3/a.
	• Based on projected shortfall in water supply, assessed various resource interventions, providing likely yields of each:
	  ○ The current (2011) potential yield for treated effluent (from Saldanha WWTW only) was 1.809 million m^3/a. Under a medium growth scenario, this yield increases to 7.655 million m^3/a by 2035.
	  ○ Available groundwater yields are not yet known and further investigation is recommended, but may vary from 0.7 million m^3/a to 15 million m^3/a.
	• The strategy recommends that the future shortfall is made up by the following interventions, **sequenced in this order**:
	  ○ Full implementation of WC/WDM
	  ○ Incremental groundwater development to supply up to 1 million m^3/a starting in 2012. **The commencement of a groundwater feasibility study was listed as an action for 2012. . *(This has not commenced)*.**
	  ○ Increased supply from the Withoogte Regional Scheme, via an **increased allocation from the WCWSS**, yielding an additional 3.65 million m^3/a by 2012.
	  ○ **Re-use of water to supply 4 million m^3/a by 2020**. Re-use is recommended in the form of (in implementation sequence):
	    ▪ Dual reticulation systems for new developments, with treated effluent used for irrigation
	    ▪ Direct use for non-potable consumption (irrigation, industrial)
	    ▪ Indirect use
	    ▪ Direct use (potable consumption) should be seen as a long-term intervention
	  ○ **Desalination at Saldanha**, to supply 5 million m^3/a by 2025. The commencement of a desalination feasibility study was listed as an action for 2012. (*This feasibility study is underway)*
	Discussion of Report Findings
	Strategies were developed for DWS in a process that was perceived by some municipalities as disconnected from the situation on the ground in the local municipality, and the DWS recommendations are not always supported. The opinion of SBM and WCDM of the strategies is not known, but it is evident from comparing this strategy to the WCDM reports, that the DWS has a different set of recommendations to the WCDM.

Report:	Key content
Report Title **Water Master Plan** **Completed by** **GLS Consulting Engineers** **Completed for:** **WCDM** **Date**: **June 2013**	Report provides detailed analysis and figures for current water use, demand, unaccounted for water, and future projections of these and shortfalls (balance), for WCDM schemes (Withoogte and Swartland). The report has the premise that a desalination plant is in planning stages, and provides information on the internal bulk infrastructure requirements to link this water to the existing reticulation works: "It is understood that desalination will be the source from which all future demand will be supplied after the existing allocation from the Berg River source is increased to a maximum of 31 025 000 kl/year (31,025 x 106 m^3/yr)." The report therefore contains detailed internal (bulk and reticulation) infrastructure descriptions including required upgrades to pumps and pipelines and costing. A Regional Bulk Infrastructure Grant (RBIG) has been applied for to fund the desalination plant, and this report has been used as the pre-feasibility study for the RBIG process (Worley Parsons, 2014).

6.2 Methodology

Traditional water re-use considers a waste water treatment works as a point source or water: effluent is collected and reticulated to the WWTW, and rather than disposing of treated effluent or returning it to surface water courses, the treated effluent is returned to some central reticulation point. Re-use of treated effluent has for example been implemented for Coega IDZ in which municipal effluent is collected and treated at the (pre-existing but upgraded) municipal WWTW, treated effluent is then reticulated to industries in the IDZ. Their effluent is in turn collected and treated at a central WWTW, before eventual discharge.

An alternative approach to water re-use is that of water cascading, in which all major water users are considered potential effluent users and point sources of effluent. Rather than use central treatment, water is cascaded between users thus one user's effluent or treated effluent becomes the next user's inflow. The water cascading approach works on the premise that in a group of users with different water quality constraints on incoming water and different process operations, the concentration of effluent generated will also differ. Generically this presents an opportunity for a mass exchange network in which mass (in this case water of different chemical compositions and concentrations) is exchanged between the users. The efficacy of the exchange depends on the magnitude of the variation in concentrations required and generated. The mass (in this case water) exchange network is a derivative of Heat Exchange Network Synthesis, which integrates the possible heat sources, hot and cold, to minimize the utility consumption (El-Halwagi and Manousiouthakis, 1989).

Given the water supply in the Saldanha area serves municipal domestic users, and a range of industries some requiring very good quality water (steel processing), and others able to use poorer quality water (coolant), this conceptual requirement for a water exchange network is met. The water exchange concept and theory was tested in Saldanha through research undertaken as an honours student project mini-thesis (Choi 2014).

The water demands (quality and quantity) and discharges (quality and quantity) were balanced in a mass exchange network using water pinch analysis Wang and Smith (1994). For simplicity, chloride concentrations (only) were used as the key contaminant in the pinch analysis on which to balance the network. The network(s) was developed for two key scenarios:

1. a base case with three current major industrial water users (Arcelor-Mittal, Duferco, and Tronox), and domestic use in the Saldanha town distribution area of the Withoogte scheme
2. a future case in which two major future water users were added (Frontier Separation Plant, and the Chlor-Alkali plant, incorporated also in section 4)

A graphical approach to the water pinch analysis was applied in which required inflow (rate and concentration) and the effluent (rate and concentration) are plotted on graphs as each industry's mass load of contaminant. The curves from each node are connected to a limiting composite curve and a 'pinch point' derived – at which a minimal water supply can meet the composite requirements. The graphical result is translated into a network reflecting the optimal water exchange. The cost feasibility of this network must then be established.

Data on required input and output water quality and quantity were sourced from these five industries, and range in confidence from data received directly from industry via questionnaire, to indicative data estimated where no other information was available.

6.3 Results

Depending on the assumptions applied, for the base case effluent from Duferco or Arcelor-Mitttal can be used at Tronox, reducing freshwater intake can by up to 6%, and effluent generation by up to 24%. In the future case, effluent from Duferco can be used by Tronox, and treated municipal effluent used by Frontier Separation Plant, with the Chlor Alkali plant being supplied by a mix of the effluent from the Frontier Separation Plant and direct from municipality. Another network option includes Duferco, Arcelor-Mittal and domestic users being supplied directly (from the Berg), Tronox and the Frontier Separation Plant supplied by Arcelor-Mittal, and the Chlor-Alkali plant being supplied by a mix of the effluent from Duferco and Arcelor-Mittal. Depending on the assumptions applied and the network, freshwater intake can be reduced by up to 15% and effluent discharges reduced by up to 76%.

6.4 Implications and recommendations

The 15% potential reduction in freshwater intake from major current and future users in Saldanha equates to around 1 million m^3/a. As stated above, this may increase when more water users in the Saldanha area are incorporated. Nevertheless the 1 million m^3/a saving is significant, and contributes to removing the near-future constraints (where demand meets supply in 2017-2018 in Figure 4-2). As demand increases in future and more developments come online, with continued implementation of WEN, the saving could also increase from 1 million m^3/a .

If the 15% could be realised for the entire scheme area (current demand around 20.36 million m^3/a, Table 2-4), the total demand would reduce by around ~3 million m^3/a. This not only removes the near-future constraints (where demand meets supply in 2017-2018 in Figure 4-2) but would delay the requirement for new water resources interventions.

