Series H: Hierarchy Guidelines



H1

BEST PRACTICE GUIDELINE

Integrated Mine Water Management

Best Practice Guidelines for Water Resource Protection in the South African Mining Industry

DIRECTORATE: RESOURCE PROTECTION & WASTE

water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA

PUBLISHED BY

Department of Water Affairs and Forestry
Private Bag X313
PRETORIA
0001
Republic of South Africa

Tel: (012) 336-7500

This report should be cited as:

Department of Water Affairs and Forestry, 2008. Best Practice Guideline H1: Integrated Mine Water Management.

Disclaimer:

Although the information contained in this document is presented in good faith and believed to be correct, the Department of Water Affairs and Forestry makes no representations or warranties as to the completeness or accuracy of the information, which is only based on actual information received, and makes no commitment to update or correct information.

Consultants:

Pulles Howard & de Lange Inc.
P O Box 861
AUCKLAND PARK
2006
Republic of South Africa

Golder Associates Africa
PO Box 6001
HALFWAY HOUSE
1685
Republic of South Africa

ISBN 978-0-9802679-5-2

Status Final document, December 2008

DOCUMENT INDEX

This document is the first in a series of the following hierarchy Best Practice Guideline documents:

BPG H1: Integrated Mine Water Management

BPG H2: Pollution Prevention and Minimization of Impacts

BPG H3: Water Reuse and Reclamation

BPG H4: Water Treatment

ACKOWLEDGE-MENTS

AUTHORS

Mr William Pulles (Golder Associates)

SPECIALISTS

Mr Johan Mare (MENCO)
Ms Riana Munnik (DWAF)
Mr Molefe Morokane (DWAF)
Mr Petrus Venter (DWAF)

Since 1999 a number of steering committee meetings and stakeholder workshops were held at various stages of the development and drafting of this series of Best Practice Guidelines for Water Resource Protection in the South African Mining Industry.

We are deeply indebted to the steering committee members, officials of the Department of Water Affairs and Forestry and stakeholders who participated in the meetings and stakeholder workshops held during the development of the series of Best Practice Guidelines for their inputs, comments and kind assistance.

The Department would like to acknowledge the authors of this document, as well as the specialists involved in the process of developing this Best Practice Guideline. Without their knowledge and expertise this guideline could not have been complemeted.

APPROVALS

THIS DOCUMENT IS APPROVED BY THE DEPARTMENT OF WATER AFFAIRS AND FORESTRY

RIANA MUNNIK

Deputy Director: Resource Protection and Waste: Mines

Date: 10/12/2008

NNDANGANENI MUSEKENE

Director: Resource Protection and Waste

Date: 2008/12/22

DEBORAH MOCHOTLHI

Chief Director: Water Use

Date: 19/01/2009

PREFACE

Water is typically the prime environmental medium (besides air) that is affected by mining activities. Mining adversely affects water quantity and quality and poses a significant risk to South Africa's water resources. Mining operations can further substantially alter the hydrological and topographical characteristics of the mining areas and subsequently affect the surface runoff, soil moisture, evapo-transpiration and groundwater behaviour. Failure to manage impacts on water resources (surface and groundwater) in an acceptable manner throughout the life-of-mine and post-closure, on both a local and regional scale, will result in the mining industry finding it increasingly difficult to obtain community and government support for existing and future projects. Consequently, sound management practices to prevent or minimise water pollution are fundamental for mining operations to be sustainable.

Pro-active management of environmental impacts is required from the outset of mining activities. Internationally, principles of sustainable environmental management have developed rapidly in the past few years. Locally the Department of Water Affairs and Forestry (DWAF) and the mining industry have made major strides together in developing principles and approaches for the effective management of water within the industry. This has largely been achieved through the establishment of joint structures where problems have been discussed and addressed through co-operation.

The Bill of Rights in the Constitution of the Republic of South Africa, 1996 (Act 108 of 1996) enshrines the concept of sustainability; specifying rights regarding the environment, water, access to information and just administrative action. These rights and other requirements are further legislated through the National Water Act (NWA), 1998 (Act 36 of 1998). The latter is the primary statute providing the legal basis for water management in South Africa and has to ensure ecological integrity, economic growth and social equity when managing and using water. Use of water for mining and related activities is also regulated through regulations that were updated after the promulgation of the NWA (Government Notice No. GN704 dated 4 June 1999).

The NWA introduced the concept of Integrated Water Resource Management (IWRM), comprising all aspects of the water resource, including water quality, water quantity and the aquatic ecosystem quality (quality of the aquatic biota and in-stream and riparian habitat). The IWRM approach provides for both resource directed and source directed measures. Resource directed measures aim to protect and manage the receiving environment. Examples of resource directed actions are the formulation of resource quality objectives and the development of associated strategies to ensure ongoing attainment of these objectives; catchment management strategies and the establishment of catchment management agencies (CMAs) to implement these strategies.

On the other hand, source directed measures aim to control the impacts at source through the identification and implementation of pollution prevention, water reuse and water treatment mechanisms.

The integration of resource and source directed measures forms the basis of the ***hierarchy of decision-taking*** aimed at protecting the resource from waste impacts. This hierarchy is based on a *precautionary approach* and the following order of priority for mine water and waste management decisions and/or actions is applicable:

RESOURCE PROTECTION AND WASTE MANAGEMENT HIERARCHY

Step 1: Pollution Prevention

↓

Step 2: Minimisation of Impacts
Water reuse & reclamation
Water treatment

↓

Step 3: Discharge or disposal of waste and/or waste water
Site specific risk based approach
Polluter pays principle

The documentation describing **Water Resource Protection and Waste Management** in South Africa is being developed at a number of different levels, as described and illustrated in the schematic diagram on this page.

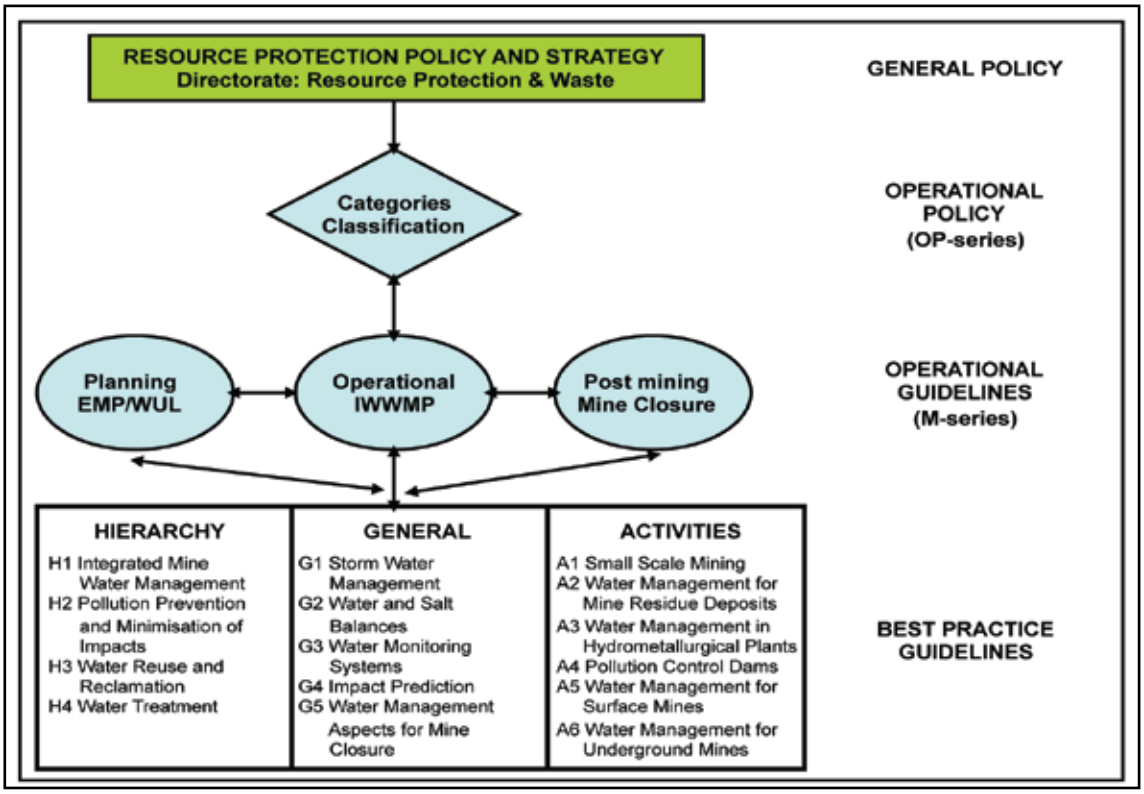
The overall Resource Protection and Waste Management Policy sets out the interpretation of policy and legal principles as well as functional and organisational arrangements for resource protection and waste management in South Africa.

Operational policies describe the rules applicable to different categories and aspects relating to waste discharge and disposal activities. Such activities from the mining sector is categorised and classified based on their potential risks to the water environment.

Operational Guidelines contain the requirements for specific documents e.g. licence application reports.

Best Practice Guidelines (BPG's) define and document best practices for water and waste management.

Schematic Diagram of the Mining Sector Resource Protection and Waste Management Strategy



The DWAF has developed a series of **Best Practice Guidelines** (BPGs) for mines in line with International Principles and Approaches towards sustainability. The series of BPGs have been grouped as outlined below:

BEST PRACTICE GUIDELINES dealing with aspects of DWAF's water management **HIERARCHY** are prefaced with the letter **H**. The topics that are covered in these guidelines include:

- H1. Integrated Mine Water Management
- H2. Pollution Prevention and Minimisation of Impacts
- H3. Water Reuse And Reclamation
- H4. Water Treatment

BEST PRACTICE GUIDELINES dealing with **GENERAL** water management strategies, techniques and tools, which could be applied cross-sectoral and always prefaced by the letter **G**. The topics that are covered in these guidelines include:

- G1. Storm Water Management
- G2. Water and Salt Balances
- G3. Water Monitoring Systems
- G4. Impact Prediction
- G5. Water Management Aspects for Mine Closure

BEST PRACTICE GUIDELINES dealing with specific mining **ACTIVITIES** or **ASPECTS** and always prefaced by the letter **A**. These guidelines address the prevention and management of impacts from:

- A1. Small-scale Mining
- A2. Water Management for Mine Residue Deposits
- A3. Water Management in Hydrometallurgical Plants
- A4. Pollution Control Dams
- A5. Water Management for Surface Mines
- A6. Water Management for Underground Mines

The development of the guidelines is an inclusive consultative process that incorporates the input from a wide range of experts, including specialists within and outside the mining industry and government. The process of identifying which BPGs to prepare, who should participate in the preparation and consultative processes, and the approval of the BPGs was managed by a Project Steering Committee (PSC) with representation by key role-players.

The BPGs will perform the following functions within the hierarchy of decision making:

- Utilisation by the mining sector as input for compiling water use licence applications (and other legally required documents such as EMPs, EIAs, closure plans, etc.) and for drafting licence conditions.
- Serve as a uniform basis for negotiations through the licensing process prescribed by the NWA.
- Used specifically by DWAF personnel as a basis for negotiation with the mining industry, and likewise by the mining industry as a guideline as to what the DWAF considers as best practice in resource protection and waste management.
- Inform Interested and Affected Parties on good practice at mines.

The information contained in the BPGs will be transferred through a structured knowledge transfer process, which includes the following steps:

- Workshops in key mining regions open to all interested parties, including representatives from the mining industry, government and the public.
- Provision of material to mining industry training groups for inclusion into standard employee training programmes.
- Provision of material to tertiary education institutions for inclusion into existing training programmes.
- Provision of electronic BPGs on the DWAF Internet web page.

CONTENTS

FIGURES

GLOSSARY AND ABBREVIATIONS

ABBREVIATIONS

BCR	Benefit/cost ratio
CBA	Cost Benefit Analysis
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
DWAF	Department of Water Affairs and Forestry
D:WUE	Directorate: Water Use Efficiency
GIS	Geographic Information System
GMP	Good Management Practice
GRI	Global Reporting Initiative
IMP	Industry, Mining and Power Generation
ISP	Internal Strategic Perspective
IWMP	Integrated Water Management Plan
IWRM	Integrated Water Resources Management
IWWMP	Integrated Water and Waste Management Plan
MPRDA	Minerals and Petroleum Resources Development Act
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NPV	Net Present Value
NWA	National Water Act (Act No. 36 of 1998)
NWCSF	National Water Conservation Strategy Framework
NWRS	National Water Resource Strategy
NWC/WDMS	National Water Conservation/Water Demand Management Strategy
PPI	Producer Price Index
PV	Present Value
SABS	South African Bureau of Standards
TDS	Total Dissolved Solids
WACC	Weighted Average Cost of Capital
WC/WDM	Water Conservation/Water Demand Management
WMA	Water Management Area
WMP	Water Management Plan
WSA	Water Services Act (Act No. 108 of 1997)
WSA	Water Services Authority
WSDP	Water Services Development Plan
WSP	Water Service Provider
WUMP	Water Use Management Plan

GLOSSARY

Clean water	Water that has not been affected by pollution.
Consumptive use	"*Consumptive use*" of water refers to the water used by businesses in closed processes that do not generate wastewater and that effectively remove that water from the water cycle. A bottling plant is an example of a business that has closed processes in which large volumes of consumptive use occurs.
Demand-side management	Any measure or initiative that will result in the reduction of the expected water use or water demand.
Dirty water	Water that is not clean water.
Distribution management	Any function relating to the management, maintenance and operation of any system of structures, pipes, valves, pumps, meters or other associated equipment, including all mains, connection pipes and water installations that are used or intended to be used in connection with the supply of water.
Efficient use of water	Water used for a specific purpose that is part of accepted and available best practices and benchmarks or water used for a purpose where benefit is derived from it.
Inefficient use of water	Water used for a specific purpose over and above the accepted and available best practices and benchmarks or water used for a purpose where very little benefit is derived from it.
Integrated Water Resource Management	This process determines the optimal way of managing water within a catchment by analysing the change in water demand and evaluating a variety of supply-side and demand-side management measures. Integrated Water Resource Management forms the basis for the Integrated Water and Waste Management Plan for a mine.

Mining area

In relation to a mining right or a mining permit, *"mining area"* means the area for which that right or permit is granted. In relation to any environmental, health, social and labour matter and any latent or other impact thereto, includes:

- any adjacent or non-adjacent surface of land on which the extraction of any mineral and petroleum has not been authorised in terms of this Act but upon which related or incidental operations are being undertaken and including any area connected to such an area by means of any road, railway line, power line, pipeline, cable way or conveyor belt, and any surface of land on which such road, railway line, power line, pipeline or cable way is located; and
- all buildings, structures, machinery, mine dumps or objects situated on or in that area which are used for the purpose of mining on the land in question.

(Minerals and Petroleum Resources Development Act, Act No. 28 of 2002).

Mining operation

Any operation relating to the act of mining and activities directly incidental thereto.

Non-consumptive use

A term used to describe the water that is used by businesses in open processes, generating wastewater that can be recycled or discharged back into the water cycle for use by other users. It should be noted that many open processes are not efficient and that they often contain an element of consumptive use. Cooling is an example of an open process that can consume significant quantities of water, but which also discharges water.

Potable water

Clean water that is suitable for human consumption and may be used within a mine process.

Primary water use

Water that is used in the process of beneficiation or washing of a mineral, from sources such as potable water, recycled/non-potable water, surface water, groundwater and fissure water. Primary water use includes potable water and water used for gardening purposes within the plant, mining and smelter areas.

Secondary water use

Water used in areas that support the primary mining function (e.g. mine village, mine offices, golf course), from sources such as potable water, recycled/ non-potable water, surface water, groundwater and fissure water. Secondary water use includes water used for dust suppression on service roads, watering gardens and grass at mine offices, soccer fields and water used in hostel areas.

Supply-side management	Any measure or initiative that will increase the capacity of a water resource or water supply system to supply water.
Total recycling and reuse of water	The amount of water reused by the organisation over a period of time for a process that would otherwise be supplied by fresh water (GRI, 2003).
Total water use	Total water use is represented by four components, namely the amount of water withdrawn from water sources, stored on site, consumed and discharged by the reporting organisation (GRI, 2003)
Water conservation	The minimisation of water loss or waste, the care and protection of water resources and the efficient and effective use of water.
Water demand	The expected water usage for a mine.
Water demand Management	The adaptation and implementation of a strategy or a programme by a water institution or water consumer (such as a mine) to influence the water demand and use of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability.
Water institution	Water institutions include both Water Management Institutions (WMI) and Water Services Institutions (WSI), as defined in the National Water Act and Water Services Act respectively.
Water recycling	Involves only one use or user and the effluent resulting from the use is collected, treated if necessary and redirected back to its original use or related application. Water recycling sometimes involves the inclusion of additional treatment or a regeneration step to remove the contaminants, which build up in the system.
Water reuse	The use of effluent without additional treatment for other beneficial purposes. Wastewater from one operation can be used in another operation on the mine, provided the level of contamination from the previous process does not interfere with the subsequent process.

Water supply services	The abstraction, conveyance, treatment and distribution of potable water, water intended to be converted to potable water or water for commercial use but not water for industrial use.
Water utilisation	Used to describe both the consumptive and the non-consumptive uses of water by businesses, whether it is raw or potable water.
Water wastage	Water lost through leaks or water use that does not result in any direct benefit to a consumer or user.
WC/WDM toolkit	A collation of various water conservation/water demand management (WC/WDM) measures that can be implemented by the consumer or water management institution to improve the productivity and efficiency of the use of water in order to optimise benefits derived from the use of water. These measures include, amongst others: type of water management system employed by the consumer; monitoring of water use and impacts to the resource; utilising water use management practices that are based on reuse and recycling water to minimise and reclaim water used in the system; and, providing key performance indicators for performance evaluation and monitoring.

1 INTRODUCTION AND OBJECTIVES OF THIS BEST PRACTICE GUIDELINE

1.1 INTRODUCTION

Government policy since 1994 has focused strongly on equitable and sustainable social and economic development for the benefit of all South Africa's people. In support of this, the National Water Policy for South Africa (NWP), adopted by Cabinet in 1997, was introduced in response to the new direction set by government and as part of a thorough review of water law existing at the time.

The NWP was preceded by the development of 28 Fundamental Principles and Objectives for a New South African Water Law, which can be found in Appendix A to the National Water Resource Strategy, 2004. Three fundamental objectives for managing South Africa's water resources, which are firmly grounded in the provisions of the Bill of Rights of the Constitution of South Africa, 1996 (No. 108 of 1996) arise from the Principles. These are the following –

- **To achieve equitable access to water**, that is, equity of access to water services, to the use of water resources, and to the benefits from the use of water resources.
- **To achieve sustainable use of water** by making progressive adjustments to water use with the objective of striking a balance between water availability and legitimate water requirements, and by implementing measures to protect water resources.
- **To achieve efficient and effective water use** for optimum social and economic benefit.

The three principles of equity, sustainability and efficiency come together in the field of water resources management to achieve integrated water resources management. As enshrined in the National Water Act, integrated water resources management is intended to enable DWAF to meet the needs of the country's people for water, jobs and economic growth in a manner that also allows for the protection and, where necessary, rehabilitation of the aquatic ecosystems.

Important proposals to facilitate achievement of the NWP's objectives include the following:

- Water will be regarded as an indivisible national asset. National government will act as the custodian of the nation's water resources and its powers in this regard will be exercised as a public trust.
- Water required to meet basic human needs and to maintain environmental sustainability will be guaranteed as a right, whilst water use for all other purposes will be subject to a system of administrative authorisations.
- The responsibility and authority for water resource management will be progressively decentralised by the establishment of suitable regional and local institutions. These will have appropriate community, racial and gender representation to enable all interested persons to participate.

As the mining sector does not enjoy a right to use water, water management within the industry needs to be undertaken in terms of the administrative authorization process which again requires consideration of and demonstration of adherence to the three principles of equity, sustainability and efficiency. The National Water Resource Strategy (NWRS) sets out the ways in which DWAF aims to achieve integrated water resources management in South Africa. It describes the policies, strategies, plans and procedures by which this will be done.

Integrated water management within the mining sector must critically also be developed within the context of the NWRS and must support a holistic Integrated Water Resource Management (IWRM) approach that adheres to the principles of socially, economically and ecologically sustainable development. IWQM advocates a holistic approach towards the protection, use, development, conservation, management and control of water. To this end, the NWRS will be reviewed and revised as a National Water Resources Strategy for Sustainable Growth and Development.

The need for a holistic IWRM approach is furthermore supported by the fact that South Africa's water resources are under extreme threat, leading DWAF to develop a number of key initiatives aimed at protecting the water resource. These include the following:

- Strategic Framework on Water for Sustainable Growth and Development – Summary Discussion Document, May 2008.
- Immediate Response Strategy for Growing Water Demands, June 2008.

The immediate response strategy states:

This response strategy … sets out measures that need to be implemented, measures that are based on sound planning done in collaboration with the stakeholders in the various parts of the country. However, the implementation of the measures is extremely important. If it is not implemented urgently, shortages of water may soon develop and the situation could deteriorate into a crisis, not dissimilar to the electricity crisis.

