ISCOR
flat steel

ISCOR VANDERBIJLPARK STEEL

ENVIRONMENTAL MASTER PLAN

SUMMARY REPORT

SERIES I
DOCUMENT IVS/MP/001
JANUARY 2003

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Draft for discussion
CONFIDENTIAL
Research for IVS

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ENVIRONMENTAL MASTER PLAN

SUMMARY REPORT

EXECUTIVE SUMMARY

The Environmental Master Plan (MP) development was initiated during July 2000 and the study was conducted over a period of 30 months and completed during December 2002.

Clear project objectives, deliverables and a strategic approach were formulated at the outset of the Master Plan study to ensure that the overarching objective of the study was met, namely:

To structure, develop and implement a holistic and integrated Environmental Management Plan for the Works.

The purpose of the Summary Document is to summarise and give an overview of the production processes and activities at the IVS Works, the study findings, main impacts and risks.

The Master Plan development process further unfolded into a prioritisation process, consideration of alternative mitigatory measures and options. The preferred options were conceptualised and costed, and a scheduled implementation and action plan was developed in an integrated manner to reduce the risk profile and to motivate the enhancement of continuous improvement.

The Summary Report concluded with the emphasis on recommended mitigation measures, the need for the implementation of the high-ranking environmental projects, and communication of the MP findings to the stakeholders.

IVS

ENVIRONMENTAL MASTER PLAN
SUMMARY REPORT

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ISCOR VANDERBIJLPARK STEEL

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SUMMARY REPORT

1. PROJECT OVERVIEW

Iscor Ltd is an industrial group involved in the production of steel products at various plants throughout South Africa.

The Vanderbijlpark Works was established in 1943 and specialises in the production of flat steel products from primary raw materials.

The management of Iscor Vanderbijlpark Steel (IVS) initiated the development of an Environmental Master Plan (MP) during 2000. The study was conducted over a period of 30 months, with a start date of July 2000 and a completion date of December 2002.

The Environmental Master Plan forms part of a sustainable continuous improvement programme addressing the Safety, Health and Environmental Management of the company.

The purpose of the Summary Document is to summarise the MP process and to give an outline and broad overview of the study findings and means of implementing the Master Plan.

2. PROJECT OBJECTIVES, DELIVERABLES, METHODOLOGY AND APPROACH

2.1 Strategic Framework

A strategic framework was drawn-up for the development of the MP. The MP process was developed within a well-defined strategic framework and the key process steps and cornerstones can be summarised as follows:

Initially a gap analysis and terms of reference (TOR) were conducted. These were then rolled over into the baseline study phase and status quo, risk and impact stage. With clearly defined objectives being set, alternative measures and options had to be considered and communicated to key stakeholders. The preferred options will be taken a step further through a confirmation step of the legal, technical feasibility, authorisations and implementation.

The strategic approach in developing the MP for IVS is in line with similar international processes, such as the United States Environmental Protection Agency (USEPA) corrective action approach for large industrial complexes. It also complies with the overarching environmental strategic policy framework of South African legislation and associated guidelines.

2.2 Project Objectives

A project team of specialists was appointed under the leadership of Dr Ockie Fourie to develop the MP, to address inter alia:

- Documentation of the environmental status quo;
- Identification and quantification of all environmental impacts and risks;
- Development of options for the improvement of the risk profile;
- Collation of an integrated plan of action;
- An integrated Environmental Monitoring System.

2.3 Deliverables

The most important deliverables of the study were to document the study findings, to produce alternative solutions and concepts in an integrated manner; and to generate a prioritised and costed plan of action.

The information generated during the MP development should be sufficient to support authorisation processes and information sharing with stakeholders.

The particular deliverables were:

- Documentation of the environmental status quo;
- Description of the main impacts and risks;
- Identification and evaluation of feasible options and one preferred option;
- Generation of integrated plans for the implementation of measures and the associated initiation of authorisation processes.

2.4 Benefits of the Master Plan

The MP study work added value to the overall IVS environmental management in terms of quantification of the impacts, risks and the formulation of mitigation actions and risk management measures. The implementation of mitigative measures will result in the minimisation of risks and impacts to an acceptable level.