The research completed to date shows that the water exchange network concept is a feasible method to reduce freshwater intake and effluent generated. It is likely that as the number of users incorporated in the analysis increases, the range of required water qualities will increase, and greater savings may be possible. There is worth therefore in conducting a broader scale pre-feasibility study of a WEN across all potential future major water users, and including in this a wider range of water qualities or contaminants (i.e. to include bacteriological constraints). The pre-feasibility study should include:

- balancing the various water demands (quality and quantity) and discharges (quality and quantity) in a mass exchange network using water pinch, where water cascades can be created to good effect, for all current major industrial users and all potential future industrial users, plus domestic demand in the Saldanha area and where appropriate the wider Withoogte scheme
- definition of the network(s), and optimisation for least-cost investment, using the tools of mass exchange network analysis
- Comparison of the total annualized cost between the optimized water system with other currently proposed water supply solutions
- an analysis of the energy (and carbon footprint) costs to provide the preferred network operation, as well as a description of other critical environmental impacts associated with its operation.

The SBM, with oversight from DWS, has the ultimate responsibility for water provision in Saldanha, and would need to manage any future feasibility and implementation phases of a Water Exchange Network, in conjunction with private partners (industry). It is therefore envisaged that the pre-feasibility study be conducted in order to gain enough information in order present a Water Exchange Network to the responsible authority as a worthy potential source and potential alternative (or at least delay of) to desalination or additional water from the Berg River. Funding for a pre-feasibility study is currently being sourced.

7 Summary and further Opportunities

7.1 Summary

This report records work completed to date (2013-2015) on GreenCape's research project "Water as a Constraint on Economic Development".

The project was initiated in 2013. The motivation for project establishment was the acknowledgement that the Western Cape is a water-stressed region, and that in order to plan for economic growth, an understanding of how much water is used by the region's economy, and where and how it is used, is required. A particular interest area for the establishment of the project was water requirements and availability for proposed development in Saldanha Bay, and whether and how water pricing could be a mechanism to realise water efficiency.

The key outcome of initial scoping highlighted that economic growth (in Saldanha Bay) *may* be constrained by (the cost of) available water. A five-year "Water as a constraint on Development" programme was thus developed to respond to this constraint, informed by insights revealed in the scoping exercise.

The overarching aim of the 5 year programme is to contribute to strategic decision-making for economic development, through answering "What are the 'right' sources of water, at what quality, for the 'right' developments, for the 'right' price?" The programme therefore intends to contribute solutions to current development challenges for Saldanha Bay, thus supporting decision-makers at local, provincial and national government, and enabling industry development in Saldanha Bay. In turn the tools developed in this process can be applied in other water-constrained catchments.

Potential solutions to alleviate the constraints posed on economic development by water availability were defined during the scoping assessment, and developing these solutions forms the various tasks for the programme. These are listed below, along with the progress made to date:

1. Alleviating constraints to development requires an integrated, systems approach to economic development and water resources planning. This approach will need to recognise the interdependent nature of water resources and economic development, and a conceptual model has been developed to describe an ideal approach2.7.
2. As a first step in implementing the required systems approach to economic development and water resources planning, development proposals were collated and their water demands estimated in order to determine implications for development planning and infrastructure. Comparing this projected water demand with planned water resources interventions highlights that water shortages may be experienced in 2017-2019 (i.e. the planned interventions are not sufficient for medium and high growth scenarios for 2017-2019).
3. Potential approaches to water resources allocation that optimises benefit ("smart" allocation) were considered, laying the foundation for a cost-benefit approach to be assessed in the next phase of work. Taking a systems approach (as described above) means that the costs/ benefits of one development or resource supply intervention should be viewed in a broader context. This includes understanding the trade-offs and knock on effects of decisions made on a catchment level. The necessity of a "Hydro-Economic Model" has been outlined.
4. In response to a water availability constraint, one of the first solutions to consider would be to reduce demand through improving water efficiency. A preliminary investigation into the potential for a "Water Exchange Network" in which waters of different qualities are cascaded (used and passed on) between major industrial users has been completed for Saldanha Bay. The results suggest freshwater intake can be reduced by up to 15% and effluent reduced by up to 76%. A pre-feasibility study is warranted

Each of the programme activities commenced here require further development in future phases of the programme, to specifically build on the below recommendations. The green boxes throughout the text raise investigations that feed into these over-arching recommendations.

7.2 Smart resource allocation and supply solutions

Recommendations towards realising smart resource allocation and supply solutions for Saldanha and the wider area include:

- It is recommended that the conceptual planning framework given in Figure 3-1 be tested with relevant decision-makers. An assessment is required to determine the extent to which this planning framework is accommodated within the existing planning structures (IDP, WSDP, SDF), to what extent it varies, and therefore what is necessary to implement this framework.
- Related to this, there is a need to determine the development future(s) that sit at the centre of the conceptual planning framework given in Figure 3-1. A regional economic development plan or outlook (as recommended at the stakeholder workshop), or a transformative scenario planning process (as recommended by the stakeholder workshop facilitators) may be beneficial to direct where investment should be promoted for Saldanha.
- Cost- benefit methodologies have been investigated and it is recommended that a method similar to Cartwright et al 2013 be implemented, to attempt to quantify the relative merits of water resource allocation, and which investments and developments should be promoted.
- The need for a hydro-economic model is described and it is recommended that the model be designed to and quantify regional trade-offs and competing resources, responding to the questions outlined here.
- The stakeholder group convened for the workshop held in February 2014 largely represent the relevant stakeholders to support the implementation of each of the above recommendations. It is therefore recommended that project results be communicated with this stakeholder group, and their participation in future project phases sought.

7.3 Broad scale Water Exchange Network

The WEN investigation carried out here shows the method has the potential to generate water use savings, and hence a pre-feasibility study on a broader scale is warranted. Funding is currently being sourced for this study.

8 References

AGES 2014. Environmental Impact Assessment Report and Environmental Management Programme for the proposed Separation Plant on portion 6 of the farm Langeberg 188, Saldanha Bay Local Municipality. Prepared in July 2014 for Frontier Separation (Pty) Ltd.

Aurecon, 2013. Environmental Impact Assessment for the Proposed Construction of an AfriSam Cement Factory, Limestone and Clay Quarries and Associated Infrastructure in Saldanha, Western Cape. Final Environmental Impact Report. Prepared by Aurecon for AfriSam South Africa (Pty) Ltd.

BKS, 2011. Bulk Infrastructure Review for Saldanha IDZ - Water Supply. (Appendix to Wesgro, 2011. Saldanha Bay IDZ Feasibility Study Revision 1, 2011.)

Blersch, C. A. and J. A. du Plessis, 2014. Planning for Desalination in the Context of the Western Cape Water Supply System. Paper presented at SANCIAHS conference, University of the Western Cape, Bellville September 2014.

