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➤ NATIONAL GROUNDWATER STRATEGY

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“Into the well from which
you drink, do not throw
stones.”

“A river that forgets its
source will surely dry up.”

African proverbs

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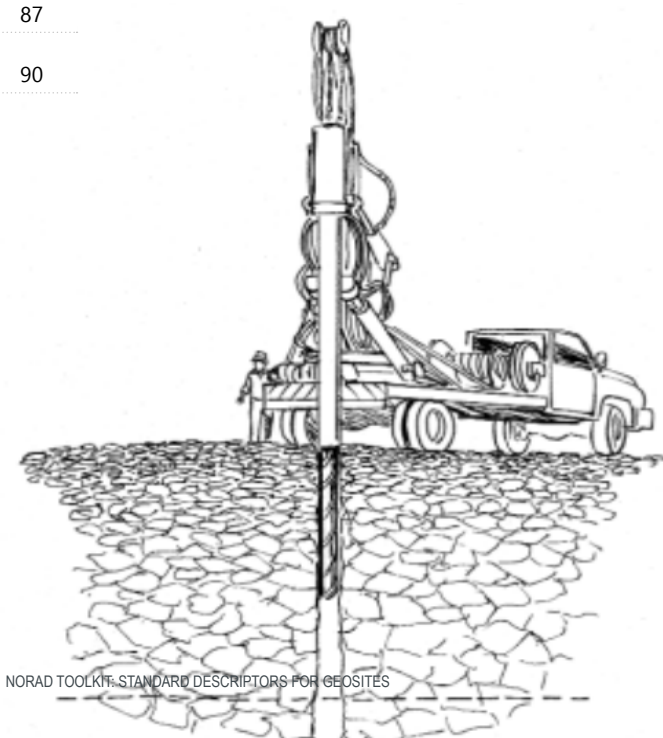
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Cl	Chloride
kl	Kilo Litre
kWh/m ³	Kilowatt hours per cubic metre
l/s	Litres Per Second
m ³ /a	Cubic Meters Per Annum
m ³ /hr	Cubic Meters Per Hour
m ³	Cubic Meters
mg/l	Milligrams per litre
million l/day	Million Litres Per Day
ML/day	Mega litres per day

Photos published in this publication were sourced from the DWS Geohydrology photobank with special acknowledgement to Olga de Beer, Ernst Bertram, Fanus Fourie, Phil Hobbs and Nico de Meillon.



Abbreviations

A	ADE	Aquifer Dependent Ecosystem	I	GMI	Groundwater Management Institute of SADC	T	SADC	Southern African Development Community
	AGW-Net	African Groundwater Network		GRA	Groundwater Resource Assessment		SALGA	South African Local Government Association
	AMCOW	African Ministers Council on Water		GRIP	Groundwater Resources Information Project		SGWCA	Subterranean Government Water Control Area
	AMD	Acid Mine Drainage		GS	Groundwater Strategy		SusIT	Sustainability Indexing Tool
B	Burdon Network	Professional network linked to the International Association of Hydrogeologists working on groundwater in the developing world	I	IAEA	International Atomic Energy Agency	T	SW	Surface water
				IAH	International Association of Hydrogeologists		SW-GW	Surface water – groundwater
C	CAP-Net	Capacity Building Network		IDC	International Development Co-operation		TBA	Transboundary aquifers
	CGS	Council For Geoscience		IDP	Integrated Development Plan	U	TCTA	Trans-Caledon Tunnel Authority
	CMA	Catchment Management Agency		IHP	International Hydrological Programme (UNESCO)		UGEP	Utilisable Groundwater Exploitation Potential
	CMS	Catchment Management Strategy		IMESA	Institute of Municipal Engineers of Southern Africa		UNEP	United Nations Environment Programme
	CoGTA	Department of Cooperative Governance and Traditional Affairs	K	ISARM	Internationally Shared Aquifer Resources Management		UNESCO	United Nations Educational Scientific and Cultural Organisation
	CPD	Continued Professional Development		ISPs	Internal Strategic Perspectives	W	URV	Unit Reference Value
D	DANIDA	Danish International Development Agency		IWRM	Integrated Water Resource Management		WARMS	Water Use Authorisation Registration Management System
	DBSA	Development Bank of Southern Africa	L	KZN	KwaZulu-Natal		WaterNet	Partnerships and networks for promoting groundwater in SADC
	DEA	Department of Environmental Affairs		LIMCOM	Limpopo River Commission		WC/DM	Water conservation / demand management
	DFID	United Kingdom Department for International Development	M	MAR	Mean Annual Runoff		WFGD	Water for Growth and Development
	DMC	Disaster Management Centre		MDGs	Millennium Development Goals	W	WISA	Water Institute of Southern Africa
	DMR	Department of Mineral Resources	N	NEMA	National Environmental Management Act		WMA	Water Management Area
	DWA	Department of Water Affairs		NEPAD	New Partnership for Africa's Development		WMO	World Meteorological Organization
	DWAF	Department of Water Affairs and Forestry	O	NGA	National Groundwater Archive		WRC	Water Research Commission
	DWS	Department Water and Sanitation		NGOs	Non-Governmental Organisations	W	WRM	Water Resource Management
	EIA	Environmental Impact Assessment		NGDB	National Groundwater Database, hosted at DWS		WRP	Water Resource Planning
E	EMP	Environmental Management Plan		NORAD	Norwegian Agency for Development Cooperation		WRSM2000	Water Resources Simulation Model 2000
	EU	European Union	P	NRF	National Research Foundation	W	WSA	Water Service Authority
F	FETWater	Framework Programme for Education & Training in Water		NWA	National Water Act (Act 36 of 1998)		WSDP	Water Services Development Plan
	FAO	Food and Agriculture Organisation		NWRS	National Water Resource Strategy		WSP	Water and Sanitation Program of the WorldBank
G	GDAS	Hydrogeological Data Access System		O&M	Operation and Maintenance		WTE	Water Trading Entity (Provider)
	GEF	Global Environmental Facility	R	ORASECOM	Orange-Senqu River Commission	W	WUA	Water User Associations
	GEOSS	Mapping and groundwater consultancy in South		PGDP	Provincial Growth and Development Plan		WULA	Water Use License Application
	GSSA	Geological Society of South Africa		PSDP	Provincial Spatial Development Plan			
	GW	Groundwater		PSP	Provincial Spatial Plan			
	GWD	Ground Water Division of the Geological Society of South Africa	S	RO	Regional Offices			
	GW-MATE	Groundwater Management Advisory Team of the WorldBank		RSA	Republic of South Africa			
	GWLS	Global Water License Services		SA	South Africa			
	GH	Geohydrology (synonymous with hydrogeology)		SACNSP	South African Council for Natural Scientific Professions			



EXECUTIVE SUMMARY

Since democratisation of the country in 1994, groundwater's role in South Africa has undergone a major change from an undervalued resource with a 'private water legal status' to a source of domestic water and general livelihood to more than 50% of communities in thousands of villages and small towns country-wide as part of the national drive to meet basic water needs.



In 2010 the Department responded to this change with an internal Groundwater Strategy, and already took the decision to work towards a national strategy together with the wider sectors. The national strategy is required to:

- Let the full role/potential of groundwater towards water security in SA unfold.
- Establish a framework within which stakeholders at all levels can become an essential part of 'good groundwater governance' in SA.
- Initiate a long-term process of rolling out sustainable groundwater utilization within WRM.

This document represents the first edition of a National Groundwater Strategy, following wide-spread consultation during 2016 among stakeholders in the water and related sectors. During the consultation, the sustainable development vision for the resource and the principle of 'local management facilitated nationally' was strongly endorsed.

'The unique, widely distributed groundwater resource, with its open access to a large number of users and a wide range of impacts, requires local level management of the shared groundwater resources within an appropriate enabling and supporting environment.'

It is important to note that IWRM remains the overall vision and the groundwater strategy will be an integral part and sub-strategy of the next National Water Resource Strategy. Groundwater resources management has already benefited greatly since 1994 from being developed within an IWRM framework across the full spectrum of policy, regulations, institutional development, protection, planning and information management. The roll-out of the NGS will have to continue within this overall framework.

South African, as well as world-wide, experience has been that management of the open access, local resource, groundwater, is complex and the evolution of appropriate groundwater management systems is a long-term process. The way forward has been captured in a groundwater governance framework, broken down into a number of strategy themes and strategic actions in which every stakeholder can now recognize the overall needs as well as his own objectives and his own areas of influence for action (see Framework following on the next page).

Its concept is based on the Global Groundwater Governance Framework completed recently (UNESCO et al., 2015), while its detail has been informed by local context, both by hydrological and by overall governance and macro-economic objectives, and most of all by stakeholder inputs from across the country and from every economic sector.



The framework should be seen as tool to achieve ongoing stakeholder understanding and role clarification in the immediate, planned roll-out of the NGS and in the longer-term process of improving overall groundwater governance and specific management systems.



NGS Groundwater Governance Framework

National Level (enabling environment)								
0. Enabling legislation and strategy (is in place) 1. Stakeholder-driven development 2. National Groundwater Leadership								
National / Regional /Basin Level								
3. Regulatory Framework	4. Groundwater Protection	5. Sustainable Utilization	6. Institutional Development	7. Awareness, Skills & Capacity	8. Redirecting Finances	9. Planning and Development	10. Information Management	11. Regional / International Partnerships
Implementing regulations at aquifer level	Protecting aquifer resources	Achieving aquifer sustainable utilization	Establishing local institutions	Building the local awareness skills & capacity	Collecting & utilizing local funds	Planning and developing shared aquifer resources	Monitoring and managing aquifer information	Enhancing aquifer management regionally and globally
12. Local Action								

The way forward will have to be tackled strategically together with stakeholders, with a strong national groundwater champion role coming from the Department of Water and Sanitation and the water science leadership role from the Water Research Commission. Jointly these two should harness stakeholder capacity in the both government and private sectors in order to facilitate local action and build capacity in new local level groundwater management institutions through sector implementation. A national stakeholder core group will be essential in order to guide and move a long-term process forward.

STRATEGY INTRODUCTION

1.1 Purpose and Scope of this Strategy

Local and world-wide experience has shown that the development of effective approaches for the management of precious underground water resources will require a long term process through which viable national, regional and local institutional systems can evolve.

A national strategy is required:

- To let the full role/potential of groundwater towards water security in SA unfold.
- To establish a framework within which stakeholders at all levels can become an essential part of good groundwater governance in SA.
- To initiate a long-term process of rolling out sustainable groundwater utilization within IWRM.

This is in line with the direction of the DWA Functional Management Committee 2/2011 to establish a national strategy by:

- Initiating a public-participation process to solicit comments on the strategy; and
- Clarifying and drafting roles and responsibilities of the wider sectors in relation to groundwater management, water security, future exploration, transboundary aquifers, etc.

It is hoped that, through the country-wide consultations and significant inputs during 2016, this document will become their framework for joint action towards sustainable, shared utilization of the precious groundwater resource.

1.2 Where are we now?

The first initiative to develop a National Groundwater Strategy (NGS) was undertaken during the early 2000s, in order to help take groundwater from a neglected private water status to that of a significant resource managed as part of Integrated Water Resource Management (IWRM) and to provide groundwater input into the first edition of the National Water Resource Strategy (NWRS1). This strategy did provide inputs to the NWRS1, but was not considered inclusive enough during its development. Hence the need for a more fully representative NGS was identified.

Following a detailed consultative process, a Framework for National Groundwater Strategy (DWAF, 2007a) was developed, serving as foundation upon which a comprehensive strategy was finally produced in 2010. The Groundwater Strategy was designed to be implemented as part of the Department's Strategic Plan 2010/11 - 2012/13, with six Priority Areas identified to allow for effective management of the nation's water resources in alignment with agreed government priorities.

The above Strategy was widely quoted in the second edition of the National Water Resources Strategy, in which a clear undertaking was made that the DWS will *"implement the National Ground Water Strategy, thereby promoting the use of groundwater on a larger scale. The focus is on supplying water mainly for household use in remote rural areas, where levels of water services are often unacceptable, as well as in other situations where groundwater can contribute to the reliability of supply for domestic and other uses"*.

This strategy was still seen as a departmental strategy and, in line with the mandate from the Departmental Management, it entered a public consultation process towards achieving buy-in and becoming the National Groundwater Strategy.

1.3 Process to develop the National Groundwater Strategy

The approach during 2016 has been to achieve essential stakeholder input and buy-in for a continuously expanding framework of 'good' groundwater governance in which the stakeholders will become the beneficiaries and the drivers of an optimally used and well governed resource.

Completed has been, at this stage, the consultation with a spectrum of stakeholders at a regional level (in each province) to learn together how a system of joint development and management of groundwater resources could evolve, taking into account the water resources, socio-economics and the IWRM institutional development of the region. It will now have to be followed up with the various individual sector leaders at national level, like mining, agriculture, local government, catchment management agencies, and the groundwater sector in terms of the private groundwater consultant companies, drillers and suppliers as well as the scientific community (represented via the Ground Water Division of the Geological Society and the Borehole Water Association of Southern Africa), to share best understanding of good governance and learn about their expectations, concerns, and potential contributions to improved groundwater governance. Civil society needs to be brought into the process to become a champion and watchdog.

Another critical consultation will be within the Department of Water and Sanitation itself. How can the widely accepted groundwater governance approach of 'national facilitation of local actions' be rolled out over time within the South African IWRM framework? What national enabling environment of assessment, planning and regulation would be required to move forward and sustain good groundwater governance?

At the same time the role and linkages of related institutions and sectors towards good groundwater governance will be explored. There is the groundwater private sector with a wealth of capacity, experience and information covering every aspect of resource development and management. There are the science councils that have had unique roles and experience with regard to groundwater's sustainable utilization.

A particular challenge for the strategy will be to maximize the role of the Water Research Commission, which has invested for 40 years already into groundwater knowledge creation and into the building of capacity in the whole water sector for the sustainable utilization and management of groundwater resources.

Groundwater practitioners, who are active in all the above institutions, are called upon to be actively involved throughout the institution-building process to share their vast experience and focus the process.

Most importantly, development of a national strategy offers new opportunities for linking users of shared groundwater resources into local institutions with a common purpose of sharing and maintaining the benefits of these resources.

A national consultation also presents an opportunity to even more strongly focus the strategy on emerging national challenges for groundwater, namely sustainable water services to thousands of communities, of finding completely new groundwater sources in areas where surface sources have reached their limits, and of protecting vulnerable groundwater resources from region-wide impacts like shale gas development.

Together, it is intended to create the sustainable development vision for the resource and roll it out in a number of strategy themes and strategic actions in which every stakeholder will recognize the overall needs as well as his own objectives and his own areas of influence.

NEED FOR A NATIONAL GROUNDWATER STRATEGY

South Africa is approaching increasing water scarcity. According to the National Water Resource Strategy 2 (2013), development of groundwater resources will be crucial for sustaining water security. Surface water, the traditional source for bulk supply, is becoming limited and even unavailable in many catchments and infrastructure and the costs of construction and maintenance are prohibitive.

Already groundwater's role in South Africa has undergone a major change during the water sector transformation post-1994, from an undervalued resource and a 'private water legal status' to a source of domestic water and general livelihood to more than 60% of communities in thousands of villages and small towns country-wide as part of the national drive to meet basic water needs.

These changes present a major challenge for the resource which occurs mainly in hard rock aquifers in which yields are limited and a water sector which had treated it largely as an emergency water supply by drilling boreholes during drought emergencies. Its sustainable utilization by many different role players at thousands of locations will require a very unique approach.

There are serious warning signals that groundwater use is presently on an unsustainable path. Water services to communities, a national priority, are under threat. Many municipal schemes from groundwater have failed or are close to failing. Municipal managers have expressed themselves against the use of groundwater and virtually no management of the resource takes place at local level. The national monitoring networks already indicate that Karst aquifers and coastal aquifers, the country's major aquifers, are under pressure in many locations through over- abstraction, declining water levels and water quality degradation. Even hard-rock aquifers in Limpopo show local declining trends in groundwater levels as a result of over-abstraction. Equally concerning is the wide-spread trend of increasing nitrate levels (parts of Limpopo, Northwest and Free State Provinces), most probably as result of human activity. Water quality impacts by Mining impacts on groundwater, which are considered to be wide-spread in problem areas, cannot be readily detected from the present national scale monitoring.

A key approach for this strategy will have to be to explicitly take into account the unique characteristics of groundwater that have a bearing on its sustainable development and management (ubiquitous occurrence, many users, open access and invisible nature, complex physical characteristics, availability of natural storage). Local level management of the shared, vulnerable resource will have to be brought about within this strategy framework, while maintaining the overall IWRM approach.

Fundamental to the strategy will be a proper valuing of the previously neglected resource as foundation for an appropriate investment into its protection, conservation and sustainable use.

From the beginning it was recognized that the National Water Act, 1998 was a framework act, which had to be underpinned with regulations to make it functional. This was particularly important for groundwater, which had not received regulatory attention in the past. Therefore a number of early initiatives were undertaken to address groundwater resources development and management strategically:

1997: Towards a regulatory framework for the development and management of groundwater in South Africa

2000: Policy and Strategy for Groundwater Quality Management in SA

2001: DWAF DANIDA Groundwater Strategy (and its piloting in two WMAs)

2004: NORAD-assisted programme: Groundwater toolkit for water services (and its piloting in two DMs)

None of these early, excellent strategies found implementation, because they were largely carried out in isolation, and because the groundwater function of the National Department had been considerably weakened at a time when implementation was to begin (see **Box A** for global groundwater challenges).

Full integration of groundwater into water resources management took time and cannot be seen as complete yet. The first National Water Resource Strategy (NWRS, 2004) did not see groundwater as a separate resource, requiring special focus and, where necessary, separate strategic plans. The national groundwater mapping programme (GRAI and GRAII) finally produced groundwater information on par with surface water information and allowed for the first time the inclusion of groundwater into Water Resources 2005 (now updated to WR 2012) and into national water resources planning.

As part of the national Department's restructuring in 2003 to prepare for its IWRM role and devolved management, specialist groundwater staff were integrated into various water management functions like Planning and Water Quality Management, and the Directorate Geohydrology was disbanded. Groundwater has benefited greatly from being rolled out as part of national planning, resource allocation and resource protection and its national visibility has increased significantly.

However, the disappearance of the Directorate Geohydrology resulted in a loss of critical mass and a rapid loss in overall groundwater capacity in the Department. This loss is of particular concern at a time when a National Groundwater Champion is needed to help new groundwater capacity in CMAs and in local government. It is clear that local government, which has the devolved water services responsibility, is presently unable to meet its objectives, including the achievement of the MDGs with respect to water and sanitation delivery, because of a complete lack of capacity for the sustainable utilisation and management of local groundwater resources. Lack of a national groundwater champion also prevents a proper synchronization of research and national development objectives and prevents the academic sector to fully play its science leadership role.

Box A**Groundwater Governance: Key deficiencies identified in global diagnostics**

Groundwater management challenges are not unique to South Africa. Below are the findings of a global groundwater diagnostic, in which South Africa participated (Groundwater Governance, 2015).

The highest level challenges are very similar throughout the world:

- Inadequate Leadership from Government Agencies
- Limited awareness of Long-Term Groundwater Risks
- No Measurement of Groundwater Resource Status
- Non-Performing Legal Systems on Groundwater
- Insufficient Stakeholder Engagement in Groundwater Management
- Limited Integration of Groundwater in Related National Policies.

Groundwater Governance, 2015



The way forward: *In the light of these general challenges, there has been a recognition, world-wide, that, with increasing level of groundwater development, there has to be an incremental institutional path, moving from technical development of the resource to groundwater management, taking account of its real value and unique characteristics, and ultimately to groundwater governance as part of IWRM. This is the path South Africa will also have to follow. South Africa has the major benefit of a functioning legal and institutional framework for the water sector in which groundwater has already evolved considerably. The Groundwater Strategy published in 2010 and the present moves towards a national framework strategy signify this development.*

NATIONAL STRATEGIC IMPERATIVES

3.1 Guidance from the NWRS2

The National Groundwater Strategy is an integral part of the National Water Resource Strategy of 2013 (NWRS2), which responds to South Africa's vision for 2030, as articulated in the National Development Plan (NDP) and to National Government Outcomes outlined in National Government's Programme of Action for 2010-2014. These priorities are key drivers for change and, as such, are the national strategic imperatives that shape the NWRS2 and the NGS.

Water has a critical role to play in the socio-economic development of South Africa. In its Vision 2030 within the National Development Plan (NDP) Government articulates the national development goal of eradicating poverty and sharply reducing inequality by 2030. To achieve this, Government has defined a New Growth Path (NGP), one of inclusive growth and development, with a focus on diversification and wide participation by South African citizens within a vibrant and growing economy. As water plays a central role in all sectors, including agriculture, energy, mining, industry, tourism, urban growth and rural development, the allocation, development and protection of water is an essential prerequisite for inclusive economic growth, poverty reduction and the significant reduction of inequality in South Africa.

High-level direction from the NWRS2 indicates the objectives of developing national water resources towards achieving SAs development priorities, namely:

- to support development and the elimination of poverty and inequality;
- to contribute to the economy and job creation; and
- to ensure water is protected, used, developed, conserved, managed and controlled sustainably and equitably.

Protection of water resources is necessary for securing ecosystem services for economic development and growth and protection of human and animal health. Protection of water resources encompasses management of quality and quantity of both surface water and groundwater and protection of the habitats.

Other relevant high-level direction includes:

- ***Addressing past imbalances (access to water services, access to water resources, access to benefits from water resource use) will be a continued focus;***
- ***Groundwater's role will be increasing; South Africa is experiencing water-stress and surface water resources are already limited in many catchments;***
- ***Climate change will be an increasingly important driver of water availability and of water requirements;***
- ***Groundwater must therefore be seen, throughout the country, as a high-priority conjunctive-use source option or, in the more arid regions, as a sole water source;***
- ***Groundwater, compared to available surface water resources, still has significant potential for development.***

3.1.1

FUTURE WATER NEEDS AND ASSOCIATED IMPACTS

The most important consideration of the NWRS2 is that water is scarce and it requires careful management to enable provision of basic water services and equitable allocation, while meeting the needs of inclusive economic growth without threatening the integrity of aquatic ecosystems.

Based on Reconciliation Strategies, surface water availability and its remaining development potential will not be sufficient to support the growing economy and associated needs in full. Surface water development potential only exists in a few water management areas, while serious challenges remain in the majority of water management areas. Also, surface water infrastructure development and the costs of construction and maintenance are prohibitive. Therefore, to meet growing needs, South Africa has to prioritise water use and consider other potential sources, including water re-use, desalination and groundwater utilisation, towards a mix of options available to supply the growing water requirements for equitable allocation for development and economic growth. To see groundwater also as a bulk water supply option will in many instances require a mind-set change.

As basis for the groundwater development and management as part of IWRM, the water needs of all the economic sectors as identified in the NWRS2 need to be considered (see **Table 3-1** below).

Table 3-1: Water needs of economic sectors in South Africa (NWRS2)

Agriculture sector

About 8.5 million people are directly or indirectly dependent on agriculture for employment and income. The sector contributes about 3% to the GDP and 7% to formal employment. The agricultural sector is made up of commercial farmers and subsistence farmers and about 1.3 million ha are irrigated. The New Growth Path (NGP) has set a target of 300 000 households in smallholder schemes by 2020 and 145 000 jobs to be created in agro-processing by 2020. Irrigated agriculture is the largest single user of water in South Africa (60%) and it has a huge potential socio-economic impact in rural communities. Water availability is the major limiting factor in the growth of this sector and poor water quality has a negative impact on agricultural exports and associated foreign income.

The Irrigation Strategy for South Africa has set a target of an increase of more than 50% of irrigated land in South Africa. For future scenarios, the DWA assumes that the volume of water allocated for agriculture will remain the same.

Forestry sector

Development opportunities for forestry are confined to high rainfall zones, such as in the Eastern Cape. For the sector to grow, more forestry areas are needed, and growth can also be enhanced by downstream processing activities, such as sawmills, pulping and paper production. Downstream activities, however, may use considerable volumes of water and pollute water resources. Forestation will reduce streamflow and protect biodiversity, especially in KwaZulu-Natal, the Eastern Cape and, to a lesser extent, in Mpumalanga and Limpopo Provinces.

Mining sector

The country is renowned for an abundance of mineral resources, accounting for a significant proportion of both world production and reserves, and South African mining companies dominate many sectors in the global industry. Mining and quarrying contributed 4.9% to gross domestic product (GDP) in 2013. While mining's contribution to GDP has declined over the past few decades, this may be offset by an increase in the downstream or beneficiated minerals industry, which the government has targeted as a growth sector. The NGP has set a potential employment target of 140 000 new jobs by 2020 for the mining sector.

Mining and related activities require significant quantities of water and impact on the environment through associated potential pollution. The mining sector is also faced with legacy issues of past pollution, for example, acid mine drainage. The development of new mines in water-scarce areas requires planning to make arrangements for the transfer of water and development of new sources, and appropriate attention to waste processing and remediation.

There are thousands of mine workings that are abandoned or derelict in South Africa. At the same time, new mining operations are underway, particularly for coal and platinum. Some of these new mines are in water-scarce areas (for example, in the Lephalale and Steelpoort Valley areas) and these activities will put more pressure on the available water resource. Both abandoned and new mines also pose a water pollution threat.

Energy sector

Although only using 2% of the available water sources, this sector contributes about 15% to the GDP of South Africa and creates jobs for 250 000 people. The sector generates about 95% of South Africa's electricity and also exports it to countries in Africa. Power generation remains a water use of strategic importance.

Energy production capacity is expected to increase as the Department of Energy is planning significant investment in new power generation capacity. Current plans include building dry-cooled coal-fired power stations that will be more water efficient. However, these power stations are located in water-scarce areas, and would strain available water resources. The return to service of older power stations, which are wet-cooled, has further burdened available water resources. The NDP proposes the use of renewable energy sources to mitigate carbon emissions. Renewable energy, such as solar energy, may also need cooling water.

Manufacturing sector

South Africa has developed an established, diversified manufacturing base that has shown its resilience and potential to compete in the global economy. The manufacturing sector contributed 15.2% to the GDP and 13.3% to jobs in 2013. The NGP has set a target of 350 000 new jobs for this sector by 2020. Water is required in the manufacturing processes and it is used for cooling.

Tourism sector

Tourism is a vital contributor to the South Africa economy. In 2013 the sector contributed directly and indirectly 7% to the GDP and 9% to sustained employment of the country. This sector is earmarked for high economic growth, which is expected to generate a significant number of new jobs. The NGP has set a target of 275 000 new jobs by 2020. Drinking water quality that matches international standards and reliable water supply and sanitation services are critical to the success of this sector. Many tourism sites require on-going attention to aquatic ecosystems.

Water services sector

Local government, through a network of district and local municipalities, provides drinking water and sanitation services to residential, commercial, and industrial sectors of the economy. As such, it is a major user of water (27% of total water use in South Africa).

Climate change

Scenarios currently indicate that the net effect of climate change for South Africa will be a reduction of water availability, although impacts will be unevenly distributed, with the eastern coastal areas of the country probably becoming wetter. In the interior and the western parts of the country, climate change is likely to lead to more intense and prolonged periods of droughts. In general, climate change will probably lead to weather events that are more intense and variable, such as sudden high volumes of rainfall, leading to flooding.

3.2 Guidance from the National Development Plan

While taking its direction from the NWRS2, some areas are highlighted here where the unique characteristics and functioning of groundwater can be seen to have a unique response to the National Development Plan (NDP). In **Table 3-2** the different strategy themes of the NGS are mapped against Outcomes outlined in the National Government's Programme of Action for 2014-2019.

Table 3-2: Importance of various National Groundwater Strategy themes in terms of Outcomes outlined in the National Government's Programme of Action for 2014-2019

No.	Priority Outcomes		NGS Links to Outcomes	NGS Theme*
1	Education	Quality basic education	*	7
2	Health	A long and healthy life for all South Africans	***	4, 3, 5
3	Safety	All people in South Africa are and feel safe	-	
4	Economy	Decent employment through inclusive growth	****	Most
5	Skills	A skilled and capable workforce to support an inclusive growth path	**	7, 10
6	Infrastructure	An efficient, competitive and responsive economic infrastructure network	***	8, 9
7	Rural Development	Vibrant, equitable, sustainable rural communities contributing towards food security for all	****	1, 5, 8, 9, 12
8	Human Settlements	Sustainable human settlements and improved quality of household life	***	3, 4, 5, 8, 9
9	Local Government	Responsive, accountable, effective and efficient local government	**	3, 6, 7
10	Environment	Protect and enhance our environmental assets and natural resources	*****	Most
11	International	Create a better South Africa and contribute to a better Africa and a better world	***	10, 11, 7
12	Public Service	An efficient, effective and development-oriented public service	**	2, 3, 6, 9, 10
13	Social Protection	A comprehensive, responsive and sustainable social protection system	-	
14	Nation Building	A diverse, socially cohesive society with a common national identity	**	1, 6, 12

*** developed in Chapter 7**

Issues that stand out are the (potential) contributions of improved groundwater governance to human health, rural development, human settlements, water infrastructure development, enhanced environmental assets and a contribution to development on the continent. A more detailed analysis is presented in **Appendix 1**.

Aspects for consideration in the National Groundwater Strategy include:

- Enabling agricultural development for food security as well as job security through groundwater's untapped role in smallholder irrigation;
- Systematic planning and implementation for groundwater to play its critical role in drought emergencies; and
- Fully visualizing and developing the role of women in local groundwater resource development and management.
- Shale gas development and groundwater resource protection.

It is important to note that the NDP was written with a surface water focus. The Groundwater Strategy will have to inform and guide the other sectors about the realistic potential of groundwater for their development objectives.

3.2.1

SUSTAINABLE DEVELOPMENT GOAL 6: CLEAN WATER AND SANITATION

In 2015 the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development (see **Box B**) in which universal access to clean water and sanitation became one of 17 Global Goals in the international sustainable development agenda. Achieving this goal will, on the one hand, require a major investment in adequate infrastructure and, on the other, the protection and restoration of water-related ecosystems such as forests, mountains, wetlands and rivers in order to mitigate water scarcity. More international cooperation is also needed to encourage water efficiency and support treatment technologies in developing countries. An integrated approach is crucial for progress across the multiple goals.

The overarching areas of concern highlighted in these goals include [universal] access to drinking water and sanitation; sustainability of water resources; disaster risk management; climate resilience, adaptation and mitigation; management and governance; rights and equity; economic benefits of allocation; monitoring of water resources and SDG targets; and cross-cutting issues, such as the water-food-energy nexus. Groundwater is not explicitly included or its role taken into consideration. An integrating proposal that had initially been made for inclusion was (Conti, 2015):

“sustainable development, management and use of surface and groundwater resources, respecting ecosystems requirements.”

UNESCO's International Groundwater Assessment Centre (IGRAC) is committed to still help craft SDG targets, which take into account the role of groundwater in sustainable development and to mobilize the network of global groundwater professionals as required to meet the SDG targets and satisfy the post-2015 development agenda. Its recommendations are shown in **Table 3-3** as an important direction for the National Groundwater Strategy.

Box B

Goal 6: Water and Sanitation in the Sustainable Development Goals (SDGs)*

**2015 UN-Water Annual International Zaragoza Conference. Water and Sustainable Development: From Vision to Action. 15-17 January 2015*

- By 2030, achieve universal and equitable access to safe and affordable drinking water for all
- By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
- By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
- By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
- By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
- By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
- Support and strengthen the participation of local communities in improving water and sanitation management.

United Nations (2015)

Table 3-3: Examples: Incorporating Groundwater into Global SDGs for 2030 on Water and Sanitation (Conti, 2015)

Target Areas	Examples of Groundwater Goals
Target Area 1: Access to Drinking Water, Sanitation and Hygiene	Enhance the role of groundwater in sustainably providing water, sanitation and hygiene Ensure that wells are built and maintained to provide long-term and safe access to groundwater resources
Target Area 2: Improved Water Quality and Waste Management	80% of drinking water wells should be protected from contamination Reduce by 25% the volume of contaminated groundwater
Target Area 3: Sustainable Use and Development of Water Resources	Decrease by 30% the number of aquifers which are overexploited and/or severely contaminated Increase by 30% the number of aquifers monitored for changes in quality and quantity Utilize non-renewable groundwater in a socially acceptable manner
Target Area 4: Disaster Risk Management	Enhance drought and flood preparedness by both including groundwater monitoring in early warning systems and groundwater wells in emergency water supply schemes Utilize storage and buffering capacity of groundwater to increase resilience to natural disasters
Target Area 5: Water Governance, Rights, Equity, Peace & Security	Include groundwater in integrated water resource management and planning, especially when implementing conjunctive use schemes Equitably and transparently distribute rights to groundwater, taking into account traditional use



NORAD TOOLKIT: GROUNDWATER PROTECTION

GROUNDWATER RESOURCES

AVAILABILITY AND UTILISATION

4.1 Groundwater occurrence

Water not only covers three quarters of the Earth's surface: it is also present almost everywhere below ground surface, down to considerable depth and in continuous motion. It represents an invisible component of the hydrosphere and of the water cycle. This groundwater represents by far the biggest portion of all liquid (not frozen) freshwater on earth – about 96% (see figure below). In comparison, the global volume of freshwater in lakes is less than 1% of the total fresh groundwater volume (see **Figure 4-1**).

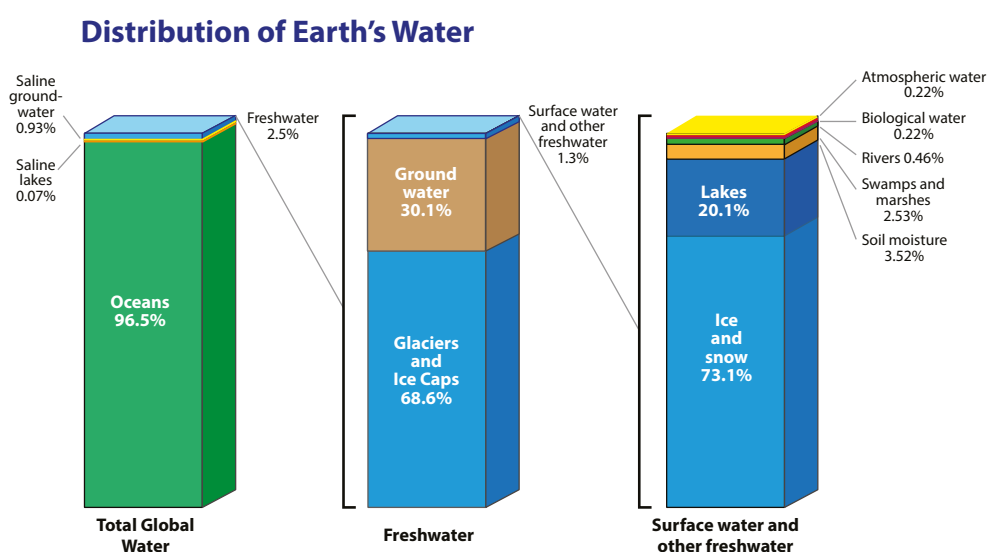


Figure 4-1. The groundwater portion of the earth's freshwater (Gleick, 1993)

4.2 Groundwater occurrence in South Africa

South Africa's aquifer systems have received their water-bearing properties, in particular the permeability, through the region's historical geological and hydrological development and as a result of the physical and chemical composition of the different rock types. **Figure 4-2** illustrates the main types of permeability found in different rock types. Permeability is termed primary if it is formed as the rock is formed (intergranular) and secondary if it is formed in the rock formation itself (fissures and caverns, fractures, joints and faults).

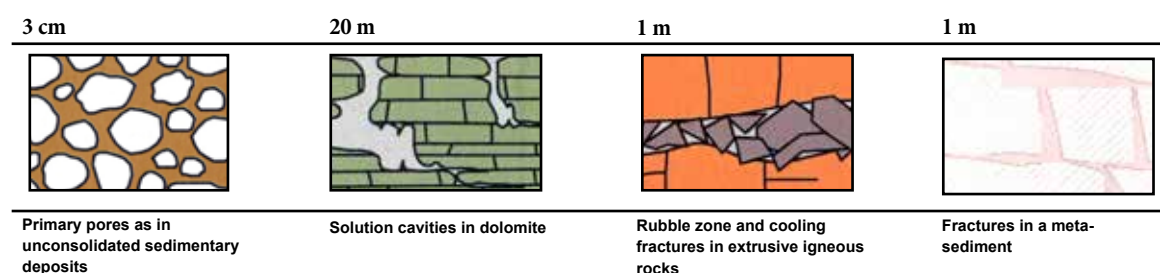


Figure 4-2. Different aquifer permeability types (Colvin et al., 2007)

The simplified geology map in **Figure 4-3** enables a national-scale view of the main aquifer types in South Africa based on the aquifer properties of the main lithology (rock type) of the different rock strata.

