Department of Water and Sanitation

STRATEGIC WATER SECTOR SUPPORT

GROUNDWATER

Water Sector Public Education and Outreach Programme Booklet

WATER IS LIFE - SANITATION IS DIGNITY

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP

CONTENTS

PREFACE

The Department of Water and Sanitation (DWS) has developed the groundwater booklet as an additional contribution to inform and empower the public to understand what lies behind the delivery of sustainable water and sanitation. When members of the public have a clear understanding of the interconnected nature of all aspects of the water and sanitation business and are aware of the principles and activities pertaining to the water and sanitation business, they are more likely to understand the key questions that they should be asking local government councillors and municipal officials.

Members of public have a massive role to play in the protection of our water resources and the sustainability of our water and sanitation services infrastructure. These roles include and are not limited to, ensuring that our water resources are not polluted, that treated water is not wasted through leakages and unauthorised connections, ensuring that water usage is efficient whilst maximising the health benefits of communities.

In South Africa the scarce fresh water is decreasing in quality because of an increase in pollution and the destruction of river catchments, caused by amongst others, urbanisation, deforestation, destruction of wetlands, industry, mining, agriculture, and accidental water pollution.The National Water Resource Strategy 2 (2013) (NWRS2) recommended the development of groundwater resources for sustaining water security because surface water is limited.

The National Groundwater Strategy (NGS) is an integral part of the NWRS2, which responds to South Africa's vision for 2030, as articulated in the National Development Plan (NDP) and the National Government Outcomes (NGO). The priorities from NDP and NGO are key drivers for change and as such, are the national strategic imperatives that shape the NWRS2 and the NGS.

This groundwater booklet is based on the NGS and has been summarised and simplified to educate the public regarding the delivery of sustainable water and sanitation services. The Department encourages the public to use the knowledge they gain to best empower themselves and those around them so that they can enjoy sustainable water services.

I trust that this book will contribute to our understanding of the groundwater and the overall - management of the water cycle in an effort to create a better life for our people.

I who participated in the drafting of this book.

DEPUTY DIRECTOR GENERAL: PLANNING AND INFORMATION MANAGEMENT
DEPARTMENJ OF WATER & SANITATION

DATE: 05/09/2019

WHAT IS THIS BOOKLET ABOUT?

The objective of this booklet is to give the public a basic knowledge of the importance of proper ground water management. The public cannot expect to have good drinking water if the entire water supply cycle is not properly managed.

Another function of this booklet is to help members of the public to ask the right questions in order to hold people accountable for the tasks that they perform.

Members of the public need to understand the importance of ground water management within their municipalities.

If consumers know about the service they are receiving then they are more likely to respect the services, protect the service and inform others as to how best to utilise the service in achieving good health, hygiene and dignity whilst ensuring sustainability of these services into the future.

The booklet encourages the public to understand groundwater management challenges unique to South Africa and how groundwater is polluted. The booklet also deals with the myth that groundwater is an unreliable and unsustainable source of water. The booklet also encourages the public to play an active role in groundwater protection.

1 GROUNDWATER DEFINITIONS AND LEGISLATIVE FRAMEWORK

A Water courses: means a river or spring, a natural channel in which water flows regularly or intermittently, a wetland, lake , or dam into which or from which, water flows and any collection of water which the minister may declare a water course.

An Aquifer: means a geological formation which has structures and textures that hold water or permit appreciable water movement through them.

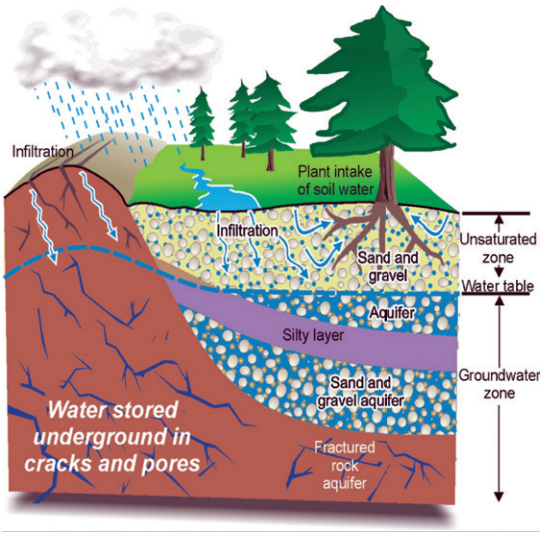

Figure 1: Schematic cross-section of an aquifer[3]

Groundwater is water that is found below the surface of the earth in the small cracks and spaces found in the rocks and sand underground. It originally comes from rain that has soaked into the ground over large areas, and is stored underground like a large sponge filled with water.[2]

A Borehole: is holes drilled into the rock formations (alluvial/hard rock) below the earth's surface using a drilling rig. By using a pump installed inside a borehole, water can be pumped from this underground sponge for people to use. It includes a well, excavation or any artificially constructed and improved underground cavity which can be used for the purpose of intercepting, collecting or storing water in or removing water from an aquifer.[1]

A spring is a place on the earth's surface where groundwater emerges naturally. The water source of most springs is rainfall that seeps into the ground uphill from the spring outlet.