BRAAF Environmental Practitioners, 2014. Revised scoping report for a proposed phosphate mine on farm Elandsfontein No 349, Portion 4 and a portion of portion 2, Malmesbury Road. Compiled by Billet Trade (Pty) Ltd T/A Braaf Environmental Practitioners on behalf of Elandsfontein Exploration and Mining (Pty) Ltd

Cartwright, A., J. Blignaut, M. D. Wit, K. Goldberg, M. Mander, S. O'Donoghue and D. Roberts. 2013. Economics of climate change adaptation at the local scale under conditions of uncertainty and resource constraints: the case of Durban, South Africa. Environment and Urbanization, Volume 25(1):1-18.

Chand Environmental Consultants, 2012. Scoping and environmental impact reporting process for the Proposed Liquefied Petroleum Gas (LPG) Handling Facility, on portion 13 of farm 127, Yzervarkensrug, Saldanha. Background Information Document and Comment Sheet

Choi, H., 2014. Developing an integrated water management model for the Saldanha Industrial Development Zone. University of Cape Town, Department of Chemical Engineering, Bachelor of Engineering Honours Thesis project report. Supervised by Prof H. von Blottnitz, Dr N. Isafiade, Hon-Prof J. Petrie.

CSIR, 2012. Final Scoping Report for the Proposed Construction, Operation and Decommissioning of a Seawater Reverse Osmosis Plant and Associated Infrastructure in the Saldanha Bay Region, Western Cape. Prepared for Worley Parsons RSA (Pty) Ltd (WPRSA) and the West Coast District Municipality (WCDM)

De Clercq, W. P., M. V. Fey & N. Z. Jovanovic, 2009. An overview of the salinization problem in the Berg river catchment (South Africa). Management of Natural Resources, Sustainable Development and Ecological Hazards II. WIT Transactions on Ecology and the Environment, Vol 127.

Deloitte, 2014. National Instrument 43-101, Independent Technical Report on the Results of a Feasibility Study for the Steenkampskraal Rare Earth Element Project in the Western Cape, South Africa for Great Western Minerals Group Ltd.

Department of Economic Development, 2011. Green Economy Accord.

Department of Economic Development and Tourism (DED&T), Provincial Government of the Western Cape 2011. A macro-economic assessment of the Western Cape Economy's Sectoral and Industrial growth prospects: 2010-2015, including an assessment of inter-industry linkages.

Department of Water Affairs and Forestry (DWAF), 2004a. National Water Resources Strategy, 1st Edition, 2004.

Department of Water Affairs and Forestry (DWAF), 2004b. Berg Water Management Area Internal Strategic Perspective Version 1, January 2004. Prepared by Ninham Shand in association with Umvoto Africa, Jakoet & Associates, and Tlou & Matji, on behalf of the Directorate of National Water Resources Planning

Department of Water Affairs and Forestry (DWAF), 2006. Project No 2002-30: Pre-feasibility Study of potential water sources for the area served by the West Coast District Municipality. Phase II: Water Quality. Analysis of Management Options at Misverstand Weir to mitigate the potential impact on salinity of the Berg Water Project and Voëlvlei Augmentation Scheme. December 2006. Compiled by J Cullis and W Kamish of Ninham Shand Consulting Engineers, for Study Leaders: Kwezi V3 Engineers

DWAF 2007a: Department of Water Affairs and Forestry (DWAF), 2007. Project No 2002-30: Pre-feasibility Study of potential water sources for the area served by the West Coast District Municipality. Phase II: Summary Report (Report 4 of 4). March 2007. Compiled by C. A. J. Vancoillie, J. T. Human and H. E. Jacobs of Kwezi V3 Engineers on behalf of Directorate: National Water Resources Planning. DWAF Report Number: P WMA19/G100/00/1607

DWAF 2007b: Department of Water Affairs and Forestry (DWAF), 2007. Western Cape Water Supply System Reconciliation Strategy Study. Report 1 of 7 Reconciliation Strategy. June 2007. Compiled by E. Van der Berg, M. Killick, A. Anderson of Ninham Shand Pty Ltd on behalf of the Directorate: National Water Resources Planning. DWAF Report Number: P WMA19/000/00/0507

DWAF 2007c: Department of Water Affairs and Forestry (DWAF), 2007. A Toolkit for Water Allocation Reform, a manual to help achieve race and gender equity in water allocations. Toolkit Output 4: IDP linkages and co-operative governance. Draft 6. January 2007. Compiled by the Directorate: Water Allocation.

DWAF 2010a: Department of Water Affairs and Forestry (DWAF), 2010. Water for Growth and Development, Version 7

DWA, 2010b Integrated Water Resources Planning for South Africa, A Situation Analysis, 2010. JA van Rooyen and DB Versfeld. DWA report number P RSA 000/00/12910. 2010

Department of Water Affairs (DWA), 2011. Reconciliation Strategy for Saldanha Town. Prepared by Umvoto Africa (Pty) Ltd on behalf of the Directorate: National Water Resource Planning.

Department of Water Affairs (DWA), 2013. National Water Resources Strategy, 2nd Edition, 2013.

DWS 2014a: Department of Water and Sanitation, South Africa. 2014. Support to the Continuation of the Water Reconciliation Strategy for the Western Cape Water Supply System: Status Report October 2014. Prepared by Umvoto Africa (Pty) Ltd in association with Worley Parsons on behalf of the Directorate: National Water Resource Planning.

Department of Water and Sanitation (DWS), 2014b: Support to the Continuation of the Water Reconciliation Strategy for the Western Cape Water Supply System: Minutes of Strategy Steering Committee Meeting, October 2014. Prepared by Umvoto Africa (Pty) Ltd in association with Worley Parsons on behalf of the Directorate : National Water Resource Planning. DWS Report No.

Duferco, 2014. Presentation of data provided at GreenCape Workshop 24 February 2014.

Element Engineers, 2010. Investigation into Alternative Water Sources for the West Coast District Municipality. Project Number 07076. (Report Volumes 1-4 and summary report)

El-Halwagi, M., M., and V. Manousiouthakis, 1989. AIChE Journal. Volume 35, Issue 8, pages 1233–1244, August 1989.

Environmental Resources Management (ERM), 2012. Saldanha Bay LPG Terminal and Storage Facility: Land-based Component. Final EIR, November 2012. Prepared by ERM for Sunrise Energy.

Environmental Resources Management (ERM), 2013. Environmental and Social Impact Assessment Report for the Gamsberg Zinc Mine and Associated Infrastructure in the Northern Cape, Final Report June 2013. . Prepared by ERM for Black Mountain Mining (Pty) Ltd.

Flugel, W. A., 1991. River Salination due to Dryland Agriculture in the Western Cape Province, Republic of South Africa. Sediment and Stream Water quality in a Changing Environment: Trends and Explanation (Proceedings of the Vienna Symposium, August 1991) IAHS Publ no 203, 1991.

Fey, M. V., and W. P. De Clercq, 2004. Dryland Salinity Impacts on Western Cape Rivers. Final report on Water Research Commission Project No K5/1342 entitled "Estimation of the Contribution from Dryland Salinity to Water Quality in the Berg River Catchment – A Pilot Study". WRC Report No. 1342/1/04, ISBN No 1-77005-305-9.