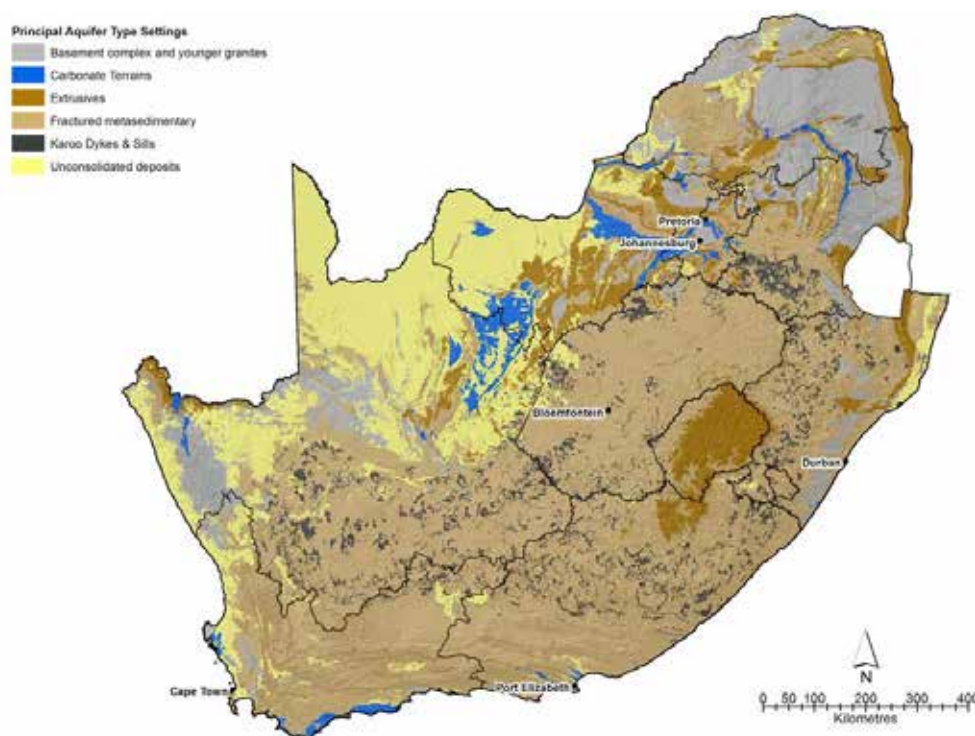


Figure 4-3. Main aquifer types in South Africa

More than 90% of South Africa is underlain by hard-rock, or secondary, aquifers controlled by secondary faulting and jointing. Primary (sandy) aquifers generally are restricted to the coast, alluvial valley deposits and the Kalahari.

A very pragmatic aquifer classification was already developed in 1995 to support the regulatory system developed by the then Department of Water Affairs and Forestry – see **Table 4-1** (Parsons, 1995).

Table 4-1: Aquifer Systems in South Africa (after Parsons, 1995)

Aquifer System Classification	Coverage of the Country (%)	General Location
Major Aquifers	18	<p>Primary aquifer systems along the coast;</p> <p>Dolomitic systems in parts of Gauteng, Mpumalanga, the Northern Cape and North West Province;</p> <p>Rocks of the Table Mountain Group bordering the Cape coast;</p> <p>Parts of the Karoo Supergroup;</p> <p>Cities and towns receiving water from major aquifer systems are Pretoria, Mmabatho, Atlantis, St. Francis Bay and Beaufort West.</p>
Minor Aquifers	67	<p>Minor aquifers occur widely across South Africa with variable borehole yield and water quality. They supply many smaller settlements, e.g. Nylstroom, Williston, Carnarvon and Richmond.</p>
Poor Aquifers	15	<p>Poor aquifers occur mainly in the dry northern and western parts of the country. The generally low borehole yields of poorer quality are, however, still of critical importance to small rural communities.</p>

A map showing the spatial distribution of major, minor and poor aquifers is shown in **Figure 4-4**. The map also shows locations where groundwater sources are used, either as sole source or in combination with surface water sources.

A critical characteristic in terms of groundwater's exploitation is the depth that has to be drilled to encounter groundwater. This is expressed as the depth to the first water strike and the country-wide situation is shown in the map, **Figure 4-5**. This depth ranges between 30 – 60 m for large parts of the country, to over 120 m, in particular under the deep sand cover in the Kalahari.

The thickness of the water-saturated formation determines the storage of an aquifer. This is particularly important in times of drought. However, the sustainable utilization of an aquifer is dependent on its natural replenishment or recharge, just as in the case of river flow. The management task is to ensure that utilisation stays within the limits imposed by rainfall and recharge. Groundwater differs from rivers in that the response to rainfall is not "flashy", but reflects over a period of months or even years. The response to droughts is also much slower, with groundwater therefore a far more buffered resource than surface water. Surface characteristics and geology can result in 'preferential recharge areas' and it is important to know and understand these. A project supported by the WRC is presently underway to map these areas, so that they can be better protected (Nel et al., 2013; Nel et al., 2015).

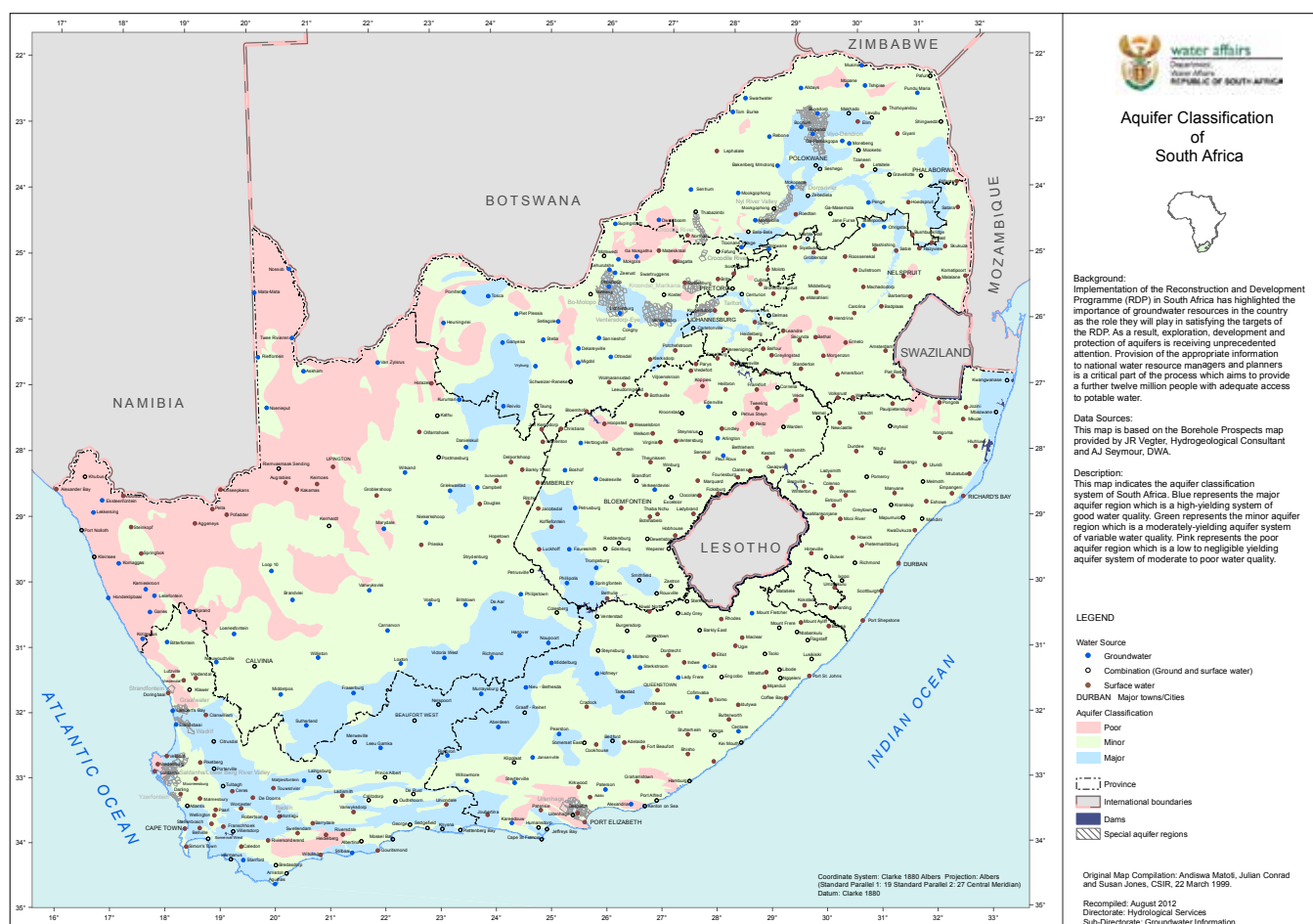


Figure 4-4. Aquifer classification in South Africa

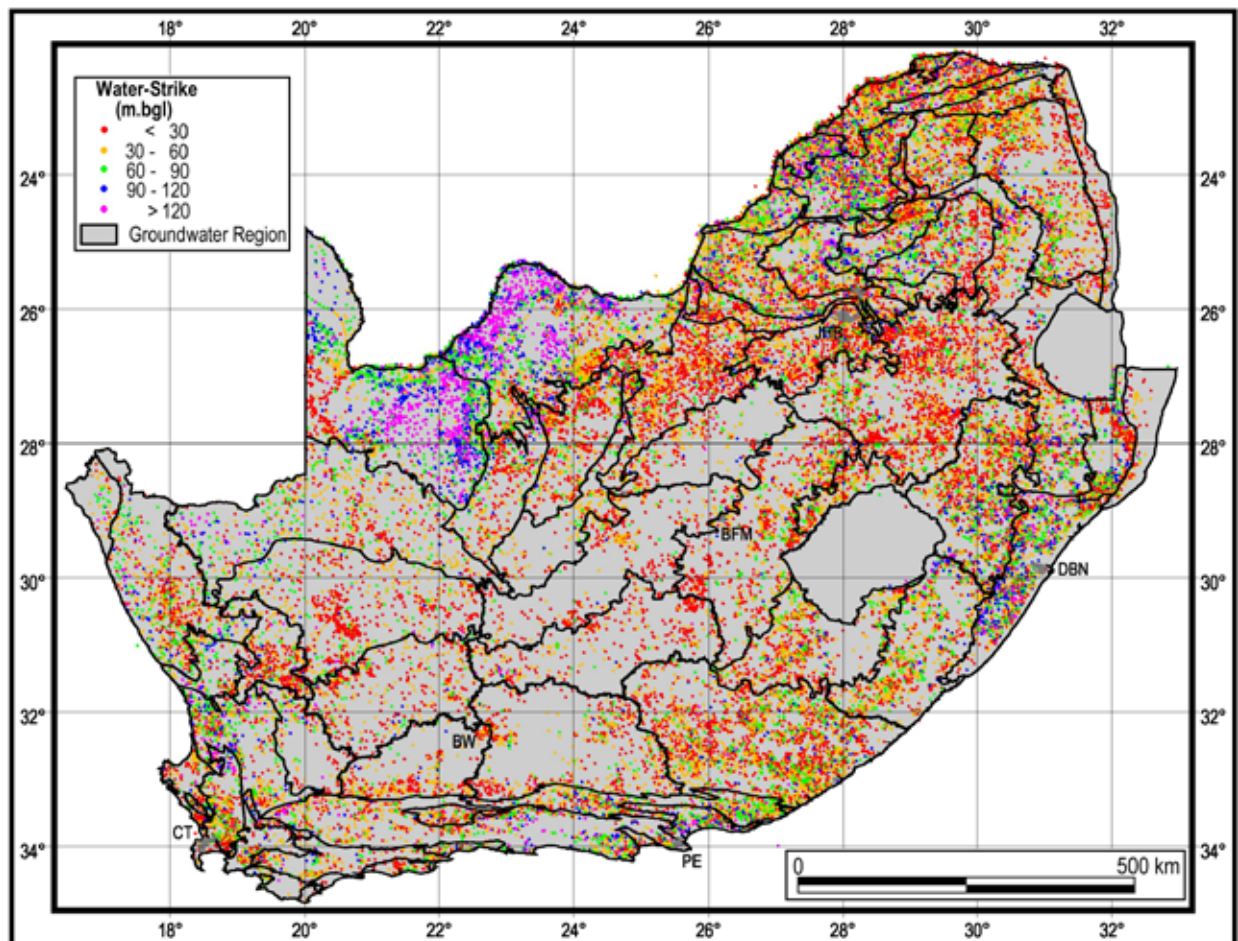


Figure 4-5. Depth to Water Strike in South Africa

4.3 Groundwater – environment linkages

An aquifer – literally a ‘water carrier’ – is both a reservoir and a transport channel. Groundwater flow in an aquifer is governed by the aquifer’s intrinsic characteristics (shape, size, permeability etc.) but also by its recharge, largely produced by infiltration of precipitation. Most of the groundwater flow eventually ends up in springs and streams. In coastal areas there may be a significant outflow into the sea. Groundwater recharge and groundwater discharge are thus the links between groundwater and the other components of the water cycle. This is illustrated in the water cycle diagram (**Figure 4-6**) (Colvin et al., 2007).

Wherever groundwater flows or discharges to the surface, Aquifer-Dependent Ecosystems (ADEs) can occur. Their identification is often difficult, but a type-setting and identification study has been undertaken to guide groundwater management and allocation (Colvin et al., 2007). Examples of known South African Aquifer-Dependent Ecosystems include:

- in-aquifer ecosystems in the dolomites (North West Province);
- springs and seeps in the TMG sandstone (Western Cape);
- terrestrial keystone species such as *Acacia erioloba* in the Kalahari;
- lakes and punctuated estuaries on the shallow sand aquifers of the east and south coast;
- riparian zones in the seasonal alluvial systems of the Limpopo;
- seeps on the Karoo dolerite sills.

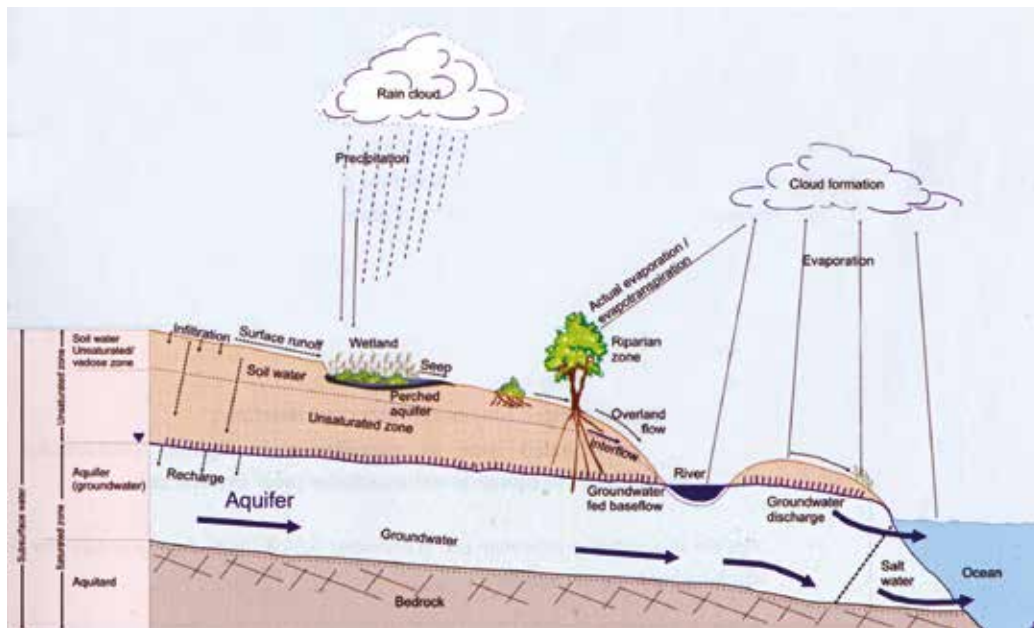


Figure 4-6. Subsurface and surface flows of water in the environment (Colvin, et al., 2007)

A first overview of the types of ADEs which are known and thought to occur in South Africa was provided by Colvin et al. (2007). **Figure 4-7** from their report shows vegetation groups with a high, medium and low probability of being linked to aquifers.

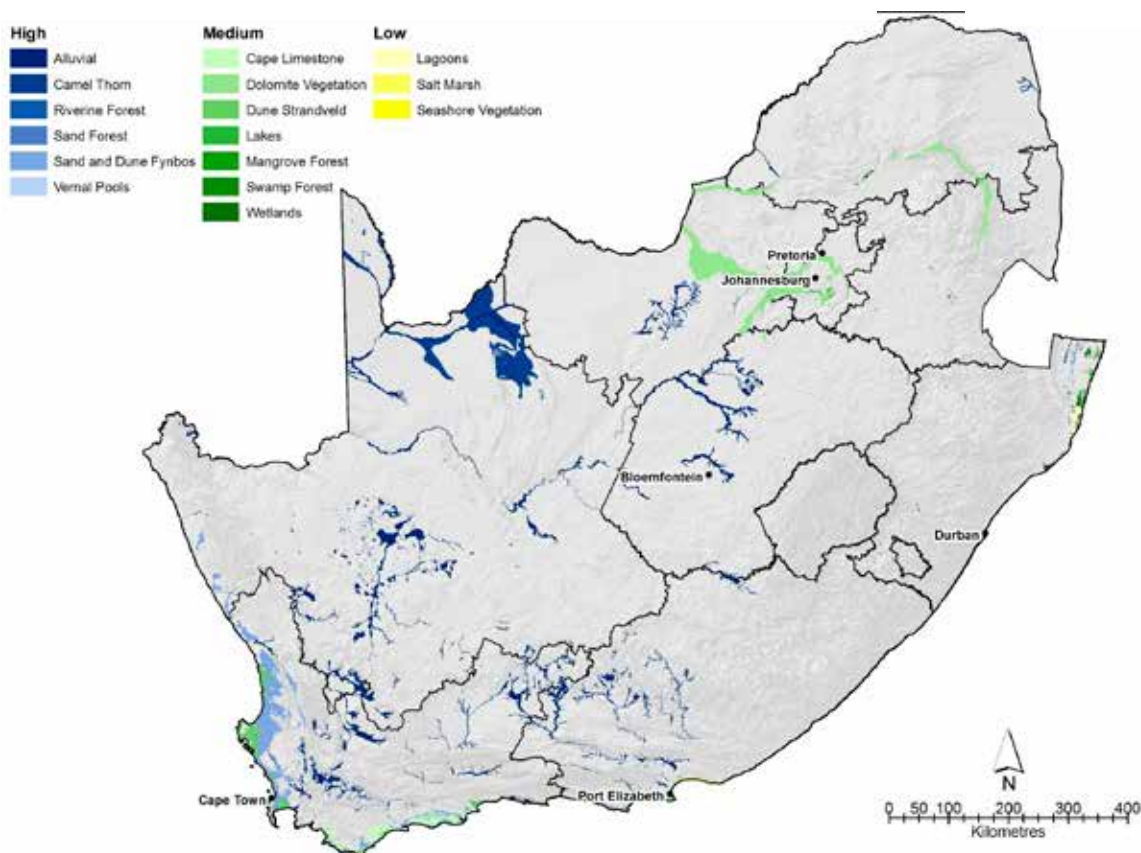


Figure 4-7. Groups of vegetation types with a high, medium and low probability of being aquifer dependent, (Colvin, et al., 2007)

An important groundwater – ecosystem linkage is the dry-weather flow in a stream or river, called base flow, resulting largely from groundwater seeping into riverbanks or the riverbed. The map below (**Figure 4-8**) provides a country-wide indication of the amount of baseflow in our rivers. It illustrates the typical semi-arid to arid climate situation in large parts of the country in which groundwater tables are too deep to contribute to river baseflow. However, groundwater is still discharged from the system by means of evaporation and evapotranspiration.

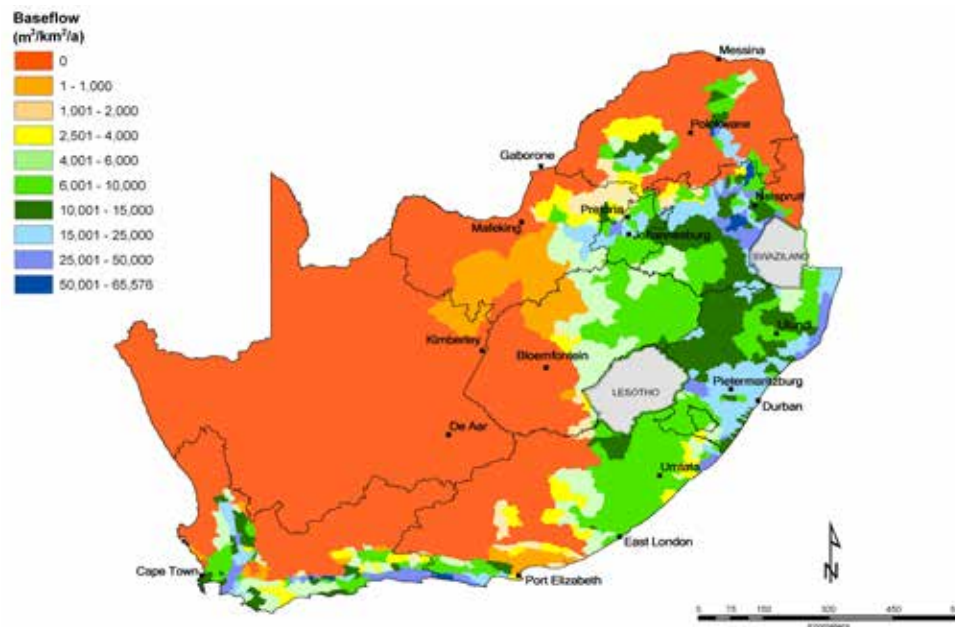


Figure 4-8. Groundwater contribution to baseflow

4.4 Groundwater resource potential

The systematic country-wide quantification of our groundwater resources as we have it today, followed out of a national groundwater mapping programme of the Department of Water Affairs and Forestry, launched in 1992, jointly with the Water Research Commission. Its first output, largely based on the life-long work of J.R. Vegter, was a series of national maps and an explanatory document published by the Water Research Commission (Vegter, 1995). In parallel, over the period 1995-2003, the Department published a set of 21 hydrogeological maps covering the country at a scale of 1:500 000, with accompanying explanatory booklets.

Because of the immediate demand for this type of information by the Department's water resources planners, a further phase of national assessment and quantification of groundwater resources at quaternary catchment level followed (2003-2005), aided by a consortium of consultants and culminating in the Groundwater Resource Assessment Phase 2. Importantly, the fourth iteration of the Surface Water Resources of South Africa (2004-2007) for the first time included groundwater, drawing largely on the database and outputs from the GRA 2 project.

Some key findings from the above studies, also summarised in the Department's Groundwater Strategy (DWA, 2010), are shown below. The total volume of available, renewable groundwater in South Africa (the Utilisable Groundwater Exploitation Potential – see **Figure 4-9**) is 7 500 million m³/a, allowing for factors such as physical constraints on extraction, potability, and a maximum allowable drawdown. Current use is between 3 000 and 4 000 million m³/a. There is thus the potential to considerably increase groundwater supplies in South Africa. In contrast, the assured yield of South Africa's surface water resources is approximately 12 000 million m³/a, but more than 80% of this is already allocated. As the National Water Act had indicated in 1998, groundwater is indeed a "significant resource".

It must be remembered that this groundwater is not evenly distributed, but spread variably, often thinly, over the whole country. This can be an advantage in providing water for small-scale local use, but to utilise it for bulk water supply to larger centres of demand, may require a large number of boreholes and connecting pipelines. This may not always be economic, and operation may be a major consideration.

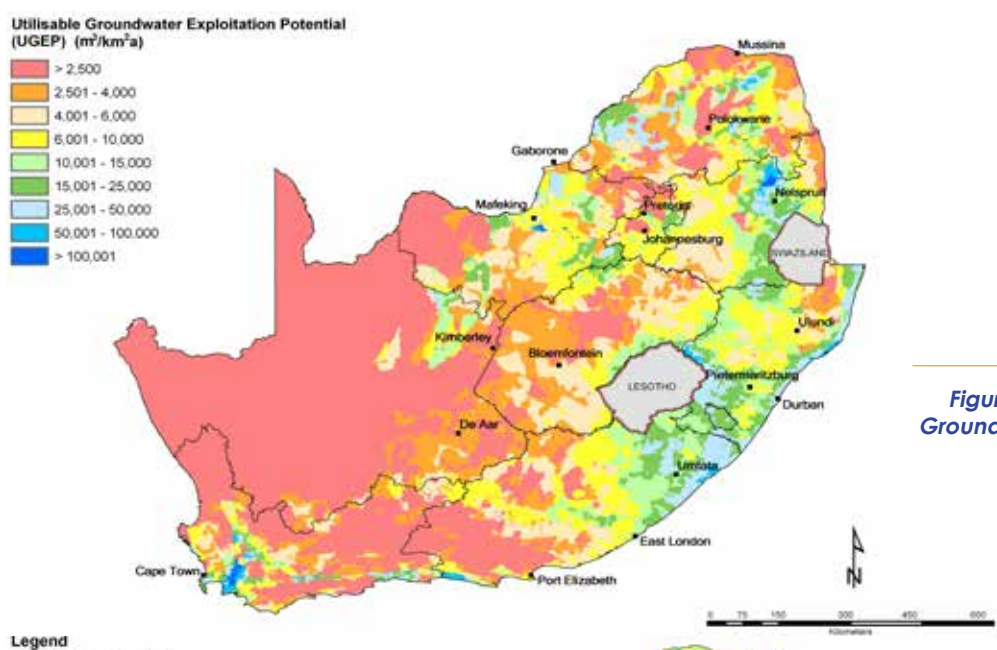


Figure 4-9. Utilisable Groundwater Exploitation Potential

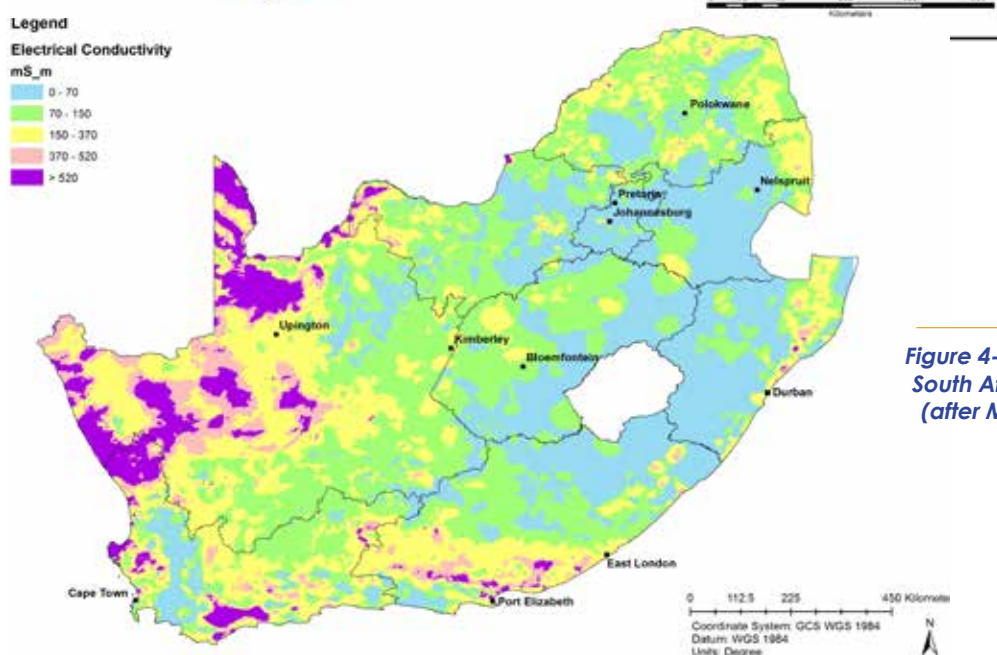


Figure 4-10. The potability of South African groundwater (after Murray et al., 2012)

The quality of South African groundwater is generally of a potable standard (the shades of blue in **Figure 4-10**). Salinity of water can be measured as electrical conductivity, expressed in units of mS/m. The target water quality is between 0 and 70 mS/m and above 150 mS/m water will have a marked salty taste. Highest salinities occur in the very arid regions and in some coastal regions. Depending on the geological formation, individual quality constituents can sometimes exceed the drinking water limit, for example flourides in parts of the North West Province.

Pollution of groundwater can be a serious problem, because the impacts of activities on the land surface are poorly understood and contamination of the underground source can go undetected for a long time.

4.5 Groundwater development

The exploitable groundwater resources of an area cannot be assessed properly without taking into account the practicalities of getting access to the groundwater and withdrawing it. Both are highly dependent on characteristics of the aquifer (depth, permeability etc.). The most economical are obviously the situations where no external energy source is required to lift the water to the surface, for example springs or flowing (artesian) boreholes. Pumping leads to energy requirements and thus higher production running and maintenance costs.

There are many different cost items involved in the drilling of a borehole. **Table 4-2** an example from sub-Saharan Africa of drilling a 50m deep borehole at an average cost of US\$ 129 per meter, i.e. nearly R 2000 per meter drilled (Danert et al., 2014). With this type of cost, the importance of professionalism in all aspects of the work, in particular the siting, drilling and equipping of the borehole, cannot be stressed enough.

Table 4-2: Example of Borehole Cost Breakdown (Danert, 2014)

Item	Unit	Quantity*	Rate (\$)	Amount (\$)
Siting	Lump sum	1	400	400
Mobilisation & demobilisation	Lump sum	1	1 538	1 538
Drilling	m	50	40.1	2 005
Casing & Completion	m	50	21.2	1 060
Well development & pumping test	Lump sum	1	478	478
Platform casting & pump Installation	Lump sum	1	935	935
Water quality testing & disinfection	Lump sum	1	50	50
Total cost				6 466
Average cost (\$/m)				\$ 129.3/m

*** 110 mm diameter u PVC lined borehole; 50 m deep; drilled by drilling rig costing \$ 170 000, depreciating over 10 000 hours.**

In a breakdown of costs and resource valuation, the wellfield operation costs make up a very important element of overall costs. At present, capital costs still tend to be considered in far more detail than the recurrent costs. Groundwater sources in South Africa today are often attended only when they fail, and indications are that this is a much more costly approach than providing for ongoing management sustainable operation and maintenance.

4.6 Groundwater utilization

Groundwater contributes 15 % of all the water resources been used in South Africa. **Figure 4-11** provides a breakdown of groundwater use for different economic sectors and **Figure 4-12** shows groundwater use per Water Management Area in terms of available groundwater resources and indicates that there is still considerable potential for groundwater development (See **Table 4-3**). Large volumes of groundwater are used for irrigation in the drier, more sparsely populated west of the country. Such a volumetric aggregate is however not always a good reflection of the importance of groundwater for a specific sector.

The Reconstruction and Development Programme (RDP) and subsequent plans and strategies have enabled major progress in supplying our citizens with an improved water supply since 1994. According to the 2010 Millennium Development Goal (MDG) Report (UN, 2010) in 1996 only 61% of the national population was using an improved drinking water source. In 2013 that figure stands at 95% (DWA, 2013), meaning that South African has easily achieved its MDG obligation in relation to water. This achievement would not have been possible without groundwater becoming an important source. In 5 of the 9 provinces more than 50% of settlements now have a groundwater supply, Limpopo leading with 84% followed by North West and Northern Cape Provinces, both with more than 65% of communities supplied from groundwater. In terms of volumes, it represents a very small portion of the overall water supplied, but in terms of the national objective of development and the elimination of poverty and inequality, it represents major progress.

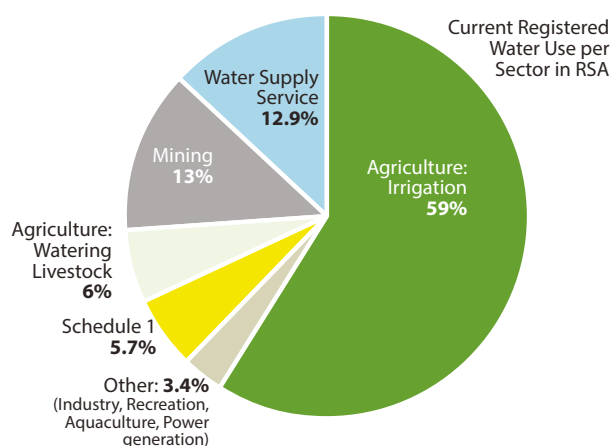
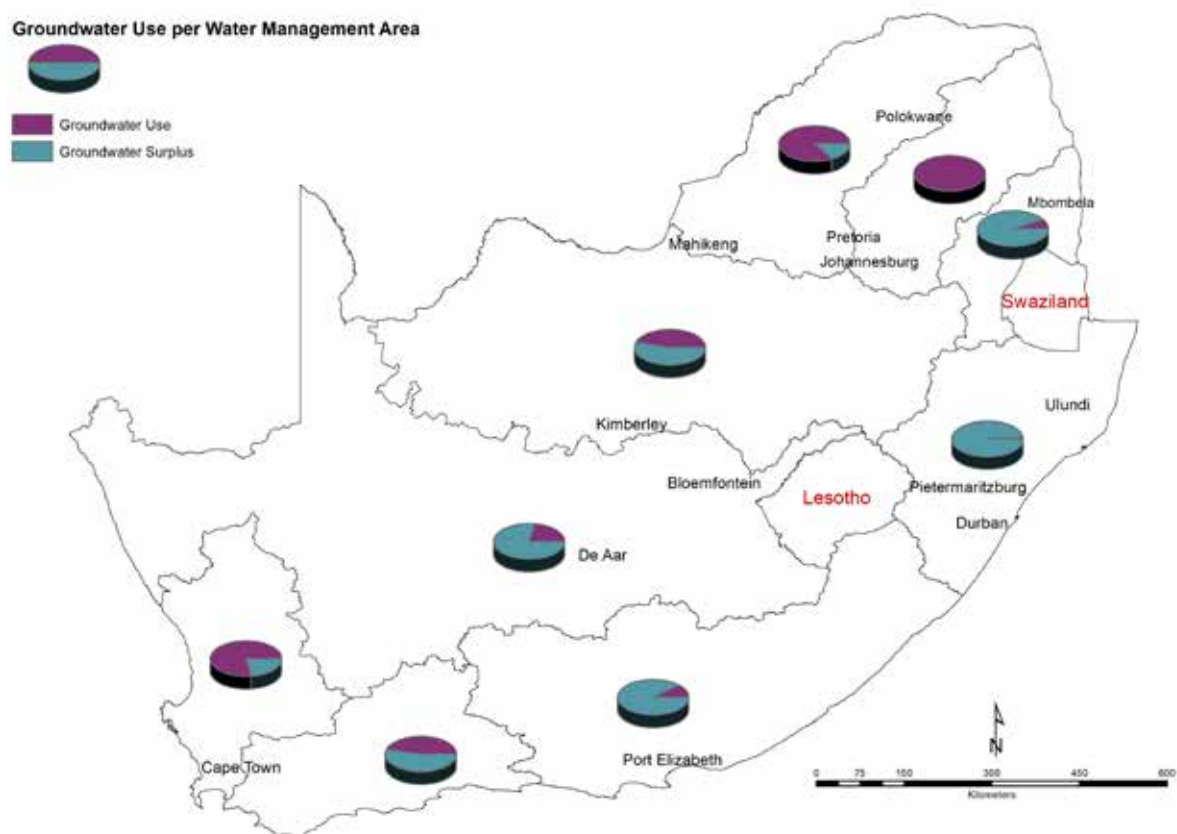


Figure 4-11. Breakdown of groundwater use for different economic sectors

Figure 4-12. Groundwater use in terms of available groundwater resource



Groundwater is becoming increasingly important for urban water supply. 22% of towns use groundwater as sole source and another 34% in combination with surface water. Water sources of domestic water supply (urban & rural) are shown in **Figure 4-13**.

A major advance towards improved development and management of the country's groundwater resources has been that groundwater use has been registered for the first time in terms of the provisions in the National Water Act, 1998. **Table 4-3** presents a summary from the Departmental WARMS database of the Registered groundwater use per economic sector for each of the 9 Water Management Areas.

A critical next step is the verification of this registered groundwater use. It will require the participation of groundwater stakeholders and could thus lay the foundation of improved groundwater governance and eventually protection.

