EXECUTIVE SUMMARY

Background

Small-scale mining already occurs on a sizeable scale in South Africa, and active measures are being taken by government to promote the development of this sector of the economy. It is realised that the success of this sector depends largely on providing these miners with technical assistance. The Department of Minerals and Energy (DME) has initiated the development of a National Small-Scale Mining Development Framework. This framework will ultimately be available to provide assistance to small-scale miners regarding the necessary regulatory and administrative procedures, reserve determination, business plans and mining methods.

Aims

The aims of the study were to identify and characterize the critical aspects with regard to the water-related impacts of small-scale mining. Once these impacts were identified, the aim was to develop and recommend appropriate strategies to assist small-scale miners in environmental management.

Approach Followed

The methodology that was followed in the course of this project included the following:

- A **literature review** was undertaken.
- **Project meetings** with representatives from the DME and Department of Water Affairs & Forestry (DWAF), as well as meetings between the Water Research Commission (WRC) Steering Committee and the project team were held throughout the study.
- **Stakeholder workshops** were held with regulators, small-scale mining experts and small-scale mining organisations.
- **Initial screening site** visits were undertaken throughout the country.
- Information obtained from the authorities was used to compile an **inventory** of small-scale mines.
- A limited number of sites for in depth regional site surveys were selected based on information gathered during the screening site visits.
- A **survey protocol** was developed for the researchers to use in intensive **regional site surveys**.
- A **questionnaire** was developed to interview small-scale miners and the associated community members.
- The **environmental impacts** observed during the regional survey findings were described.
- A **handbook was produced** that described the water-related impacts of small-scale mining.
- Appropriate **environmental assessment tools and management options** were described and recommended in the final report.

Findings

The 1:100 year flood line was used to delineate the area for which the impact on water quality should be considered. Where possible, both legal and illegal operations were included in the study. Small-scale mining, like the rest of the mining industry, is required to adopt measures that will promote environmental sustainability by means of the application of consistent standards and acceptance of the "polluter pays" concept. All policy principles pertaining to environmental management by larger mines are also applicable to small-scale mining

operations. However, a balance should be maintained between encouraging economic development and preserving high standards of environmental management.

There is no set **definition** of what is meant by a small-scale mine. The definition of small-scale mining varies depending on the purpose for which the term is being used. The working definition used in this study is based on the amount of material moved per annum, on the number of employees and on the level of mechanization:

> A defined **upper limit** (in accordance with the DME) where the mine must not move more than 600 000 tons material/annum (50 000 tons/month) or when the total area disturbed by mining activities is restricted to approximately 10 ha at closure.
>
> All small-scale mining types ranging from artisanal mines to small companies excluding **junior companies** (junior companies = companies employing between 50 and 200 employees). This includes companies who are classified as **micro** (< 5 employees) to **very small** (<20 employees) to **small** (<50 employees).

The **level of mechanisation** will also be used where **micro-scale** mining refers to artisanal mining that involves no mechanisation and whose prime motivation is subsistence; **medium-scale** small-scale mining where mining is not subsistence orientated and involves mechanisation on a limited scale (one truck, one front-end loader and a mechanical pan/washer); to **large-scale** small-scale mining that is not subsistence oriented and involves the use of extensive mechanical equipment (several trucks, front-end loaders and mechanical equipment for the processing of ore).

The **mining types** that were considered to be part of the study and that are known to have the greatest impact on the water environment were identified through consultation with national representatives of the DME and DWAF. The types of mining identified include diamond diggings, sand-winning (dry-pit mining, wet pit mining, bar skimming and mining of pits on adjacent floodplains or river terraces), coal mining, gold mining/panning and alluvial gold deposits, clay mining and peat extraction. Due to other parallel initiatives in the peat industry; slate mining being described as large scale; and coal mining being defined as having a large environmental impact irrespective of mine size; these forms of mining were not included in this study.