GEOSS, 2014. Geohydrological Assessment – Updated Scoping Report - Elandsfontein, West Coast. GEOSS Report No: 2014/08-08. Prepared for Braaf Environmental Practitioners. September 2014.

GreenCape, 2013. Water as a Constraint on Economic Development, 2013-2014 Synthesis Report. Report prepared by Helen Seyler, Nisbert Chimboza of GreenCape Sector Development Agency, for Trade and Sector Development, Department of Economic Development and Tourism, Western Cape Government.

Hoekstra, A. Y., Ashok K. Chapagain, Maite M. Aldaya and Mesfin M. Mekonnen, 2011. The Water Footprint Assessment Manual, Setting the Global Standard. Published in 2011 by Earthscan.

Kamish, W., 2008. Hydrosalinity modelling of the Berg River using ACRUSalinity. Master of Science in Engineering (Civil) thesis presented to Stellenbosch University, December 2008.

Morris Environmental & Groundwater Alliances (MEGA) 2014, in association with Chand. Draft Environmental Impact Assessment Report for the Proposed Chlorine, Caustic Soda, and Hydrochloric Acid Facility, Saldanha, prepared for Chlor-Alkali Holdings (Pty) Ltd, October 2014. MEGA Report number: J-612-2-14

National Planning Commission, 2011. National Development Plan Vision for 2030. 11 November 2011. ISBN: 978-0-621-40475-3 RP270/2011

Orexx, 2014. Application for Phosphate prospecting right on Portion 2 of the farm Yzervarkensrug 127, January 2014. Orexx PO (Pty) Ltd.

pers. comm. Isa Thompson, DATE OF SANCIAHS CONFERENCE 2014: Conversation regarding WCWSS reconciliation intervention options.

pers. comm. Hannes Marais, 8 September 2014: Meeting with GreenCape and IDZ, 8 September 2014, regarding Withoogte Scheme and treatment methods.

pers. comm. Nik Faasen, 16 October 2014: Meeting with GreenCape and West Coast District Municipality, 16 October 2014, regarding Withoogte Scheme and treatment methods.

pers. comm. Nik Faasen, 4 December 2014: Email correspondence between GreenCape and West Coast District Municipality, 4 December 2014, regarding future water allocation for the WCDM

PGWC, 2012. Western Cape Sustainable Water Management Plan. Compiled by Aurecon on behalf of the Department of Environmental Affairs and Development Planning.

PGWC, 2013a. Green is Smart: Western Cape Green Economy Strategy Framework.

PGWC, 2013b. Provincial Economic Review and Outlook 2013, Western Cape Government, Provincial Treasury. ISBN: 978-0-621-42299-3

PGWC, 2013c. Municipal Economic Review and Outlook 2013, Western Cape Government, Provincial Treasury. ISBN: 978-0-621-42298-6

PGWC, 2014. Project Khulisa. Report on the first phase, October – December 2014. Ministry of Economic Opportunities.

Reos Partners, 2014. Integrating economic development planning and water resources in Saldanha Bay. Report on a half-day workshop, for GreenCape, 24 February 2014.

Saldanha Bay Local Municipality (SBM), 2013. IDP (Integrated Development Plan) 2012-2017. Revision 1, 2013.

Saldanha Bay Local Municipality (SBM), 2014. Water use data provided by Gavin Williams.

SRK, 2013a. RMI Specialty Metals Complex at Saldanha. Final Scoping Report prepared for Rare Metals Industries (Pty) Ltd. Prepared by SRK, November 2013, Report number 452704/2

SRK, 2013b. Re-commissioning of Premier Fishing's Southern Seas Fishmeal Plant at Saldanha. Revised Final Environmental Impact Assessment Report. Report Prepared for Premier Fishing SA (Pty) Ltd. Report Number 431676/10.

Statistics South Africa (STATS SA), 2003. Natural Resource Accounts: Water Accounts for the nineteen Water Management Areas. Report No. 04-05-01 (2003). STATS SA, Pretoria

Storey Eng (Pty) Ltd, 2014. Water Supply Report in support of Environmental Impact Assessment for the Proposed Chlorine, Caustic Soda, and Hydrochloric Acid Facility, Saldanha, prepared for MEGA.

UN (United Nations), 2005. Integrated environmental and economic accounting for water resources. United Nations Statistics Division and London Group, (Draft), UN, New York.

van Niekerk, P., and J.A. du Plessis, 2013. Unit Reference Value: Application in appraising inter-basin water transfer projects. Water SA Vol. 39 No. 4 July 2013

van Zyl, H., 2013. Environmental and Social Impact Assessment Report for the Gamsberg Zinc Mine and Associated Infrastructure in the Northern Cape, Economic Specialist Report. Prepared by Independent Economic Researchers on behalf of ERM. Draft Report April 2013.

Wang. Y.P. & Smith. R. 1994. Wastewater minimization. Chemical Engineering Science. Vol. 49. No. 7. Pg 981-1006

Wesgro, 2011. Saldanha Bay IDZ Feasibility Study Revision 1, 2011.

West Coast District Municipality (WCDM) 2013. Water Master Plan. Prepared by GLS Consulting, June 2013.

West Coast District Municipality (WCDM) 2014. Presentation by Nik Faasen to the Steering Committee Meeting of the WCWSS. DATE 2014

Worley Parsons, 2012. Final Environmental Impact Report for the Proposed Crude Oil Storage Tank Farm, Saldanha Bay. Compiled by Worley Parsons (Pty) Ltd, for MOGS (Pty) Ltd.

Worley Parsons, 2014. West Coast District Municipality Sea Water Desalination, RBIG Report Phase 2A: Technical Feasibility. Presentation given to RBIG Planning Committee, June 2014.

WRC, 2013a. The Role of Water in the Green Economy in the Context of Sustainable and Economic Growth in SA - A Preliminary Investigation. By D. Naidoo, Dr S Moola and Dr H Place of Nemai Consulting C.C. February 2013.

WRC, 2013b. Water in the Western Cape Economy. Report to the Water Research Commission, by Guy Pegram and Hannah Baleta. WRC Report No K5-2075. Draft, December 2013.

9 Appendix 1 Data Inventory

Table 9-1 summarises a list of data sources collated at GreenCape during the completion of the above work.