A key component of the strategy to address water management in South Africa (and of the immediate response strategy) is the implementation of water conservation and water demand management (WC/WDM) and to this end, the following two documents are directly relevant to this BPG, (and the complete series of BPGs that have been developed) and integrated water management within the mining sector:

- National Water Conservation and Water Demand Management Strategy, August 2004, DWAF.
- Generic Water Conservation and Water Demand Management Framework Guideline for the Mining Sector in South Africa, October 2006.

The key principles of WC/WDM are based on the hierarchy of water management:

- **Avoid water use**: this principle seeks to reduce, wherever possible, the use of water where waterless options exist.
- **Reduce water use**: this principle seeks to reduce the amount of water used through measures such as efficient water use and cleaner production.
- **Reuse and recycle water**: this principle seeks to reuse and recycle water as far as possible, in accordance with applicable rules and regulations.
- **Disposal of water**: this principle seeks to ensure that the disposal of water, or treated wastewater that is not recycled or reused, do not cause degradation to the receiving environment.
- **Feedback and adaptive management**: feedback and adaptive management involve modifying water use habits to achieve more efficient use of water, thus reducing overall water consumption by an industrial/commercial facility.

These same principles underpin integrated mine water management and will be expanded upon in this document.

Additionally, it is critical to consider the broader environmental impacts of mining with respect to biodiversity, global warming and desertification and how these factors may impact on the national water resource. A brief discussion of these factors is presented in Chapter 3.

A catchment management strategy is the framework for water resources management in a water management area. The NWRS provides the framework within which all catchment management strategies will be prepared and implemented in a manner that is consistent throughout the country. Integrated mine water management must therefore be undertaken within the framework of the NWRS and specifically within the context of the relevant catchment management strategies. While most of the water management actions within a mining operation can be defined as source-based measures (and the series of BPGs are aimed primarily at these source based measures), the mine will invariably have some impact on the national water resource, through ground and/or surface water and through point and/or diffuse pollution pathways or water abstraction pathways. Whenever this happens, the mine will need to take cognizance of the resource-directed measures that are addressed within the relevant catchment management strategy. For this reason, Chapter 4 of this document presents a discussion of the application of the principles of integrated water resource management.

It needs to be understood that the mining sector is a relatively small contributor to GDP (5.2% in 2007) but that it has a significant demand on the water resource, both in terms of water abstraction (quantity) and in terms of water quality due to pollution impacts. Given the priority within DWAF to address the water related aspects of equity and poverty eradication and given the fact that in many areas water allocations are fully subscribed, the industry can expect an ever increasing imperative to maximize its efficiency in the use of water. Water is a key national and social resource that has many competing

users and demands and the mining sector will have to demonstrate optimized and efficient integrated water management in order to justify its continued demand on the national water resource.

1.2 OBJECTIVES OF THIS BPG

This BPG is aimed at defining the overall role of the Best Practice Guidelines for Water Resource Protection in the South African Mining Industry in supporting integrated water management at mining sites and will provide DWAF staff, mines and consultants with guidance on how and when to make use of the different BPGs. This first BPG has the following four primary objectives:

- To ensure that it is understood that, in the planning and implementation of integrated mine water management, cognizance needs to be taken of integrated water resource management aspects at national, regional and site-specific levels in addition to the source-directed actions mainly addressed in the BPGs.
- To present and promote the concepts and benefits of integrated mine water management throughout the mine life cycle, using practical examples to illustrate the application of the key principles.
- To ensure that DWAF personnel, mining proponents and consultants understand the role of the BPGs and how and when to use them in implementing integrated mine water management.
- To define the minimum contents of an IWMP, the level of detail required and the role of specialists in preparing and reviewing IWMPs.

1.3 APPLICABILITY, FOCUS AND STRUCTURE OF THIS BPG

As integrated mine water management underpins all aspects of water management at mine sites and as this BPG explains the use of and relationships between all the other BPGs, this BPG is applicable to all mining operations, regardless of whether they are in the exploration, planning, operational or closure phase. While the BPGs and principles of integrated mine water management can be most optimally applied to new mining ventures that are still in the planning phase, all the BPGs, this one included, are also directly relevant and applicable to all mines, even those that have stopped operations and are in the decommissioning and mine closure phases.

This BPG is structured as follows:

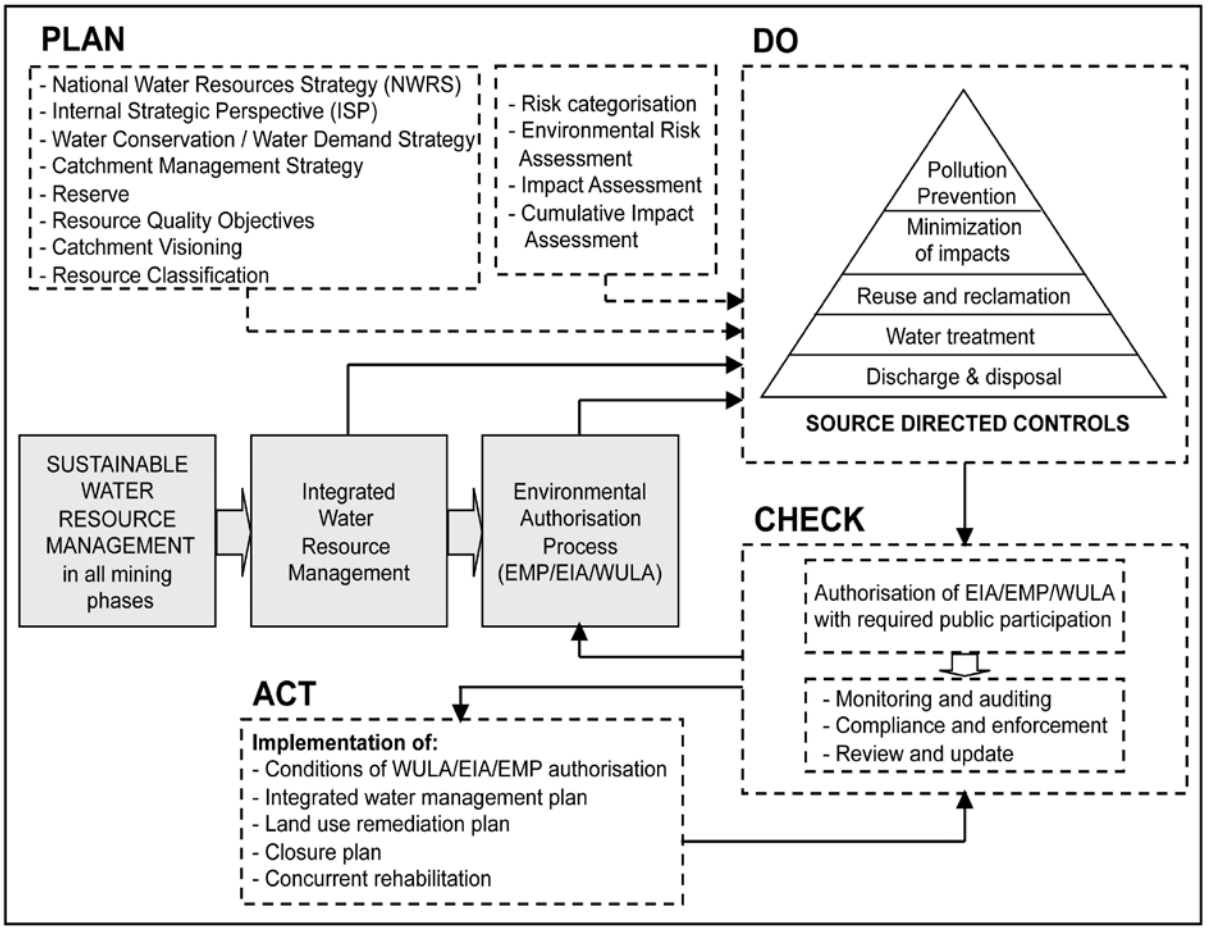
- Chapter 2 covers the general principles for integrated mine water management.
- Chapter 3 presents an overview of the issues of biodiversity, climate change and desertification and how these influence integrated mine water management.
- Chapter 4 presents an overview of the principles of integrated water resource management, within the context of the National Water Resource Strategy and how these key strategic issues need to be incorporated and considered within integrated mine water management.
- Chapter 5 presents a discussion on the principles of integrated mine water management and how these should be implemented at a mine site over different stages of the mine life cycle. The discussion will cover both source-directed controls and resource-directed measures. The discussion will include demonstration of the principles through the use of typical mine site layouts and typical mine water management issues in order to demonstrate practically how integrated mine water management principles and the BPGs should be applied on mine sites.
- Chapter 6 explains the structure and interrelationships between all the BPGs that have been produced and how they should be used
- Chapter 7 presents specific guidance on the contents and scope of an Integrated Water Management Plan (IWMP) that should be submitted to DWAF by mining proponents, the level of detail required and specific areas where suitably qualified specialists should be used, both in preparation and review of an IWMP.
- Chapter 8, summarises the current legal framework in South Africa within which integrated mine water management must be undertaken.

As integrated mine water management incorporates and integrates many different concepts, it is important that the user of this BPG should read and understand this whole document.

2 GENERAL PRINCIPLES OF INTEGRATED MINE WATER MANAGEMENT

In order to understand how integrated water management is set to function at mining sites, it is first necessary to understand how the integrated water quality management (IWQM) model is being developed for South Africa and the national water resource as a whole. An IWQM model is shown in Figure 2.1 below

Figure 2.1: Integrated Water Quality Management (IWQM) Model



The IWQM model shown in Figure 2.1 is based on a broad 4-step process: plan; do; check and act, with a regular interaction between the steps of check and act. The planning process requires consideration of the various broad water resource management strategies and initiatives within DWAF, such as the National Water Resources Strategy, the Internal Strategic Perspective, the Water Conservation/Water Demand Strategy, relevant Catchment Management Strategies, the Reserve, Resource Quality Objectives, Catchment Visioning and the Resource Classification. Together with these broader initiatives, there is a need to address the site specific issues, using a risk-based approach to address and define the risks, both for individual mining features, the integrated mine site and the cumulative regional context.

At the same time, the mine will need to take account of various environmental authorization processes with which it needs to comply (e.g. environmental management plan (EMP), environmental impact assessments (EIA) and a water use licence application (WULA) and will need to submit the relevant documentation to the relevant authorities for approval. With regard to the WULA, there are a number of documents that have been issued by DWAF that give very specific guidance on how the planning process should be undertaken, the nature and type of assessments that should be undertaken and the type of documentation that should be submitted to DWAF for review. Guidance is also provided to DWAF officials involved in the WULA assessment and approval process as to what features to be looking for in the submitted documents and the nature of the process that should be followed. Specific guidance is provided in the document:

Department of Water Affairs and Forestry (2007), Internal Guideline: Section 21 (e), (f), (g), (h), (j) Water Use Authorisation Application Process (Waste Discharge Related)

Both the main document and the various appendices should be used as guidance to what DWAF will be requiring in a WULA.

The planning process will move into the DO step where the actions that need to be undertaken to give effect to the plan are specified and then undertaken. These actions are essentially source-directed controls and they follow the water management hierarchy, i.e. first priority must be given to identifying and implementing measures that are aimed at pollution prevention and the minimisation of impacts - also see ***BPG H2: Pollution Prevention and Minimisation of Impacts***. The second priority in actions is the identification and implementation of water reuse and reclamation actions – see ***BPG H3: Water Reuse and Reclamation***. Finally, there may be a need for the identification and implementation of water treatment actions – see ***BPG H4: Water Treatment***. Only as a last resort, should consideration be given to discharge and disposal options, and then only within the constraints of the various integrated water resource management issues that were considered in the broader planning process.

The DO step in the IWQM model is then followed by the CHECK step, which is an ongoing step, to be undertaken both the mining proponent and by DWAF. The check process also entails two levels of checking, firstly to check whether the specified and agreed actions are being implemented and then secondly to check whether the specified actions are having the desired effect. Non-compliance with the first type of check would entail actions aimed at enforcement of the agreed measures. Non-compliance with the second type of check would entail a review of the WUL and submission of a revised WULA with different actions aimed at ensuring that the desired level of water resource protection is achieved.

Finally, the ACT step is an ongoing process that relates to the implementation of the various actions over the life cycle of the mine. There are various plans and actions that have a bearing on the water resource as shown in the ACT box in Figure 2.1 that need to be implemented. It must also be noted that the ACT step is an iterative step together with the CHECK step.

In order to successfully implement integrated mine water management in a manner that complies with the source and resource directed measures required by the relevant legislation, certain essential principles must be adhered to, as listed below.

- **Compliance with the water management decision-taking hierarchy.** This is an essential requirement as the water management decision-taking hierarchy forms the foundation of DWAF's approach to mine water management. It is essential to be able to demonstrate that pollution prevention, water reuse/ reclamation and water treatment principles have been considered and optimally applied before discharge is approved.
- **Life-cycle approach.** This means that a holistic view should be taken over the life cycle of a mine and that integrated mine water management must address all these phases from feasibility studies and authorisation through mine construction, mine operations, mine decommissioning and closure and the long term residual and latent water impacts after mine closure. It essentially implies that the cost-benefit of an action must be viewed over the full life-cycle of the mine and if properly applied will favour pollution prevention options.
- **Plan for closure.** This means that the environmental and water management actions that are implemented during the planning, construction and operational phases of the mine, should be designed with the risks and requirements of the mine at closure in mind. This principle also requires that concurrent rehabilitation be kept up to date during the operational life of the mine in order that minimum final rehabilitation is left for the decommissioning and mine closure phases.

- **Cradle to grave principle.** The mine must retain responsibility for all its waste streams and their consequential impacts, even when they have moved outside the mine boundaries.
- **Precautionary principle.** Integrated mine water management must be based on conservative assumptions and must use appropriate and accepted best practice techniques to anticipate all potential impacts. In applying the *precautionary principle*, the disposal of waste and/ or discharge of water containing waste will only be allowed, if the receiving environment has the capacity to assimilate the additional waste load.
- **Water conservation and water demand management (WC/WDM).** Integrated mine water management must recognize the principles of equity and efficiency and must optimize waste minimization and recycling, water conservation and water demand management in order to ensure that there is equitable competition for water as a scarce social resource. The hierarchy of actions in WC/WDM is given in Section 1.1 above.
- **Consideration of temporal variability of water quality and quantity.** Integrated mine water management must make use of accepted techniques that are capable of qualitatively and quantitatively defining water quality and quantity variations and their impact on surface and ground water systems, currently and in the future.
- **Risk-based approach.** The mine should apply appropriate risk assessment techniques to quantify the potential current and long-term risks associated with its practices or activities and then apply appropriate management actions to minimise or mitigate the potentially significant risks.
- **Continual improvement**. For the reason that planning, by necessity, is typically based on limited data, initial predictions can only be validated during the operational phase. Integrated water management must include measurable, quantifiable objectives, and relevant performance indicators which need to be identified, set, implemented, monitored and audited. Based on the compliance to objectives and targets, the plan should be reviewed on an on-going basis and updated on a frequent basis (as stipulated) as part of compliance with Environmental Management Systems (EMS) as well as in support of the principle of continual improvement. (The continuous improvement could be driven by additional information not previously available, deficiencies in the existing system (controls, plans or management structure), changes in the external environment, changes in the mine plan, changes in regulation, review of the real risks that manifest themselves, etc.) This process is also illustrated in Figure 2.1.
- **Cumulative impacts**. Mine sites are typically quite extensive and cover significant geographic areas with aspects such as mining operations (shafts or pits), waste dumps, tailings disposal facilities, pollution control dams, metallurgical plants, storm water management structures, pollution control dams, water treatment facilities, haul roads, residential complexes with housing, runoff and sanitation issues, etc. While impact assessments can be undertaken for each individual aspect of the mining operation, the cumulative impact within the mine site must also be considered.
- **Regional impacts**. The mineral ore bodies being mined (e.g. coal, gold, platinum) are generally regionally concentrated, with the result that many different mining companies operate adjacent to each other. In such scenarios, the mining activities invariably result in the establishment of hydrological interconnections between adjacent mines – both for ground and surface water systems and the activities of any one mine will have consequences for adjacent mines. In such scenarios, the regional interactions must be defined and understood in order to serve as the framework for integrated water management at the individual mine level.
- **Public participation**. To gain community acceptance, the IWMP must address the requirements and expectations of all Interested and Affected Parties (IAP), communities and stakeholders, including the relevant authorities.
- **Use suitably qualified persons**. Many of the aspects of integrated water management require modeling (e.g. hydrology, geohydrology, geochemistry) or design activities that need to be undertaken by persons with the suitable technical qualifications and expertise with access to suitable resources.
- **Management commitment**. Total company and management commitment is fundamental to ensuring effective implementation of the IWMP and to prevent and/or minimise existing and potential environmental impacts. The company must derive an IWWM policy, clearly stating the industry's approach to IWWM.

Integrated mine water management plans and actions must clearly demonstrate that they have incorporated

all of the above principles or, alternatively, must clearly motivate why any of the above principles are not relevant.

In addition to the abovementioned integrated water quality management principles and in support of the primary objectives of this BPG, the following additional principles are identified:

PRINCIPLES RELATING TO THE ROLE OF BPGs

- The BPGs should be used as a complete and integrated set of documents, which are extensively cross-referenced and which together, address all aspects of integrated mine water management.
- The use of the BPGs and adherence to the principles and procedures set out in the BPGs will ensure that mines meet DWAF's minimum requirements for integrated mine water management.
- DWAF personnel will make use of the BPGs when developing and setting conditions to a water use authorization such as a licence (WUL) and these conditions will not be in conflict with the principles and procedures set out in the BPGs.

PRINCIPLES RELATING TO INTEGRATED WATER RESOURCE MANAGEMENT

- Integrated mine water management must give effect to both source-directed measures (contained in the BPGs) and resource-directed measures (not covered in the BPGs but found in other documents).
- Integrated water resource management (IWRM) must include consideration of land management aspects and practices.
- IWRM as applied at mines should seek to develop a water management system, based on the water management hierarchy, which strives to achieve zero impact.
- A mine that wishes to apply for authorization to discharge to the water resource will need to take explicit account of the variety of resource-directed measures that are illustrated in Figure 2.1 in their planning and water use licence application (WULA) and submit an IWMP.

PRINCIPLES RELATING TO IWMP DOCUMENTS

- The IWMP must consolidate all the various outputs (e.g. EMP, EIA, EMS) of the integrated mine water management process into a single, integrated, simplified, coherent, manageable and implementable plan. IWMPs are not compilations of numerous documents into a single large unmanageable document.
- The IWMP must be sustainable and must clearly support the iterative process of planning, implementing, monitoring, auditing, reviewing and updating required to ensure that continuous improvement happens.
- IWMPs should contain a standardized and agreed level of detail in accordance with the risk-based approach and should provide information to ensure that DWAF officials can consider the WULA and subsequently issue a WUL.

3

INTEGRATED MINE WATER MANAGEMENT IN THE CONTEXT OF BIODIVERSITY, GLOBAL WARMING AND DESERTIFICATON

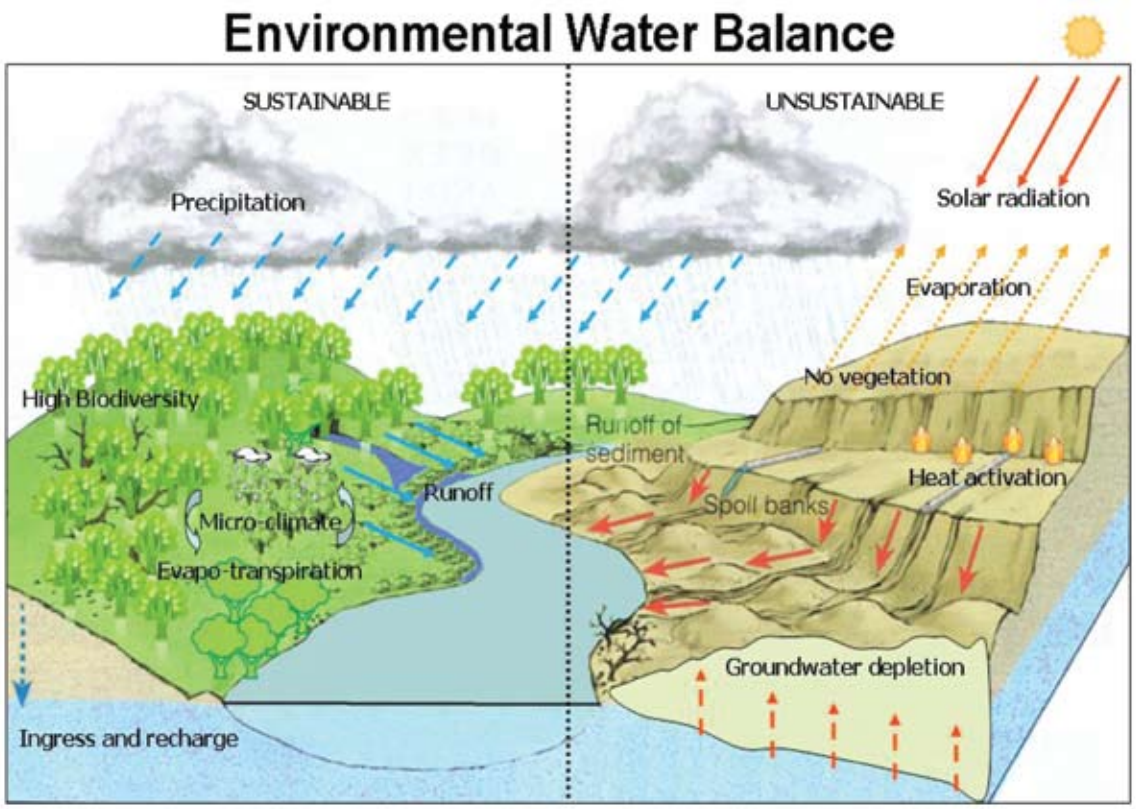
Sustainable environmental management can only be addressed through proper implementation of sound Integrated Water Resource Management principles. IWRM does not provide a complete solution to all the dimensions of desertification, but no strategy for land use and desertification will be successful unless it includes strategies for managing water. The operational strategy therefore needs to make provision for improved alternative approaches to be endorsed by mining with specific reference to rehabilitation that must consider:

- Preservation of organic matter, waste minimisation and recycling
- Protein production from organic material (vermiculture and aquaculture)
- Increase vegetation and precipitation through forestation
- Land rehabilitation, vegetation and erosion control to include biodiversity and greening programs
- Management of protective species and eradication of invasive species
- Protection and development of wetlands
- River and floodplain protection with greenbelt conservation (within 1:100 year)
- Storm water management to promote retention and increase recharge
- Groundwater protection and recharge
- Diffuse source management
- Water conservation and demand management
- Integrated monitoring program and information management

As illustrated in Figure 3.1, the implementation of the concepts as described above promotes the initiation of the environmental water balance. A vegetation cover of high biodiversity improves the overall environmental balance as it contributes towards the micro climate where evapo-transpiration causes condensation within the leave canopy (foliage) allowing for some water to be retained in the system. The moist conditions within the system allow for increased ingress and recharge of aquifers, improved vegetation and less sediment runoff.