A Well field: is a collection of boreholes – usually sited on one aquifer.

A catchment: in relation to a watercourse or watercourses or part of a watercourse means the area from which any rainfall will drain into the watercourse through surface flow to a common point or common points.

Groundwater legislative framework

South Africa is a water scarcity country. According to the National Water Resource Strategy 2 (2013), development of groundwater resources will be crucial for sustaining water security. Surface water, the traditional source for bulk supply is becoming limited. The National Groundwater Strategy (2016) is an integral part of the National Water Resource Strategy of 2013 (NWRS2), which responds to South Africa's vision for 2030, as articulated in the National Development Plan (NDP).[4]

Today, South Africa's groundwater is recognised as a common asset whose trusteeship is vested in the state. The National Water Act 36 of 1998 (NWA) recognised groundwater as public water, and abolished the riparian principle of private water4. This means municipalities can now have access to groundwater resource on private land through negotiations[5]. Groundwater is now seen as part of the water cycle, and therefore as connected to other water resources.

2 BRIEF BACKGROUND OF GROUNDWATER USAGE, DEVELOPMENT AND MANAGEMENT

Water not only covers three quarters of the earth's surface, it is also present almost everywhere below ground surface, down to considerable depth and in continuous motion. It represents an invisible component of the hydrosphere and of the water cycle. Water sources are divided into two main categories – surface water and groundwater. [1]There are a number of systems that give access to groundwater i.e. springs, dug wells, wells and boreholes.

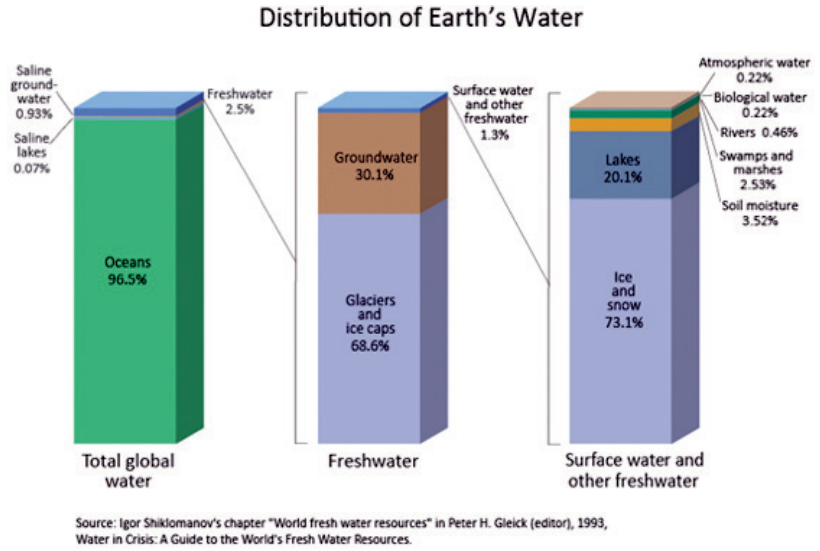

Figure 2: The groundwater portion of the earth's freshwater4

South Africa's groundwater resources have not received the same level of attention, either from managers or users, as surface water. Groundwater plays a vital role in society as a major water resource to rural communities of South Africa. Just like Dams and Reservoirs, aquifers need to be well managed.

Many Local municipalities rely on groundwater to meet their legislative mandate to provide basic water services to their communities and in some cases to augment the surface water supply. In most cases the resource is not protected, not understood and not well managed and as a result it is viewed as an unreliable source. Groundwater in most places is underutilised, but it has the potential to make a much greater contribution to meeting the country's water needs than is currently the case.

As an essential component of South Africa's total water resource, groundwater contributes in economic growth and socio-economic development and is important today in sectors ranging from agriculture to domestic water supplies. Over the last few years groundwater has undergone a major change from an undervalued resource to a source of domestic water and general livelihood to more than 50% of communities in thousands of villages and small towns country-wide[4].

3 THE BENEFITS OF DEVELOPING GROUNDWATER

Groundwater in South Africa is an important resource for all sectors, and its development is crucial for sustaining the water security for all. Groundwater is often ideal for rural water supply purposes, for the following reasons:

Groundwater is a “proximal/local resource” – if favourable geological conditions exist it is usually found close to where it is needed, making it ideal for small-scale water supplies in rural areas and for smaller municipalities that are not having big budgets and may not be in the position to afford the cost and the maintenance long pipelines from distant surface water sources.

