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Gap Analysis and Action Plan – Scoping Report (Final)

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This report emanates from the project Policy, Legal and Institutional Development for Groundwater Management in the SADC Member States (GMI-PLI) commissioned by the Southern African Development Community Groundwater Management Institute (SADC-GMI), and executed by Pegasys.

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FOREWORD

The Southern African Development Community (SADC) Member States, through the support of International Cooperating Partners have gone through a series of Water Sector Reforms which varied in terms of policy, legal and institutional development. The focus of the water sector reforms has been on Integrated Water Resources Management and aimed at achieving sustainable and equitable distribution of water resources in the respective Member States. To a large extent, the water sector reforms did not comprehensively address the sustainable management of groundwater resources, yet 70% of the population in the SADC region depend on it. Climate change continues to negatively affect the availability of surface water, placing significance reliance on the use of groundwater for both urban and rural supply throughout the region. Human wellbeing, livelihoods, food security, ecosystems, natural habitats, industries and urban centres growth throughout the SADC Region are increasingly becoming more reliant on groundwater. The SADC region in general has an abundance of groundwater resources. However, due to several factors which include the lack of an enabling policy, legal and institutional environment, only an estimated 1.5% of the available renewable groundwater resources are currently being utilised.

It is estimated that there are about 30 Transboundary Aquifers (TBAs) and 15 transboundary river systems and that these systems are central to the water security of the region. There is therefore a need for Members States to establish and strengthen existing policy, legal and institutional frameworks to achieve equitable and sustainable access to water resources through joint management of the transboundary resources. It is in view of the above and in response to the need to strengthen the sustainable use of groundwater resources conjunctively with surface water at both the national and regional level, that the Southern African Development Community – Groundwater Management Institute (SADC-GMI) was established by the SADC Secretariat, on behalf of the Member States.

The vision of the SADC-GMI is, “to be a Centre of Excellence in promoting equitable and sustainable groundwater management in the SADC region”. The key focus areas of SADC-GMI are to 1)advocate, raise awareness and provide technical support in SADC around sustainable management through the dissemination of information and knowledge; 2) create an enabling environment for groundwater management through policy, legal and regulatory frameworks; 3) promote action-oriented research; 4) promote impact-oriented capacity building and training for groundwater management in the region; 5) lead and promote regional coordination for groundwater management; and 6) support infrastructure development for groundwater management.

In pursuance of the focus area of creating an enabling environment, SADC-GMI implemented the project entitled "Policy, Legal and Institutional Development for Groundwater Management in the SADC Member States, (GMI-PLI)". The methodology for said project included the development of the Desired Future State, conducting a baseline study of best practices, and description of policy, legal and institutional frameworks which promote sustainable groundwater management. Using an in-Country Experts model, a systematic analysis of the existing policy, legal and Institutional frameworks in comparison with the Desired Future State was conducted to identify gaps that required to be addressed in order to fulfil the SADC-GMI mandate – to achieve sustainable groundwater management in all 16 SADC Member States. The analytical assessment of the gaps identified at national level culminated in the production of 16 National Gap Analysis & Action Plan Reports and the higher-level Regional Gap Analysis Report. The latter summarises the findings across the SADC region.

This National Gap Analysis for South Africa provides an overview of the existing gaps in policy, legislation, strategy, guidelines and the institutional frameworks and further suggests enablers required to unlock the identified gaps/challenges. The report provides a clear guidance for South Africad to develop an implementation roadmap through a process of prioritising the Strategic Actions in close liaison and in consultations with all relevant stakeholders. It is hoped that these National/Regional Gap Analysis and Action Plan Reports will aid South Africa to develop their own Roadmap which will ultimately advance the groundwater narrative and bring it at par with surface water in terms of policy, legal and institutional frameworks which will no doubt enhance sustainable groundwater management at a national and regional level in the SADC Region.

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	Gap Analysis and Action Plan – Scoping Report: Democratic Republic of Congo	1.3
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LIST OF ACRONYMS

ACRONYM	DEFINITION
AGSA	Auditor-General of South Africa
AMCOW	African Ministers' Council on Water
AMD	Acid Mine Drainage
BGCMA	Breede-Gouritz Catchment Management Agency
CIWA	Cooperation in International Waters in Africa
CMA	Catchment Management Agency
CME	Compliance, Monitoring and Enforcement
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DWAF	Department of Water Affairs and Forestry
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
FETWAter	Framework Programme for Research, Education & Training in the Water Sector
GDE	Groundwater Dependant Ecosystems
GEF	Global Environment Facility
GESI	Gender, equity and social inclusion
GMI-PLI	Groundwater Management Institute – Policy, Legal and Institutional
GW	Groundwater
IAH	International Association of Hydrogeologists
IDP	Integrated Development Plan
MAP	Mean Annual Precipitation
MAR	Mena Annual Runoff
MoSCOW	Must have, Should have, Could have, and Won't have
NDP	National Development Plan

ACRONYM	DEFINITION
NGIS	National Groundwater Information System
NGS	National Groundwater Strategy
O&M	Operation and Maintenance
PLI	Policy, Legal and Institutional
PMG	Parliamentary Monitoring Group
RBO	River Basin Organisation
RSA	Republic of South Africa
SADC	Southern African Development Community
SADC-GMI	Southern African Development Community - Groundwater Management Institute
SANS	South African National Standards
SDG	Sustainable Development Goal
SOE	State-Owned-Enterprises
TWUA	Tshiping Water User Association
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UWC	University of Western Cape
WMA	Water Management Area
WMI	Water Management Institution
WRC	Water Research Commission
WSDP	Water Services Development Plan
WUA	Water User Association

1. INTRODUCTION

1.1 Background to the GMI-PLI Project

The critical role of groundwater in building the region's resilience to climate change and improving water security is reflected by the World Bank in their June 2017 online article: *People in Southern Africa are largely dependent on groundwater shared between countries and communities for health and well-being, food production, and economic growth*. As climate variability alters the amount of surface water that is available, people in the region are increasingly turning to groundwater, a resource that is already challenged by threats of depletion and pollution.

The sustainable management of groundwater is a key part of the broader water security for the region, especially in understanding transboundary aquifers. The Southern African Development Community (SADC) has established the Groundwater Management Institute (GMI) to better understand the region's needs and improve their groundwater management capabilities.

The SADC Groundwater Management Institute (SADC-GMI) is the implementing agency of the World Bank funded Sustainable Groundwater Management in SADC Member States Project. This funding is secured through the Global Environment Facility (GEF) and the Cooperation in International Waters in Africa (CIWA) trust. Part of this funding has been dedicated by the SADC-GMI to respond to gaps in the existing policy, legal and institutional (PLI) frameworks for groundwater management in the region towards fulfilling one of four main components of the project –"Enhancing institutional capacity of governments in SADC Member states and transboundary organisations". The objective is to be met through a series of organised steps which broadly included the development of a benchmark document called the Desired Future State Document, a Gap Analysis and high-level Action plan for all SADC Member States and for the region, development of a suite of guidelines to strengthen groundwater management regionally. To inform the guideline on the development of a groundwater PLI Roadmap, Tanzania was selected as a pilot from which to draw lessons and develop the process.

This report presents the outcomes of the gap analysis for South Africa.

1.2 Socio-economic drivers for South Africa

South Africa has articulated its developmental objectives in terms of socio-economic development and upliftment through the National Development Plan (NDP) 2030: Our Future make which sets out targeted actions to build a capable and developmental state which includes (NPC, 2012): (a) stabilising the political-administrative interface; (b) making the public service and local government administration careers of choice; (c) develop technical and specialist professional skills; (d) strengthening delegation, accountability and oversight (e) improving interdepartmental coordination; (f) taking a proactive approach to improving relations between national, provincial and local government; (g) strengthening local government; and (h) clarifying the governance of state-owned-enterprises (SOEs). The [implementation of the NDP and] the economy has stalled as the result of missteps in policy interventions, weaknesses in collective decision making and poor execution of policies and strategies, combined with the damaging effects of state capture

and corruption (Ramaphosa, 2017). The above-mentioned has also led to water insecurity driven by a massive backlog in water infrastructure maintenance and investment, glaring inequities in access to water, and deteriorating water quality, all exacerbated by recurrent droughts driven by climatic variation (DWS, 2018). The crisis in the water sector is putting at risk the attainment of the developmental objectives with the consequent impacts on human wellbeing and slowing of the South African economy.

1.3 Water resources

1.3.1 Status of water resources (surface water, groundwater and transboundary)

South Africa is a water scarce country (Damkjaer and Taylor, 2017; Donnenfeld, Crookes and Hedden, 2018; Meissner et al., 2018) with mean annual precipitation (MAP) of 450 - 500 mm (Scott and Gush, 2017; Meissner et al., 2018), which is greatly exceeded by evaporative demand that ranges between 1400 and 3000 mm per annum (Scott and Gush, 2017). More importantly, Southern Africa and [South Africa] are characterized by high rainfall variability on a wide range of temporal and spatial scales which have an impact on agriculture, water resources and the economy at large. The disjuncture between economic activity and water availability require inter-basin transfer e.g. the Lesotho Water Highlands Project. The relative low rainfall imprints itself on the availability surface water and groundwater resources of the country. Van Wyk, van Tonder and Vermeulen, (2012) examining hyetograph-hydrograph time-series data sets, found that episodic rainfall events are responsible for rapid, but sustainable groundwater recharge events. The recurrence rate of these events in the semi-arid and arid regions is still low and aquifer storage-recharge is therefore not an annual event (van Wyk, van Tonder and Vermeulen, 2012). The implications of climate change on water resources are that more rainfall is projected for the east of the South Africa in the form of more rain days and more days with bigger rainfalls whilst less rainfall is projected along the west coast and the adjacent interior, with the possibility of a slight increase in inter-annual variability (Lumsden, Schulze and Hewitson, 2009).

The naturalised mean annual runoff (MAR) amounts to 49 251 million cubic meters (m^3) per annum (Bailey and Pitman, 2016) of which the amount that can be abstracted at a high assurance of 10 240 million m3 is available for use through dams, basin transfers and other water resource developments (DWA, 2013). The utilisable groundwater exploitation potential has been estimated at 10 350 million m^3 per annum (7 500 million m^3 per annum during drought conditions) (Woodford and Rosewarne, 2006; Bailey and Pitman, 2016). The following beneficial uses of groundwater are recognised:

- **Rural water supply**: Groundwater has played a strategic role in supplying unserved rural communities (50% to 90% of communities are served since 1994, depending on province) with basic water supply and infrastructure (Adams *et al.*, 2015; Cobbing *et al.*, 2015). More than half of South Africa's population depend on groundwater. In rural Limpopo Province for example, groundwater accounts for almost 70% of rural domestic water supply (du Toit *et al.*, 2012). A number of smaller towns in the western arid regions (areas corresponding with climatic aridity and minimal rainfall) of South Africa are mostly dependent on groundwater resources e.g. De Aar (Van Tonder and Kirchner, 1990; Murray *et al.*, 2012), Kathu (Gamagara Municipality, 2013) and Mahikeng (Cobbing and De Wit, 2018).

- **Urban water supply**: The recognition of groundwater as part of the water supply mix to urban areas is only recently recognised. Approximately 20 million m^3 per annum is supplied to the City of Tshwane from groundwater sources, accounting for approximately 7.5% of the total (the remaining 270 million m^3 per annum is supplied from dams or imported from water boards) (Dippenaar, 2013). The Atlantis aquifer is supplying 5.4 – 5.7 million m^3 per annum to the Cape Town metropole area water supply (Bugan *et al.*, 2016) which is presently about 1% of the total water supply.
- **Water security**: Strategies to ensure a water secure South Arica recognise groundwater for conjunctive use. Groundwater contributes to drought resilience by providing a buffer against water shortage (Albrecht *et al.*, 2017). The Atlantis Water Supply Scheme provides an excellent example of a wise and efficient water use, including water recycling for potable services (Bugan *et al.*, 2016). It also has alleviated some of the pressures on surface water resources in the [Western Cape] region (Bugan *et al.*, 2016), especially on the impact of drought on the City of Cape Town. In the region the City of Windhoek is an example of using managed aquifer recharge to augment water supplies (Murray *et al.*, 2018). The Vaal Gamagara Water Supply Scheme from Delportshoop to Hotazel and beyond is the main bulk regional water infrastructure in the Northern Cape Region which is augmented with groundwater sourced from dewatering activities at Kolomela and Sishen Iron Ore Mine (DWS, 2015).
- **Food security**: Agriculture is the largest single user of groundwater (DAFF, 2015). The Dendron dolomitic aquifer in the [Limpopo] Province of South Africa has been the sole source of irrigation water for commercial agriculture (Masiyandima *et al.*, 2002).
- **Economic services**: Aquifers contribute to South Africa's economy through producing fresh water for use in various forms of production and consumption (Pearce *et al.*, 2013).
- **Environmental services**: Many ecosystem services have a direct link with groundwater storage, recharge and discharge (Bergkamp and Cross, 2006). This is further discussed in section 1.3.2.

The quality of groundwater has been impacted by various land-use activities. The closure of coal and gold mines with no rehabilitation and remediation has resulted in pollution of groundwater by acid mine drainage (McCarthy, 2011; Coetzee, 2016; Sakala et al., 2018). In urban areas the indiscriminate use of chemicals and generation of wastes at both domestic and industrial level tend to concentrate potential sources of contamination (Pietersen et al., 2010). Agriculture is the biggest user of groundwater and also contributes to diffuse contamination (Pietersen et al., 2010). In the Cape Flats aquifer the concentrations of chloride, nitrate, potassium and sodium exceeded maximum limits mainly due to the agricultural activities and partially due to the natural movement of water through the geological formation of the Cape Flats region (Ruben Aza-Gnandji et al., 2013). Nitrate is the most common agricultural contaminant and pesticides and herbicides are likely to be a problem in some areas (Pietersen et al., 2010). There are large parts of South Africa that have high salinity and fluoride concentrations in the groundwater due to geogenic contamination. High fluoride concentration, above health limits, in groundwater related to long residence time of groundwater due to enhanced water-rock interaction was observed in the Namaqualand and Waterberg regions (Abiye, Bybee and Leshomo, 2018). Evaluating the abundance of Escherichia coli and the prevalence of pathogenic E. coli virulence genes in water from boreholes in the Stinkwater peri-

urban community found that the water sources were not microbiologically safe for human consumption (Abia et al., 2017).