Table 9-1 Data Inventory

SPATIAL / GIS DATA							
Theme	**Path & File Name**	**Dataset**	**Data type**	**Format**	**Projection**	**Description**	**Source**
Topographic	50k topographic data/…	Topographic data (buildings, roads, rail, rivers, dams, landuse etc.)	vectors	shapefile	Geographic, WGS84	1:50 000 topographic vector data. Vegetation file has 'orchard vineyard' attribute	NGI
	Cadastral/ WC_Informal_settlements_2011-Release2	informal settlements	polygon	shapefile	Geographic, WGS84	not covering CT informal settlements	PGWC DHS
	WR90/twnall	major towns & cities	polygon	shapefile	Geographic, WGS84	very few in the study area	WRC (WR90)
	WR2005/dams_wr2005	dams & lakes	polygon	shapefile	Geographic, WGS84		WRC (WR2005)
	WR2005/prim_riv_wr2005	pri_rivers	lines	shapefile	Geographic, WGS84	primary rivers , attribute incl name, class & order	WRC (WR2005)
	WR2005/sec_riv_wr2005	sec_rivers	lines	shapefile	Geographic, WGS84	secondary rivers, attribute incl name, class & order	WRC (WRC2005)
	SRTM/srtm-berg	DEM	raster	tiff	Geographic, WGS84	30 arc second (90m) shuttle radar topography mission (SRTM), 2001, digital elevation model	GLCF
Demarcation / cadastral	Census_2011_Spatial_Geography/PR_SA_2011	Provincial boundaries	polygon	shapefile	Geographic, WGS84	provincial municipal boundaries	STATS SA
	Census_2011_Spatial_Geography/DC_SA_2011	DM boundaries	polygon	shapefile	Geographic, WGS84	district municipal boundaries	STATS SA
	Cadastral/Demarcation	LM boundaries	polygon	shapefile	Geographic, WGS84	local municipal boundaries	Demacation Board
	Census_2011_Spatial_Geography/WD_SA_2011	Municipal Ward boundaries	polygon	shapefile	Geographic, WGS84	municipal Ward boundaries	STATS SA
	Census_2011_Spatial_Geography/MP_SA_2011	Main Place boundaries	polygon	shapefile	Geographic, WGS84	main place areas	STATS SA
	Census_2011_Spatial_Geography/SP_SA_2011	Sub-Place boundaries	polygon	shapefile	Geographic, WGS84	sub-place areas	STATS SA
	Census_2011_Spatial_Geography/EA_SA_2011	Enumaration Areas boundaries	polygon	shapefile	Geographic, WGS84	enumaration areas with EA_TYPE attribute such urban, farm, industrial	STATS SA
Water Resources	bergwma	Berg WMA boundary	polygon	shapefile	Geographic, WGS84	Berg Water Management Area, used as study area boundary	DWA
	WR2005/quat_wr2005	Quaternary catchments	polygon	shapefile	Geographic, WGS84	drainage regions at quaternary scale	WRC (WR2005)
	WR2005/WR2005 Berg Quat	MAR (Runoff)	database	excel		Mean annual runoff. The quaternary catchments attribute table has MAR in it.	WRC (WR2005)

SPATIAL / GIS DATA							
Theme	Path & File Name	Dataset	Data type	Format	Projection	Description	Source
	WR2005/WR2005 Berg Quat	MAP (Rainfall)	database	excel		Mean annual precipitation. G10J had no value, it was taken from taken from G10Ja/b	WRC (WR2005)
	WARMS/abstraction (DW760)	registered abstraction data	database	excel	decimal degrees	abstraction data, include whether company or individual & states WU sector (Register No 22104526 missing coordinates, deleted in the GIS worksheet);	DWA (warms datarequests@dwaf.gov.za)
	WARMS/DW765 & DW767 Waste discharge non-point source	registered waste discharge non-point source	database	excel		DW765 and DW767 no coordinates provided - Non-point source. Requested clarification from DWA. Meantime it can be linked to Quaternary catchment.	DWA (warms datarequests@dwaf.gov.za)
	WARMS/DW766 & DW780 Waste discharge point source	registered waste discharge point source	database	excel	decimal degrees	DW766 & DW780 has discharge point coordinates. In DW766 12 entries have no coordinates, deleted in the GIS worksheet. Highlighted in yellow in original worksheet. DW780 only has one point.	DWA (warms datarequests@dwaf.gov.za)
	WARMS/Stream flow reduction (DW764)	registered stream flow reduction	database	excel	decimal degrees	WARMS registered stream flow reduction data	DWA (warms datarequests@dwaf.gov.za)
	GRAII/baseflow	baseflow	raster	arc binary grid			DWA
	GRAII/recharge	Recharge	raster	arc binary grid	ALBERS, WGS84 -18 0 0.0 /* 1st standard parallel -32 0 0.0 /* 2nd standard parallel 24 0 0.0 /* central meridian	GRAII recharge - 1x1km	DWA
	GRAII/wl_1x1km	waterlevel	raster	arc binary grid	ALBERS, WGS84 -18 0 0.0 /* 1st standard parallel -32 0 0.0 /* 2nd standard parallel 24 0 0.0 /* central meridian	GRAII waterlevel - 1x1km	DWA
	GRAII/Berg1_GRA11	GRAII various	database	excel		GRAII database with various values such as recharge, volume of water stored in aquifer, groundwater potential utilisation	DWA
	WR2005/stream_gauges	stream gauges	point	shapefile	Geographic, WGS84	WR2005 data	WRC
	WR2005/transfers/watertransline	national water transfer lines	line	shapefile	Geographic, WGS84	WR2005 data	WRC
	WR2005/PG1c_40_50_final_Berg wquality	Surface water quality	database	excel		table with ground measurements	DWA

SPATIAL / GIS DATA							
Theme	Path & File Name	Dataset	Data type	Format	Projection	Description	Source
	500_hydrogeology/3117_Calvinia and 3317_Cape Town	hydrogeological map series data (yield, groundwater quality, lithology, springs etc.)	vectors	shapefile	Geographic, WGS84	1:500k Cape town and calvinia sheets (yield, geology, quality)	DWA (georequests@dwa.gov.za / KototsiL@dwa.gov.za)
Groundwater	WR90/rsa_geol	rsa_geol	polygon	shapefile	Geographic, WGS84	1:mil geology map from WR90	WRC
	WR90/geol	geol_wr90	polygon	shapefile	Geographic, WGS84	generalised geology map towards water resources	WRC
	NGA/NGA_basic-info	NGA_basic-info	database	excel	decimal degrees	groundwater point basic information incl. site type, surface geology	DWA
	NGA/NGA_abstraction	NGA_abstraction	database	excel	decimal degrees	groundwater abstraction	DWA
	NGA_field measurements	NGA_field measurements	database	excel	decimal degrees	groundwater field measurements including water quality.	DWA
	NGA_waterlevel	NGA_waterlevel	database	excel	decimal degrees	groundwater water levels.WaterLevel table too big - over 54000 records.	DWA
	GRAII/Catchm_highly_stressed/Catchm_highly_stressed_dd	highly stressted catchments	polygon	shapefile	Geographic, WGS84	GRAII highly stressed catchments	DWA
	GRAII/gw_regions/SA_GWRegions_alb	regions	polygon	shapefile	Geographic, WGS84	GRAII groundwater regions	DWA
	GRAII/gw_use	groundwater use	polygon	shapefile	Geographic, WGS84	attribute table provides summary rural, municipal, agriculture etc. per WMA	DWA
	GRAII/gw_quality/Tvalues_ngdb_dd	T values	points	shapefile	Geographic, WGS85	groundwater T values	DWA
	GRAII/gw_quality/Tvalues_dd	NGDB T values	points	shapefile	Geographic, WGS86	Groundwater NGDB T values	DWA
	GRAII/gw_quality/SA_qual_dd	Ground water quality (EC)	polygon	shapefile	Geographic, WGS84	GRAII groundwater quality based on the 1:500k hydrogeological data	DWA
Landuse / cover	Landcover/hdr.adf	Land cover	raster	arc binary grid	ALBERS, WGS84 -33 0 0.0 /* 1st standard parallel -24 0 0.0 /* 2nd standard parallel 25 0 0.0 /*	NLC2009	SANBI
	WR2005/WR2005 Berg Quat	Landuse (km2)	database	excel		linked to quat catchment. Landuse (forestry, alien-vegetation, irrigation & farm dams) area (km2) per quaternary catchment - linked to quaternary catchment file	WRC
	WR2005/Landuse/irrigation-nlc96 & deforest-nlc96	landuse classes	polygon	shapefile	Geographic, WGS85	land cover classes from NLC2006	WRC
	Protected_Areas/Protected_Areas_NBA_2011	Biodiversity	polygon	shapefile	Geographic, WGS84	has protected forest layers	SANBI