Groundwater is becoming increasingly important for urban water supply. Twenty two percent (22%) of towns use groundwater as sole source and another 34% in combination with surface water. Water sources of domestic water supply (urban & rural) of various cities, towns and villages are shown in the map below.

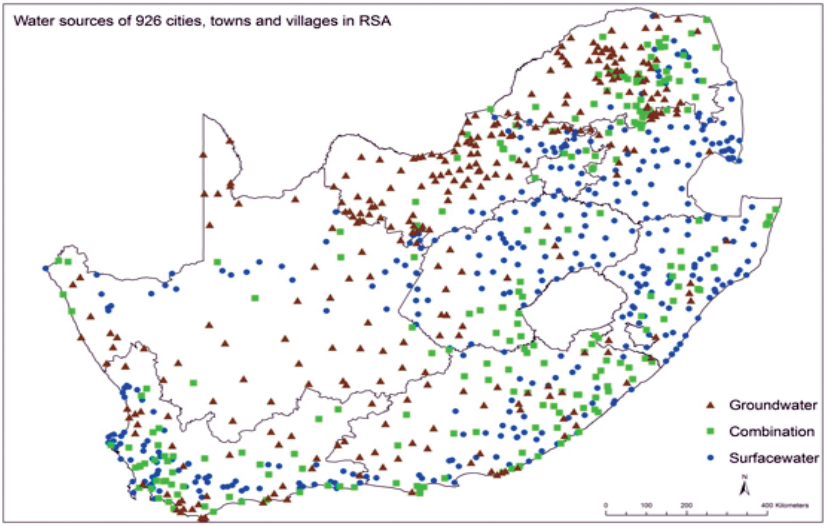

Figure 3: Water Sources of cities, towns and villages in SA3

Groundwater is more resistant to the effects of drought than surface water, because very large amounts of water are stored underground, and rates of evaporation are low. This means that boreholes can continue to yield water long after rivers and streams have dried up if managed sustainably through good groundwater monitoring.

Groundwater can also be developed “incrementally”. Surface water supplies usually require a large initial investment (e.g. dam and treatment plant) but boreholes can be drilled as demand increases and budgets allow.

The natural quality of groundwater is usually good, with little or no treatment needed. This is because harmful microbiological pathogens such as bacteria and viruses usually cannot survive for long in aquifers. This means that expensive treatment plants, with associated operation and maintenance implications, are usually not necessary for small-scale supplies. Some treatment of groundwater is often carried out however (e.g. chlorination), it must be noted that not all groundwater is safe to drink without treatment. The map in Figure 4 shows the natural groundwater quality of South Africa as indicated by electrical conductivity (Electrical conductivity give you the amount of various inorganic salts dissolved in water by measuring of the ability of water to conduct an electrical current).

Groundwater can be polluted by anthropogenic activities related to mining, industrial and domestic activities with vulnerability of source ranging from one area to the other and this must be taken into consideration before the use of groundwater especially in dense settlement or urban areas or area located close to commercial areas with potential to pollute groundwater and first basic chemical testing is advisable for user

Groundwater is normally less susceptible to pollution compared to surface water, since an overlying unsaturated zone generally protects it. However, once polluted, groundwater is difficult and expensive to clean up. Groundwater quality monitoring is therefore a crucial component during utilization.

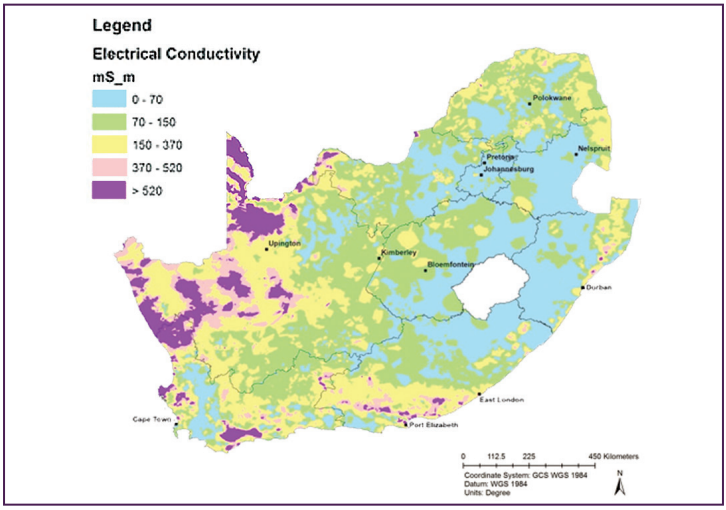

Figure 4: Natural groundwater quality in South Africa[3]

4 GROUNDWATER USERS

Groundwater contributes 15 % of all the water resources being used in South Africa. Figure 5 below provides a breakdown of groundwater use for different economic sectors in the country. Large volumes of groundwater are used for irrigation in the drier, more sparsely populated parts of the country[4].