South Africa has several shared river basins which includes the Incomati, Limpopo, Maputo and Orange-Senqu. The shared river basins have governance mechanisms in place with the Southern African Development Community (SADC) Protocol providing guidance. However, like many developing countries, SADC states struggle with implementing many of their well-formed policies, laws and procedures (Merrey et al., 2017). South Africa has a number of shared aquifer systems which include the Karoo Sedimentary Aquifer/Orange-Senqu River Basin aquifers, Coastal Sedimentary Basin V, Coastal Sedimentary basin VI/Coastal Plain Sedimentary Basin Aquifer, Rhyolite-Breccia Aquifer, Stampriet Aquifer System, Khakhea/Bray Dolomite, Zeerust/Lobatse/Ramotswa Dolomite Basin Aquifer, Limpopo Basin and Tuli Karoo Sub-Basin (Nijsten et al., 2018). (UNESCO, 2016) conducted a diagnostic assessment of the Stampriet Aquifer System that included the collection and processing of national data (hydrogeological, socio-economic and environmental, gender, legal and institutional), and the harmonization of data across all three countries (Botswana, Namibia and South Africa) to enable a joint assessment of the transboundary resource. It was estimated that at least 20 million m3 per annum was abstracted; 66 percent of this volume is from Kalahari aquifers, 33 percent from the Auob Aquifer and 1 percent from the Nossob aquifer (UNESCO, 2015). The breakdown of water use is as follows: 47 percent for irrigation, 37.5 percent for stock watering, 16 percent for domestic use, and 0.5 percent for tourism. Lack of monitoring data (climate, groundwater abstraction, water levels, water quality) seriously hampered a systematic diagnostic analysis (UNESCO, 2015). (Altchenko et al., 2017) conducted a hydrogeological assessment of the Ramotswa Transboundary Aquifer which is a karstic dolomite aquifer straddling the international border between Botswana and South Africa. Locally, groundwater has been contaminated by human activities with nitrate and coliform due to contamination from pit latrines and agricultural activities (i.e. livestock excreta) (Altchenko et al., 2017).

1.3.2 Groundwater environment and ecology

Besides being a vital water supply to people the ecological functioning of groundwater in the environment is incipient. There is recognition that groundwater ecosystems deliver services that are of immense societal and economic value, such as: (a) purification of water and its storage in good quality for decades and centuries, (b) active biodegradation of anthropogenic contaminants and inactivation and elimination of pathogens, (c) nutrient recycling, and (d) mitigation of floods and droughts (Griebler and Avramov, 2015). For example, the primary aquifer on the Maputaland Coastal Plain in northern KwaZulu-Natal, South Africa, is the principal source of water for rivers, lakes and most of the wetlands in dry periods, and is recharged by these systems in wet periods (Kelbe, Grundling and Price, 2016). Groundwater discharge zones in the lowland areas support more permanent wetlands with dominantly peat or high organic soil substrates, including swamp forest and most of the permanent open water areas (Kelbe, Grundling and Price, 2016). Although, there are examples of the role groundwater plays in environmental functioning, the science and understanding are in a developmental phase.

1.3.3 Status of groundwater infrastructure

Groundwater infrastructure is generally in a poor condition. Much of the success and sustainability of groundwater schemes rests with the groundwater infrastructure, in particular the borehole itself, the installed casing, screens and pump equipment, as well as the well-head completion around the borehole (sealing, water runoff, etc.) (Adams et al., 2015). Although South Africa has done relatively well in the provision of groundwater infrastructure there is a requirement to equally pay attention to its operation and maintenance (O&M) (Adams et al., 2015). Whilst hydrogeological topics such as recharge, transmissivity and groundwater quality are important (and influence O&M), it is O&M that "makes or breaks" a groundwater supply, and most interview respondents agreed that O&M is the key to groundwater scheme reliability (Cobbing et al., 2015). 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) when monitoring is not taking place (DWS, 2016). There are also irregular, fruitless and wasteful spending related to borehole drilling and construction in the Giyani area, e.g. R2.4m per borehole (AGSA, 2018; PMG, 2018). The lack of O&M and wasteful spending is impacting on the sustainability of groundwater schemes.

1.3.4 Groundwater supply and demand

The absence of regulatory controls on drilling and borehole construction means that there is almost no understanding of groundwater use. The NGS (DWS, 2016) provides a breakdown of groundwater use for different sectors such as agriculture-irrigation (59 percent), mining (13 percent), water supply services (12.9 percent), agriculture-watering livestock (6 percent), schedule 1 groundwater use (5.7 percent) and other use (3.4 percent – industry, recreation, aquaculture, power generation). In most of the water management areas (WMA) there is a groundwater surplus except for the Olifants WMA. The Limpopo WMA is also close to full-utilisation of groundwater resources (DWS, 2016). There are, however, groundwater resources available to meet additional demand in the future.

2. METHODOLOGY

2.1 Overview

The methodology for the gap analysis included conducting a desktop review of available literature. This was coupled with the development of a desired future state to provide a baseline for groundwater management and is discussed in more detail below. Key stakeholders were also identified during the early stages of the gap analysis and multiple engagements were held whereby a questionnaire was administered to evaluate the current state of groundwater management in the country. Based on the desktop review, stakeholder engagements and results from the questionnaire, a draft gap analysis report and action plan was developed which was then validated at Validation Workshops. These workshops involved key groundwater actors from the Member State and provided an opportunity to obtain buy-in and support for the gap analysis reports as well as obtaining further inputs. The draft report was also circulated to broader stakeholders i.e. Water User Associations, Water Service Providers etc. whereby written comment was received. The draft gap analysis report was then finalised based on the comments received from the Validation Workshops and broader stakeholders. The methodology outline is illustrated in the figure below.

Figure 1. Methodology outline

The literature collected consists of policies, legislation, tools, standards and groundwater governance assessments conducted in South Africa. Full lists of documents reviewed are presented in **Appendix A.** The stakeholders consulted are listed in **Appendix B**. For each of four categories of policies, legislation, strategies, and institutions, gaps and challenges were identified, and enablers formulated to unlock the gaps (Sections 3-6). Challenges to implementation are described in Section 7 and Section 8 presents an Action Plan for the Groundwater Management Regulatory Framework of South Africa. The structured questionnaire is based on the Desired Future State and is elaborated on below.

The desired future state has been contextualised for the SADC region, taking into account:

- The high levels of groundwater dependency in many SADC countries, in rural areas in particular;
- The variety of geohydrological contexts;
- High levels of poverty, gender disparities, social exclusion and pollution; and
- Relatively low levels of state capacity – skills, infrastructure and finance.

It sets out the ***minimum*** requirements that support the delivery of national, regional and international developmental goals, including the Sustainable Development Goals, meeting basic human needs to water, energy and food (the WEF nexus), and the protection of ecosystems that are dependent on groundwater.

The sections below describe, at a high level, what is considered to be the minimum best practice for policy, legislation and subsidiary legislation, regulations and standards for effective groundwater management. For a more detailed description of the desired future state, see **Appendix C**.

The **minimum policy requirements** that should be in place are:

- A long-term policy to protect groundwater by preventing pollution and overuse.
- The social, economic and environmental values of groundwater are all recognised.
- The human right to water is recognized and a rights-based approach to groundwater management is taken.
- Groundwater is recognised as a highly important source of domestic and agricultural water supply and a key resource for poverty alleviation, food security, and the sustainable economic development of rural areas.
- The biophysical and ecological linkages between ground and surface water for their use, protection and management are recognised, including land use zoning for groundwater protection and recharge (conjunctive use).
- The importance of the maintenance of the ecological integrity of wetlands in groundwater management is recognised (recharge zones).
- Intersectoral collaboration is promoted and facilitated.
- The need for adaptive management is recognised.
- The roles of various stakeholders and water users in groundwater management is recognised and participation of stakeholders is promoted and facilitated.
- An apex body that is responsible explicitly for GW management and playing the role of custodian/trustee on the part of the state is clearly defined.
- Effective institutional arrangements are coordinated at transboundary, national and local levels.
- Public access to geohydrological data held by the state is promoted and facilitated.
- Additional environmental principles necessary to protect and sustain groundwater are mandated, including: the precautionary principle, the principle of gender equity and social inclusion (GESI), the principle of subsidiarity, and the principle of intergenerational equity.

The **minimum legislative requirements** that should be in place are those that explicitly addresses the use, management, and protection of groundwater and provides the necessary tools for the state to regulate,

manage, control, protect and develop groundwater resources in conjunction with surface water resources. At a minimum, legislation and/or subsidiary regulations should:

- Provide the status of groundwater noting that all water has a consistent status in law, irrespective of where it occurs, and there is explicit reference to groundwater and conjunctive use management; and recognise the human right to water recognized in groundwater legislation, facilitating prioritization of drinking water and basic human needs, as well as small-scale users.
- Regulate groundwater quantity by providing conditions for accessing groundwater through water use authorisations system that does not discriminate (especially against the rural poor), is not tied exclusively to land tenure and enables effective compliance monitoring and enforcement.
- Provide groundwater protection mechanisms that includes regulating pollution (point source and non-point source), regulates depletion, regulates abstraction and recharge (usually via permitting) and provides for the sustaining wetlands;
- Enables integrated planning through specifying the need for long term plans (at catchment or basin level) to ensure the sustainable use of groundwater, including drought management plans and cross-sectoral coordination.
- Make provision for institutional arrangements including the mandate, competence and power of the relevant authorities, enabling the integrated management of groundwater and surface water resources, engaging in the arbitration of competing demands and diverging interests regarding groundwater abstraction and use, and support the collaborative engagement with other sector authorities, competent for public health, land-use planning, soils management, and waste management.
- Support effective stakeholder engagement through specifying when and how stakeholders, the public and/or other water users are to be engaged in the development of laws and regulations, planning, decision making and self-management regarding groundwater and should specifically address the issue of the involvement of women and youth in decision-making and the implementation of groundwater supply schemes.
- Provide for Monitoring and data collection to support regulation including protocols for data collection, management, exchange and dissemination, including standardization and harmonization of data, as well as national monitoring and information systems for the management of data and information.
- Regulate to ensure water conservation and efficiency of use.
- Support compliance and enforcement through clear mechanisms for promoting compliance with groundwater regulations through enforcement provisions that enable inspections, the imposition of fines and/or additional administrative penalties and other instruments to address failure to comply with the law.
- Conflict resolution mechanisms and/or the right to appeal.
- Enable the development of regulations on any relevant matter in the legislation to regularise aspects of groundwater management and incentivise appropriate use of groundwater resources.

The actual **requirements for subsidiary regulation** will differ from country to country, according to their own National Legislation. However, it is important to understand the extent to which critical issues around

groundwater management have been translated into regulations. Below are some examples of how this could look.

- Subsidiary legislation or regulations pertaining to use, protection including on-site sanitation, borehole drilling, and appropriate financial and economic regulatory tools e.g. water pricing.
- Clear protocols and standards on data collection and storage.
- Templates for municipal by-laws.
- Community management of groundwater and community participation in groundwater management.

From an **institutional perspective**, it is critical that countries have as a minimum, a dedicated Ministry for water resource management, which is also the custodian for ground water management. Noting that the groundwater is a localised resource, decentralised institutions at trans-boundary, catchment and local government level are crucial, where groundwater management fits into overall mandate for water resource management.

3. POLICY

3.1 Evolution

Before South Africa was colonised, water use was regulated by customary rights (Kidd, 2017) which meant that water belonged to the community and was used for a common good. Historically, traditional leaders were mainly responsible for the management of water resources in their rural communities (Kapfudzaruwa and Sowman, 2009). This mainly applied to small-scale groundwater use from springs or hand-dug wells in rural areas. Following colonisation there was an increasing emphasis given to private rights to water and was predicated upon a link between the right to use water and ownership of land adjacent to that water (Godden, 2005). There was no comprehensive groundwater management policy during this time and groundwater was considered mostly private for the exclusive use of the land-owner (Lazarus, 1998; Tewari, 2009). The inattentiveness to sound groundwater policy principles led to the dewatering of the dolomitic aquifers overlying the gold-bearing reefs of the Witwatersrand and the subsequent acid mine drainage (AMD) problem. The water reforms of the 1990s led to the White Paper on a National Water Policy for South Africa which saw groundwater as a common good and also the right of water not tied to the land (DWAF, 1997b).

Although conjunctive use and management of surface water and groundwater is not explicitly mentioned in the Policy, Section 6.4 discusses the establishment of a water conservation and utilization policy in relation to optimum use of water for each of the main user sectors, agriculture, industry and mining (Pietersen, Beekman and Holland, 2011). Furthermore, Section 6.6.3 states that the development and use of all water resources should be undertaken in accordance with the principles of Integrated Environmental Management, thereby placing water use and management in a broader perspective (Pietersen, Beekman and Holland, 2011).

3.2 Policies to support groundwater management

Following the National Water Policy (DWAF, 1997b) a specific Policy and Strategy for Groundwater Quality Management in South Africa (DWAF, 2000) was developed. The policy was comprehensive in as far it dealt with groundwater quality management but there was lesser emphasis on groundwater abstraction and control. The following policy goals were developed (DWAF, 2000): (a) to implement source-directed controls to prevent and minimise, at source, the impact of development on groundwater quality by imposing regulatory controls and by providing incentives; (b) to implement resource-directed measures in order to manage such impacts as do inevitably occur in such a manner to protect the reserve and ensure suitability for beneficial purposes recognised by the [National Water] Act (RSA, 1998); and (c) to remedy groundwater quality where practicable to protect the reserve and ensure at least fitness for the purpose served by the remediation.

There are a number of recent policies that have been developed that have groundwater implications. The Integrated Water Quality Management Policy sets out the vision, goal, values, underlying principles and policy responses for managing the quality of both surface and underground water resources (DWS, 2017a).

The draft Mine Water Policy provides the position of the DWS on mine water management, including AMD (DWS, 2017b). The draft Wetland Policy is an intervention to ensure that the management, wise use and conservation of wetlands is realised (DWS, 2017c). These policies deal with groundwater issues to some extent.

3.3 Gaps and challenges identified

The literature review and consultation undertaken indicates that certain difficulties may be identified with regards to the current policy state affecting groundwater management:

- The Groundwater Quality Management in South Africa (DWAF, 2000) was not implemented and most policies developed to date are not explicit about dealing with groundwater management. There is weak inter-sectoral integration and collaboration with regards to groundwater management (Knüppe, 2011; Pietersen, Beekman and Holland, 2011; Pietersen *et al.*, 2012; Seward, 2015; Seward and Xu, 2015). The requirement for protection zoning of groundwater resources has received hardly any attention.
- The National Groundwater Strategy (DWS, 2016) has identified the need for a national groundwater management policy which lays down norms and standards to guide regional and local groundwater management practices. The same need was identified by Lazarus (1998) which noted "*the fact that no coherent national management policy has been developed and enforced by the National Directorate of Geohydrology clearly lies at the core of a management system that has been criticised for being too ad hoc and thus lacking uniformity and consistency. The absence of national norms and standards governing utilisation, conservation, resource characterisation, which are monitored and enforced contributes to the general fragmentation of groundwater management*".
- The policies and strategies for water management do not consider the uniqueness of the subsurface but rather focus on coordination of land-based activities. The steadily more intensive multiple uses of the subsurface space and subsurface resources leads undeniably to a progressively stronger interaction between the different uses, usually with negative externalities (van der Gun, Aureli and Merla, 2016).
- The policy and supporting policies align to the prescripts of taking into account social, economic, gender and environmental values of water. However, the functional strategies place emphasis largely on environmental aspects and to some degree social considerations (basic human needs and reserve) but hardly address the economic and equity (addressing past imbalances) aspirations in the National Water Policy. Nevertheless, the social aspects of the policy meant that groundwater became an important resource for water supply.
- The customary rights to water are mentioned but are not dealt with in the policy.
- The role of groundwater in marine discharges is not addressed in the water policy due to uncertain jurisdiction responsibilities between Department of Environment Affairs (DEA) and DWS.
- Adaptive management is recognised in policies and plans but poorly implemented (Knüppe, 2011; Pietersen, Beekman and Holland, 2011). Knüppe (2011), in a systematic and participative analysis of groundwater governance in South Africa, concluded 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 consider the complex system linkages between hydrogeological, political, socio-economic and environmental domains.

