CHAPTER 3 - WATER AND MINING

3.1 Water in South Africa

South Africa is a water-stressed country; it is semi-arid and often experiences erratic unpredictable extreme events of floods and droughts. South Africa receives an average annual rainfall of less than 450 mm compared to a world average of 860 mm (DWAF, 2004). The distribution of rainfall is uneven, large percentage being received in the geographically small escarpment areas remote from the major demand centres such as Gauteng.

Stream flow in South African rivers is relatively low due to variable surface runoff. The combined flow of all rivers in the country amounts to approximately 49 000 million cubic metres per year, less than half of that of Zambezi river, the closest large river to South Africa (DWAF, 2004). Groundwater plays a major role in water supply, especially in rural areas. There are substantial groundwater reserves, but recharge estimates are uncertain, and so is the renewable resource value (Fuggle & Rabie, 1992). Due to the predominantly hard rock nature of South Africa's geology, only about 20% of groundwater that occurs in major aquifer systems can be utilised on a large scale (DWAF, 2004). Groundwater use can be limited by its quality which does not always meet the users' requirements; it can be too mineralised for direct use without treatment, particularly in the drier parts of the country. Groundwater currently contributes between 13 and 15% of the total water use in South Africa. It is estimated that the total groundwater water use in South Africa is approximately 300 m3/year (Pietersen, 2005). Approximately 400 communities depend on groundwater for domestic purposes. The aquifers with large quantities of water include the dolomites of the west Rand and Far East Rand (Pietersen, 2005).

South Africa's groundwater resources will be increasingly exploited in the future. Coupled with this increasing demand is the large volume of dissolved salts derived primarily from the mining industry that are discharged to the environment annually. Due to the long time residence time of water in the subsurface environment, the effects of pollution may become apparent only tens to hundreds of years afterwards. Contamination of groundwater has become a major concern because once an aquifer is contaminated, it is generally extremely difficult to clean up and restore the purity of its water.

South Africa has advanced mining production, but lags behind with respect to use, distribution and conservation of water – women walk long distances to draw water from the streams, mosquitoes breed in stagnant pools while schools have no taps (SA Waterbulletin, 2000). Seven million people (16% of the population) do not have access to a basic water supply (Environmental Data Interactive Exchange, 2002)**.** In addition, the limited water resources are threatened by chemical pollution from mining activities.

The Department of Water Affairs and Forestry (DWAF) is the custodian of the South African water resources. Part of its mission is to ensure that the quality of water resources remains fit for recognised water uses and that the viability of aquatic ecosystems are maintained and protected.

3.2 Water in the South African Mining Industry

South Africa is renowned for its wealth in mineral resources, with extensive gold deposits and mining activities in the Witwatersrand region. In contrast to this mineral wealth, water resources are limited and vulnerable to environmental impacts from the mining industry. As water is essential for life, its pollution not only endangers aquatic life, but also terrestrial organisms that need water for their existence.

Water is a necessity for mining, both in terms of quantity and quality. The use of water in mining covers a variety of processes, from potable water to cooling water to acting as a transport medium, with many uses in between. Water is extensively used in the mining industry, especially in gold mines, with large volumes being used in the direct mining operations through the use of hydraulic drills, for cooling and dust suppression, as well as in the metallurgical and refining operations, ore washing and transportation of wastes to slimes dams and stockpiles. Mining and bulk industries required 6% of the country's total requirements in 2000 (DWAF, 2004). In 2002 the gold mines of the Witwatersrand alone consumed approximately 1% of the country's total use (Chamber of Mines of South Africa, 2002). Mining, large industries and power generation account for 8% of water use in South Africa (DWAF, 2004).

Impacts on surface and groundwater quality can occur during exploration, construction and operation of mines, as well as at abandoned and rehabilitated mine sites. Uncontrolled drainage from mines can contribute potentially harmful materials to local waterways and may degrade the water's suitability for domestic, agricultural or industrial uses, or be harmful to the ecology of the receiving environment (Minerals Council of Australia, 1997).

The type of receiving water into which wastewater is discharged is an important factor in determining the effect and ultimate fate of discharged pollutants. The Minerals Council of Australia (1997) states that physical characteristics such as temperature, flow, pH, salinity, dissolved oxygen, light penetration determine the behaviours of a specific pollutant in the aquatic environment. The capacity of the receiving environment to dilute and assimilate the effluent is also of primary importance.