Water sources of 926 cities, towns and villages in RSA

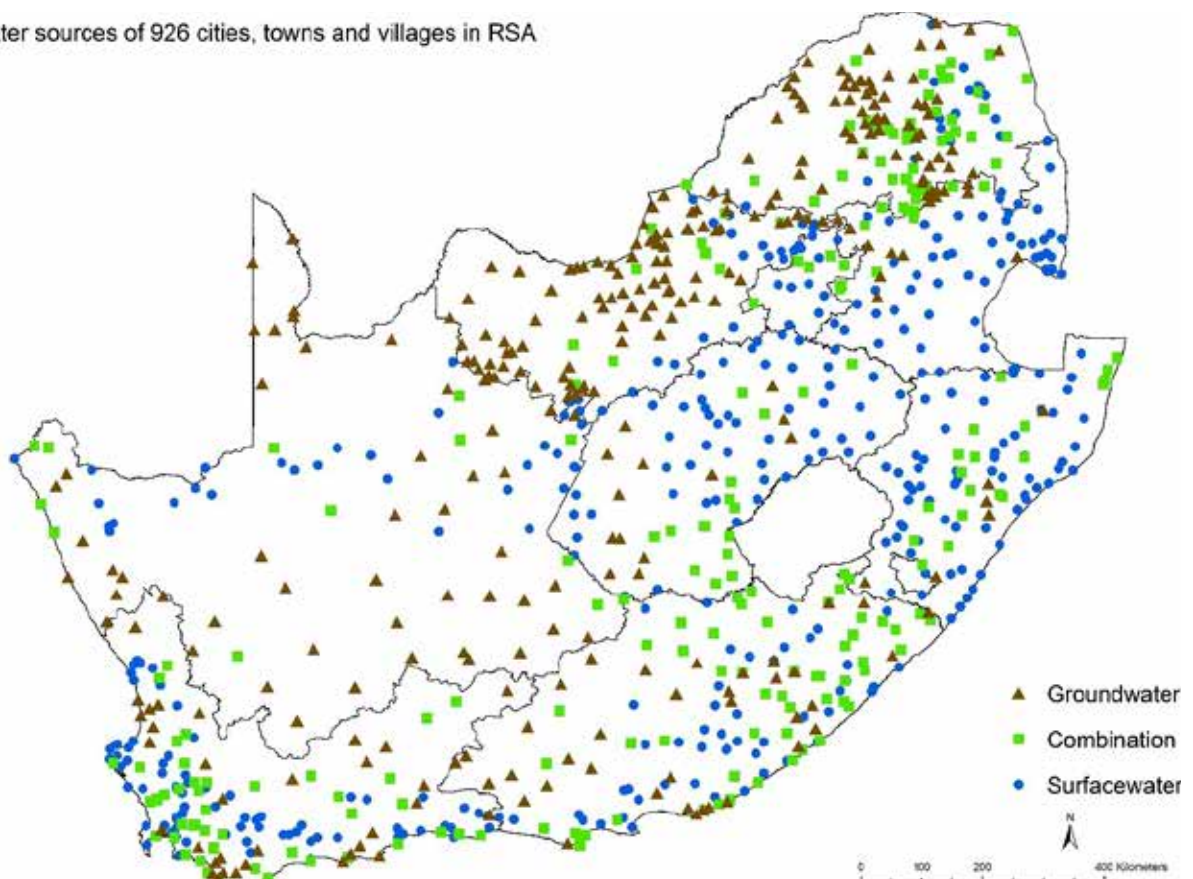
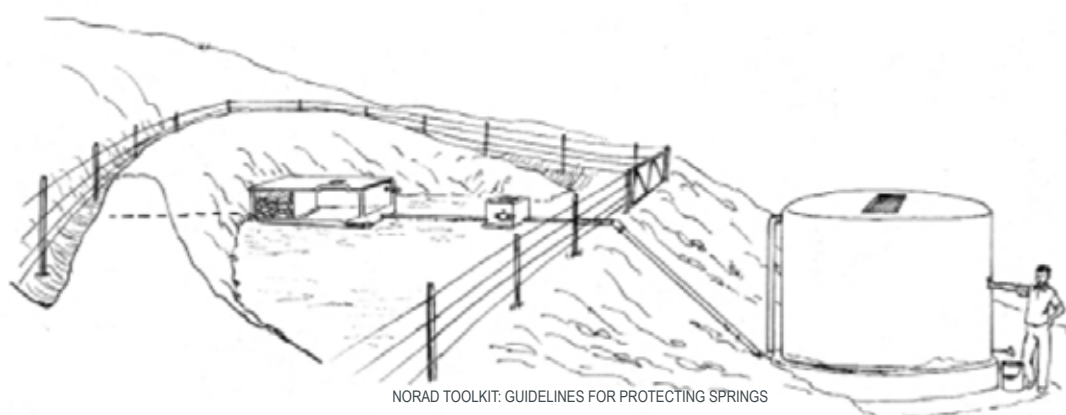


Figure 4-13 Water sources of domestic water supply (urban & rural)

Table 4-3. Sectoral Registered groundwater use according to WMA (million m³/annum) (WARMS, DWS)

WMA	Domestic	Agriculture	Mining	Industry	Power Generation	Total	Groundwater use as % of total use
LIMPOPO	258.01	510.02	37.39	17.61	0.00	823.03	30%
OLIFANTS	36.08	171.38	344.23	6.06	0.64	558.38	21%
INKOMATI-USUTHU	18.47	17.40	3.96	1.65	0.04	41.52	2%
PONGOLA-UMZIMKULU	7.47	8.32	0.04	2.66	0.01	18.51	1%
VAAL	57.36	366.80	125.15	22.05	0.00	571.35	21%
ORANGE	12.45	133.13	2.61	3.02	0.09	151.30	6%
MZIMVUBU-TSITSIKAMMA	51.48	83.40	0.26	1.71	0.28	137.13	5%
BREDE-GOURITZ	19.32	192.30	0.05	6.16	0.00	217.83	8%
BERG-OLIFANTS	4.46	183.74	0.66	15.18	0.04	204.07	7%
TOTAL	465.10	1666.49	514.34	76.10	1.09	2723.13	





“

Groundwater is a key resource for poverty reduction and economic development of rural and peri-urban areas.

STRATEGY

OBJECTIVES AND PRINCIPLES

5.1 The objectives of the NWRS2

VISION *The water sector vision for the National Water Resources Strategy 2, as aligned with the vision of South Africa 2030, is: Sustainable, equitable and secure water for a better life and environment for all.*

GOAL Towards achieving this vision, the overall goal is: Water is efficiently and effectively managed for sustainable growth and development.

OBJECTIVES

- 1: Water supports development and the elimination of poverty and inequality.
- 2: Water contributes to the economy and job creation.
- 3: Water is protected, used, developed, conserved, managed and controlled sustainably and equitably.

5.2 The objectives of the NGS

VISION *Our Precious Shared Groundwater Resource Sustaining Life, Environment and Development throughout South Africa.*

GOAL To ensure sustainable, accessible and cost-effective groundwater supplies for human survival and socio-economic development, while maintaining the environmental services that groundwater is supporting, in an integrated development approach.

OBJECTIVES

- 1: To achieve improved rural water supplies for basic and livelihoods needs from groundwater and other local sources.
- 2: To achieve sustainable small town / village supplies from groundwater, practicing integrated water resource management at local scale.
- 3: To improve water security for urban development from groundwater through a range of conjunctive-use options, integrated with waste water management.
- 4: To expand irrigated agriculture, especially for small-scale and supplementary irrigation from groundwater, with focus on sustainability and appropriateness and cost-effectiveness of technology.
- 5: To develop new groundwater sources in increasingly complex locations, including brackish water, for industrial / mining supply in situations of increasing water scarcity.
- 6: To actively pursue the protection and conservation of groundwater resources by all sectors of society, taking cognisance of its general vulnerability and of the range of essential services, including vital ecosystem services, which the hidden resource can provide.
- 7: To achieve sustainable resource utilization through appropriate groundwater resource governance resulting in capacitated local participative resource management, enabled and supported by a coordinated national / regional water sector.

5.3 Principles to inform the NGS

Above all, groundwater resource development and management will have to be guided by the principles of the National Water Act. Sustainability, Equity and Efficiency are the principles that guide the protection, use, development, conservation, management and control of water resources. These principles recognize, inter alia:

- the basic human needs of present and future generations
- the need to redress (correct) past discrimination
- the need to protect water resources
- the need to share water resources with other countries,
- the need to promote social and economic development through the use of water,
- the need to use water to the best possible social and economic advantage.
- the need to establish representative water management institutions, and
- the need to ensure participation of stakeholders and users in decisions that affect them.

A number of principles are unique to groundwater and must guide how governance of groundwater translates into practice. The principles below have emerged from the global groundwater diagnostic already referred to (Groundwater Governance, 2015) and have been combined with groundwater and development principles experienced in South Africa.

1 Unique Development Role

Groundwater is a key resource for poverty reduction and for the economic development of rural and peri-urban areas, because of its ubiquitous occurrence and its protected/buffered nature.

Using this role, the country could be broadening its current focus on human rights to water beyond access to drinking water and sanitation provision to providing integrated services to enhance livelihoods of especially the poor.

2 Conjunctive use

Groundwater should not be managed in isolation, but conjunctively as appropriate with other water sources to improve water security and assure ecosystem health. Natural storage of groundwater systems is their most valuable asset. This allows maximizing the productive capacity across a flow system (surface and / or groundwater) through conjunctive use by taking 'the right water, from the right place, at the right time'.

This gives groundwater a critical role in adaptation to climate change. It also allows for step-wise and adaptive development of resources.

3 Protection of a vulnerable system

Land-use exerts a major influence on groundwater in terms of contamination from a wide range of activities and through impacting groundwater recharge processes. The potential negative impacts are enhanced by ignorance and by the unseen nature of groundwater.

Groundwater recharge zones are thus in urgent need of protection from pollution and degradation and for this groundwater management needs to be harmonised with land management.

4 Co-governance of subsurface space

Effective groundwater governance requires co-governance of subsurface space – a concept, which is still in its infancy, but needs to be developed. In South Africa this principle will be well understood because of the risks presented to whole regions through shale gas development presently under consideration.

5 Unique management requirements

Groundwater's life-sustaining role and vulnerable character requires holistic approaches to resource management and protection – in particular integrated water and sanitation delivery.

Institutions and approaches need to be attuned to local conditions (wide-spread distribution and physical complexities as well as social acceptance as private resource). Generally these conditions:

- limit direct government interventions and require focus on preventative management approaches;
- bring out the importance of involving local communities (most familiar and most directly affected) in the management of groundwater resources;
- may require novel approaches of valuing, planning, and implementing widely distributed systems;
- make it clear that investing in education of stakeholders will always be critical and will ultimately lead to a society-driven sustainable development.

This management approach must be led, nurtured and supported by a national government 'groundwater champion'.

6 Integrated Water Resource Management

Despite some unique characteristics and development requirements and challenges, groundwater is an integral part of the hydrological cycle. Principle 2 of the fundamental principles underpinning the National Water Act, 1998 declares groundwater fully subject to national control and part of IWRM, which is the vision of the Act.

'All water, wherever it occurs in the water cycle, is a resource common to all, the use of which shall be subject to national control. All water shall have a consistent status in law, irrespective of where it occurs.'

Integration must take place at three effective levels, integration within the hydrological cycle (the physical processes), integration across land and water, across catchments and aquifers (spatial integration), and integration across the overall social and economic fabric from national to local level.

Importantly, there needs to be coordination with the macro-policies of other sectors – such as agriculture, energy, health, urban and industrial development and the environment. In many cases policy action in these sectors holds the key to groundwater resource sustainability.

Groundwater in South Africa has benefited greatly from being developed within an IWRM framework across the full spectrum of policy, regulations, institutional development, protection, planning and information management. The roll-out of the NGS will have to continue within this overall framework.



NORAD TOOLKIT: FRAMEWORK FOR GW MANAGEMENT



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Securing water for all is often not only a question of water resources and of finances, but equally a matter of good governance.

GROUNDWATER GOVERNANCE

6.1 The concept of governance

The water community has increasingly emphasized that the global water crisis is centrally a crisis of governance. The first key message from the final report of the 2012 Marseille World Water Forum expresses this clearly - The 'water crisis' the world community faces today is largely a governance crisis. Securing water for all, especially for vulnerable populations, is often not only a question of the water resources situation (water availability, quality, supply, needs) and financing, but equally a matter of good governance.

Governance has recently been defined by the UNDP as:

'the exercise of political, economic and administrative authority in the management of a nation's affairs at all levels — and thus comprises the mechanisms, processes and institutions through which the citizens of the nation articulate their interests, mediate their differences and fulfill their legal rights and obligations.'

Governance is a broader notion than government, is dynamic in nature and enmeshed in the social, economic, biophysical and political landscape in which it occurs. Key principles that underpin good governance include participation, transparency, equity, accountability, coherency, responsiveness and being integrative.

6.2 Groundwater governance

Appropriate governance is particularly important for groundwater, a very complex common pool (open access) resource. Because of its ubiquitous nature and relative ease of local access, there are widely distributed and generally dispersed abstraction points and many stakeholders, who are involved in its development, use, as well as misuse. Also, changing land-use patterns through agricultural intensification, urbanization and deforestation have wide-ranging impacts on resource recharge and quality. Determining who is implicated and who should be involved in conserving and protecting aquifers to maintain a set of groundwater uses is a key challenge for groundwater governance. Principles for the governance of 'common pool resources' were first defined by Ostrom (see **Box C**). The above considerations complicate the traditional national approaches to resource regulation and require a very high degree of participative management. These also require novel approaches to the systematic planning, financing and implementation of hundreds and even thousands of small, locally-dispersed groundwater schemes (Braune et al., 2008 and Burke and Moench, 2000).

It is important not to lose sight of major emerging issues and technologies that will have implications for groundwater governance. The disposal of nuclear waste is one extreme example, as is the use of hydro-fracturing to mobilise shale gas. Others will include the storage of carbon dioxide, the continuing threat of acid mine drainage and the deeper encroachment of the built environment. These will continue to pose new governance challenges.

With the focus on local stakeholder involvement, a number of major issues will have to be addressed from the beginning of the roll-out of this strategy to encourage stakeholders to be more willing to contribute to the management efforts, in particular (Burke and Moench, 2000):

- Proper valuation of groundwater: stakeholders respond to economic factors
- Scientific understanding and reliable supporting data: without understanding, people are often unwilling to act
- Education and social ethics: broad-based education is often central to building social support for proper management methodologies.

Box C**Ostrom Principles to Counteract the 'Tragedy of the Commons'**

In 1968 Grant Harding first coined the expression 'tragedy of the commons' in respect of 'common pool resources – defined as 'natural resources that are difficult to divide up or to fence in, for which what one resource user does can effect what is available to other users'. For almost 40 years subsequently Elinor Ostrom (Nobel Laureate for Economics 2009) has been leading research and analysis to understand how institutions for the regulation of many types of 'common pool resource' can be developed, sustained and modified, how and why they are (or are not) effective, and how best to transfer such knowledge (Ostrom, 1990). In relation to the governance of groundwater, a very important common pool resource, application of the Ostrom Principles would suggest that the following general approach is required:

- Clearly-defined boundaries for the purpose of resource evaluation and allocation
- Congruence between resource allocation and the prevailing local conditions and constraints
- Formal recognition by government of the rights of the community to organise resource use
- Collective arrangements for the participation of stakeholders in decision-making
- Layers of nested stakeholder groups to cope with larger resource systems
- Effective monitoring by persons who are part of, or accountable to, stakeholders
- Graduated sanctions on resource users who do not respect the communal rules
- Conflict-resolution mechanisms which are readily accessible and of low cost

This outline structure is the approach that has been advocated for promoting sustainable groundwater resource management by the GW•MATE initiative of the World Bank in their excellent briefing Notes Series on groundwater resources governance.

Foster and Kemper, 2002-2009

These need to work in concert with legal and regulatory frameworks that both enable local populations to develop management approaches suited to regional conditions, and provide avenues for higher level interventions to address the actions of large individual consumers or polluters.

The management approach advocated under these unique circumstances has been coined as 'top-down facilitation of local actions' (Foster, 2006) and is illustrated in **Figure 6-1**.

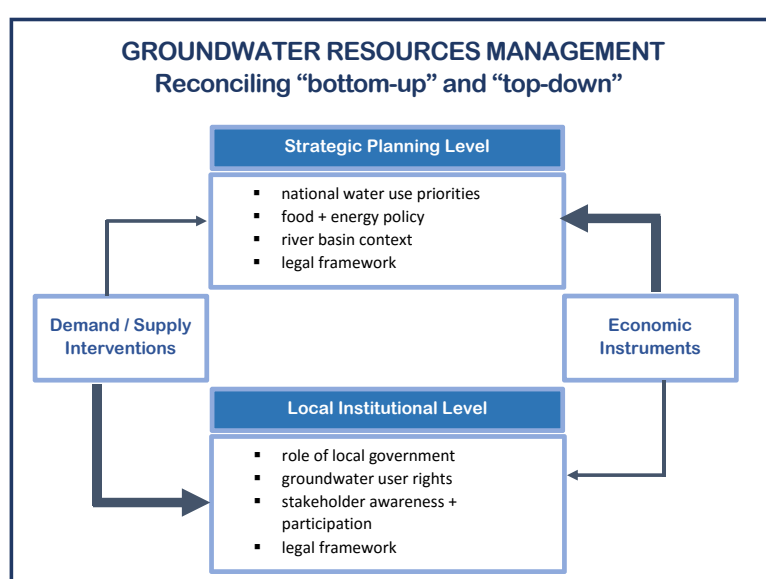


Figure 6-1: Groundwater Resource Governance (Forster, 2006)

6.3 Governance provision for implementation of groundwater management

The importance of governance to take place at all the appropriate levels, i.e. policy, national support and local action level, is illustrated in the useful groundwater-specific analytical framework (see **Box D**), coming out of Groundwater Governance - A Global Framework for Action (2011-2014) (Wijnen et al., 2012).

In a case study on groundwater governance in South Africa that formed part of a World Bank project, Pietersen et al. (2012) concluded: ***"Strengthening and implementing groundwater governance measures should preferably follow a 'parallel track and adaptive approach' within the existing legal and institutional framework. Such an approach would strengthen the said frameworks without disruption, taking cognizance of the capacity and willingness to implement."***

In this regard, Knüppe (2011), in a systematic and participative analysis of groundwater governance in South Africa, concluded further that **the South African groundwater management regime still lacked the capacity for adaptive management**, i.e. moving from conventional bureaucracies to adaptive structures that could increasingly take into account the complex system linkages between hydrogeological, political, socio-economic and environmental domains. **She suggested a number of supporting approaches, such as tools for cooperation, participation and information networks, to facilitate the implementation of adaptive water management approaches and hence to achieve institutional change in the political arena of groundwater management.**

While it is crucial to encourage whatever management actions are currently feasible, the long-term process of developing flexible, integrated management systems should not be delayed. A strategic framework is seen as an essential precursor and progressive instrument for effective groundwater management (Burke and Moench, 2000).

A Water Research Commission project has been completed in South Africa (Riemann et al., 2011) to establish a pragmatic framework for the elaboration and implementation of such local action level groundwater governance. This management framework for aquifer protection and aquifer utilization is illustrated in **Appendix 2** together with their respective responsibility matrix.

Box D

Strategic Framework for Groundwater Governance

"Governance is the operation of rules, instruments and organisations that can align stakeholder behaviour and actual outcomes with policy objectives."

Enabling Environment / Policy level

Processes by which a nation establishes its objectives for groundwater, integrates those policies with water, land and environmental policies, and aligns and harmonises them with other related policies affecting groundwater.

Strategic / National level

Institutions and instruments designed by a nation to align stakeholder behavior and actual outcomes with policy objectives. These include planning, regulation, economic instruments, institutional development and information management.

Local level

Organisations and institutions that control actual outcomes on the ground and respond (in varying degrees) to the rules and incentives from strategic level governance. This level includes the individual groundwater users, local collective management institutions and relevant public agencies.

Wijnen et al. (2012)

It is intended to use this framework (and further refined products) as tool to achieve stakeholder understanding and role clarification in the immediate development of the NGS and in the longer-term process of improving groundwater management systems.



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28 10 22 AM

The unique, widely distributed and open access groundwater resource requires local level management within an appropriate enabling and supporting environment...

NATIONAL STRATEGY

7.1 From Policy Framework to Action

The importance of a groundwater policy framework and appropriate principles as a way of integrating regional and national groundwater policy and leading to action on the ground can be illustrated in the framework development for New South Wales in Australia.

Box E

New South Wales (Australia) State Groundwater Policy

There had been rapid development of groundwater since the early 1980s, initially for rural towns, industry and mining and more recently for high-value agriculture. Besides water allocation, land-use planning, urban planning and environmental protection were seen as critical to the sustainable development of the resource. In 1997, the government of New South Wales released its State Groundwater Policy Framework, which was supported by three subsidiary policies on: (i) groundwater quality protection (ii) groundwater quantity management and (iii) groundwater-dependent ecosystems. Its guiding principles were a mix of principles, like those underpinning South Africa's National Water Act and unique groundwater principles as elaborated in the chapter Objectives and Principles of this Strategy.

Implementation was guided by risk assessment, so that increased focus and levels of management would be applied to more stressed aquifers on a priority basis. The management tools introduced through the framework document included:

- Groundwater management plans (ultimately ~ 20 were developed in high/over-exploited situations);
- A Water Sharing Plan based on combined surface and groundwater assessment;
- Groundwater Management Committees;
- Supporting guidelines for local government and industry;
- Creation of aquifer resources and vulnerability maps;
- An education strategy;
- Legislative mechanisms for groundwater management;
- Licensing tools and conditions for users that better reflect resource protection objectives;
- Economic instruments applicable to groundwater management.

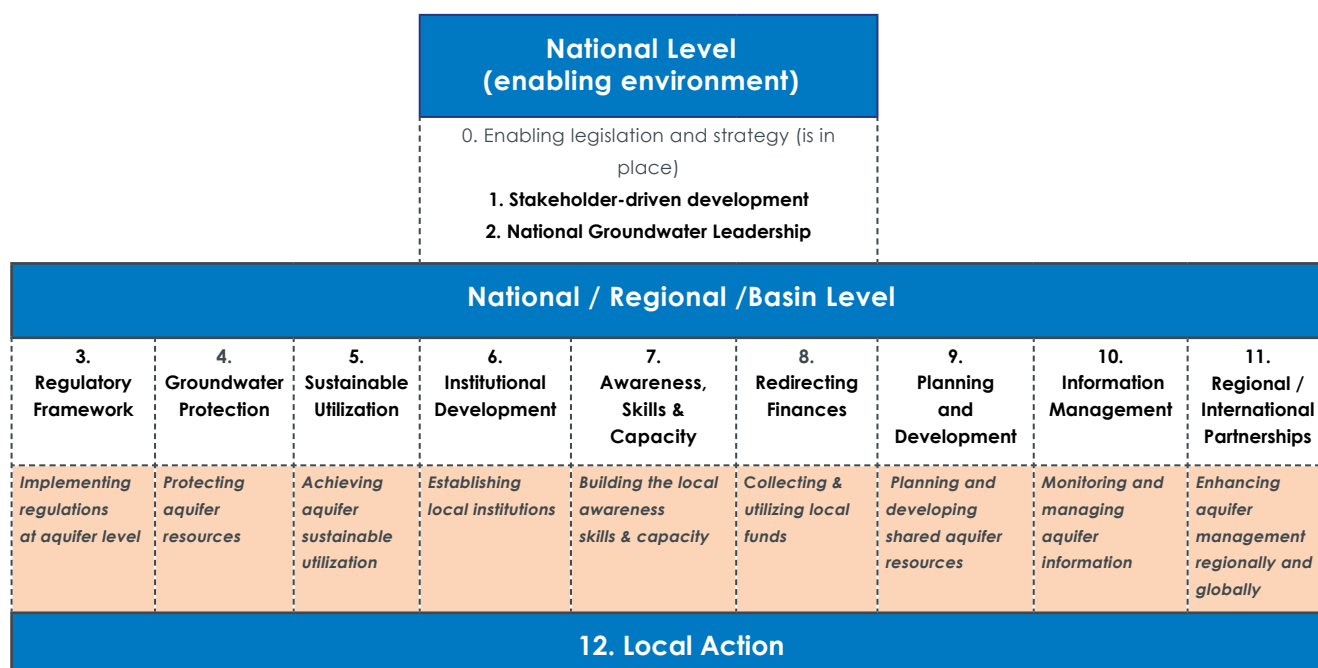
Giordano and Villholth (2007)

7.2 NGS Groundwater Governance Framework

To address the groundwater vision and objectives and the present inadequate groundwater management situation in South Africa outlined above, a groundwater governance framework for action has been developed. Its concept is based on the Global Groundwater Governance Framework completed recently (UNESCO et al., 2015), while its detail has been informed by local context, both by hydrological and by overall governance and macro-economic objectives, and most of all by stakeholder inputs from across the country and from every economic sector. Governance will have to happen at three essential levels, namely a national enabling level a national strategic level and a local level. Over time, the local action level will fully unfold and will mirror every strategy theme presently required at the national / regional facilitation level and will convert strategies into actions. This is illustrated in the Strategy Framework on the next page.

The Framework illustrates that, as Local Action unfolds, each of the National/ Regional/ Basin Level strategic actions will be mirrored by corresponding action at the local level.

NGS Groundwater Governance Framework



It should be clear that the different strategy themes are highly inter-related. For example, while Groundwater resource protection (Theme 4) and Sustainable groundwater resource utilization (Theme 5) have been addressed under separate themes, both will require regulation (Theme 3) to become fully effective. These three themes together will make up the local level resource management. Like in any groundwater management, this will have to be supported by appropriate information (Theme 10). Local resource management will only start functioning fully, once local, properly capacitated institutions are in place (Themes 6 and 7). The overall roll-out will have to be maintained by appropriate financing (Theme 8) and Planning (Theme 9). Regional and international partnerships (Theme 11) can greatly enhance any aspect of this framework and its implementation. Groundwater awareness-raising has been grouped under Theme 7 - Water sector skills & capacity development (central in framework) and will be critical in all governance levels and strategy themes. Importantly, every aspect of the framework, national and local, has to link to the already existing enabling IWRM policies and legislation. To bring about the challenging 'national facilitation of local actions' approach, will require an ongoing stakeholder will and drive and a national groundwater champion to lead the process (Themes 1 and 2).

Besides the existing enabling legislation and strategy, the other critical enablers, namely national groundwater leadership and stakeholder-driven development, need to be established without delay. The essential local actions need to be facilitated by a wide range of actions at the national / CMA level. A critical role of national groundwater leadership will be to maintain the vertical integration between the different governance levels and to build strong functional linkages to other sectors that are using and / or impacting groundwater.

7.3 NGS Strategy Themes

The objectives of the twelve strategy themes are shown below. In the rest of the chapter, each one has been developed in terms of Objectives, Principles, Situation Assessment, Current challenges, and Strategic Actions:

01	Stakeholder-driven development and implementation Continuously improve stakeholder understanding and collectively agree on and work within an expanding framework of local level participative management and 'good groundwater governance.'	> pg 35
02	National Groundwater Leadership Develop and maintain the national groundwater champion that must hold the overall groundwater governance framework together and facilitate and support its roll-out, smooth functioning and growth.	> pg 39
03	Responsive groundwater regulatory framework Anchor the shared understanding of groundwater governance in appropriate policy and regulations that will enhance sustainable and efficient use of groundwater resources.	> pg 41
04	Groundwater resource protection Develop and maintain approaches for pro-active protection of groundwater resources and aquifer-dependent ecosystems to secure a sustainable supply of water for human survival and socio-economic development, while maintaining essential groundwater environmental services.	> pg 47
05	Sustainable groundwater resource utilization Translate practical understanding of groundwater resources into appropriate guidance material to fully capacitate those responsible at all levels for sustainable groundwater resource utilization, covering planning, development, management and protection.	> pg 53
06	Appropriate institutional development Develop, facilitate, capacitate and support appropriate institutions that will allow effective local-level participative management of groundwater resources.	> pg 61
07	Water sector awareness, skills and capacity Develop and maintain skills and capacity for the sustainable development and management of groundwater resources at all management levels and with participation of all stakeholders as part of a long-term, ongoing process.	> pg 65
08	Redirecting Finances Redirect incentive policies and public expenditures impacting groundwater by and within different sectors to achieve a combined, much stronger focus on sustainable and efficient groundwater management.	> pg 73
09	Groundwater resource planning and development Achieve integrated groundwater resource planning at national, regional and local levels that will fully and sustainably establish the unique potential of groundwater for socio-economic development.	> pg 75
10	Information management Grow and maintain the groundwater resource knowledge base, focusing on the resource itself, its socio-economic role and its appropriate management. Develop and maintain effective and efficient information and information systems, as a shared national objective and an integral part of water management strategies, in support of groundwater development and management at all levels.	> pg 79
11	Regional and international partnerships Actively participate in and grow appropriate regional and international partnerships towards groundwater resource understanding and optimal utilization, including transboundary resource management.	> pg 91
12	Local Action Manage and maintain actions on all strategy fronts in a concerted effort from government at different levels, from municipalities and utilities, the private sector, civil society, educational institutes, media and professional associations to achieve the essential local level actions for sustainably managing shared groundwater resources.	> pg 95

“ Social dimensions are as important as technical dimensions in the development of approaches to address emerging groundwater challenges.



STAKEHOLDER-DRIVEN DEVELOPMENT AND IMPLEMENTATION

THEME 1



Objectives

Continuously improve stakeholder understanding and collectively agree on and work within an expanding framework of local level participative management and 'good groundwater governance.'

Principles

Social dimensions are as important as technical dimensions in the development of approaches to address emerging groundwater challenges. Effective user participation based on education and constructive dialogue is therefore an essential input for resolving complex issues relating to groundwater. Without this, important and urgent management requirements often cannot be implemented in practice.

SITUATION ASSESSMENT

Provision in Policy and Strategy

The National Water Act, 1998 provided for a fundamental reform of the law relating to water resources in South Africa. The scarce resource belonging to all people, government's role as national trustee, the ultimate aim of water resource management and the institutional development to enable participation are all covered in the Preamble of the Act (below).

The National Water Resource Strategy 2 spells out the required institutional development in terms of:

- Regional water utilities (for regional bulk services – water and wastewater)
- Catchment management agencies (nine CMAs to undertake water resource management)
- Catchment management forums (for effective participation)
- Water user associations (WUAs) (co-operative associations of individual water users – can have delegated management powers).

PREAMBLE - National Water Act, 1998

Recognising that water is a scarce and unevenly distributed national resource which occurs in many different forms which are all part of a unitary, interdependent cycle;

Recognising that while water is a natural resource that belongs to all people, the discriminatory laws and practices of the past have prevented equal access to water, and use of water resources;

Acknowledging the National Government's overall responsibility for and authority over the nation's water;

Recognising that the ultimate aim of water resource management is to achieve the sustainable use of water for the benefit of all users;

Recognising that the protection of the quality of water resources is necessary to ensure sustainability of the nation's water resources in the interests of all water users; and

Recognising the need for the integrated management of all aspects of water resources and, where appropriate, the delegation of management functions to a regional or catchment level so as to enable everyone to participate.



EXPERIENCE FOR GROUNDWATER TO DATE

A generally recognized factor that must drive sustainable groundwater utilization is participation of local water users and other stakeholders. Despite the good intent of the National Water Act, 1998, this critical requirement is still virtually completely missing for groundwater resources. There are no Water User Associations for groundwater and very few local monitoring committees are functional. Some of the reasons for this situation are:

- Establishment of CMAs has been very slow and is still not complete;
- A structured process is still required for identifying functions that CMAs can delegate to WUAs with capacity;
- WUAs have largely come about through the process of transformation of the former Irrigation Boards and these had very little interest in groundwater.
- Groundwater's previous "private water" nature still plays a major role in its lagging far behind the institutional development for surface water resources.
- There is no sustained DWS support available to establish and empower Water User Associations and monitoring committees for groundwater.
- Verification of groundwater use, a prerequisite for local participative management, is laborious and has not received priority and funding.

Process to Guide Local Level Implementation

The world-wide experience is that the evolution of groundwater management systems is a long-term process. A phased approach and a management framework that can articulate the local level complexity, but has a common multi-dimensional approach, addressing both the social and technical dimensions, is essential to the management of the resource.

The approach starts with the commitment at policy level to review policy and ensure stakeholder participation (including establishment of mechanisms necessary for that to occur), followed by the establishment of a core group composed of stakeholders, experts, government representatives and concerned individuals. This group is essential in order to guide and move a long-term process forward. It then proceeds through analysis of needs and constraints to experimentation and, finally, to widespread implementation. **Figure 7-1** attempts to illustrate this process (Burke and Moench, 2000).

The strategic analysis that follows, designed to produce a baseline assessment of needs, constraints and opportunities, must include an institutional analysis, covering aspects such as (Burke and Moench, 2000):

- What are the roles and functions of current institutions and their suitability/capacity for addressing different aspects of emerging problems?
- Do existing institutions have the capacity to address management needs, including the involvement of critical stakeholders?
- If not, how might they be restructured or what capacities need to be developed for them to address those needs.

In a follow-on phase of the long-term process, the focus would be to transform the initial conceptual strategic framework into a practical and implementable management and policy strategy. Key products of this third phase would include the legislative and policy frameworks necessary to specify the way management organisations can be formed at the scale needed and the array of powers they might utilize. Such reforms would only be possible following a significant period of dialogue and debate.

A fourth and final phase in the long term process would take the experience gained to scale, moving from demonstration projects to widespread implementation. For this to occur, mechanisms must be in place to enable natural resource management across communities, economic sectors, and political or administrative jurisdictions.

CURRENT CHALLENGES

Key challenges in terms of groundwater stakeholder involvement experienced in South Africa in recent years include:

- ! Despite the good intent of the National Water Act, 1998, stakeholder involvement, a critical requirement for groundwater management, is still virtually completely missing for groundwater resources.
- ! The distributed, invisible and common pool nature of groundwater resources makes management of a shared resource very difficult.
- ! The national will to overcome these problems and establish participative management for groundwater has so far been lacking.
- ! Different users do not speak to each other – no Aquifer forums or CMA forums exist; no Government forum with local users (LM/DWS/CMA and local users is in place).

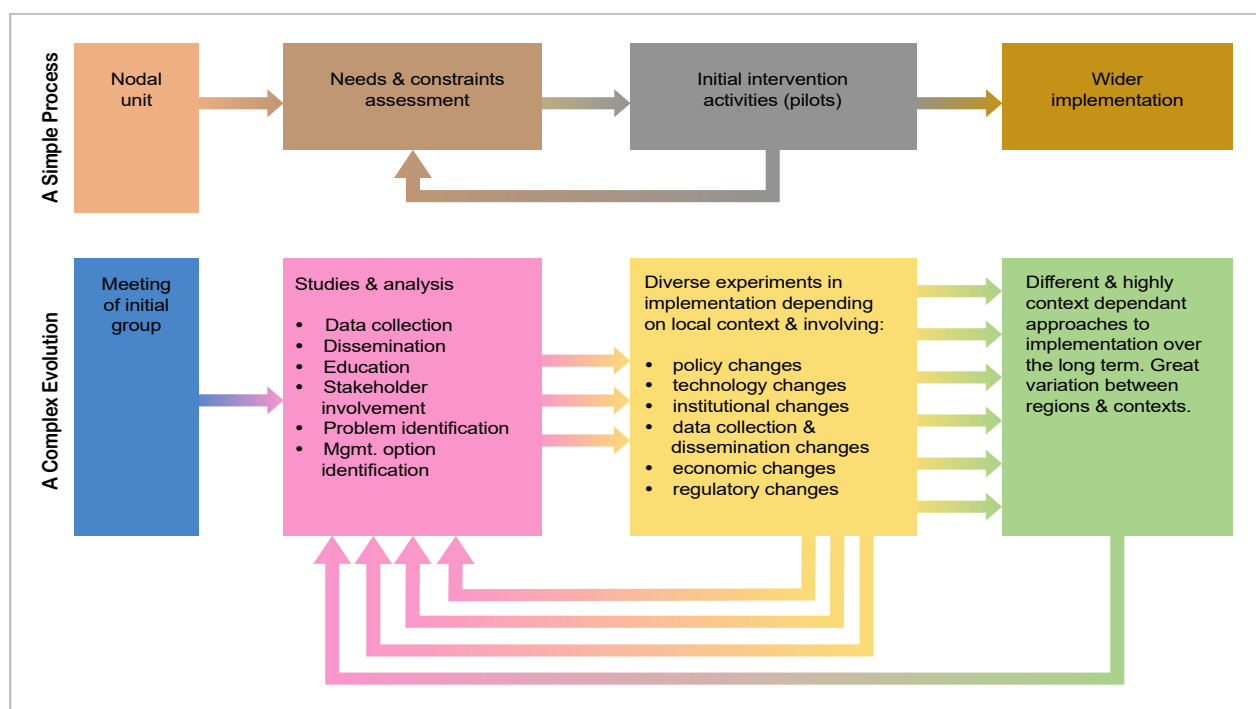


Figure 7-1: A process to guide complex and diverse local level implementation

STRATEGIC ACTIONS

DWS COMMITMENT

DWS needs to make a firm commitment to policy innovation with stakeholder participation and to encourage formation of a stakeholder core group with sufficient interest and concern to guide and carry the groundwater institutional development process forward. Consultation and communication regarding improved groundwater governance can be started through workshops at national/ regional level.

STAKEHOLDER ENGAGEMENT PROCESS

Mechanisms for the ongoing productive engagement of stakeholders need to be put in place. A national stakeholder core group is central to this development (see below). Flowing from the national level, the stakeholder engagement should work down to all governance levels. Some guidance in terms of the stakeholder involvement process was provided in the various Multi-sector Stakeholder Provincial Workshops.

- Use should be made of the processes already part of the NWRSI roll-out. This includes sector leaders monitoring individual implementation plans.
- The strategy should be introduced through regional institutions, starting with presentations of the strategy in catchment management forums.