- Stakeholder involvement, a critical requirement for groundwater management, is virtually completely missing for groundwater resources (DWS, 2016). Different users do not speak to each other – no Aquifer forums or Catchment Management Agency (CMA) forums exist; no Government forum with local users (LM/DWS/CMA) and local users is in place (DWS, 2016). This point to a gap that local management of water resources (subsidiarity principle) should have a much stronger focus in policy.
- This shortcoming in National Groundwater Leadership was recognised in the NGS (DWS, 2016) and an attempt was made to address this through the establishment of a Groundwater Governance Unit. This includes coordination of institutional arrangements at transboundary, national and local levels (DWS, 2016).
- The draft Mine Water Policy inadequately addresses the impacts of mines on groundwater resources due to dewatering of the resource (Albertus Viljoen, personal communication, November 2016).

3.4 Enablers required to unlock these gaps/challenges

The table below reflects the enablers required to unlock the identified gaps and challenges being experienced.

Table 1: Enablers required to unlock the policy gaps and challenges

Groundwater gap/challenges	Enablers
Lack of full implementation of water policy (inertia and resistance to change)	▪ Awareness amongst decision-makers (Pietersen *et al.*, 2018) ▪ Incentive schemes ▪ Jurisdictional areas of political and administrative structures match with aquifer boundaries (Theesfeld, 2010) ▪ Collaboration among different political / administrative structures when an aquifer straddles over different jurisdictional areas ▪ Functional strategies also address the economic and equity aspirations as communicated in the National Water Policy
Weak inter-sectoral integration and collaboration	▪ Coordination agreements (Babbitt *et al.*, 2017) ▪ Inter-ministerial structures (CapNet, AWG-Net and GW-Mate, 2010) ▪ Local groundwater management institutions ▪ Specific coordination policy and legislation
No National Groundwater Management policy (Lazarus; 1998; DWS, 2016)	▪ Clear groundwater management objectives (to be established by government[1])

[1] The NGS has seven objectives (DWS, 2016): (a) To achieve improved rural water supplies for basic and livelihoods needs from groundwater and other local sources; (b) To achieve sustainable small town / village supplies from groundwater, practicing integrated water resource management at local scale; (c) To improve water security for urban development from groundwater through a range of conjunctive-use options, integrated with waste water management; (d) To expand irrigated agriculture, especially for small-scale and supplementary irrigation from groundwater, with focus on sustainability and appropriateness and cost-effectiveness of technology; (e) To develop new groundwater sources in increasingly complex locations, including brackish water, for industrial / mining supply in situations of increasing water scarcity. brackish water, for industrial / mining supply in

Groundwater gap/challenges	Enablers
	▪ Updated Groundwater Quality Management policy (DWAF, 2000) which includes Groundwater Quantity Management and Groundwater Dependent Ecosystems (GDEs) (NSW Government, 1997) ▪ Protection zoning e.g. subterranean control areas (DWS, 2016) or red zones (McDonnel and Fragaszy, 2016) ▪ Allocating different types of water (freshwater vs. brackish groundwater (McDonnel and Fragaszy, 2016)
Absence of subsurface characterisation in policies	▪ Policies and science based methodologies to regulate the multiple uses of the subsurface space (van der Gun *et al.*, 2012)
Limited recognition of customary groundwater rights	▪ Transformation of a customary right into a statutory right (Mechlem, 2016)
No consideration of marine groundwater discharge in groundwater policy[2]	▪ Policy on GDEs to recognise marine groundwater discharges in groundwater policy
Weak implementation of adaptive management	▪ Principle of adaptive management incorporated in groundwater policy e.g. as *"a systematic process for improving management policies and practices by systemic learning from the outcomes of implemented management strategies and by taking into account changes in external factors in a pro-active manner* (Pahl-Wostl *et al.*, 2010)."
No local groundwater management and participation of stakeholders	▪ Explicit framework for local groundwater management in South Africa including multi-stakeholder dialogues ▪ Local water management institutions e.g. Groundwater Sustainability Agencies (Babbitt *et al.*, 2017)
No national groundwater leadership	▪ Defined leadership and job requirements ▪ Leadership commitment and competence
Rent-seeking behaviour	▪ Criminal prosecution

situations of increasing water scarcity; (f) 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; and (g) 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.

[2] This responsibility falls under the jurisdiction of the DEA and is a disjunct in responsibility between DEA and DWS (Nicollete Vermaak Personal Communication 31 January 2019).

4. LEGISLATION

4.1 Evolution

The water law in South Africa prior to 1994 was based on the development needs (domestic, agricultural and industrial) of white settlers. Roman law, Roman Dutch law and later English and American law shaped the South African water law (Kavin, 2000). The result of this was the distinction made between public and private water. In 1912 the Irrigation and Conservation of Waters Act No. 8 of 1912 (Tempelhoff, 2017) was introduced which dealt mainly with irrigation. Priority use of water was given to agriculture. The legislation was repealed in 1956 through the introduction of the Water Act No. 54 of 1956 (Tempelhoff, 2017). This was necessary due to the rapid growth of the mining and industry. However, the 1956 Act entrenched the concept of private water and there was no obligation to share resources equitably. The lack of accountability to proper groundwater resource management and use commonly resulted in over-exploitation of groundwater resources (Lazarus, 1998). The Water Act of 1954 made the following distinction between different categories of groundwater (Lazarus, 1998; Kavin, 2000): (a) subterranean water; (b) public surplus water; and (c) deemed private water.

Subterranean water was a special category of groundwater, the right to use and control of which was vested in the Minister. This was done through the declaration of a subterranean Government water control area and as a result different allocation rules applied. A second category of groundwater potentially subject to regulation was water which fell within the statutory definition of public water. Surface water (streams) qualified as public water was further categorised as either normal flow or surplus water (Lazarus, 1998; Kavin, 2000). Since underground water could not qualify as normal flow since it did not visibly flow, it was qualified as surplus water. As such, it effectively escaped any form of strict regulation, and it was no different from private water. Private water was water that was pumped from boreholes and its use and enjoyment vested in the owner of the land on which it was found (Lazarus, 1998; Kavin, 2000). The National Water Act (RSA, 1998) rectified this anomaly by recognising groundwater as public water (Pietersen, 2004)

4.2 Legislation to support groundwater management

The Constitution of South Africa sets out that everyone has a right to an environment that is not harmful to their health or wellbeing and to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures that (a) prevent pollution and ecological degradation; (b) promote conservation; and (c) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development (RSA, 1996). The point of departure The National Water Act (RSA, 1998) introduced the following measures important to groundwater resources (Pietersen, 2004):

- Formal recognition of the unity of the hydrologic cycle
- Provision for resource protection and sustainability through resource directed measures and source directed controls
- Confirmation of water as a national resource under national management

- Obligations to meet rights of neighbouring states with regards to shared watercourses
- Decentralisation of water management within a national framework
- Limitation of rights into perpetuity
- Requirement to allocate water specifically to achieve social and economic optimal water use
- Formal requirement for water conservation and demand management
- Economic pricing of water

The recognition of the unity of the hydrological cycle means that groundwater is subject to the same protection measures as surface water. The above measures are sophisticated and required tools and technologies to be developed to support sustainable groundwater management and utilisation. Groundwater is not mentioned explicitly in the National Water Act, but the provisions are implicit. The following regulatory instruments are provided for: water use licenses, general authorisations (for the first-time groundwater addressed specifically), compulsory licensing, controlled activities, pollution remediation and emergency action. Pietersen et al. (2011) has identified the following issues with regard to groundwater management:

- **Controlling groundwater use**: The National Water Act make provisions for the regulation of water use through registration of water use and different types of authorisations (schedule 1 water use; general authorisations; existing lawful use and water use licenses). The position regarding the licensing of groundwater, however, is often unclear to both users and planners, especially with regards to regulating local government (as a water user). Together with the slow process of assessment and approval of applications it has resulted in a backlog in issuing groundwater licenses.
- **Regulating the construction of wells and boreholes**: Construction of boreholes (which includes wells) is only mentioned under 'Conditions for issue of general authorisations and licenses (Chapter 4, Section 29e of the National Water Act): "*in the case of taking or storage of water (iii) specifying the method of construction of a borehole and the method of abstraction from the borehole*". Chapter 11 of the National Water Act refers to the acquisition, construction, alteration, repair, operation and control of government waterworks. There is, however, no explicit regulation concerning the construction of boreholes.
- **Controlling groundwater pollution**: The National Water Act make provisions for a waste discharge charge system which is based on the polluter pays principle. A system has been established but has not yet been implemented. There are several examples of groundwater pollution in South Africa (most prominent is acid mine drainage) which is not being effectively addressed.
- **Financing groundwater** (DWS, 2016): Groundwater-related expenditure is taking place in different branches of DWS, for example in support of water resources planning and of water services implementation. 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. Other sectoral legislation that impacts on groundwater discussed in Table 2.

Table 2: Sectoral legislation and implications for groundwater management

Legislation	Implications for groundwater management
Hazardous Substances Act 1973	▪ Regulates disposal of hazardous waste in a special category facility to minimise groundwater pollution
The Development Facilitation Act, 1995	▪ Makes it obligatory for land development applicants to consider factors such as geological formations and hazardous undermined areas.
Conservation of Agricultural Resources Act 1983	▪ Land user must take certain measures to protect the irrigated land on his farm unit effectively against waterlogging and salinisation, all of which would have an indirect effect on water quality and pollution ▪ Intensive farmers should not pollute the environment (Conrad *et al.*, 1999)
Water Services Act 1997	▪ Access to basic water supply and sanitation ▪ Provides a regulatory framework and establishment of water services institutions such as water boards, water services providers which use groundwater as a resource
National Environmental Management Act 1998	▪ Makes provision for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that promote cooperative governance and procedures for co-coordinating environmental functions exercised by organs of state (Pietersen, Beekman and Holland, 2011).
Nuclear Energy Act 1999	▪ Provides special provisions for the safe disposal of radioactive materials to minimise groundwater pollution
Disaster Management Act 2002	▪ Provide the mechanisms for relief in situations of water scarcity through implementing groundwater management programmes ▪ Provide opportunity for strategic planning for drought situations
Mineral and Petroleum Resources Development Act 2002	▪ Requires environmental management plans that requires minimisation of polluting activities that impacts on groundwater. The plans must be supported by detailed groundwater investigations (Pietersen, Beekman and Holland, 2011).
National Environment Management: Air Quality Act 2004	▪ Regulates greenhouse gases and its potential impacts on the water environment (Pietersen, Beekman and Holland, 2011).
National Environmental Management: Waste Act 2008	▪ Requires reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development (Pietersen, Beekman and Holland, 2011).

Legislation	Implications for groundwater management
	▪ Requires remediation of land that may have a negative impact on the environment (Pietersen, Beekman and Holland, 2011).
Spatial Planning and Land Use Management Act, 2013.	▪ Must make provision for sustainable water management in spatial planning.

4.3 Gaps and challenges identified

The literature review and consultation undertaken indicates that certain difficulties may be identified with regards to the current legislative state affecting groundwater management (DWS, 2016):

- Insufficient co-operation between different government departments involved in land-use management and activities which impact upon groundwater resources.[3]
- Despite the good intent of the National Water Act, stakeholder involvement, a critical requirement for groundwater management is almost completely missing for groundwater resources.
- 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 issuing of licences is based on outdated information, desktop reserves based on surface water boundaries, no Water Resource Classification set, and Resource Quality Objectives determined (Nicollete Vermaak Personal Communication 31 January 2019).
- The challenge of dealing with illegal water use while only 20 percent of groundwater use has been verified at this stage, a process which must be 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 because of limited capacity in Regional Offices to carry out compliance monitoring.
- Lack of legislative clarity on how to regulate the groundwater resource when utilization/authorization is driven by economic factors (mining & dewatering) and how to offset these impacts caused to regional groundwater levels and utilization (Albertus Viljoen, personal communication, 16 November 2018).
- 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.
- Limited groundwater monitoring is taking place and the issue of groundwater data in private hands has not yet been resolved.

[3] The Department of Mineral Resources and the Department of Water & Sanitation have no memorandum of understanding in place in the issuing of mining rights if water use authorization is required. This leaves a loophole for the regulation of the water resource (Albertus Viljoen, personal communication, November 2018).

- The implementation of the legislation has not been supported by the necessary regulations for groundwater management.

4.4 Enablers required to unlock these gaps/challenges

The table below reflects the enablers required to unlock the identified gaps and challenges being experienced.

Table 3: Sectoral legislation and implications for groundwater management

Groundwater gap/challenges	Enablers
No specific enabling provisions for groundwater management	▪ Specific groundwater legislation and statutory instruments e.g. Sustainable Groundwater Management Act for California (Kiparsky *et al.*, 2017)[4] ▪ Fully-Integrated Water Resources Legislation including enabling provisions for groundwater management ▪ Statutory rules for timeframes of implementation / updates
Insufficient co-operation between different government departments	▪ Provisions in legislation for multi-sectorial participations in local-level institutions for groundwater management
Lack of stakeholder involvement	▪ Stakeholders represented in local-level institutions for groundwater management
Conflict mechanisms not implemented	▪ Consistent jurisprudence (Water Tribunal), greater clarity of rights, duties and institutions (Couzens *et al.*, 2017) ▪ Mediation mechanisms for conflict resolution
Limited compliance monitoring and enforcement due to insufficient capacity and resources	▪ Regulations for compliance monitoring and enforcement ▪ Compliance monitoring functions can be delegated to local level to assist the Regulator in this regard (Albertus Viljoen, personal communication, November 2018)
Backlog in issuing groundwater abstraction licenses	▪ Pre-authorisation for groundwater uses in legislation ▪ Designated priority areas e.g., strategic aquifers, overexploited aquifers for issuing groundwater abstraction licenses
Illegal water use	▪ Groundwater metering included in regulations for compliance monitoring and enforcement ▪ Appropriate penalties for illegal water use
Limited uploading of groundwater data and licenses	▪ Regulations for capturing, processing, reporting and sharing of data (including privately held groundwater data)
Limited groundwater monitoring	▪ Regulations for groundwater monitoring
No regulations	▪ Technical regulations for drilling, borehole construction and completion, pumping tests and water quality tests

[4] The Sustainable Groundwater Management Act specifically: (a) establishes a definition of sustainable groundwater management, (b) establishes a framework for local agencies to develop plans and implement strategies to sustainably manage groundwater resources, (c) prioritizes basins with the greatest problems (ranked as high- and medium-priority); and (d) sets a 20-year timeline for implementation (WEF, 2015).