In contrast unsustainable conditions are created where lack of vegetation causes the earth to be exposed to high levels of solar radiation and evaporation. The net result is increased temperature in soils with the associated decrease in groundwater levels. The barren desert conditions that are created have no means to retain moist and during rainy events the quick runoff also deplete the surface of soils and organic sediments.

Figure 3.1: Graphical conceptualisation of the Environmental Water Balance cycle



These concepts and principles will be further illustrated and elucidated in this BPG on Integrated Mine Water Management as well as other BPG's published in the A (Activity), G (General) and H (Hierarchy) series. A more detailed discussion on the issues relating to biodiversity, desertification and global warming is presented in Appendix A.

4

APPLICATION OF THE PRINCIPLES OF INTEGRATED WATER RESOURCE MANAGEMENT

The broad National Water Policy (NWP) and the various strategic initiatives that underpin Integrated Water Resource Management (IWRM) are summarised in Section 1.1. This discussion aims to demonstrate that whereas the BPGs and most aspects of mine water management address source-directed controls, there is a broader resource-directed strategy that the mines need to slot into. DWAF, through the National Water Resource Strategy (NWRS) is mandated to give effect to the NWP and the three key principles of equity, efficiency and sustainability. While mine water management will continue to have a source-directed focus, the mere fact that mines consume water through abstraction from the national water resource and that they impact on the water resource quality through point and/or diffuse pollution, requires that mine water management take cognisance of the principles of IWRM.

DWAF is in the process of updating the NWRS and will be reissuing it as the National Water Resources Strategy for Sustainable Growth and Development. This refocusing of the NWRS is driven by the following principle:

Vision: A robust and accountable water sector, which successfully meets demand for water security and reliable and effective water services, and enables equitable, environmentally sustainable economic growth and social development in South Africa.

This vision is underpinned by the following principles:

(1) All economic and development planning must include an assessment of water availability and effluent management.

(2) Decisions regarding the use of water must balance the economic, social and environmental dimensions of water.

(3) Decisions regarding the use of water must focus particularly on poverty eradication and social justice.

(4) Water investment should give equal emphasis to the maintenance and refurbishment of the current asset base, and the development of new infrastructure.

(5) Priority should be given to optimizing efficient use and productivity to obtain more value per unit of water

(6) Sound management and use of local resources, including groundwater, should be prioritized before accessing more distant resources.

(7) Institutional reform should tailor the institutional arrangements of the water sector to fit more closely with the capacity to deliver.

(8) Sustainable service provision and water management rests on a strong partnership between citizens and government, with mutual accountability.

In ensuring that the principle of efficiency is addressed within IWRM, emphasis must be placed on water conservation and water demand management (WC/WDM) and reference is made to the overall strategy and to the framework that was developed specifically for the mining industry (see Chapter 8).

4.1 EXTRACT FROM THE NWRS

The following extract is taken from the NWRS as a discussion and explanation of the role that IWRM plays in the management of the national water resource.

Integrated water resources management (IWRM) may be defined as a process which promotes the co-ordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. IWRM therefore aims to strike a balance

between the use of resources for livelihoods and conservation of the resource to sustain its functions for future generations, and promotes social equity, environmental sustainability and economic efficiency. Because the resource cannot be considered separately from the people who use and manage it, a balanced mix of technological and social approaches must be used to achieve integrated management.

The dimensions of integrated water resources management

Freshwater is a complex ecological system that has a number of dimensions. Surface water, groundwater, quantity and quality are all linked in a continuous cycle - the hydrological cycle - of rainfall, runoff from the land and infiltration into the ground, and evaporation from the surface back into the atmosphere. Each component may influence the other components and each must therefore be managed with regard to its inter-relationships with the others.

Water as a system also interacts with other systems. Human activities such as land use, waste disposal and air pollution can have major impacts on the quantity and quality of water available for human use, while the abstraction and storage of water and the discharge of waste into water resources can impact on the quality of the natural environment. These interactions must be considered and addressed by water resource managers.

Taking an even broader view, water must also be managed in the full understanding of its importance for social and economic development.

It must also be borne in mind that South Africa shares four major river basins, which together cover about 60 per cent of South Africa's land area and account for around 40 per cent of the total surface runoff, with neighbouring countries. The NWP accords high priority to harmonious relations over water with neighbouring states and the NWA provides for water to be made available to meet international rights and obligations. The international dimensions of IWRM are therefore critically important for South Africa.

Co-operative planning and management of water resources

The complexity of managing water as a system and its interactions with other systems is further compounded by the large number of institutions and organisations - both domestic and international - involved in the administration and management of the various systems.

The Department of Water Affairs and Forestry (the Department) is currently responsible for water resources management at national level. The Act requires the Department to ensure that its programmes are in accordance with government policy and are co-ordinated with relevant programmes of other national departments. Similarly, other departments have a responsibility to ensure that, where relevant, their programmes take account of the realities of South Africa's water situation. This is particularly important when it comes to planning developments that depend on water for their success. In these instances the availability of water must be factored into plans at the beginning of the development process. One of the purposes of the NWRS is therefore to provide sufficient information about water resources to facilitate coherent and holistic planning, as well as establishing a platform for informed interactions between water resource managers and development planners in other sectors.

In terms of the Act and the NWRS the Department is in the process of establishing 19 catchment management agencies, each operating in a defined water management area, to manage water resources at a regional level. These agencies will be responsible, among other things, for ensuring that there is consonance between their water-related plans and programmes and the plans and programmes of all other role players in the catchments they manage. The agencies will therefore have to establish co-operative relationships with a range of stakeholders, including other water management institutions, water services institutions, provincial and local government authorities, communities, water users ranging from large industries to individual irrigators, and other interested parties.

The success of integrated water resources management will therefore depend heavily on the development of a framework of co-operation among all relevant institutions, organisations and individuals. This co-operative framework must facilitate planning at all geographic scales ranging from international projects to activities on individual smallholdings, and the co-ordination of programmes.

Integrated water resources management, poverty and gender

The need for an integrated approach to managing water resources has been articulated at a number of

international meetings during the last three decades, each of which has stressed the importance of water for human survival, health and productivity. The two most recent global forums - the United Nations Millennium Summit, September 2000, and the World Summit on Sustainable Development, August 2002 - reaffirmed that people must be at the centre of the sustainable development and use of water resources. Resolutions, agreements and targets arising from these events emphasised, among other things, the importance of water in addressing poverty issues, and the importance of factoring gender considerations into all aspects of water management. In an African context these sentiments are echoed in the policy objectives of the New African Partnership for Development and the Southern African Vision for Water, Life and the Environment in the 21st Century[11].

IWRM does not provide a complete solution to all the dimensions of poverty, but no strategy for poverty eradication will be successful unless it includes strategies for managing water. The provision of basic water and sanitation services is an essential element of water's contribution to poverty eradication, because it addresses issues of health and hygiene, and the effort required in collecting and carrying water from remote, often polluted water sources. Providing free basic services goes some way to making water affordable to the poor. Basic water services do not however make adequate provision for productive livelihoods

The rural poor, many of whom do not yet have access to reliable water supplies or sanitation services, often rely for their livelihoods on cultivating food, gathering natural products and other water-dependent activities. But their water sources are often unreliable and insufficient, threatened by droughts and floods, and eroded or degraded by developments over which they have no control.

In South Africa water is regarded as a social, environmental and economic good. Nevertheless, after basic human needs and the requirements for maintenance of ecosystems have been satisfied, there will inevitably be competition for access to the remaining available water. It is essential that water-related policies are implemented in ways that give special attention to ensuring that the poor can meet their needs, and that they are given a voice in decisions that affect them.

In order to successfully address issues of equity IWRM must also consider gender - that is, the implications for men and women of legislation, polices, and implementation strategies and programmes, and the measures required to enable them to participate in water resources management on an equal footing. It has also been shown by international and local experience that poverty eradication initiatives are greatly enhanced by the involvement of women in all aspects of water resources management at all levels.

Women and men bring different perspectives and viewpoints to water management, and play different roles. There are however often considerable imbalances between women and men, in for instance their levels of education and the influence they are able to exercise, and these imbalances must be addressed in initiatives to capacitate the two groups to participate in decision-making. Poor black women are one of the most marginalised groups in South African society. Conscious efforts must therefore be made to involve them in water resources management processes and to ensure that the management of water contributes to meeting their needs.

Careful analysis will be required of water-related developments, whether they involve the construction of infrastructure or relate to demand-side management, to take into account the benefits and costs that accrue to women and men, and to ensure that one group does not benefit at the expense of the other. Special emphasis must be placed on the involvement of women in water resources management institutions and in policy development.

It is not possible to separate issues of poverty, race and gender, but it is necessary to understand how they interact with and impact each other. An integrated approach to managing water resources will contribute to building a society free from poverty and discrimination.

4.2 IWRM AND CATCMENT MANAGEMENT STRATEGIES

The key implication of IWRM for mining and mine water management is the recognition that mines do not have a right to water. Water is a scarce resource and mines require an authorisation to use water and this water use licence will be subject to conditions that are in line with IWRM and which are aligned with the principles of equity, efficiency and sustainability. This approach is also consistent with the water management hierarchy which requires that mines must be able to demonstrate that they have optimised the application of actions aimed at

preventing pollution, minimising impacts and reducing water demand through water reuse and reclamation and other water conservation measures.

Wherever there is a water quantity or quality implication for the water resource, the mine's water use licence application (WULA) will be reviewed within the context of DWAF's central objective of managing water resources to ensure that water is used to support equitable and sustainable social and economic transformation and development. This review process will be undertaken within the context of catchment management strategies (CMS).

While a CMS gives effect to the founding principles of equity, efficiency and sustainability, it must also adhere to the following supporting principles:

- Coherence between national and local water-resource related strategies and plans.
- Collaboration with key institutions, stakeholders and beneficiaries.
- Stakeholder engagement and capacity building
- Transparency.

The NWA (1998) in Chapter 2, Section 9, provides an outline of what the contents of a CMS must contain in order to ensure that the founding and supporting principles are applied within the context of the catchment. DWAF has also issued a guideline for catchment management strategies (see Chapter 9 – References) that provides specific guidance on the procedures for developing a CMS. Essentially a CMS will comprise of 4 main clusters of information and strategies:

Part A: Foundational Information. This includes a situation description of the catchment both in terms of its current status and likely future status with regard to biophysical, social, technical, economic, political and institutional characteristics. The situation description then forms the basis of a situation assessment, leading into a reconciliation or balance of beneficial, effective and efficient water requirements with water availability (quality and quantity) for the current and future scenarios and the identification of priority strategic actions to ensure the beneficial use of water. This information is then used, in conjunction with public participation, to develop a collective medium to long term vision for the desired future state of the water management area (WMA) that can be used to derive sub-strategies that are realistic and locally attainable.

Part B: Water Resource Management Strategies. These strategies that aim to ensure that the identified vision is achieved include both resource directed measures (RDM) and source directed controls (SDC). The RDM and SDC are interdependent and apply both to surface and groundwater. The RDM sub-strategy must give effect to the Class, Reserve and Resource Quality Objectives (RQO) of the water resources and associated protection measures. The SDC aims to develop a sub-strategy that will draw on incentives and disincentives, verification, allocation planning, re-allocation, authorisation and licensing, water management and pollution control, augmentation measures and compliance and enforcement to realise the ideals of equity, efficiency and sustainability.

Part C: Facilitating Strategies. This part comprises 3 sub-strategies of public engagement and capacity development; information management and monitoring; and finance or funding.

Part D: Institutional Arrangements & Co-operative Governance. The objective of this part is to set out strategic actions for the establishment and maintenance of appropriate co-operative and collaborative relationships for IWRM based on the institutional environment.

4.3 IMPLICATIONS OF IWRM FOR INTEGRATED MINE WATER MANAGEMENT

The key implications of IWRM and CMS for integrated mine water management and IWMPs, relate to the resource directed measures, particularly the Class, Reserve (Basic Human Needs Reserve and Ecological Reserve) and RQOs. This information is then used to define the allocatable water resources and to draw up an allocation plan. All the steps other than determining the Reserve and defining the allocatable water resources have strong public participation elements where all users, including the mines will have the opportunity to provide their input.

The development of the RDM essentially entails the definition and understanding of four key concepts:

(1) The present state of the water resource in question which is represented by the Present Ecological State.
(2) Determining a desired state for the water resource, formally referred to as the Management Class (MC).

(3) The amount and quality of water needed to achieve the MC and water for basic human needs, collectively known as the Reserve.

(4) The variables that will be monitored to ensure that the above are achieved, known as the RQOs.

The described process is an ideal end objective and the current resource constraints dictate that for the foreseeable future, only interim and preliminary Reserves and RQOs will be developed.

Important implications of the requirements of the Reserve and Classification are as follows:

- The Reserve has priority over all other water uses.
- No water use licence may be issued without at least a preliminary determination of the Reserve.

5 APPLICATION OF THE PRINCIPLES OF INTEGRATED MINE WATER MANAGEMENT

The principles that underpin integrated mine water management are set out and discussed in Chapter 2 of this BPG, but in order to simplify the understanding of how these principles should be interpreted and applied, the following **four key principles** are reiterated and explained as the fundamental cornerstones of integrated mine water management:

(1) **Risk-based approach:** This implies that the mine's whole environmental management system and the integrated water management system in particular, are based on an assessment, understanding and management of the true risks. Whereas mine water management systems are very often based on minimum compliance with current legislation and standards, this approach has a large inherent risk associated with the fact that environmental and water management legislation is firmly grounded on the principles of continuous improvement. The IWMP that is based on minimum compliance will therefore continuously be subjected to the need to change and update to accommodate shifting legal and regulatory goalposts. On the other hand, an IWMP that is based on addressing the real scientifically-validated environmental and water resource risks, regardless of the legal need to do so, is based on a firm scientific foundation with a much lower risk of continuous change. Additionally, a proper risk-based approach will also tend to favour the water conservation and pollution prevention approach, as does the life-cycle approach and proper application of the water management hierarchy.

(2) **Life-cycle approach:** The consequences of water management actions implemented now must be evaluated, quantified and understood over the full life-cycle of the mine, right through to post-closure. This will invariably lead to a greater emphasis on the selection, optimisation and implementation of pollution prevention options even when the upfront costs are higher. The benefit of the life-cycle approach, water conservation and pollution prevention options in general, is that they typically have much lower life-cycle costs and lead to a water management system with much lower inherent financial and environmental risks.

(3) **Water management hierarchy:** The water management hierarchy sets a very clear priority order in which management options must be considered. The key principle in effective and efficient mine water management is that it requires that all water conservation and pollution prevention options are first considered and exhausted before moving on to impact minimisation measures, water reuse and reclamation and eventually treatment as a last option. Provided that the risk-based and life-cycle approaches are also properly applied, it will generally be found that decisions on preferred options will tend to be the pollution prevention options (these will include water conservation and water demand management options).

(4) **Management commitment:** The absolute commitment of senior mine management to the principles of integrated mine water management is crucial in the success or failure of the strategy at any mine site. The commitment from senior management has a number of facets which include the following: commitment to spend time and money up front to properly understand mining options and to select the best from a risk-based life-cycle approach; commitment to the implementation of the IWMP by making appropriate human and financial resources available, commitment to modifying the performance assessment criteria for senior management to include life-cycle environmental and water management performance criteria on a par with short-term profitability criteria; commitment to enforcing a culture of environmental awareness within the company with real penalties for non-compliance; understanding of and commitment to the principles of sustainability.

If the above four key principles are fully subscribed to at a mine site then the probability of success for integrated mine water management is high. However, it must be recognised that there are a number of key challenges that pose a threat to effective integrated mine water management:

- **Short-term profit focus**: The reality of the modern world where competition occurs on the global market and no listed company is immune to the fickleness of investors who are able to manipulate company fortunes instantaneously through on-line trading, is that the pressure for short-term financial performance is immense and cannot be ignored. This system is in place in many South African mining companies where Mine Managers are measured and rewarded on the basis of short-term quarterly performance results. Until all companies subscribe to, abide by and are measured against the same global sustainability criteria, there will be a motivation to rather consider the cheaper short-term water management option in spite of knowledge that there is a better and more cost-effective option when considered from a life-cycle perspective. The temptation to pursue the 'wrong' short-term option becomes significantly higher when the company does not have sound corporate sustainability principles and when it operates within a regulatory environment where the ability of the regulator to properly enforce the law is compromised for whatever reason (i.e. lack of resources, lack of skill, lack of competence, corruption of officials etc.), allowing the mine to believe that there is a reasonable chance that it will not ever be forced to address the real long-term risks and incur the additional costs.
- **Paying lip service to sustainability and environmental management:** While most, if not all, South African companies have an integrated safety, health and environmental policy and system in place, the unfortunate reality is that in many cases only lip service is paid to the environmental (and water) management aspects. Whereas significant human and financial resources are allocated to health and safety and severe penalties are imposed on personnel or contractors who infringe health and safety procedures, the same does not always apply to environmental and water management policies. Attending a mine induction course is all that is required to demonstrate that environmental and water management issues do not receive the required priority to ensure that integrated mine water management can be effectively implemented. As long as water management remains the sole responsibility of a few dedicated water management personnel and not the personal responsibility of all company employees and contractors (as is the case with safety), water management will remain reactive and will not become proactive as is required for good integrated mine water management.
- **Use of technical personnel who are not suitably qualified:** Whether as employees or contractors/ consultants, the use of technical personnel who are not suitably qualified poses a significant threat to effective integrated mine water management. This risk applies to the mining proponent who may then make poor decisions based on incorrect information or an inability to understand the alternatives and consequences of each. However, this risk to effective integrated mine water management is also there if the regulator (DWAF) employs persons who are not suitably qualified and who are therefore unable to properly evaluate IWMPs submitted by mines and are unable to properly and effectively engage with the mine personnel during site visits.
- **Lack of transparency and honest objective review:** It is a reality that there are many mines that base their environmental and water management systems and plans on minimum compliance and not on an independent risk assessment. Furthermore, there are unfortunately situations where risks and impacts not explicitly covered by minimum compliance requirements are then ignored and not communicated to external stakeholders in the hope that they will simply disappear – resulting in a lack of transparency. Additionally, IWMPs are seldom subjected to objective independent review and while this may have less consequence for DWAF when this problem applies to mines that still have a long operational life, there is a significant risk that water conservation and pollution prevention options are then not being optimally considered, leading to potential longer-term impacts. As the mine gets closer to mine closure, the risk to DWAF of an inadequate IWMP increases rapidly and the need for independent review by suitably qualified persons becomes more critical.

It is worth emphasizing that critical review of the abovementioned four key principles and four key challenges, either by mine management team or the responsible or reviewing regulator will give the best possible indicator of the state of integrated mine water management at the particular site in question.