In southern Africa, the most important environmental impacts caused by small-scale miners appear to be related to:

- Accelerated erosion of areas adjacent to workings that have been de-vegetated for construction materials or fuel wood leads to increased suspended sediment loads in nearby streams and rivers.
- Excavation of flood terraces and riverbanks increases the instability of these riverbanks and enhances the likelihood of increased flood scouring.
- Alteration of river channels and flows due to mining of alluvial deposits in the river bed.
- Excavation of river sediments exposes these sediments to oxidising conditions and enhances the solubility and release of any metal ions that may previously have been previously trapped as insoluble sulphides.
- Acid mine drainage and associated water quality problems in receiving waters.
- Gold panning and operation of sluice boxes increases loads of suspended sediments in downstream reaches.
- Wash-off of mercury used to concentrate gold leads to increased risks of mercury toxicity to aquatic and terrestrial organisms, as well as to the miners.

- Wind-blown dusts from unprotected tailings and waste rock dumps enter aquatic environment.

Three different regions were identified during initial site visits for **regional site surveys**. These regions include sand-winning sites in the Umbogintwini and Umgeni Rivers near Durban in KwaZulu-Natal; diamond diggings along the Vaal River near Kimberley and Windsorton in the Northern Cape Province; and sand-winning sites along the Krokodilspruit and Boekenhoutkloofspruit north of Pretoria.

The impacts observed during the regional site visits indicate that sand-winning and gravel extraction operations impact primarily on the instream habitat and on the riparian habitat. Specific impacts on the instream habitats that were observed include:

- Riverbed degradation, *e.g.* diamond-digging along Vaal River.
- An increase in suspended sediment, *e.g.* diamond-diggings at Amendelshoogte and the sand-winning operations along the Krokodilspruit River.
- Changes in morphology and in hydraulics of river channel, *e.g.* Vaal River.
- Destruction of spawning habitat of fish and macro-invertebrates, *e.g.* Umgeni and Umbogintwini Rivers where sand-winning takes place close to the river mouth.

Impacts on the riparian habitat that were observed during the regional visits include:

- Destruction of the *riparian zone* (stream banks, riparian vegetation and vegetative cover) - this phenomenon was observed where gravel diggings and sand-wining operations were present along the banks of the Vaal River in Windsorton, the Umbogintwini and Umgeni Rivers in KwaZulu-Natal and the Krokodilspruit River in Gauteng. Destruction of this zone leads to stream bank destabilisation and this leads to increases in erosion, stream temperatures and sediment input.
- Reduced vegetative bank cover – this is caused by undercut banks that may be removed during sand/gravel extraction, resulting in reduced shading and increased water temperatures.

Singly, many of the effects of small- scale mining on the water environment may well be insignificant. However, when they occur simultaneously, their significance may increase by orders of magnitude. The overriding principle is that the greater the number of small-scale mines in an area, the greater the cumulative impacts are on the water environment. The major cumulative impacts observed during the regional site visits include:

- Loss of riparian habitat due to large areas of riparian vegetation being removed.
- Riverbank destabilisation after vegetation removed.
- Soil erosion of arable land adjacent to mined areas.
- Increased surface areas of discard (sand, rock and other forms of waste) that can be mobilised during rain and ultimately are deposited in the rivers.
- Increased mobilisation of sediments, which become available and clog the aquatic environment.
- Increased incidents of oils (from machinery) and chemical (if refinement takes place) spills into rivers.
- Increased potential of mobilization of metals, sulphates, acid mine drainage and other possible toxicants (such as arsenic).
- Loss of arable land due to lack of rehabilitation.
- Large tracts of land becoming a safety hazard (for people and livestock).

The duration of these impacts are mainly long term. For example, many areas along the Vaal and Orange Rivers were mined a century ago and the environmental footprints are still

prevalent. Unless appropriate rehabilitation takes place in areas that are on the riverbanks, the land largely remains unusable unless the area is naturally restored by for example, floods. The mining that takes place within the riverbed or flood plain has more chance of being restored back its original status over time due to floods.

During the regional site visits, structured interviews were conducted with small-scale miners and local communities near Kimberley (Longlands, Barkley West and Windsorton), Wolmaransstad, Cullinan and Durban (Vukani informal settlement next to the Umgeni River and Izimbokodweni settlement next to the Umbogintwini River).