Groundwater gap/challenges	Enablers
	▪ Regulations for operation and maintenance of groundwater supply schemes ▪ Regulations for groundwater monitoring including provision and exchange of groundwater data and information ▪ Regulations and standard operating procedures for compliance monitoring and enforcement (including groundwater metering)

5. STRATEGY AND GUIDELINES

5.1 Evolution

No prior strategic planning of groundwater took place before 1998. Provisions in the Water Act of 1956 limited the use of groundwater in subterranean water control areas as a measure for groundwater management (Pietersen, 2004). However, the right to the use and control of subterranean water that was allocated and used immediately prior to the declaration of the control area vests in the land owners to which the right was allocated (Lazarus, 1998). The right to the use and control of subterranean water only vested in the Minister if the water was unallocated or unused immediately prior to the declaration of the area as a subterranean government water control area (Lazarus, 1998). The National Groundwater Strategy was developed in 2010 and updated in 2016 (DWAF, 2010; DWS, 2016). The NGS 2016 update has a number of strategic themes of which each one has been developed in terms of Objectives, Principles, Situation Assessment, Current challenges, and Strategic Actions (DWS, 2016). However, the NGS 2016 has not been signed off so it is not yet approved at the stakeholder participation/implementation level. There is a suite of reports, standards and protocols that were developed to support the implementation of the National Water Act.

5.2 Strategies and guidelines to support groundwater management

The strategic themes and actions in the NGS 2016 are summarised in Table 4.

Table 4: Strategic themes and actions (DWS, 2016)

Strategic themes	Actions
Stakeholder-driven development and implementation	▪ Ensure DWS 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 ▪ Put into place mechanisms for the ongoing productive engagement of stakeholders ▪ Establish national stakeholder core group ▪ Roll-out groundwater awareness raising ▪ Establish a South African Groundwater Trust ▪ Establish an effective networking / communication system
National Groundwater Leadership	▪ Establish Groundwater Governance Unit in DWS ▪ Conduct needs and constraints assessment
Responsive groundwater regulatory framework	▪ Continue work on groundwater resource and source valuation and assessments ▪ Develop national groundwater policy which lays down norms and standards to guide regional and local groundwater management practices ▪ Initiate policy coordination at national level with respective institutions ▪ Review the processes of Schedule 1, General Authorisation, Licensing and Compulsory Licensing in terms of implementation experience and

Strategic themes	Actions
	groundwater development priorities to achieve administrative efficiency and effectiveness and user cooperation ▪ Start groundwater use verification ▪ Develop regulations for subterranean water control areas ▪ Implement aquifer management in priority aquifers ▪ Prepare regulations for different groundwater sectors ▪ Develop regulations for the groundwater industry drillers and pump installers ▪ Enforce compliance
Groundwater resource protection	▪ Implement policy and strategy for groundwater quality management ▪ Undertake a national assessment of the present impact of pollution on groundwater resources ▪ Make public awareness and understanding of groundwater issues as well as existing and emerging pressures and impacts ▪ Implement groundwater use verification ▪ Use groundwater licenses, including general authorisations, much more to achieve resource protection objective ▪ Review RDM methodology as it relates to groundwater ▪ Protect groundwater resources for domestic water supply ▪ Establish mechanisms to regulate and prohibit land-based activities that impacting on groundwater ▪ Establish formal cross-sector collaboration to enhance sustainable utilization of the resource
Sustainable groundwater resource utilization	▪ Develop a series of specific, prioritised objectives and implementation plans ▪ Foster good hydrogeology practice ▪ Review and develop guidelines to foster good hydrogeology practice ▪ Introduce guidelines with relevant training programmes ▪ Strengthen inter-departmental cooperation ▪ Establish mechanisms for ongoing auditing and awareness raising ▪ Develop national capacity for groundwater governance ▪ Appoint local hydrogeologists in municipalities
Appropriate institutional development	▪ Develop a strategic governance framework ▪ Capacitate municipalities ▪ Ensure compliance with existing government requirements ▪ Communicate and awareness raising about groundwater ▪ Develop practical guidelines on all aspects of groundwater scheme operation and maintenance and institutional arrangements ▪ Systematically develop, capacitate and support local management institutions ▪ Identify and strengthen within-sector support structures and processes which could facilitate local-level management ▪ Define and communicate the roles and responsibilities of Catchment Management Agencies ▪ Create a fully capacitated national groundwater champion to fulfil the critical national facilitation responsibility

Strategic themes	Actions
Water sector awareness, skills and capacity	▪ Address capacity development strategically ▪ The DWS should take the lead role in groundwater capacity building ▪ The WRC should continue its critical capacity-building role for groundwater resources development and management ▪ The FET-Water approach needs to be further developed for capacity development in the groundwater governance field ▪ 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 ▪ Establish groundwater centre of excellence ▪ The private sector needs to play a much larger role in education and training ▪ Focus on technical education and training ▪ 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 ▪ There needs to be systematic capacitating of municipalities for groundwater ▪ Introduce groundwater at basic education level ▪ Foster long-term relationship: government / academic institutions ▪ Develop Public/private sector partnerships ▪ Involve stakeholders ▪ Participate in regional, continental and international initiatives ▪ Develop capacity building indicators ▪ Develop planned approach to groundwater awareness raising
Redirecting Finances	▪ Develop understanding groundwater development ▪ Align groundwater finance ▪ Encourage private investment ▪ Invest in governance ▪ Improve efficiency of charging for groundwater use
Groundwater resource planning and development	▪ 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 ▪ Develop groundwater plans at catchment and priority aquifer level ▪ Include groundwater management plan in catchment strategies ▪ Establish guidelines for the groundwater content of emerging Catchment Management Strategies ▪ Develop and implement “Best Practice Guidelines” for the mining sector as well as for the municipal, agriculture, energy and forestry sectors ▪ Mainstream the critical role of groundwater in drought risk management ▪ Involve stakeholders ▪ 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.

Strategic themes	Actions
	▪ 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 ▪ Implement groundwater development and management framework
Information management	▪ Develop a Groundwater Research & Development Plan ▪ National champion to direct appropriate data and information flow ▪ Address the vital issue of groundwater data and information management strategically, as foundation for improved management and cooperation of stakeholders ▪ Develop groundwater monitoring strategy ▪ Verify groundwater use information ▪ 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 system ▪ Engage and support relevant authorities to improve hydrological and environmental monitoring programmes necessary for groundwater management ▪ Groundwater data from mining and other private sectors should be a public domain ▪ Harmonise data bases / information systems ▪ Initiate new phase of groundwater assessment ▪ Develop integrated information service ▪ Ensure knowledge sharing ▪ Publicise groundwater information ▪ 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 ▪ Establish aquifer monitoring and modelling as an integral part of aquifer management by all sectors ▪ Implement National State of Water Resources Reporting
Regional and international partnerships	▪ 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. ▪ Develop a groundwater management plan for each of the RBOs with shared aquifer systems with South Africa ▪ South Africa should become an active participant in UNESCOs International Hydrological Programme ▪ Ensure widespread membership of IAH ▪ 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

Strategic themes	Actions
	▪ 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.
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 ▪ Aquifer management needs to be introduced on a priority basis ▪ Actions by local municipalities ▪ Action from private sector players ▪ Action from utilities ▪ Action by media and civil society

The following strategies and guidelines were developed:

- Data Acquisition and Management Strategy for Water and Sanitation in the Republic of South Africa (DWS, 2017b)
- Groundwater Sampling Manual (WRC, 2017)
- Review, Evaluation and Optimisation of the South African Water Resources Monitoring Network: Implementation Strategy (AECOM, 2017)
- Review, evaluation and optimisation of the South African water resources monitoring network: Scientific Review Report (AECOM, 2016)
- Groundwater Management Framework (Riemann, Chimboza and Fubesi, 2012)
- A Guideline for the Assessment, Planning and Management of Groundwater Resources in South Africa (DWAF, 2008)
- NORAD Toolkit for Water Services (DWAF, 2004b)
- A Protocol to Manage the Potential of Groundwater Contamination from On-site Sanitation (DWAF, 2003)
- Minimum Standards and Guidelines for Groundwater Resource Development for the Community Water Supply and Sanitation Programme (DWAF, 1997a)
- SANS Standards (e.g. SANS 10299: 2003: Development, maintenance and management of groundwater resources; SANS 241-1: 2015: Drinking water Part 1: Microbiological, physical, aesthetic and chemical determinants; SANS 251-2: Drinking water Part 2: Application of SANS 241; and SANS 5667-11:2015 Water quality — Sampling Part 11: Guidance on sampling of groundwater)

5.3 Gaps and challenges identified

The literature review and consultation undertaken indicates that certain difficulties may be identified with regards to the strategy and guidelines state affecting groundwater management:

- Limited government commitment to implement strategies and guidelines at all levels
- Lack of coordinated inter-governmental strategic planning and implementation

- Insufficient human capacity / shortage of staff in government to implement provisions for groundwater management
- The lack of effective monitoring, compliance and control systems regulating groundwater abstraction
- Procurement delays in equipment, instrumentation and renewal of laboratory contracts
- Vandalism of instrumentation and lack of access to private land
- Guidelines and standards more than a decade old

5.4 Enablers required to unlock these gaps/challenges

The table below gives the enablers required to support the implementation of the strategy and guidelines implementation.

Table 5: Enablers required to support strategy and guidelines implementation

Groundwater gap/challenges	Enablers
No government commitment to implement strategies and guidelines, especially at decision-making levels	▪ Presidential directive or decree ▪ Government leadership and policy on groundwater management (Pietersen *et al.*, 2018) ▪ Public opinion in support of groundwater management ▪ Private sector initiatives and engagement ▪ Groundwater valuation
Insufficient human capacity / shortage of staff in government to implement provisions for groundwater management	▪ Training and education ▪ Facilitation and mentoring ▪ Collaborative research programmes ▪ Private-Public-Civil society partnerships ▪ Internships
The lack of effective monitoring, compliance and control systems regulating groundwater abstraction	▪ Regulations (see section 4.4)
Procurement delays	▪ Treasury regulations, guidelines and procedures ▪ Priority setting ▪ Performance monitoring ▪ Civil society advocacy and pressure groups
Vandalism of instrumentation	▪ Awareness creation ▪ Community ownership and acceptance ▪ Protection measures ▪ Prosecution
Lack of access to private land	▪ Incentives ▪ Regulations
Outdated guidelines and standards	▪ Updated guidelines and standards including best practices

6. INSTITUTIONAL FRAMEWORK

6.1 Evolution

There is general agreement that devolution of groundwater management functions to the lowest technically competent level should be encouraged while retaining a strong central authority for overall management of all water resources (Lazarus, 1998). In the 1956 National Water Act several Subterranean Water Control Boards or Irrigation Boards were established. The 1998 National Water Act required transformation of the Irrigation Boards into Water User Associations. A WUA is a co-operative association of individual water users who wish to undertake water-related activities for their mutual benefit (DWAF, no date).

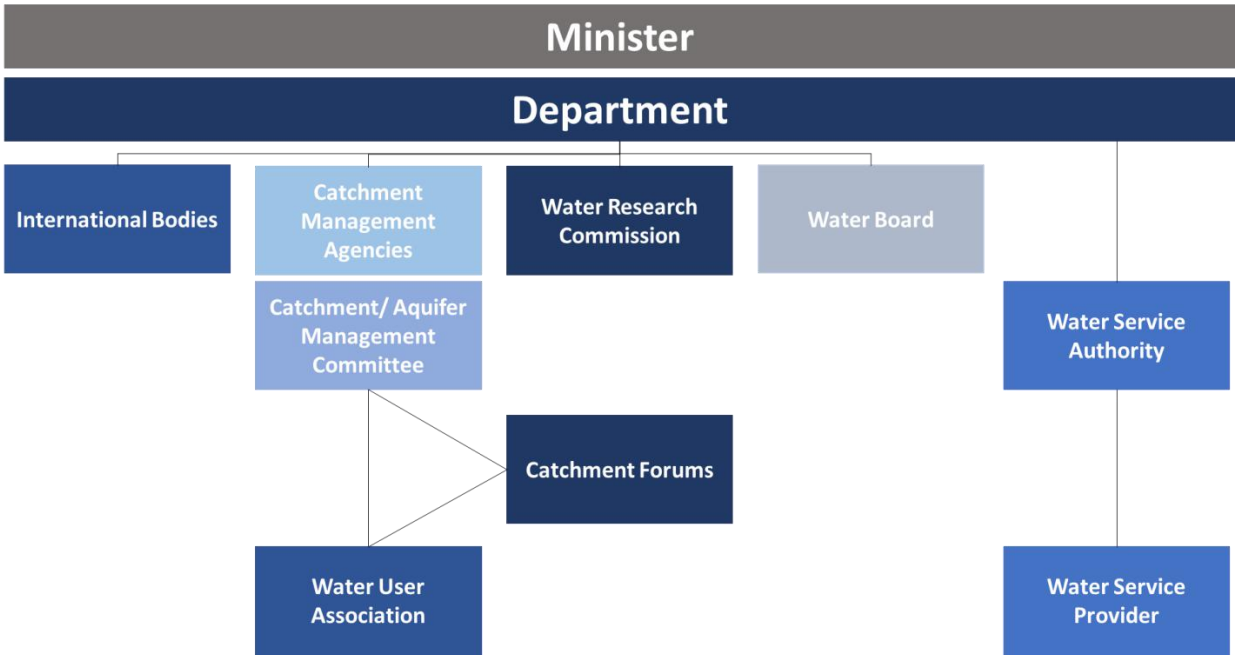

Figure 2: WMIs that has relevance to groundwater management

The Water Management Institutions (WMIs) as it pertains to groundwater is illustrated in Figure 2 and their roles and responsibilities outlined in Table 6.