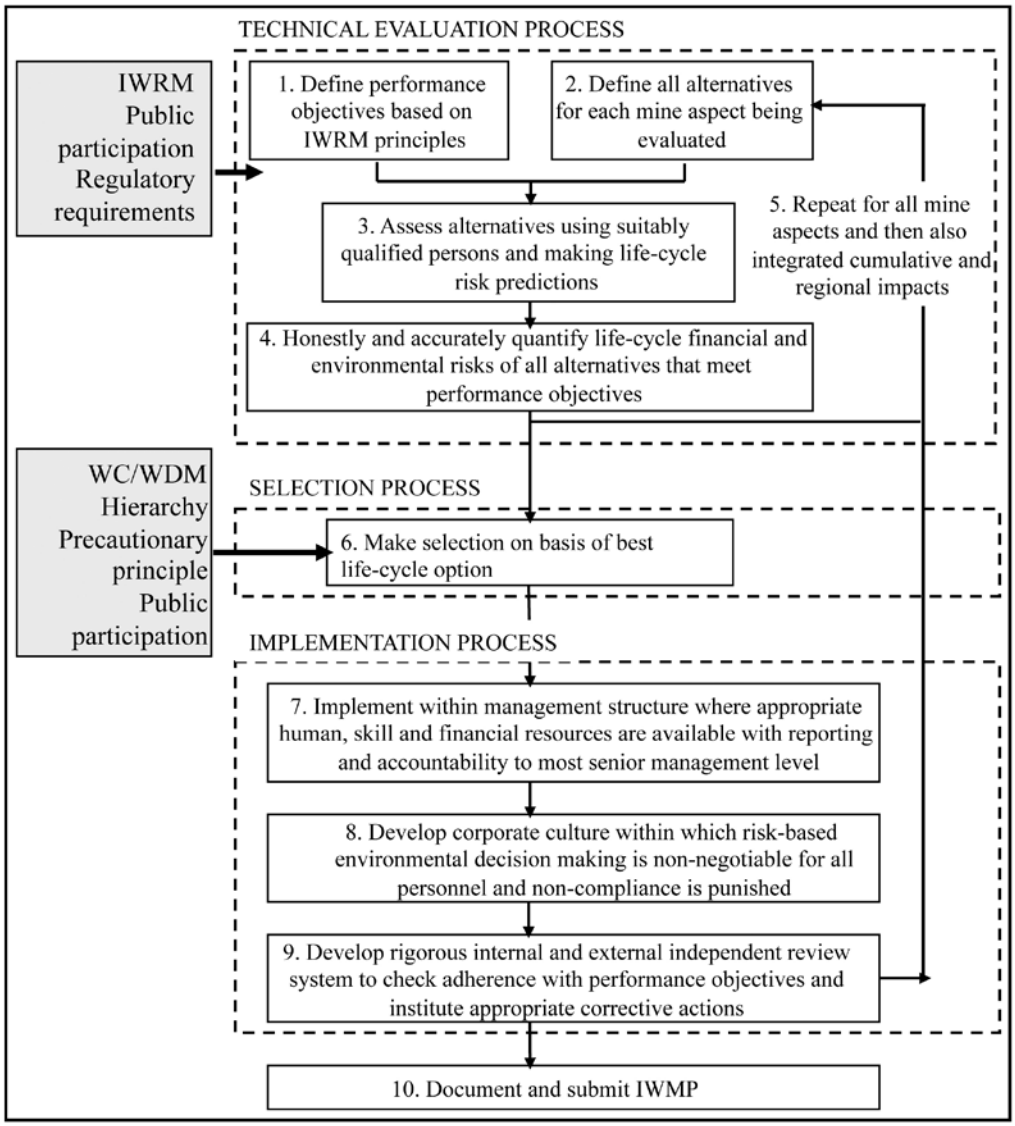
5.1 PROCEDURE FOR DEVELOPMENT OF AN IWMP

The appropriate integrated water management plan is very site specific and will depend on site-specific features

of the mine in question as well as the status of the water resource in that area. It is therefore not possible to define a universally good integrated water management plan. However, key principles are universally applicable and there is a sound logical procedure that should be adopted to ensure that the optimum integrated mine water management plan is developed for each specific mine site. Application of the above four key principles and avoidance of the above four challenges, within the context of the logical procedure shown in Figure 5.1, should result in the development and effective implementation of a robust IWMP.

The procedure shown in Figure 5.1 comprises of 9 steps/considerations that are described and discussed in the following sections of this chapter. Figure 5.1 which focuses on the technical procedures and the implementation/management requirements for an IWMP could and should be read in conjunction with Figure 2.1 which focuses on the regulatory drivers associated with the development of an IWMP.

Figure 5.1: Procedure for development of an IWMP



Step 1 Define Performance Objectives

One of the critical steps required in developing an IWMP s to set the target point that defines the minimum requirements that the mine will need to comply with. This objective can be defined in many different ways but will always require the input of external stakeholders (regulators and public stakeholders) and will need to make reference to a variety of regulatory initiatives, primarily those that derive from the National Water Resource Strategy and others such as shown in Figure 2.1. The primary initiatives that will need to be considered include the following:

- National Water Resources Strategy (NWRS)
- Catchment Visioning
- Internal Strategic Perspective (ISP)
- Catchment Management Strategy
- Resource Classification
- Reserve
- Resource Quality Objectives
- Water Conservation/Water Demand Management (WC/WDM) Framework

The details of these different initiatives are summarised in Chapter 8 and the application of the key principles thereof is discussed in Chapter 4.

The key requirement in this step in the development of an IWMP is to obtain guidance and minimum compliance criteria from DWAF and other stakeholders on the acceptable water abstraction that can be planned for in the case of a new mine and the resource quality objectives that would apply for the catchment and water resource likely to be impacted upon by the mining activities. This is a process which is currently still in development and currently, only interim and preliminary objectives can be provided.

Step 2 Define Alternatives

For each of the mine aspects being evaluated, it is necessary to develop as complete a set as possible of alternative ways in which the aspect could be located/constructed/managed/operated/rehabilitated/closed. In developing these alternatives, the primary consideration should be one of maximising the potential for prevention of pollution and minimization of impacts as set out in ***BPG H2: Pollution Prevention and Impact Minimization***. Additionally, the principles and objectives of water conservation and water demand management (WC/WDM) should also enjoy priority consideration at this stage in order to minimize the impact on the national water resource (see WC/WDM documents and guidelines shown in references).

In developing these alternatives, it is also necessary that each alternative be fully described in order that it can be properly assessed in the next step of the process. This description must also take account of the full-life-cycle of the aspect being considered, e.g. if it is a new tailings disposal facility that needs to be built, then the description must include all the life cycle issues from location, design, construction, operation, through decommissioning, rehabilitation and post closure and must specifically identify and qualitatively describe all the potential issues, impacts and risks from a water resource (quantity & quality; surface and ground water) perspective.

The same process must be undertaken for each of the mine aspects that may potentially have a water management impact. For example, to continue with the tailings disposal facility example, the assessment must include options with regard to:

- the type of tailings produced (chemical quality, water content, paste technology, etc.);
- the conveyance of tailings from the plant to the tailings disposal facility (pipeline route, river crossings, emergency & spillage control measures, etc.);
- design details for underdrainage and seepage prevention/collection/monitoring;
- facility operational strategy and effects on water balance (e.g. size of pool, penstock design, tailings placement options (paste, cyclones, spigots), rate of rise);
- return water facilities (sizing of return water dam and pumps, lining of dams, overflow issues, balancing with water demand and storage facilities in plant, etc.)

The end point of this step is a thorough listing of alternatives for each mine aspect being evaluated, with a detailed qualitative description of the potential water resource risks for each alternative over the full life-cycle of the mine aspect being considered. While it may appear onerous to go through this comprehensive and extensive process, it must be understood that they key to optimal implementation of pollution prevention and impact minimization measures is proper planning and incorporation of these measures into the planning phase. Optimum implementation of pollution prevention measures also has significant benefits in terms of

reducing life cycle costs and risks and specifically reduces risk and liability at mine closure.

Step 3 Assessment of Alternatives

This phase is a technically complex phase, with the nature and type of assessment that needs to be undertaken being very dependant on the aspect and alternative being evaluated. In each instance, the question that needs to be answered will essentially be as follows:

What is the quantified impact/risk that this alternative poses to the water resource in terms of quantity and quality, considered over the full life cycle of the mine or for as long as the impact/risk may persist?

Wile the question may be slightly modified or rephrased to suit particular site-specific circumstances, the essence will remain the same.

For most situations that present a potential for long-term water quality risks, the procedures and methodology set out in ***BPG G4: Impact Prediction*** will be applicable, as well as the approaches set out in ***BPG H2: Pollution Prevention and Minimisation of Impacts***. Other situations will arise where only hydrological investigations are required, such as in assessment of storm water management options and in this case ***BPG G1: Storm Water Management*** would provide guidance on appropriate assessment techniques.

The key consideration in undertaking this step, is that suitably qualified specialists must be used and that they should be using models/techniques that comply with best practice and which are professionally justifiable and open to review, if and when required. It should be noted that whenever an assessment is being undertaken with the aim of including it in a mine closure plan, then particular requirements for transparency and review will apply as discussed in ***BPG G5: Water Management Aspects for Mine Closure***.

The assessment process described here needs to be undertaken for each mining aspect under consideration and will then also eventually need to be compiled into an integrated assessment where the cumulative impacts/ risks of the preferred combinations of options on the water resource are evaluated.

Step 4 Quantify Life Cycle Financial/ Environmental Risks

In Step 1, the process for establishing a set of performance objectives was described as these define the minimum targets that any management actions will need to comply with. It is a matter of principle that the statement can be made that any alternatives that cannot comply with the performance objectives should be rejected and not considered any further, unless there is a very clear and strong motivation to engage with DWAF and other Stakeholders in order to negotiate a revision of the previously agreed performance objectives.

For those alternatives that can potentially meet the agreed performance objectives, the following information must be quantified and presented:

- Residual latent environmental risks associated with the alternative.
- Benefits that the option may have in terms of performing better than the set performance objectives (this could include lower than necessary environmental impact/ risk, higher degree of pollution prevention, higher sustainability, greater social benefit, etc.).
- Capital, operating, decommissioning and post-closure cost estimate for the option over its full life-cycle.

It is critical that this assessment be undertaken in an honest, transparent and fully justifiable manner and that it not serve as a means to artificially enhance the benefit of an alternative that is preferred for ulterior motives. Such an exercise is again a highly specialised task and suitably qualified and objective specialists should be involved in the process.

Step 5 Repeat Process for all Aspects

Again, as for the assessment exercise (Step 3), the process presented in Step 4 above, should be repeated for all the mine aspects being considered as well as for a range of combinations of preferred options to represent the integrated cumulative impact/risk for the whole mine site. The outcome of this exercise should be documented in a format that presents all the data in a user-friendly manner that facilitates direct comparison between the options.

Step 6 Select Best Life-Cycle Options

The outcome of the assessment and quantification steps described in Steps 3 and 4 above need to be evaluated and considered in order to identify the preferred options. While it is clearly understood that it is the responsibility of the regulator (DWAF) to set the performance objectives and that it is the responsibility of the mining proponent and not DWAF to select and implement the appropriate management options to meet these water resource

performance objectives, it is necessary to engage with DWAF and other stakeholders, through a public participation process in order to obtain their input into the selection process.

The selection of the best alternatives, either at a specific mine-aspect level or at a fully integrated mine site level should also take specific account of the following initiatives:

- Precautionary principle that mandates the use of conservative assumptions in the absence of reliable data
- Adherence to the water management hierarchy, i.e. first optimise pollution prevention options, then impact minimisation options, then reuse and reclamation options (with or without treatment) before considering any discharge to or impact on the water resource.
- Water conservation and water demand management considerations
- Land use and closure

The purpose of the engagement with public stakeholders and DWAF in this step is to establish whether there are any fatal flaws with, or major objections against any of the options being considered, given that DWAF will ultimately have the right to define any appropriate licence conditions that they deem necessary to manage the risks associated with an option/alternative that they consider as posing an unacceptable risk.

The alternatives/options that are selected for implementation should be documented with clear and defensible motivations for their selection over other alternatives.

Step 7 Develop Appropriate Management Structure for IWMP Implementation

A key component in an effective IWMP, is an effective and supportive management structure within which the IWMP can be implemented. It is imperative that a clear management structure be developed that not only addresses the hierarchy and reporting structure of water management personnel, but that it also provides for sufficient human and financial resources to properly implement the IWMP. Within this structure it is also important that the following specific issues are explicitly addressed:

- Job descriptions with specification of appropriate qualifications and level of experience for each of the positions in order to ensure that persons with appropriate skills levels are appointed.
- Reporting structures up to senior management level to ensure that water management enjoys priority and regular attention of the mine's senior management.
- Inclusion of water management aspects into the key performance areas of all senior management in order to ensure that adherence to the IWMP is assessed as part of the individual's job performance.

Step 8 Develop Appropriate Corporate Culture

For integrated mine water management to be successfully implemented at a mine site, it is necessary to establish a corporate culture where effective water management is viewed as a non-negotiable element of all mine decision-making. This requires extensive training of all mine staff and mine contractors in order that they fully understand not only the specific actions stipulated in the IWMP but that they understand, subscribe to and adhere to the underlying principles.

The mines have successfully implemented this way of thinking and corporate culture when it comes to safety issues, which demonstrates that it is conceptually possible to instil the same culture when it comes to water management issues, provided the will is there to do so by senior management. The keys to success here are, training, rigorous enforcement of IWMP objectives and principles and application of punitive measures for non-compliance. Incorporation of water management issues into the key performance areas of senior management is also important in achieving the desired corporate culture.

It is also important that the same culture of responsible water management is enforced on contractors that work on the mine and that appropriate induction training courses are developed and that appropriate compliance management systems are developed and enforced.

Step 9 Institute Monitoring, Auditing and Review Systems

It is a key requirement of an IWMP, see Figure 2.1, Figure 5.1 and Chapters 2 and 7 of this BPG, that a rigorous procedure for monitoring, auditing, performance review and application of corrective actions to ensure that the IWMP is complied with is developed and implemented. Such a monitoring/auditing/review system should cater for both internal review actions as well as regular independent external review. It is critical that the review process not simply focus on compliance with stipulated IWMP actions or water use licence conditions,

but that the review critically assess the success of the implemented actions in meeting the originally stated performance objectives (see Step 1 above), as it is deviation from the performance objectives that should initiate corrective action to revise the IWMP. Additionally, in line with the principle of continuous improvement, it is necessary to make provision for a review and change in the performance objectives at least every 5 years or more frequently if required.

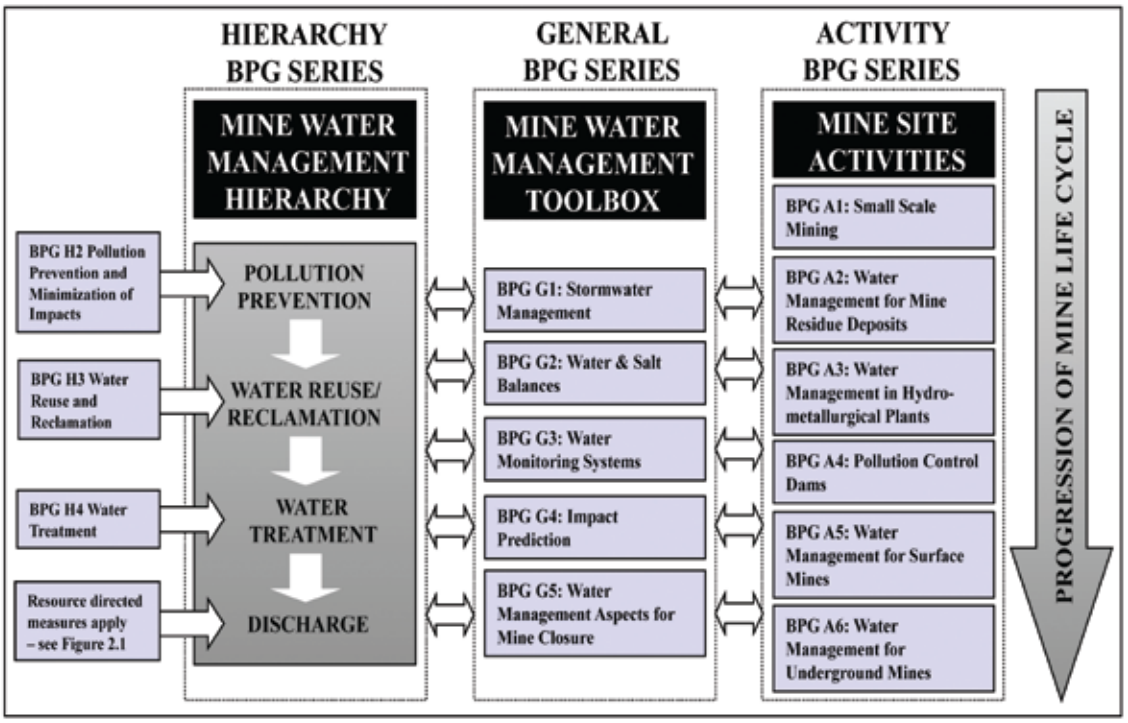
Step 10 Develop and Submit IWMP

Once the abovementioned process has been completed, the IWMP document should be prepared in accordance with the Operational Guideline to Assist in the Compilation of an Integrated Water and Waste Management Plan (January 2008 and later revisions).The requirements in terms of the content of the IWMP are also set out in this Operational Guideline, as discussed in Chapter 7 of this BPG.

6 STRUCTURE AND USE OF THE BEST PRACTICE GUIDELINE DOCUMENTS

This chapter presents a discussion of how the BPG series has been planned and structured and how the various BPG documents should be used.

Figure 6.1: Structure of BPG Series



As described in the Preface to this BPG, the complete series of BPGs has been grouped as outlined below.

Best Practice Guidelines dealing with aspects of DWAF's water management **Hierarchy** are prefaced with the letter **H**. The topics that are covered in these guidelines include:

- H1. Integrated Mine Water Management
- H2. Pollution prevention and Minimisation of Impacts
- H3. Water Reuse and Reclamation
- H4. Water Treatment

Best Practice Guidelines dealing with **General** water management strategies, techniques and tools, which could be applied cross-sectorally are always prefaced by the letter **G**. The topics that are covered in these guidelines include:

- G1. Storm Water Management
- G2. Water and Salt Balances
- G3. Water Monitoring Systems
- G4. Impact Prediction
- G5. Water Management Aspects for Mine Closure

Best Practice Guidelines dealing with specific mining **Activities** or **Aspects** are always prefaced by the letter **A**. These guidelines address the prevention and management of impacts from:

- A1. Small-Scale Mining
- A2. Water Management for Mine Residue Deposits
- A3. Water Management in Hydrometallurgical Plants
- A4. Pollution Control Dams
- A5. Water Management for Surface Mines
- A6. Water Management for Underground Mines

The BPGs are intended to perform the following functions within the hierarchy of decision making:

- **Utilisation by the mining sector as input for compiling water use licence applications (and other legally required documents such as EMPs, EIAs, closure plans, etc.) and by DWAF for drafting licence conditions.**
- **Serve as a uniform basis for negotiations through the licensing process prescribed by the NWA.**
- **Used specifically by DWAF personnel as a basis for negotiation with the mining industry, and likewise by the mining industry as a guideline as to what the DWAF considers as best practice in resource protection and waste management.**
- **Inform Interested and Affected Parties on good practice at mines.**

A brief summary of the content and intent of the various BPGs is given in Sections 6.2, 6.3 and 6.4 below.