Mining brings sulphide-containing minerals into contact with air, where they are oxidised and react with water to form sulphuric acid. This, together with various trace elements, impact on groundwater. Tailings dams and waste rock heaps are also sources of acidic drainage water, affecting surface and underground water. The chemical deposits left behind by explosives are usually toxic, and they contaminate and increase the salinity of mine water.

3.3 Gold Mining in South Africa

South Africa has substantial gold ore reserves, estimated at 40 000t, representing 40% of global reserves. The South African gold mining industry's production declined by 4.7%

to 375.8 tons in 2003 (Chamber of Mines of South Africa, 2004) due to a number of factors including the stronger rand, lower rand gold price and cost pressures. The gold sector, despite the lower production remained the industry's largest sector by value and South Africa's largest export contributor. The sector's 2003 sales were R3.13 billion and it was the largest employer in the mining industry with an average of 188 424 employees for the first six months of 2004; this compares favourably to PGM and coal sectors which employed an average of 127 672 and 47 249 respectively (Chamber of Mines of South Africa, 2004). South Africa's main gold-producing area is concentrated in the Witwatersrand basin and yields 98% of South Africa's gold output (Mbendi, accessed on 26/05/04). The major gold producers are Anglogold, Goldfields, Harmony, and Durban Roodeport Deep. Anglogold is South Africa's largest producer with operations in the Vaal River, West Wits (the study area) and East Rand areas.

3.4 Mining and Sustainable Development

The international mining community has accepted the need for a new image and a new relationship between mining and society at large for the past six years. The need for this comes from the fact that mining is no longer considered socially acceptable in many quarters, and a realisation that for companies to maintain shareholders, access to capital and land the industry has to change its historical image (characterised by lack of rehabilitation). This challenge is addressed in part through the move to endorse sustainable development as a necessary outcome of mining.

Sustainable development is fundamentally defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own' (World Commission on Environment and Development, 1987). The environment has a limited capacity to sustain mining due to the depletion of finite resources and the negative biophysical and social environment caused by the process of extraction. In terms of the biophysical impacts the international industry has been dealing with the environment as a management issue for many years and laws, guidelines and best practice for avoiding, minimising, mitigating and recovering from impacts are well established (World Summit on Sustainable Development, 2002). Some mining companies, as part of their corporate culture, use environmental management, with external audits, ISO certification, collaboration with environmental groups, and awards for excellence.

In terms of the impacts of mineral extraction on the social environment, industry's capacity to deal with the impacts is limited as social issues, if not new, have only been given enough of attention in recent years. There is not yet enough skill and experience within the industry; the management of social impacts is rarely integrated into how companies do business, and there is insufficient regulatory or legal framework to provide the rules.

The mining industry also has to deal with the remaining aspect of sustainable development – the human development needs of present and future generations. Meeting current needs requires attention to how the risks and benefits of mining are distributed in order to meet the human development needs of today. Meeting future needs calls for the conservation of mineral resources and environmental integrity for the benefit of future generations. There is tension therefore between these two contrasting challenges.

Mining is an essential industrial activity that underpins industrial development. By virtue of its depletion of mineral resources, mining is not sustainable. It is only when industry and government work together to bring long-term development in the area, financed by taxes and royalties from a mining operation that will continue after the project closes can sustainable development be achieved. In addition, if a mine site is managed properly and rehabilitation after decommissioning is in harmony with the local ecosystem, then the cost to environment can be kept at a minimum (Khanna, 2000).

3.5 Legislation

From 1970 onwards South African perspectives on what should be encompassed by environmental legislation have broadened considerably to include economic, political and social perspectives as an integral part of environmental planning and protection. Environmental issues and scientific studies always lead to higher costs; therefore, a balance of interests has to be maintained for healthy production and sustainable development. The *aide-memoire* for Environmental Management Programme Reports (EMPR) states that particulars should be given about the developer's ability to make the necessary provision to implement the measures described in the EMPR, which, once agreed to, are legally binding (Fuggle & Rabie, 1995).

Minerals Act 50 of 1991

An EMP in respect of the surface of land concerned in any prospecting or mining operations shall be submitted by the holder of the prospecting permit or mining authority concerned to the Director of Mineral Development for his approval, and no operations shall commence without such approval from the latter. The Director-General may, pending the approval of the EMP, require that an EIA be carried out in respect of the intended prospecting or mining operations by a professional body designated by the Director-General. Any costs in respect of an EIA shall be borne by the holder of the prospecting permit or mining authorisation (Dalton *et al.*, 1998).