SPATIAL / GIS DATA							
Theme	**Path & File Name**	**Dataset**	**Data type**	**Format**	**Projection**	**Description**	**Source**
	Protected_Areas/Formal_Protected_Areas	Formal Protected areas	polygon	shapefile	Geographic, WGS85	has protected forest layers	SANBI
	informal_protected_areas	Informal protected areas	polygon	shapefile	Geographic, WGS85		SANBI
Remote sensing	Landsat_7ETM/…	Satellite imagery - Landsat 7 ETM	raster	tiff	Geographic, WGS84	p175r083 July 2000 and p175r084 June 2000	GLCF

LIST OF KEY REPORTS / STUDIES	
Report description	**Dept / Organisation**
List of all towns, LMs, DMs in Berg	
Water Services Development Plans, latest.	from LMs
Internal Development Plans - all LMs, every 5 years	from LMs
Saldanha - Information on projected development incl all current EIAs	various sources
All Towns Water Reconcilliation Strategies: strategy per settlement across WC for reconciliation of water supply & demand for predictions up to 2040	DWA:NWRP online (by Umvoto)
National Water Resources Strategy - 2nd edition	DWA:NWRP online
The Berg Water Availability Assessment Study - the latest water resources assessment for Berg	DWA:NWRP online (by Ninham Shand & Umvoto)
IWRM Action plan	DEA&DP (by Aurecon)
BOCMA Catchment Management Strategy status quo report by Aurecon	BOCMA (by Aurecon)
BOCMA Catchment Management Strategy report by Aurecon	BOCMA (by Aurecon)
Role of water in Economy in W.C.	WRC (by Pegasys)
Saldanha Bay Scenario Planning project	REOS & ACDI
Green Economy documents - Various reports including Green Economy Strategy Framework, Green Economy white paper.	various sources
National Development Plan	

10 Appendix 2 Water Availability and Use across the Berg

Where and how the available water is used across the Berg, and to what economic benefit was explored through analysis of various datasets including the water use registrations held within the DWS's Water Authorisiation Registration Management System database (WARMS). These datasets and summary insights are presented below.

10.1 Water resources

- Higher rainfall is received in the upper berg catchments compared to the lower berg catchments with values ranging from 225 mm/a to 1650 mm/a (Figure 10-1). The high rainfalls in the upper berg is attributed to relief rainfall as these areas are mountainous. The high rainfall and topography translates directly into a similar distribution of mean annual runoff (Figure 10-2).
- The distribution of groundwater recharge is similarly affected by the rainfall distribution (Figure 10-3), but will also be controlled by the infiltration capacity of the underlying geology.
- Electrical conductivity is a proxy for the status of (chemical) water quality. Groundwater quality declines from the upper Berg to lower Berg (Figure 10-4), predominantly caused by the underlying geology which changes from Table Mountain Group quartzite in mountainous areas, to Malmesbury Shale and Cape Granite Suite in the lower Berg.
- Informal settlements, WWTW, industrial effluent, agricultural runoff, amongst others, are all potential pollution sources to the Berg River. Potential pollution point-sources are shown in Figure 10-5. The map is incomplete as only informal settlement information excludes those within the City of Cape Town (due to datasets available). The "sources of waste" shown in the figure are a combination of known WWTW and currently active waste discharge permits from WARMS.

Figure 10-1 Annual Rainfall Distribution in Berg WMA (data from WR2005)

INSET

Figure 10-2 Mean Annual Runoff Distribution in Berg WMA (data from WR2005)

INSET

Figure 10-3 Groundwater Recharge Distribution in Berg WMA (data from GRAII)

INSET

Figure 10-4 Groundwater Quality (EC) in Berg WMA (data from GRAII)

INSET

Figure 10-5 Potential sources of water pollution in Berg WMA (data from Department of Human Settlements, and WARMS discharge permits)

INSET

10.2 Water use

- WARMS data should contain all registrations for water use in the Berg WMA, including those from the WCWSS and those "off-grid". An analysis of the WARMS data shows that abstractions registered under a 'scheme' account for the greatest volume, which relates to the WCWSS (51% of the registered volume abstracts from 'scheme') (Figure 10-6). Off-grid abstractions cluster in rural mountainous areas (the Winelands), and away from the City of Cape Town. The low-lying Swartland, Saldanha Bay and Bergrivier areas are mostly devoid of "off-grid" surface water abstractions, given that surface water resources are not present (few tributaries, low rainfall and low MAR), and any off grid abstractions in these areas are from groundwater.
- The sum of the volume of the registrations per water use sector shows that the greatest user is water services provider, totaling 346 million m3/a (Figure 10-7). This reflects municipal use (municipalities act as water services providers) from the WCWSS (it is lower than the total supplied to municipal from the WCWSS as the volume contributed from Theewaterskloof may be registered to coordinates in the Breede WMA). The sum of all registrations for agriculture suggest that agricultural sector is registered for around 340 million m3/a (similar to Table 2-3).
- The sum of all water use (all resources, all user types) per quaternary catchment illustrates the higher water use in the mountainous catchments, where the higher MAR and recharge exists and where agriculture is supported (for example G10E, Tulbagh) (Figure 10-8). This is however skew as the location of the use does not always coincide with the location of the registration (as is the case for the registrations for use by the City of Cape Town from the major dams of the WCWSS, most of which are logged in the position of the dam, excluding one which is logged to the centre of the city). The largest 15 registered water users are marked, which relate to registrations for water service providers' abstraction from the WCWSS ("Industry (urban)" in WARMS), and major irrigation board or water user association abstraction from the WCWSS.

Figure 10-6 All registered abstractions in Berg WMA, showing the registered abstraction resource (data processed from WARMS)

INSET

Figure 10-7 All registered abstractions in Berg WMA, showing the registered user (data processed from WARMS)

INSET

Figure 10-8 Sum of registered abstractions per quaternary catchment in Berg WMA, and location of largest 15 water users (data processed from WARMS)

INSET

10.3 Linking water and the economy

- The majority of the water available in the Berg is used in the City of Cape Town. The City of Cape Town metro also contributes the bulk of the GDP of the catchment, at 88.39%, followed by Stellenbosch LM at 4.15% and Drakenstein LM at 3.85% respectively. (GDP information from MERO (PGWC, 2013c), processed spatially to calculate the GDP for the portion of the LMs that falls within Berg).