6.1 APPLICATION OF BPGs WITHIN MINE SITES

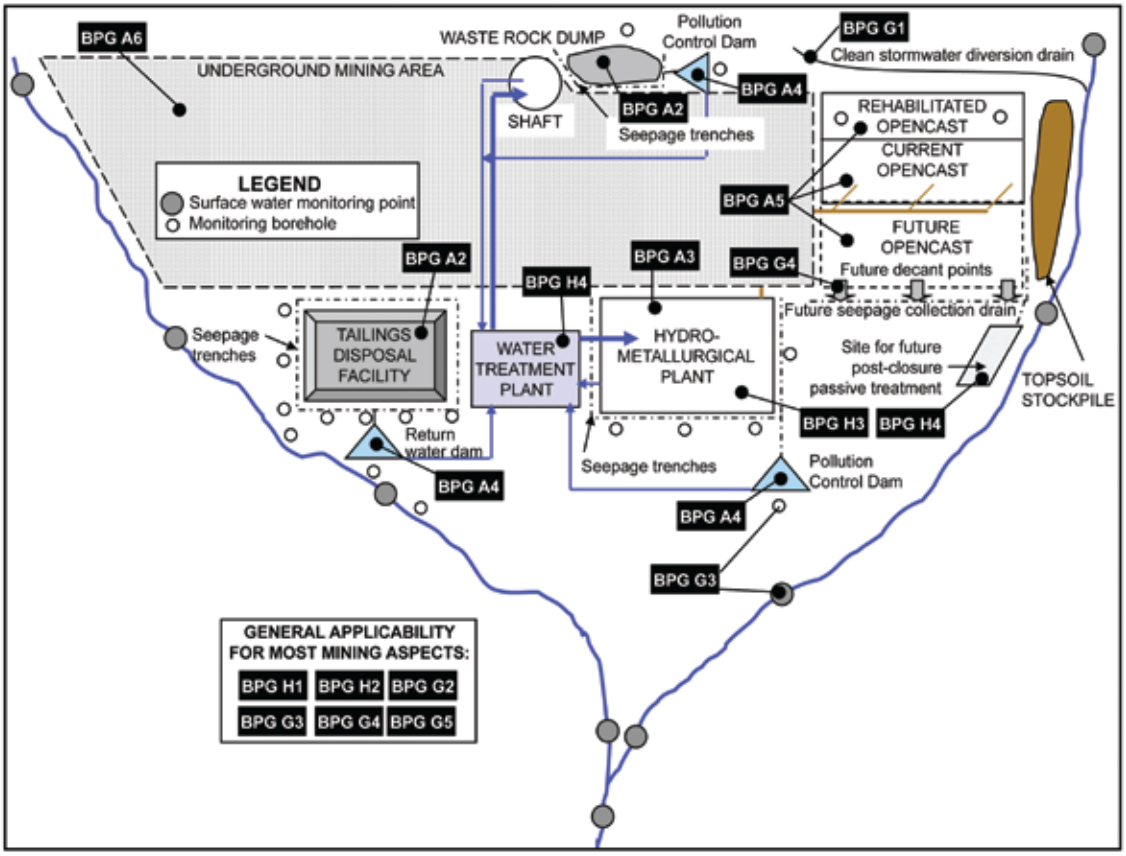
Mine sites are typically complex operations that may include the following activities:

- Underground mining operations
- Surface mining operations
- Hydrometallurgical plants
- Waste disposal facilities such as tailings disposal facilities, waste rock dumps, coal; discard dumps, slurry ponds
- Storm water management systems
- Water pollution control systems and pollution control dams
- Water quantity and quality monitoring networks
- Water treatment plants
- Infrastructure such as roads, railway lines, power lines, potable and sewage treatment plants, residential and recreational areas.

Additionally mines follow a very distinct life cycle from exploration, feasibility, planning, construction, operation, decommissioning through to closure and post-closure aftercare.

The different BPGs that have been produced all have particular application to different aspects of the mining process and to different components of the water management system at the mines. The applicability of the different BPGs to these different aspects of a mining operation is illustrated graphically in Figure 6.2 below.

Figure 6.2: Applicability of BPGs to mining sites



6.2 HIERARCHY SERIES OF BEST PRACTICE GUIDELINES

There are four BPGs in this series and the basic purpose and contents of these BPGs can be summarized as shown below.

6.2.1 BPG H1: Integrated Mine Water Management

This refers to this specific BPG and the purpose and objectives of this BPG are given in Section 1.2 of the document. This BPG is aimed at defining the overall role of the Best Practice Guidelines for Water Resource Protection in the South African Mining Industry in supporting integrated water management at mining sites and will provide DWAF staff, mines and consultants with guidance on how and when to make use of the different BPGs and how to implement integrated water management at mine sites.

6.2.2 BPG H2: Pollution Prevention and Minimisation of Impacts

Pollution prevention is the foundation of the ***hierarchy of decision-taking*** used by DWAF with the purpose of protecting the water resource from waste impacts. This Best Practice Guideline deals with the first step, i.e. Pollution Prevention and also reiterates the key issues relating to impact minimization, i.e. Water Reuse and Reclamation and Water Treatment.

The core of integrated water management at mining sites is the mine water management hierarchy which essentially states that mines must, in the first instance seek to optimally implement pollution prevention measures. The common thread throughout all pollution prevention options is to prevent or minimize pollution through the application of appropriate assessment techniques, the application of appropriate design and the ongoing and effective management and re-evaluation of the installed pollution prevention measures.

The primary objectives of this BPG are documented as follows:

- To ensure that pollution risks and pollution prevention opportunities have been identified, optimized and implemented during the exploration, planning, operation and closure phases of a mining project.
- To ensure that measures implemented and decisions taken at any point in time, consider the effect of those decisions throughout the remaining life cycle.
- To present a process to identify the pollution risks and opportunities that remain after optimization of pollution prevention measures, which are then addressed in terms of impact minimization. To ensure that where pollution prevention fails to reduce remaining impacts to acceptable levels, that additional water reuse and reclamation and water treatment strategies will be implemented to minimize the impacts to the water environment to the level deemed acceptable in terms of consideration of resource-directed management measures.
- To define procedures that can be utilized to identify and assess pollution prevention and impact minimization management actions.
- To promote the consideration of the impacts of a management action over the full life-cycle of the mining operation in order that pollution prevention is maximized over the full life-cycle.

6.2.3 BPG H3: Water Reuse and Reclamation

The development of appropriate water reclamation strategies is one of the fundamental components of an integrated mine water management strategy. Water reclamation and reuse is also a high risk activity if it is not carried out according to a well defined procedure that includes the following steps:

- Identification of all sources of water quality deterioration on a mine
- Identification of all water users on a mine with detailed specification of the water quantity and quality requirements (this process essentially entails the definition of the worst possible water quality that a user can tolerate without suffering unacceptable water quality related effects and requires a clear knowledge of the consequences for each user of different water qualities)
- Delineation of all physical features of a mine's water reticulation system including tanks, dams, pumps and pipeline capacities.
- Optimization process to evaluate all the above data, together with water treatment requirements in order to define the most appropriate and cost effective water reclamation strategy.

The development and implementation of inappropriate water reclamation strategies can have very severe consequences for a mine in terms of effects such as corrosion, scaling, reduced recovery efficiencies, reduced security of supply, excessive water consumption, etc. and this BPG aims to assist in ensuring that the risk of encountering these negative consequences is minimised.

6.2.4 BPG H4: Water Treatment

The implementation of integrated mine water management at a mine may, in many instances require the incorporation of a certain degree of water treatment. Water treatment may be required to improve the quality of the water to such an extent that it can be reused by the mine or other users. Water treatment may also be required as a final step to render water suitable for discharge in accordance with the conditions of a water use authorisation, catchment management objectives, reserve requirements and/or downstream user requirements.

Water treatment is a consideration for exploration, operational and defunct/closed mines, although the water treatment technology of choice may be different (e.g. active treatment during operation versus passive treatment after closure). This BPG only serves as an overview of possible water treatment options and does not aim to discuss all the various water treatment alternatives available at any point in time, in detail. New treatment technologies are continuously being developed and existing technologies are improved and this guideline is therefore not fully comprehensive and can therefore not replace the function of a water treatment specialist familiar with the latest technologies available on the market.

The objectives of this BPG are:

- To clearly describe the technical methodology that should be applied by a mine to identify the constituents of concern that may require mine water to be treated to enable sustainable reuse or discharge (in accordance with an approved water use licence, catchment management objectives etc.).

- To describe a methodology that, when applied, will enable the identification of suitable types of water treatment technology for the removal of constituents of concern and safe disposal of residues (brine and sludge management) thereafter.
- To enable the mine to prepare the relevant sections of an IWMP that deals with water treatment.

6.3 GENERAL SERIES OF BEST PRACTICE GUIDELINES

There are five BPGs in this series and the basic purpose and contents of these BPGs can be summarized as shown below.

6.3.1 BPG G1: Storm Water Management

The separation of clean and dirty water on mines is one of the most fundamental pollution prevention principles within the mine water management hierarchy. Although the principle is a very simple one, it is nevertheless often misapplied and this BPG sets clear guidelines on how to achieve it by focusing on the following:

- practical procedure to develop stormwater management plan;
- define the content of a management system that will ensure compliance with the targets and objectives of the plan;
- define where expertise of suitably qualified persons is required at the various stages of plan development, implementation and operation;
- reference relevant legislative and policy issues that need to be considered in a stormwater management plan.

It is believed that application of this BPG will have major benefits in reducing pollution and reducing water demand on South African mines. It also makes a major contribution to optimising water reclamation strategies as addressed in BPG H3.

6.3.2 BPG G2: Water and Salt Balances

The water and salt balance is considered the most fundamental building block and foundation of a mine water management system. Without an effective and accurate water and salt balance, it is not possible to ensure that the mine water management strategy is properly focused.

Water and salt balances can be used as a tool to:

- define and drive water management strategies;
- audit water usage from various sources;
- identify points of high water consumption or wastage;
- identify and quantify imbalances
- locate and quantify sources of seepage and leakage;
- identify and quantify pollution sources;
- assist with the design of storage requirements and minimising the risk of spillage;
- simulate and evaluate various water management strategies before implementation;
- assist in decision making.

Water and salt balances should be used as an ongoing water management tool and, for this reason, they should be updated on a regular basis, both in terms of adding new data and ensuring that the reticulation system reflects all changes that have been made. This requirement for updating should be borne in mind when selecting the approach to be used for the balances.

6.3.3 BPG G3: Water Monitoring Systems

The development and maintenance of well designed and effective monitoring programmes are essential within any mine water management strategy on the basis that “one cannot manage what one cannot measure”. This BPG deals with the following aspects of a monitoring strategy:

- definition of the objectives of a monitoring strategy
- design of a monitoring strategy (including both discrete and continuous monitoring)
- monitoring and sampling equipment and procedures
- procedures for implementation of monitoring programme
- data management system
- audit and quality assurance of monitoring programme

This BPG is cross referenced to BPG G2 and BPG G4 which both have a strong requirement for data derived from well structured monitoring programmes.

6.3.4 BPG G4: Impact Prediction

The ability to make reliable predictions of potential impact on the water resource at some future time, is

fundamental to the science of environmental risk/impact assessment and management at mine sites, especially those where reactive sulphide minerals are encountered. The process of making these predictions and the success and reliability of these predictions is dependant on the following elements:

- Characterization and knowledge of the source term that gives rise to the impact.
- Characterization and knowledge of the environmental pathway along which the impact migrates.
- Characterization and knowledge of the receptor that experiences the impact.
- Correct formulation of the key questions that need to be answered by the impact prediction exercise.
- Knowledge of the capabilities and limitations of the various tools that can be used to make impact predictions.
- Understanding of the issues of risk and uncertainty inherent in the tools and the assessment procedure and how these combine to affect the confidence that can be placed in the impact prediction that is made.
- Access to the various tools and proper training and experience in selecting the appropriate tools for the assessment being undertaken and in using the selected tools.
- Adequate and appropriate independent review of the prediction methodology and results.
- Design and implementation of an appropriate post-prediction monitoring programme, followed by validation and calibration of the predictions.

These elements are addressed in this BPG.

6.3.5 BPG G5: Water Management Aspects for Mine Closure

While mine closure is an action that is regulated in terms of the Mineral and Petroleum Resources Development Act (MPRDA), 2002 (Act 28 of 2002), the post-closure impacts associated with mining operations very often include significant impacts on the water resource and hence DWAF has a particular interest in the water management aspects associated with mine closure. Legacies of historic mining activities abound in South Africa and DWAF is faced with legal and financial responsibility to address the water-related impacts of many of the abandoned and ownerless mines. The key to ensuring that current mining operations do not become tomorrow's water management legacies is to ensure that the correct attention is paid to all water management aspects of a mine's closure application and this is the focus of this Best Practice Guideline.

This BPG is intended to be a practical document that provides a generic procedure on the very important topic of mine closure planning, with specific emphasis on the identification and management of water-related closure risks and liabilities. This BPG aims to ensure that, at the end of mining, the mine has a plan that can be implemented to sustain, protect and preserve the water quality and quantity upstream and downstream of the mine after mine closure and that sensitive habitats are identified and protected. It further aims to ensure that the procedure is sustainable, affordable to both the mining sector and government and meets the relevant legal requirements.

The BPG also presents a process and criteria that DWAF officials will use in evaluating a mine's closure plan and making a decision on whether or not to recommend approval of the mine closure plan.

6.4 ACTIVITY SERIES OF BEST PRACTICE GUIDELINES

There are six BPGs in this series and the basic purpose and contents of these BPGs can be summarized as shown below.

6.4.1 BPG A1: Small-scale Mining

The environmental impacts of the small-scale mining sector have tended to be ignored. It is often assumed that because they are small these operations have little impact. However, given the growing numbers of such operations, increasing access to mechanized mining methods, and often, haphazard management, small-scale mining does have the potential to significantly affect the environment and our scarce national water resources. There is therefore an increasing need to address the problems of pollution and health and safety hazards associated with small-scale mining. It requires a concerted effort on the part of the mining industry and government to ensure that small-scale mining not only operates on a financially sustainable basis but also in an environmentally responsible manner. Moreover, successful resource protection management in the small-scale mining sector will require an approach that provides guidance and support and sets limits of acceptability.

This BPG is intended to be a practical "hands-on" document that gives practical advice on the very important topic of resource protection and water management in the small-scale mining sector. This BPG aims to pay attention to the fact that the acceptable practices proposed are sustainable and affordable to a sector that is often operating with limited resources. This particular guideline is prepared in two versions:

(1) A Standard format aimed at Department officials viz. water pollution control officials and environmental management personnel.

(2) A User format aimed at the small-scale miners, produced in English, Sotho and Zulu.

This BPG describes typical small-scale mining scenarios and develops generic integrated assessment procedures. It uses a constructivist approach to detail regulatory requirements and procedures, the water management hierarchy, operational implementation and management. It therefore provides a useful tool to assist in the sustainable development of this sector.

The specific objectives of the BPG are:

- To describe relevant mining documentation and legal requirements;
- To assist in identifying potential areas of concern or impact for each of the small-scale mining types;
- To encourage planning and prioritisation of water management actions for resource protection by small-scale mining operators;
- To clarify what is required by the regulators to satisfy them that pollution prevention/minimization, water reuse and treatment requirements have been correctly applied at each stage of the life cycle of the mine;
- To describe best management practices that are appropriate for the small-scale mining sector and ensure continual improvement and protection of the environment and water resources.

Furthermore, this BPG provides a logical decision support system that enables the regulators to assess risk to water resources by the various small-scale mining operations. It also aims to ensure consistency in the approach of the DWAF from mine to mine, and region to region and thus encourages uniformity in water use licence conditions.

6.4.2 BPG A2: Water Management for Mine Residue Deposits

The management of the disposal of mine residue is of critical importance to the success of any mining project. Methodologies and locations for mine residue deposition and disposal may vary between mines and for different mineral types. The mine residue disposal aspects are often the main focus of regulatory scrutiny during the permitting process for a mine development, and during mine operations and closure, due to the inherent risk in the operations of these facilities and the long-term nature of the impacts. Successful management of mine residue disposal requires a good understanding of the methodologies and the complete life cycle of Mine Residue Deposits (MRDs).

The following documentation exists within South Africa to assist in the understanding of the design, operations and closure of MRDs:

- Chamber of Mines of South Africa: Guidelines for Environmental Protection. The Engineering Design, Operation and Closure of Metalliferous, Diamond and Coal Residue Deposits, and
- SABS 0286: 1998. Code of Practice for Mine Residue.

Water management for MRDs is a critical aspect of the design, operational management and closure of these facilities. It is thus also important that practitioners within this field have a good understanding of the management of water, both surface and groundwater, when designing and/or operating a MRD facility. To this end, the Department: Water Affairs and Forestry (DWAF) have commissioned an activity-related Best Practice Guideline (BPG) to focus on the water management aspects within and around MRDs.

The BPG provides details on the recommended processes to follow for best practice water management for various types of MRDs. In practice, the actual process followed may vary, depending on the site-specific conditions of the MRD. In these instances, a motivation should be provided to DWAF detailing the need to deviate from the recommended processes. The recommended processes should however be followed in instances where the MRD is used to contain sulphide or other reactive materials.

This guideline seeks to provide the necessary guidance for the management of water-related aspects for MRDs by attainment of the following objectives:

- To provide practical guidance and steps on water management best practice over the full life cycle of the MRD or the mines MRD requirements
- To provide clarity on legal requirements and compliance and to provide guidance on the legal requirements for water management, in terms of the prevailing South African legislation
- To minimise potential impacts on safety and the environment over the life of the MRD or mines MRD requirements through the use of best practice guidelines for water management
- To cover water management aspects for various types of MRDs
- To provide guidance on appropriate tools to be used for water management on MRDs, to complement those that are covered in other BPGs
- To provide examples of some of the water management aspects for MRDs.

6.4.3 BPG A3: Water Management for Hydrometallurgical Plants

The Hydrometallurgical Processing Plant is an integral part of the mining operation on many mines, including gold, coal and platinum. Hydrometallurgical processing plants typically feature as a central component of the mining operation in that these receive the raw ore from the mine and may produce the saleable product, the solid waste streams and a significant portion of the liquid effluent. While the operations and water balance of the average hydrometallurgical processing plant are integrally linked with the preceding mining operation and the subsequent residue disposal facility and its associated return water systems, there are particular features that relate to water management within the hydrometallurgical processing plant itself.

The type of hydrometallurgical processing plant that is addressed in this BPG is one that focuses on the unit processes typically encountered in such a plant and would include: milling and grinding circuits; separation circuits (magnetic or other); refining circuits; classifiers, hydrocyclones, screens, filters, thickeners, flotation processes, electro-winning, leaching, solvent extraction, metal recovery and precipitation.

This BPG is specifically aimed at water containing waste within hydrometallurgical processing plants associated with all types of mines and can also be applied to small-scale mines if simplified. Pyrometallurgical and smelter operations are not considered, although many of the principles and procedures covered in this BPG may be applicable to such operations. The primary objectives of this document are formulated as follows:

- To promote a strategic water management approach at hydrometallurgical processing plants that views and manages water as a key business asset with social, cultural, environmental and economic value.
- To provide a practical and logical process whereby water management within hydrometallurgical processing plants can be optimized.

6.4.4 BPG A4: Pollution Control Dams

Pollution control dams (PCDs) form an integral and important part of the water management systems on a mine. Different types of PCDs may exist on a mine site, such as process water dams, stormwater dams, evaporation dams and other dams, possibly including excess mine water dams and natural pans. The purpose of PCDs for the mine and in the water management circuits are to:

- Minimise the impact of polluted water on the water resource
- Minimise the area that is polluted as far as possible, by separating out clean and dirty catchments, and
- Capture and retain the dirty water contribution to the PCDs that can not be discharged to the water resource, due to water quality constraints, and manage this dirty water through recycling, reuse, evaporation and/or treatment and authorised discharge.

The design, operation and closure of PCDs are important aspects in the successful operation of a mine, given the inherent safety and environmental risks posed by structural failure, spillage or overtopping of these facilities. It is thus important that practitioners within this field have a good understanding of the management of water, both surface and groundwater, when designing and/or operating PCDs and this BPG addresses this need. Best practice for mine water PCDs is developed from a combination of the following requirements:

- Legislative requirements
- Industry norms and generally accepted good practices
- Technically and environmentally sound design practices
- Life cycle planning for the PCD
- Management of hazards and risks
- Effective water resources management, both for

the mine site and within the regional Catchment Management Plan, and

- Other factors, such as site specific conditions.

Effective design, operation, management and closure of PCDs are ensured through adherence to the above requirements. This Best Practice Guideline therefore covers the full life cycle of a PCD, including design, construction, operations and closure.

The overall objective of this guideline is to ensure that a best practice approach is adopted by all industry stakeholders involved in the design, operations and closure of PCDs on a mine site within South Africa and to enable DWAF personnel to establish that best practice has been applied. The specific objectives of the Best Practice Guideline are as follows:

- To provide guidance on water management best practice for PCDs
- To inform DWAF officials and other users of the BPG on the procedures involved in the specification and design of PCDs
- To provide guidance on the philosophy of the planning and operations of PCDs and the integration of these into the overall mine water management system
- To ensure that potential impacts on safety and the water resource are acceptable/managed over the life of the PCD, in a consistent manner throughout South Africa, through the use of best practice guidelines for water resource management, and
- To provide guidance on appropriate tools for the design and management of PCDs, to complement those that are covered in other BPGs.

6.4.5 BPG A5: Water Management for Surface Mines

The primary focus for BPG A5 is to provide guidance on water management for surface mining activities. Water management for surface mining is however also, by necessity, linked into the overall mine site-wide water balance, as well as into the regional or catchment water management objectives and requirements. BPG A5 thus covers the regional water management context within which the mine operates and the links to the mine water balance, with reference to the other BPGs, as applicable.

This guideline seeks to provide the necessary guidance on water management for surface mining by meeting the following objectives:

- To provide an overall context for water management which will illustrate the integration between water management in the broader catchment and the mine-specific water management
- To explain the hierarchy of water management and its applicability to surface mining
- To provide practical guidance on the water management measures to be included in the mines Environmental Management Plan (EMP), Integrated Water and Waste Management Plan (IWWMP) and Water Use Licence Application (WULA) documents. These documents are submitted by the mine in order to comply with the requirements stipulated in the Minerals and Petroleum Resources Development Act (Act 28 of 2002) and the National Water Act (Act 36 of 1998) and the applicable regulations
- To provide practical guidance and steps on water management best practice over the full life cycle of a surface mine
- To cover water management aspects for various types of surface mines and mining methods
- To assist in ensuring efficient water use on a mine, and
- To provide guidance on appropriate tools to be used for water management on surface mines, to complement those that are covered in other BPGs

6.4.6 BPG A6: Water Management for Underground Mines

This BPG deals with water management issues below surface and within the underground mining operation and excludes water management associated with the subsequent hydrometallurgical processing plant. While the underground water system may partially go to surface before going underground again, this BPG focuses on when water leaves surface and is sent into the mine shaft for use within the various underground mining operations and ends when wet ore (including water/moisture) and water and or slurries from the mining operation arrive at the top of the shaft to be sent to hydrometallurgical processing plants for processing or for storage and/or disposal, or for treatment and subsequent reuse back underground. This BPG applies to all underground mining operations.