- A special effort needs to be made to achieve buy-in from municipalities, especially from rural areas.
- The groundwater private sector should be involved through its institutions like the Ground Water Division and the Borehole Water Association.
- Local level participation should be achieved through appropriate local institutions, e.g. municipal districts should be assisted by DWS in terms of coordination of Water Sector Forums.
- Agreement on a common Groundwater Code of Practice may be an appropriate way to initially focus and pull a very diverse group of stakeholders together.

STAKEHOLDER CORE GROUP

The national stakeholder core group is essential in order to guide and move a long-term process forward. It should be composed of stakeholders, experts, government representatives and concerned individuals. The relevant sector representatives in the core group should, as part of the process, become groundwater champions in their sector. Its key task initially will be the development of an implementation action plan (see next page).



STRATEGIC ACTIONS CONT.

IMPLEMENTATION ACTION PLAN

The key objective of such a plan will be to achieve local level (aquifer) management by appropriate empowered and capacitated local institutions on a prioritised basis. For this purpose the needs, constraints and opportunities, including the institutional set-up, has to be considered. National empowering and strategic actions need to be prioritised and coordinated. The complete process is illustrated in **Figure 7-1**, with much of the background information already in place in South Africa.

GROUNDWATER AWARENESS-RAISING

The long-term process of institutional development must be supported by a major ongoing awareness campaign at all levels regarding the need for improved groundwater management to achieve the desired understanding, participation and support for long-term transformation. This will be rolled out under Theme 7: Awareness-raising, Skills and Capacity-development.

GROUNDWATER TRUST

It is strongly suggested to establish a South African Groundwater Trust through involvement of the groundwater sector / industry as a whole to develop and lead a multilevel awareness and education campaign, both inside and outside the public sectors. The widely-distributed hydrogeological fraternity should be used as extended arm of the Trust. Randwater and the DWS's Learning Academy could play a role in the functioning of the Trust. Examples of such cooperation towards groundwater outreach are the Groundwater Trust in the United States and the South Australian Groundwater Forum. The Groundwater Division of the Geological Society of South Africa could play a major role as neutral player to bring sector players together and focus them on common objectives. It could play a lead role with regard to a Trust, but would have to be empowered by the sector.

EFFECTIVE NETWORKING

An effective networking / communication system needs to be established as the highest priority towards the stakeholder engagement process. Starting with the national core group it should grow rapidly into the various sectors and finally become the network of local level groundwater management together with its supporting higher level stakeholders.

Such an authorized South African groundwater governance 'networker' (authorized by DWS and the national stakeholder core group would hold the stakeholders together through ongoing communication and continuously focus them on a set of agreed critical deliverables which can only be achieved through cooperation). The networker would play a major orchestrating role of receiving and sharing information and resources like progress reports, best practice and awareness material.

The need for a networker / a communication system was emphasized over and over by stakeholders during the provincial consultations. Here some of their comment.

- Good communication / feedback will be crucial in the beginning to maintain interest and participation of stakeholders.
- All stakeholders should be exposed to implementation of plans of action and feedback should be made available
- Departments must talk to each other – at the moment they are often not aware of each other.
- Improved stakeholder communication is very important with the entry point being the district municipality in local government.
- Communication must be encouraged in different ways – Dialogue boxes; Social media should be used to highlight good and bad practices. A website will be essential.

The recently introduced WRC approach of a Community of Practice should be strongly considered to help grow the 'Groundwater Governance' community.

NATIONAL GROUNDWATER LEADERSHIP

THEME 2



SITUATION ASSESSMENT



Objectives

Develop and maintain the national groundwater champion that must hold the overall groundwater governance framework together and facilitate and support its roll-out, smooth functioning and growth.

Principles

The widely accepted management (governance) approach for groundwater is 'national facilitation of local actions.' This brings out the critical importance of national leadership to create the enabling environment of groundwater policy and regulation, the appropriate institutions, capacity-development and ongoing support.

Government has to play the central role of 'guardian' for natural resources such as groundwater. Besides the strategic-level resource management functions listed below, a critical long-term role will be that of mobilizing stakeholder participation and of building the capacity of the lower and middle levels of management.

The key oversight functions which need to be performed regarding the groundwater field are shown below, with the respective themes (numbers in brackets):

- Setting and maintaining groundwater management norms and standards (3)
- Ensuring resource evaluation, valuation and strategic planning (10,8,9)
- Groundwater information management (10)
- Ensuring groundwater awareness raising and stakeholder involvement (1,12)
- Ensuring resource quality protection and impact mitigation (4)
- Ensuring abstraction and use regulation (3)
- Ensuring groundwater sustainable utilization (5)
- Ensuring groundwater monitoring (10)
- Ensuring hydrogeological exploration for groundwater development (9,10)
- Vertical and horizontal policy integration / harmonization (1)
- Achieving a synchronisation of groundwater research with national development objectives (12)
- Supporting local level management with capacity development, information and auditing (12,6,7,10)
- Growing regional and international partnerships to continuously improve groundwater governance (11).
- To continuously improve groundwater governance together with stakeholders (1).

At an early stage, it will be important for the institution responsible for groundwater resources to analyze potential impediments to the management process (inadequate groundwater management boundaries, weak regulatory enforcement, lack of social consensus, poor inter-institutional coordination) and define ways of confronting them.



In the light of the present lack of depth in skills and leadership in hydrogeology at national level, there has been a wide-spread call in recent years, inside and outside the Department, for a well-capacitated groundwater champion in DWS – a groundwater governance unit, which can guide and direct the required oversight. DWS has now taken the decision, that a groundwater unit will be created to oversee integrated local management (Mochotlhi, 2014). To see such a unit in perspective, this theme should be read together with all the other strategy themes.

CURRENT CHALLENGES

Key challenges experienced in terms of creating a national groundwater champion in recent years include:

- ! At present, the country lacks the depth in skills and leadership in hydrogeology to drive the understanding and acceptance of groundwater from national down to local management level. Steps must be taken to strengthen geohydrological skills and build technical training capacity at institutions across the country (Water for Growth and Development Strategy, DWAF, 2008a).
- ! There is still limited understanding at DWS decision-making level on the long-term role and unique and critical governance requirements of groundwater resources.
- ! Lack of leaders in various sectors to champion groundwater use and protection in their sector.

STRATEGIC ACTIONS

GROUNDWATER GOVERNANCE UNIT

There is a great urgency with the establishment of such a unit in DWS. This is because nothing can happen in terms of NGS implementation without this leadership entity. At this stage not even a groundwater forum still meets within DWS to achieve some form of coordination.

A task description for such a unit needs to be developed as soon as possible in the light of the requirements for an enabling environment and strategic-level management as well as support of the unfolding institutional development and specifically to enable local-level groundwater resource management. Key oversight functions are listed under 'Situation assessment' above.

Because of the ultimate objective to develop capacity for the management of local shared aquifer resources, the groundwater capacity in DWS Regions will be essential arms of the national champion. The unit will not be about doing everything, but being the entry and coordination point. The unit must be a place where all the actions are linked which are presently often happening uncoordinated – e.g. planning; financing; guidelines; monitoring. Focus should not only be on developing an appropriate structure, but on all the necessary coordination processes.

For greatest efficiency and effectiveness, one could foresee a 'governance center' which, in formally agreed ways, could draw on the resources of other institutions to fulfil the evolving, wide range of its responsibilities. During the provincial consultations, stakeholders felt very strongly about the requirement of a national groundwater champion and their inputs can help to further understand what needs to be put in place:

- The NGS should already show how DWS will develop a strong national groundwater leadership and how its capacity will be distributed.
- The governance unit should be at a Chief Directorate or Directorate level in order to emphasize the development role of groundwater at this stage of national water resources development, to have visibility to the Minister, to be able to secure the required funding and to achieve widely coordinated roll-out of the Strategy.
- DWS Regional Offices must have a strong groundwater oversight role to avoid the large amounts of money spent wrongly at the moment; Regional Hydrogeologists should be regional groundwater champions, properly aligned with the national champion, who will achieve transformation of groundwater management at local level.
- Elements of a one-on-one capacity development for municipal groundwater management are already practised in some Regions.
- Leadership of groundwater should start with an institution that will play a critical role in directing and coordinating the financing of groundwater development and management.

NEEDS AND CONSTRAINTS ASSESSMENT

An essential early action for this unit will be the strategic analysis highlighted under Theme 1, together with stakeholders, to analyse potential impediments to the management process (e.g. inadequate groundwater management boundaries, weak regulatory enforcement, lack of social consensus, poor inter-institutional coordination, lack of adequate information) and define ways of confronting these.

RESPONSIVE GROUNDWATER REGULATORY FRAMEWORK

THEME 3



SITUATION ASSESSMENT



Objectives

Anchor the shared understanding of groundwater governance in appropriate policy and regulations that will enhance sustainable and efficient use of groundwater resources.

Principles

Policy and legislation are key enablers of the intended groundwater governance approach of “national facilitation of local actions.” While continuing to operate within an overall IWRM framework, for effectiveness and efficiency in implementation, regulation that takes into account the unique characteristics of groundwater that have a bearing on its sustainable development and management (ubiquitous occurrence, many users, open access and invisible nature, complex physical characteristics, availability of natural storage), needs to be developed and rolled out within this framework. All approaches need a focus on impact prevention and on user education and support.

Policy Shift

With the promulgation of the National Water Act, groundwater lost its previous status of private water (rights to groundwater were held by the owner of the overlying property, who could essentially abstract groundwater with little or no control) and became recognised as a common asset, whose custodianship is vested in the state and which is subject to all the stipulations of the Act. The Act states that water is an indivisible national resource (rivers, streams, dams, and groundwater) for which national government is the custodian. It contains rules about the way the water resource is protected, used, developed, conserved, managed and controlled in an integrated manner. The Act is premised on balancing the three legs of social benefit, economic efficiency and environmental sustainability.

Furthermore, the National Environmental Management Act (Act of 1998) and the Minerals and Petroleum Resources Development Act (Act of 2002) lay out new obligations for the mining and other industries in terms of the monitoring and remediation of pollution of water resources.

In terms of the National Water Act, 1998 groundwater is fully subject to national control and part of IWRM, which is the vision of the Act. ‘All water, wherever it occurs in the water cycle, is a resource common to all, the use of which shall be subject to national control. All water shall have a consistent status in law, irrespective of where it occurs.’ Groundwater in South Africa has benefited greatly from being developed within an IWRM framework across the full spectrum of policy, regulations, institutional development, protection, planning and information management. The roll-out of the NGS will have to continue within this overall framework.

Important for the management of local groundwater resources are the subsidiarity approaches. The 1997



Water Policy White Paper (DWAF, 1997) stipulates that responsibility for the “development, apportionment and management of available water resources” should be delegated to a “catchment or regional level in such a manner as to enable interested parties to participate.” The present generalised lack of technical and managerial expertise in the country led to the decision in 2012 to reduce the number of Catchment Management Agencies to nine from the original proposal of 19 CMAs.

Up to now only two CMAs have been gazetted and regional level water management is still carried out by the offices of the national department.

Based on a framework of developmental water management adopted in the National Water Resource Management Strategy and on experience of the last fifteen years, a decision has recently been taken to bring the National Water Act and the Water Services Act into one, seamless piece of legislation governing the entire water value chain (DWA, 2013). One consequence of this will be a multiple water use approach, which incorporates all water uses in an area, to be followed in planning and implementation of water schemes.

Despite the raised policy profile for groundwater in South Africa, the second National Water Resources Strategy (DWA, 2013), twenty years later, recognizes that ‘groundwater is an important, currently under-valued and under-used resource’. Some findings related to proper valuation of the resource made in a SADC evaluation, hold for South Africa too (Braune et al., 2008):

- Growing awareness at decision-making levels about the importance of groundwater is not adequately reflected in policies and practices.
- Investment in groundwater, relative to its potential to address national objectives, is limited and this is still offset by pollution and ineffective maintenance.

Since then the Water Research Commission has put the spotlight on the important valuation issue (Pearce et al., 2013). It is clear that aquifers are natural assets. They form part of the ecological infrastructure of a country. And the values of these assets theoretically appear on a country’s natural resources balance sheet.

Groundwater Use Authorisation

The most important mechanism to bring groundwater fully operating within the National Water Act. 1998 framework is the mechanism of water use authorisation. In general, a water use must be licensed, unless it is listed as a Schedule 1 use in the Act, is an existing registered lawful use or is permissible under a general authorisation. The authorisation hierarchy obtained through these different instruments is shown in **Figure 7-2**.

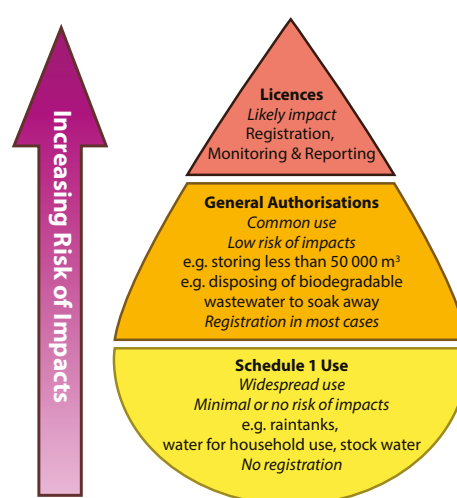


Figure 7-2: Water use authorisation hierarchy

General Authorisations are used to alleviate the burden of issuing licences for common, but low-impact water uses. The first General Authorisation, of 1999, accepted a ceiling of 50% of ‘Groundwater Harvest Potential’ for different regions as basis and was consolidated into 4 zones for section 21(a) water use. In 2004 the GA’s were revised to 5 zones (see **Table 7-1**). A new revision is expected in 2016.

Areas that were already groundwater-stressed, were excluded from the general authorisation. The first groundwater-use registration drive was completed in 2000, providing the first overall assessment of groundwater use. For groundwater, the registration requirement had been set for uses of 10 m³/day and more. This was to form the basis for water resource planning, prioritisation of licensing, adjusting of general authorisations, where necessary and for implementation of a water-use charge system.

Table 7-1: General Authorisation for S 21 (a) Groundwater use (2004) in terms of the National Water Act, 1998

Zone	General Authorisation (m ³ /ha/annum)
1 (arid regions)	Only Schedule 1 use
2	< 45
3	> 45
4	>150 <400
5	> 400

Determination of the Reserve (the Ecological and Basic Human Needs Reserve) as defined in the NWA, 1998, is part of every groundwater licence application. A general concern in the water sector is that the issuing of groundwater abstraction licences takes prohibitively long and this is one of the reasons why groundwater users in the mining and agriculture sector shy away from groundwater use. The delay is partly due to a lack of appropriate groundwater-specific methodologies for the Reserve determination as well as the lack of groundwater specialist capacity in the regulatory arm of the DWS.

The achieving of compliance with licence conditions has become a major new priority for the DWS and its Regional Offices. Monitoring information must be checked and must be uploaded to the relevant national databases for archiving. Guidance must be given with regard to improved management and monitoring. Licences must be regularly reviewed based on compliance information, and where necessary, compliance must be enforced.

Compliance in terms of sustainable groundwater use by municipalities is at this stage still poor. This is a serious concern, because domestic water supply to communities represents the most strategically important use of groundwater in South Africa.

Currently, the Department owns and manages water resource infrastructure itself, with an asset value of approximately R100 billion. Regulatory oversight in the form of standards setting, monitoring of performance, setting of prices, etc. of the groundwater component of this infrastructure requires serious improvement.

Registration of Drilling Contractors

An estimated 80 000 to 100 000 water boreholes are being drilled annually. In terms of the need for a preventative management approach for this widely distributed resource, there is an urgent need to regulate the drilling industry in order to maintain a high standard of work. The drilling industry in South Africa through the Borehole Water Association of Southern Africa (BWA) embarked on a process of self-regulation. Since its inception in 1980, the BWA has been committed to establishing minimum standards of practice for the industry (www.bwa.co.za). Its initial effort resulted in the publishing of general guidelines or a code of practice for its members - 'A Minimum Code of Practice for Borehole Construction and Pump Installation'. Since 1996 this was followed by a project to develop a comprehensive 9-part set of groundwater industry standards (drilling, pump installation, rehabilitation of boreholes etc.) through the South African Bureau of Standards (SABS) (e.g. SABS, 2003).

The Department of Water and Sanitation recently embarked on a project to investigate the mechanisms for successful registration of drilling contractors as well as possible training and controlling mechanisms. A particular objective is to get the data from the thousands of boreholes drilled annually on a national database for the benefit of the country as a whole. This had already been proposed at the time of writing the National Water Act, 1998, but it was then felt that registration of water use was a major task and immediate priority, whereas the more detailed aspect of borehole registration should follow later. This must now be seen as a very high priority.

Regulations Specifically for Groundwater

A separate chapter on groundwater was initially foreseen for the Act, but this was not pursued to maintain the focus on integrated water resource management in the intended framework legislation. The work was published by the Water Research Commission (Lazerus, 1997) and needs to be revived in support of urgently required groundwater regulation. Some of the gaps / challenges identified in that assessment are shown in the following section on 'Challenges'.

Groundwater protection, including pollution control and groundwater quality protection will be discussed under the theme 'Groundwater Resource Protection'.



CURRENT CHALLENGES

Key challenges in terms of groundwater policy and legislation experienced in recent years include:

- ! The absence of a national groundwater management policy which lays down norms and standards to guide regional and local groundwater management practices;
- ! The lack of implementation of the 'Policy and Strategy for Groundwater Quality Management in SA, 2000;
- ! Insufficient co-operation between different government departments involved in land-use management and activities which impact upon groundwater resources;
- ! The absence of clear and effective regulation of subterranean government water control areas;
- ! The absence of strategies to involve the private sector and communities in the regulation and management of groundwater resources;
- ! The lack of professionalism in parts of the groundwater industry;
- ! The absence of an effective conflict-resolution mechanism to resolve disputes between competing users concerning over-abstraction or interception of groundwater resources;
- ! The lack of effective monitoring, compliance and control systems regulating groundwater abstraction.
- ! The backlog in issuing groundwater abstraction licenses, resulting in groundwater use taking place without proper regulation.
- ! The challenge of dealing with illegal water use while only 20% of groundwater use has been verified at this stage, a process which must be seen as a major task ahead and for which only limited capacity exists within the regulator.
- ! The lack of uploading groundwater-use monitoring information on the relevant data base as required in term of the licenses.
- ! The slow process of achieving compliance with water-use licence conditions as a result of limited capacity in Regional Offices to carry out compliance monitoring.

- ! The poor compliance by municipalities in terms of sustainable groundwater use for domestic water supply to communities. Regulatory oversight in the form of standards setting, monitoring of performance, setting of prices, etc. of the groundwater component of this infrastructure requires urgent high-level attention.

STRATEGIC ACTIONS

VALUATION OF GROUNDWATER RESOURCES

Focused development work on groundwater resource and source valuation and assessments should continue until it has become standard practice in groundwater resource planning and implementation at all levels, for example in exploration drilling, characterisation of aquifer potential and pre-feasibility and feasibility studies.

GROUNDWATER NORMS AND STANDARDS

As a basis for integrated and cooperative management of groundwater resources, a clear and widely-understood national groundwater policy which lays down norms and standards to guide regional and local groundwater management practices should be developed and systematically implemented. As next step these could become regulated Best Practice. These standards should ultimately be included into all the various groundwater development instruments, eg licenses, municipal supplies and funding instruments. Standards and guidelines are required for the different focus areas: Borehole, Wellfield and Aquifer.

POLICY COORDINATION

In terms of the important principle of integrated land, water and environment management, policy coordination should be initiated at national level with the respective institutions to ultimately work through to all levels to align and harmonise such policies towards more sustainable groundwater utilisation.

This policy coordination should work down to specific regulation, where necessary:

- In particular appropriate municipal by-laws to ensure protection and efficient management and use of local groundwater resources.
- Self-regulation by a specific sector must be seen as an ideal in participative management.

GROUNDWATER USE AUTHORIZATION

The overall processes of Schedule 1, General Authorisation, Licensing and Compulsory Licensing need to be reviewed in terms of implementation experience and groundwater development priorities to achieve administrative efficiency and effectiveness and user cooperation. This was seen as critical during the provincial consultation. Guidance provided here included:

- Water use authorization needs to be used as starting point for coordination of various resource management activities.
- A rethink on pre-authorization is required. Groundwater has resilience and does not need upfront perfect information; improved information for adjusting the licence can be obtained during operation. This approach can be captured in license conditions.
- Registration of Schedule 1 should be strongly considered, not for control purposes, but in order to obtain the information and ensure overall sustainable utilisation of groundwater resources.

GROUNDWATER USE VERIFICATION

Verification of groundwater use registration as well as licence compliance monitoring should start without delay. This information is at this stage seriously missing in planning and licensing. In the implementation, priority should be given to the most stressed and most vulnerable groundwater resource areas.

SUBTERRANEAN GOVERNMENT WATER CONTROL AREAS

While the subterranean government water control areas are used extensively as part of the classification and licensing process, water-use rights in these areas in terms of the previous Act need to be urgently clarified and appropriate regulations provided for use in these areas, fully synchronized with the general water-use regulation outside these areas.

AQUIFER MANAGEMENT

Aquifer management, including drawing up water-sharing agreements, using conceptual and numerical models, monitoring, regular assessment and adaptive management needs to be implemented by aquifer management committees in identified priority aquifers, based on appropriate guidelines and regulations.

REGULATED GROUNDWATER USE

Specific regulations should be prepared for all sectors using and impacting groundwater. Groundwater use for domestic water supply should receive priority in this regard so that national water security objectives can be met.

This would include appropriate national guidelines, half-yearly

assessments by a professional hydrogeologist, following the monitoring and management direction provided, and full participation in aquifer management committees, where these have been established.

Early warning systems and borehole, wellfield and aquifer operating rules need to be developed.

Regulation can also be achieved through the particular sectors themselves.

- DWS should assist local municipalities in terms of setting and implementing by-laws which incorporate groundwater management.
- By-laws should include control of drilling boreholes in residential areas and registration of these as part of resource quantification and awareness raising.
- All sectors should have an enforceable core infrastructure approval process before any development can take place.

REGULATION OF THE GROUNDWATER INDUSTRY

As part of the preventative management principle in the case of groundwater, appropriate regulation of the groundwater industry, in particular drillers and pump installers, is now urgently required.

- This is to be undertaken jointly by the regulator and the industry to find the appropriate mix of voluntary regulation by the industry and agreed national regulation.
- Everything needs to be based on drilling standards/ code of practice.
- The submission of acquired borehole data into a national data base is one of the key objectives of the regulation.

COMPLIANCE

A general concern among stakeholders was the current lack of enforcement of regulations.

- The NGS should upfront address how the groundwater strategy implementation will be enforced.
- Lessons can be learned from the environmental sector on how compliance is achieved – for example drilling deeper than 20m for mining requires an environmental licence.
- Identified non-compliances needs to be handled and processed through a judicial system. Non-adherence to rules needs to be dealt with appropriate fines.
- Because of the importance of compliance in a move towards local management, a special section that monitors compliance should be considered.

“ The highest protection requirement is
the protection of community water supplies by
preventative means.



GROUNDWATER RESOURCE PROTECTION

THEME 4



SITUATION ASSESSMENT

Water Resource Protection

Resource degradation through pollution of underlying groundwater is wide-spread in Africa in both urban and rural areas (Xu and Usher, 2007). This is because of its invisible nature - it takes a long time to notice that it has become polluted and, unlike surface water, it has limited ability to purify itself. In South Africa our knowledge of groundwater pollution is only incidental, because monitoring information is only available at a national / regional level, whereas pollution impacts are often very localized and compliance monitoring is not yet functional. A major concern, picked up through the national monitoring, is increasing nitrate levels in boreholes in parts of Limpopo, Northwest and Free State.

The NWA provides for the protection of water resources through three main measures, namely:

- Classification of water resources;
- Determination of the Reserve and
- Setting the Resource Quality Objectives (RQOs) for the selected class.

The Water Resource Classification System (WRCS) was formally established in September 2010 whereby water resources are categorised according to specific Classes that represent a management vision of a particular catchment. Before classification of water resources was systematically introduced in various catchments, the key Resource Directed Measures process was the Reserve determination in support of water use licensing. A Reserve determination, covering both Basic Human Needs and the Ecological Reserve, must be undertaken when a license application for water allocation is processed. Determination of the Reserve for aquatic ecosystems entails investigation of the relationship of major interactive components of the hydrologic cycle, namely groundwater and surface water bodies, including rivers, lakes and estuaries. Depending upon the current stress of the water resource in question,



Objectives

Develop and maintain approaches for proactive protection of groundwater resources and aquifer-dependent ecosystems to secure a sustainable supply of water for human survival and socio-economic development, while maintaining essential groundwater environmental services.

Principles

In South Africa's situation of widespread and highly localised groundwater occurrence and use, it will be physically and economically impossible to protect all groundwater resources to the same degree. For effective and focused intervention, a differentiated protection approach is necessary, based on the vulnerability – and regional, as well as local importance - of aquifers.

The special nature of groundwater must be recognised in implementing policy. Impacts on groundwater are often long term and irreversible. The precautionary principle must therefore be strictly applied when making decisions about groundwater resources.



the Reserve determination required may be a rapid or intermediate estimate, or a comprehensive evaluation.

Experience with RDM implementation has made it clear that the unique characteristics and role of groundwater resources in the South African water resources environment have not yet been properly addressed. Groundwater resources are seen as a contributor to surface water systems and all the protection focus is on these and not on the groundwater resource itself. As a result, despite almost country-wide implementation, RDM has to date given very little practical protection for groundwater resources and its various uses. The Basic Human Needs Reserve, which could play a critical role to secure groundwater quality for domestic water supply, has not yet been used in this way.

Groundwater Quality Protection

Protection of the quality of groundwater resources is an essential part to meeting the Sustainable Development Goals. A comprehensive groundwater quality protection strategy of the Department (DWAF, 2000) had been virtually forgotten in the GRDM methodology development. It stated then: "As the country's people start depending more

and more on groundwater, so the need grows to provide for the security of its supply. Protection of groundwater has, therefore, now become a national priority."

This strategy foresaw three main functional groupings, namely Source-directed strategies, Resource-directed strategies and Remediation strategies and a fourth group, Integrated strategies, to integrate and support the work of the other three as shown in **Figure 7-3** (DWAF, 2000).

The (pollution) source-directed strategies are equally important for groundwater resource protection as the Department's RDM measures (the Resource-directed strategies). Other departments and other legislation, such as the National Environmental Management Act, 1998 (NEMA), are crucial instruments for preventing or minimizing various forms of high impact on groundwater sources. Classification of groundwater resources, which could provide an important signal to the Department and other authorities to implement source-directed control measures, has, however, not yet been properly undertaken as a result of the RDM focus on surface water systems (as highlighted above).

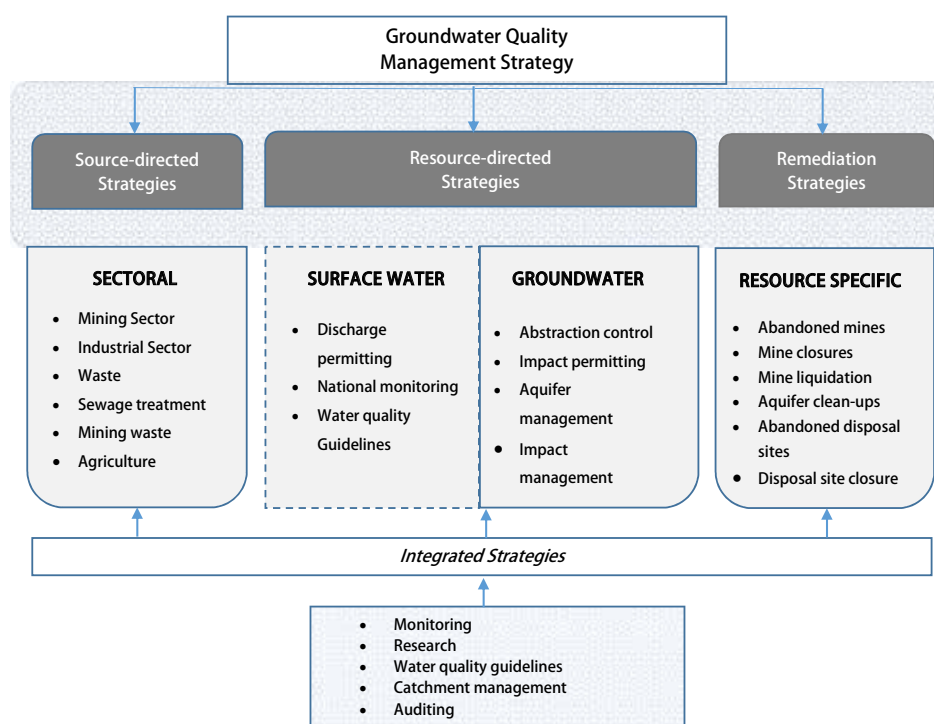


Figure 7-3: Relationship between the three main groundwater quality management strategies and the functional groups around each (DWAF, 2000)

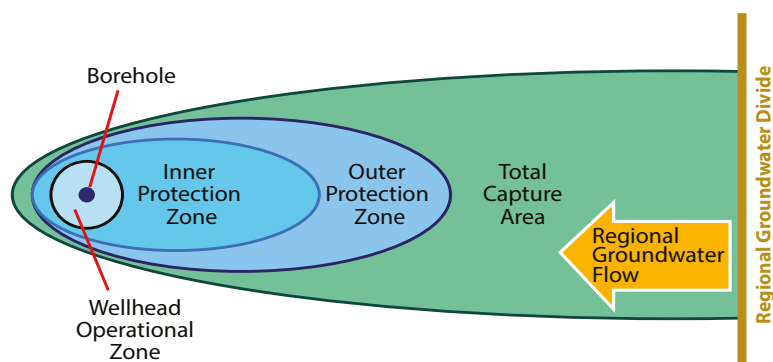


Figure 7-4: Common protection areas delineated around drinking water supplies

Protecting Sources of Drinking Water

The highest protection requirement in terms of the groundwater quality protection policy is the protection of community water supplies by preventative means. This measure is standard practice for the protection of groundwater resources in many parts of the world. It includes minimum requirements regarding borehole construction, land-use controls around the abstraction points (see **Figure 7-4**) and where necessary, site-specific protection of the aquifer (recharge zones) itself. It is critical that local-level communities and government become convinced of the merits of this approach, because zoning of land for different purposes is a function of local government.

The Department in 2007 initiated a project in this regard with the UWC, namely „Feasibility Study towards the Policy Development on Aquifer Protection Zoning“, but this was not followed through. A new opportunity to link-in groundwater protection zoning is the WRC project „Strategic Water Source Areas“.

CURRENT CHALLENGES

Key challenges for groundwater resource protection experienced in recent years include:

- ❗ Knowledge about groundwater pollution is very limited, because national monitoring will only rarely pick it up, whereas compliance monitoring has not yet properly kicked in;
- ❗ This is a concern, because incidences of groundwater pollution need to be addressed as soon as they are detected. It is far cheaper and easier to prevent pollution or address it in the early stages, than to attempt to “clean up” an aquifer afterwards.

- ❗ Groundwater use is not yet adequately verified and thus resource management and protection cannot be focused appropriately;
- ❗ RDM measures have to date not focused on the unique protection needs of groundwater resources and have achieved no practical groundwater resource protection despite considerable investment;
- ❗ Protection of groundwater supplies for domestic use, initially the highest protection priority, has been completely neglected to date. This can present a threat to the achievement of the Sustainable Development Goal on Water and Sanitation;
- ❗ The wide-spread serious threat of acid mine drainage is still tackled piece-meal and urgently needs a comprehensive and cooperative approach with regard to groundwater issues at abandoned and derelict mines;
- ❗ Emerging problems like nitrate pollution, largely as a result of poor sanitation, need to be properly assessed and addressed before they become a wide-spread threat to water security.
- ❗ Groundwater has not yet been systematically addressed with appropriate guidelines and regulations in the cooperative approach, so important for integrated land and water management.



STRATEGIC ACTIONS

POLICY AND STRATEGY FOR GROUNDWATER QUALITY MANAGEMENT

The comprehensive strategy, already developed in 2000 with wide participation and signed off by the Minister, needs to be fully implemented. If necessary, it should be aligned with the more recent RDM framework. This should take place and be incorporated as a sub-strategy of the NGS. Aspects for inclusion raised during the provincial consultations include:

- Achieve alignment with the Waste Act in terms of groundwater protection.
- Put emphasis on groundwater remediation which is not sufficiently covered in the Water Act. Draw on the experience of countries that already have guidelines for known contaminants.
- Focus on critical issues like acid mine drainage and shale gas development.
- Address institutional aspects like involving the polluting industries and clarifying the resource protection role of municipalities.

Because this important policy and strategy is now already almost 20 years behind in implementation, an **action plan for its roll-out** needs to be developed.

GROUNDWATER POLLUTION ASSESSMENT

Undertake a national assessment of the present impact of pollution on groundwater resources, taking into account the main pollution pressures, the different aquifer classes and their vulnerability to pollution. This is essential because national monitoring has not provided a proper baseline. As part of the stakeholder-driven implementation of the NGS, such information should be in the public domain.

The assessment should be undertaken as a cross-sectoral collaboration including state, regional and local level. The state would have the responsibility, but the regional and local level participants (to include municipalities, regional government, regional and local water management and other parties like agriculture specialists, nature protection NGOs and similar). should be invited to contribute to the assessment with their local and regional knowledge of challenges and possibilities.

PUBLIC AWARENESS

Make public awareness and understanding of groundwater issues as well as existing and emerging pressures and impacts a key instrument in the precautionary approach to groundwater protection. Develop a strategy in this regard as part of the stakeholder consultation process.

The Danish experience can help in the planning of this action:

- Public awareness and responsibility is seen as very important in order to do the local implementation of different measures.
- Awareness and regulation has created an attitude at grassroots level: you should not pollute “our” ground-/drinking water.
- Public awareness has been increased through information awareness campaigns, installation of water meters in every household, involvement in the action plans regarding protection of local groundwater and inclusion of normal citizens on the boards of the water works.

GROUNDWATER USE VERIFICATION

Registration of groundwater use has only provided a broad picture of present groundwater use country-wide. The detail borehole and abstraction information on which practical protection measures have to be based, can only be achieved through groundwater use verification. Immediate priority should now be given to verification through a 3-year programmatic approach, using aquifer importance, vulnerability and stress condition as criteria for prioritizing the implementation.

GROUNDWATER-USE AUTHORISATION

Use groundwater licenses, including general authorisations, much more to achieve resource protection objectives. Licence conditions must provide, inter alia, for the collection of groundwater quality monitoring information and uploading of this information to the national databases.

RESOURCE-DIRECTED MEASURES

RDM methodology as it relates to groundwater must be urgently reviewed to address the unique hydrogeological characteristics and vulnerability of groundwater systems, unique groundwater-dependent ecosystems as well as the role that these groundwater systems play in the country's development.

STRATEGIC ACTIONS CONT.

- The methodology must include technical support requirements in terms of appropriate exploration geophysics and drilling, pumping tests and distributed numerical models.
- An appropriate groundwater resource classification approach should be urgently developed, as an integral part of the RDM Classification System. As for surface water resources, the resource class of a groundwater resource (aquifer or other resource unit) should determine the planning and implementation of more detailed protection measures through appropriate Resource Quality Objectives.
- Because RDM methodology is very information-intensive, such methodology revision will have to inform a groundwater resource information strategy, including a revision of GRA2, with emphasis on resource exploration, assessment, monitoring and information storage and sharing.

PROTECTION OF GROUNDWATER SOURCES FOR DOMESTIC SUPPLY

Groundwater sources for domestic use should receive the highest protection priority with measures such as:

- Minimum requirements regarding borehole construction;
- Wellhead protection zoning;
- Site-specific protection of the aquifer (recharge zones) itself, where necessary.
- Certain aquifers/areas need to be classified as no-go areas. This is becoming critical in the light of possible hydraulic fracturing for shale gas exploration.

The Danish advice, based on their experience is:

- Initiate implementation of protection zones around boreholes, well head protection zones and larger no-go zones immediately after adoption of NGS.
- This should be followed by a period of increasing the level of knowledge of each of the specific areas, based on which an adjustment of the zoned areas could be considered.
- Danish legislation requires local authorities to use the latest knowledge and technology when they are managing the local use of groundwater, even where the geo- and hydrological knowledge of the area is incomplete.

REGULATION AND PROHIBITION OF LAND-BASED ACTIVITIES

There is at this stage no legislative mechanism in the NWA

providing for the declaration of protected areas or no go areas. A good example of how this can be achieved, is the MOU between DWS and CoGTA in the Free State.