Groundwater users fall into four (4) categories, namely: Schedule 1 users, General Authorization (users requiring registration), Existing Licence Use and Licensed. The different categories of users are defined below.

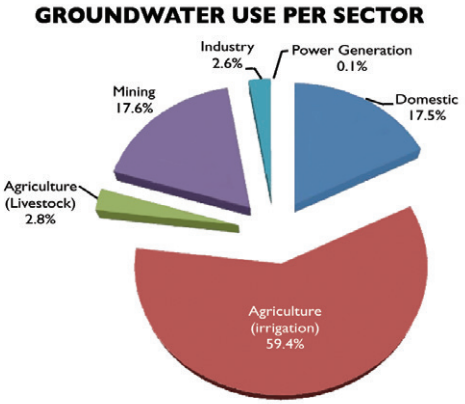

Figure 5: Breakdown of groundwater use for different economic sectors[3]

Scheduled 1: Scheduled 1 users are those users who are extracting a minimal quantity of groundwater on any given day per property. In terms of the National Water Act (1998) they are not required to register this use. Presently, this makes reference to users who use less than 10 kilolitres of groundwater on any given day.

Existing Lawful Use: Any lawful use of water authorized by or under any law which took place at any time during the period from 1 October 1996 to 30 September 1998, i.e. the two years before the National Water Act came into effect.

General Authorization: In terms of the National Water Act (1998), all users that abstract more than 10 kilolitres per property on any given day are required to register this water use. Typically, this would require a municipality to register all boreholes within its jurisdiction. General Authorisations are revised every five years.[6]

Licensed: A water user is required to apply for a license when the water use exceeds the limits specified in the general authorisations, which is updated regularly.[7] Monitoring and reporting of the specific water use will be a requirement of the General Authorisation and license conditions.

5 THE IMPORTANCE OF GROUNDWATER PLANNING, MANAGEMENT AND MONITORING IN MUNICIPALITIES

Planning within the Department of Water and Sanitation is a process of matching water availability with water requirements. Planning typically involves the investigation of development options to meet water requirements through a predetermined sequence of increasingly detailed phases. Planning generally follows an assessment during which the various water development options (including groundwater options) are identified. Planning ensures that the information is made clear to the decision-maker.[5]

Greater use of groundwater resources does indeed hold enormous promise for accelerating sustainable access to improved water services and augmenting supply in many parts of the country. The lead times for developing groundwater resources are far shorter than are typically found in big surface water development projects, which allows for delivery of the benefits far sooner.

There is also a scope for substantial cost savings in developing local decentralized groundwater based schemes, instead of big regional surface water schemes with major pipelines conveying water from distant impoundments.

Groundwater management for community water supply involves taking responsibility for protecting groundwater from contamination and ensuring its sustainable use. It includes the management of data collection, transfer and analysis, and the implementation of recommendations

Groundwater management can be grouped into five main areas:

- Fulfilling legal obligations (i.e. ensuring use and protection of groundwater according to national and international laws).
- Monitoring and analysing data (e.g. groundwater levels, abstraction and quality).
- Optimising groundwater usage.
- Protecting groundwater from contamination.
- Creating awareness and educating people about sustainable groundwater use.

The Need for Groundwater Management[8]

For rural water supply purposes, there are four reasons why groundwater should be managed:

- **Prevent the aquifer from being over-pumped** - If an aquifer is over-pumped, a long-term depletion of the groundwater results throughout the entire aquifer. This over-abstraction can negatively affect all users of the aquifer, including aquifer dependant ecosystems.

- **Optimise individual borehole pumping rates** - If individual borehole pumping rates are too high, a localised depletion of groundwater results. Energy is also wasted, since the pumping head is unnecessarily high; and if the water level in the borehole is drawn down to the pump intake, a combination of air and water will be pumped. Pumps can be damaged in this way. Also reduces pressure in borehole can lead to collapse.
- **Prevent poor quality groundwater from entering the aquifer** - If abstraction yield from the aquifer is incorrect, poor quality groundwater can be drawn into the aquifer.
- **Minimize groundwater contamination from surface sources such as pit latrines, animal kraals, fertilizers, underground storage, waste disposal facilities and dipping tanks.**

Groundwater management does not need to be expensive. It is far cheaper to manage groundwater than to deal with a crisis, which may result from a lack of management. Groundwater should be managed in terms of its quantity and quality. This would ensure that the resource is used efficiently, to its full potential, and it would minimise the risk of deteriorating quality or availability.