While water is used for a variety of applications within an underground mining operation, the typical uses to which water is put within an underground mine are the following:

- Mine service water to operate mining equipment such as rock drills, continuous miners and longwall shearers.
- Dust suppression.
- Mine cooling.
- Underground workshops
- Conveying fine ore from underground to surface as pumped slurries.
- Backfill for ground support
- Potable water and sanitation underground

In addition, underground mining operations are also impacted upon by water ingress into the mining void through sources such as the following:

- Hydraulic connections to surface water resources such as sinkholes in rivers
- Dewatering of the aquifer within which the mine is located through mining operations or specific features such as boreholes (cable holes, rescue holes, prospecting holes)
- Fracturing of overlying strata due to high extraction mining techniques with subsequent leakage of the overlying aquifer into the mine void
- Ingress through geological features or from dewatering of dolomitic compartments
- Mine shafts

This water ingress may result in safety risks and increased cost for dewatering operations. Finally, underground mining operations may also impact on the water resource in the following manner:

- Water ingress into the mine reduces the ability of the surface and/or ground water resource to provide other water users with water.
- Water quality deteriorates in the mine workings due to contact between the water circuits and sulphide minerals in the ore, explosives used in the mining operation, cyanide from backfill operations, bacterial contamination from poor sanitary practices and other chemicals used in the mining operation.
- Closed mines will fill up and may decant contaminated water into the surrounding aquifers or surface water resources.
- Flooded underground mines may be dewatered in order to initiate re-mining operations
- Intermine flow may occur within a regional setting, where water from an adjacent mine flows into and becomes part of the water balance of the receiving mine.

To ensure that improved water management within underground mining operations avoids, or at least significantly reduces, the potential negative effects, while still complying with the strategic imperatives imposed by the external environment within which these mines operate, it is necessary that water management operations are firmly based on sound and correct principles. It is the objective of this BPG to provide guidance on these key issues.

The primary objectives of this BPG can be stated as follows:

- To provide DWAF officials with an understanding of the water management issues involved in underground mining operations in order that they are able to interact with mine water managers on a more proactive basis with regard to water management issues that have their origin in the underground mining operations.
- To provide information to water managers with the mining industry that will provide clarity on information that DWAF officials will be seeking from them.
- To promote a strategic water management approach at underground mining operations that views and manages water as a key business asset with social, cultural, environmental and economic value.
- To provide a practical and logical process whereby water management within underground mining operations can be optimized.
- To provide guidance on factors that need to be considered when planning for all life cycle phases and particularly closure of underground mining operations.

7

CONTENTS OF AN INTEGRATED WATER MANAGEMENT PLAN

In order to ensure some consistency and standardization in the level of detail and type of information presented in an IWMP, it is desirable to provide some guidance as to the contents and layout of an IWMP. As the level of detail and structure may change in future in response to changes to the NWA and/or its regulations, it is considered more appropriate that the specific requirements on content of an IWMP be covered and published in an Operational Guideline that can be more readily updated as when it becomes necessary to do so.

For this reason, the reader of this BPG or person wishing to develop an IWMP is referred to the following document:

Operational Guideline To Assist In The Compilation Of An Integrated Water And Waste Management Plan

that was prepared by DWAF in January 2008 and which may be reviewed and updated at a later stage. This document is available on request from DWAF and can also be downloaded from the DWAF website.

The compiler of an IWMP should also make use of the following document:

Department of Water Affairs and Forestry (2007), Internal Guideline: Section 21 (e), (f), (g), (h), (j) Water Use Authorisation Application Process (Waste Discharge Related)

8 LEGAL FRAMEWORK

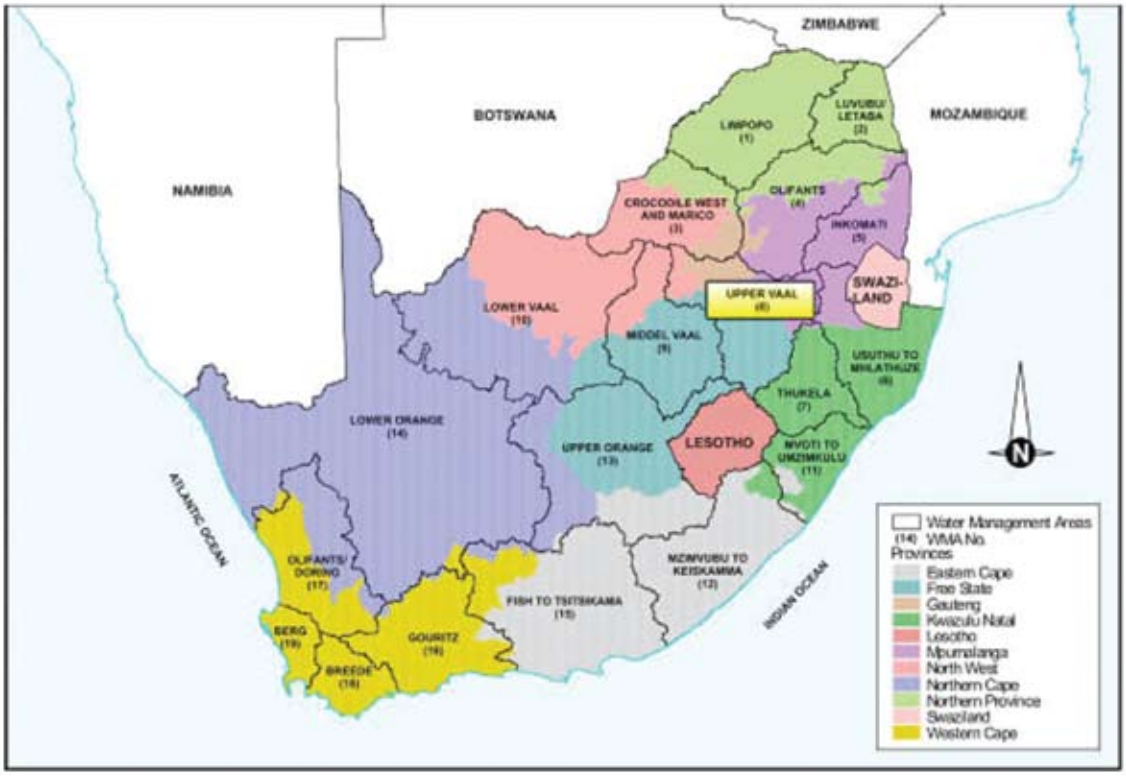
8.1 INTRODUCTION

The legal review provides an outline of the requirements for water management within the prevailing mining, water and environmental legislation in South Africa. The legal review focuses in two main areas, namely:

Section 8.2 covers the water management requirements in the national legislation, including the National Environmental Management Act, 1998 (Act 107 of 1998), the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) and the National Water Act, 1998 (NWA), (Act 36 of 1998). The provisions included in other legislation are also considered

Section 8.3 covers the policies, strategies and guideline documents that have been developed by DWAF at a national level to assist in effective water management throughout South Africa. These policies and strategies are required to be implemented regionally, or on a catchment basis in the case of DWAF. The guideline documents have been developed to assist the catchment-based implementation process. This implementation is currently being undertaken through DWAF's regional offices, but will in future be delegated to Catchment Management Agencies (CMAs) who will be responsible for all water management within a defined catchment area. Figure 8.1 indicates the division of the country into the 19 Water Management Areas (WMAs).

Figure 8.1: Water Management Areas in South Africa



Note that the regulatory environment is continuously being amended within South Africa. The legal framework and review included in this BPG thus covers the current legislative status.

8.2 SOUTH AFRICAN NATIONAL LEGISLATION

8.2.1 Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996)

Section 24 of the Constitution provides that *everyone has the right … to an environment that is not harmful to their health or well-being; and … to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures that - (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development*.

Section 33 of the Constitution entitles everyone to administrative action that is lawful, reasonable and procedurally fair and, if one's rights have been adversely affected by administrative action, to be given written reasons for the decision.

Section 38 provides *locus standi* or the right to get involved to any member of public. This means that a member of public has the right to take appropriate action to prevent environmental damage. This may include taking action against the responsible authority for failing to perform its duties in preventing environmental damage or against an individual or authority who are in the process of undertaking a water use identified in the NWA without the necessary authorisation to undertake such water use.

8.2.2 National Environmental Management Act, 1998 (Act 107 of 1998)

The National Environmental Management Act, 1998 (NEMA) contains certain principles in section 2. These principles apply throughout the country to the actions of all organs of state (as defined in the Constitution) that may significantly affect the environment and:

- Shall apply alongside all other appropriate and relevant considerations, including the State's responsibility to respect, protect, promote and fulfil the social and economic rights in Chapter 2 of the Constitution and in particular the basic needs of categories of persons disadvantaged by unfair discrimination
- Serve as the general framework within which environmental management and implementation plans (referred to in section 11 of NEMA) must be formulated
- Serve as guidelines by reference to which any organ of state must exercise any function when taking any decision in terms of NEMA or any statutory provision concerning the protection of the environment
- Serve as principles by reference to which a conciliator appointed under NEMA must make recommendations, and
- Guide the interpretation, administration and implementation of NEMA, and any other law concerned with the protection or management of the environment.

NEMA reiterates the provisions of section 24 of the Constitution, and contains the internationally accepted principles of sustainability. It therefore becomes a legal requirement that these principles must be taken into consideration in all decisions that may affect the environment. Furthermore, the need for intergovernmental co-ordination and harmonisation of policies, legislation, and actions relating to the environment, is emphasised. NEMA also emphasises the need for a mechanism that promotes sustainable use, and states that a risk-averse and cautious approach, which takes into account the limits of current knowledge about the consequences of decisions and actions, must be used in decision-making. It is also important to note that the Best Practical Environmental Option (BPEO) is defined in NEMA as *the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long term as well as the short term*.

In the context of mining, these principles are given further effect through section 37 of the MPRDA, which stipulates that the principles set out in section 2 of NEMA:

- Apply to all prospecting and mining operations, as the case may be, and any matter relating to such operation, and

- Serve as guidelines for the interpretation, administration and implementation of the environmental requirements of the MPRDA.

Section 28 of NEMA further establishes a general duty of care on every person who causes, has caused or may cause significant pollution or degradation of the environment to take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

New EIA Regulations, promulgated under NEMA, came into effect on 03 July 2006 (as covered in Government Notices R385, R386 and R387 of 21 April 2006 - the "NEMA EIA Regulations").

8.2.3 Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002)

8.2.3.1 Mining Authorisation

Section 5(4)(a) of the MPRDA stipulates that no person may prospect for or remove, mine, conduct technical or reconnaissance operations, explore for and produce any mineral or petroleum or commence with any work incidental thereto (including the construction of any residue deposits) on any area without *inter alia* an approved environmental management programme or approved environmental management plan, as the case may be.

8.2.3.2 Prospecting rights

If the application for a prospecting right is accepted by the Regional Manager, the Regional Manager must within 14 days from the date of acceptance notify the applicant in writing to *inter alia* submit an environmental management plan (section 16(4)(a)). The granting of a prospecting right only becomes effective on the date on which the environmental management plan is approved in terms of section 39 of the MPRDA (section 17(5)). The application for renewal of a prospecting right must *inter alia* be accompanied by a report reflecting the extent of compliance with the requirements of the environmental management plan, the rehabilitation completed and the estimated cost thereof (section 18(2)(c)) and the Minister must grant the renewal of a prospecting right if the application complies with sections 18(1) and 18(2) and the holder of the prospecting right has *inter alia* complied with the requirements of the approved environmental management plan (section 18(3)(c)). The holder of a prospecting right must comply with the requirements of the approved environmental management plan in terms of section 19(2)(c). In the case of a retention permit, the environmental management plan approved in respect of the prospecting right remains in force as if the prospecting right had not lapsed in terms of section 32(2) (section 32(3)) and the holder of the retention permit must give effect to the approved environmental management plan (section 35(2)(a)).

8.2.3.3 Mining rights

If the application for a mining right is accepted, the Regional Manager must within 14 days from the date of acceptance notify the applicant in writing to *inter alia* conduct an environmental impact assessment and submit an environmental management programme for approval in terms of section 39 (section 22(4)). A mining right granted in terms of section 23(1) comes into effect on the date on which the environmental management programme is approved in terms of section 39(4) (section 23(5)). An application for renewal of a mining right must *inter alia* be accompanied by a report reflecting the extent of compliance with the requirements of the approved environmental management programme, the rehabilitation to be completed and the estimated cost thereof (section 24(2)(b)) and the Minister must grant the renewal of a mining right if the application complies with sections 24(1) and 24(2) and the holder of the mining right has *inter alia* complied with the requirements of the approved environmental management programme (section 24(3)(c)). The holder of a mining right must comply with the requirements of the approved environmental management programme in terms of section 25(2)(e).

8.2.3.4 Mining Permits

If the Regional Manager accepts the application for a mining permit, the Regional Manager must, within 14 days from the date of acceptance, notify the applicant in writing to *inter alia* submit an environmental management plan (section 27(5)(a)). The Minister must issue a mining permit if *inter alia* the applicant has submitted the environmental management plan (section 27(6)(b)).

8.2.3.5 Environmental management

Section 37 requires that the principles set out in section 2 of NEMA must apply to all prospecting and mining operations, and that the generally accepted principles of sustainable development must be applied by integrating

social, economic and environmental factors during the planning and implementation phases of mining projects.

Section 38(1) requires that the holder of a reconnaissance permission, prospecting right, mining right, mining permit or retention permit:

- Must at all times give effect to the general objectives of integrated environmental management laid down in Chapter 5 of NEMA
- Must consider, investigate, assess and communicate the impact of his or her prospecting or mining on the environment as contemplated in section 24(7) of NEMA
- Must manage all environmental impacts in accordance with his or her environmental management plan or approved environmental management programme, as the case may be; and as an integral part of the reconnaissance, prospecting or mining operation, unless the Minister directs otherwise;
- Must as far as it is reasonably practicable, rehabilitate the environment affected by the prospecting or mining operations to its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development, and
- Is responsible for any environmental damage, pollution or ecological degradation as a result of his or her reconnaissance prospecting or mining operations and which may occur inside and outside the boundaries of the area to which such right, permit or permission relates.

Section 39 of the MPRDA deals with the requirements of an environmental management programme or plan, whichever is applicable. Section 40 allows for the consultation with other State departments that administers any law relating to matters affecting the environment.

Section 41 deals with the financial provision for remediation of environmental damage, and the requirement to maintain and retain the financial provision in force until the Minister issues a certificate in terms of section 43, which states that the holder of a prospecting right, mining right, retention permit or mining permit remains responsible for any environmental liability, pollution or ecological degradation, and the management thereof, until the Minister has issued a closure certificate to the holder concerned. In terms of section 43(5) no closure certificate may be issued unless the Chief Inspector (MHSA) and the DWAF (NWA) have confirmed in writing that the provisions pertaining to health, safety and management of potential pollution to water resources have been addressed.

Section 42 deals specifically with the management of residue stockpiles and residue deposits, and stipulates that these must be managed in the prescribed manner on any site demarcated for that purpose in the environmental management programme or plan in question only. Regulation 73 provides comprehensive supporting information for this section of the act.

In line with section 20 of the NWA and section 30 of NEMA, section 45 of the MPRDA allows the Minister to direct the implementation of urgent remedial measures in the case of ecological degradation, pollution or environmental damage which may be harmful to the health or well-being of anyone. If the holder of the relevant right, permit or permission fails to comply with this directive, the Minister may take the necessary steps to implement the required remedial measures and recover the cost for implementation from the holder concerned.

8.2.3.6 Mineral and Petroleum Resources Development regulations

Government Notice No. R.527 (R527), dealing with the mineral and petroleum resources development regulations was published in the Government Gazette of 23 April 2004 (GG No. 26275, Volume 466). In particular, Part III of R527 deals with environmental regulations for mineral development, petroleum exploration and production.

In terms of regulation 48, an environmental impact assessment contemplated in section 39(1) of the MPRDA is a process which results in the compilation of a:

- Scoping report, the contents of which is described in regulation 49, and
- An environmental impact assessment report, the contents of which are described in regulation 50.

The contents (framework) of an environmental management programme or plan, whichever is applicable, is described in regulations 51 and 52, respectively, while the requirements for monitoring and performance assessments of these programmes/plans are described in detail in regulation 55. The methods and quantum of financial provision for the rehabilitation, management and remediation of negative environmental impacts (including those associated with mine residue deposits) are given in regulations 53 and 54.

Regulations 56 deals with the requirements for mine

closure, including the principles for mine closure, closure objectives and the contents (framework) of the environmental risk assessment report and closure plan.

Part IV of R527 deals with pollution control and waste management regulation and stipulates a number of requirements specific to the management of mine residue stockpiles and deposits (regulation 73). Regulation 73(1) stipulates that the assessment of impacts relating to the management of residue stockpiles/deposits must form part of the environmental impact assessment report (regulation 50) and environmental management programme or plan, as the case may be. Other requirements with respect to the design, operation and maintenance, and decommissioning and closure of a mine residue deposit include:

- Characterisation of mine residue, by a competent person, to identify any significant health or safety hazard and environmental impact that may be associated with the residue when stockpiled or deposited at the site(s) under consideration (regulation 73(2))
- Classification of residue stockpiles/deposits, by a competent person, in terms of the safety and environmental hazard/impact thereof. The classification will determine the level of investigation and assessment required, the requirements for design, construction, operation, decommissioning, closure and post-closure maintenance, and the qualifications and expertise required of person undertaking the necessary investigations and/or assessment (regulation 73(3))
- Selection and investigation of a site, following the prescribed process, with specific requirements for geotechnical and groundwater investigations (regulation 73(4))
- Incorporations of prescribed considerations during the design of residue stockpile/deposits (regulation 73(5))
- Implementation of a monitoring system for residue stockpiles/deposits with respect to potentially significant impacts (regulation 73(7)), and
- Management requirements for residue deposits during the decommissioning, closure and post-closure phases (regulation 73(8)).

A holder of any right or permit must further ensure that (regulation 73(6)):

- The residue deposits, including surrounding catchment paddocks, are constructed and operated in terms of the approved environmental management programme/plan
- The residue deposit is constructed strictly in accordance with the design, and if not, that the necessary approvals are obtained and the environmental management programme/plan amended accordingly
- All residue transported to and the surplus water removed from the site are recorded as part of the monitoring system
- Appropriate security measures are in place to limit unauthorised access to the site
- Specific action is taken in respect of any sign of pollution
- Adequate measure are implemented to control dust pollution and erosion of the slopes, and
- Details of the rehabilitation of the residue deposit are provided in the environmental management programme/plan.

Other requirements which could apply to surface mining are stipulated, namely:

- Regulation 64: Air quality management and control
- Regulation 65: Fire prevention
- Regulation 66: Noise management and control
- Regulation 68: Water management and pollution control
- Regulation 69: Disposal of waste material, including mining waste, and
- Regulation 70: Soil pollution and erosion control.

8.2.4 National Water Act, 1988 (Act 36 of 1998)

8.2.4.1 Water use

Section 21 of the NWA stipulates the following water uses:

(a) taking water from a water resource
(b) storing water
(c) impeding or diverting the flow of water in a watercourse
(d) engaging in a stream flow reduction activity contemplated in section 36
(e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1)

(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit

(g) disposing of waste in a manner which may detrimentally impact on a water resource

(h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process

(i) altering the bed, banks, course or characteristics of a watercourse

(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people, and

(k) using water for recreational purposes.

Note that in the above, waste includes *any solid material or material that is suspended, dissolved or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted*.

In terms of section 4 of the NWA, water may only be used if it is a Schedule 1 use, a continuance of an existing lawful use (ELU), or authorised in terms of a general authorisation (GA) or licence. A water use may therefore not be implemented unless it is properly authorised through one of these types of authorisations. The circumstances that will determine the type of authorisation to be issued for a specific water use that is not a Schedule 1 use, and the different possibilities for regulating particular water uses are briefly discussed below.

8.2.4.1.1 Existing Lawful Water Uses (Sections 32 to 35)

Section 32 identifies water uses that were authorised under legislation, which was in force immediately before the date of commencement of the NWA (such as the 1956 Water Act), as ELUs. This is subject to the requirement that such water use took place at any time during the two years prior to the date of commencement of the NWA. Should a person have had such authorisation to use water but have not exercised this authorisation in the two years prior to this date, that person may apply to have the water use declared as an ELU in terms of section 33 of the Act. The section on ELU is designed to enable existing economic activities based on the use of water to continue until such time as compulsory licensing is called for in a particular catchment management area.