- Develop a suite of regulations for land-based activities which may affect the quantity and quality of groundwater (section 13 of the National Water Act), i.e. the location and nature of development in relation to its impact on groundwater quality; develop a suite of guidelines and best practices to underpin these regulations.
- Work towards a national policy of integrated (ground) water and sanitation development as a precautionary way to protect the investment that is being made in groundwater infrastructure and in the health benefits of uncontaminated groundwater sources.
- The Groundwater Protocol, which is part of all on-site sanitation implementation, needs to be evaluated and its monitoring and control by DWS needs to be improved.
- A comprehensive water policy framework needs to be developed within the Department to deal with (ground)water issues at abandoned and derelict mines. The mine closure strategies currently being developed elsewhere in government should be developed in close cooperation with the Department and groundwater specialists. Appropriate Departmental guidelines should be prepared to underpin these external regulations.
- Regulation of groundwater related issues such as construction of septic tanks at different areas, development of cemeteries next to wetlands and construction of pit latrines on shallow aquifers or dolomitic areas.

CROSS-SECTOR COLLABORATION

Establish formal cross-sector collaboration to enhance sustainable utilization of the resource. This is extremely important for widely occurring and hidden groundwater resources.

The NGS should influence implementation tools in other sectors towards practical groundwater protection and it should influence action against groundwater pollution through other available inter-governmental avenues.

Vertical collaboration is equally important. Local and regional levels of administration should be included in as many projects as possible, both national and local. They often have knowledge that the national level do not, and they are often required to implement certain actions dependable on the outcome of the projects.

Activities relating to groundwater resource protection should become part of national KPIs, with monitoring and reporting of these from lower levels.

“ On the ground, there is a lack of skilled technicians and other O&M specialists, particularly in small towns and remote areas where many groundwater schemes are found.



SUSTAINABLE GROUNDWATER RESOURCE UTILISATION

THEME 5



SITUATION ASSESSMENT



Objectives

Translate practical understanding of groundwater resources into appropriate guidance material to fully capacitate those responsible at all levels for sustainable groundwater resource utilization, covering planning, development, management and protection.

Principles

Groundwater is facing increasing development pressures. In this situation it is becoming critical that its unique characteristics need to become widely understood and properly considered in development, management and protection of the resource in order to achieve sustainable resource utilization.

Groundwater has unique characteristics and has unique development, management and operation and maintenance requirements, which all need groundwater specialist attention if it is to be utilized sustainably. With increasing devolution of groundwater resource management to lower levels, in particular to CMAs and WUAs, this requirement will have to be addressed through appropriate regulation, clear guidance and ongoing education and training initiatives and awareness raising. Unique aspects of sustainable utilization that need to be addressed in this way include:

- Groundwater source development
- Groundwater source protection (more fully addressed under Theme 4)
- Conjunctive use of groundwater and other water sources
- Artificial recharge of groundwater sources
- Operation and maintenance of groundwater sources

Abstraction Works

The process of establishing a water supply borehole represents a significant investment in both financial terms and in faith. The financial terms relate to the cost of construction of the facility and, if successful, its subsequent proving and equipping. The faith aspect relates to the anticipation that the borehole will be successful, an intangible factor that depends not only on the competence of the person(s) responsible for marking the site of the borehole, but also on the competence of the contractors (drilling and pumping) who will be responsible for seeing the process through to its conclusion. In both instances, competence can be measured by the knowledge, experience and integrity of the parties involved (Hobbs, 2010).

Poor borehole development practice can result in large cost overruns, much increased operation and maintenance cost and complete failure of the abstraction facility.



All this can lead to giving groundwater itself a bad name, a situation that we continue to have in South Africa. Application of a compendium of 'best practice' directions is probably the most practical indicator of good management, given the complex management environment of widely-distributed groundwater and close to a hundred thousand boreholes drilled every year.

The main national standards in this regard are the Department's (Hobbs and Marais, 1997) and those of the South Africa Bureau of Standards (SANS, 2003). Self-regulation is striven for by the Borehole Water Association of Southern Africa (BWA). It was formed in 1980 with the strategy to:

- Promote awareness via education of the consumer of the responsible use of the resource and its future management;
- At all times guaranteeing the protection of groundwater by demanding the application of minimum standards of practice from its members.

This is an area for ongoing improvement, because changes to borehole designs, procurement and contract management practices, well clustering for economies of scale, siting and supervision practices as well as support to and professionalization of the private sector can all serve to bring drilling costs down, and improve construction quality and success rate.

Knowledge of groundwater development standards for different aquifer environments must be seen as a part of groundwater resource assessment and planning, because the exploitable groundwater resources cannot be assessed properly without taking into account the practicalities and costs of getting access to groundwater and withdrawing it.

Vulnerable Aquifers

Groundwater resources are commonly vulnerable to pollution, which may degrade their quality. Unlike flowing surface water, groundwater has low resilience to pollution, which increases its vulnerability to pollution and makes the effects of pollution persistent. Groundwater in shallow water table aquifers and in karst aquifers is the most vulnerable to all pollution processes, no matter whether these are local and ongoing, accidental or diffuse over large areas. Caves or natural sinkholes often become uncontrolled waste dumps.

In principle, deep, confined aquifers are protected against

pollution generated at the surface. However, they can be penetrated by boreholes that bring waters of different layers and qualities into contact. They can also not be expected to be protected against the effects of anything stored or injected underground.

Groundwater resources are also sensitive to how and at what rate they are abstracted. Significant declines in the water table can lose the hydraulic connection with surface water bodies, can lead to significantly higher pumping costs and may also cause compaction of aquifer material and irreversible degradation of the hydraulic characteristics. In addition it may cause environmental impacts, eg the drying up of wetlands. Coastal aquifers are particularly vulnerable as even minor disturbances of the dynamic equilibrium can result in seawater intrusion.

Evaluating the fragility and vulnerability of groundwater systems, in whatever circumstances, is an integral part of assessing the exploitable groundwater resources (Margat and van der Gun, 2013). Resource development, management and protection have to be undertaken accordingly.

Sustainable Yield

Sustainability refers to renewable natural resources; therefore, sustainability implies renewability. In nature, surface water and groundwater are related. Surface water can become groundwater through infiltration, while groundwater can become surface water through exfiltration. Therefore, surface water and groundwater are inextricably connected; renewability of one cannot be considered or evaluated without regard to the other.

Sophocleous (2000) and others (Seward et al., 2006) pointed out that the traditional concept of safe yield ignores the fact that, over the long term, natural recharge is balanced by discharge from the aquifers by evapotranspiration and/or exfiltration into streams, springs, and seeps. Consequently, if pumping equals recharge, eventually streams, marshes, and springs may dry up. Additionally, continued pumping in excess of recharge may eventually deplete the aquifer.

Sustainable yield, a concept that is replacing safe yield, does not depend on the size, depth, or hydrogeologic characteristics of the aquifer. It assumes that all groundwater pumping comes from capture (Sophocleous, 2000); the greater the intensity of pumping, the greater the capture. Capture comes from decreases in natural discharge and

increases in recharge. Natural discharge supports riparian, wetland, and other groundwater-dependent ecosystems, as well as the baseflow of streams and rivers (See **Box F**). Sustainable yield depends on the amount of capture, and whether this amount is socially acceptable as a reasonable compromise between little or no use, on one extreme, and sequestration of all natural discharge, on the other extreme.

A holistic approach to groundwater sustainability considers the hydrological, ecological, socioeconomic, technological, cultural, institutional and legal aspects of groundwater utilization, seeking to establish a reasonable compromise between conflicting interests. In South Africa, the National Water Act, 1998 and its requirement that the Ecological Reserve and the Basic Human Needs Reserve must first be addressed before groundwater can be allocated for use, gives direction for dealing with this compromise.

Artificial recharge is obviously an appropriate approach in situations where a lot of the natural recharge has already been captured by abstraction and natural discharge has

been depleted, in particular in for situations where this discharge plays a critical role, e.g. preventing seawater ingress in coastal aquifers.

With increasing importance and vulnerability of the combined surface water / groundwater system, it becomes increasingly important to develop a comprehensive conceptual water budget, understand the boundaries and rate of replenishment of the system, monitor water use and water ecosystem parameters like groundwater levels, spring flow and wetland conditions and work with stakeholders to understand trade-offs and develop consensus. Numerical models of such aquifer systems are essential support tools to achieve the agreed sustainable situation.

Box F**Recharge and discharge in groundwater systems**

Three groundwater scenarios are possible (as illustrated in the figure):

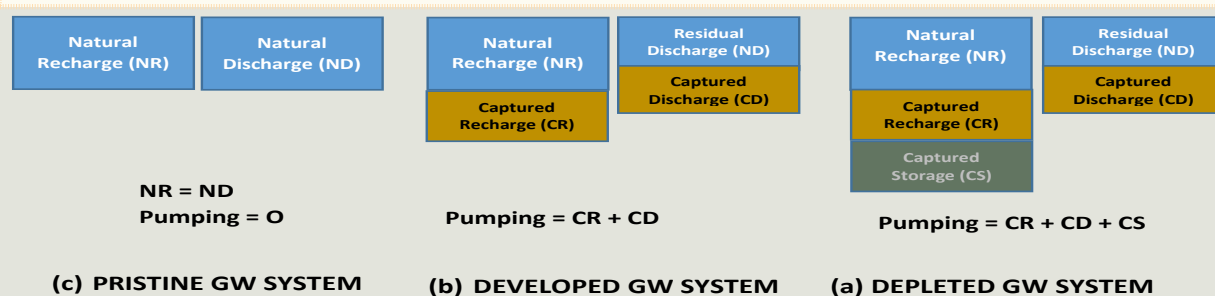
- A pristine groundwater system, in equilibrium or steady state, in the absence of pumping;
- A developed groundwater system, in equilibrium or steady state, with moderate pumping at a fixed depth; and
- A depleted groundwater system, in non-equilibrium or unsteady state, with heavy pumping at an ever increasing depth.

In the pristine groundwater system, [average] natural recharge is equal to [average] natural discharge, net recharge is zero, and pumping is zero.

In the developed groundwater system, net recharge is equal to the sum of captured recharge plus captured discharge. Net recharge varies with the intensity of pumping; the greater the intensity of pumping, the greater the net recharge. Captured recharge is the increase in recharge induced by pumping. Likewise, captured discharge is the decrease in discharge induced by pumping. Then, residual discharge is equal to natural recharge minus captured discharge.

In the depleted groundwater system, in addition to captured recharge and captured discharge, there is also captured storage. Net recharge is equal to captured recharge plus captured discharge. Pumping in the depleted groundwater system is equal to net recharge plus captured storage.

The greater the level of development, the greater the amounts of captured recharge and captured discharge, and, in the case of a depleted system, captured storage. The greater the captured discharge, the smaller the residual discharge. Since all aquifer discharge feeds surface water and evapotranspiration, it follows that intensive groundwater development can substantially affect local, subregional, or regional groundwater-fed surface water bodies and groundwater dependent ecosystems.



Ponce (2007)



Using the Groundwater Buffer

Both groundwater professionals and water resource planners are stressing the importance of not going for either a groundwater or a surface water solution, but seeking conjunctive use solutions. This has to do with both water security and with resource sustainability. "Conjunctive use of surface and groundwater consists of harmoniously combining the use of both sources of water in order to minimize the undesirable physical, environmental and economic effects of each separate solution and to optimize the efficient use of the total water resource."

Groundwater resources development can in most aquifers go beyond intercepting part or all of the natural flux provided by aquifer recharge. It may also include a deliberate use of the groundwater buffer provided by the aquifers.

The groundwater storage reserves may buffer not only between wet and dry seasons but also between wet and dry years, and compensate for the lack of surface water during dry periods, like surface water reservoirs do. Groundwater buffers thus have an important role in drought-proofing communities. They will also prove to be invaluable in mitigating predicted water-scarcity problems relating to climate change.

Such an active and carefully planned utilization of the reserves should not be confused with over-abstraction, as long as temporary depletion of reserves is followed by periods of recovery and a long-term hydrodynamic equilibrium is pursued. Importantly, depletion of aquifer

storage can enhance aquifer recharge. There are estimates that more intensive use of the groundwater buffer could raise the global groundwater flux by about 40% (Margat and van der Gun, 2013).

Because of the available buffer, groundwater lends itself to an adaptive management approach. A new resource development does not need perfect information to start with and management objectives, e.g. the borehole or wellfield yields can be adjusted as improved information becomes available through monitoring or when other conditions change.

Resource Augmentation - Artificial Recharge

Artificial recharge is a related practice, making more intensive use of the buffer capacity of aquifers by augmenting the resources. Often it is based on diverting surface water peak flows, thus providing a smoother flow regime and losing less water to evaporation. The most common methods used involve injecting water into boreholes or transferring water into spreading basins where it infiltrates the subsurface. Underground water storage is an efficient way to store water because it is not vulnerable to evaporation losses and it is relatively safe from contamination.

Internationally, artificial recharge is becoming an increasingly recognised form of water storage and conservation. The different approaches of managing the water buffer to achieve water security have featured strongly at recent World Water Forums. In South Africa,

Box G

Atlantis Artificial Recharge Scheme

The town of Atlantis is situated about 50km north of Cape Town, in the Western Cape Province, and has a population of over 100 000 people. It has no major surface water sources, and annual rainfall is only about 450mm. Atlantis abstracts water supply from boreholes at two wellfields to the west and south-west of the town, supplying 30-40% of the town's water. Groundwater consumption in 2004 was 2.8 million m³.

Artificial recharge of the aquifer, first begun in the early 1980s, is carried out to improve water security during droughts, re-use wastewater and storm run-off, and help to prevent the intrusion of seawater into the aquifer. Treated waste water and storm run-off is diverted to two large recharge basins about 500m up-gradient of one of the wellfields, which are used to infiltrate the good quality water back into the aquifer for later abstraction.

Poorer quality waste water (some of it from the town's industrial area) is infiltrated down-gradient of the wellfields, between the town and the sea, where it is disposed of conveniently and responsibly and also helps to ensure saline water is kept out of the aquifer. Together with some imports of good quality surface water from the Cape Town municipal supply, Atlantis is able to meet its water supply needs using combined groundwater abstraction and artificial recharge. Management by the municipality includes dealing with technical issues such as clogging, pH adjustment and water softening – good management procedures are in place and the system operates reliably (DWA, 2010).

this technology is still very much under-utilised, with only one major and a few minor established artificial recharge schemes (See **Box G**).

However, the Department has made a major effort to promote the technology by way of a government strategy (DWAf, 2007b) and by extensive documentation to guide its country-wide implementation. Purposes for artificial recharge, also called Managed Aquifer Recharge, as included in the Departmental planning options, are:

- Store and conserve water in the subsurface for later use;
- Prevent seawater intruding into coastal aquifers by creating hydraulic barriers at the coastline;
- Use aquifer media for water treatment, like a large-scale sand filter;
- Maintain the Reserve, whereby surplus water (fresh or waste) would feed areas where the Reserve is considered to be under threat due to large-scale abstraction.

DWS's artificial recharge website provides access to all the documents and tools listed here:

Operation and Maintenance

Overall, groundwater is perceived by many (if not most) municipal role-players and communities as an unreliable and difficult source to manage, and they have a marked preference for surface water sources – ideally with bulk potable water supplied by a water board.

National Resources for Artificial Recharge

- Artificial Recharge Strategy (2007)
- Potential Artificial Recharge Areas in South Africa (2009)
- A check-list for implementing successful artificial recharge projects (2009)
- Lecture notes on artificial recharge (2009)
- Artificial Groundwater Recharge: Recent initiatives in Southern Africa (2010)
- The Atlantis Water Resource Management Scheme: 30 years of Artificial Groundwater Recharge (2010)
- Artificial Recharge Strategy, Version 2 (2010)
- Potential Artificial Recharge Schemes: Planning for Implementation (2010)
- Planning and Authorising Artificial Recharge Schemes (2010)

www.artificialrecharge.co.za

Failure of groundwater supply schemes is often blamed on the resource (i.e. the aquifer or the groundwater) rather than on the infrastructure (borehole, pump, pipes, valves etc.) used to abstract the groundwater. It is common to hear that "the borehole dried up", or "the groundwater ran out". This is partly because groundwater is out of sight – it seems mysterious to the layperson in comparison with surface water. In fact, failure of groundwater supply schemes is almost always either due to failure of infrastructure (e.g. a blocked borehole screen) or unsuitable pumping regimes (e.g. pumping at very high rates for short periods of time) that are related to a lack of monitoring.

A vital element of groundwater management therefore is day-to-day operation and maintenance (O&M), including the maintenance of infrastructure (cleaning and de-scaling pipes, replacing worn out components, cleaning of boreholes, checking the operation of switchgear, etc.) as well as the monitoring of groundwater levels, groundwater quality, demand, etc. (See **Box H** for the benefits of O&M)

Since groundwater is a "distributed resource", meaning it is generally found locally, the basic skills and personnel for proper operation and maintenance of groundwater systems ideally need to be distributed widely rather than only available at certain key points or large towns. This presents a challenge that is different to O&M of surface water systems, which can often be centralised to a greater degree.

Box H

Benefits of Operation and Maintenance

A recent cost-benefit study of groundwater supplies for rural areas in developing countries found that:

- Almost 40 times more benefit, than cost, is provided with a properly constructed, operated and maintained well system.
- A 3 to 5 fold increase in net value is realized with the implementation of an operation and maintenance (O&M) program.
- Neglecting O&M results in much more substantial loss of overall value than most people realise. As Taljaard (2008:42) states, "Basic first-line maintenance is an absolute necessity for sustainable operation of any borehole and plant and should be conducted conscientiously."

At present capital costs tend to be considered in far more detail than recurrent costs. Groundwater sources in South Africa today are attended to only when they fail, and indications are that this is a more costly approach than providing for on-going O&M.

Cobbing, et al. (2013 Del. 3.)



The challenge is one of lack of understanding and of capacity. At the decision-making level, the operation and maintenance budgets come under pressure from other budgetary demands throughout the financial year, and planning O&M under such circumstances is difficult. On the ground, there is a lack of skilled technicians and other O&M specialists, particularly in small towns and remote areas where many groundwater schemes are found.

There is, however, very high agreement that carrying out O&M on groundwater sources results in lower costs and higher reliability overall.

CURRENT CHALLENGES

Key challenges in terms of sustainable groundwater resource utilization experienced in recent years include:

- ! There is still a widespread lack of understanding about the unique characteristics of groundwater that have a bearing on its appropriate utilization, management and protection;

- ! The lack of understanding is reflected in a lack of appropriate regulation of groundwater resources nearly 20 years after groundwater had been recognized as a significant resource in the National Water Act, 1998.

- ! No special management/protection attention has been given to the country's most vulnerable aquifers, the dolomitic aquifer systems and the coastal aquifers. Serious degradation of these important resources has taken place.

- ! Many excellent guidelines for appropriate management and protection of South Africa's groundwater resources have been produced through projects of the Water Research Commission and by the Department itself. Very few of these have ever found practical application.

STRATEGIC ACTIONS

SUSTAINABLE UTILISATION OBJECTIVES AND PLANS

The overall objective of guidance implementation needs to be translated into a series of specific, prioritised objectives and implementation plans together with the relevant stakeholders, e.g. guidance for resource development, resource planning, source operation and maintenance and resource / source protection.

Sector and institutional (WSDPs and CMS) groundwater plans need to be developed. Protection is discussed separately under Theme 4.

GOOD HYDROGEOLOGICAL PRACTICE

Good hydrogeological practice is essential in the complex, integrated resource and socio-economic environment in which sustainable utilization is taking place. This must include always obtaining a proper system understanding,

adequately monitoring and modelling system behaviour and adapting groundwater utilization and aquifer management accordingly, jointly with informed stakeholders. To achieve continuity in approach and information from source development to O&M, tender documents should already be appropriately written.

REVIEW / DEVELOPMENT OF GUIDELINES

Focused guidelines need to be developed and adapted for the above objectives to become part of a series of official, widely available and regularly reviewed guideline documents. Existing documents to form the basis of this action, is listed in the block.

Danish experience has shown the benefit of involving stakeholders in guideline development. It taps into their own understanding of local issues and achieves buy-in. Focus should also be on showing them how to deal with uncertainty which is a general phenomenon in groundwater situations and available information.

TRAINING PROGRAMMES IN SUPPORT OF GUIDELINE IMPLEMENTATION

Guidelines should be introduced with relevant training programmes for the specific stakeholder groupings. Danish experience of letting the stakeholders themselves perform the training programmes, is very effective.

INTER-DEPARTMENTAL COOPERATION

Inter-departmental cooperation should be strengthened through formal agreements and focused guidelines, in particular:

Drilling programmes implemented by:

- Department of Education,
- Department of Health
- Department of Agriculture, Forestry and Fisheries

Integrated authorization system to improve the regulation of environmental management, water resource management and related activities / land- uses such as mining:

- Department, the Department of Environmental Affairs
- Department of Mineral Resources

ONGOING AUDITING AND AWARENESS-RAISING

The Blue Drop Assessment, updated to allow for the proposed groundwater assessment, should be implemented as soon as possible, as part of an overall strategy to improve local groundwater management. Setting of standards and guidelines must go hand in hand with regular auditing of the implementation of these.

NATIONAL CAPACITY FOR GROUNDWATER GOVERNANCE

Direction of the support for sustainable groundwater resource utilization must become one of the key responsibilities of the groundwater governance structure to be established within the Department of Water and Sanitation. The skills required cover the whole spectrum of groundwater resource planning, development, management and protection. This is addressed further under Theme 2.

LOCAL HYDROGEOLOGIST

Because of the urgency in this regard, the Groundwater Division had an initiative of groundwater consultancies "adopting a municipality" and providing a free service to get the municipal groundwater management in order. This was successful in parts, but a free service cannot be sustainable.

- District and Local municipalities' will have to appoint/ contract/share a hydrogeologist to manage their aquifers, if necessary in terms of appropriate regulation.
- The contracted Hydrogeologist should be held co-accountable for good practice.

Selected Existing Guidelines

- Minimum Standards and Guidelines for Groundwater Resource Development for the Community Water Supply and Sanitation Programme (DWAF, 1997).
- Policy and Strategy for Groundwater Quality Management in South Africa (DWAF, 2000).
- A Protocol to Manage the Potential of Groundwater Contamination from On-site Sanitation (DWAF, 2003).
- NORAD Toolkit for Water Services (DWAF, 2004).
- Artificial Recharge Strategy (DWAF, 2007).
- A Guideline for the Assessment, Planning and Management of Groundwater Resources in South Africa (DWA, 2008).
- Groundwater Management Framework (WRC – Riemann et al., 2011).



A champion needs to be found within each sector, e.g. in municipalities, who is respected and understands/speaks the local government language and sees to groundwater management issues and solutions within the municipal environment.



APPROPRIATE INSTITUTIONAL DEVELOPMENT

THEME 6



SITUATION ASSESSMENT



Objectives

Develop, facilitate, capacitate and support appropriate institutions that will allow effective local-level participative management of groundwater resources.

Principles

Given the situation of a widely-distributed resource affected by a plethora of local users and polluters, the required management (governance) approach has been coined as 'national facilitation of local actions.' This brings out the importance of the stakeholder-driven local-level management for groundwater and the appropriate local institutions to achieve this.

Water Resources Institutional Development

In South Africa, the subsidiarity principle provided the umbrella opportunity for the management of local groundwater resources. The 1997 Water Policy White Paper (DWA, 1997) stipulates that responsibility for the "development, apportionment and management of available water resources" should be delegated to a "catchment or regional level in such a manner as to enable interested parties to participate."

A major purpose of the Act is to achieve the establishment of suitable institutions for appropriate and participative management of water resources. This is particularly important for highly localized groundwater resources which cannot be physically managed centrally. The Act provides for three levels of management, namely national government, nineteen catchment management agencies (now consolidated into nine) at the regional management level and water user associations acting cooperatively at the local level.

All three levels hold specific opportunities and responsibilities for improved groundwater management. Water user associations can practice conjunctive use of water resources and practice artificial recharge of aquifers, put catchment conservation into practice on their land and reverse over-exploitation and degradation of water resources. They can also create an opportunity for community development through the sharing of skills and resources. The catchment management level which has devolved management responsibilities is crucial for addressing groundwater development, management and use in a planned and integrated way in the public interest. It will also have to provide the essential support for local-level management, which has been completely lacking in South Africa for groundwater management.

Water Services Institutional Development

In line with the interim Constitution, the White Paper confirmed that the long-term goal was to have democratic



local government take responsibility for both providing and sustaining water services. This happened when local government came in place after the elections of 2000. The Strategic Framework for Water Services established in 2003, mapped out a vision for how the water sector as a whole will work in providing water services. The then DWAF was to continue to set the policy frameworks and oversee and regulate the activities of all water service institutions.

A key responsibility was to systematically develop the capacity of local government, jointly with relevant role players in national government, SETAs and professional associations. The recent joining of the water and sanitation functions in national government and the strong focus on regional implementation and support should greatly help in this regard. The highest level of this joining is to bring the National Water Act and the Water Services Act into one, seamless piece of legislation governing the entire water value chain.

Water Services from Groundwater

From 2000, with the advent of wall-to-wall municipal government and the introduction of local government in the former 'homelands' for the first time, responsibility for managing thousands of groundwater schemes was transferred from the Department and community-management structures to new municipal administrations. In essence there was a decentralization of management responsibility from the Department 'down' to local government, and centralization of operational responsibility 'up' from community-management structures to local government, without ensuring that the local government structures have the ability to perform the necessary functions.

Since then there have been many reports of scheme failure, starting with the much publicized Dinokana disaster in 2004 (sudden groundwater supply failure from an excellent dolomitic aquifer after a complete lack of groundwater level monitoring) and Delmas in 2005 (disbanding a local groundwater supply, following inadequate sanitation and a typhoid outbreak through polluted groundwater, for a much more expensive piped surface water scheme). There are no overall figures of performance of groundwater schemes, because of a complete lack of scheme monitoring and reporting to DWS Regional Offices or CMAs. The majority of smaller groundwater supply schemes are not

covered by the Blue Drop reporting system. The available evidence suggests that the reasons for failure have less to do with hydrogeology and aquifer yields than with the lack of implementing operational requirements of sound groundwater management. It exposes a widespread lack in appropriate institutional capacity and necessary skills levels of water services providers.

A complimentary concern is the widespread wariness of groundwater as a source of municipal water in South Africa. Despite the raised profile at a national planning level, experience on the ground indicates that many municipalities only turn to groundwater as a very last resort in case of drought emergency.

Local Collective Management Institutions

Some form of regulation and organisation of local groundwater users is generally seen as essential for the sustainable development of the resource. Working cooperatively is new for groundwater users for whom the resource had been their 'private water' before the new water legislation was promulgated. The Act now provides for local-level organization through the institution of a Water User Association (WUA). WUAs are defined in the NWA as water management institutions whose members voluntarily agree to undertake water related activities for their mutual benefit. Principal functions of an Association are concerned with management of the water resource or infrastructure. Typical examples (surface water related) in this category are preventing water wastage or unlawful use, regulating flow of the watercourse, protection of the water resource and monitoring flow quantity and quality. The Minister of Water and Sanitation must establish a WUA, once he or she is satisfied that it is in the public interest and that wide public consultation has taken place.

Despite the good intent of the National Water Act, 1998, the establishment of local collective management institutions is still virtually completely missing for groundwater resources. There are no Water User Associations for groundwater and very few local monitoring committees are functional. Besides the challenges of a complex and poorly understood resource, its previous „private water“ nature still plays a major role in this lagging far behind the institutional development for surface water resources management and monitoring.

CURRENT CHALLENGES

Key challenges in terms of groundwater institutional development experienced in recent years include:

- ! The weakness in the groundwater function in national government is of particular concern at a time when new groundwater capacity has to be built in CMAs, local government, and local management institutions. Without a groundwater champion and a critical capacity in national government the country will not be able to move forward meaningfully towards good groundwater governance.
- ! The devolution of water resource management to lower levels, as foreseen by the National Water Act, 1998, and seen as critical for good groundwater governance, is taking much longer than expected.
- ! Participation of local water users and other stakeholders in the management of local groundwater resources has not yet taken place and groundwater is lagging far behind surface water resources in terms of institutional development. Despite the good intent of the National Water Act, 1998, this critical requirement is still virtually completely missing for groundwater resources.
- ! Lack of capacity in municipalities where groundwater has, in many instances, become the sole source of domestic water supply, is regarded by many as the most important factor holding back sustainable development and management of groundwater resources in South Africa. This has resulted in a widespread wariness of groundwater as a reliable and sustainable source of municipal water in South Africa and is starting to give groundwater as a resource a bad name.
- ! The biggest challenge for water management in South Africa will be the bridging period of the next ten to twenty years in which transformation from a highly centralized situation to new functional and highly participative institutions at different levels will have to take place.

STRATEGIC ACTIONS

A STRATEGIC GOVERNANCE FRAMEWORK

Systematically develop a strategic framework with key stakeholders as an essential precursor and progressive instrument for effective groundwater governance:

- Ensure that it becomes a formal part of the National Water Resource Strategy and catchment management strategies, as the accepted way to integrated water resources management implementation.
- As basis for capacity development and support, an analysis is required of the relevant vocational and professional inputs needed into groundwater management, and the relationship between these in terms of planning/oversight/analysis/direction/operation rules.

CAPACITATING MUNICIPALITIES

The general trend for decentralization and the establishment of new institutions to achieve sustainable water and sanitation services at local level needs to be supported with systematic capacity development in parallel:

- Local government should be brought on board as a major local player in sustainable groundwater resource development, utilization and protection, both as immediate focus and as part of a multi-stakeholder mobilization. Capacity building needs to be targeted at municipalities in cooperation with the whole sector, in particular the Department of Cooperative Governance and Traditional Affairs (CoGTA), the Local Government SETA, the South African Local Government Association (SALGA) and the Institute of Municipal Engineers of Southern Africa (IMESA).
- Councillor induction can play a major role to inform and capacitate councillors on the benefit of groundwater and the role it can play in water and sanitation service delivery.
- Approaches in this regard could include awareness raising, guidelines and training and targeted support, with a special focus on potentially underutilized local government capacity.

COMPLIANCE WITH EXISTING GOVERNMENT REQUIREMENTS

Water Boards (Utilities) are subjected to annual reporting in terms of applicable legislation. However, their reports only cover the surface water schemes they manage, including the volumes abstracted, but very little, if any, on groundwater schemes.

This indicates a lack of monitoring of groundwater use (abstraction and water levels) by these institutions.

- This gap should be closed by compelling these



STRATEGIC ACTIONS CONT.

institutions to report on both surface and groundwater including the quality of groundwater supplied, in terms of the requirements set Water Services Act.

- As part the Public Finances Management Act (PFMA), an Asset Register must be kept by municipalities and be updated annually. Boreholes and borehole equipment are not listed and this should be addressed by municipalities, whether through instruction by the Auditor General or other (Blue Drop, etc.).

COMMUNICATION AND AWARENESS-RAISING

- A champion needs to be found within each sector, for example in municipalities, who is respected and understands/speaks the local government language and sees to groundwater management issues and solutions within the municipal environment.
- It is crucial to collect and tell the success stories of community water supply schemes supplied from groundwater to counter the growing perceptions that groundwater is an unreliable and not a sustainable source.

GUIDELINES

Practical guidelines on all aspects of groundwater scheme operation and maintenance and institutional arrangements in this regard need to be developed urgently, to be used by all sectors. As mentioned under Theme 5, stakeholders themselves should be involved in the development of these guidelines as well as in offering training in this regard.

LOCAL PARTICIPATIVE MANAGEMENT INSTITUTIONS

Systematically develop, capacitate and support local management institutions, in particular monitoring committees to collect data and source management solutions, aquifer management committees and water user associations. These should increase the influence of stakeholders, and create platforms for information sharing, consensus-building and joint resource enhancement and protection.

- The process could begin with the initiation of community forums and community-based organizations. Structured processes, events and tools should be developed to facilitate participation by targeted persons and organisations/forums.
- Water User Associations could become an active part of aquifer management, if the CMA delegates the relevant

functions to them and funds from water use charges are directed to them.

- District and Local municipalities utilising the same aquifer / compartment or sharing it with other users, must become part the above-mentioned local management institutions or help with their establishment where these do not yet exist.
- Existing stakeholder forums need to be involved and civil society needs to be brought into the process to become a champion and watchdog.

NATIONAL SECTOR SUPPORT FOR LOCAL MANAGEMENT

- Through improved sector understanding, identify and strengthen within-sector support structures and processes which could facilitate local-level management by that sector, e.g. training in land-care matters provided to farmers by the Department of Agriculture, could include groundwater resource management and sustainability issues.
- Widely-occurring local-level needs, e.g. improved understanding required by farmers of water-use allocation processes, could be fed back to the Department of Water Affairs and Sanitation.
- Coordination of stakeholders (sectors) at national level should be replicated at provincial/ regional/ catchment level. Provincial Planning Committees should play a role here.

CATCHMENT MANAGEMENT AGENCIES

The roles and responsibilities of Catchment Management Agencies need to be clearly defined and communicated to allow them to become the fully capacitated regional arm of the national planning, coordination, facilitation and support function that is required to achieve sustainable local action.

NATIONAL GROUNDWATER CHAMPION

Urgently create a fully capacitated national groundwater champion to fulfil the critical national facilitation responsibility. This groundwater capacity at national level is required in all aspects of groundwater governance, from strategic planning and assessment to developing the necessary regulations and guidelines and supporting local institutional development. There is capacity and willingness in the private and academic sectors, which needs to be harnessed in win-win partnerships. This is unpacked further under Strategy Theme 2.

WATER SECTOR AWARENESS, SKILLS AND CAPACITY

THEME 7



SITUATION ASSESSMENT



Objectives

Develop and maintain skills and capacity for the sustainable development and management of groundwater resources at **all** management levels and with participation of all stakeholders as part of a long-term, ongoing process.

Principles

Capacity building is a long-term, continuing process, in which all stakeholders should participate (ministries, local authorities, non-governmental organizations and water user groups, professional associations, academics, private consulting firms and others).

It is important that all levels of capacity development must be addressed, the individual, the institutional and societal levels. When all these work together we will see a well-performing groundwater sector. It is important to have ways to measure capacity and monitor progress in its development.

Unfolding of Groundwater Capacity

The capacity available for groundwater development and management in South Africa (**Table 7-2**) at national level can be described in the same eras used to describe different periods of groundwater investigation and research (**Table 7-3**) under Theme 10.

The rise in groundwater capacity, peaking in the 80's and 90's through the merging of the Groundwater Division of the Geological Survey into the Division of Geohydrology of the Department of Water Affairs and then seriously declining from 2003, when the Department of Water Affairs disbanded its Directorate of Geohydrology, is clearly illustrated.

Present Capacity Situation

Overall, the country has an excellent capacity in the groundwater resources field, on par with the best in the world. Many new groundwater consulting companies were established throughout South Africa during the past twenty years. There is a strong hydrogeologist and groundwater technical corps, well-coordinated and represented by the Ground Water Division of the Geological Society and the Borehole Water Association of Southern Africa. Appropriate academic institutions were established and wide-ranging research has been undertaken for 40 years and more. The Council for Geosciences, the Department of Water and Sanitation, the Water Research Commission and the CSIR have all been major role players at different points in time.

Various Memorandums of Understanding have been signed between government and parastatals to share the load and capacitate each other in various fields of expertise.

Water Research Commission

The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water



research and development as well as the building of a sustainable water research capacity in South Africa. The WRC serves as the country's water-centered knowledge 'hub', leading the creation, dissemination and application of water-centered knowledge, focusing on water resource management, water-linked ecosystems, water use and waste management and water utilisation in agriculture. Its mandate includes enhancing knowledge and capacity-building within the water sector. Through cross-cutting

Impact Areas, a strong integration of research activities is achieved towards national development objectives.

The WRC investment into groundwater research in South Africa has been strategic and ongoing for 40 years now. This investment has, in all probability, been the most significant contribution to the building of capacity for the sustainable utilization and management of groundwater resources in South Africa. It has included:

Table 7-2: Capacity available during eras of groundwater investigation and research activities according to Vegter (2001)

1888-1935	Pre-geophysics era	State drilling service with geologist support
1936-1955	Era of geophysical borehole siting	Developments as a result of recommendations of the Interdepartmental Committee of Enquiry re Groundwater Supplies, 1953: Establishment of a new Division of Hydrological Research in the Department of Irrigation; Strengthening of the Geological Survey personnel.
1956-1976	Quest for quantification era	Developments as a result of Expert Committee of Enquiry into the Groundwater Situation in the RSA, 1973: DWAFs Chief Directorate of Scientific Services evolved from Division of Hydrological Research, comprising three Divisions (later Directorates) – Hydrology, Geohydrology and Hydrological Research. Underground Water and Geophysics Branch of the Geological Survey. Very few private hydrogeologists as professional service providers.
1977-1997	Era of expanding activity	From the 1970s onward there has been a growth of (hydro)-geological and engineering consulting firms operating in the groundwater field. The Council for Scientific and Industrial Research (CSIR), the Atomic Energy Board (AEB), and several universities (Orange Free State, Witwatersrand, Western Cape) also entered the field. In 1977 the Groundwater Division of the Geological Survey transferred to DWAF and merged with the Division of Geohydrology. Part of the overall contribution of these two organisations up to the end of this era is contained in about 3000 internal Geohydrology reports. The Institute for Ground Water Studies (IGS) and the UNESCO Chair in Groundwater were established at the University of the Orange Free State and the University of the Western Cape respectively. More private hydrogeology companies were established.
1998-	Integrated management era	In 2003, as part of a major DWAF restructuring, the Directorate of Geohydrology was disbanded and staff integrated into various water resource management functions, eg hydrological information, planning, pollution control, resource directed measures as well as DWAF Regional Offices. In 2008, serious capacity shortcomings in the national Department of Water Affairs (DWA) were pointed out in a submission by the groundwater sector, represented by the Groundwater Division of the Geological Society to the Parliamentary Portfolio Committee on Water Affairs and Forestry during their Review of the National Water Act: <i>"An inability to implement the National Water Act, as a result of a lack of sufficient skilled and experienced staff, prevents groundwater from being used productively and sustainably to promote economic growth and social upliftment."</i> (Groundwater Division, 2008)

- Capacitating the water sector with knowledge and tools for improved groundwater resource management;
- Increasing the number of students involved in water research as a source of human capital for the water sector as a whole;
- Encouraging the achievement of post-graduate qualifications as part of groundwater research;
- Placing particular emphasis on the support of historically disadvantaged students and researchers;
- Helping to develop strong research and teaching centers in groundwater hydrology in South Africa and continue to support academic institutions through groundwater research projects and science networking;
- Helping to create research infrastructure in specialized fields such as isotope hydrology.
- Widely publicizing research findings through attractive research reports and publications like Water Wheel and Water SA and creating easy access through the WRC Knowledge Hub.