The results of the questionnaire were varied but the following are the most important findings:

- the communities living in close proximity to small-scale mining operations were aware of issues such as rehabilitation and the environmental impacts associated with mining activities.
- mining was seen as a viable form of a living
- environmental issues and impacts were largely ignored by the miners
- the required mining documentation, such as EMPR's, were seen as a license to mine only and were largely not consulted any further (for example for rehabilitation and closure)
- the local communities would prefer to become employed in the mining sector rather than become employed in the rehabilitation of small-scale mines.
- the regulators had difficulty in visiting, least of all regulating, the vast number of small-scale mining operations.
- the regulators concentrated on the more formal larger scale mining operations.

The environmental assessment approach used in the current study included the application of three habitat assessment indices to each site – habitat assessment matrix (HAM), habitat quality index (HQI) and the Intermediate Habitat Integrity Assessment (IHIA). These indices are recommended by DWAF's Resource Directed Measures (RDM) office and are standard indices used by the River Health Programme. These indices evaluate each mining site on a numerical scale so that results are readily comparable.

Participation by interested and affected parties was vital in assisting the project team with the design, planning and implementation of a handbook to be used by miners to assist them in responsible mining. It was necessary to ensure that any decisions regarding content took into account the needs, interests, and values of the community, mining sector, regulators, *etc*. A stakeholder workshop was convened with the aim being to discuss possible education, implementation strategies and to engage in an understanding of the water-related issues of small-scale mining. The following groups were invited to this workshop:

> Authorities, Small-scale mining associations, Sedibeng and Bakakga Mining, South African Women in Mining (SAWIMA), Minerals and Energy Policy Centre (MEPC), GEMS, Chamber of Mines, CSIR –(Environmintek and Miningtek), De Beers, University Mining Departments (University of Witwatersrand and Venda) and the WRC steering committee members.

Based on the research that was undertaken during this study and on the input gained from the **stakeholder workshop**, management issues relating to small-scale mining were identified. The stakeholder workshop also allowed delegates to give new input on the content and structure of a **handbook** that was produced to assist small-scale miners to mine responsibly. The title of this handbook is "Environmentally responsible mining: Water management guidelines for small-scale mining."

The challenge in environmentally managing small-scale mining is to develop appropriate **implementation strategies and environmental management systems**. These strategies must be relevant, understandable, and affordable to the small-scale miner and should aim at maintaining a balance between encouraging economic development and preserving high standards of environmental management. Various strategies for managing the water-related impacts caused by small-scale mining were identified during this study. These strategies include:

- Improved and harmonized legislation
- Governmental structure and mining laws
- Education and training
- Capacity building
- Collaboration forum and co-ordination
- Working for rehabilitation
- Technical support and appropriate technology
- Best practice guidelines
- Improved stakeholder participation in decision-making
- Environmental management systems.

In order to determine the water-related impacts of small-scale mines, the following environmental assessment tools and processes are recommended:

- The small-scale miners are trained to mine in an environmental responsible manner, especially those that are applying to mine for the first time
- The legislative requirements are made more accessible and understandable prospective small-scale miners
- The water quality impacts of small-scale miners are monitored on a regional (large scale) rather than on an individual mine basis

Recommendations

The **development and success** of small-scale mining projects in South Africa is presently limited by problems associated with access to mineral rights, access to finance, a lack of appropriate structures that assist small-scale mining development, operations that are located far from major markets and lack of management, marketing and technical skills. New small-scale mine operators face technical barriers to participate in mining, including lack of skills in dealing with aspects such as complex metallurgical processes, practical mining problems and business skills. The small-scale mining sub-sector can currently offer little security, such as security of tenure. Formalization of the sub-sector and appropriate policy frameworks would mobilize small-scale mining associations.

The challenge in environmentally managing small-scale mining is to develop appropriate **implementation strategies and environmental management systems**. These strategies must be relevant, understandable, and affordable to the small-scale miner and should aim at maintaining a balance between encouraging economic development and preserving high standards of environmental management. Various strategies for managing the water-related impacts caused by small-scale mining were identified during this study.

It is very important that small-scale miners become more environmentally friendly as the results can impact both the environmental and our health and make it difficult for people nearby to get clean and safe water.

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