A Guideline for the Assessment, Planning and Management of Groundwater Resources in South Africa

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DEPARTMENT WATER AFFAIRS AND FORESTRY
Water Resource Planning Systems

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Cover photos:

Top left:	Well 6 at Caroluspoort Scheme east of De Aar. 2000
Top right:	Riet Scheme booster pump station southeast of De Aar. 2000
Bottom left:	Electronic water level logger hut on the farm Plessisdam, north of De Aar. 2000.
Bottom middle:	Caroluspoort Scheme reservoir east of De Aar. 2000.
Bottom right:	Caroluspoort Scheme booster pump station west of De Aar. 2000.

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REPORT OBJECTIVES

The objectives of a Guideline for the Assessment, Planning and Management of Groundwater Resources in South Africa are:

- To provide assistance and guidance to all role-players involved in the assessment, planning and management of the groundwater resources of South Africa, and
- To ensure that all role-players in the management of groundwater resources of the country have clear guidance on the processes to follow.

The Guideline will therefore assist in ensuring that the water management function in the above areas is streamlined and meets the objectives of both the Department and other role-players.

ACRONYMS

ARD	Acid Rock Drainage
BM	Benchmarking
BPG	Best Practice Guidelines
BWS	Bulk Water Supplier
CMA	Catchments Management Agency
CMS	Catchment Management Strategy
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GMP	Good Management Practices
ICM	Integrated Catchment Management
IDP	Integrated Development Plan
ISP	Internal Strategic Perspective
IWRMP	Integrated Water Resources Management Plan
IWRM	Integrated Water Resources Management
km^2	Square Kilometer
L/s	Litres per second
mamsl	Metres above mean sea level
Ml/d	Megalitres per day
m	Metre
mm	Millimetre
mm/a	Millimetres per annum
mS/m	Milliesiemens per metre
m^3	Cubic metre
MAP	Mean Annual Precipitation
MPRDA	Mining and Petroleum Resources Development Act (Act No. 73 of 2002) 1989)
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NWA	National Water Act (Act No. 36 of 1998)
NWRS	National Water Resource Strategy
NWC/WDMS	National Water Conservation/Water Demand Management Strategy
ppm	Parts per million
RDM	Resource Directed Measures
RQO	Resource Quality Objective
RWQO	Resource Water Quality Objective
TDS	Total Dissolved Solids
TMG	Table Mountain Group
WMA	Water Management Area
WSA	Water Services Act (Act No. 108 of 1997)
WMI	Water Management Institution
WMP	Water Management Plan
WSDP	Water Services Development Plan
WSI	Water Services Institution
WSP	Water Service Provider
WUAu	Water Use Authority
WUA	Water User Association

GLOSSARY OF TERMS

AQUICLUDE

A geologic formation, group of formations, or part of formation through which virtually no water moves.

AQUIFER

A geological formation which has structures or textures that hold water or permit appreciable water movement through them. Source: National Water Act (Act No. 36 of 1998).

BOREHOLE

Includes a well, excavation, or any other artificially constructed or improved underground cavity which can be used for the purpose of intercepting, collecting or storing water in or removing water from an aquifer; observing and collecting data and information on water in an aquifer; or recharging an aquifer. Source: National Water Act (Act No. 36 of 1998).

BOUNDARY

An aquifer-system boundary represented by a rock mass (e.g. an intruding dolerite dyke) that is not a source of water, and resulting in the formation of compartments in aquifers.

CONE OF DEPRESSION

The depression of hydraulic head around a pumping borehole caused by the withdrawal of water.

CONFINING LAYER

A body of material of low hydraulic conductivity that is stratigraphically adjacent to one or more aquifers; it may lie above or below the aquifer.

DOLOMITE AQUIFER

See “Karst” Aquifer

DRAWDOWN

The distance between the static water level and the surface of the cone of depression.

FRACTURED AQUIFER

An aquifer that owes its water-bearing properties to fracturing.

GROUNDWATER

Water found in the subsurface in the saturated zone below the water table.

GROUNDWATER DIVIDE or GROUNDWATER WATERSHED

The boundary between two groundwater basins which is represented by a high point in the water table or piezometric surface.

GROUNDWATER FLOW

The movement of water through openings in sediment and rock; occurs in the zone of saturation in the direction of the hydraulic gradient.

HYDRAULIC CONDUCTIVITY

Measure of the ease with which water will pass through the earth's material; defined as the rate of flow through a cross-section of one square metre under a unit hydraulic gradient at right angles to the direction of flow (m/d).

HYDRAULIC GRADIENT

The rate of change in the total hydraulic head per unit distance of flow in a given direction.

INFILTRATION

The downward movement of water from the atmosphere into the ground.

INTERGRANULAR AQUIFER

A term used in the South African map series referring to aquifers in which groundwater flows in openings and void spaces between grains and weathered rock.

KARST (KARSTIC)

The type of geomorphological terrain underlain by carbonate rocks where significant solution of the rock has occurred due to flowing groundwater.

KARST (KARSTIC) AQUIFER

A body of soluble rock that conducts water principally via enhanced (conduit or tertiary) porosity formed by the dissolution of the rock. The aquifers are commonly structured as a branching network of tributary conduits, which connect together to drain a groundwater basin and discharge to a perennial spring.

MONITORING

The regular or routine collection of groundwater data (e.g. water levels, water quality and water use) to provide a record of the aquifer response over time.

OBSERVATION BOREHOLE

A borehole used to measure the response of the groundwater system to an aquifer test.