Academic Sector

Already in 1973, the then Minister of Water Affairs and Forestry started negotiation with the University of the Free State concerning an Institute for Groundwater Studies (IGS). It was to be established at the same time as the Water Research Commission to train potential researchers which could contribute to the working of the WRC.

Almost 20 years later, with the reopening of the global science world to South Africa, a UNESCO Chair in Groundwater was created at the University of the Western Cape to serve the southern African region with developing groundwater expertise.

Approximately 600 students graduated in the last 10 years from these two institutions alone, 127 with a Masters or PhD. Approximately 70 % of these postgraduate qualifications would have been achieved through a WRC project.

The WRC also supports several other universities (Fort Hare, Venda, Pretoria, Zululand, KwaZulu-Natal, North West and Witwatersrand), science councils, NGOs and consulting firms in developing groundwater expertise.

Through the academic institutions that have developed and that had the benefit of this research investment, a significant human resources development impact has been

achieved nationally, in the southern African region and on the continent as a whole. Very importantly, experience from the groundwater industry is increasingly being made available on a voluntary basis for education and training at academic institutions. Young graduates are thus the key carriers of the country's groundwater capacity.

Council for Geoscience

The Council for Geoscience (CGS) is one of the National Science Councils of South Africa and is the legal successor of the Geological Survey of South Africa, which was formed in 1912. The organization has a Water Geoscience Unit which provides professional consulting and contract research in the broad field of hydrogeology, groundwater resource management, rural water supply, environmental management, groundwater characterisation, and groundwater contamination management.

Overall, the Council is in a unique position through its huge geological knowledge base and expertise and the established branch offices of the organization to support the increasingly decentralised water management and be a partner in specialized groundwater research. Its research focus is determined by its statutory-funded projects that bear national importance, as well as collaborative research projects and research funded by various institutions, including the Water Research Commission.

CSIR

The Council for Scientific and Industrial Research (CSIR) has been active in groundwater research and development since the mid-1950s, a decade after its establishment in 1945. The period since 1994 is characterised by a shift from a mainly scientific and technological research and development focus targeting regional groundwater resources, to the application of scientific research with a focus on practical implementation in the service of society and the environment. A more recent shift is that from a groundwater-centric staff complement to one which offers expertise across a broader spectrum of water resources science. Disciplines now include surface water hydrology, vadose zone hydrology, agro-hydrology and environmental hydrology/hydrogeology driven by the paradigm of Integrated Water Resource Management (IWRM).

The many different technical competencies and excellent laboratory infrastructure within the organization has allowed it to undertake significant multidisciplinary work in this field.



Institutional Capacity Challenges

The capacity challenge in South Africa at this point in time lies at the institutional level. Lack of appropriate capacity in critical stakeholders, in particular in municipalities where groundwater has, in many instances, become the sole source of domestic water supply, is regarded by many as the most important factor holding back sustainable development and management of groundwater resources in South Africa. The key issue is a complete lack of capacity for the sustainable utilisation and management of local groundwater resources.

Serious capacity shortcomings in the national Department of Water Affairs & Forestry were pointed out to the Parliamentary Portfolio Committee on Water Affairs and Forestry in 2008. Even though a Departmental Groundwater Strategy was prepared in 2010, with considerable input from the private sector, very few of the recommendations have been rolled out so far, because the Department does not have the capacity and leadership / organization to act on them. The weakness in the groundwater function in national government is of particular concern at a time when new groundwater capacity has to be built in soon to be established CMAs and in local government.

The Department is able to contract out a considerable proportion of technical groundwater work to the private sector. However, this role still demands a thorough understanding of the issues and experience as well as technical competence, which is increasingly lost. This lack in capacity at national level also prevents a proper synchronization of research and national development objectives and prevents the academic sector to fully play its science leadership role.

Human Capacity Decline

There has been a decline in the number of “person-years” of experience in hydrogeology in the state sector. Experienced professionals are leaving public institutions to work in the private sector and in foreign countries due partly to the inability of these institutions to attract and retain such staff.

Retired personnel are often not replaced. In addition, the number of vacant posts in the Department for hydrogeologists is around 47% and 53% for geotechnicians and this is compounded by its inability to attract staff. More than 50% of the current groundwater personnel have fewer than 5 years’ experience and do not have experienced mentors to guide them.

Historically the Department was the “conveyor belt” for delivering groundwater professionals in South Africa. However, key groundwater planning, development and management functions are being completely eroded within the Department.

Experienced hydrogeologists are also necessary for mentoring younger professionals – without this function it takes longer for new recruits to gain the skills they need, and deprives them of job satisfaction. In the worst case, a vicious circle of high staff turnover and dwindling institutional memory will occur.

Partnerships

The new water resource management hierarchy and new and more integrated approaches to water resources management will require a strategic approach to research and development, technology transfer and capacity building. The networking of education and training providers and users, as well as researchers, as recommended by the UNESCO/WMO mission to South Africa in 1998 in their FET-Water proposal, will need urgent and widely coordinated implementation. This is fully in line with the national objective of cooperative governance, but will need a national champion to implement it.

International Cooperation

International cooperation has greatly benefited the South African groundwater sector, in particular during the challenging period of making groundwater a part of IWRM. This has included a UNESCO/WMO Mission in 1998 to assess Education and Training needs of the water resources management services in South Africa, a DANCED-assisted cooperative project intended to support the implementation of programs towards achieving IWRM (2001-2004), and a NORAD-assisted programme for the sustainable development of groundwater sources under the Community Water Supply and Sanitation Programme (2000-2004).

South Africa’s groundwater research and development capacity also plays a major regional role in southern Africa and wider. At this stage there are only about three other institutions in the SADC outside South Africa, which have groundwater research and development (R&D) and teaching capacity. Not surprising then that the Institute of Groundwater Studies at the University of the Free State was requested to host the newly inaugurated SADC Groundwater Management Institute.

CURRENT CHALLENGES

Some of the reasons for the capacity gaps are unique to groundwater, but others are an outflow of the general gap in science and engineering capacity in South Africa at this point in time. Some key challenges for groundwater capacity development experienced in recent years are listed below. (Braune and Adams, 2009).

- ! Poor standard of maths and science university entrants, largely a legacy of an inferior education system for the majority of the population over many years and an inability of the school system to catch up over the last 25 years;
- ! The global scarcity of science & technology manpower, the much greater mobility of professionals and a resulting global competition for the limited pool of available skills;
- ! The great difficulty in retaining skilled, experienced specialists and technical managers in the public sector. Most of the professional capacity in South Africa is located outside the public sector and will remain so;
- ! Seriously missing is the public sector as a major player in capacity building and mentoring;
- ! Mentoring of new entries becomes a problem in this situation. Universities, on the other hand are unable to provide practical education and training without real life problems, access to technical infrastructure and funding support for mobility.
- ! While the public sector work is still done by means of outsourcing, the private sector has not yet taken on a role in national capacity building;
- ! The complete lack of capacity within municipalities for the sustainable utilisation and management of local groundwater resources is regarded by many as the most important factor holding back sustainable development and management of groundwater resources in South Africa;
- ! The specific lack of groundwater capacity is strongly related to the continued undervaluing of the resource at decision-making level, and thus in a lack of systematic investment in its sustainable utilization;
- ! The very vulnerable capacity situation in the groundwater academic sector is as a result of a lack of role-player cooperation in groundwater capacity building. This needs to be urgently addressed together with innovative solutions, before international groups mobilize more of our skills for initiatives outside of South Africa.

STRATEGIC ACTIONS

CAPACITY DEVELOPMENT

Capacity development will have to be addressed strategically by the groundwater sector as a whole in order to make a difference.

- A capacity gap analysis needs to be undertaken within the emerging groundwater governance framework and linked to the groundwater research planning of the WRC and to existing capacity building initiatives in different sectors.
- The key players in groundwater capacity building need to be identified and engaged in a common way forward.
- For maximum impact, there will have to be synergy between capacity building for groundwater and that of related IWRM components, in particular community water supply.
- This could be a recurring initiative which will over time link to catchment management strategies and aquifer management plans.

DWS LEAD ROLE

- The Department of Water and Sanitation should take the lead role in groundwater capacity building;
- This should be part of a national water sector capacity building strategy linked to the National Water Resources Strategy.
- DWS should strategically plan for groundwater capacity building (incorporate into Groundwater strategy and Groundwater master plans) and anchor it in MOUs or MOAs with national as well as more local academic institutions (like the agreement between Minister and Institute for Groundwater Studies in the 70s). This would provide continuity in groundwater science inputs into DWS policy development and water resources studies.
- The Department's PSP contracts present an opportunity for the leveraging of such capacity development, but it needs high-level support in-house.
- The national groundwater champion within DWS has a crucial role towards achieving proper synchronization of groundwater research with national development objectives and in this way



STRATEGIC ACTIONS CONT.

will be helping the academic sector to play its science leadership role.

- Groundwater should become a priority in the DWS Learning Academy programme.

WRC LEVERAGING ROLE

The WRCs 2015 National Water Research, Development, and Innovation (RDI) Roadmap provides a structured framework to focus the contribution of RDI activity to the implementation of national policy, strategy and planning in water resources management in South Africa. In particular the four plan areas under 'Water Supply' have a strong bearing on the roll-out of the NGS (WRC, 2015):

- 1.1. Increase ability to make use of more sources of water, including alternatives
 - 1.2. Improve governance, planning and management of supply and delivery
 - 1.3. Improve adequacy and performance of supply infrastructure
 - 1.4. Run water as a financially sustainable "business" by improving operational performance
- The WRC should continue its critical capacity-building role for groundwater resources development and management.
 - As the key role player, it should help build a coherent knowledge infrastructure among government and private sector research and educational institutions in South Africa. The partners like SALGA, WISA, and regional networks should be actively used in knowledge transfer.
 - Utilizing of synergies should also extend to regional and international initiatives like AMCOWs, the Africa Groundwater Commission and UNESCO's International Hydrological Programme.
 - As part of this strategy it will be essential to continue to build networks of people and technology across institutional borders to share information and experiences and improve its usefulness and accessibility.

FET-WATER

The South African water sector urgently needs a framework programme for effective 'collaboration, sharing and networking' for the provision of education, training and capacity building in the water sector. This was the overall recommendation of

the UNESCO/WMO Mission to Assess E&T Needs of the Water Resources Management Services in South Africa (DWA/UNESCO/WMO, 1998), as expressed in the proposed programme 'Framework for Education and Training in Water' (FET-Water).

- The FET-Water approach needs to be further developed for capacity development in the groundwater governance field. With the strong emphasis on achieving cooperative projects between stakeholders and on the strategic leveraging of resources and harmonising complimentary relationships for support, in particular WRC/DWS/NRF/Private sector.
- A particular niche for FET-Water would be to achieve a lot more cooperative projects between stakeholders – umbrella MOUs between them would ease the way; There should be some umbrella cooperation strategy between WRC and NRF.

ACADEMIC INSTITUTIONS

Universities are a key player in groundwater capacity development.

- Universities need to take the lead to bring further resources and key partners on board and into the wider arena of groundwater national capacity development (e.g. UNESCO and other UN Agencies in the case of the University of the Western Cape).
- It is essential that educational organisations and professional associations intensify the efforts to build capacity in groundwater governance and to come up with new courses and curricula to groom new cohorts of 'broader' professionals. This entails going beyond aquifer systems, and bring understanding for the way and means to govern the entire subsurface space and balance various social and economic objectives.
- Academic institutions can play a major role in offering 'refresher' short courses to 'older' hydrogeologists with focus on the latest research findings and technology developments.

SA GROUNDWATER CENTER OF EXCELLENCE

SA needs its own groundwater centre of excellence to undertake the leadership and coordination required for the strategic, but long neglected resource.

- It should be a (virtual) centre pulling together the diverse groundwater research and education capacity in the country.
- Both the main groundwater centres in South Africa

STRATEGIC ACTIONS CONT.

are operating beyond the limits of their supervisory capacity already, and preparing them for an increased responsibility should be part of the capacity building strategy.

- A dedicated, industry-supported, groundwater chair or center could facilitate such cooperation.

PRIVATE SECTOR ROLE

The private sector needs to play a much larger role in education and training (as is happening in the mining sector).

- It has a major role in the mentoring of students through practical work experience and support of post-graduate studies. Its human and technology resources should be available for mentoring and practical experience-gaining on a voluntary basis.
- A specific suggestion was to establish regional cooperation through an MOU that local consultants could have with their DWS Region to allow on-the-job experience and training for learners in the region not in their employ.
- The Ground Water Division of South Africa could play a much stronger role in mobilizing the groundwater sector as nurturer of the groundwater human resources.

TECHNICAL EDUCATION & TRAINING

Groundwater technical capacity-building has been neglected and needs serious attention. There should be a rethink on the role of universities and technical universities to cater for different capacity gaps in various parts of the water sector.

- The NGS should address the issue of lack or no formal training courses for groundwater personnel.
- Training is needed at local level from pump operators to technicians and in most cases even managers.
- Technical managers should be involved in field visits when groundwater projects are undertaken in order to capacitate them in terms of field training.

PRACTICE BY COMPETENT PERSONS

Groundwater is a highly applied field of science requiring significant understanding of fundamental scientific principles applied to a highly variable and important resource.

- Development, management, education & training and governance of this resource should be practiced by competent persons.
- This requirement should be widely applied in job

advertisements, education & training outcomes and tender specifications.

- Non-groundwater practitioners / contractors involved groundwater resource development need to be led by norms and standards and regulations.
- Where necessary, ie in domestic water supply from groundwater and in environmental impact assessment, the use of a competent hydrogeologist should be regulated.
- There should be a groundwater sector-wide strategy for registration of hydrogeologists and a system of required Continued Professional Development, driven and coordinated on behalf of the groundwater sector by the Groundwater Division of the Geological Society of South Africa.
- Groundwater professionals are important, but equally important is the training of employed workers.

CAPACITATING OF MUNICIPALITIES

Municipalities have the vital role in terms of groundwater governance to provide a sustainable water service from groundwater sources. It is essential that they are capacitated for this task on an ongoing basis. The stakeholder consultation provided the following guidance:

- There needs to be systematic capacitating of municipalities for groundwater – similar to the training of plumbers in the 'War on Leaks'
- Capacity building should start at the decision-maker level to achieve an appreciation of the issues and capacities required at the working level to deal with them. This also applies to other local institutions like water user associations.
- There should be appropriate awareness campaigns and training for Councils by DWS through SALGA, starting with the training workshop for every new Council.
- Districts need to be capacitated through hiring of hydrogeologists who will overlook the whole district's groundwater requirements.
- An auditing culture and system needs to be established for councils and districts so as to bring accountability into the vital function of groundwater governance for domestic water services.
- As an overall approach, we need to continue and strengthen the initiative "Adopt a Municipality".

GROUNDWATER IN BASIC EDUCATION

Without water there is no life. Already water is becoming



STRATEGIC ACTIONS CONT.

the limiting factor for development in many parts of the country. While groundwater is the most accessible source for most communities, it is little understood and vulnerable to a variety of impacts. During the provincial consultation, stakeholders stressed the importance of already introducing an understanding of water systems at school level.

- Water resources and their sustainable utilisation and management should be incorporated into the school curriculum as a long term plan.
- Groundwater should be an integral part of this topic, stressing its role in development and its interrelationships in the hydrological system.
- There is a need for inter-departmental partnership between DWS and Department of Education to achieve this in a sustainable way.

LONG-TERM RELATIONSHIP: GOVERNMENT / ACADEMIC INSTITUTIONS

Groundwater academic institutions have largely been created by government in the interest of national development. Their relationship with government for this purpose should be anchored in agreements of sustainable cooperation, including focused Education & Training programmes, technical support from the academic institutions, annual bursary provision and cooperative research opportunities offered by government.

PUBLIC/PRIVATE SECTOR PARTNERSHIPS

As professional service providers the private sector groundwater professionals have a critical opportunity to provide for capacity-building of municipal staff and the transition of management functions from national to local institutions.

National government (DWS) should use this opportunity to facilitate innovation and reward/fund excellence.

STAKEHOLDER INVOLVEMENT

The increasing and systematic involvement of all stakeholders, from the central government to the communities, from the public and private sector alike, is seen as the critical factor in a long-term, sustained process to strengthen institutions, develop human resources and create the supporting policy and legal environment.

INTERNATIONAL COOPERATION

South African water research should become more

Africa-orientated. Participating in regional, continental and international initiatives provides real opportunities for dealing with the capacity gap in South Africa. The thrust should be anchored in the regional cooperation objectives of both the national Department of Water and Sanitation and the WRC.

CAPACITY BUILDING INDICATORS

Adequate capacity-building indicators need to be found for the groundwater sector and need to be continuously monitored.

GROUNDWATER AWARENESS-RAISING

As part of the NGS there should be a planned approach to groundwater awareness building. This should be pursued jointly with the key stakeholders.

- The long-term process of institutional development must be supported by a major ongoing awareness campaign at all levels to achieve the long-term transformation towards good groundwater governance.
- This requires that science and applied technology serve to enhance education and outreach programs in order to broaden stakeholder understanding.
- Awareness building should be a deliverable of every programme and project and should be proactively supported by the WRC.
- Awareness-raising must go hand in hand with appropriate valuation of the resource. It can be noted here that Danish users pay the equivalent of R125 for a cubic meter of groundwater (this includes the cost of resource protection and waste water treatment).
- Academic institutions and individual specialists should do a lot more to showcase and promote groundwater and development on campus and externally, in particular through various media.
- The private sector and individual specialists should do a lot more to showcase and promote groundwater and development in their sphere of influence and externally, in particular through various media;
- Awareness raising and information sharing should include other government departments.
- There should be a systematic focus on parliamentary decision-makers (national, provincial and local).

Wherever possible, the structures and processes already existing for IWRM, should also be used for groundwater awareness-building;

Education of children should become the key strategy to create the desired shift in society's awareness and understanding of groundwater's role and sustainable utilisation.

REDIRECTING FINANCES

THEME 8



SITUATION ASSESSMENT

Groundwater-related expenditure is taking place in different branches of DWS, for example in support of water resources planning and of water services implementation. Related expenditure will also take place in other sectors like health, agriculture, mining and local government. Very little coordination between these potentially-related activities is taking place at present.

A critical shortcoming in financing for groundwater is the poor appreciation of the funds required for groundwater development. Groundwater development is still generally accepted as the drilling of a few boreholes.

The groundwater function in DWS has shrunk since restructuring of the Department in 2003 and the loss of the Directorate Geohydrology. No further resource assessment has been taking place since then and important functions like groundwater monitoring are seriously under-resourced.

Lack of finance could become a serious bottleneck to the implementation of the groundwater governance framework, particularly because of groundwater's 'private water', neglected, and under-valued status.

The actions below are a first attempt to remedy the situation at a strategic level. International experience in this regard was included, obtained from the Global Groundwater Governance Framework completed recently (UNESCO et al., 2015).

STRATEGIC ACTIONS

UNDERSTANDING GROUNDWATER DEVELOPMENT

An understanding should urgently be developed of the different stages of groundwater development under different physical and demand conditions, and the time and costs involved. This will allow for a better planning of investment in groundwater.

Objectives

Redirect incentive policies and public expenditures impacting groundwater by and within different sectors to achieve a combined, much stronger focus on sustainable and efficient groundwater management.





STRATEGIC ACTIONS CONT.

ALIGN GROUNDWATER FINANCE

Align all public groundwater finance with the new priorities. Aligning happens inside and outside the Department, e.g. All Towns national planning and its follow-through in Regions (Water Services) and implementation by municipalities.

- Alignment is important between different sectors, e.g. there should be no provision of farming subsidies in groundwater-stressed areas and there should be a significant charge for using high volumes of groundwater to counter over-use. Consider subsidies for developing appropriate groundwater use in stressed areas, including the promotion of switching from irrigarion farming to an alternative sustainable groundwater practice. Other subsidies, in particular for fuel and electricity should be strongly discouraged in such situations.
- Municipalities should include funds in their budget for feasibility studies of potential groundwater sources in their areas. In some instances this is already happening.
- In appropriate settings provide economic incentives to encourage groundwater conservation, in particular artificial recharge of aquifers.
- Wherever money is spent on groundwater there should be a strategy to use a portion for groundwater skills development.
- Address financing as a high priority in the hierarchy of groundwater decision-making and action.

ENCOURAGE PRIVATE INVESTMENT

The systems of regulations and incentives should encourage private investment in sustainable groundwater management.

- In this regard, develop investment portfolios in sustainable and productive groundwater management. In addition, ensure that investments in other sectors (such as roads, aquaculture and leisure) can be tailored to have groundwater benefits like promoting recharge.
- Alternative approaches are necessary to leverage

parallel investments by groundwater users and by the beneficiaries of other functions of aquifer systems.

- Many investment programs that serve the sustainable use of groundwater are likely to contribute to other livelihood and ecosystem functions, and this multi-functionality should make the programmes more attractive to investors.

INVEST IN GOVERNANCE

Funding of groundwater governance must be in line with its strategic importance.

- The basic groundwater management functions should not be compromised: there needs to be investment in the actors, institutions, policies and knowledge.
- Legal instruments and regulatory provisions must be matched by the means required for their implementation.
- Improved groundwater management and O&M will be a huge cost saving. Planning and allocating money for groundwater O&M is money well-spent.

IMPROVE EFFICIENCY OF CHARGING FOR GROUNDWATER USE

Groundwater use should be charged as incentive to conserve and protect the resource. This, in turn, means that there must be adequate measurement of use.

- Because of the many abstraction points, efficiency in measurement and charging is required. For example, where water is metered at hydrants, breakthroughs in information and communication technology make charging for water more feasible and more efficient.
- Mobile money – held on smartphones – for instance can be used to pay for water use and ensure full payment of charges.
- Ideally, groundwater use charges should be used for its sustainable development and management.
- Alternatively, with all charges going to a catchment fund, groundwater's management needs and backlog need to be recognized.
- Importantly, tariffs should not be uniform, but should be set according to the (groundwater) management needs of a catchment.

GROUNDWATER RESOURCE PLANNING AND DEVELOPMENT

THEME 9



SITUATION ASSESSMENT

Groundwater in the Planning Function

The vision of the National Water Act, 1998 is Integrated Water Resources Management. All water resource management at national, catchment and local levels should be based on the principles of IWRM. Groundwater resource management should not operate in isolation, but should be part of the drive towards integrated water resources management. In this way scarce resources can be shared and major synergies can be achieved.

It was therefore crucial that, with the major restructuring of the Department in 2003, groundwater was integrated into the various water resource management functions, in particular the water resource planning function. Groundwater is now fully part of the planning basket, with groundwater specialists in the planning team. This has had tremendous benefits for groundwater resource development and management:

- At the national level it led to development of a Departmental Groundwater Strategy and the extensive inclusion of groundwater into the second edition of the National Water Resources Strategy.
- Groundwater became part of the nationwide programme to develop water reconciliation strategies for WMA's, metro's, towns, villages and clusters of villages across the country, starting in 2008. These studies provided the groundwater potential for each municipality at a local scale and identified possible target aquifers in the vicinity of the towns, where this appears to be feasible (e.g. DWA, 2011);
- Groundwater staff had the opportunity to comment on major municipal projects to be undertaken with government grant funding, e.g. the Municipal Infrastructure Grant (MIG);
- Departmental guidelines could be prepared, addressing various aspects of sustainable

Objectives

Achieve integrated groundwater resource planning at national, regional and local levels that will fully and sustainably establish the unique potential of groundwater for socio-economic development.

Principles

Groundwater is an integral part of the hydrological cycle. Groundwater in South Africa has benefited greatly from being developed within an IWRM framework across the full spectrum of policy, regulations, institutional development, protection, planning and information management. The roll-out of the NGS will have to continue within this overall framework. Integration must take place at three effective levels, integration within the hydrological cycle (the physical processes), integration across land and water, across river basins (catchments) and aquifers (spatial integration), and integration across the overall social and economic fabric from national to local level.





development and management of groundwater resources (e.g. DWAF, 2008b and Murray and Ravenscroft, 2010).

Greater use of groundwater sources does indeed hold enormous promise for accelerating sustainable access to improved water service and augmenting supply in many parts of the country. The lead times for developing groundwater resources are far shorter than are typically found in big surface water development projects, which allows for delivery of the benefits far sooner. There is also scope for substantial cost savings in developing local decentralized groundwater-based schemes, instead of big regional surface water schemes with major pipelines conveying water from distant impoundments.

Planning at different levels

While planning has been well established at the national level, there are as yet no catchment management plans (strategies) as foreseen in the National Water Act, 1998. Until such time as the CMAs are operational, water management at WMA level is guided by a series of documents developed by the Department between 2002 and 2004 called Internal Strategic Perspectives (ISPs). The essential element of stakeholder consultation is still missing.

At the municipal level, each municipality designated as Water Services Authority, must develop a Water Services Development Plan (WSDP) as part of the Integrated Development Plan (IDP) process that concentrates on increasing access to water services, and must also take into account water supply sustainability. This level still suffers from a serious lack of technical capacity. There are examples of municipalities' general planning documents containing little on groundwater, despite having a major aquifer system in their area, despite having a profitable local industry relying on these resources and despite serious degradation of the resource through over-abstraction and acid mine drainage.

The role of the national groundwater function as auditor, enabler and capacitor of the new levels of groundwater planning and implementation will thus be critical in coming years.

Challenges with Groundwater for Municipal Supply

Despite this raised profile on paper, experience on the ground indicates that many municipalities only turn to groundwater as a last resort or in emergencies. Groundwater is perceived as an unreliable and difficult source to manage. According to the Department, 'more than 70% of WSAs do not want localised solutions and prefer regional schemes.' Financing via the Regional Bulk Infrastructure Grant (RBIG) gives municipalities large financing in their own control, often resulting in a complete neglect of local groundwater sources. In some cases very expensive options such as desalination are implemented as short or medium term solutions, without groundwater being given early, serious consideration (e.g. at Sedgfield).

In general, municipal water supply from groundwater remains a major problem. World-wide it is accepted that drinking water supply to communities requires the highest standards of planning, implementation, operation and maintenance. Local government in South Africa, at this stage, does not have the groundwater technical capacity to undertake this function responsibly. Policy, regulation and comprehensive support is required for a more sustainable way forward.

CURRENT CHALLENGES

Key challenges for groundwater resources planning and development experienced in recent years include:

- ! Whilst national water resource planners are well aware of the potential of groundwater, many planners and managers at regional and local level do not incorporate groundwater into their water development plans, or else treat it as a last resort, to be used only in emergencies.
- ! Groundwater management links to groundwater-dependent sectors like agriculture, rural development, health and environment are not well established in policy or in practice. Decision-makers in the fields of climate change preparedness, rural poverty alleviation, sanitation backlogs and related fields do not always have adequate information about the ways in which groundwater can assist them, and spatial planning documents rarely consider

groundwater, even where groundwater is a potential major factor in continued economic development.

- ! Investment in groundwater, relative to its potential to address national objectives, is limited and groundwater is unlikely to attract high profile champions in the construction industry, because developments are generally modest when compared to surface water impoundments and long-distance pipelines.
- ! Planning and financing processes and accompanying study and exploration investment, addressing groundwater (often in the form of many, widely distributed, relatively small, individual sources) systematically through all phases, are not in place. In particular, a lack of macro planning for groundwater prevails.
- ! Local and vulnerable groundwater resources need a much more participative approach to development, operation and protection. This is still completely missing.

- ! Despite groundwater's crucial role in drought preparedness and emergency response, particularly in rural areas, groundwater as part of drought risk management has not yet been mainstreamed into on-going planning and development processes.
- ! Lack of adequate monitoring and assessment of groundwater resources is resulting in poor attention to groundwater planning at all levels. This is particularly serious for drought risk management.
- ! Within municipalities, groundwater is widely perceived as unreliable and a difficult source to manage. The real problem is that local government in South Africa, at this stage, does not have the groundwater technical capacity to undertake this function responsibly.

STRATEGIC ACTIONS

GROUNDWATER PRIORITY

The groundwater development priority must be worked through into Treasury instructions and other instruments of planning and financing, i.e. catchment management strategies and WSDPs and IDPs.

MACRO PLANNING

The country should ultimately be covered with groundwater plans at catchment and priority aquifer level. Planning should not only address water resource reconciliation issues, but also the regulatory support and the human and institutional capacity requirements for a sustainable utilisation of local water resources. At this stage such macro planning does not really exist. The focus is water resource planning. That there is appropriate capacity to manage is implied and not a planning outcome; this needs, at this stage, norms and standards coming from elsewhere.

CATCHMENT MANAGEMENT STRATEGIES

The national and catchment management strategies should become major vehicles for integration. Each catchment management agency (CMA) should include a groundwater management plan as part of the catchment management framework and to have sufficient groundwater specialists available to oversee sustainable development, monitoring and management of groundwater resources.

GROUNDWATER PLANNING GUIDELINES

Establish guidelines for the groundwater content of emerging Catchment Management Strategies (CMS), and other water resource management guideline documents.

BEST PRACTICE GUIDELINES

Develop and implement "Best Practice Guidelines" for the mining sector as well as for the municipal, agriculture, energy and forestry sectors to ensure the protection of groundwater resources. Where necessary, these need to be regulated, e.g. Water Services regulations for WSDPs.



STRATEGIC ACTIONS CONT.

DROUGHT RISK MANAGEMENT

The critical role of groundwater in drought risk management needs to be mainstreamed into ongoing planning and development processes.

- There needs to be a move away from crisis management to ongoing implementation of drought-proofing measures.
- This could entail the development of regional and sub-regional information on areas expected to be most affected by drought, with plans for monitoring and targeting drought-proofing measures during and ahead of droughts (e.g. rehabilitation of groundwater supply infrastructure and well deepening).

STAKEHOLDER INVOLVEMENT IN PLANNING

The importance of aquifer and basin plans is that stakeholders can be systematically introduced to the groundwater resources in their area and involved in the drawing up and regularly reviewing such plans. This process must be formally established through the NGS.

GROUNDWATER INFORMATION

Appropriate information is often the bottleneck in planning – especially the lack of monitoring by municipalities.

- There needs to be regional reporting on the implementation of the All Towns plans and the business processes followed – municipalities very often follow their own limited understanding.
- Groundwater information needs to be developed for planning at various levels of a scope and level of detail comparable to other options in water resource assessments. This should include information on groundwater infrastructure and cost requirements.

GROUNDWATER DEVELOPMENT

Conduct groundwater resource assessment and development programmes (including the rehabilitation of existing water supply boreholes) for towns threatened by surface water shortages as water needs increase.

- Funds are available for groundwater source development, but municipalities need to be

supported and guided by DWS and other sectors in terms of sector plans.

- It is important that water resource protection and conservation and operation and maintenance of groundwater sources is already addressed in these plans. Shared aquifer management should also be addressed so that it can be enforced once that stage is reached.
- It would greatly help if DWS could support the source development by municipalities with exploratory drilling (for drought proofing). This could be seen as a new level of exploration (aquifer exploration as part of GRA III).
- Implement groundwater development programmes for domestic and productive water use to support national imperatives such as the Comprehensive Rural Development Programme, the Water Allocation Reform process, addressing the Millennium Development Goals, etc.
- Develop groundwater in a conjunctive manner with other local resources (such as surface resources, reuse, desalination and rain water harvesting).

GROUNDWATER DEVELOPMENT AND MANAGEMENT FRAMEWORK

Stakeholders at the National Dialogue all agreed that the Groundwater development and management framework presented by Riemann (shown in Appendix II), could become the overall framework within which the joint actions at different management levels could be unpacked:

- Conceptualisation
- Reconnaissance
- Pre-feasibility
- Feasibility
- Design
- Construction
- Operation

GROUNDWATER INFORMATION MANAGEMENT

THEME 10



SITUATION ASSESSMENT

Objectives

Grow and maintain the groundwater resource knowledge base, focusing on the resource itself, its socio-economic role and its appropriate management. Develop and maintain effective and efficient information and information systems, as a shared national objective and an integral part of water management strategies, in support of groundwater development and management at all levels.

Principles

No sustainable development of a scarce natural resource is possible without understanding the resource and managing it wisely according to this growing understanding' (Minister of Water Affairs, Ronnie Kasrils, 2003).

Such understanding must include the resource and its environmental connections, the users and their needs and the appropriate management and expansion interventions. Proper understanding is particularly important for groundwater, because of its hidden and neglected nature.

To transform water management in South Africa from a highly centralized to a strongly devolved and participative approach, information management will become a strategic requirement. This is particularly important for groundwater governance – 'national facilitation of local actions'. A rapidly increasing number of stakeholders will have to provide groundwater data and will need information support. A groundwater information system must lead and maintain this whole process, created and sustained by vision and commitment and anchored in legislation. Groundwater information systems must be mutually aligned with Acts, Strategies and Guidelines in order to complement each other. The principle upon which this alignment is envisaged is depicted in **Box I**.

Role of Information Management

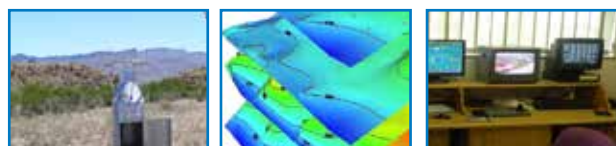
The regular collection, analysis and dissemination of data and information are fundamental for any programme of groundwater management that wants to influence policy, decision makers and public opinion. Lack of information and lack of access to information are the two issues widely identified by experts and stakeholders as constraining the development of effective strategies and policies for managing groundwater. This is while international experience shows a move towards even more data-intensive groundwater assessment methodologies. Increasing data density and availability in South Africa should be a core part of future groundwater resource assessments. Ultimately models and information must become the basic tools, which groups of stakeholders of shared aquifer resources use to reach agreement on management options.

The critical success factors for a future groundwater information system include:

- A dynamic system (continuously updated and adapted)
- Participative and client-driven development
- Appropriate technology to achieve participation and effectiveness
- Central direction, coordination and maintenance
- Openness to all

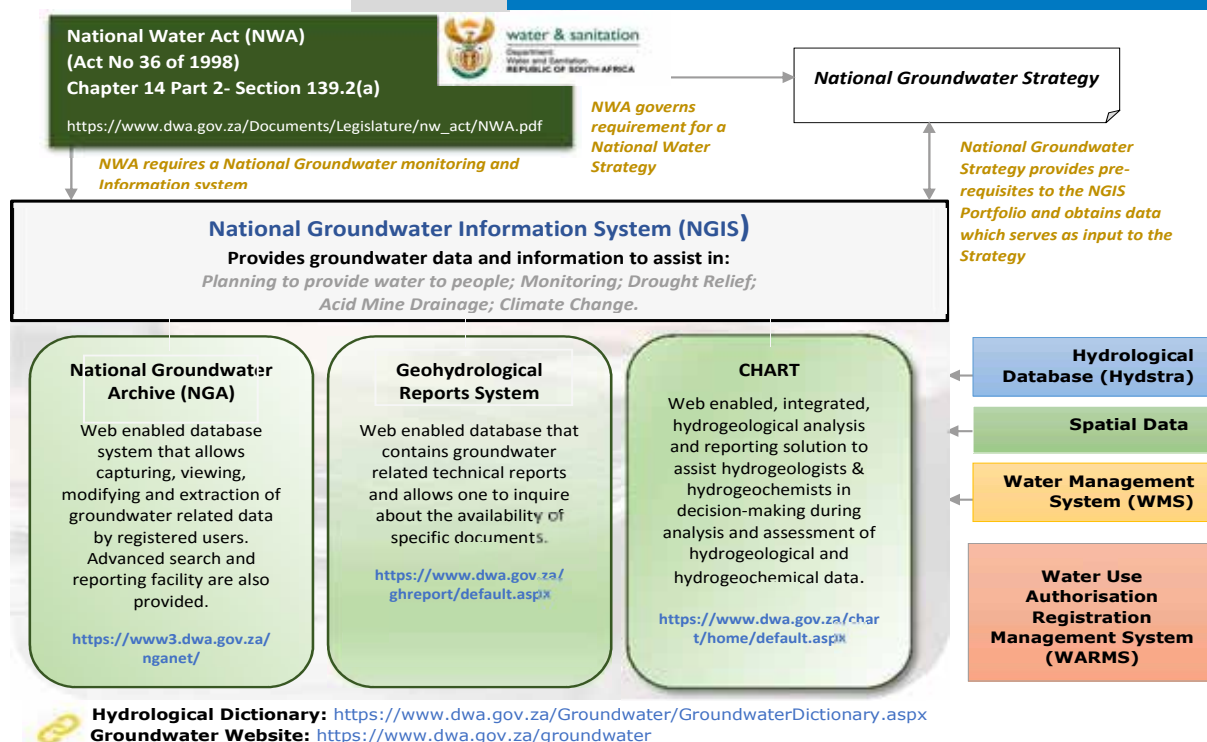
The emerging groundwater information management systems in South Africa are shown in **Box I**.