The proposed integrated plan addressed, evaluated and confirmed the benefits to be reaped from the suggested actions, as being:

- Progressing towards Zero Effluent Discharge (ZED);
- Continuous improvement of the air quality emissions by implementation of the coke and gas cleaning project and Sinter Plant upgrades;
- Upgrade and rehabilitation of the existing residue management facilities, waste minimisation and the development of new residue management facilities and associated pollution control measures;
- Formulation of an overall framework to initiate and align the authorisation processes with the implementation of environmental management measures.

2.5 Study area and Disciplines

The study area was defined as the total Works area of the IVS plant, including:

- The main Works area (South and North);
- The residue management facilities (solid, sludges and liquids);
- Support and service related activities within the Works perimeter fence;
- Potentially impacted areas outside the works perimeter

The environmental disciplines which were addressed include:

- Residue characterisation (solids, sediments and leachates)
- Soil profiles
- Geology and ground water
- Surface water
- Process effluents
- Air quality
- Terrestrial and aquatic eco-systems
- Noise
- Visual
- Archaeology and cultural interest
- Public consultation
- Regulatory requirements
- Socio-economics
- Geotechnical, land capability and land-use

2.6 Project Team

The key members of the project team consisted of:

Organisation	Responsible Person	Task
Ockie Fourie Toxicologists	Dr H O Fourie	Project management Toxicology of residues Soils
Francois Marais & Associates	Mr F Marais	Project co-ordination Noise Visuals Archaeology & cultural interest
Van Renssen& Fortuin	Mr C van Renssen	Surface water Infrastructure design Geotechnical Land use / Land capability
Jasper Müller Associates	Mr J Müller	Geology Geohydrology Fauna & flora Aquatic eco-systems Environmental Monitoring System

Organisation	Responsible Person	Task
Richard Paxton & Associates	Dr R Paxton	Process effluents Water treatment
Enpro	Dr N Boegman	Air
Ken Smith Environmentalists	Mr K Smith	Public participation
Moolman Attorneys	Mr A Moolman Mr M Vermaak	Enviro-legal Regulatory processes

Further specialists were appointed to address disciplines as required, including noise, visuals, archaeological and cultural interest, and socio-economics.

Special acknowledgement is to be given to the late Mr Moolman, who passed away during August 2002, for his valued input during the MP study.

2.7 Methodology and Approach

The methodology and approach adopted by the Project Team was characterised by the implementation of a **holistic integrated management style**, which concentrated on technologies / measures to bring about pollution prevention.

Against this background it must be kept in mind that IVS started operations during the "technical explosion" era during which inadequately considered production practices were the order of the day. In the mean time, various laws and regulations addressing health, safety and the environment were developed, as well as improved industrial and manufacturing technologies.

The MP, in line with these developments, advocated on-going evaluation, replacement and refurbishing of equipment at IVS in an effort to adhere to current environmental criteria as well as the MP objectives.

- **The environmental status quo**

Three main sub-study areas were delineated where baseline studies were conducted, namely:

- Zones within the IVS Works area;
- Zones in the receiving environment beyond the IVS perimeter;
- The larger study area (Vaal River in the South up to the residential areas North of the Works area, including the confluence of the Leeuwspruit into the Vaal River in the East and the confluence of the Rietkuil Spruit in the West).

The IVS Works area was divided into 42 units, which were then consolidated into logical, geographical and operable zones (Master Plan zones termed environmental management areas.) These were sub-divided into environmental management areas within the Works perimeter (6 areas) and environmental management areas outside the Works perimeter (4 areas).

The term baseline studies (investigations) is described as the process of information-gathering in terms of impacts and risks to human health, the environment and regulatory requirements. A risk comprises the possible transgression of acceptable risk levels and safety measures as contained in the regulatory guidelines, processes and literature; while an impact is characterised by causing a disturbance to the normal course of the environment and everyone in it.

- **Impacts and risks**

Baseline studies were performed, implementing a risk-based approach. That is, the key specialist environmental components were quantitatively investigated by implementing a source, pathway and receptor description method. Synergies were developed by identifying and quantifying cumulative and overlapping impacts.