Table 6: Roles and responsibilities of institutions in groundwater resource management (DWAF, 2008; WRC, 2010; Schreiner *et al.*, 2011)

Level	Institution	Roles and Responsibilities	Regulation
National	Department Water Affairs and Sanitation (National Office)	▪ Responsibility to "protect, use, develop, conserve, manage and control water resources in a sustainable manner. for the benefit of all" ▪ Develop policies, strategies and guidelines for effective resource management.	▪ Set national norms and standards for water use ▪ Sets national targets (quality, quantity, reserve etc.) ▪ Ensure CMA is achieving objectives

Level	Institution	Roles and Responsibilities	Regulation
		▪ Organizational approach ○ Centralized planning and policy making ○ Support function to Regional Offices ○ Decentralized implementation, regional and catchment level	and targets and complying with national policy and NWRS ▪ Allocates water between WMAs and to strategic users ▪ Set raw water pricing
	Department Water Affairs and Sanitation (Regional Offices	▪ Delegated responsibility of water resource management ▪ Implementing policies, strategies and guidelines ▪ Audit of CMA with its related functions and responsibilities	
Regional	Catchment Management Agency (CMA)	▪ Responsible for the day-to-day management of groundwater resources ▪ Delegated responsibility for some water management activities, including water use allocation ▪ Delegation managed and monitored against a specific catchment management strategy for each WMA	▪ Sets WMA targets, objectives, norms and standards ▪ Regulates waster use in WMA (quantity and quality), including compliance monitoring and enforcement, issuing and policing of licenses
	Aquifer Management Committee	▪ Responsible for cross-boundary coordination where the aquifer spans more than one WMA	
Local	Catchment Committee	▪ Responsible for day-to-day management of the groundwater resources within the WMA or local catchment	
	Water User Association	▪ Responsible for the management of the water resources being utilized, including groundwater resources	
	Metropolitan, District and Local Municipalities	▪ Planning and developing water services and infrastructures to ensure acceptable minimum levels of provision to their constituents ▪ Management of local water sources	▪ Develop and enforce ▪ by-laws ▪ Set retail water tariffs

Level	Institution	Roles and Responsibilities	Regulation
	Water Boards	▪ Organs of state established to provide water services to other water services institutions	-
	Catchment Forums	▪ Monitoring and management of water resource development schemes	-

The South African Water Research Commission (WRC), which has invested for 40 years into groundwater knowledge creation and into the building of capacity in the whole water sector for the sustainable utilization and management of groundwater resources (DWS, 2016). The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development.

There are a few professional bodies that deal with groundwater management. The Groundwater Division of the Geological Society of South Africa advances science and technology of groundwater and promotes the efficient use of groundwater as well as professionalism throughout the groundwater industry. Several hydrogeologists in South Africa also belong to the International Association of Hydrogeologist who also aims to develop the understanding, wise use and protection of groundwater resources throughout the world. All practising hydrogeologists in South Africa needs to be registered with the South African Council for Natural Scientific Professions who is the legislated regulatory body for natural science practitioners in South Africa. The NGS 2016 identifies the following institutions that deals with groundwater aspects (DWS, 2016):

- **Academic sectors**: The main groundwater academic centres are the Universities of the Free State and Western Cape. Approximately 600 students graduated in the last 10 years from these two institutions alone, 127 with a MSc or PhD.
- **Council for Geoscience**: 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.
- **CSIR**: The CSSIR, since 1994 has shifted 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.

6.2 Institutional arrangements to support groundwater management

The implementation of the above-mentioned WMIs has met limited success. The Catchment Management Agencies have not been implemented except for the Breede-Gouritz CMA and Inkomati Usuthu CMA. Groundwater requires local water management but a limited number of WUAs have been established resulting in poor groundwater management outcomes. The Tshiping Water User Association (TWUA) is an example WUA that mainly deals with groundwater in the Northern Cape region. There are various competing uses for groundwater in the region. In the past decade, mining increased from 3 to 37 mines, 2 new solar power plants were established and the population increased by 21% within 5 years (van Dyk *et al.*, 2017). Stakeholders expressed the concern that water use licenses are issued without due regard of the cumulative impact of these abstractions on groundwater resources. The lack of implementation of the subsidiarity principle, which was an opportunity for groundwater management, means that the mind-set of groundwater as a private resource persists among politicians and the community at large.

6.3 Gaps and challenges identified

The literature review and consultation undertaken indicates that certain difficulties may be identified with regards to the institutional framework state affecting groundwater management (DWS, 2016):

- There are issues with regards to the failure to establish CMAs and the transition from DWS provincial offices. This has created much uncertainty and it has been difficult to maintain and build key competencies in this uncertainty.
- The continual shifts in policy have been problematic and there have been several fundamental shifts in the last decade. Policy stability is critical to enable the development of institutions.
- The weakness in the groundwater function in national government is of concern at a time when new groundwater capacity must 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.
- No transboundary organisation dealing with groundwater.

6.4 Enablers required to unlock these gaps/challenges

The following enablers are required to unlock the institutional gaps and challenges.

Table 7: Enablers required to unlock the institutional gaps and challenges

Groundwater gap/challenges	Enablers
Few CMAs and groundwater-related WUAs established	▪ Policy certainty ▪ Accelerate establishment of CMAs and WUAs
Weak groundwater function in national government	▪ Groundwater Governance Unit for coordination ▪ Groundwater Champion ▪ Groundwater Chief Directorate at national level, with adequate staff and equipment
Delays in devolution of water resource management to lower levels because of the slow establishment of WMIs	▪ Senior hydrogeologist / head of groundwater in each CMA ▪ Local level groundwater governance organizations (successors to WUAs) in all areas of over-abstraction, and all areas where multiple users coincide (e.g. urban use and irrigation)
Limited participation in local groundwater management	▪ Qualified Hydrogeologist in each District Municipality that is partially groundwater reliant ▪ Local-level institutions for groundwater management with delegated responsibilities
No capacity for groundwater management at local level	▪ Capacitated Local Government (skills and resources)
No transboundary organisation dealing with groundwater	▪ Transboundary groundwater agreements ▪ Groundwater capacity in RBOs

7. CHALLENGES TO IMPLEMENTATION

- **Gaps in groundwater**
  - The subsidiarity principle for groundwater management should have been stronger/more emphasis placed on policy and legislation. Currently there is institutional misalignment as groundwater requires local management and functional Water User Associations (WUAs) and Catchment Management Agencies (CMAs).
  - Groundwater and management of the resource only receive attention during emergency and drought situations.
  - There is a need for a national groundwater management policy which lays down norms and standards to guide regional and local groundwater management practices.
  - The policies and strategies for water management do not consider the uniqueness of the subsurface but focus on coordination of land-based activities.
  - The policy and supporting policies align to the prescripts of considering social, economic, gender and environmental values of water. However, the functional strategies place emphasis largely on environmental aspects and to some degree social considerations (basic human needs and reserve) but hardly address the economic and equity aspirations in the National Water Policy. Nevertheless, the social aspects of the policy meant that groundwater became an important resource for water supply.
  - The customary rights to water are mentioned but are not dealt with in policy and legislation.
  - The role of groundwater in marine discharges is not addressed in water policy.
- **Limited tools for implementation**
  - There is no pricing mechanism or incentives for groundwater use with proper ring-fencing of finances for water supply.
  - The implementation of the legislation has not been supported by the necessary regulations for groundwater management.
- **Limited protection of water resources**
  - The recognition of groundwater as a strategic resource for poverty alleviation, energy and food security, and sustainable economic development is incipient leading to poor protection measures.
  - Adaptive management is recognised in policies and plans but poorly implemented.
- **Lack of appropriate stakeholder engagement**
  - Despite the good intent of the National Water Act, stakeholder involvement, a critical requirement for groundwater management is almost completely missing for groundwater resources (DWS, 2016).
- **Limited capacity**
  - There is no groundwater leadership.

- Limited groundwater monitoring is taking place and the issue of groundwater data in private hands has not yet been resolved.
- A large City like Cape Town struggles with groundwater management but there is the expectation that smaller municipalities cope with management of groundwater resources.
- The lack of capacity in government is hindering implementation.

- **There are no systems planning for drought - the new normal**
- **Corruption has taken place with thousands of boreholes drilled with no supporting evidence.**

8. ACTION PLAN

The MoSCoW method of prioritisation has been used to develop the action plan. This method identifies the *Must have*, *Should have*, *Could have*, and *Won't have* elements for the Groundwater Management Regulatory Framework.

Table 8: Action Plan "Must Haves"

Prioritisation	Element	Description
Must have: ***those elements of the regulatory framework that are critical***	**Policy**	▪ Establish clear groundwater management objectives ▪ Align jurisdictional areas of political/administrative structures with aquifer boundaries ▪ Include protection zoning e.g. subterranean control areas ▪ Include multiple uses of the subsurface space ▪ Incorporate principles of adaptive management ▪ Consider different types of water (freshwater vs. brackish groundwater) ▪ Include customary rights ▪ Establish explicit framework for local groundwater management in South Africa including multi-stakeholder dialogues ▪ Decide on institutional form of local groundwater management institutions ▪ Establish and operationalise local groundwater management institutions ▪ Multi (social) media (Facebook, Twitter, Podcasts, YouTube) campaign for politicians and decision-makers on the socio-economic consequences of not implementing groundwater management policy. Such a campaign would be assisted by policy briefs that clearly show the advantages and cost savings inherent in groundwater use, drawing on established local examples such as the Atlantis MAR scheme, Mahikeng, Pretoria, etc.
	Legislative	▪ Standard and operating procedures for compliance monitoring and enforcement (including measures for unauthorised water use and groundwater metering) ▪ Schedules penalties for illegal water use ▪ Groundwater monitoring: capturing (including privately held groundwater data), processing, reporting and sharing of data ▪ Drilling, borehole construction and completion, pumping tests and water quality tests ▪ Operation and maintenance of groundwater supply schemes
	Institutional	▪ DWS must establish a groundwater Chief Directorate at national level, with adequate staff and equipment ▪ Establish local level groundwater governance organizations (successors to WUAs), negotiated with stakeholders, in all areas of over-abstraction, and all areas where multiple users coincide (e.g. urban use and irrigation) ▪ Each CMA (must have a senior hydrogeologist / head of groundwater

Prioritisation	Element	Description
		▪ Transboundary groundwater management ▪ Capacitate RBOs in groundwater management ▪ Establish transboundary groundwater agreements
	Strategy/ Guidelines	▪ Implement Managed Aquifer Recharge (water banking) ▪ Include the Green Drop and Blue Drop approach for municipalities in the NGS with explicit requirements for groundwater reporting and monitoring ▪ Ensure functional strategies that also address the economic and equity aspirations as communicated in the National Water Policy ▪ Develop awareness campaign on the costs and benefits of groundwater management targeted at the public ▪ Establish Private-Public-Civil Society partnerships on groundwater management ▪ Capacitate government institutions in groundwater management (skills and resources) through training, mentoring and funding ▪ Implement the Data Acquisition and Management Strategy for Water and Sanitation in the Republic of South Africa and the Implementation Strategy for Water Resources Monitoring Network

Table 9: Action Plan "Should Haves"

Prioritisation	Element	Description
Should have	**Policy**	▪ Develop groundwater management policy (to include groundwater quality, quantity and groundwater dependent ecosystems –the latter also with regards to marine discharge) ▪ Establish specific coordination mechanisms in policy for groundwater management
	Legislative	▪ Develop groundwater management regulations ▪ Establish mediation mechanisms for conflict resolution ▪ Provide greater clarity of rights, duties and institutions for consistent jurisprudence
	Institutional	▪ Every DM that is partially groundwater reliant should employ a qualified hydrogeologist, and that person should report quarterly to the DWS
	Strategy/ Guidelines	▪ Implement treasury regulations, guidelines and procedures to minimise delays in procurement by ▪ Setting priorities ▪ Performance monitoring and reporting ▪ Ring-fencing of finances for water supply

Table 10: Action Plan "Could Haves"

Prioritisation	Element	Description
Could have	**Policy**	▪ Make provisions for groundwater leadership

Prioritisation	Element	Description
	Legislative	▪ Amend National Water Act to include provisions for groundwater management ▪ Statutory rules for timeframes of implementation / updates ▪ Multi-sectorial participations in local-level institutions ▪ Pre-authorisation for groundwater use ▪ Priority groundwater management areas for issuing groundwater abstraction licenses ▪ National Groundwater Strategy
	Institutional	▪ Establish a scheme for young DWS hydrogeologists to work in the private sector for a year to gain experience and perspective ▪ Establish the secondment of experienced private sector staff to DWS
	Strategy/ Guidelines	▪ Awareness creation on the value of groundwater infrastructure including instrumentation ▪ Community ownership and acceptance ▪ Protection measures ▪ Prosecution ▪ Incentives ▪ Update guidelines and standards with reference to groundwater management regulations

Table 11: Action Plan "Won't Haves"

Prioritisation	Element	Description
Won't have	**Policy**	▪ Continued institutional dominance of surface water in a country where the majority relies on groundwater, and where surface water resources are fully allocated
	Legislative	▪ Continued legal and policy uncertainty regarding groundwater institutions and local governance
	Institutional	▪ Consolidation and dominance of interim and relatively weak local groundwater governance organisations
	Strategy/ Guidelines	▪ Lack of traction for revised NGS

9. REFERENCES

Abia, A. L. K., Schaefer, L., Ubomba-Jaswa, E. and Le Roux, W. (2017) 'Abundance of Pathogenic Escherichia coli Virulence-Associated Genes in Well and Borehole Water Used for Domestic Purposes in a Peri-Urban Community of South Africa', *International Journal of Environmental Research and Public Health*, 14(3).

Abiye, T., Bybee, G. and Leshomo, J. (2018) 'Fluoride concentrations in the arid Namaqualand and the Waterberg groundwater, South Africa: Understanding the controls of mobilization through hydrogeochemical and environmental isotopic approaches', *Groundwater for Sustainable Development*, 6, pp. 112–120. doi: https://doi.org/10.1016/j.gsd.2017.12.004.

Adams, S., Braune, E., Cobbing, J. E., Fourie, F. and Riemann, K. (2015) 'Critical Reflections on 20 Years of Groundwater Research, Development and Implementation in South Africa', *South African Journal of Geology*, 118(1), pp. 5–16. doi: 10.2113/gssajg.118.1.5.

AECOM (2016) *Review, Evaluation and Optimisation of the South African Water Resources Monitoring Network: Scientific Review Report*. Pretoria, South Africa.

AECOM (2017) *Review, Evaluation and Optimisation of the South African Water Resources Monitoring Network: Implementation Strategy*. Pretoria, South Africa.

AGSA (2018) *Report of the auditor-general to the joint committee of inquiry into the functioning of the Department of Water and Sanitation: Challenges facing the water and sanitation portfolio*. Auditor General of South Africa.