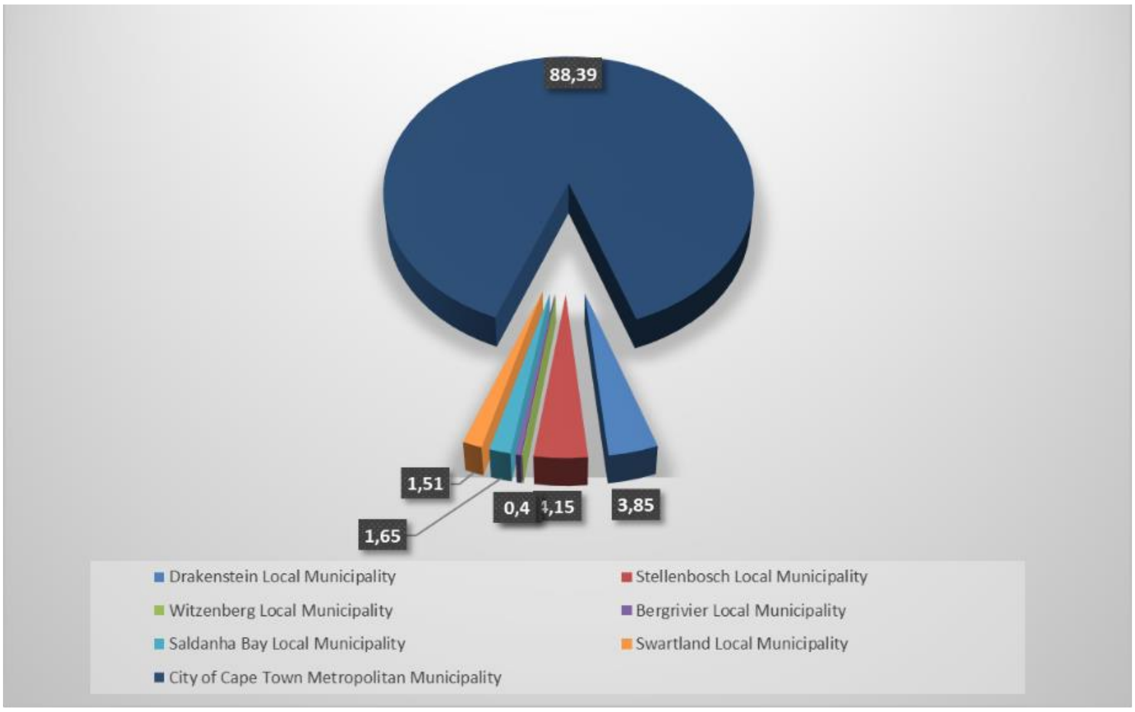


Figure 10-9 Contribution per LM (%) to the GDP in the Berg WMA (using data from PGWC, 2013c)

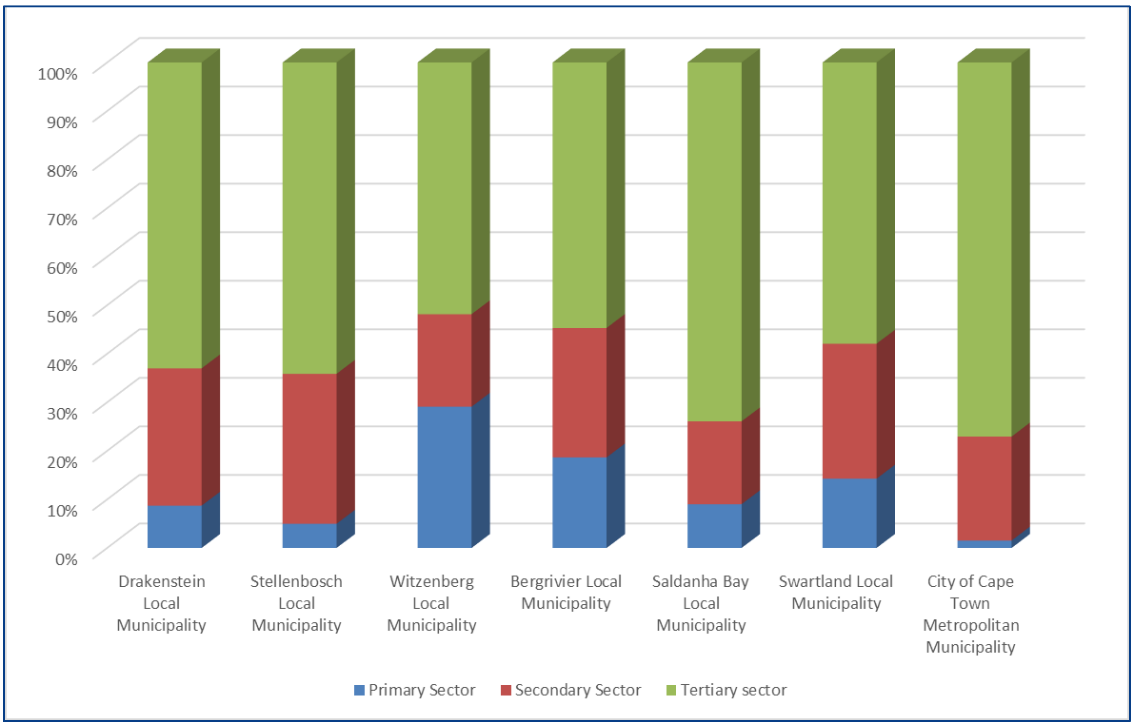


Figure 10-10 GDP contribution per economic sector, per LM within the Berg WMA (using data from PGWC, 2013c)

Figure 10-11 Green Water Footprint of Primary Sector across the Berg

INSET

Figure 10-12 Blue Water Footprint of Primary Sector across the Berg

INSET

Figure 10-13 Economic productivity (as Jobs / m3 water) of the primary sector across the Berg

INSET

Figure 10-14 Economic productivity (as GDP / m3 water) of the primary sector across the Berg

INSET

Figure 10-15 Economic productivity (as Jobs / m3 water) of the tertiary sector across the Berg

INSET

Figure 10-16 Economic productivity (as GDP / m3 water) of the tertiary sector across the Berg

INSET

11 Appendix 3 Stakeholder & Initiatives mapping

11.1 Initiatives mapping

A number of recent or current projects and initiatives were identified during inception phase, which have similar aims or similar content to the GreenCape project. Connections have been made with the project workers, in order to ensure overlaps and repeat work is minimized, and the value of work is maximized. Key parallel projects are summarised in Table 11-1 below.

The Berg River Improvement Plan (BRIP) is an umbrella project, established by Provincial Government of the Western Cape (PGWC) to tackle water quality in the Berg River catchment, and to coordinate all work carried out by PGWC on the Berg River. Various projects are conducted under six tasks within the BRIP, all with the aim of improving water quality in the Berg. This study forms falls within the BRIP Task 6: Water Pricing, and the project researchers are members of the BRIP Steering Committee.