Failure of groundwater supply schemes due to lack of operation and maintenance is often blamed on the resource (i.e. the aquifer or the groundwater) rather than on the infrastructure (borehole, pump, pipes, valves, etc.) used to abstract the groundwater or on other causes such as electrical supply failure. It is common to hear that "the borehole dried up", or "the groundwater ran out". This is partly because groundwater is out of sight – it seems mysterious to the layperson in comparison with surface water. In fact, failure of groundwater supply schemes is almost always either due to failure of infrastructure (e.g. blocked borehole screen) or unsuitable pumping regimes (e.g. pumping at very high rates for short periods of time) that are related to a lack of monitoring. Unsuitable pumping regimes can cause infrastructure failure in several different ways.[9]

Groundwater monitoring forms part of the groundwater management function, and specifically, includes data collection, capturing and analysis of current well field status. Boreholes need to be properly equipped in order to make monitoring possible.

The purpose of monitoring groundwater is to be able to know how much water is available for use and if it is suitable for drinking. When we pump water from a borehole, the water level underground will drop.[2] We cannot see groundwater because the infrastructure blocks our view, thus the water level meter need to indicate the level of the water in the borehole.

Figure 6: Measuring the Water Level with a water level meter[3]

Groundwater is monitored by recording how much water was used and by recording the level of the water under the ground. Monitoring of groundwater during borehole operation entails measuring:[2]

- Water levels and volumes abstracted;
- Water quality within the aquifer (using appropriate sampling methods to be representative of the aquifer);
- Always being on the alert for and reporting on potential sources of groundwater; pollution, and
- Measuring precipitation.[1]

Groundwater levels should be obtained on a monthly basis. In order to establish a routine, however, it may be advisable to collect the data on a daily or weekly basis. The data only needs to be interpreted twice a year or monthly, depending on the vulnerability of the aquifer to over-utilisation. A dip meter, which consists of an electrical cable and a multimeter or a light, is used for measuring borehole water levels.

Possibly the most important element of groundwater management is day to day operation and maintenance (O&M). O&M refers mainly routine tasks that should be carried out in the course of operating a groundwater supply scheme. A groundwater supply scheme might be as simple as a single borehole with a hand pump, although schemes usually involve more than one borehole, pipe-work, electrical control systems, treatment systems, etc. O&M tasks include maintaining infrastructure (cleaning and descaling pipes, replacing worn out components, cleaning of boreholes, etc.) as well as the monitoring of groundwater levels, groundwater quality, water demand, etc.[5]

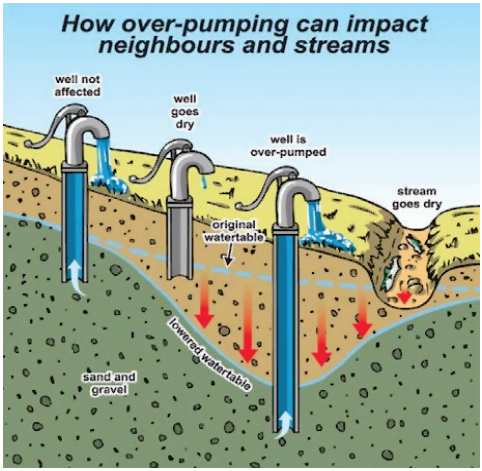

Figure 7: Over abstraction of a borehole

O&M tasks can be thought of as necessary for asset management. In contrast to data collection and "resource management", there is very little information in the literature regarding O&M, yet in most cases it is a failure of O&M rather than a failure of the regional groundwater resource that leads to groundwater scheme disruption and failure.[5]

There are many factors that determine the quality of O&M. The main ones are quality of staff, access to dedicated O&M funds, and the quality of records and analysis of information. This requires resources like motivated staff, necessary tools, equipment, consumables, transport – and careful planning. It is the responsibility of the WSA and other consultants to provide an O&M Manual for each borehole separately and for the complete wellfield.[5]

The pump operator is a vital link in the groundwater monitoring chain. If the pump operator does not keep good records, all these other stakeholders such as the WSA and the Department of Water and Sanitation will be unable to do their jobs in managing groundwater.

A lack of reliable groundwater data makes it difficult to make accurate assessments of the availability (i.e. quantity and quality) and abstraction (i.e. rates, quantities and drawdown levels) of groundwater. Hence, the importance of groundwater information management – record keeping captured into a database

Lack of adequate monitoring and assessment of groundwater resources may result in poor attention to groundwater planning at all levels. This is particularly serious for drought risk or disaster management.

6 AREAS OF CONCERN ON GROUNDWATER MANAGEMENT, MONITORING AND PROTECTION

What are some of the areas of concern?

Groundwater management challenges are not unique to South Africa. Below is a summary of the main challenges for managing municipal groundwater systems in South African municipalities.