Albrecht, T. R., Varady, R. G., Zuniga-Teran, A. A., Gerlak, A. K. and Staddon, C. (2017) 'Governing a shared hidden resource: A review of governance mechanisms for transboundary groundwater security', *Water Security*, 2, pp. 43–56. doi: 10.1016/j.wasec.2017.11.002.

Altchenko, Y., Genco, A., Pierce, K., Woolf, R., Nijsten, G.-J., Ansems, N., Magombeyi, M., Ebrahim, G., Lautze, J., Villholth, K., Lefore, N., Modisha, R. C. O., Baqa, S., McGill, B. and Kenabatho, P. (2017) *Resilience in the Limpopo Basin: The potential role of the transboundary Ramotswa Aquifer - Hydrogeological report*. Available at: http://ramotswa.iwmi.org/Data/Sites/38/media/pdf/hydrogeological_report_2017.pdf.

Babbitt, C., Hall, M., Hayden, A., Lucia, A., Garcia Briones, A. L., Young, R. and Brozović, N. (2017) *Groundwater Trading as a Tool for Implementing California ' s Sustainable Groundwater Management Act*. Environmental Defense Fund.

Bailey, A. and Pitman, W. (2016) *Water Resources of South Africa*. Pretoria: Water Research Commission. Available at: http://www.wrc.org.za/Knowledge Hub Documents/Research Reports/TT 683-16.pdf.

Bergkamp, G. and Cross, K. (2006) 'Groundwater and ecosystem services: towards their sustainable use', *International Symposium on Groundwater Sustainability (ISGWAS)*, pp. 177–193. doi: 10.1073/pnas.0707823105.

Bugan, R. D. H., Jovanovic, N., Israel, S., Tredoux, G., Genthe, B., Steyn, M., Allpass, D., Bishop, R. and Marinus, V. (2016) 'Four decades of water recycling in Atlantis (Western Cape , South Africa): Past , present and future', *Water SA*, 42(4), pp. 577–594.

CapNet, AWG-Net and GW-Mate (2010) *Groundwater Management in IWRM: Training Manual*. Available at: http://scholar.google.ca/scholar?start=100&q=iwrm&hl=en&as_sdt=1,5#58.

Cobbing, J. E., Eales, K., Gibson, J., Lenkoe, K. and Cobbing, B. L. (2015) 'Operation and maintenance (O&M)

and the perceived unreliability of domestic groundwater supplies in South Africa', *South African Journal of Geology*, 118(1), p. 17 LP-32. Available at: http://sajg.geoscienceworld.org/content/118/1/17.abstract.

Cobbing, J. and De Wit, M. (2018) 'The Grootfontein aquifer : Governance of a hydro- social system at Nash equilibrium', *South African Journal of Science*, 114(5), pp. 1–7.

Coetzee, H. (2016) 'Management of water levels in the flooded mines of the Witwatersrand , South Africa', in *IMWA 2016 Mining Meets Water - Conflits and Solutions*, pp. 630–635.

Conrad, J., Colvin, C., Sililo, O., Gorgens, A. and Weaver, J. (1999) *Assessment of the impact of agricultural practices on the quality of groundwater resources*. Pretoria: Water Research Commission.

Couzens, E., Maduramuthu, D., Bellengère, A., Couzens, E. and Bellengère, A. (2017) '"Water Security and Judicial and Administrative Confusion in South Africa: The Trustees of the Time Being of the Lucas Scheepers Trust, IT 633/96 v MEC for the Department of Water Affairs, Gauteng 2015 ZAGPPHC 211 (17 April 2015)"', *PER / PELJ*, 20. doi: http://dx.doi.org/10.17159/1727-3781/2017/v20n0a1686.

DAFF (2015) *Irrigation Strategy for South Africa*. Pretoria: Department of Agriculture Forestry and Fisheries. Available at: http://www.daff.gov.za/doaDev/sideMenu/ForestryWeb/dwaf/cmsdocs/Elsa/Docs/Forests/Woodl/Final Irrigation Strategy March 2015 with cover (3).pdf.

Damkjaer, S. and Taylor, R. (2017) 'The measurement of water scarcity: Defining a meaningful indicator', *Ambio*. Springer Netherlands, 46(5), pp. 513–531. doi: 10.1007/s13280-017-0912-z.

Dippenaar, M. A. (2013) *Hygrogeological Heritage Overview: Pretoria's Fountains - Arteries of Life*.

Donnenfeld, Z., Crookes, C. and Hedden, S. (2018) *A delicate balance: Water scarcity in South Africa*. Institute for Security Studies. Available at: https://issafrica.org/research/southern-africa-report/a-delicate-balance-water-scarcity-in-south-africa.

DWA (2013) *National Water Resource Strategy*. Pretoria: Department of Water Affairs.

DWAF (1997a) *Minimum standards and guidelines for groundwater resource development for the community water supply and sanitation programme*. Pretoria: Department of Water Affairs and Forestry.

DWAF (1997b) *White Paper on a National Water Policy for South Africa*. Pretoria: Department of Water Affairs and Forestry.

DWAF (2000) *Policy and Strategy for Groundwater Quality Management in South Africa*. Pretoria: Department of Water Affairs and Forestry.

DWAF (2003) *A Protocol to manage the potential of Groundwater Contamination from Sanitation Practices*. Pretoria: Department of Water Affairs and Forestry.

DWAF (2008) *A Guideline for the Assessment, Planning and Management of Groundwater Resources in South Africa*. Pretoria: Department of Water Affairs and Forestry.

DWAF (2010) *Groundwater Strategy*. Department. Pretoria: Deoartment of Water Affairs and Forestry.

DWAF (no date) *Water management Institutions Overview*. Pretoria: Department of Water Affairs and Forestry.

DWS (2015) *Vaal Gamagara Bulk Water Scheme Implementation Readiness Report*. Pretoria: Department of Water and Sanitation.

DWS (2016) *National Groundwater Strategy of South Africa*. Pretoria.

DWS (2017a) *Integrated Water Quality Management Policy*. Pretoria: Department of Water and Sanitation.

DWS (2017b) *Mine Water Management Policy Position - Draft for external consultation and discussion*. Pretoria: Department of Water and Sanitation.

DWS (2017c) *Wetland Policy (Draft)*. Pretoria: Department of Water and Sanitation.

DWS (2018) *National Water and Sanitation Master Plan: Volume 1: Call to Action (Version 8.3) Ready for the Future and Ahead of the Curve*. Pretoria: Department of Water and Sanitation. Available at: http://www.dwa.gov.za/National Water and Sanitation Master Plan/Documents/NWSMP Call to Action v8.3 18 Jan 2018 CORAL version.pdf.

van Dyk, G., Baloyi, L., Wiegmans, F. and van Wyk, E. (2017) 'Bulk groundwater use from mine de-watering and dolomite aquifers in the Northern Cape, benefits, impacts, regulation and sustainability', in *15th Biennial Groundwater Conference*.

Gamagara Municipality (2013) *Kathu Water Management Plan*. Kathu: Gamagara Municipal Council and Administration.

Godden, L. (2005) 'Water law reform in Australia and South Africa: Sustainability, Efficiency and Social Justica', *Journal of Environmental Law*, 17(2), pp. 181–205. doi: 10.1177/0021909614550895.

Griebler, C. and Avramov, M. (2015) 'Groundwater ecosystem services: a review', *Freshw. Sci.*, 34(1), pp. 355–367. doi: 10.1086/679903.

van der Gun, J., Aureli, A. and Merla, A. (2016) 'Enhancing groundwater governance by making the linkage with multiple uses of the subsurface space and other subsurface resources', *Water (Switzerland)*, 8(6). doi: 10.3390/w8060222.

van der Gun, J., Merla, A., Jones, M. and Burke, J. (2012) *Governance of the subsurface space and groundwater frontiers*. Rome.

Kapfudzaruwa, F. and Sowman, M. (2009) *Is there a role for traditional governance systems in South Africa's new water management regime?*, *Water SA*. doi: 10.4314/wsa.v35i5.49195.

Kavin, H. (2000) 'Legal position of underground water in terms of the National Water Act 1998 (Special emphasis on existing water use)', in *Course on Groundwater and the National and Water Services Acts*. Pretoria: Groundwater Division of South Africa.

Kelbe, B. E., Grundling, A. T. and Price, J. S. (2016) 'Modelling water-table depth in a primary aquifer to identify potential wetland hydrogeomorphic settings on the northern Maputaland Coastal Plain, KwaZulu-Natal, South Africa', *Hydrogeology Journal*, 24(1), pp. 249–265. doi: 10.1007/s10040-015-1350-2.

Kidd, M. (2017) 'Climate change, groundwater and the law: exploring the connections in South Africa', *Water International*. Routledge, 42(6), pp. 678–690. doi: 10.1080/02508060.2017.1351057.

Kiparsky, M., Milman, A., Owen, D. and Fisher, A. (2017) 'The Importance of Institutional Design for Distributed Local-Level Governance of Groundwater: The Case of California's Sustainable Groundwater Management Act', *Water*, 9(10), p. 755. doi: 10.3390/w9100755.

Knüppe, K. (2011) 'The challenges facing sustainable and adaptive groundwater management in South Africa', *Water SA*, 37(1), pp. 67–79.

Lazarus, P. (1998) *Towards a regulatory framework for the management of groundwater in South Africa*. Pretoria: Water Research Commission.

Lumsden, T. G., Schulze, R. E. and Hewitson, B. C. (2009) 'Evaluation of potential changes in hydrologically relevant statistics of rainfall in Southern Africa under conditions of climate change', *Water SA*,

35(5), pp. 649–656. doi: 10.4314/wsa.v35i5.49190.

Masiyandima, M., Van der Stoep, I., Mwanasawani, T. and C Pfupajena, S. (2002) *Groundwater management strategies and their implications on irrigated agriculture: The case of Dendron aquifer in Northern Province, South Africa*, *Physics and Chemistry of The Earth - PHYS CHEM EARTH*. doi: 10.1016/S1474-7065(02)00096-7.

McCarthy, T. S. (2011) 'The impact of acid mine drainage in South Africa', *South African Journal of Science*, 107(5/6), pp. 1–7. doi: 10.4102/sajs.v107i5/6.712.

McDonnel, R. and Fragaszy, S. (2016) *Groundwater use and policies in Abu Dhabi*. UASAID.

Mechlem, K. (2016) 'Groundwater Governance : The Role of Legal Frameworks at the Local and National Level — Established Practice and Emerging Trends'. doi: 10.3390/w8080347.

Meissner, R., Funke, N., Nortje, K., Jacobs-Mata, I., Moyo, E., Steyn, M., Shadung, J., Masangane, W. and Nohayi, N. (2018) 'Water security at local government level in South Africa: a qualitative interview-based analysis', *The Lancet Planetary Health*. Elsevier Ltd, 2. doi: 10.1016/S2542-5196(18)30102-5.

Merrey, D. J., Prakash, A., Swatuk, L., Jacobs, I. and Narian, V. (2017) 'Water Governance Futures in South Asia and Southern Africa: Déjà Vu All Over Again?', in Karar, E. (ed.) *Freshwater Governance for the 21st Century*. Springer Open. doi: 10.1007/978-3-319-43350-9.

Murray, R., Baker, K., Ravenscroft, P., Musekiwa, C. and Dennis, R. (2012) 'A groundwater-planning toolkit for the Main Karoo Basin: Identifying and quantifying groundwater-development options incorporating the concept of wellfield yields and aquifer firm yields', *Water SA*, 38(3), pp. 407–416. doi: 10.4314/wsa.v38i3.6.

Murray, R., Louw, D., Merwe, B. Van Der, Peters, I. and Murray, R. (2018) 'Windhoek , Namibia : from conceptualising to operating and expanding a MAR scheme in a fractured quartzite aquifer for the city ' s water security', *Sustainable Water Resources Management*. Springer International Publishing, 4(0123456789), pp. 217–223. doi: 10.1007/s40899-018-0213-0.

Nijsten, G.-J. J., Christelis, G., Villholth, K. G., Braune, E. and Gaye, C. B. (2018) 'Transboundary aquifers of Africa: Review of the current state of knowledge and progress towards sustainable development and management', *Journal of Hydrology: Regional Studies*. Elsevier, (February), pp. 1–14. doi: https://doi.org/10.1016/j.ejrh.2018.03.004.

NPC (2012) *National Development Plan: Our future - make it work*. Pretoria: National Planning Commission. doi: ISBN: 978-0-621-41180-5.

NSW Government (1997) *The NSW State Groundwater Policy Framework Document*. Department of Land & Water Conservation, NSW Government.

Pahl-Wostl, C., Holtz, G., Kastens, B. and Knieper, C. (2010) 'Analyzing complex water governance regimes: the Management and Transition Framework', *Environmental Science & Policy*, 13(7), pp. 571–581. doi: https://doi.org/10.1016/j.envsci.2010.08.006.

Pearce, D., Peck, H., Riemann, K., Harris, K. and Hartnady, C. (2013) 'the Economics of Sustainable Groundwater Ecosystem Services', in *13th Biennial Groundwater Division Conference and Exhibition*. Durban: Groundwater Division of South Africa.

Pietersen, K. (2004) *A decision-making framework for groundwater management in arid zones (with a case study in Namaqualand)*. University of the Western Cape.

Pietersen, K., Beekman, H., Cobbing, J. and Kanyerere, T. (2018) *Consultancy for capacity needs assessment to determine priority challenges for capacity development initiatives in Member States*.

Bloemfontein, South Africa: Southern African Development Community Groundwater Management Institute.

Pietersen, K., Beekman, H. and Holland, M. (2011) *South African Groundwater Governance Case Study*. Pretoria, South Africa: World Bank, Department of Water Affairs and Water Research Commission.

Pietersen, K., Beekman, H., Holland, M. and Adams, S. (2012) 'Groundwater governance in South Africa: A status assessment', *Water SA*, 38(3).

Pietersen, K., Kellgren, N., Roos, M. and Chevallier, L. (2010) *Explanatory Brochure for the South African Development Community (SADC) Hydrogeological Map & Atlas*. Southern African Development Community.

PMG (2018) *Department of Water and Sanitation irregular, fruitless and wasteful expenditure: hearing*, *Public Accounts Committee Meeting Minutes*. Available at: https://pmg.org.za/committee-meeting/25848/ (Accessed: 19 July 2018).

Ramaphosa, C. (2017) 'How we will rebuild South Africa', *City Press*, 19 November. Available at: https://www.news24.com/Columnists/GuestColumn/how-we-will-rebuild-south-africa-20171119-3.

Riemann, K., Chimboza, N. and Fubesi, M. (2012) 'A proposed groundwater management framework for municipalities in South Africa', *Water SA*, 38(3), pp. 445–452. doi: 10.4314/wsa.v38i3.10.

RSA (1996) *Constitution of the Republic of South Africa*. doi: 10.1017/S0021855300011499.

RSA (1998) *National Water Act*, *Government Gazette*. South Africa.