PHREATIC SURFACE

The surface at which the water level is in contact with the atmosphere: the water table.

PIEZOMETRIC SURFACE

An imaginary or hypothetical surface of the piezometric pressure or hydraulic head throughout all or part of a confined or semi-confined aquifer; analogous to the water table of an unconfined aquifer.

POROSITY

Porosity is the ratio of the volume of void space to the total volume of the rock or earth material.

PRODUCTION BOREHOLE

A borehole specifically designed to be pumped as a source of water supply.

RECHARGE

The addition of water to the saturated zone, either by the downward percolation of precipitation or surface water and/or the lateral migration of groundwater from adjacent aquifers.

RECHARGE BOREHOLE

A borehole specifically designed so that water can be pumped into an aquifer in order to recharge the ground-water reservoir.

SATURATED ZONE

The subsurface zone below the water table where interstices are filled with water under pressure greater than that of the atmosphere.

SPECIFIC CAPACITY

The rate of discharge from a borehole per unit of drawdown, usually expressed as $m^3/d \cdot m$.

SPECIFIC YIELD

The ratio of the volume of water that drains by gravity to that of the total volume of the saturated porous medium.

STORATIVITY

The volume of water an aquifer releases from or takes into storage per unit surfacearea of the aquifer per unit change in head.

TRANSMISSIVITY

Transmissivity is the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It is expressed as the product of the average hydraulic conductivity and thickness of the saturated portion of an aquifer.

UNSATURATED ZONE (also termed VADOSE ZONE)

That part of the geological stratum above the water table where interstices and voids contain a combination of air and water.

WATERSHED (also termed CATCHMENT)

Catchment in relation to watercourse or watercourses or part of a watercourse means the area from which any rainfall will drain into the watercourses or part of a watercourse through surface flow to a common point or points. Source: National Water Act (Act No. 36 of 1998).

WATER TABLE

The upper surface of the saturated zone of an unconfined aquifer at which pore pressure is equal to that of the atmosphere.

EXECUTIVE SUMMARY

The National Water Act (Act 36 of 1998) (NWA) was promulgated to provide for reform of the law relating to water resources, recognising that water is a scarce and unevenly distributed national resource that belongs to all people. The NWA provides the Department of Water Affairs and Forestry (the Department) with a mandate to protect, use, develop, conserve, manage and control South Africa's water resources in an integrated manner (NWRS, 2004).

The aquifers of South Africa represent important water resources that are relied on by many users for their water use. The development and protection of these groundwater resources are currently being undertaken in response to local pressures and decisions, potentially taking cognisance of the NWA but without the benefit of standard procedures. The Department therefore identified the need to develop a guideline document (referred to as the Guideline) that can be followed and adhered to when undertaking assessment, planning and management of groundwater resources within the country.
The Guideline will assist in the sustainable development, protection and management of the groundwater resources and will assist in achieving the overall goal of integrated water resources management (IWRM) within the Department. Although the assessment, planning and management of groundwater resources are seen as important within the overall scope of IWRM, the Guideline is presented as a separate document.
The importance of assessment, planning and management of the groundwater resources in South Africa are highlighted by the following:

- No such guideline currently exists to guide the Water Manager/Service Provider in the procedures required for the assessment, planning and management of the groundwater resources
- Groundwater represents an important water resource as part of conjunctive use for bulk and local use, as well as for extensive irrigation. In some areas, groundwater from various aquifers represents the sole source of water use or is a critical resource in times of drought. In these areas or circumstances, the such aquifers would be considered to be of strategic importance
- Overall planning and management of aquifers are essential to ensure their sustainable development. Individual private abstractions often take no account of the impact of these abstractions on the total resource
- Past experiences have indicated that a lack of effective assessment, planning and management of the resource can result in significant detrimental impacts on the aquifer systems. For example, unmanaged and uncontrolled abstraction and/or dewatering of the aquifers can lead to boreholes, wetlands and springs drying up; and in the case of karst aquifers, sinkhole formation.
- Potential groundwater yields from certain aquifer systems (i.e. karst formations) can be significantly higher than yields from other rock formations. However, these same characteristics that allow high borehole yields (e.g. fracture flow) can also be responsible for

sudden failure of the resource (e.g. dewatering of a fracture).

- Aquifer systems can be, due to the physical characteristics of the host rock, vulnerable to over-exploitation, unsustainable practices and pollution. This vulnerability aggravates the potential impact of land use on the groundwater resources
- The direct interaction between aquifer systems and adjacent ecosystems makes these ecosystems particularly vulnerable to pollution and abstraction impacts, to the same degree as the aquifers themselves. Protection of the aquifers will therefore lead to the protection of these ecosystems

The Guideline is presented in three separate chapters to improve user-friendliness. The details included in each of the chapters, and their proposed use, are:

- ***Chapter 1:*** Provides a conceptual overview of the Guideline in terms of the purpose of the guideline, the location of the groundwater resources, the regulatory framework, principles and approaches, and the institutional arrangements. Chapter 1 can be used by role-players who seek to gain an initial insight into the assessment, planning and management of groundwater resources
- ***Chapter 2:*** Provides details of the process and related activities that should be followed during the assessment, planning and management functions. This chapter is aimed at the role-players who require a detailed understanding of the processes to be followed during assessment, planning and management, to enable the overall management, integration and control of these processes, and
- ***Chapter 3:*** Provides detailed procedures, in the form of check-lists with guiding notes, for carrying out the assessment, planning and management functions. This chapter is aimed at those role-players tasked with the operational aspects of these functions.

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