- Clear data of existing number of boreholes
- The cost for operations and maintenance of the Groundwater systems
- Human Resources and technical skills,
- Funding constraints and lack of equipment
- Institution capacity

Within municipalities, groundwater is widely perceived as unreliable and a difficult source to manage. Local government in South Africa, at this stage, does not have the groundwater technical capacity to undertake this function responsibly. Experience on the ground indicates that many municipalities only turn to groundwater as a last resort, as opposed to the primary or supplementary resource.

Lack of information and lack of access to information are the two issues widely identified by experts and stakeholders as constraining the development of effective strategies for managing groundwater.

A lack of effective assessment, planning and management of groundwater resources can result not only in poor service delivery to water users, but also to significant detrimental impacts on the aquifer systems themselves.

Protection of water resources encompasses management of quality and quantity of both surface water and groundwater and protection of the habitats. Groundwater pollution can come from a variety of sources, and in the worst cases can make groundwater unsafe to drink and uneconomical to treat.

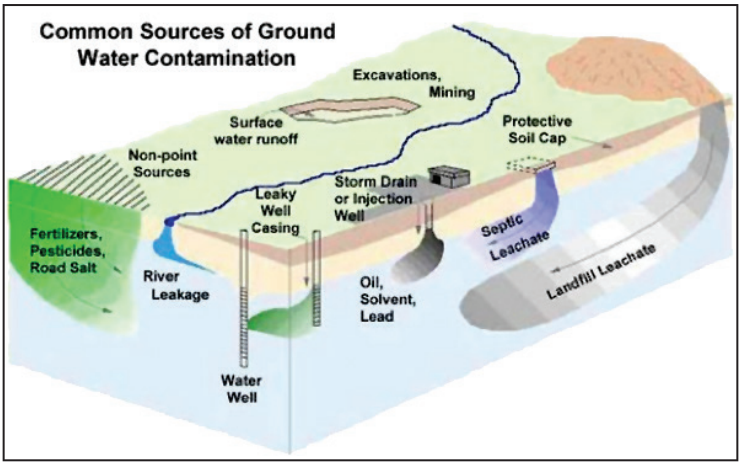

Figure 8: Common sources of groundwater contamination

What can possibly be done/possible solutions?

Policy, regulation and comprehensive support is required for a more sustainable way forward.

The regular collection, analysis and dissemination of data and information are fundamental for any programme of groundwater management that wants to influence public opinion and policy and decision makers.

Good management of groundwater resources is the key to reliable, efficient groundwater supplies. This applies equally to schemes as small as a single borehole and to large systems supplying urban areas.

Monitoring (borehole water levels, water quality, pumping rates, etc) is probably the single most important component of good groundwater management.

Staff and technical practitioners with hydrogeological background should be appointed by municipalities to ensure more effective and sustainable groundwater management, particularly as groundwater becomes increasingly relied on for municipal water supply. A "Municipal Hydrogeologist" should be considered in budget negotiations.

Local government are a major player in sustainable groundwater resource utilisation and protection. Therefore capacity building initiatives needs to be targeted at municipalities by the water sector in cooperation with other interested stakeholders. District and local municipalities must be encouraged to include groundwater Technicians and Hydrogeologist in their structures.

While government institutions are legislatively responsible for managing and protecting groundwater, it is the users of water resources who, in fact, manage most human impacts on groundwater at the local neighbourhood level. Local communities also have far better knowledge of local water resources, local practices that may contaminate groundwater, and the rules for water use in their communities.

Zoning or wellhead/borehole/spring protection is one of the most important measures of protecting important or vulnerable groundwater sources. A wellhead/borehole/spring protection area can be defined as "the surface and subsurface area surrounding a borehole / spring or well field, supplying a public water system, through which contaminants are likely to move toward and reach such borehole / spring or well field" Zones of contribution are defined around a borehole /spring or well field using hydrogeological principles. The protection are is divided up in to zones, which get increasing prohibitions an restrictions as the zone of the abstraction point is reached.[11]

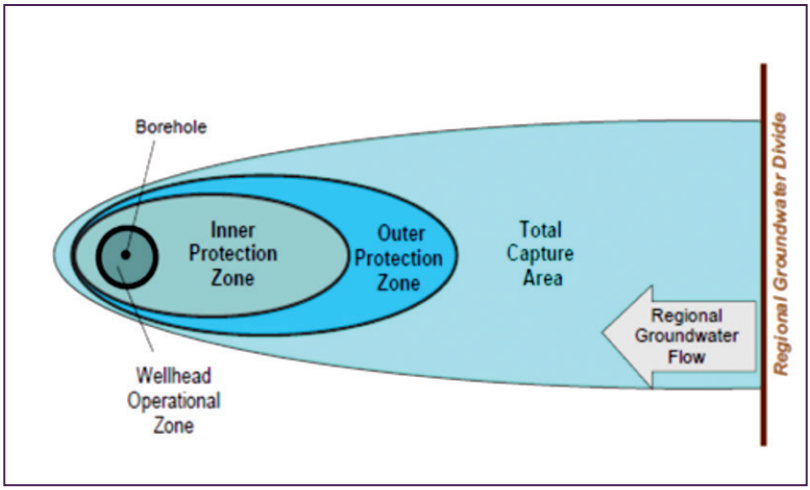

Figure 9: Common protection areas delineated around drinking water supplies[4]