Ruben Aza-Gnandji, C. D., Xu, Y., Raitt, L. and Levy, J. (2013) 'Salinity of irrigation water in the Philippi farming area of the Cape Flats, Cape Town, South Africa', *Water SA*, 39(2), pp. 199–210. doi: 10.4314/wsa.v39i2.3.

Sakala, E., Fourie, F., Gomo, M. and Coetzee, H. (2018) 'GIS-based groundwater vulnerability modelling : A case study of the Witbank , Ermelo and Highveld Coal fields in South Africa', *Journal of African Earth Sciences*. Elsevier Ltd, 137, pp. 46–60. doi: 10.1016/j.jafrearsci.2017.09.012.

Schreiner, B., Chimuti, S., Gouws, M. and Mbanda, V. (2011) *Towards Water Resources Regulation in South Africa Volume 1: Survey of Approaches to Water Resources Regulation*. Pretoria, South Africa.

Scott, D. F. and Gush, M. B. (2017) 'Chapter 11. Forest Management and Water in the Republic of South Africa', in Garcia-Chevesich, P. A., Neary, D. G., Scott, D. F., Benyon, R. G., and Renya, T. (eds) *Forest management and the impact on water resources: a review of 13 countries*. Paris: United Nations Educational, Scientific and Cultural Organization, pp. 159–168. Available at: https://researchspace.csir.co.za/dspace/bitstream/handle/10204/9160/Gush_2017.pdf?sequence=1.

Seward, P. (2015) *Rethinking groundwater governance in South Africa*. University of the Western Cape.

Seward, P. and Xu, Y. (2015) *Key Interventions to Improve Local Groundwater Governance*. Pretoria.

Tempelhoff, J. (2017) 'The Water Act, No. 54 of 1956 and the first phase of apartheid in South Africa (1948–1960)', *Water History*. Springer Netherlands, 9(2), pp. 189–213. doi: 10.1007/s12685-016-0181-y.

Tewari, D. D. (2009) 'A detailed analysis of evolution of water rights in South Africa: An account of three and a half centuries from 1652 AD to present', *Water SA*, 35(5), pp. 693–710. doi: 10.4314/wsa.v35i5.49196.

Theesfeld, I. (2010) 'Institutional challenges for national groundwater governance: Policies and issues', *Ground Water*, 48(1), pp. 131–142. doi: 10.1111/j.1745-6584.2009.00624.x.

du Toit, W., Holland, M., Weidemann, R. and Botha, F. (2012) 'Can groundwater be successfully implemented as a bulk water resource within rural Limpopo Province? analysis based on GRIP datasets', *Water SA*, 38(3), pp. 391–398. doi: 10.4314/wsa.v38i3.4.

Van Tonder, G. J. and Kirchner, J. (1990) 'Estimation of natural groundwater recharge in the Karoo aquifers of South Africa', *Journal of Hydrology*, 121(1–4), pp. 395–419. doi: 10.1016/0022-1694(90)90243-Q.

UNESCO (2015) *Global Diagnostic on Groundwater Governance*.

UNESCO (2016) *Stampriet: Transboundary Aquifer System Assessment*. Paris: International Hydrological Programme of the United Nations Educational, Scientific and Cultural Organization.

WEF (2015) *The 2014 Sustainable Groundwater Management Act: A Handbook to Understanding and Implementing the Law*. Water Education Foundation. Available at: www.watereducation.org.

Woodford, A. and Rosewarne, P. (2006) *How Much Groundwater Does South Africa Have?* Cape Town. doi: 10.3402/polar.v4i1.6921.

WRC (2010) *Water resources regulation: Key issues and principles*. Pretoria, South Africa.

WRC (2017) *Groundwater Sampling Manual*. Pretoria: Water Research Commission.

van Wyk, E., van Tonder, G. and Vermeulen, D. (2012) 'Characteristics of local groundwater recharge cycles in South African semi-arid hard rock terrains: Rainfall-groundwater interaction', *Water SA*. doi: 10.4314/wsa.v38i5.14.

APPENDIX A: LITERATURE INVENTORY LIST

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
2016	National Groundwater Strategy	DWS	DWS		www.dws.org.za
2011	South African Groundwater Governance Study	Pietersen et al.	WRC, DWS and World Bank	KV 273/11	www.wrc.org.za
2016	An analysis of the challenges for groundwater governance during shale gas development in South Africa	Pietersen et al.	Water SA		www.wrc.org.za
2010	Explanatory Brochure for the South African Development Community (SADC) Hydrogeological Map & Atlas	Pietersen et al.	SADC-WD		
2016	Position Paper: Groundwater Management in the Southern African Development Community	Pietersen and Beekman	SADC-GMI		www.sadc-gmi.org
2018	The Grootfontein aquifer : Governance of a hydro- social system at Nash equilibrium	Cobbing and De Witt	South African Journal of Science	S Afr J Sci. 2018;114 (5/6)	http://dx.doi.org/10.17159/ sajs.2018/20170230

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
2008	Protocol for the Assessment of the Status of Sustainable Utilization and Management of Groundwater Resources with Special Reference to Southern Africa	Braune et al.	WRC		
2013	Regional Diagnosis for the Sub-Saharan Africa Region	Braune and Adams	WRC	TT 578/13	
2006	How much groundwater does South Africa have?	Woodford et al.	SRK		
2016	Review, evaluation and optimisation of the South African water resources monitoring network: Scientific review report	AECOM	DWS		
2017	Review, evaluation and optimisation of the South African water resources monitoring network: Implementation strategy	AECOM	DWS		
2016	Shared global vision for groundwater governance 2030 and a Call for Action	FAO	FAO		

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
2013	Trends in local groundwater management institutions	Moench et al.			
2015	A Framework for groundwater use authorisations as part of groundwater governance in water scarce areas within South Africa	Kotze	Free State University		
1997	White paper on a national water policy for South Africa	DWAF	DWAF		
2016	Modes and Approaches of Groundwater Governance: A Survey of Lessons Learned from Selected Cases across the Globe	Varaday et al.	Water	Water 2016, 8, 417; doi:10.3390/w8100417	www.mdpi.com/journal/water
2001	Development of a Code of Good Practice for Groundwater Development in the SADC Region	SADC WSCU	SADC WSCU		
2003	Southern African Development Community Regional Situation Analysis	Farr et al.	BGS		

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
2006	Challenges to transboundary aquifer management in the SADC region	Beetlestone			
2008	A critical overview of transboundary aquifers shared by South Africa	Cobbing et al.	Hydrogeology Journal	Hydrogeology Journal (2008) 16: 1207–1214	
2009	The basement aquifers of Southern Africa	Titus et al.	WRC	TT 428-09	
2009	ORASECOMs institutional linkages and the role of groundwater	Beekman et al.	Groundwater Division		
2012	Identifying transboundary aquifers in need of international resource management in the Southern African Development Community region	Davies et al.	Hydrogeology Journal	Hydrogeology Journal (2013) 21: 321–330	
2013	Key Issues Related to Groundwater Management in the Orange-Senqu River Basin	ORASECOM	ORASECOM		
2015	Rethinking groundwater governance in South Africa	Seward	University of the Western Cape		

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
2000	Policy and strategy for groundwater quality management in South Africa	DWAF	DWAF		http://www.dwa.gov.za/Documents/Policies/WDD/GroundWater.pdf
2013	A proposed groundwater management framework for municipalities in South Africa	Riemann et al.	Water SA	Water SA Vol. 38 No. 3 International Conference on Groundwater Special Edition 2012	
2012	Groundwater policy and law in South Africa and mainland Tanzania: A comparative study	Ali	University of the Western Cape		
1998	Towards a regulatory frameowrk for groundwater management	Lazarus	WRC	789/1/98	
2015	Key intervention to improve local groundwater governance	Seward and Xu	WRC	2238/1/15	
2014	20 Years of Groundwater Research, Development and Implementation in South Africa 1994-2014	Braune et al.	WRC	SP 78/14	

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
1998	National Water Act	RSA	Government Gazette	Vol. 398 No. 19182	
2016	Groundwater Governance: The Role of Legal Frameworks at the Local and National Level—Established Practice and Emerging Trends	Mechlem	Water	Water 2016, 8, 347; doi:10.3390/w8080347	
2016	Review, evaluation and optimisation of the South African water resources monitoring network: Scientific Review Report	AECOM	DWS		
2017	Review, Evaluation and Optimisation of the South African Water Resources Monitoring Network: Implementation Strategy	AECOM	DWS		
2018	Report of the auditor-general to the joint committee of inquiry into the functioning of the Department of Water and Sanitation: Challenges facing the water and sanitation portfolio	AGSA	Auditor General of South Africa		

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
2017	Resilience in the Limpopo Basin: The potential role of the transboundary Ramotswa Aquifer - Hydrogeological report	Altchenko et al			
2016	Water Resources of South Africa	Bailey and Pitman	Water Research Commission	TT 683/16	
2015	Operation and maintenance (O&M) and the perceived unreliability of domestic groundwater supplies in South Africa	Cobbing et al.	South African Journal of Geology	118(1)	

APPENDIX B: STAKEHOLDER LIST

Full Stakeholder List

Title	Name:	Surname:	Affiliation:	Role:	Sector Group	Telephone	Cell Number	Email:	Priority (yes/no)
Mr	Fanus	Fourie	Department of Water and Sanitation	Scientific Manager	National Government	012 336 7303		fourief@dws.gov.za	yes
Dr	Shafick	Adams	Water Research Commission	Executive Manager	National Government/ Research			shaficka@wrc.org.za	yes
Prof	Eberhard	Braune	University of the Western Cape	Professor	Academia			ebaune123uwc@gmail.com	yes
Mr	Zacharia	Maswuma	Department of Water and Sanitation	Director	National Government			MaswumaZ@dws.gov.za	yes
Mr	Khangwelani	Netili	Department of Water and Sanitation	Water Scientist	National Government			NetiliK@dws.gov.za	yes

Title	Name:	Surname:	Affiliation:	Role:	Sector Group	Telephone	Cell Number	Email:	Priority (yes/no)
Mr	Sakhile	Mndaweni	Department of Water and Sanitation	Scientific Manager	National Government			MndaweniS@dws.gov.za	no
Mr	Ramusiya	Fhedzisani	Department of Water and Sanitation	Scientific Manager: Groundwater Resources Assessment & Monitoring	National Government	012 336 7309	063 407 4021	RamusiyaF@dws.gov.za	yes
Mr	Eelco	Lucas	University of the Free State	Institute for Groundwater Studies	Academia			LukasE@ufs.ac.za	no
Dr	Matthys	Dippenaar	Groundwater Division of South Africa	Chairperson	Academia			matthys.dippenaar@up.ac.za	no
Dr	Johanita	Kotze	Anglo America	Lead Water Management – Africa and Australia	Business	011 638 3027	082 658 4082	johanita.kotze@angloamerican.com	yes

Title	Name:	Surname:	Affiliation:	Role:	Sector Group	Telephone	Cell Number	Email:	Priority (yes/no)
Dr	Paul	Seward			National Government/ Research			sewardp@vodamail.co.za	no
Dr	Roger	Parsons	Parsons and Associates Specialist Groundwater Consultants	Consultant	Provincial Government/ Business	028 273 8676	083 310 6504	roger@pasgc.co.za	no

Stakeholders engaged

Name	Organisation
Dr Shafick Adams	Water Research Commission
Prof Eberhard Braune	University of the Western Cape
Mr Z Maswuma	Department of Water and Sanitation: Surface and groundwater Information
Mr S Mndaweni	Department of Water and Sanitation: Integrated Hydrological Planning
Ms S Naicker	Department of Water and Sanitation
Mr WA Nyalungu	Department of Water and Sanitation
Mr John Sibanyoni	Breede-Gouritz Catchment Management Agency

Stakeholders that completed the questionnaires

Name	Position	Stakeholder Group
Dr Shafick Adams	Executive Manager, WRC	Research, Government
Prof Eberhard Braune	Retired Department of Water Affairs (DWAF) official and academic at the University of the Western Cape (UWC)	Research
Mr Z Maswuma	Director: Surface and groundwater Information, DWS	Focal contact person, Government
Mr S Mndaweni	Scientific Manager: Integrated Hydrological Planning, DWS	Government
Ms S Naicker	Production Scientist, DWS	Government
Mr WA Nyalungu	Control Scientific Technician, DWS	Government
Mr John Sibanyoni	Geohydrologist/ Acting Water Use License Manager, BGCMA	Catchment Management Agency, Government

Validation Workshop and Broader Stakeholders

Name	Position	Stakeholder Group
Ms Nicolette Vermaak	Scientist Production (Geohydrologist) at the Department of Water Affairs	Government (Validation Workshop)
Ms Rachel Mpe	Geohydrologist at the Department of Water and Sanitation	Government (Validation Workshop)
Mr Sakhile Mndaweni	Scientific Manager at Department of Water Affairs	Government (Validation Workshop)

Name	Position	Stakeholder Group
Mr Albertus Viljoen	CEO at Tshiping WUA	Water User Association (Broader Stakeholder)

APPENDIX C: DESIRED FUTURE STATE SUMMARY

Reflection of Policy Framework as per the minimum requirement for the Desired Future State

Minimum requirement for desired future	Status	Comment
A long-term policy to protect groundwater by preventing pollution and overuse. This policy is comprehensive, implemented at all appropriate levels, consistent with other water management policies and be duly taken into account in other sectorial policies;	Partially	The National Water Policy is the overarching policy for water management in South Africa. There is a specific Policy and Strategy for Groundwater Quality Management in South Africa which is comprehensive in as far it deals with groundwater quality management but there is lesser emphasis on groundwater abstraction and control. The National Groundwater Strategy has identified the need for a national groundwater management policy which lays down norms and standards to guide regional and local groundwater management practices. To date there has been limited implementation of policies and weak inter-sectoral integration and collaboration.
The social, economic and environmental values of groundwater are all recognised;	Partially	The policy take into account social, economic, gender and environmental values of water but the role of groundwater is not fully understood.
The human right to water is recognized and a rights-based approach to groundwater management is taken, *inter alia*, through:	Achieved	Although no specific reference to groundwater – the basic human needs of water is recognised within policy.
Prioritization of drinking water/basic human needs in water legislation;	Achieved	Basic Human Needs: Principle 8 - The water required to ensure that all people have access to sufficient water shall be reserved.
Ensuring that land-based rights cannot entitle unlimited access/use of freshwater, including groundwater;	Achieved	Rights to water not tied to land ownership: Principle 3 - There shall be no ownership of water, but only a right to its use (for environmental and basic human needs) or an authorisation for its use. Any authorisation to use water in terms of the Water Law shall not be in perpetuity.
Ensuring groundwater is legally recognized as a public good;	Achieved	Since 1998 groundwater has been recognised as a public good: Principle 2 - 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.
Recognising the role of groundwater in meeting basic human needs for food security;	Not achieved	The recognition of groundwater as a strategic resource for poverty alleviation and food security is incipient leading to poor protection measures.
Legal recognition of customary rights to freshwater, including groundwater;	Not achieved	The customary rights to water are mentioned in policy but not legally recognised.