Each environmental management area was sub-divided into sub-zones to capture potential environmental impacts. The division accommodates the diversity of activities performed in the MP zone, as well as the complexity of the geographical locations of the waste and waste water facilities..

- **Identification of alternatives**

The baseline studies lead to identification and quantification of potential environmental impacts and risks, thus enabling the project team to list possible mitigation measures to address them. Subsequently, a process of comparison and evaluation deducted the preferred alternative(s), e.g.

- Baseline studies were performed on the 10 identified environmental management areas;
- Impact / risk assessments were performed per management area;
- Primary objectives as well as site- and area-specific management objectives were determined;
- Alternatives were listed and first order evaluation was done;
- A suggested preferred and most likely alternative was determined by comparison and evaluation of alternatives;

Technical, environmental, economic and regulatory criteria were considered for each environmental management area so as to develop alternative mitigatory measures. These measures manage impacts and reduce risks in compliance with acceptable risk levels per area and discipline.

The possible future development of these impacts, as well as the risks these impacts might pose on human health and the environment, were also taken into account. This resulted in the development of options to **improve** the risk profile per environmental management area.

Alternatives for the following processes were considered:

- Residue management;
- Process-water management;
- Air quality management;
- Ground and surface water management systems;
- Environmental management per discipline / environmental component for each environmental management area.

The suggested alternatives are subject to detailed technical, environmental and economic assessments to confirm the preferred option.

By considering the alternatives during the MP integration process, the preferred environmental management option for each Environmental Management area was identified. Cost estimates reflecting a cost profile for implementation, as well as a timeframe for implementation, was compiled accordingly.

- **Development of the integrated plan**

A prioritisation process was done according to risks, impacts and Environmental Management areas relating to the specific activities causing these risks and impacts. The results derived from considering the alternatives, together with the alignment of the MP with regulatory requirements and prioritisation of suggested measures, were all taken into account.

This resulted in the development of an implementation strategy, which in turn required the compilation of cost estimates for the preferred option coupled to an accompanying timeframe.

The MP study outcome and implementation strategy were divided into two components, namely:

- The **feasibility study requirements** dealing with technical cost and benefit analyses as well as conceptual designs; and
- **Official permitting** and authorisation processes, dealing with feasibility studies as prescribed by the regulator, which include the consideration of alternatives and consultation with stakeholders as regulatory requirements.

From these two components, a confirmation step of the preferred alternative should be derived, leading to:

- Authorisation and permitting;
- Detailed design; and
- Implementation and construction.

It is envisaged that the consideration of alternatives might be re-visited during the detailed feasibility study phase and the formal permitting and authorisation processes.

- **Environmental Monitoring Systems**

During the MP investigations, a large number of monitoring equipment units, at various points in the study area, were commissioned for investigative monitoring purposes. This infrastructure was retained for ongoing environmental monitoring purposes. The monitoring infrastructure is supplemented by a computerized data base system, which supports interactive information generation through GIS application.

Effective environmental monitoring forms the backbone of integrated environmental management. In order to ensure effective monitoring, the entire environmental monitoring system was formally documented in an Environmental Monitoring System Manual.

The environmental monitoring system is a dynamic entity and it will require ongoing maintenance and optimisation as activities on the site change.

A report is being compiled to reflect the environmental status at IVS using all measurable component data generated up until December 2002.

- **Benchmarks**

Local legislative requirements and applicable guidelines were used throughout the MP study as reference material in terms of benchmark standards. However, the results of the study findings were compared with accredited national and international organisations including amongst others, the US Environmental Protection Agency, World Health Organisation and the South African and European Bureau of Standards.

2.8 Steering Committee

A Steering Committee was established to guide the progress of the study and to facilitate liaison with the Works. The committee consisted of the study team and the following staff members of Vanderbijlpark Steel:

Mr B van der Merwe
Mr P van den Bon
Mr F Bezuidenhout

2.9 Interaction with the authorities

To ensure that the study did not proceed in isolation, a Consultation Committee was also created, consisting of the Steering Committee and representatives from DWAF, DEAT and GDACEL.