National Environmental Management Act (NEMA) 107 of 1998

Everyone has a right to an environment that is not harmful to his/her health or well being. The state must respect, protect, promote, and fulfil the social, economic and environmental rights of everyone and strive to meet the basic needs of previously disadvantaged communities; inequality in the distribution of wealth and resources, and the resultant poverty, are among the important causes as well as the results of environmentally harmful practices (Dalton, *et al.*, 1998)

Sustainable development requires the integration of social, economic and environmental factors in the planning, implementation and evaluation of decisions to ensure that development serves present and future generations; everyone has a right to have the environment protected, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development (Dalton, *et al.*, 1998). Principles of Integrated Environmental Management (IEM) found in Section 2 of NEMA apply to all prospecting and mining operations. These principles include the polluter pays, consideration of alternatives to select the Best Practical Environmental Option (BPEO), bearing in mind the carrying capacity of resources, precautionary approach and participatory principles of transparency, democracy and environmental awareness and training.

If a certain level of harm to the environment is authorised by law or cannot be reasonably avoided or stopped, such pollution and/or degradation must be minimised and rectified.

National Water Act (NWA) of 1998

Sustainability and equity are identified as central guiding principles in the protection, use, development, conservation, management and control of water resources. These guiding principles recognise the basic human needs of present and future generations, the need to protect water resources, the need to share some water resources with other countries, the need to promote social and economic development through the use of water (Dalton *et al*, 1998).

Regulation 704 of the Water Act of 1998

This regulation relates to the use of water for mining and related activities. It aims to protect water resources; every person in control of a mine must take reasonable measures to prevent water containing waste or any substance which causes or is likely to cause pollution from entering any water resource, either by natural flow or by seepage, and must retain or collect such waste for use, re-use, evaporation or for purification and disposal. The person should also prevent erosion or leaching of materials from any residue deposit/stockpile by providing effective measures to prevent this material from entering and polluting any water resource.

The Waste Discharge Charge System (WDCS)

The WDCS is a framework being developed by DWAF for discharge of waste in water resources to enable effective management of water quality in catchments. It is based on the polluter-pays-principle and its objectives are to:

- Promote the sustainable development and efficient use of water resources.
- Recover the costs of managing water quality.
- Promote internalization of environmental costs by those who impact on the environment.
- Create financial incentives for those who discharge to reduce waste and use water resources in an optimal way.

DWAF recognizes eleven water uses in a catchment:

1. Taking water from a resource
2. Storing water
3. Impeding or diverting the flow of water in a watercourse
4. Engaging in a stream flow reduction activity
5. Engaging in a controlled activity
6. Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit
7. Disposing of waste in a manner which may detrimentally impact on a water resource
8. Disposing in any manner of water which contains waste from, or which has been heated in, any industrial power process
9. Altering the bed, banks, course or characteristics of a watercourse
10. Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for safety of people
11. Using water for recreational purposes

The WDCS will apply to water uses 5, 6, 7, 8, and 10. The system is made up of four tiers (tier 1 to tier 4) – Tier 1 is the basic charge covering the administrative costs of the system; it applies to the water users. Tier 2 is a load-based (load being the product of concentration of pollutant and volume of water) charge imposed on the polluter when s/he exceeds the target concentration for the water resource. The charge will be limited to salinity as TDS (charge ranges from R0.30 to R0.60/kg), total phosphorus (charge between R2.70 to R5.40/kg), ammonium and ammonia (R0.60 to R1.20/kg), and nitrogen oxides (R0.60 to R1.20/kg). Tier 3 apply to the polluter when the maximum allowable resource-directed value (MARDV), the upper limit in in-stream quality applicable to the class according to which the water resource is classified. Tier 4 is charged when toxic or inhibitory levels are reached (DWAF, 2004). Tier 3 and Tier 4 charges will be higher than Tier 2 charges as their purpose is to be a deterrent to the polluter. The system is expected to be deployed in 2007.

Minerals and Petroleum Resources Development Act of 2002

The Minerals and Petroleum Resources Development Act builds up from NEMA; it requires that any prospecting or mining operation be conducted in accordance with generally accepted principles of sustainable development by integrating social, economic and environmental factors in planning and implementation of prospecting and mining projects in order to ensure that exploitation of mineral resources serves present and future generations.

The person extracting a mineral must rehabilitate the environment affected by the prospecting/mining activity to its natural or predetermined state or to a landuse, which is in line with the principles of sustainable development.