Minimum requirement for desired future	Status	Comment
Legal mechanisms to ensure gender equity in access, use and management of freshwater, including groundwater;	Partially	There is policy and legal prescripts to ensure gender equity in access, use and management of water resources but poorly implemented.
Provision of pricing mechanisms that incentivize equitable distribution of rights to access and use of groundwater, as well as prioritization of small-scale users' livelihoods and food security needs, especially youth and women.	Not achieved	There is no prizing mechanisms or incentives for groundwater use and its role in meeting social obligations.
Groundwater is recognised as a highly important source of domestic and agricultural water supply and a key resource for poverty alleviation, food security, and the sustainable economic development of rural areas;	Partially	There has been recognition in rural areas and small towns of the importance of groundwater. In its implementation rural water supplies are seen as drilling of a borehole whilst no proper assessment is done. In agriculture, groundwater is still viewed as a private resource. The recognition of groundwater as a strategic resource for poverty alleviation, energy and food security, and sustainable economic development is incipient.
The biophysical and ecological linkages between ground and surface water for their use, protection and management are recognised, including land use zoning for groundwater protection and recharge (conjunctive use);	Achieved	Principle 2 - 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 should have a consistent status in law, irrespective of where it occurs. Principle 5 -In a relatively arid country such as South Africa, it is necessary to recognise the unity of the water cycle and the interdependence of its elements, where evaporation, clouds and rainfall are linked to groundwater, rivers, lakes, wetlands and the sea, and where the basic hydrological unit is the catchment.
The importance of the maintenance of the ecological integrity of wetlands in groundwater management is recognised (recharge zones);	Achieved	Principle 5 -In a relatively arid country such as South Africa, it is necessary to recognise the unity of the water cycle and the interdependence of its elements, where evaporation, clouds and rainfall are linked to groundwater, rivers, lakes, wetlands and the sea, and where the basic hydrological unit is the catchment.
Intersectoral collaboration is promoted and facilitated so that the needs and impacts of different sectors (e.g., land, agriculture, mining, municipal, and environment) are taken into account in groundwater management and the impacts of developments in those sectors on groundwater are accounted for;	Not achieved	The underground environment is not visualized or seen in policy and legislation. The proposed coordination is above surface but ignores subsurface processes which are important for groundwater management. There is poor sector coordination regarding groundwater use. The NGS 2016 recognises that there is insufficient co-

Minimum requirement for desired future	Status	Comment
		operation between different government departments involved in land-use management and activities which impact upon groundwater resources.
The need for adaptive management is recognised due to the inherent limitations in the nature of scientific information in conjunction with the widely occurring dynamic processes of climate, social and institutional change;	Partially	Adaptive management is recognised in policies and plans but weakly implemented.
The roles of various stakeholders and water users in groundwater management is recognised and participation of stakeholders in decision-making and groundwater management is promoted and facilitated;	Not achieved	Despite the good intent of the National Water Act, stakeholder involvement, a critical requirement for groundwater management, is virtually completely missing for groundwater resources. 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. This point to a gap that local management of water resources should have been much stronger in policy – subsidiarity principle.
An apex body that is responsible explicitly for GW management and playing the role of custodian/trustee on the part of the state is clearly defined;	Not achieved	There is a shortcoming in National Groundwater Leadership.
Effective institutional arrangements are coordinated at trans boundary, national and local levels;	Not achieved	Weak institutions.
Public access to geo-hydrological data held by the state is promoted and facilitated	Achieved	National Groundwater Information System (NGIS) • National Groundwater Archive • Geohydrological Reports System • CHART The NGIS is web enabled and available online for users through a registration process
- Additional environmental principles necessary to protect and sustain groundwater are mandated, including: the precautionary principle, the principle of gender equity and social inclusion (GESI), the principle of subsidiarity, and the principle of intergenerational equity.	Partially	The policy and supporting policies make provisions for the principles as listed by the National Water Policy. However, the subsidiarity principle for groundwater should have been stronger/more emphasis placed.

Reflection of Legal Framework as per the minimum requirement for the Desired Future State

Minimum requirement for desired future	Status	Comment
Provide Status of Groundwater		
All water has a consistent status in law, irrespective of where it occurs	Achieved	Preamble of the National Water Act: Recognizing that water is a scarce and unevenly distributed national resource which occurs in many different forms which are all part of a unitary, inter-dependent cycle
Explicit reference to groundwater and conjunctive use management in catchment/water management and development plans and drought/emergency management plans	Not achieved	Groundwater is implicit in the provisions of the National Water Act so no explicit mention of groundwater.
Human right to water recognized in groundwater legislation, facilitating prioritization of drinking water and basic human needs, as well as small-scale users	Achieved	Section: 16 – 18 of the National Water Act: Reserve: The basic human needs Reserve Schedule 1 water use: Permissible water use: Water for household use, stock water
Regulate Groundwater Quantity ***a. Provide conditions for accessing groundwater*** Water use authorizations:		
Legislation must enable the authorisation of groundwater use (with a system that does not discriminate, especially against the rural poor);	Achieved	A system of water use authorisation with conditions (section 27) for allocation
The permitting of groundwater use should not be tied exclusively to land tenure;	Achieved	Public trusteeship of nation's water resources Entitlement to water use
Legislation should allow for the categorisation of water users;	Achieved	Categorisation of water users in as far water use charges are concerned are mentioned in the National Water Act (Chapter 5 Financial Provisions Part 1: Water use charges) and also in the National Water Resources Strategy.
Groundwater should be declared a public asset and/or authority vested in government to restrict, in the public interest, the rights accruing from its private ownership to prevent over-abstraction or inequitable access/use by landowners;	Achieved	Public trusteeship of nation's water resources Entitlement to water use
New legislation should strive towards changing ownership rights to use (usufruct) rights, subject to a government-controlled, permit system for large scale users with appropriate non-permit systems for addressing the needs of small scale users	Achieved	Water use authorisation system
The legislation recognises and legalises affordable, small-scale and indigenous solutions;	Not achieved	
The legislation should enable the regulation of borehole drillers, regulation for drilling, control	Achieved	Through promulgation of regulations but none to date – only standards and guidelines.

Minimum requirement for desired future	Status	Comment
of drillers, information from drillers and standards for borehole drilling;		
Legislation should give water inspectors the right to enter land with the offenses and associated penalties noted in the legislation (this includes appropriate fines and jail time that needs to be adjusted annually);	Achieved	Section 125. Requires warrant if land owner does not give permission.
The legislation should enable the regulation of exploration;	Not achieved	Guidelines only.
The legislation should allow for zoning for overused/fragile aquifers;	Achieved	Chapter 3: Protection of Water Resources – Part 1: Classification of water resources – Part 4: Pollution prevention Chapter 4: Use of water – Section 29 A responsible authority may attach conditions of every general authorisation or licence – Part 4: Streamflow reduction activities Section 37: Controlled activities
Groundwater use organizations should be integrated into existing institutional frameworks (e.g., catchment management, customary institutions)	Partially	Chapter 8: Establishment of water user associations. Strongly advocated in the NGS but not yet implemented to its fullest extent
Stakeholder engagement		
The legislation should specify when and how stakeholders, the public and/or other water users are to be engaged in planning, decision making and self-management with regard to groundwater;	Partially	The National Water Act promotes the integrated management of water resources with the participation of all stakeholders but not achieved in implementation.
There should be specific mechanisms for directly involving stakeholders in the development of laws and regulations related to groundwater and decisions that may impact the use or quality of groundwater on which they depend for drinking, livelihoods, food security, economic or cultural well-being; and	Partially	Stakeholder participation in development of water management strategies and water management institutions. Governing bodies of catchment agencies Catchment management committees Water User Associations
The legislation should specifically address the issue of the involvement of women and youth in decision-making and the implementation of groundwater supply schemes.	Partially	No explicit reference but equity central to the National Water Act. There are separate gender policies (women and youth)
Monitoring and data collection to support regulation		
The legislation should specify the need and parameters for a sustainable system for data collection, management and dissemination,	Achieved	Chapter 14: Monitoring, assessment and information

Minimum requirement for desired future	Status	Comment
including standardization and harmonization of data. This entails a national monitoring and information system which captures quantity and quality data from key aquifers;		
The legislation should specify the need for drought monitoring systems which extend beyond rainfall, surface water and food security indicators to groundwater and groundwater supply status, including the appropriate prediction of future hydrogeological conditions;	Partially	Duty to make information available to the public National Information System There is no real provision for groundwater drought monitoring
In transboundary basins, legislation should address the need for standardization and exchange of data as well as the establishment of joint inventories; and	Partially	Chapter 10: International Water Management • Section 102: Establishment of bodies to implement international agreements • Section 103: Governance and functions of bodies
The legislation should enable access by the public to geohydrological data held by the state.	Achieved	Section 14: Duty to make information available to the public
iii. Water conservation and efficiency of use Legislation should enable regulation to ensure the efficient use of groundwater, such as the use of economic incentives and imposition of technologies.	Not achieved	Economic incentives and compulsory licensing nor implemented.
Compliance and Enforcement		
Clear mechanisms for promoting compliance with groundwater regulations should be included in the legislation	Not achieved	There is CME taking place.
Enforcement provisions should include, *inter alia*, inspections authority for groundwater management institutions, the ability to impose fines and/or additional administrative penalties and adjust those as necessary, and enumerate criminal offenses associated with failure to comply with the law.	Achieved	Various provisions in the National Water Act Chapter 16: Offences and Remedies
Conflict resolution mechanisms and/or the right to appeal		
Regulatory measures		
The legislation must enable the relevant authority (Minister) to make regulations on any relevant matter in the legislation	Not achieved	Schedule 3 Part 6 of the National Water Act This has been neglected since the writing of the National Water Act
Legislation should provide a clear ability for the government to pass regulatory measures, such as abstraction fees and waste disposal charges, to provide revenue to water management	No achieved	Schedule 3 Part 6 of the National Water Act This has been neglected since the writing of the National Water Act

Minimum requirement for desired future	Status	Comment
institutions and to incentivise appropriate use of groundwater		

Reflection of Strategy and Guidelines Framework as per the minimum requirement for the Desired Future State

Minimum requirement for desired future	Status	Comment
Provide Status of Groundwater		
Groundwater Protection Mechanisms ***Regulating Pollution (Point source and non-point source)***		
i. Water quality targets; ii. Regulation of emissions/wastewater discharge/waste storage including the impact of mines on groundwater quality: Permits can be used to regulate the discharge, disposal and possibly the storage of waste should specifically take into account the vulnerability of the aquifer concerned and the provisions necessary for its protection;	Yes	SANS Standards
iii. Classification of water bodies; and	Partially achieved	Resource Directed Measures
iv. Reducing and regulating abstraction.	Partially achieved	Schedule 3 Part 6 of the National Water Act Examples: • National Water Act: Limiting use of water for urban and irrigation purposes from Tosca Molopo groundwater aquifer (G.40577 GoN 60) • National Water Act: Limiting use of groundwater for irrigation from Ventersdorp Eye Subterranean Government Water Control Area (G.40515 GoN 1594)
v. Powers of compliance monitoring and enforcement	Not achieved	.
Regulating Depletion		
Regulation of abstraction and recharge (usually via permitting);	Achieved	Water use authorisations Schedule 3 Part 6 of the National Water Act Examples:

Minimum requirement for desired future	Status	Comment
		• National Water Act: Limiting use of water for urban and irrigation purposes from Tosca Molopo groundwater aquifer (G.40577 GoN 60) National Water Act: Limiting use of groundwater for irrigation from Ventersdorp Eye Subterranean Government Water Control Area (G.40515 GoN 1594
Sustaining wetlands;	Partially achieved	Provisions in legislation but not implemented. • Chapter 3: Protection of Water Resources • Chapter 4: Use of water
Land use zoning – prohibition of abstraction in certain zones; cropping or irrigation practices; protection zones for recharge areas; no surfacing/drainage requirements; and	Partially achieved	Provisions in legislation but not implemented. • Chapter 3: Protection of Water Resources – Part 1: Classification of water resources – Part 4: Pollution prevention • Chapter 4: Use of water – Section 29 A responsible authority may attach conditions of every general authorisation or licence – Part 4: Streamflow reduction activities Section 37: Controlled activities.
Legislation must make it mandatory for installation of monitoring equipment of boreholes especially for large-scale users (the information must then be supplied to the state).	Not achieved	
Powers of compliance monitoring and enforcement		
Planning		
The legislation should specify the need for long term plans to ensure the sustainable use of groundwater, including drought management plans and cross-sectorial coordination;	Achieved	National Groundwater Strategy
Where water legislation provides for catchment level or basin level planning, groundwater should be integrated into those	Partially	Integration has taken place to a limited degree.

Minimum requirement for desired future	Status	Comment
plans (for example through impact assessment requirements);		
The legislation should specify that groundwater management planning should take into account and be integrated into land use and environmental planning; and	Partially	Not specific to groundwater but the National Water Act requires integrated land-use and environmental planning.
Planning should be cyclical and based on continuous learning from data and stakeholder feedback to ensure adaptive management and effective responses to changing climatic, social, political and institutional contexts/drivers.	Partially	• Section 5: NWRS updated every five years • NGS 2010 updated 2016 • Draft Water and Sanitation Master Plan

Reflection of Institutional Framework as per the minimum requirement for the Desired Future State

Minimum requirement for desired future	Status	Comment
Legislation should contain provision for its effective implementation, including the mandate, competence and power of the relevant authorities in accordance with uniform governance principles;	Achieved	The National Water Act provides for three levels of management, namely national government, nineteen catchment management agencies (now consolidated into nine or one) at the regional management level and water user associations acting cooperatively at the local level
Water authorities or coordinating bodies should have the competence to integrate all aspects of water management and should be rendered competent to arbitrate among various competing demands, and diverging interests regarding groundwater abstraction and use, both in the short-term and in the long-term;	Not achieved	• Limited capacity water management and water services • No devolved management responsibilities as mentioned in the National Water Act
The authority or body should collaborate with other authorities, competent for public health, land-use planning, soils management, waste management;	Partially	Clear provisions in legislation but weak coordination and collaboration.
Water user associations and other appropriate forums (such as municipalities) should be utilized to strengthen the user advocacy role	Not achieved	

Minimum requirement for desired future	Status	Comment
and achieve new partnerships and a joint management of the common resource.		

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SOUTHERN AFRICAN DEVELOPMENT COMMUNITY
TOWARDS A COMMON FUTURE

GROUNDWATER MANAGEMENT INSTITUTE