3. OVERVIEW OF THE WORKS AND MAIN RESIDUE SOURCES

3.1 Production Processes

The Iscor Vanderbijlpark Steel (IVS) works is a conventional steel plant, which has been extensively modernised and expanded since its establishment in the mid-1940s.

In more detail, fine iron ore is sintered as a feed to blast furnaces, together with coarse ore, coke and minor additives. The coking of coal also produces tar and other organic products, fuel, gas, ammonia and hydrogen sulphide. The blast furnace liquid iron is refined in basic oxygen furnaces to steel which is cast into continuous slab.

A further quantity of fine iron ore is pre-reduced with coal in rotary kilns as in mini plants. This is melted down in arc furnaces together with scrap steel, refined and cast into slabs. The steel slabs are milled to sheet, cleaned, etched and coated by tinning, painting or electrical or hot dip galvanising.

A number of secondary activities, required to support the main steel making and finishing, or to work up by-products and other residues, are also conducted on the site. These include:

- Storing and blending of raw materials
- Temporary holding of intermediate materials for reuse or sale
- Handling and treatment of liquid effluents
- Handling of solid residues
- Work-up of organic and inorganic components of coking
- Steam generation
- Excess gas flaring
- Gas storage
- Oxygen production
- Mould foundry
- Scrap metal recovery
- Pickle liquor recovery
- Ferrite production
- Paint blending
- Maintenance engineering

3.2 Consolidated Plant Area (CPA) residue sources.

This area covers most of the production activities listed above that give rise to practically all the residues in the form of solid waste, liquid effluents and air emissions.

The main solid residue comprises the slags from the smelting and refining activities. Most of the blast furnace slag is sold to the cement industry.

The arc furnace slag is re-used in the sinter, while the slag from the oxygen furnaces is disposed of in the Consolidated Residue Management Facility (CRMF) area after scrap steel recovery.

Dusts and fumes are collected by bag filtration at numerous points within the CPA, particularly at the direct reduction, sinter, blast furnaces, arc furnaces, desulphurisation area and basic oxygen furnaces. Where the particulates can-not be reused in that process or in another operation, they are deposited in the CRMF. Sludges from scrubbers, notably at the blast furnaces, also report to the CRMF. The basic oxygen furnace scrubber sludge is dried in the CRMF and then returned to the sinter feed.

Effluents arise at the coke ovens and its associated operations, the blast furnaces and the basic oxygen furnaces as part of gas cleaning. Minor effluent streams also arise at the various coating operations or as floor wash-down. These effluents are routed to either the Central Effluent Treatment Plant (CETP), the Terminal Effluent Treatment Plant (TETP), the Biological Treatment Plant, and to coke quenching. Alternatively they are stored in one of the holding dams in the CRMF area for evaporation.

The storm water system for the CPA has already been partially separated from the effluent streams and drains by canals either to the TETP for the southern part, or to the Leeuwspruit impoundment for the northern plant, for quality assessment prior to release.

Most of the sources of air pollution are fitted with abatement equipment, and the residual emissions have been quantified and assessed for environmental impact and risk. The two notable exceptions are the coke oven gas work-up where the installed abatement equipment has reached the end of it's useful life and is technologically outdated, and the sinter plant main stack where it was found impossible to operate the installed gravel bed filters. Major projects are underway to install new abatement equipment.

3.3 Consolidated Residue Management Facility Area (CRMF)

Essentially this area is used to deposit solid residue, to contain watery effluent in holding dams and to temporarily place raw materials and intermediates for later reuse or sale. Also included are the blending of raw materials, sludge ponds and the CETP.

The present solid materials residue dump has grown over the years, and is at present being shaped with a view to capping and closure. Contaminated surface water run-off is being impounded and stored in the effluent dams. Ground water contamination has been found and delineated. The effluent impoundment dams also have ground water contamination plumes.

The limited surface water run-off from the raw material storage and blending beds is impounded and routed to the TETP for treatment and release. The same applies to the intermediate product storage areas.