The Wellhead Operational Zone is the first 5 m around the borehole that includes the sanitation seal, concrete collar, fencing, etc. The Inner and Outer Protection Zones presents the second line of defence and is based, just like a minimum distance, on travel time which will ensure bacteriological breakdown. The Total Capture Area represents the whole borehole catchment area contributing

water towards the borehole, i.e. the area that will need land-use restrictions to prevent contamination which are not attenuated from reaching the borehole at some stage.[11]

Spring water moves downhill through soil or cracks in rock until it is forced out of the ground by natural pressure. Like shallow wells, springs may be contaminated by surface runoff or other contamination sources on or below the ground surface[15].

Typical land-use constraints in the different zones in a community water supply and sanitation environment could be:

Inner and Outer Protection Zones

- Pit latrines;
- Informal waste disposal;
- Cattle kraal;
- Sewage sludge;
- Cemeteries;
- Small settlement (and all mention constraints in the Total Capture Area)

Figure 10: Pit latrines and water well interface[12]

Total Capture Area

- Light industry with potential pollution sources;
- large informal settlements using pit latrines;
- hospitals or clinics
- Sewage treatment;
- Mass livestock;
- Waste disposal facilities[11]

The picture (Figure 10) illustrate how easy polluted water from the pit latrines are been pumped out at the borehole because the borehole is too close to the pit latrines – within the borehole's abstraction cone/interface and downstream of the pit latrines

7 GROUNDWATER AND SURFACE WATER INTERACTION

Historically, groundwater and surface water have been viewed, and managed as two separate entities. Most water resource management plans focus on the latter, but constant development of land, and water resources has made it clear these two systems affect each other both in resource quality and quantity.

Recent research has shown that development is not the only reason why it is important to understand how surface water and groundwater interact. Climate change is likely to affect the availability and distribution of both, so increasingly this interaction is playing a bigger role of water resource management. In the simplest terms, if we don't know how much water infiltrates from a river into an aquifer, we don't know how much water to allocate from the river to a particular user.

In addition, surface water systems have significant impact to groundwater systems- and groundwater systems can also often affect surface water systems. This is because the surface water infiltrates down to the underground water.

It is therefore just as important to protect the surface waters from being contaminated by sanitation systems and other contamination sources as it is to protect groundwater. Groundwater can be easily polluted depending on the nature of the subsurface and the depth of the water table.[3]

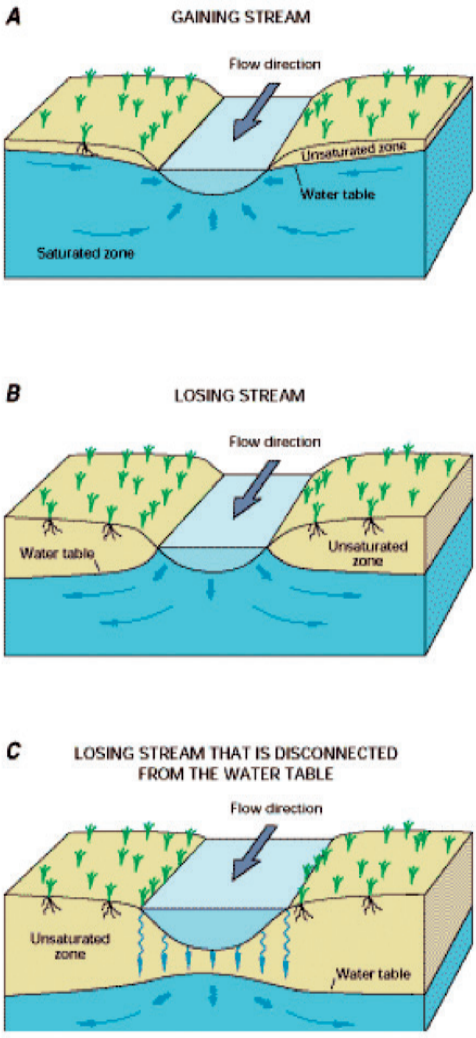

Figure 11: Surface groundwater interaction[3]

8 COMMUNICATION AND AWARENESS OF GROUNDWATER DEVELOPMENT AND MANAGEMENT

Groundwater is the primary source of water supply to several towns in South Africa, however lack of awareness of groundwater's potential is still one of the main problems faced by the water sector. One of the greatest challenges in implementing groundwater development programmes across South Africa remains poor perceptions of the resource.