Table 11-1 Summary of similar initiatives and projects

Project Title	Person & Group Completing project	Client / Funder	Key Project Contents
Water in the Economy	Pegasys Strategy and Development (Pty) Ltd - Guy Pegram, Hannah Baleta	WRC (unsolicited research proposal bid)	Quantified water flows through economy via water footprints of major W.C. economies, in 3 nodes of interest. Including Saldanha & WCDM
Water – energy – food nexus in the Berg River	ACDI (UCT) – Mark New	Phase 1: British High Commission, Phase 2: DEA&DP via CHEC	1. Literature review re resource demands in Berg & development of conceptual model 2. Quantitative assessment of WEF in Berg through development of integrated models
Water – energy – food nexus (national focus)	WWF - Tatjana von Bormann	British High Commission	1. Assimilation of national data & research for nexus, & promotion of nexus theme via workshop. 2. Quantitative assessment of nexus
Water efficiency of various energy options esp. renewable	Joint consortium ERC & Pegasys	WRC (solicited research proposal bid)	Assessment of trade-offs between water use efficiency and renewable energy options for South Africa. Outcome - toolkit on incorporating water considerations in energy planning & decision-making.
Scenario Planning for Saldanha Bay LM	Reos Partners for ACDI (UCT)	(Part of CHEC appointment?)	1st steps in Transformative Scenario Planning (applies 'theory u' & complex systems thinking approaches to scenario development)
Western Cape Infrastructure Framework	Consortium led by Palmer Development Group (pdg).	PGWC Department of Transport and Public Works (DTPW)	DTPW have completed the "Western Cape Infrastructure Framework" which is an on-going process aiming to align infrastructure planning and development in the W.C to enable development.
Implementation of All Towns Reconciliation Project	Umvoto Africa	DWS:NWRP	Support (to LMs) for the implementation of reconciliation actions to meet future water demand. Actions determined in previous studies that assessed development scenarios (in IDPs) to determine future municipal water demand
Implementation of WCWSS Reconciliation Strategy Study	Umvoto Africa	DWS:NWRP	Support (to the WCWSS Strategy Steering Committee) for the implementation of reconciliation interventions to meet future water demand for the WCWSS. Involves update of water demand projections, update of prioritisation of interventions, collation of intervention options across WCWSS.

Of the above projects, the findings of the "Water in the Economy" project are particularly relevant (WRC, 2013). The key similarities between the completed WRC work, and the original project questions are as follows:

1. Based on existing information, the WRC project summarised the current water resources situation and future development plans in three key nodes. One of the nodes was the West Coast District Municipality (WCDM), and Saldanha Bay.
2. The WRC project calculated the water footprint per economic sector, per district municipality (DM), for Western Cape, and based on this, provided a discussion of how water moves through the economy.
3. The WRC project provided possible pictures (or development scenarios) of the future, and suggested what decisions would need to be taken now, to proceed along particular development trajectories.

Much of the description of links between the economy and water resources, how and where the economy uses water, and how the value of water "flows through the economy", were therefore addressed in the WRC work. Considering the intentions of the GreenCape project, and with cognisance that the results intend to inform decision making in Saldanha Bay, the following key differences between the WRC work and the GreenCape intentions, shaped the programme outline:

1. Economic data is generally available per DM, or at least relative to political boundaries. Water information is generally available per WMA, or catchment, and certainly on water-related boundaries. The WRC project did not utilise geographic information systems (GIS) to cut or merge this data to the same boundaries. Although useful insights ensued, they remain at a certain generic level.
2. Water use per data is discussed at a sector-wide level, across the Berg, without unpacking the individual high users within this sector (hotspot users). Applying a spatially disaggregated approach could reveal interesting results of where, within the system, particular users constrain available resources, and vice versa.
3. The WRC project generated a method for water footprinting per sector, with the intention that this can inform economic development decisions. The water footprinting was not compared to water availability (remaining in the first accounting stage of water footprinting, according to the Water Footprint Network methodology), which would be required to inform development decisions.
4. In the assessment of future development, planned developments are extracted from published or established sources, such as Integrated Development Plans (IDPs), and are assessed against current water resources availability, rather than linked to water resource plans already 'in the pipeline'. From the water perspective, this is likely because the bulk of the WRC project was conducted before the "All Towns Reconciliation Strategy Study" was available from DWS, which made access to future water resource intervention plans very easy. From a development perspective, the IDPs are the best source of information at desktop level, however are often very generic.

In summary, without the WRC project this GreenCape project would have had to start with a much broader investigation into the baseline water and economics situation. However, the high-level approach of the WRC project, leaves the GreenCape project to respond to the specific queries raised by DED&T in relation to economic and water resource development in the Western Cape and specifically in Saldanha.

11.2 Workshop Report

INSERT

12 Appendix 4 Water Demand of Saldanha Industrial Developments

Table 12-1 List of Saldanha Bay developments incorporated into water demand projection

Project / Grouped Industry Description	Reference
Wind turbine component manufacturing and assembly	BKS, 2011
Solar component manufacturing and assembly	BKS, 2011
Rare Metals Industries - Speciality Metals Complex at Saldanha (Titanium slag beneficiation to sponge & Zirconium beneficiation)	SRK, 2013a
Zircon beneficiation (milling) to zircon powder	BKS, 2011
Offshore supply base	BKS, 2011
Vessel repair and maintenance services dry dock	BKS, 2011
Arcelor Mittal - Hot Briquetted Iron (HBI) production	BKS, 2011
Downstream Industrial	BKS, 2011
Port	BKS, 2011
Customs control area (CCA)	BKS, 2011
Vedanta Zinc - receipt and export zinc concentrate at Saldanha port	van Zyl, 2013, and ERM, 2013
Frontier Metals - Saldanha Separation Plant ("SSP project") for REE's transported in from Zandkopsdrift Mine (in N Cape)	AGES, 2014
Steenkampskraal Rare Earth project - Great Western Minerals Group Ltd. [Monazite & Thorium]	Deloitte, 2014.
Phosphate mine - Elandsfontein Exploration and Mining (Edms) BPK {“EEM”}	BRAAF, 2014 and GEOSS, 2014
Sunrise Energy LPG import and storage terminal, Farm 129/2, Ystervarkensrug	ERM, 2012
Chlor-Alkali Holdings (Pty) Ltd - Proposed Chlorine, Caustic and HCI Plant on Uyekraal Farm and Langeberg Farm, Saldanha	MEGA, 2014 and Storey, 2014
Re-commissioning of Premier Fishing’s Southern Seas Fishmeal Plant at Saldanha	SRK, 2013b
Avedia Energy: LPG Handling facility on Farm 127 (Bottling in CT)	Chand 2012.
AfriSam - Limestone quarry and cement plant	Aurecon, 2013.
MOGS - Crude Oil storage tank farm and associated infrastructure on Farm Os Fontein 194/0, Saldanha.	Worley Parsons 2012
Orexx (Pty) Ltd: Application for phosphate prospecting right	Orexx, 2014