A number of sludge ponds exist within the CRMF area, including those for the CETP and the previously used blast furnace sludge.

Very little dust originated from the solid residue dump during 2001 as confirmed by monitoring. During the second half of 2002 the dump shaping did increase the dust generation and this was recorded quantitatively. The placement of new residues, particularly from the operation of the sinter mixing bed, creates some dust.

3.4 Residue minimisation

The formation of residue, be it solid, liquid or dispersed in the atmosphere (as gases or fine particulates) is to a greater or lesser degree inevitable in any production process.

In the case of steel making, the residue would consist mainly of smelting and refining slags; material handling dusts; scrubbing sludges (to keep the atmosphere clean); various process effluents; gases and particulates, (of which parts are collected and disposed of as solids).

Minimisation of residues may be affected essentially in two ways. Firstly by using raw materials with lower levels of impurities. For instance low ash low sulphur coal, and high purity iron ore. The scope for this approach is limited by available and economic viability within the total production cost structure. IVS has no choice but to use the locally available high ash medium sulphur coal. A further example is the raw water supply. The present Vaal Barrage water is of such poor quality that after two or three passes through a cooling tower it has to be purged as effluent. Vaal Dam water is of better quality and will produce less effluent as it can be circulated for longer, but is not freely available.

The second possibility is by adjusting or changing the process. The opportunities are limited by the constraints of installed equipment, production rate requirements and operational feasibility. An example of potential reduction of residue formation would be the judicious use of oxygen in the steel refining process, achieving maximum impurity reduction with a minimum use of oxygen and therefore fume formation. This is however time consuming and uneconomical utilisation of installed productive capacity beyond a certain point. A further example would be to feed changes to the blast furnaces to reduce the number of slips and thus the uncontrolled fume and gas emissions to atmosphere.

3.5 IVS Materials Balance (Approximate figures)

Other than raw water intake at about 7 kiloliter per ton of steel produced, the annual raw materials intake includes 4,4 million tons of iron ore, 2,5 million tons of coal and 0,4 million tons of additives like lime, dolomite, fluxing agents, alloys and other minor components. From this, 3,0 million tons of cast steel slab is produced. This leaves 4,3 million tons of input materials as by-products and residues.

About 30% of the iron ore mass is oxygen which combines with carbon from the coal to form 2,3 million tons of carbon monoxide. This eventually burns as fuel gas to 3,6 million tons of carbon dioxide. The remaining coal and anthracite also burn to 3,6 million tons of carbon dioxide. The combustion of the coal further produces about 1,1 million tons of water.

The IVS operations produce approximately 2,2 million tons per year of solid residue. Of this, 16% is reused immediately; 1% is stored for later use and 33% is sold, giving a 52% utilisation level. The remaining 48% has to be disposed of in a residue facility on site.

This approximately 1,1 million tons consists of 44% dusts and fumes; 3% sludge from the air pollution abatement installations; 53% slag, mainly from the basic oxygen furnaces. Approximately 1 800 tons per year of mainly desalination and electrolytic sludges and gas line deposits are disposed of at the Wastech site at Holfontein.

Projects in the investigative stage to further minimize disposal include:

- Application of BOF slag for agricultural lime
- Recycling of various dusts and sludges to sinter plant
- Application of DR – dusts/Dolochar in cement kilns and boilers
- Application of various dusts in brick manufacturing

The watery effluents contain soluble compounds leached from the solid residue and other imported impurities. Thus the 21 million kiloliters of raw water used annually, at an average total of dissolved solids of 350 parts per million, would contribute 7 350 tons salt load per year to the IVS residue load.

4. BASELINE STUDY AREA, FINDINGS AND MAIN IMPACTS

4.1 Baseline study area

The baseline studies for the MP were concentrated within the IVS plant area, with particular emphasis on the areas where solid, liquid or gaseous residue, originates or is impounded. The secondary study's emphasis was on the plant site perimeter. Here any contamination transgression would identify potential impacts outside the plant operational area. In addition, certain areas surrounding the plant were studied, particularly along the water courses emanating from the site, where impacts on the eco-system could best be identified.