Effective communication is needed to:

- raise awareness on the advantages of using groundwater (such cost effectiveness),
- convey the best practical ways to develop and maintain groundwater supplies, and;
- dispel the myths that groundwater is unreliable, unsafe or backward.

The occurrence, 'use value' and threats to groundwater must be better understood by the public, decision-makers, water resource managers and others in order to achieve Integrated Water Resources Management.

The degree to which people understand groundwater and its contributions to water supply, the environment and economic development and other services determines the perceived value of the resource.

The long-term process of institutional development must be supported by a major ongoing awareness campaign at all levels regarding the need for improved groundwater management to achieve the desired understanding, participation and support for long-term transformation. This requires enhanced education and outreach programs in order to broaden stakeholder understanding.

The information sharing and awareness on groundwater management should also include among others, all water users and government departments.

9 THE ROLE OF WSA AND WSP ON GROUNDWATER MANAGEMENT

Operation and maintenance (O&M) of groundwater supply systems is usually seen as the responsibility of the applicable Water Services Authority (WSA) or Water Services Provider (WSP). However critical to successful O&M are more generic municipal or institutional functions and procedures such as budgeting, training and retention of staff, accountability frameworks, succession planning and other features.

These have a great bearing on whether services are delivered and routine tasks accomplished including groundwater management. It is likely that poor or non-existent operation and maintenance of groundwater schemes is the main reason for scheme failure, rather than intrinsic constraints imposed by the groundwater system such as lack of recharge

The WSA is responsible for entering the information provided by the pump operator regarding the level of the water in the borehole, the amount of water that has been pumped and any other problems or changes that they may have noticed with the borehole and the pump to be analysed, in order to provide proper recommendations.

The WSP is the organisation that operates the water scheme on a day-to-day basis, and part of their activities is that of O&M.

The WSP must ensure that regular measurements are taken of the water levels in the boreholes as well as the abstraction from the borehole. These measurements must be accurately recorded in the borehole logbook and captured in a database. The WSP must also make sure that these records are passed on to the WSA for future reference.

Figure 12: Not a well-run scheme[13]

The roles and responsibilities in monitoring groundwater

Pump operators[2]

The pump operator is a vital link in the groundwater monitoring chain. The pump operator records the level of the water in the borehole and the amount of water that has been pumped. The pump

operator also notes any problems or changes that they may have noticed with the borehole and the pump.

It is the role of pump operator to ensure that that the information or data reaches the technicians or the WSA for analysis towards making proper recommendations.

Councillors

Political leaders are decision makers, and have authority towards ensuring that budgets are made available to purchase equipment for repairs, appoint professional contractors and ensuring proper maintenance of the borehole systems to ensure effective and efficient service delivery.

As part of their oversight role, councillors must hold the responsible officials accountable by ensuring that regular measurements are made of the water levels in the boreholes as well as the abstraction from the borehole, and that these measurements are accurately recorded.

The councillor should also ensure that there is awareness creating programmes on the importance of protecting groundwater resources.

Figure 13: Flow Meter: Measuring the Amount or Volume of Water Pumped

Community members

Members of the community need to make sure that they protect the borehole systems, that the water infrastructure is not vandalised in order to ensure sustainable water service delivery. The community should also ensure that the groundwater source is not exposed to pollution.

Community participation is considered essential in the context of groundwater protection. It is clearly essential that the community participate in the selection of the most appropriate waste and sanitation options for their community that will ensure the protection of the environment and safeguard the health of the community.[14]

10 CONTACT INFO

Any of the DWS Regional Offices or Catchment Management Agencies (CMA) offices can be contacted for support on sustainable development and management of groundwater

11 REFERENCES

1 DWS Northern Cape: O&M Handbook Water Supply Services

2 DWS Norwegian Agency for Development Cooperation 2004 (NORAD 6.1)

3 DWS website

4 DWS National Groundwater Strategy 2016

5 WRC Report No.1917/1/10Groundwater Management Framework

6 Intergrated Water Resource Management 2004

7 NORAD 1.2

8 NORAD 1.1

9 DWS 20 Years of Groundwater 1994-2014

10 WRC Report No.861/1/02a Guidelines for the Monitoring & Management of Gw

11 A Guideline for Groundwater Protection for the Community Water Supply & Sanitation Programme

12 DWS Artificial Recharge Strategy: Version 1.3; June 2007

13 Ricky Murray – O&M Presentation 2012

14 NORAD 3.1

15 NORAD 3.2

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