8.2.4.1.2 General Authorisations (GAs) (Section 39)

The aim of GAs is to set a cut-off point below which strict regulatory control is not necessary. If a water use is not described under Schedule 1, but authorised under a GA as published in the Government Gazette, such water use does not require a licence, unless the GA is repealed or lapses, in which case licensing will be necessary. For example, Government Notice No. 399 (GN399) of 26 March 2004 provides for GAs with respect to water use in terms of section 21(g).

8.2.4.1.3 Licences (Sections 40 to 52)

A person who wishes to use, or who uses water in a manner that is not a Schedule 1 use, not covered under a GA, or in a manner that is not regarded or declared as an ELU, may only use that water under the authority of a license (section 4). The NWA makes provision for two types of applications for water use licences, namely individual applications and compulsory applications. The provisions applicable to an individual application for a water use license are described in sections 40 to 42 of the NWA. These sections also provide that a responsible authority may require an assessment by the applicant of the likely effect of the proposed water use on the resource quality, and that such assessment be subject to the Environmental Impact Assessment (EIA) regulations promulgated under section 26 of the Environment Conservation Act, 1989 (Act 73 of 1989) (ECA). In terms of sections 43 to 48 of the NWA, compulsory applications for licences will be required under certain circumstances (e.g. in catchment management areas which are under water stress) from all water users using a particular water resource or in a specific geographical area, irrespective of whether or not their water use has been authorised by a GA or an ELU. Compulsory applications for the authorisation of these water uses are subject to the development of a Water Allocation Plan, which needs to be prepared by the responsible authority.

In the event that the purpose of the NWA will be met by the granting of a license, permit or other authorisation under any other law, the licensing authority may either dispense with the requirement for a license in terms of section 22(3), or may combine the various license requirements of other organs of state into a single license (section 22(4)). These provisions are of particular importance with regard to certain multiple water uses (section 22(4)),

such as may occur for underground mining, e.g. a mine may require water use licenses under sections 21(a), (b), (c), (f), (g) and (j).

Section 27 of the NWA specifies some factors that must be taken into consideration when considering a water use authorisation, including:

(a) existing lawful water uses
(b) the need to redress the results of past racial and gender discrimination
(c) the efficient and beneficial use of water in the public interest
(d) the socio-economic impact of the water use or uses if authorised of the failure to authorise the water use or uses
(e) any catchment management strategy applicable to the relevant water resource
(f) the likely effect of the water use to be authorised on the water resource and on other water users
(g) the class and the resource quality objectives of the water resource
(h) investments already made and to be made by the water user in respect of the water use in question
(i) the strategic importance of the water use to be authorised
(j) the quality of water in the water resource which may be required for the Reserve and for meeting alignment with the catchment management strategy
(k) international obligations, and
(l) the probable duration of any undertaking for which a water use is to be authorized.

These decision-making considerations are important when contemplating the prioritisation of a particular application, and when establishing preferences when evaluating competing applications for specific water uses.

Section 148(1)(f) of the NWA makes provision for an appeal to the Water Tribunal against a decision on a license application under section 41 by the applicant or any other person who has lodged a written objection against the application. If applicable, appeals against decisions on license applications may also be taken to the High Court.

8.2.4.2 Water use regulations

Government Notice No. 704 (GN704), regulations on use of water for mining and related activities aimed at the protection of water resources, was promulgated in terms of section 26 of the NWA on 4 June 1999. These regulations are covered in detail in **BPG A5: Water Management for Surface Mines** and are not covered here.

8.2.4.3 Dam safety requirements

Chapter 12 of the NWA contains measures aimed at improving the safety of new and existing dams with a safety risk so as to reduce the potential for harm to the public, damage to property or to resource quality. A dam with a safety risk means any dam which can contain more than 50 000 m^3 of water (irrespective whether such water contains substances or not) and which has a wall of a vertical height of more than 5 metres, or which has been declared as a dam with a safety risk under section 118(3)(a). Dam Safety Regulations published in Government Notice R.1560 of 25 July 1986, which are still in force under the NWA, require that dams with a safety risk must be classified into categories, and that licenses must be issued before any task relating to a specific category of dam may commence. These regulations also prescribe the conditions, requirements and procedures to classify, register, obtain a license to construct a new dam, impound a dam, or alter an existing dam. It further stipulates the requirements and responsibilities in respect of dam safety inspections, emergency procedures, recording and reporting.

8.2.4.4 Other important requirements in the NWA

Section 19 of the NWA further stipulates the general duty of care on persons who own, control, use or occupy land on which any activity or process is or was performed or undertaken, or any other situation exists which causes, has caused or is likely to cause pollution of a water resource, to take all reasonable measures to prevent any such pollution from occurring, continuing or recurring.

Section 20 deals with the reporting, containment and remedying of any incident or accident in which a substance pollutes or has potential to pollute a water resource or have a detrimental effect on a water resource. It further states that the CMA may take the necessary measures, if the remedial measures fail or inadequately comply, at the expense of the responsible person(s). Section 30 of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) stipulates similar requirements.

Sections 56 to 60 deals with water use charges and allows the Minister to establish a pricing strategy with charges for any water use to fund the direct and related costs of water resource management, development and use, and

for achieving equitable and efficient allocation of water. These charges may be used to ensure compliance with prescribed standards and water management practices according to the *user pays* and *polluter pays* principles. Provision is made for incentives for effective and efficient water use and could therefore be used as a means of encouraging reduction in waste and water wastage.

The Department of Mineral and Energy Affairs (DME) administrates the Mineral and Petroleum Resources Development Act, 2002 (MPRDA), but due to the major impact that mining can have on the environment, especially the water environment, DME is obliged to consult with DWAF with regard to certain decisions made in terms of this Act.

8.2.5 Mine Health and Safety Act (MHSA), 1996 (Act 29 of 1996)

Section 2(1) stipulates that the owner of a mine that is being worked must ensure, as far as reasonably practicable, that the mine is designed, constructed and equipped to provide conditions safe for operations and a healthy working environment and that the mine is commissioned, operated, maintained and decommissioned in such a way that employees can perform their work without endangering the health and safety of themselves or of any other person. Section 2(2) further stipulates that the owner of a mine that is not being worked, but in respect of which a closure certificate has not been issued, must take reasonable steps to prevent injuries, ill-health, loss of life or damage of any kind from occurring at or because of the mine. The Chief Inspector of Mines has the power to monitor and control those environmental aspects at mines that affect, or may affect, the health or safety of employees or other persons and is required to consult with the Director: Mineral Development concerning the exercise of those powers.

The above is reiterated in Section 5 which states that every manager must, to the extent that it is reasonable practicable:

- Provide and maintain a working environment that is safe and without risk to the health of employees
- Identify the relevant hazards and assess the related risks to which persons who are not employees may be exposed, and
- Ensure that persons who are not employees, but who may be directly affected by the activities of the mine, are not exposed to any hazards to their health and safety.

Regulation 2.10.15, promulgated in terms of the MHSA, stipulates that the appointed manager must ensure that in the construction of any dump or any slimes dam in the neighbourhood of any building, thoroughfare or other public road, railway or public place, no danger to life or limb or damage to property can result there from.

In terms of Section 9, a manager must prepare and implement a code of practice on any matter affecting the health or safety of employees and other persons who may be directly affected by activities at the mine if the Chief Inspector requires it. These codes of practices must comply with guidelines issued by the Chief Inspector.

According to section 11(1) every manager must:

- Identify the health and safety hazards to which employees may be exposed while at work
- Assess the health and safety risks to which employees may be exposed while at work, and
- Record the significant hazards identified and risks assessed and make these records available for inspection by employees.

Sections 11(2) and 11(3) states that the manager must determine and implement all measures necessary to:

- Eliminate the risk
- Control the risk at source
- Minimise the risk
- Provide protective equipment, and
- Institute a programme to monitor the risk.

8.2.6 National Environment Management: Air Quality Act, 2004 (Act 39 of 2004)

This is the first major revision of legislation affecting air pollution since 1965. The Act makes a radical shift in the approach to air quality management practices in South Africa bringing us into line with modern international trends. It should be noted that the Atmospheric Pollution Prevention Act (45 of 1965) (APPA) still regulates "Scheduled Activities" and will only be repealed on 11 September 2009.

The National Environment Management: Air Quality Act, Act 39 of 2004 (NEM AQA) must be interpreted and applied in accordance with the principals specified in the National Environmental Management Act (NEMA). The NEM: AQA serves to repeal APPA and various other laws dealing with air pollution.

The object of this Act is -

(a) to protect the environment by providing reasonable measures for -
   (i) the protection and enhancement of the quality of air in the Republic;
   (ii) the prevention of air pollution and ecological degradation; and
   (iii) securing ecologically sustainable development while promoting justifiable economic and social development; and
(b) generally to give effect to section 24(b) of the Constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people.

The AQA legislation requires that, once the Act comes into force, DEAT must develop and publish the South African national air quality framework within a strict timetable of deadlines which will outline how air quality will be managed in the country. In terms of air quality monitoring the national framework must establish national standards for how municipalities will monitor ambient air quality and source emissions, as well as how provinces will monitor air quality and the performance of municipalities in this regard. It must also ensure that, inter alia, the public has the opportunity to participate in the enhancement and protection of air quality; that there is public access to air quality information; that the norms and standards set actually prevent the worsening of air quality and reduce emissions; and that there are regular reports on air quality. To ensure its continuing relevance the framework will also have to be reviewed at least every five years.

By bringing this Act into force DEAT has enabled the setting of national, provincial, and local air quality standards. It also means that air quality officers must now be appointed in all three spheres of Government; that a detailed air quality management planning system must be established; that DEAT can declare Controlled Emitters; declare Controlled Fuels (for instance regulating the use of alternative fuels like waste tyres); designate priority pollutants; and demand air pollution prevention plans from specified polluters.

It is intended that the setting of norms and standards will achieve the following:

- The protection, restoration and enhancement of air quality in South Africa
- Increased public participation in the protection of air quality and improved public access to relevant and meaningful information about air quality
- The reduction of risks to human heath and the prevention of the degradation of air quality.

DEAT has not yet brought into effect those sections of the Act that require or imply specialist capacity that does not yet exist at local government level, and for the same reason they have not yet repealed the existing air quality legislation. The 9 September 2008 Government Notice has also excluded the industrial licensing sections of the new Act.

A key aspect of the new approach to air quality, as reflected in the Act, is the establishment of national ambient air quality standards. These standards provide the goals for air quality management plans and also provide the yardstick by which the effectiveness of these management plans is measured. The Act provides for the identification of priority pollutants and the setting of ambient standards with respect to these pollutants. The Act provides for the establishment of a multi-stakeholder National Air Quality Committee, which will advise the Minister on the implementation of the Act.

The Act ensures that air quality planning is integrated with existing activities. The implications of this are that plans that are required in terms of the National Environmental Management Act must incorporate consideration of air quality. In addition, integrated development plans, developed by municipalities, also have to take air quality into account.

The Act describes various regulatory tools that should be developed to ensure the implementation and enforcement of air quality management plans. These include:

- Priority Areas, which are air pollution 'hot spots'
- Listed Activities, which are 'problem' processes that require an Atmospheric Emission Licence
- Controlled Emitters, which includes the setting of emission standards for 'classes' of emitters, such as motor vehicles, incinerators, etc.
- Control of Noise
- Control of Odours.

In order to facilitate implementation of and compliance with the Act, the Act provides for government to turn down licence applications from applicants who have a bad trail record of air quality management practices. It also provides for government to demand that 'problem'

industries appoint qualified air quality management practitioners.

The Act also deals with South Africa's international obligations in terms of air quality management. Provision is made for the control of processes impacting on South Africa's neighbours and the global atmosphere in general. This section of the Act is viewed as significant in that it enables government to implement the swift responses that are requirements of some international investment opportunities.

The Act as a whole is underpinned by the adoption of a comprehensive approach to the management of offences and penalties, which includes the provision of transitional arrangements. The Act provides for flexibility so that permissible emission limits can be amended on a progressive basis in order to achieve air quality standards.

Certain sections of the Act came into force on 11 September 2005, but DEAT excluded certain sections until such a time as local authorities had the capacity and skills to cope with the implementation of the legislation. Many of the excluded sections relate to listed activities and licensing of listed activities which will be regulated in terms of APPA.

8.2.7 Environment Conservation Act, 1989 (Act 73 of 1989)

Waste is defined in section 1 of the Environment Conservation Act, 1989 (ECA) as *any matter, (whether gaseous, liquid or solid, or any combination there-of) which from time to time may be proclaimed by the Minister (of Environmental Affairs and Tourism) by notice in the Government Gazette as an undesirable or superfluous by-product, emission, discharge, excretion, or residue of any process or treatment.*

Government Notice No. 1986 in Government Gazette 12703 of 24 August 1990 describes what is meant by waste in this context. This definition specifically excludes (and is therefore not applicable to mine residue deposits):

- Water used for industrial purposes as governed under the 1956 Water Act
- Any matter discharged into a septic tank or french drain sewerage system
- Building rubble used for filling or levelling purposes
- Any radio-active substances
- Any minerals, residue, waste rock or slimes produced at a mine, or
- Ash produced by or resulting from the generation of electricity.

Section 19 and 20 of the ECA deal specifically with waste management and pollution prevention.

8.2.8 National Heritage Resources Act, 1999 (Act 25 of 1999)

Section 34 stipulates that a permit is required from the relevant provincial heritage resources authority to alter or demolish any structure or part of a structure which is older than 60 years. Various other forms of protection may also apply.

8.2.9 National Nuclear Regulator Act, 1999

The National Nuclear Regulator Act, 1999 (NNR) is applicable to "facilities specifically designed to handle, treat, condition, temporarily store or permanently dispose of any radioactive material which is intended to be disposed of as a waste material". The following sections of the NNR are relevant to mines:

- Chapter 3 provides details on authorisations of facilities and the responsibilities of holders of nuclear authorisations. A licensing guide (LG-1032) has been published by the Council for Nuclear Safety (CNS). This guide provides details on the methodology for the assessment of nuclear hazards and guidance on submissions to the CNS
- Chapter 4 details the financial securities and liabilities that are applicable to holders of nuclear authorisations, and
- Chapter 5 provides information on safety and emergency measures.

8.2.10 Other Acts

The Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) and the Biodiversity Act, 2004 (Act 10 of 2004) are also relevant for mining.

8.3 SUMMARY OF APPLICABLE WATER MANAGEMENT POLICIES AND STRATEGIES

8.3.1 National Water Resource Strategy (NWRS)

The National Water Resources Strategy, 2004 (NWRS) is the implementation strategy for the NWA and provides the framework within which the water resources of South Africa will be managed in an integrated manner in the future. This strategy sets out policies, strategies, objectives, plans, guidelines, procedures and institutional arrangements for the protection, use, development, conservation, management and control of the country's water resources. The NWRS sets out the current government objectives for managing water resources in South Africa as follows:

- To achieve equitable access to water, that is, 1) equity of access to water services, 2) equity to the use of water resources, and 3) equity to the benefits from the use of water resources
- To achieve sustainable use of water, by making progressive adjustments to water use to achieve a balance between water availability and legitimate water requirements, and by implementing measures to protect water resources and the natural environment
- To achieve efficient and effective water use for optimum social and economic benefit.

The NWRS also lists important principles to facilitate achievement of these policy objectives, such as:

- Water will be regarded as an indivisible national asset. The Government will act as the custodian of the nation's water resources, and its powers in this regard will be exercised as a public trust
- Water required to meet basic human needs and to maintain environmental sustainability will be guaranteed as a right, whilst water use for all other purposes will be subject to a system of water use authorisation.
- The responsibility and authority for water resource management will be progressively decentralised by the establishment of suitable regional and local institutions, with appropriate community, racial and gender representation, to enable all interested persons to participate.

Water use for mining activities will be subject to the requirements of a water use authorisation. The benefits and need for this water use will be assessed in the context of the water availability and spread of water use in the catchment.

8.3.2 Catchment Management Strategies (CMS)

The country has been divided into 19 WMAs (see Figure 8.1). The delegation of water resource management from central government to catchment level (as proposed above) will be achieved by establishing Catchment Management Agencies (CMAs) at each WMA level. The NWRS requires that each CMA progressively develop a Catchment Management Strategy (CMS) for the protection, use, development, conservation, management, and control of water resources within its WMA. The Department's eventual aim is to hand over certain water resource management functions to CMAs. Until such time as the CMAs are established and are fully operational, the Regional Offices (ROs) of the Department will continue managing the water resources in their areas of jurisdiction.

The water management and water licensing issues for an underground mine will thus be dealt with by the Regional Office of the Department of Water Affairs and Forestry, until the CMAs are established and operational.

8.3.3 Internal Strategic Perspectives (ISP)

The objective of the Internal Strategic Perspective (ISPs) is to provide a framework for the management of the water resources in each WMA, until such time as the ROs can hand over the management functions to the established CMA. The ISP provides details on the Department's view on how Integrated Water Resource Management (IWRM) should be practiced in each WMA. This will ensure consistency when answering requests for new water licences, and informing existing water users (including authorities) on how the Department will manage the water resource within the area of concern. Stakeholders must be made aware of the bigger picture as well as the management detail associated with each specific water resource management unit.

The ISPs for each WMA provide details on the available water resources and the current and future use of the water resource. The ISPs thus provide useful catchment-

based information to the planning and water management team on a surface mine.

8.3.4 Water Resource Availability and Utilisation in South Africa

This report provides an overview of South Africa's available water resources for 1996 and the current patterns of utilisation. This availability and utilisation has then been projected to 2030, based on the present trends in water use and population growth, indicating that South Africa will reach the limits of its economically usable, land-based fresh water resources during the first half of the century.

The report indicates that these trends can be changed to ensure the secure and adequate supply of water and to sustain the prosperity and natural environment of South Africa. Key recommendation made in the report in this regard include a) coordination of water allocation priorities with national development objectives and strategies for the country as a whole, b) greater emphasis be placed on water conservation and c) comprehensive programme to install a new appreciation of the value of water and the importance of the changed approach to the utilisation of water.

The details in the report include:

- A summary of the water requirements and resource potential for the various regions within the country
- Future options on availability and utilisation of water, and
- Recommendations on the way forward.

8.3.5 The Philosophy and Practice of Integrated Catchment Management: Implications for Water Resource Management in South Africa

The Department of Water Affairs and Forestry, through the NWA and the National Water Policy, have identified that naturally occurring water usually can be effectively and efficiently managed only within a river basin or catchment area, because of the need to manage, or at least account for, all aspects of the hydrological cycle. Thus, the Department recognises and accepts that an integrated catchment management (ICM) approach will be adopted in South Africa (DWAF, 1986). This approach is seen to facilitate the achievement of a balance between the interdependent roles of resource protection and resource utilization.

The document identifies the role of central government in Integrated Catchment Management (ICM) as being one of leadership, aimed at facilitating and co-ordinating the development and transfer of skills, and assisting with the provision of technical advice and financial support, to local groups and individuals. Where specific areas of responsibility fall outside the mandate of a single government department, appropriate institutional arrangements are required to ensure effective inter-departmental collaboration. At a lower level in this process, individual landholders and communities must be recognized as competent partners. Where these individuals may lack the necessary skills for full participation, the lead agencies must take responsibility for assisting with their development and application.

The document identifies five basic principles for effective ICM as follows:

- A systems approach which recognizes the individual components as well as the linkages between them, and addresses the needs of both the human and natural systems
- An integrated approach, rather than a comprehensive approach, in which attention is directed towards key issues of concern identified by all stakeholders in the process
- A stakeholder approach which recognizes the importance of involving individual citizens and landowners, as well as government agencies, in a participatory process to define all decisions around the conservation and use of natural resources which affect their lives
- A partnership approach which promotes the search for common objectives, and defines the roles, responsibilities and accountabilities of each agency and individual who participates in the process of decision making, and
- A balanced approach where close attention is given to decisions designed to achieve a sustainable blend of economic development, protection of resource integrity, whilst meeting social norms and expectations.

8.3.6 A Strategic Plan for the Department of Water Affairs and Forestry to Facilitate the Implementation of Catchment Management in South Africa

The Strategic Plan provides the Department of Water Affairs and Forestry with a strategic plan to facilitate the implementation of the concept of ICM. The philosophy of managing water resources on an ICM approach is taken as a guiding principle in the strategic plan.

The strategic plan document is divided into two parts, namely part I which is designed to meet urgent management interests in the form of an Implementation Strategy, a Programme of Activities and a Schedule of Human Resources, and Part II which provides the motivation and context for individual proposals in Part I.

The strategic plan provides details on the concepts, functionalities and institutional structures surrounding "Integrated Water Resource Management on a Catchment Basis", as follows:

- Framework for IWRM in RSA which will evolve in a three-tiered framework comprising a National Water Resources Strategy (NWRS), a Statutory Framework for CM and CM Processes/ Strategies/ Plans in particular catchments
- CM Functions: Three classes of CM Functions are distinguished, namely Core, Physical Development and Administrative functions, and
- Institutional Context and Evolution of CM: the Department is foreseen to play a leading role regarding CM, both through a National CM Facility (Directorate), and through the Regional Offices.