Box I

Groundwater Information Systems: Governing Principles



Groundwater Data

Concern, already recognised with the writing of the National Water Act, 1998, was that information from private drilling (approximately 100 000 boreholes are drilled in South Africa per year) is not ending up on the National Groundwater Database. It is likely that a process to centralize “private” data would be a very cost effective and rapid way of expanding national groundwater data archives.

Groundwater data – water levels, ¹Geosite locations, groundwater quality, and other parameters – is the foundation of groundwater management. Without data, managers and users cannot “see” the resource.

The Department currently stores and makes groundwater data available via a web-enabled information system called the National Groundwater Archive (NGA). The NGA was made available on the internet to all in October 2008.



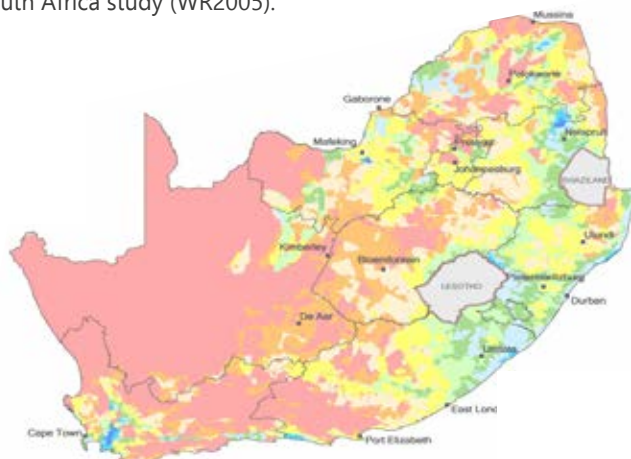
¹ Geosite includes the types: Borehole, Drain, Dug Well, Lateral/Radial Arm Collector, Mine, Seepage Pond, Sinkhole, Spring, Tunnel & Well Point.

Groundwater Information Management in South Africa

A first national assessment of available groundwater resources was initiated in 1995 through the publication of Groundwater Resources of South Africa, consisting of a report and accompanying set of groundwater maps published by the WRC (Vegter, 1995).

The regional mapping was undertaken by the Department of Water Affairs and Forestry, leading to the publication of a series of 21 hydrogeological maps by 2003 (see **Box J**).

Importantly, the follow-on assessment phase, Groundwater Resources Assessment (GRA2), completed in 2005, led, for the first time, to the inclusion of a groundwater component in the Water Resources of South Africa study (WR2005).



Box J

Groundwater Maps of South Africa

Groundwater data is required for making products such as groundwater maps that are needed to manage water resources, help find borehole drilling sites and avoid areas of poor water quality. The first comprehensive picture of the groundwater resources of South Africa (depth to groundwater, groundwater quality, etc.) was only produced in 1995 – the set of seven maps and accompanying report was based on a statistical analysis of data on 120 000 boreholes in the national database.

This was followed in 1998 by a groundwater “harvest potential” map of South Africa, giving the first estimates of how much groundwater could be sustainably abstracted in any given area. In 2003 the first set of regional hydrogeological maps was completed by the Department of Water Affairs, covering the whole country at a scale of 1:500 000 on twenty-one sheets, and broadly following an international standard hydrogeological map legend.

These maps (known as the Hydrogeological Map Series) show type of aquifer (e.g. intergranular or fractured) and median borehole yield, together with geology, rainfall, and other information. They are very useful for planning, but like all maps at that scale, it cannot replace fieldwork for siting boreholes or for detailed groundwater investigations. The process leading to the production of these maps is called the Groundwater Resource Assessment Phase 1, or GRA 1.

Groundwater Monitoring

Ongoing monitoring is essential to be aware of the state of an aquifer system and its response to external impacts and management interventions. Monitoring takes place at a national (unimpacted) level, a regional (²unimpacted and ³impacted) level and a local (aquifer) level in support of management at these different levels. Besides establishing national monitoring programmes, the National Water Act, 1998 also requires the Minister to establish mechanisms to coordinate the monitoring at the different levels.

While monitoring of our rivers and dams has started around a hundred years ago, only a few groundwater level records are longer than 40 years. The map of national groundwater level monitoring stations still shows large blank areas and investment into groundwater monitoring is about 15% of that for the surface water network (DWAF, 2004), whereas it is no less important.

Groundwater Data Use

The Water Use Authorisation Registration Management System (WARMS), is based on registered volumes, which have a high level of uncertainty because a systematic verification process has not started yet. Groundwater-use data has only been collected with the licensing process since 1998.

Before this there had been no need for groundwater users to supply the Department with groundwater use, level and

quality information except in the Subterranean Government Water Control Areas (SGWCAs).

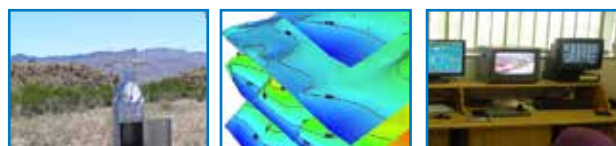
Groundwater Data Requirements

A lack of reliable groundwater data makes it difficult to make accurate assessments of the availability (i.e. quantity and quality) and abstraction (i.e. rates, quantities and drawdown levels) of groundwater. This, in turn, leads to poor management and an inability to foresee resource degradation through drought and pollution. Lack of data on the status of water supply infrastructure (i.e. borehole construction, pumps, etc.) is a major constraint on investment in operation and maintenance activities. All the above illustrate a lack of ‘ownership’ for the underground resource.

Questionable data sets almost always lead to incorrect assumptions about groundwater use and sustainability. The document: “South African Integrated Water Resource Management (IWRM)” advises to verify groundwater data sets and data need to be captured in a manner that serves the needs of both the National Water Act (NWA) and the Water Services Act (WSA). Therefore, when developing a Water Services Development Plan (WSDP) for a district municipality where groundwater plays a strategic role, the data need to be available to the water management authority in a format that is usable for the district municipality. Data requirements have to include water service needs such as infrastructure information, accurate spatial distribution, sustainable yields, and management requirements. Data also need to satisfy the requirements of the National Water Resource Strategy (NWRS) and future Catchment Management Strategies (CMSs), and include more traditional hydrogeological data such as recommended yields, strike depths, transmissivity, storativity, aquifer type, etc.

² **Unimpacted areas:** Areas where no or little abstraction is taking place and the environment is still intact to the extent that it reflects near-natural conditions. Monitoring in such area will provide the baseline conditions against which the degree of impacts can be measured in different aquifer units. This is the focus of national monitoring programmes.

³ **Impacted areas:** Areas where significant abstraction is taking place and/or significant contamination from overlying land uses is occurring. This is the focus of water use impact monitoring and the monitoring accompanying the local management of aquifers.



Related hydrological and environmental datasets (e.g. rainfall volume, chloride concentrations in rainfall, spring-flow measurements, etc.) are also key to the better understanding of our groundwater resources. However, these are not always designed with groundwater in mind, and are not aligned with groundwater management strategies.

Limpopo is one of the areas in South Africa where groundwater is most widely used as the only domestic water supply.

In view of the above, Limpopo initiated and implemented, already in 2002, a Groundwater Resource Information Programme (GRIP), assessing “private” data and thus became the first province in South Africa to do so (See **Box K**).

Box K
The GRIP Project
<http://griplimpopo.co.za/>

The Groundwater Resource Information Project (GRIP) is a national Department of Water Affairs project to improve data holdings by accessing unpublished or “private” data as well as “new” groundwater data collected by visiting boreholes in the field – particularly in priority areas.

GRIP will also develop systems and procedures for the collection and verification of unpublished data. GRIP was started in Limpopo Province, and extended to KwaZulu-Natal, the Eastern Cape and Mpumalanga and it is planned to extend it to the Free State. To date, GRIP has been most fully implemented in the Limpopo Province, where it began in 2002 and is still underway. More than 2 500 villages have been visited in Limpopo Province, in excesses of 31 000 Geosites have been verified, and 1 500 additional pumping tests have been added to the provincial database.

Limpopo Province now has probably the most extensive and best verified dataset on rural groundwater resources in the country, and enough is known about groundwater in the province to allow it to be much better integrated into general water resource management. The extra data has led to a higher borehole drilling success rate in the province, saving a considerable amount of money. The GRIP data for Eastern-Cape is currently available via the NGA. The GRIP data for Limpopo and KwaZulu-Natal is in the process of being migrated to NGA.

Decentralised Data

Data on groundwater in South Africa exists in various different databases held by a variety of organizations and individuals. Many of these databases are inaccessible (e.g. those held by private companies) or are difficult to access (e.g. groundwater data held at a provincial level). Combining databases would make groundwater planning easier and cheaper.

The process should start by integrating those databases that are already publicly available (in theory), and later address the problem of “private” groundwater data. The NGA is designed to encourage the entering of “private” data generated by private companies and other groundwater-related institutions that would normally not be seen by the Department. Within the NGA the use of “private” data has been addressed in terms of Data Ownership, Data Confidentiality amongst others, enabling external organisations to make use of the Departmental system. The NGA is continuously being enhanced to incorporate new needs.

It is likely that the capturing of data will need to be combined with a legal requirement, as there is currently little incentive for private companies and organisations to capture their data on the NGA. It is acknowledged that the non-sharing of “private” data confers a short competitive advantage, despite being to the long-run detriment of groundwater management and possibly even to the profession of hydrogeology.

All geohydrological investigations undertaken via Departmental initiatives, are available in hard copy as technical reports. Many of these are now electronically available on the web-enabled Geohydrological Reports System accessible via the internet (See **Box L**).



Box L**DWS Groundwater Geohydrological Reports System**
<http://www.dwa.gov.za/ghreport/>

Geohydrological Reports System is a database that contains groundwater related technical reports. In excesses of 7 500 technical reports are available in the library at National Office. These reports reflect the hydrogeological investigations done by Department officials or consultants.

A web based system allows one to inquire about the availability of specific documents and download in PDF format.

Approximately 2 780 out of 7 500 are internal reports (GH report). The oldest report (GH3357) is a report on the Zeerust Springs dated 5 November 1906. This report contains spring flow records of various springs, volumes used for irrigation and plans to manage the use. In 1912 a Prof. Schwart wrote a report (GH1140) for the mayor of Uitenhage on the Uitenhage Springs.



Characteristics of Groundwater Resources

Groundwater resources management has to deal with balancing the exploitation of a complex resource (in terms of quantity, quality and surface water interactions) with the increasing needs of water and land users (which can pose a threat to resource availability and quality).

All aquifers have two fundamental characteristics: a capacity for groundwater storage and a capacity for groundwater flow. Different geological formations vary widely in the degree to which they exhibit these properties and their spatial extent can vary with geological structure from a few to many thousands of square kilometres.

The flow boundaries of groundwater (in space and depth) are generally more difficult to define than for surface water systems and may vary with time. The difference is further accentuated because groundwater forms the 'invisible part' of the hydrological cycle.

The recharge rates of aquifers are a fundamental consideration in the sustainability of groundwater resource development. Furthermore, understanding aquifer recharge mechanisms and their linkages with land-use is essential for integrated water resources management. The quantification of natural recharge, however, is subject to significant methodological difficulties, data deficiencies and resultant uncertainties because of wide spatial and temporal variability of rainfall and runoff events and widespread lateral variation in soil profiles and hydrogeological

conditions. Nevertheless, for most practical purposes it is sufficient to make approximate estimates, and refine these subsequently through monitoring and analysis of aquifer response to abstraction over the medium term.

Aquifers are experiencing an increasing threat of pollution from urbanization, industrial development, agricultural activities and mining enterprises. Varying degrees of vulnerability to these impacts can be distinguished according to the depth of the water table, soil permeability and conditions at the land surface.

With progressive development, it becomes more and more important to understand the functioning of the groundwater system and its interaction with both the aquatic and terrestrial environment. However, not only the scientific factors, but also institutional and social acceptance is crucial in addressing sustainability.

Knowledge of South Africa's Groundwater Resources

According to Vegter (2001) the use of groundwater in South Africa has grown from about 700 to an estimated 3500 million m³/annum between 1950 and 1999 respectively. He described the increasing activity of groundwater investigation and research during this period of increasing groundwater use in a number of eras (**Table 7-3**).

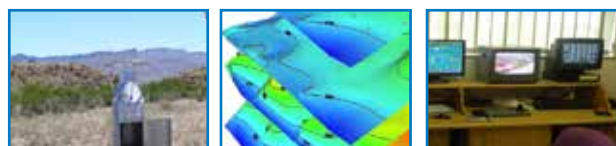


Table 7-3: Eras of groundwater investigation and research activities according to Vegter (2001)

1888-1935	Pre-geophysics era	Locating borehole sites based on surface indications; the first regional and national assessments of the water-bearing properties of the more important geological formations (based on data from some 10 000 boreholes drilled by the Department of Irrigation and its predecessors).
1936-1955	Era of geophysical borehole siting	The Geological Survey supported the drilling activities of the Department of Irrigation and also other central (eg Railways) provincial and local authorities with borehole siting, using geophysical methods. This reduced the development costs of groundwater supplies and improved the understanding of different groundwater systems.
1956-1976	Quest for quantification era	There was a growing recognition of the need for not only siting boreholes scientifically, but for a quantitative assessment of different groundwater supplies. Such assessment became a prerequisite where subsidies were granted to local authorities for groundwater exploitation for urban supplies (in terms of the Water Act, 1956). Where local authorities were reluctant to use groundwater resources, the Department of Water Affairs and Forestry (DWAF), supported by the Geological Survey undertook the exploration and resource assessment. Only in a few instances were the above government team able to observe the performance of these groundwater supply schemes over time to improve the evaluation of groundwater resources. A lot of experience, data and information was gained on the dolomitic groundwater resources during the intensive investigations of dewatering, subsidence and sinkhole formation on the Far West Rand. Unfortunately this intensive data collection was not maintained.
1977-1997	Era of expanding activity	Systematic exploration of the dolomitic formations of the Southern Transvaal as an emergency water supply for the PWV area. A large number of regional investigations of Karoo, coastal and stream-aquifer systems were concluded. In 1995 the first comprehensive estimates of groundwater availability at a national scale were published. These and later regional maps mainly relied on data held by DWAF in its databases – much of which was gathered over decades of government-sponsored drilling programmes.
1998-	Integrated management era	By 2003 the DWAF had made available a set of twenty three “general” hydrogeological maps at a scale of 1:500 000 which together cover the entire country (Groundwater Resources Assessment phase 1 - GRA1). This was followed by the GRA2 phase, concentrating on the quantification of the resource, water quality characterization, the quantification of recharge and groundwater/surface water interaction, the classification of aquifers, and the quantification of groundwater use for the above mapped areas. This phase was largely undertaken by consultants.

Groundwater Research & Development

The first WRC groundwater-related research project, initiated in 1974, dealt with the recharging of storm water into the Cape Flats aquifer. The initial research focus was on resource characterisation and groundwater technology. The investment from the WRC in these study fields over the years has undoubtedly led to a greater understanding of South Africa’s complex aquifer systems, and finding ways to effectively manage them.

Since 2000 a greater resource management focus within an integrated water resource management framework was added to the WRC research portfolio. This progression of research focus reflects the progression of groundwater attention nationally, before and after the promulgation of the National Water Act in 1998.

Funding for groundwater projects has varied between 6% and 16% of the Commission’s annual research spending.

In 2012, more than R5-million was invested in groundwater projects, with another R2.8-million in 2013. The current areas of focus include groundwater-surface water interactions and improving understanding of South Africa's vast fractured rock aquifers in terms of hydraulic behaviour and chemical characteristics. Another focus is around building, understanding and developing the necessary tools for groundwater management at the local (i.e. municipal) level (Adams, 2013).

Emerging Capacity Needs

The above resource estimates undertaken to date, will in most cases not be adequate in new local groundwater investigations (aimed at establishing a reliable water supply for a town, or tackling a groundwater pollution plume, or improving environmental flows, for example). All of these situations call for a high degree of confidence in the outcomes of the work – usually much higher than can be obtained by using regional estimates based on limited local data only. More sophisticated methods for groundwater resource management, in particular numerical modelling of a shared (trans-boundary) aquifer system, also require a high degree of certainty in the description of the system in space and time.

A major effort will be required in the regular assessment of the sustainability of present abstractions countrywide in terms of quantity, quality and environmental contribution.

To date South Africa has largely developed shallow, unconfined groundwater resources. However, increasing water scarcity and greater reliance on groundwater resources, for example in the Limpopo province, will require

a systematic exploration effort to locate possible deeper systems. This will require a groundwater development capacity greater than the country had in the era of expanding activity to enable locating, characterizing and evaluating resources.

Closure of a large number of coal mines and the prospect of region-wide mining of shale gas pose new threats for South Africa's vulnerable groundwater resources at an even larger scale than for the re-watering of dolomitic groundwater systems and the consequent acid mine drainage related to region-wide gold mine closure. Good groundwater systems understanding will have to feed into the much improved mining planning and authorization processes and mitigation measures will need to be in place before hydraulic fracturing for shale gas development proceeds in South Africa.

The capacity gap for groundwater resource assessment that has developed in South Africa (and in many other countries) has been well illustrated by Davies et al. (2015). Their figure of how hydrogeological experience has changed over the last 40 years (**Figure 7-5**).

The key conclusion of Davies et al. (2015) based on experience in many different regions, also needs serious consideration in this strategy.

“We need to return to basics and not rely on digital models founded on inadequate data of uncertain pedigree, and get out into the field to carry on the trade of sensible, pragmatic hydrogeology that provides sustainable outcomes for the benefit of the people.”

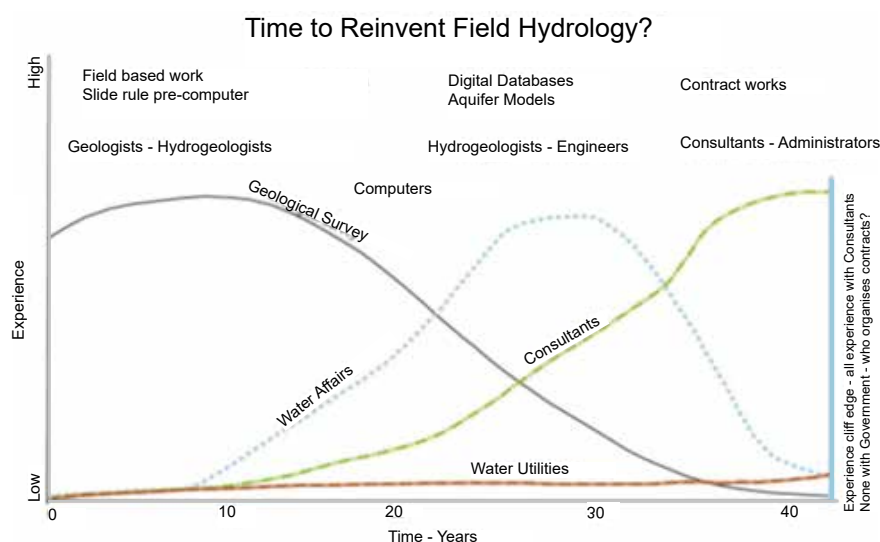
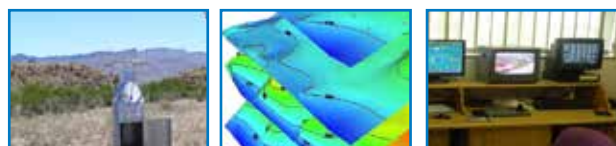


Figure 7-5: How the distribution of hydrogeological experience has changed during the last 40 years. (Davies et al., 2015)



CURRENT CHALLENGES

Key challenges for groundwater information management experienced in recent years include:

- ! There has been a continued undervaluation of groundwater resources at national, regional and local levels even under the National Water Act, 1998.
- ! The last systematic exploration of whole groundwater systems as part of national water resource planning (GRA I, GRA II and GRIP) has taken place some 20 years ago. No alternative arrangements for this type of regional exploration have been made since.
- ! The almost complete loss of groundwater technical capacity in national government is a major concern in the light of groundwater's increasing importance, but also increasing development and management challenges.
- ! Past regional and national assessments of groundwater resources have been largely based on data resulting from state drilling operations. Drilling services of DWS have, however, ceased for a number of years already, except for the Limpopo Region and small, under-resourced teams in the Western Cape and Northern Cape. Drilling by other state departments (i.e. Department of Health, Department of Agriculture and Provincial Departments of Education) takes place without the type of professional supervision that would ensure data quality.
- ! There has been limited national investment into groundwater monitoring compared to surface water. No national targets have been set for monitoring, resulting in a very uneven monitoring effort by different DWS Regions. Despite the long-standing national need of making available data from the many private consultants and private sector drillers to a national data base and sharing these in the national interest, very little has happened to date.
- ! Inaccessibility and decentralisation of 'private data' is a serious problem.
- ! Groundwater use information is still inadequate for management, because very little verification has been undertaken.
- ! Monitoring has not yet become the basis of improved aquifer management.
- ! Local municipalities, agriculture and the mining sector are not monitoring their groundwater use / impact / levels / quality.

- ! There has been virtually no evaluation of supply sustainability of the many municipal supply schemes from groundwater that have been developed in the last twenty years and even before. This could be a major source of information for any national/ regional groundwater resource assessment. This is also concerning because the lack of technical capacity of municipalities is well known. A few thoughts on the value of information in decision-making are provided in **Box M**.

Box M

The Value of Information

As fresh water resources are declining in quantity and deteriorating in quality, water resource management is of greater importance than ever before. Decision-making in water resource management is a difficult task that requires sound and reliable information about the water resource in terms of physical, hydrological and demographic characteristics. In the case of groundwater, its invisible nature adds uncertainties that complicate the decision-making process and add to the information challenge.

Information has become an issue in all fields of development and the value of information has become a much-studied scientific concept. Value of information or VOI is defined as:

"VOI is the amount a decision maker would be willing to pay for information prior to making a decision."

Studies in many different sectors have shown:

- Good Information Reduces Costs
- Information Saves Time
- Information Improves Decision Making
- Information Yields Customer Satisfaction

As more investments in high-tech information technology like satellite remote-sensing are contemplated, indications are that the expected impact of investing in these is positive, but that outcomes strongly depend on the accuracy of the information system and the range of informational benefits perceived. However, more data do not necessarily mean more information and not necessarily better decision-making. In the case of wide-spread groundwater systems, Vivier and van der Walt (2011) suggest that data-gathering programmes should be planned to be iterative to allow for assessment of information sufficiency as decisions are beginning to be made. They also suggest that groundwater specialists should be trained in basic decision-making principles and processes.

With new institutions and devolved management of shared groundwater resources, accessible and appropriate information becomes extremely important to aid good interaction of local institutions and shared decision-making. Staged devolution, capacity-building and national support are critical ingredients for this type of management arrangement.

STRATEGIC ACTIONS

APPROPRIATE GROUNDWATER KNOWLEDGE BASE

A Groundwater Research & Development Plan must be established that includes the following:

- Overall required groundwater strategic knowledge base.
- Available national groundwater knowledge capacity and propose cooperative ways of addressing the overall needs.
- Include stakeholders in such an assessment to achieve greater understanding and a greater drive towards cooperation and buy-in.
- The role of international cooperation to grow the groundwater resource knowledge base.

NATIONAL GROUNDWATER CHAMPION

A multi-directional flow of appropriate data and information is key to a stakeholder-driven, sustainable utilisation of groundwater resources. The National Champion's ongoing directing and coordinating role in this regard will be central to achieving the information objectives. The Champion role is further addressed under strategy Theme 2.

GROUNDWATER DATA AND INFORMATION

Address the vital issue of groundwater data and information management strategically, as foundation for improved management and cooperation of stakeholders. Focal points include:

- An assessment of current information needs such as, inter alia, Acid Mine Drainage (AMD), fracking and gas from coal.
- Identify sources of existing data, information and major gaps.
- A more detailed level of information products is required, in particular groundwater vulnerability and risk maps at catchment and aquifer level in mining areas, industrial areas and areas of high vulnerability.
- Review the current standards for groundwater data collection and management, with emphasis on appropriateness and value for money i.e. the existing NORAD Toolkit that includes the Standard Descriptors for Geosites (SDG), Operator's Manual, etc. (See **Box N**)
- Achievement of a major increase in data accessibility with the consideration of a legal requirement within Departmental tender clauses and for private companies and organisations to capture their data on the NGA.
- Pay special attention to interlinking surface water databases with the groundwater databases. This would support the vision of conjunctive use and would make it easier for stakeholders to see the two in connection.
- Establish a data culture nationally. While this must be the responsibility of a National Groundwater Champion, a facility like the former Computing Centre for Water Research could be considered for this purpose.

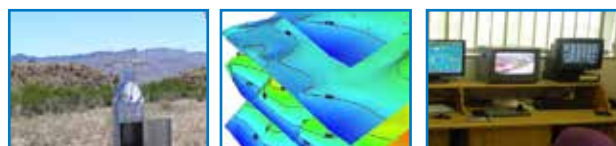
Box N

Norwegian Agency for Development Co-operation (NORAD)
<http://www.dwa.gov.za/Groundwater/NORADtoolkit.aspx>

The NORAD-assisted programme for the sustainable development of groundwater sources under the Community Water and Sanitation Programme in South Africa (DWAF, 2004 b) undertook a series of inter-related projects aimed at enhancing capacity of water services authorities and DWAF to promote and implement sustainable rural water supply schemes based on groundwater resources and appropriate technologies. The Geological Survey of Norway, as partner, brought with it skills in groundwater, used all over Africa for NORAD- funded programmes.

The NORAD Toolkit includes, inter alia, the following pertinent guidelines and manuals:

- Standard Descriptors for Geosites (SDG),
- Implementing a rural groundwater management system: a step-by-step guide,
- Involving community members in a hydrocensus,
- Guidelines for protecting boreholes and wells,
- Decision making framework for municipalities,
- Groundwater monitoring for pump operators,
- Etc.



STRATEGIC ACTIONS CONT.

GROUNDWATER MONITORING STRATEGY

- Develop a comprehensive groundwater monitoring strategy (quantity, quality, use, supporting measurements like rainfall, isotopes and chlorides), based on proper valuation of the resource, its various roles and its functioning in the different sectors and at different governance levels, with provision for monitoring guidance and auditing.
- The groundwater monitoring strategy should be integrated with surface water monitoring and coordinated with the monitoring of ecosystems, including aquifer dependent ecosystems like swamps, wetlands etc.
- Monitoring is needed for different purposes which must be clearly specified and addressed, e.g. water use authorization, resource protection and planning.
- The strategy needs to address the lack of systematic groundwater resources and abstraction monitoring in large parts of the country and to achieve a more integrated monitoring system with that of surface water.
- The strategy should address the monitoring responsibilities of all sectors, in particular where domestic water supply is involved.
- Undertake this development as a WRC project with full stakeholder involvement. Link with the important DWS project presently underway to review and plan all monitoring together with key partners like the WRC and the South African Environmental Observation Network (SAEON).

GROUNDWATER USE INFORMATION

- Verify water use from groundwater according to the General Authorisations and/or licensing conditions.
- Implement programmes to enforce compliance with respect to water use license conditions.
- Enforce non-compliance with respect to water use license conditions.
- Prioritise major and stressed aquifers.
- Implement legal regulations regarding capturing of information on the NGA.

CENTRALIZED “PRIVATE” DATA

Many reports are produced country-wide without the collected data ending up on the Departmental information systems. Due to the fact that this information is not available for general use, the following corrective measures must be applied:

- Develop legal regulations stating conditions regarding the need to centralise “private” data (held e.g. by municipalities, private consultants and drillers) as a cost-effective and rapid way of ensuring data availability on the Departmental information systems.
- Develop these legal regulations in consultation with the groundwater industry, addressing both historic information and information from all future investigations.
- For example, the WSDP approach by which municipalities are obliged to provide plans and specific data to DWS Water Services, should also be utilized for groundwater data and information. Coordination between the two information systems is required to introduce the specific data sets that groundwater management requires.
- The general approach will be an on-line system of data capture by the different sectors, rather than providing data to a national office.

RELATED DATA FROM OTHER INSTITUTIONS

- Engage and support relevant authorities to improve hydrological and environmental monitoring programmes necessary for groundwater management, such as the rainfall monitoring systems maintained by the South African Weather Service, the Department of Agriculture and the integrated information system to record and report on the status of active and abandoned mines maintained by the Department of Mineral Resources.
- Groundwater data from mining and other private sectors should be a public domain.
- An integrated approach should be followed in acquiring groundwater and surface water information to maintain the integrated nature of the resource and to ease the administrative burden.

STRATEGIC ACTIONS CONT.

HARMONISATION OF DATA BASES / INFORMATION SYSTEMS

The present situation is a variety of public and private data bases with different accessibility, whereas the vision is interlinked databases with open access. This is a challenge globally:

- Improve aspects of accessibility and exchange of data, standardization of data capturing formats for various purposes, reporting of data and information, etc.
- Include provisions /clauses in all Departmental tenders and contracts specifying that all data collected as part of the project be captured on the Department information systems, in a standard format linked to, for example, the NGA.
- Initially, harmonisation between the NGA (groundwater-related data) and the WARMS (groundwater use data) will be critical, whereas the ultimate will be harmonisation with surface water data.

NEW PHASE OF GROUNDWATER RESOURCE ASSESSMENT

A new phase of groundwater resource assessment needs to be urgently initiated which focuses on local level resource management and protection. Its design can be shaped as a support to the groundwater development framework set out in Appendix 2, in particular the pre-feasibility, feasibility and options analysis stages.

Objectives would include country-wide protection zoning of groundwater sources for domestic supply, joint management of vulnerable and stressed aquifers and a new drive to achieve bulk water supply options from groundwater (including widespread small-scale solutions).

The approach could be modelled on the Danish national programme of groundwater mapping which extended over a 10-15 year period. It would entail systematic use of the best available data and information, including the 1: 50 000 geology sheets of the Council for Geoscience. This information could be grounded and enhanced through aerial geophysics in priority areas.

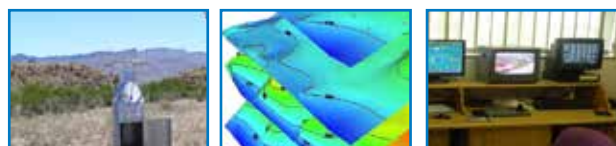
INTEGRATED INFORMATION SERVICE

- Define standard information products based on the best available data from the Departmental information systems (e.g. equipment asset register reports, water resources status reports, pre-defined purpose-made maps, etc.) (See National State of Water Resources Reporting).
- Work towards a GIS supported information service, e.g. by providing web services that can be used for development of individual solutions for different purposes.
- Provide an integrated groundwater information service at municipal and aquifer management level.
- Promote the use of existing Departmental groundwater information systems and tools by different institutions.
- Achieve a streamlined flow of data and appropriate processes/systems to manage it through analysing the expected flow of data and information from and to different stakeholders and levels in the water management hierarchy.

KNOWLEDGE SHARING

Make groundwater knowledge management an on-going contribution from the groundwater science sector to the long-term process of developing increasing stakeholder involvement towards good groundwater governance.

- Achieve ever wider sharing, archiving and effective communication of information and knowledge products.
- Share information, knowledge and experience across and far beyond national boundaries to achieve benefits from understanding global and regional patterns and processes and recognize potentials, problems and trends related to groundwater. This links strongly to national government's international obligations.
- The WRC should remain the lead organization in this regard.

**Box O****Departmental Groundwater Website**

<http://www.dwa.gov.za/groundwater/>

The website is the window on all the sections in the Department that are involved in groundwater. Some of what the visitor can expect includes the latest news, forms, data, maps, documents, reports, a glossary, products, links, contacts and lots more.

STRATEGIC ACTIONS CONT.

PUBLICITY OF GROUNDWATER INFORMATION

A vast amount of groundwater information is available and needs to be appropriately promoted for universal use.

- The brochures accompanying the 21 general hydrogeological maps of the country are particularly useful in this regard. The outstanding ten brochures need to be developed without delay. The brochures should also be made available electronically. A limited effort here could provide major resource for raising the regional understanding of groundwater resources.
- Foster widespread promotion and use of the information system amongst the hydrogeological community, so that hydrogeological data and information exchange can be more readily achieved. The Departmental Groundwater website serves as a starting point to achieve this goal (See **Box O**).

GROUNDWATER USE AND INFRASTRUCTURE INFORMATION

In order to stop the wastage of groundwater infrastructure:

- Implement a groundwater equipment asset register.
- Gather and capture groundwater data on existing infrastructure, to enable its inclusion in water supply schemes by means of initiating and/or extending the GRIP programme in all relevant regions.

MONITORING AS PART OF AQUIFER MANAGEMENT

- Establish aquifer monitoring and modelling as an integral part of aquifer management by all sectors.
- Achieve this through the responsible CMAs and the licensing process. Implement this as part of an information management process for all catchments, facilitated by the national groundwater champion.

NATIONAL STATE OF WATER RESOURCES REPORTING

Information systems should be geared for regular, integrated and streamlined national and regional state of water resources reporting. Such reports should at least address key questions such as (example of the Australian Water Resources 2005 – a Baseline of Water Resources):

- What is the size of South Africa's total water resource and its distribution?
- How much of South Africa's water resource was used by different economic sectors and the environment?
- How is the state of South Africa's resources changing (water levels and quality)?
- Where are South Africa's stressed rivers, catchments and aquifers?

This should, in future, be discussed in terms of set Resource Classes and Resource Quality Objectives and should indicate remedial measures where necessary.

Publishing geographical data can highlight areas with few or no data, as well as poor quality data and thereby be used to exhibit inadequate data collection from specific regions or stakeholders.

Using the Blue Drop and WSDP systems, could provide an indication (bird's eye view) of, not only the state of water resources, but the state of management of groundwater by municipalities.

REGIONAL AND INTERNATIONAL PARTNERSHIPS

THEME 11



SITUATION ASSESSMENT



Objectives

Actively participate in and grow appropriate regional and international partnerships towards groundwater resource understanding and optimal utilization, including transboundary resource management.

Principles

Sharing knowledge and experience across boundaries has the potential to accelerate our learning processes significantly. It improves efficiency, stimulates development and reduces the probability of making wrong decisions.

Sharing Knowledge

Groundwater has been the Cinderella of water resources in many parts across the globe. A lot has been learned from each other's failures and breakthroughs, technical, social and managerial. Besides area-specific information, e.g. about the dolomitic groundwater systems in China or Zambia, there are various international institutions and programmes of crucial importance for enhancing and disseminating knowledge on groundwater around the world. South Africa has benefitted tremendously from its groundwater international cooperation, in particular taking it from its 'private water' role to that of a significant player in Integrated Water Resource Management. Equally, South Africa has a lot to give in terms of Africa-relevant and well-documented groundwater research.

Our Neighbours and Transboundary Institutions

Formal regional cooperation in the SADC Water Sector was established in 2000 through a protocol, the Revised Protocol on Shared Watercourses in the Southern Africa Development Community. Of its 15 major river basins which are shared by two or more nations, 11 have by now some form of institutional framework for shared management, e.g. ORASECOM and LIMCOM.

The Water Sector of the SADC has developed a 'Groundwater Management Programme for the SADC Region'. The Programme is part of the Regional Strategic Action Plan for Integrated Water Resources Development and Management, undertaken with the support of many cooperating partners. The Programme, far from being a substitute to the responsibilities of individual member States, is rather a support and incentive mechanism to increase the efficiency of national programmes, with due consideration of transboundary issues. As part of this programme, a SADC Groundwater Institute has been established and the University of the Free State was contracted to host the regional facility.



Through the UNESCO-ISARM programme, in support of the SADC Groundwater Management Programme, transboundary aquifers were identified in the region. The Southern Africa Hydrogeological Map and Atlas project further expanded on this work (SADC, 2010). The most recent map of transboundary aquifers in Africa, shown in Figure 7.6, was developed by IGRAC (IGRAC, 2015). Detail on the individual transboundary aquifers is available on IGRAC's Global Groundwater Information System (GGIS) online: <http://tbamap.un-igrac.org/>

The Continent

A major opportunity has arisen to take continent-wide action through a resolution by the African Ministers Council on Water (AMCOW) taken in 2007 at its 6th Ordinary Session in Brazzaville, namely that AMCOW would become the custodian of a continent-wide strategic groundwater initiative. Its vision is expressed in a roadmap for an African Groundwater Commission which is to function under the umbrella of AMCOW to facilitate and direct regional, national, and international action on a number of fronts (AMCOW, 2008).