8.3.7 Towards A Strategy For Waste Discharge Charge System (WDCS)

The Waste Discharge Charge System (WDCS) forms part of the Pricing Schedule for Water Use Charges established in terms of section 56 of the NWA and will be introduced to address the particular issue of excessive water pollution.

The resource quality objectives (RQOs) form the integral basis and fundamental principle of the WDCS. Water resource management in South Africa links the acceptable level of impact to the concept of RQOs, which balance the need to protect water resources with the need to develop and use these resources. The setting of RQOs is catchment specific, based on the social, economic and political drivers for development and utilisation of a specific water resource. RQOs are to be set as part of the classification system for water resources, through a process of consensus seeking among water users and other stakeholders, in which the government is responsible for ensuring that environmental interests are represented. The WDCS will therefore focus on reducing discharge loads in order to achieve or maintain RQOs in a catchment. Where RQOs are being met, the WDCS is not applied. Where RQOs are exceeded or in threat of being exceeded, the WDCS may be applied as part of water quality management in the catchment. The WDCS applies to surface water and groundwater resources where RQOs have been defined and an adequate understanding of the resource supports the implementation of the system.

The WDCS will be applied to a particular catchment area in which a water quality problem exists. This could be a whole catchment in which a widespread water quality problem occurs or a sub-catchment within a larger water basin.

Where downstream RQOs are more stringent than upstream RQOs, and downstream RQOs are exceeded or threatened, the WDCS may be applied in the upstream catchment even if the upstream RQOs are achieved.

The implementation of the WDCS will however also support the Source Management Strategy and achieve the following supportive and additional objectives:

- To encourage efficient resource utilisation (incentive objective)
- To recover costs of activities aimed at pollution abatement and damage caused by pollution (financial objective)
- To discourage excessive pollution (deterrent objective), and
- To promote sustainable water use (social objective).

Four levels of discharge charges are envisaged in the strategy, as follows:

- Tier 1: Basic/Administrative charge: this charge will cover the administrative and management functions in the catchment,
- Tier 2: Load-based charge, for pollution loads higher than the Recommended Resource-Directed Value (RRDV) for the catchment, and

- Tier 3 and 4: Deterrent charges for pollution loads higher than the Maximum Allowable Resource-Directed Value (MARDV).

The Department will use the WDCS as a tool for source control and management, which will provide the following benefits:

- A strong financial incentive to reduce pollution loads to the water resource, particularly if the pollution loads discharged are in excess of the RRDV and the MARDV, and
- The revenue from the WDCS will be ring-fenced to cover water quality management work within the Department. This work will include rehabilitation and remediation projects, waste abatement work (such as regional treatment facilities or on-site pollution prevention or treatment) and investigative studies.

8.3.8 Water Conservation and Water Demand Management (WC/WDM)

The management of water resources and the provision of water services culminated in a new approach which Water Conservation and Water Demand Management (WC/WDM) plays a crucial role in ensuring environmental sustainability, socio-economic equity and efficiency. The NWA and Water Services Act, Act 108 of 1997, (WSA) has provided an enabling environment in which all relevant institutions could be required to integrate WC/WDM into their strategic roles and responsibilities. It is thus a requirement that mines (and other water use sectors) consider WC/WDM during all life cycle phases and strategies. In this instance the DWAF has compiled three sectoral strategy documents, complementary to the present National Water Conservation and Water Demand Management Strategy, namely:

- Agriculture
- Water Services, and
- Industry, Mines and Power Generation.

These documents provide detailed information in terms of strategic outputs, prioritised activities and key role-players. The NWC/WDMS objectives to be achieved by each sectoral strategy include:

- To facilitate and ensure the role of WC/WDM in achieving sustainable, efficient and affordable management of water resources and water services
- To contribute to the protection of the environment, ecology and water resources
- To create a culture of WC/WDM for all consumers and users
- To create a culture of WC/WDM within all water management and water service institutions
- To support water management and water services institutions to implement WC/WDM
- To promote the allocation of adequate capacity and resources by water institutions to WC/WDM
- To enable water management and water services institutions to adopt integrated planning, and
- To promote international co-operation and participate with other Southern African countries, particularly basin-sharing countries in developing joint WC/WDM strategies.

The Industry, Mining and Power Generation sector, because of its diversity, is considered to offer numerous opportunities for contributing towards WC/WDM. Such opportunities include the efficient use of water during industrial production, re-use of water, recycling of water from other sectors.

8.3.9 Water Allocation Reform

As custodians of the national water resource, the DWAF is obliged to promote the beneficial use of water in the best interests of all South Africans.

In order to do this, water allocations must be carried out in a manner that promotes equity, addresses poverty, supports economic growth and provides opportunities for job creation. The allocation process recognises that redressing the effects of previous discriminatory legislation is necessary for social stability and to promote economic growth. Moreover, the water allocation process must allow for the sustainable use of water resources and must promote the efficient and non-wasteful use of water.

However, allocating water without ensuring that all users have the capacity to use this water productively will limit these benefits. Water allocations should, therefore, not only aim at realising the above goals, but must work closely with all spheres of government and other institutions to promote the productive and responsible use of water. Likewise, where possible, water reallocations should try to minimise possible negative impacts on existing productive lawful water users who are contributing to social and economic stability, growth and development. Water allocations must promote shifts in water use patterns that are equitable but also phased and carefully considered.

These objectives go well beyond the Department's primary mandate and require the active pursuit of cooperative governance arrangements to support the productive use of water. Accordingly, approaches to reallocating water between users will initially be rolled out in areas experiencing shortages of water. However, in order to address the urgent short-term need for equity across the country, rollout will also be fast-tracked in areas where there are less serious water availability concerns. These implementation approaches take into account the prevailing resource and capacity constraints within the Department and our country.

8.3.10 Water Classification System

The water classification system using A to F ecological categories has been used for preliminary Reserve determinations. A need had been expressed for a classification system that integrates ecological and user requirements into management classes and which allows for the examination of the socio-economic and ecological implications of water management decisions. The National Water Resource Classification System (NWRCS) is a set of guidelines and procedures for determining the desired characteristics of a water resource, as represented by a Management Class (MC). The MC outlines the attributes that the responsible authority and society require of different water resources. The NWRCS will be used in a consultative approach with all relevant stakeholders to classify water resources in order to facilitate a balance between protection and the utilisation of the water resource.

The outcome of the water classification process incorporating economic, social, ecological and stakeholder consent will be promulgated by the Minister or her delegated authority setting the MC for every significant water resource, which will be binding on all authorities or institutions when exercising any power, or performing any duty under the NWA. The MC of a resource sets the boundaries for the volume, distribution and quality of the Reserve as well as Resource Quality Objectives. The MC ranges from Natural to Heavily Used/Impacted and essentially describes the desired ecological condition of the resource, and conversely, the degree to which the resource could be utilised.

8.3.11 The National Groundwater Strategy

The groundwater quality management strategy forms part of the DWAFs National Water Resource Strategy. South Africa's water resources are very unevenly distributed across the country, and in arid or water-scarce areas. The value and vulnerability of groundwater represent a strategic component of the water resources of South Africa. Security of groundwater supplies is thus essential and protection of groundwater has become a national priority.

It is common for groundwater to be poorly managed. It takes a long time to detect that it has become polluted and groundwater has only limited ability to purify itself. It is difficult, often impossible, and also very expensive to restore polluted groundwater to its original quality. The major reason for poor management of groundwater resources, however, has been a lack of a structured approach to management as well as a lack of knowledge and information about groundwater.

In order to manage groundwater quality in an integrated and sustainable manner within the context of the National Water Resource Strategy and thereby provide an adequate level of protection to groundwater resources and secure the supply of water of acceptable quality, the DWAF has identified the following policy goals:

- 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
- 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 recognized, and
- To remedy groundwater quality where practicable to protect the reserve and ensure at least fitness for the purpose served by the remediation.

Principles that will guide the implementation of this strategy include subsidiary and self-regulation, pollution prevention, integrated environmental management, equity, sustainability, the polluter pays, and public participation.

.

9 REFERENCES

Department of Water Affairs and Forestry (2003), A conceptual introduction to the nature and content of the water quality management and assessment components of a catchment management strategy – Edition 1.

Department of Water Affairs and Forestry (2004), National Water Resource Strategy, First Edition.

Department of Water Affairs and Forestry (2004), National Water Conservation and Water Demand Management Strategy.

Department of Water Affairs and Forestry (2006), Generic Water Conservation and Water Demand Management Framework Guideline for the Mining Sector in South Africa.

Department of Water Affairs and Forestry (2007), Internal Guideline: Section 21 (e), (f), (g), (h), (j) Water Use Authorisation Application Process (Waste Discharge Related).

Department of Water Affairs and Forestry (2007), External Guideline: Generic Water Use Authorisation Application Process.

Department of Water Affairs and Forestry (2007), Guidelines for the Development of Catchment Management Strategies: Towards equity, efficiency and sustainability in water resources management.

Department of Water Affairs and Forestry (2008), Operational Guideline To Assist In The Compilation Of An Integrated Water And Waste Management Plan.

Department of Water Affairs and Forestry (2008), Strategic Framework on Water for Sustainable Growth and Development – Summary Discussion Document, May 2008.

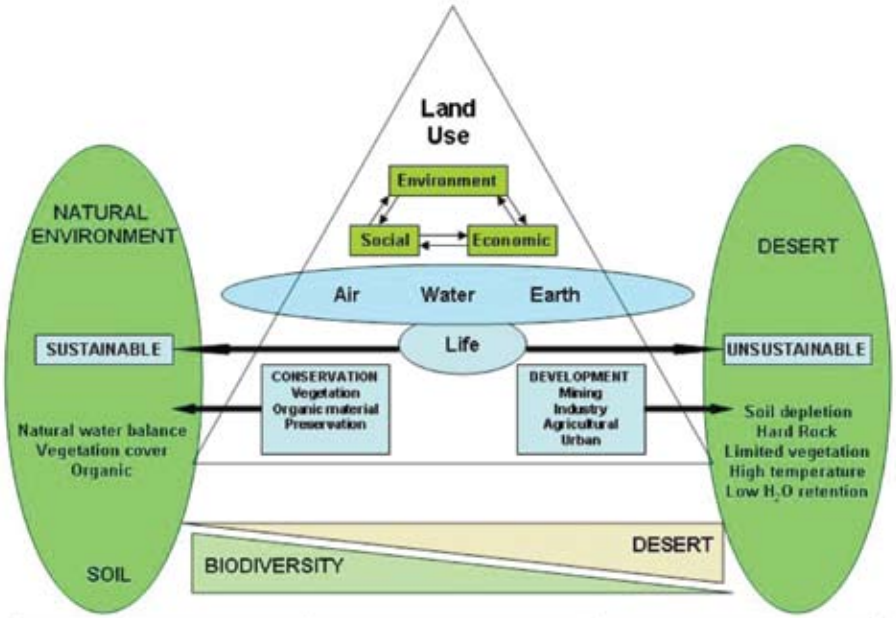
APPENDIX A: INTEGRATED MINE WATER MANAGEMENT IN THE CONTEXT OF BIODIVERSITY, GLOBAL WARMING AND DESER-TIFICATON

A.1 WHAT IS BIODIVERSITY?

Biodiversity, a contraction of the phrase "biological diversity," is a complex topic, covering many aspects of biological variation. In popular usage, the word biodiversity is often used to describe all the species living in a particular area. Therefore biodiversity is seen as the sum of life and its processes including the variety of living plants, animals and other organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary process that keep them functioning.

As depicted in Figure A.1 various land uses impact on biodiversity and in many instances creates unsustainable environmental conditions. Many of the anthropogenic impacts that could be associated with development such as mining and industrialisation contribute towards global warming.

Figure A.1: Biodiversity in the context of Integrated Environmental Management



SUSTAINABLE	CRITERIA	UNSUSTAINABLE
Retention, recharge	Stormwater	Quick runoff
Conservation	Organic Waste	Depletion
High diversity	Vegetation	Low diversity

Global warming is the increase in the mean temperature of the earth due to excessive emissions of greenhouse gases such as carbon dioxide, methane, and nitrogen. It is commonly acknowledge that global warming increases the Earth's average temperature, which in turn causes changes in climate. A warmer Earth may lead to changes in rainfall patterns, a rise in sea level, and a wide range of impacts on plants, wildlife, and humans. One such impact is the creation of deserts.

As environmental impacts culminate in desertification it is important to define this concept in relation to Integrated Environmental Management. A simple definition would be: "Desertification

is the process which turns productive areas into a non-productive desert as a result of poor land-management". However, desertification could generally be defined as environmental conditions that occur in arid and desert like environments where:

- Vegetation is little to none, occasionally and small with low biodiversity
- Soils are exposed rock and sand
- Air is exposed to extreme heat temperatures and heat waves that destroy life and vegetation
- Water is little to none with low rainfall, quick runoff, seepage and evaporation

A.2 GLOBAL PROBLEM STATEMENT

Desertification is becoming a major problem as more and more of the world's land surface is turned into desert. The new deserts which are being created are not necessarily hot, dry sandy places, but are instead any areas where the soil has been so mistreated by humans that it is now rendered useless for crop cultivation. This phenomenon is becoming more applicable to this country as South Africa is located in a predominantly semi-arid part of the world. The climate varies from desert and semi-desert in the west to sub-humid along the eastern coastal area, with an average rainfall for the country of about 450 mm per year (mm/a), well below the world average of about 860 mm/a, while evaporation is comparatively high. As a result, South Africa's water resources are, in global terms, scarce and extremely limited.

Deforestation contributes towards desertification. Not just nutrients are lost when the forest is removed. The water cycle itself is disrupted, and the initial consequence is increased erosion because there is no vegetation to act as a "buffer" to hold the water in the plants and soils. Another likely consequence is a long-term and irreversible decline in available water in the region. Deforestation occurs with development such as urbanisation, mining, industry as well as agricultural. In all of these activities the common denominator is the eradication of natural vegetation. A fundamental function of vegetation cover is to create micro-climate with shadows that cool soil down that reduces evaporation. In addition it retains moisture and fertilises the soil as well as promotes water ingress and increases water retention.

Figure A.1 provides for a schematic presentation to illustrate the interrelationship between desertification and development with the associated destruction of the natural environment and increased impacts stemming from the various land use activities. It is important that Integrated Environmental Management should focus on the functionality of vegetation as it directly influences evaporation and sustains biodiversity. Civilisation as seen from the perspective of urbanisation, industrialisation and mining is a stimulus for desertification as it promotes all criteria associated with this phenomenon i.e.:

- Hard surfaces
- Exposed soils
- Quick water runoff and low retention
- Limited vegetation; and
- Extreme temperatures

Industry and mining in particular could be held directly responsible for extensive earth moving operations that result in ever growing hard surfaces inclusive of infrastructure, tailings storage facilities, waste rock dumps, haulage roads and ROM stock piles. There is also inappropriate storm water management as quick run off is induced with little infiltration and the maximisation of evaporation. Rehabilitation is typically characterised by a lack of species diversity, poorly established vegetation and maintenance practices that do not endorse sustainability. The barren environment associated with rehabilitated areas gives rise to extreme temperatures, increased evaporation, reduction of groundwater in perched aquifers, increase in runoff with concomitant erosion, gully formation and silt load.

It is thus evident that desertification reduces the ability of land to support life, affecting wild species, domestic animals, agricultural crops and people. The reduction in plant cover that accompanies desertification leads to accelerated soil erosion by wind and water. It has been reported that South Africa is losing approximately 300-400 million tonnes of topsoil every year. As vegetation cover and soil layer are reduced, rain drop impact and run-off increases. It would be careless if regulators and environmental managers' disregarded the tremendous impact caused by desertification and should engage, as a matter of utmost urgency, in initiatives incorporating alternative approaches in Integrated Environmental Management.

A.3 GLOBAL INITIATIVES

The need for an integrated approach to managing water resources has been articulated at a number of

international meetings during the last three decades, each of which has stressed the importance of water for human survival, health and productivity. The two most recent global forums - the United Nations Millennium Summit, September 2000 and the World Summit on Sustainable Development, August 2002 - reaffirmed that people must be at the centre of the sustainable development and use of water resources. Resolutions, agreements and targets arising from these events emphasized, among other things, the importance of water in addressing poverty issues, and the importance of factoring gender considerations into all aspects of water management. In an African context these sentiments are echoed in the policy objectives of the New African Partnership for Development and the Southern African Vision for Water, Life and the Environment in the 21st Century. This approach was further strengthened during the recent **World Summit on Sustainable Development Plan** tabled for implementation.

The Johannesburg Plan of Implementation (JPoI) affirmed the Millennium Development Goals for water, also agreed to develop integrated water resources management and water efficiency plans by 2005, through actions to, among other initiatives:

- Develop and implement national/regional strategies, plans and programmes with regard to integrated river basin, watershed and groundwater management, and introduce measures to improve the efficiency of water infrastructure to reduce losses and increase recycling of water
- Employ the full range of policy instruments
- Improve the efficient use of water resources and promote their allocation among competing uses in a way that gives priority to the satisfaction of basic human needs and balances the requirement of preserving or restoring ecosystems and their functions
- Develop programmes for mitigating the effects of extreme water-related events
- Support the diffusion of technology and capacity-building for non-conventional water resources and conservation technologies

A.4 DESERTIFICATION WITHIN THE NATIONAL CONTEXT

It should be noted that pronounced differences are evident among the water management areas with respect to water availability and water requirements, which are attributable to the large spatial variations in climate, the level and nature of economic development and population characteristics. Similarly, there are large differences within water management areas with respect to hydro-meteorological conditions and economic activity which cannot be adequately represented or managed without further spatial differentiation. Water management areas were therefore divided into sub-areas to enable improved representation of the water resources situation in the country and to facilitate the applicability and better use of information for strategic management purposes.

There is evidence that global temperatures are rising. Some climate models suggest that this could increase the variability of climate and decrease rainfall in South Africa. According to these models stream flow could decrease, possibly by as much as 10 per cent by 2015 in the most affected parts of the Western Cape. The models suggest that the reduction in runoff will progress from the west to the east coast by about 2060. The effect on groundwater recharge is less predictable, but could even be greater. An increase in the variability of stream flow would mean that, even if the average rainfall were to remain the same, natural yields and reliability would be reduced and the unit cost of water from dams would increase. The water requirements of plants, and therefore irrigation requirements, would also increase should warmer climatic conditions manifest themselves. A decrease in water availability will also impact on water quality, thereby further limiting the extent to which water may be used and developed.

In addition, the management of water as a renewable natural resource must be carried out in a manner consistent with the broad environmental policy of government and within the framework of environmental legislation, that is, the National Environmental Management Act, 1998 (No. 107 of 1998), and those parts of the Environment Conservation Act, 1989 (No. 73 of 1989), that have not yet been repealed by the more recent legislation.

Water as a system also interacts with other systems. Human activities such as land use, waste disposal and air pollution can have major impacts on the quantity and quality of water available for human use, while the abstraction and storage of water and the discharge of waste into water resources can impact on the quality of the natural environment. These interactions must be considered and addressed by water resource managers.

A5 LAND USE ON A REGIONAL CONTEXT

The Act recognises the potential influence of land use practices on the proportion of rainfall that reaches streams or penetrates to groundwater. Currently, afforestation is the only stream flow reduction activity that is subject to authorisation as a water use, although other land-based activities are being investigated. Other factors that may influence water availability and that were accounted for in the NWRS database are invasive alien vegetation, some rain-fed cultivation of crops and impervious surfaces in urban areas. It is important that consideration be given in relevant catchment management strategies to the protection of mountain catchment areas from which large quantities of runoff originate.

The type of destruction as caused by anthropogenic developments as described for the various water use sectors have similar impacts as those caused by afforestation which is a declared stream flow reduction activity regulated in terms of section 21(f) as contemplated in section 36 of the NWA. At this stage the other activities could as yet not be declared as stream flow reduction activities.

In some parts of the country, overgrazing and denudation has significantly increased the quantities of sediment that reach the rivers, leading to a loss of reservoir storage and significant changes in the morphology of some rivers. It has been estimated that the costs associated with the combined downstream losses from sediment are an order of magnitude greater than the national investment in soil conservation. The management of land must therefore become a focus for co-operation among the government departments responsible for administering land use.

To meet the country's growing water requirements, water resources are highly developed and utilised in large parts of the country. As a result of the many control structures (dams and weirs), the abstraction of water and return flows to rivers, as well as the impacts of land use, the flow regime in many rivers has been significantly altered. In some instances this has resulted in a severe degradation of the quality of water and the integrity of aquatic life in rivers. The anticipated further industrialisation of the economy and urbanisation of the population will result in further deterioration of the country's rivers unless appropriate and timely corrective measures are taken.

These measures must include the principle of soil management as an integral part of land and water resource management. The content of organic material (%) in soil must be determined and rehabilitation practices must be directed to ensure that the organic levels are at least maintained if not improved. Disturbed areas that are not properly rehabilitated after land use such as mining could have, as a total result, a dried out catchment, increased sponge areas and destruction of wetlands. Emphasis must be placed on the preservation of organic material. Rehabilitation and remediation will therefore focus on the artificial establishment of vegetation embedded in the fundamental principle of conservation of organic material.