Global Partners

UNESCO's International Hydrological Programme (IHP) has a strong and on-going groundwater component. African countries are, however, not yet organized in the same way as, for example, Latin America, to receive the full benefit of participating in the IHP programmes. The most visible and continent-wide programme is the UNESCO-IHP ISARM initiative (Internationally Shared Aquifer Resources Management) initiative. It is presently in a stage of identifying transboundary aquifer systems (TBAs) in Africa which will be followed by monitoring of these systems in a globally supported Global Environmental Facility (GEF) programme as well as by selected case studies of joint Trans-Boundary Aquifer (TBA) management.

UNESCO's groundwater work is facilitating through the establishment of chairs and centres, in particular the UNESCO Chair in Groundwater at the University of the Western Cape and the recently established UNESCO Category II Groundwater Centre in Kenya. The excellent IHP groundwater publications cover virtually every aspect of groundwater and development and are available free of charge.

The Global Environmental Facility (GEF) was created to support the sustainable development and management of large common-property environmental systems. Their approach to key stakeholder involvement, to co-funding and of a systematic diagnostic analysis of the threatened environmental system, followed by a strategic action plan to address the issues, often has a high sub-regional impact. To date the region has had GEF support for the SADC Groundwater and Drought Programme and for the Illumedden Transboundary Aquifer Programme.

Significant contributions are also made by several other actors, among others the UN Food and Agriculture Organization (FAO), the International Atomic Energy Agency (IAEA), the World Meteorological Organization (WMO), the International Water Management Institute (IWMI) and the World Bank. The Bank has played a significant groundwater advocacy and support role, to a large extent enabled by its GW-MATE programme (Groundwater Management Advisory Team) of producing practical summary publications by international experts of every aspect of groundwater resources management and of case studies around the world.

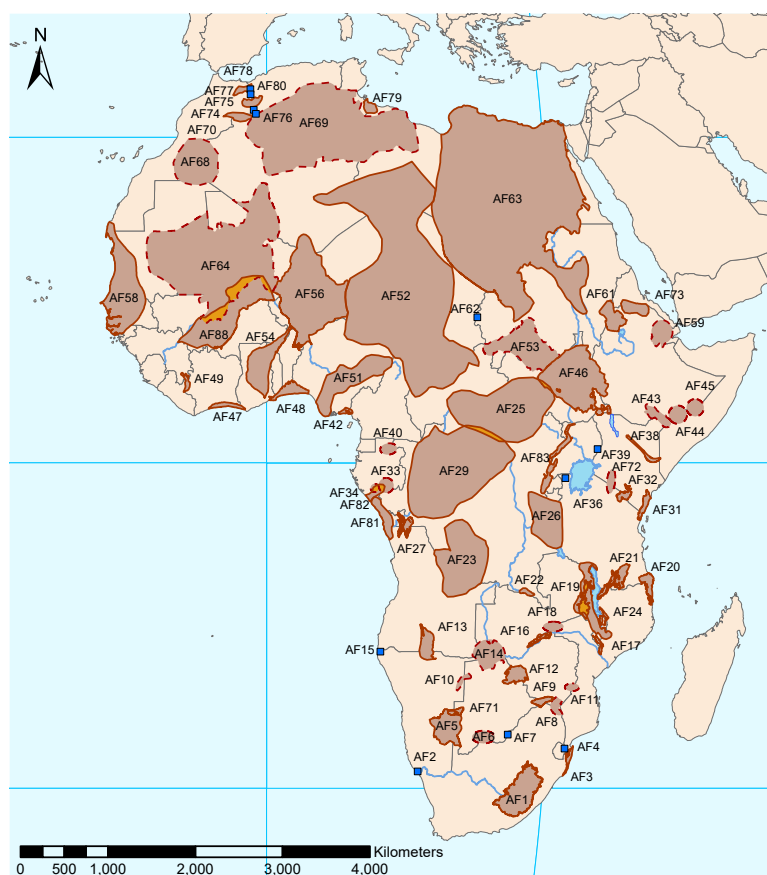


Figure 7-6: Transboundary Aquifers of Africa (IGRAC, 2015)

Professional Associations

The International Association of Hydrogeologists (IAH) is a world-wide professional association and has individual membership throughout Africa and many African countries have a formal national committee of the IAH. The IAH is a formal partner in the UNESCO-IHP groundwater programme.

Networks

Networks, supported by international funding, play a crucial role in capacity building in the region. WaterNet is a regional network of university departments and research and training institutes specialising in water. The network aims to build regional institutional and human capacity in Integrated Water Resources Management (IWRM) through training, education, research and outreach by harnessing the complementary strengths of member institutions in the region and elsewhere. It arranges many short courses, produces region-relevant publications and runs an annual water conference. WaterNet has recently become integrated into the institutional structure of the SADC Water Sector.

Cap-Net UNDP is an international network for capacity development in sustainable water management. It is made up of a partnership of autonomous international, regional and national institutions and networks committed to capacity development in the water sector. The recently established Africa Groundwater Network (AGW-Net), in collaboration with CAP-Net and others, has produced excellent groundwater training material and runs regular courses. It was established to increase awareness of the potential and value of groundwater across the continent and to contribute to capacity building in the groundwater sector in Africa.

Academic Institutions

Most national universities have a Department of Geology with a groundwater component. The challenge is that these institutions and their groundwater part usually have very limited staff and capacity. A number of these institutions play a sub-region / region-wide role, e.g. the UNESCO Chair in Groundwater at the University of the Western Cape and the SADC Groundwater Management Institute, hosted at the University of the Free State in South Africa.

A promising development is the establishment of NEPAD Centres of Excellence to allow Higher Education and Research institutions in a region to cooperate across national and discipline boundaries and focus their science on the development of the region. This is the result of the emphasis which Africa's Science and Technology Consolidate Plan

of Action (CPA) had put in 2003 on developing an African system of or network for scientific research and technological innovation to address challenges of securing and sustaining water. This became one of the main flagship programmes of the New Partnership for Africa's Development (NEPAD). The first of these in the water field, the Southern Africa NEPAD Water Centres of Excellence, has by now nine countries as members and is already undertaking a major project for the African Union. A Western Africa Centres of Excellence is presently becoming operational. This presents a major opportunity for groundwater cooperation across country and institutional boundaries.

An excellent way of strengthening the capacity of local institutions is that of twinning with well-established international groundwater role players. Groundwater management in Uganda, for example, has benefitted tremendously from a long-standing cooperation with the University College of London.

National Policy

In terms of the NWRS2, the DWS is committed to engage with international partners bilaterally and through multilateral forums. Through international engagements the South African water sector shares valuable lessons and learns from international best practices to improve service delivery and aspects of the whole water value chain.

South Africa is a signatory to the Revised Protocol on Shared Water Courses in the SADC; it thus has an obligation to fulfil its commitments through cooperation with its neighbours in the management of international waters in the interest of regional economic integration, peace and security. South Africa shares four major rivers systems with six neighbouring countries.

Water Research Commission

Since its inception, more than 40 years ago, the WRC has been striving to fulfil its mandate of serving the water sector, including promoting co-ordination, co-operation and communication in the area of water research and development. In this period South Africa has become a world leader in water and sanitation technology and its groundwater capacity is on par with the best in the world. The WRC recognizes South Africa to be part of the global village, a village of shared natural phenomena like global warming and the present El Niño cycle, shared human conditions of increasing poverty and inequality, as well as the international responses in terms of policy and innovation. The WRC already has collaboration agreements with a number of leading international water



research institutions. Regional and global cooperation is part of its Roadmap (WRC, 2015) and a revision of the Water Research Act, 1971 is presently underway, which will, inter alia, address ways to facilitate international collaboration.

One suggested role of national coordination would be the creation of a database of all groundwater work done in South Africa (public, private and universities) and liaise in this regard internationally (IAH, UNESCO, etc.).

CURRENT CHALLENGES

Before 1994, South Africa had been in international isolation, because of Apartheid. The water sector has not yet fully responded to the opportunities offered by international collaboration.

STRATEGIC ACTIONS

SADC AND AFRICA

Besides the regional facilities, i.e. the SADC Groundwater Management Institute hosted by the University of the Free State and the NEPAD Southern Africa Water Center of Excellence hosted by the University of Stellenbosch, the UNESCO Chair in Groundwater at the University of the Western Cape is an important regional groundwater player.

- South Africa should become an active and leading player in the SADC Groundwater Programme and become a champion of the African Groundwater Commission in the roll-out of AMCOW's Africa Groundwater Initiative.
- The Department should use the opportunity of bilateral and multi-lateral talks to put groundwater on the various regional development agendas.

BASIN COMMISSIONS

Groundwater is forming an integral part of the transboundary basins' resources.

- Basin Commissions like ORASECOM and LIMCOM should take groundwater fully on board and need to develop a groundwater management plan for each of these basins. This is illustrated by ORASECOM's most recent proposed strategic actions: "Incorporate groundwater resources into the overall planning model starting with transboundary aquifers and

(potential) conjunctive use aquifers." (ORASECOM, 2014).

UNESCO INTERNATIONAL HYDROLOGICAL PROGRAMME

South Africa should become an active participant in UNESCO's International Hydrological Programme. Because this is an inter-governmental programme, national leadership from DWS is essential. Once South Africa's role in this programme is established, it could also play an important lead role for groundwater in Africa.

INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS (IAH)

Ways should be urgently sought for widespread membership of South African groundwater professionals in the IAH. Because of the substantial costs involved, a deal should be sought by the Groundwater Division, on the one hand with the main employers of these professionals in South Africa and on the other with the IAH.

GROUND WATER DIVISION

The Ground Water Division of the Geological Society should become a sector leader to help take many of the coordination efforts into the groundwater sector. Its potential lead role in South African Groundwater Trust is raised under Theme 1.

SUSTAINABLE DEVELOPMENT GOALS (SDGS)

The UN Sustainable Development Goals 2015 for the first time introduced a separate goal on water and sanitation. African countries, including South Africa, take international development goals very seriously and measure and compare their progress in terms of these. Most of the specific targets, e.g. access to drinking water; sustainability of water resources; disaster risk management and climate resilience, adaptation and mitigation, cannot be achieved without the development and proper management of groundwater resources.

- It is strongly recommended to develop groundwater targets for the implementation of the National Groundwater Strategy, which can be directly related to the respective Target Areas of Goal 6 of the SDG.
- The value of such a development would be considerably enhanced if it is carried out jointly with countries in the region.

LOCAL ACTION

THEME 12



Objectives

Manage and maintain actions on all strategy fronts in a concerted effort from government at different levels, from municipalities and utilities, the private sector, civil society, educational institutes, media and professional associations to achieve the essential local level actions for sustainably managing shared groundwater resources.

Principles

The unique, widely distributed groundwater resource, with its open access to a large number of users and a wide range of impacts, requires local level management of the shared groundwater resources within an appropriate enabling and supporting environment.

SITUATION ASSESSMENT

Very little groundwater local action has happened in South Africa to date. Key reasons for this are the slow establishment of catchment management agencies, the lack of national regulation in this regard and lack of sustained support for the establishment and capacitating of appropriate local management institutions. Coordinated action on a number of national fronts will be required in order to achieve systematic implementation of sustainable local level groundwater management. Functioning local institutions will be the ultimate test for good groundwater governance in South Africa.

STRATEGIC ACTIONS

ROLL-OUT OF LOCAL ACTION

A key comment during the provincial consultations was that the strategy framework to achieve local actions appears very top-down. We realized that this was South Africa's legacy of national water resource development and management implementation, with virtually no local action for groundwater at this moment. To achieve a better illustration of a future situation of 'national facilitation of local actions', the original framework diagram was turned horizontally to indicate the need for growing local actions under each of the strategy themes 3-11. **Over time, the local action level will fully unfold and will mirror every strategy theme presently required at the national / regional facilitation level and will convert strategies into actions. This is illustrated in the Strategy Framework on Page 32.**

Because of the lack of local experience at this level, the experience gained in the Global Groundwater Governance initiative has been consulted widely for possible strategic actions at this level (UNESCO et al., 2015).



STRATEGIC ACTIONS CONT.

CATCHMENT MANAGEMENT AGENCIES

CMAAs are the first line of IWRM roll-out in South Africa and need to play this role for groundwater too.

- As a trigger for all local action, each CMA, as highest priority, needs to develop a groundwater management plan for its catchment with the full involvement of the relevant stakeholders.
- These plans need to include the water needs of the catchment in terms of rural, urban, agricultural, mining as well as environmental water needs. These should be addressed in terms of the groundwater resources of the catchment in terms of their potential, accessibility and vulnerability.
- Specific actions covering the strategic themes in the figure above need to be the heart of the plan.

AQUIFER MANAGEMENT

Aquifers are the resource unit for local action.

- Aquifer management needs to be introduced on a priority basis, starting with the most vulnerable and most stressed systems as well as systems for domestic water supply.
- Users of a shared aquifer resource have to organize themselves to implement aquifer management, including grass roots awareness-raising, detailed planning, implementation of regulations, demand/supply-side measures, resource / source protection, and groundwater use/ resource monitoring.
- This may require geohydrological professional support in terms of resource assessment and specialized aquifer monitoring and modelling.

ACTION BY MUNICIPALITIES

Local government is responsible for a sustainable water service provision, including from local groundwater resources. As such municipalities are responsible for the operation and maintenance of groundwater infrastructure and the conservation and protection of their groundwater sources.

- As groundwater is quintessentially a local resource, much of the effort to apply the governance framework and ensure management in line with policy goals rests with local government bodies and decentralized agencies in close cooperation with local stakeholders.

- It is thus essential that municipalities fully participate and take a lead in the management of shared aquifer resources.
- Local governments are uniquely positioned to foster integration between land management and groundwater management and protection.
- As such they should support integration of land use planning and groundwater management – to protect groundwater source protection and recharge zones, but also to develop healthy and productive landscapes by managing groundwater recharge at scale.
- Increasingly, other uses of the sub-surface space risk interfering with aquifers, and municipalities need to monitor and manage this. They are well positioned to help achieve an integrated management of the sub-surface zone.

It will be critical to change perceptions about groundwater in the whole municipal sector.

- This must be achieved through working closely with SALGA.
- Buy-in in individual municipalities should be achieved through the training and empowering of the respective councillors.
- Municipalities should be encouraged to make much more use of local NGOs in order to empower grassroots people (e.g. adopt a borehole approach).
- There should be an early thrust to establish best practice in municipalities that are taking a groundwater lead and to use these as demonstration for whole sector.

ACTION FROM PRIVATE SECTOR PLAYERS

The private sector is a main user, not least the myriad private owners of agricultural wells, and hence has an obligation to take joint responsibility for the groundwater resource in its sphere of influence.

Almost everywhere, agriculture is the primary user of groundwater, and this is in the hands of both private small farmers and large agricultural corporations.

Small farmers have to be brought into the governance framework through participatory institutional approaches. This is challenging, in particular because they fell outside any regulatory or monitoring under the previous water legislation.

- As stakeholders they will now have to work in

STRATEGIC ACTIONS CONT.

partnership with government and with each other to develop and operationalize institutional measures for self-regulation and local collective management.

Larger agricultural ventures can be formal partners of government in good practice sustainable management.

- Sustainable use of groundwater and control of pollution can be part of an agreed long-term business model, requiring the business to invest in the protection and efficient and sustainable use of the groundwater collective asset.
- One possibility would be to include sustainable, non-polluting groundwater use in the current thrust towards certification and labelling of sustainable practices.

Industries are major users of water and have considerable know-how to use water more sustainably.

- They can be called on to conserve groundwater and protect quality.
- There is a trend in some industries to reuse process water and hence save on costs and pollution loads and to contribute to groundwater resource conservation.
- There is an important function of government agencies here to regulate and allocate water to high yielding clean industries.

Mining companies, including the oil and gas sector, compose a special stakeholder group in groundwater governance. A major attempt should be made to make the sector a partner and the good offices of the Chamber of Mines should be sought in this regard. The sector has geo capacity and information and is very aware that it needs groundwater solutions. Mines also have an interest in the communities around them, their basic services and their food security – an opportunity for local partnerships.

- As mining companies share the same subsurface space as groundwater users, they are called upon to share data and be responsible users in terms of pollution, safety and geological disturbance.
- They should, as far as possible, take a long-term lifecycle view of their operations, for example by leaving mining sites in as good a condition as they found them.

ACTION FROM UTILITIES

Utilities represent a professional water corps at local level.

- There is usually scope for utilities – water suppliers, irrigation service providers, energy companies – to work within groundwater management plans on conservation and resource protection.
- Action is required from local utilities to secure their groundwater sources and to control leakage and discharge of untreated waste water.
- Energy utilities are encouraged to liaise closely with groundwater managers, for example to achieve water conservation goals through energy pricing.

ACTION BY MEDIA AND CIVIL SOCIETY

Media have a unique communication role in society and their combined network is wider than water sector communication could ever reach.

- Media – both traditional and new – could provide more in-depth coverage, making the case for the need to govern and manage groundwater.
- This coverage could create broad and factual understanding and highlight current risks and future potential, in order to create broad awareness and better understanding.
- Wider public discussion could trigger citizen initiatives, increase political support and strengthen the motivation of those directly involved to act on the issues.
- The current highly networked world and the ability to report fast and visually, provides the opportunity to both ‘name and shame’ offenders as well ‘raise and praise’ change-makers and champions.

Civil society is also called upon to contribute to wider awareness of groundwater challenges and opportunities and of the need for more effective governance. Awareness activities should cast the net wide, so that many champions are encouraged.

- Beyond this, civil society could undertake initiatives to contribute to better groundwater governance – linking stakeholders, promoting new approaches and developing local visions.
- Civil society can also act as a watchdog on inappropriate policies and report on gross violations of water use, pollution and the destruction of groundwater-dependent ecosystems.



Achieving the listed deliverables would be a major step forward in implementing the NGS and, most importantly, implementing the National Water Resources Strategy.

The achievement is completely dependent on a new way forward of a stakeholder-driven process led by the Department of Water and Sanitation.

STRATEGY IMPLEMENTATION

After the consultation in all nine provinces and with all economic sectors, there are high expectations among stakeholders in terms of immediate roll-out of the NGS. This can be indicated from the following comments:

- Stakeholder communication and feedback will be essential in order to maintain interest and participation.
- NGS should address how the groundwater strategy implementation should be enforced.
- NGS should start with local level implementation, with attention to the critical path to achieve these.

A bottom-line requirement for the way forward can be summarised as follows:

The way forward will have to be tackled strategically together with stakeholders, with a strong national groundwater champion role coming from the Department of Water and Sanitation and the water science leadership role from the Water Research Commission. Jointly these two should harness stakeholder capacity in the both government and private sectors in order to facilitate local action and build capacity in new local level groundwater management institutions through sector implementation. A national stakeholder core group will be essential in order to guide and move a long-term process forward.

An essential approach for each sector will be to be guided and enabled within the sector by the sector umbrella organisation, ie. SALGA in the case of local government, Agri SA and the Chamber of Mines in the case of the agricultural and mining sectors respectively. To implement groundwater as part of IWRM, the first line relationship will have to be with the respective Catchment Management Agencies. Entry to the local level could be facilitated through the umbrella body of water user associations.

This approach should be taken into each sector by hanging groundwater aspects onto various existing structures and processes within a sector. Examples of this would be groundwater introduced into sector guidelines and best practice, groundwater introduced into sector plans like Water Services Development Plans and Catchment Management Strategies and groundwater introduced into high level sector policies like the municipal Standard Chart of Accounts.

To be able to talk groundwater with each sector, it will be important to jointly prepare a list of all the bulk groundwater schemes for each sector, both urban and rural. From here, the Groundwater Development and Management Framework, developed through the WRC (Riemann et al, 2011), should be filled in to spell out actions required from different stakeholders at each level of groundwater development and management.

In this stakeholder-driven implementation, two principles of the National Water Act, 1998, which have not been addressed as strongly as environmental sustainability, come into play, namely equity and efficiency. It can be noted here that Denmark has a water sector act which has efficiency and capacity as its main focus.

In the intended science-driven roll-out of the NGS, South Africa's Water Research, Development, and Innovation (RDI) Roadmap: 2015-2025 will be a critical vehicle to take the strategy forward. It can fit under a number of Clusters / Priorities of the Roadmap, e.g. Alternative sources, Govern, plan and manage and Operational performance.

To be able to effectively contribute to the roll-out of the NGS, stakeholders are expecting that DWS will, as a foundation for cooperation, create order in terms of regulated groundwater use and practice.

Without taking away from the prioritised Strategic Action Plan that needs to be urgently developed with stakeholders, the following critical early actions are apparent from the Strategy as a whole and from the various Theme actions. This is captured in the roll-out tables:

	Key Deliverables in First Year of Roll-out	THEME
<input type="checkbox"/>	The national groundwater champion designated and developed	2
<input type="checkbox"/>	Stakeholder communication initiated with a website in this regard (linked to the Community of Practice - below)	1
<input type="checkbox"/>	The National Stakeholder Core Group established and functional	1
<input type="checkbox"/>	A Groundwater Governance Strategic Action Plan, indicating critical deliverables and respective stakeholder responsibilities, developed	1
<input type="checkbox"/>	A Groundwater Governance Community of Practice established as a long-term process for achieving a stakeholder-driven NGS roll-out initiated (potentially through a WRC programme)	1
<input type="checkbox"/>	A 'groundwater awareness-raising through stakeholders' strategy developed, including the media	1, 7, 12
<input type="checkbox"/>	Groundwater sector organisation in response to the participation requirements (Groundwater Division; Groundwater academic institutions) underway	1
<input type="checkbox"/>	Plans for groundwater source protection by municipalities in place (with WRC support)	4
<input type="checkbox"/>	A prototype groundwater management plan developed for one CMA (possibly as a WRC consultancy)	9
<input type="checkbox"/>	A strategy for a new, more detailed, phase of groundwater resource assessment in place	10

	Key Deliverables in 3 Years of Roll-out	THEME
<input type="checkbox"/>	A Groundwater Code of Practice (widely understood national policy) developed cooperatively	3, 4, 5
<input type="checkbox"/>	A groundwater management plan for each CMA developed (per example – above) as basis for overall roll-out to local level	9
<input type="checkbox"/>	Introduction of groundwater sustainable utilisation into various sector development plans as the basis for the roll-out of further sector actions.	9
<input type="checkbox"/>	Promotion of relevant available guidelines ongoing and commissioning of critical new ones underway	5
<input type="checkbox"/>	Groundwater use verification completed country-wide	3
<input type="checkbox"/>	A country-wide groundwater pollution assessment undertaken	4
<input type="checkbox"/>	A suite of groundwater regulations developed and publication initiated	3
<input type="checkbox"/>	The first local shared aquifer management institutions in place in all nine CMAs	6, 7
<input type="checkbox"/>	The new phase of regional / local groundwater resource assessment underway	10
<input type="checkbox"/>	A National Groundwater Information System in place, adapted and expanded with participation of stakeholders	10
<input type="checkbox"/>	A groundwater capacity building strategy developed and implementation underway	7
<input type="checkbox"/>	A groundwater education & training programme, initiated jointly by the groundwater academic and technical institutions, for stakeholders at all governance levels	7
<input type="checkbox"/>	Indicators of 'groundwater sustainable utilisation and good governance', linked to the Water & Sanitation SDGs, developed. (See Table 3-3 examples)	10, 11
<input type="checkbox"/>	District / Local Municipalities have started to appoint/contract hydrogeologists to manage water supplies from groundwater and shared aquifers.	5, 6, 12

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APPENDICES

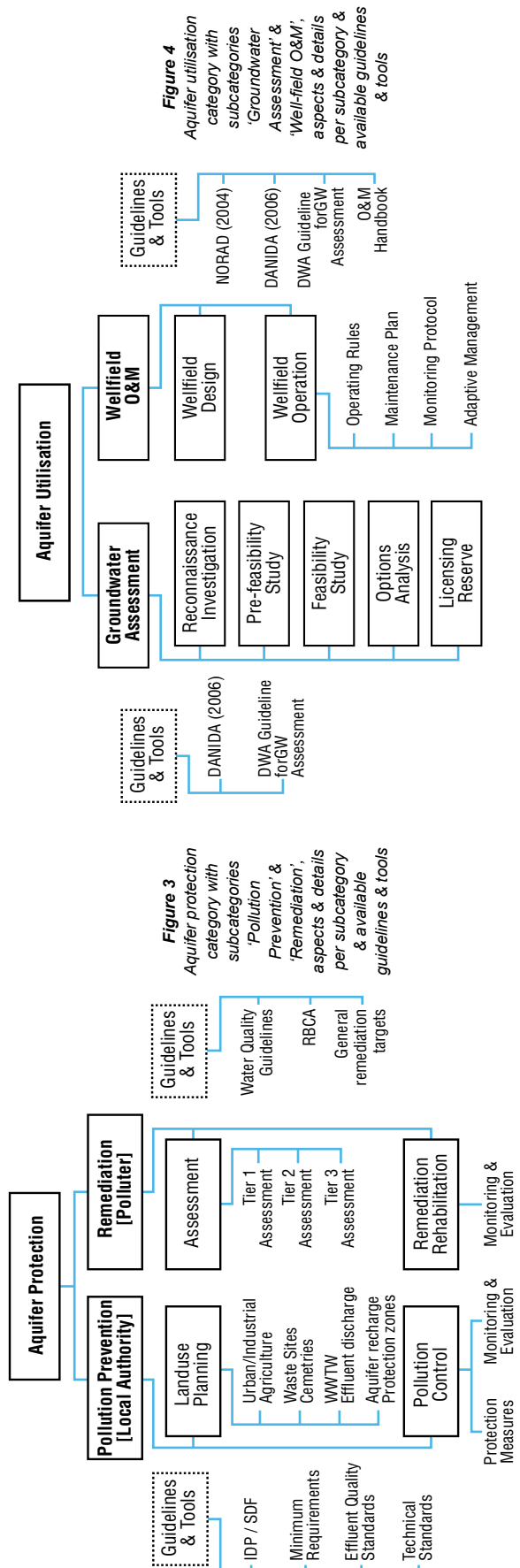
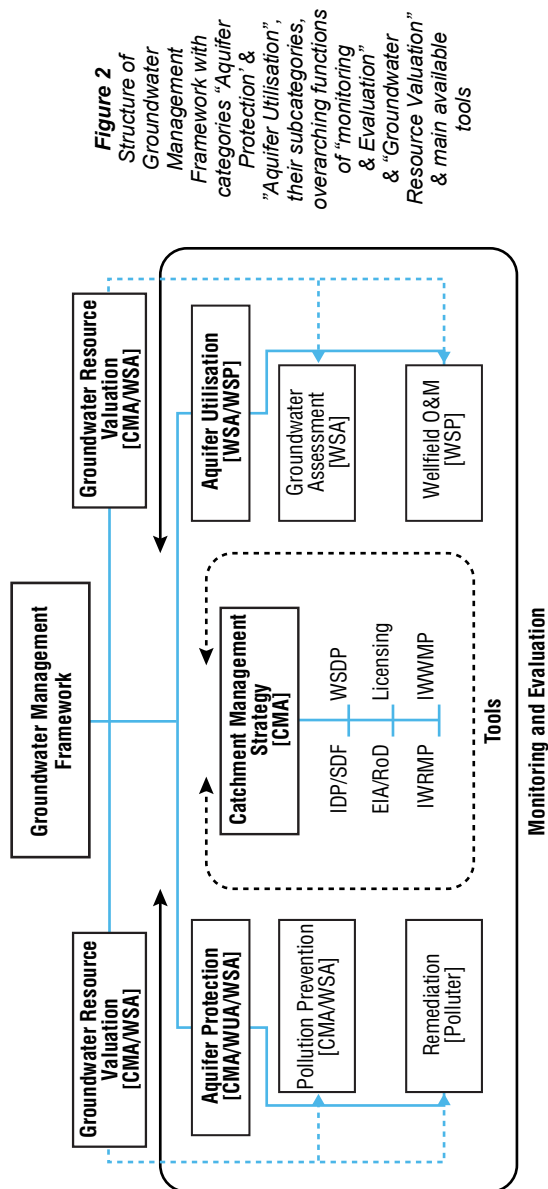
APPENDIX 1: NGS CONSIDERATIONS RELATED TO NATIONAL PLANNING COMMISSION'S VISION 2030

Outcomes	Objectives	NGS Considerations
ECONOMY AND EMPLOYMENT (Outcome 6)	An additional 11 million jobs; Increase the benefit to the country of our mineral resources by increasing water Infrastructure	<p>This needs to be read together with objectives 'Environmental Sustainability and Resilience' and 'Inclusive Rural Economy'. Groundwater was able to provide a basic domestic water supply to about 60% of communities throughout the country in some 15 000 villages. Although largely limited in yield, this resource could also play an important role in creating productive livelihoods for the poor in smallholder irrigation. Its natural storage can provide the resilience to bridge seasonal and even over-year shortages in water for irrigation.</p> <p>The WAR programme is expected to provide financial support to resource poor farmers.</p>
ECONOMIC INFRASTRUCTURE (Outcome 6)	Incorporate a greater share of gas in the energy mix, using shale gas	<p>This would represent by far the most widespread intervention and potential impact South Africa has experienced into the underground domain in which fresh groundwater resources occur.</p> <p>Based on the experience of other mining initiatives and their lasting environmental impacts, in particular, coal and gold, groundwater resource protection should be pro-actively developed and be central in any shale gas mining planning and implementation.</p>
	A comprehensive management strategy including an investment programme for water resource development, bulk water supply and wastewater management for major centres by 2012, with reviews every five years;	<p>Making 30-40% groundwater contribution possible in the supply diversification is one of the big tickets for groundwater development.</p> <p>This represents a development scale that groundwater resources in South Africa have never functioned at.</p> <p>An agreed groundwater planning and development framework needs to be developed as a matter of urgency, which illustrates, in a comparative way with surface water resources, the development steps, effort/cost and time frames required for groundwater resources.</p>
ENVIRONMENTAL SUSTAINABILITY AND RESILIENCE (Outcome 10)	A set of indicators for natural resources, accompanied by publication of annual reports on the health of identified resources to inform policy.	<p>Because of its largely local role and unseen nature, a wide range of impacts from human impacts on and beneath the land surface go undetected for long periods of time. Addressing the quality challenge (mining, sanitation, salinity) is one of the big issues of groundwater development.</p> <p>Groundwater requires a pro-active, preventative approach to resource protection. Implementation of the DWS 'Policy and Strategy for Groundwater Quality Management' of 2000 needs implementation without delay.</p>

Outcomes	Objectives	NGS Considerations
Continue.. ENVIRONMENTAL SUSTAINABILITY AND RESILIENCE (Outcome 10)	Improved disaster preparedness for extreme climate events	<p>Poor communities are particularly vulnerable to droughts and similar water-related disasters which destroy their assets and incomes. Groundwater, used conjunctively with other water resources, has a major role in providing drought resilience.</p> <p>To date, the response to droughts continues to be emergency drilling programmes. As a way of disaster preparedness, we should combine development and maintenance of water for productive use and water for basic domestic services for economies of scale and community interest in the infrastructure. Such investment would also enhance the resilience of people and the economy to climate change.</p> <p>See 'Economy and Employment'</p> <p>Achieving sustainability through optimal utilization of groundwater storage and recharge is another big challenge of groundwater development.</p>
INCLUSIVE RURAL ECONOMY (Outcome 7)	<p>Rural economies will be activated through improved infrastructure and service delivery, a review of land tenure, service to small and micro farmers (especially women);</p> <p>The transformation of the economy should involve the active participation and empowerment of women.</p>	<p>See 'Economy and Employment'</p> <p>Women have carried the traditional burden of domestic water supply and use in the household. They are often also the primary users of water for productive activities such as agriculture. In an increased use of groundwater for productive purposes, women need to play an important role in line with advancing women's equality and building on their experience.</p>
SOUTH AFRICA IN THE REGION AND THE WORLD	Strengthening regional cooperation in food and energy markets and water	<p>Groundwater's unique characteristics and development role present challenges of both neglect and resource degradation throughout the continent and globally. Given South Africa's past neglect of groundwater on the one hand, and the potential for major advances with implementation of the NGS and the excellent R&D support available in South Africa on the other, it is imperative that regional and global cooperation is sought (eg the SADC Water Division, AMCOW's Africa Groundwater Commission, the UNESCO International Hydrological Programme (IHP) and the International Association of Hydrogeological Science (IAH)).</p>
HEALTH CARE FOR ALL (Outcome 2)	Prevent and control epidemic burdens	<p>Due to the slow development of sanitation and the non-functioning of many water supplies, there is still a serious threat of water-borne diseases in rural areas in South Africa. Groundwater which is generally seen as safe drinking water is particularly at risk because of undetected pollution.</p> <p>Particularly strict standards are required where groundwater serves as domestic water supply.</p>

Outcomes	Objectives	NGS Considerations
HEALTH CARE FOR ALL (Outcome 2)	Prevent and control epidemic burdens	<p>Due to the slow development of sanitation and the non-functioning of many water supplies, there is still a serious threat of water-borne diseases in rural areas in South Africa. Groundwater which is generally seen as safe drinking water is particularly at risk because of undetected pollution.</p> <p>Particularly strict standards are required where groundwater serves as domestic water supply.</p>
BUILDING A CAPABLE AND DEVELOPMENTAL STATE (Outcome 9)	Relations between national, provincial and local government are improved through a more proactive approach to managing the intergovernmental system.	<p>Good governance for the very vulnerable, common pool, very widely distributed resource, groundwater, is particularly challenging. In South Africa the achievement of the MDGs is threatened, because of a failure in groundwater governance.</p> <p>It is generally recognized that the internationally accepted governance approach for groundwater of 'national facilitation of local actions' requires a strong national groundwater champion.</p> <p>The re-establish such a champion within DWS lies at the heart of the whole NGS.</p>
	Develop regional utilities to deliver some local government services on an agency basis where local or district municipalities lack capacity.	<p>The lack of capacity for providing water services from groundwater sources is particularly challenging for groundwater, because of the unseen and widely distributed nature of the resource.</p> <p>New regional institutions should immediately take groundwater resources on board and develop the necessary capacity to undertake this challenge.</p>

APPENDIX 2: GROUNDWATER GOVERNANCE AT LOCAL LEVEL (RIEMANN ET AL., 2011)



*The levels of responsibility and involvement of staff from the various relevant institutions at different levels for the different aspects of Aquifer Protection and Aquifer Utilisation are shown in the two Responsibility Matrices. The meaning of the labels is given below each table. The proper functioning of all responsibilities and information flows is essential for adaptive management which is foundational for groundwater resource management.

RESPONSIBILITY MATRIX FOR ASPECTS OF **AQUIFER PROTECTION***

	WSA					WSP / Water Board					DWS/CMA			WUA			DEA		
	Labour	Operator	Supervisor	WR Manager	Head Development	Labour	Operator	Supervisor	Manager	Head Development	Technician	WR manager	Head Development	Case Officer	Manager	Head Development	Polluter		
Aquifer Protection (SDM)																			
Landuse																			
Catchment Management Strategy				C															
Development/ update of IDP/ SDF				R	A														
Landuse Planning				R	A														
Waste management									R	A									
Waste water management				I					R	A									
Effluent quality management				I		S	R	A	I										
Remediation																			
Groundwater remediation				I															
Monitoring																			
Groundwater monitoring	S	R	A	I															
Regional GW monitoring				I															
GWQ monitoring (pollution)				I	S	R	A	I											
Ecological Monitoring																			

R Responsible
A Accountable
S Supportive
C Consulted
I Informed

This role conducts the actual work/owns the problem. There should be only one R.

This role approves the completed work and is held fully accountable for it.

This role provides additional resources to conduct the work or plays a supportive role in implementation.

This role has the information and/or capability to complete the work. Two-way communication (typically between R and C).

This role is to be informed of progress and results. One-way communication (typically from R to I).

RESPONSIBILITY MATRIX FOR ASPECTS OF AQUIFER UTILISATION*

	WSA					WSP / Water Board					DWS/CMA			WUA			DEA		
	Labour	Operator	Supervisor	WR Manager	Head Development	Labour	Operator	Supervisor	Manager	Head Development	Technician	WR manager	Head Development	Technician	WR manager	Head Development	Case Officer	Manager	Head Development
Groundwater development (RDM)																			

R Responsible This role conducts the actual work/owns the problem. There should be only one R.

A Accountable This role approves the completed work and is held fully accountable for it.

S Supportive This role provides additional resources to conduct the work or plays a supportive role in implementation.

C Consulted This role has the information and/or capability to complete the work. Two-way communication (typically between R and C).

I Informed This role is to be informed of progress and results. One-way communication (typically from R to I).



Ensuring SOME
FOR ALL
FOREVER
TOGETHER

*National Shared-Vision,
Grasdak, 1996*