The larger study area extended along the Leeuwspruit and the Rietkuilspruit/Rietspruit up to their confluences with the Vaal River. It also extended towards the East, North and West for as far as impacts could be expected. The study areas were to some degree defined by the specific discipline.

Thus, the noise survey and visual aspects were undertaken along the site perimeter because that is what is relevant. By contrast, the sampling for soil, waste streams and impoundments could only be done at their fixed origins.

Geological evaluations, on the other hand, have to cover a larger area in order to be of value. In the case of air pollution, a survey of the sources is confined to the site. The assessment of potential impacts must be based on the modelled results of ambient concentrations outside the site perimeter.

4.2 Key findings of the Baseline Studies

A major **geological** fault transects the Northern part of the site with a horizontal displacement of about 2 kilometres. The entire study area is underlain by geological formations belonging to the Transvaal System. Whereas most of the Western part of the study area is underlain by Silverton Shale, the Northeastern part of the IVS site is underlain by a succession of quartzite, lava, and shale, with dolomite further to the East. Several of these geological contacts occur within the IVS perimeter, whilst both a regional dolerite dyke and a regional fault, cut through the IVS site. The geological contacts, the fault and the dyke all represent potential geological "fatal flaws" with respect to the development of waste management facilities. However, areas underlain by the Silverton Shale are more suitable for the development of such facilities.

Concerning **ground water**, four aquifer types occur in the study area. Surficial Perched Aquifers, with limited lateral continuity, are developed within the soil horizon, in depths varying between 2 *m* to 5 *m* below surface. These aquifers are insignificant from a water supply perspective. However, they do play a role in ground water contaminant migration, in close proximity to surface infiltration sources. In the study area, their saturation status varied between fully saturated close to the infiltration sources to unsaturated, further away from these sources.

Shallow weathered zone aquifers are developed within the weathering profile of all the geological formations. They have lateral continuation over significant distances and vary in thickness between 5 *m* to 35 *m* below surface. These aquifers possess water-bearing characteristics of significant magnitude. They support a wide range of water use applications in the area, including domestic and small agricultural applications. They are, however, classified as minor aquifer systems, with a moderate vulnerability and a medium susceptibility. These aquifers represent the main conduits for ground water contaminant migration of surface induced contaminants on the IVS property, to areas beyond the IVS perimeter. They have hydraulic continuity with the surface streams in the area and contribute significant volumes to stream base flow.

Ground water flow is from the centre of the IVS site towards and across the Western and Eastern boundaries of the IVS site (water divide running north/south on site), parallel to the northern boundary, and from the south, across the southern boundary, into the IVS site. Flow velocities generally vary between 1 *m/year* to 10 *m/year*.

Deeper fractured aquifers are associated with the regional dolerite dyke contact zones, as well as the fault zone in the area. Although both the dyke contacts and the fault zone were verified to possess enhanced hydraulic attributes, they do not represent the preferential flow zones under natural conditions of ground water flow. However, should external stresses such as pumping be applied, these aquifers will represent preferential ground water flow paths.

Alluvial aquifers are developed along the streambeds in the area. However, they are limited in both lateral extent and depth, and are not believed to play any significant role in contaminant migration related to the IVS sources of ground water pollution.

The pristine **ground water** quality in all four aquifer types is good. However, elevated concentrations of metals such as Fe and Mn will occur as a result of the aquifer host rock geochemical composition.

Meteorological data as part of the **surface water** investigations was evaluated and an assessment was made of the environment prior to the Works' construction. The IVS site is situated on high topography, and on a local watershed, which divides the site into Eastern and Western catchment areas. To the West surface water drains into the Rietkuilspruit which discharges into the Rietspruit, in turn the Rietspruit discharges into the Vaal River at the Loch Vaal upstream of the Vaal Barrage. The Eastern catchment drains towards the Leeuwspruit, which drains directly into the Vaal River east of Vanderbijlpark. The Works obtains its water for process purposes from one of two sources, namely the Vaal Dam situated upstream in the catchment of the Vaal River, and the Vaal River itself to the South of Vanderbijlpark. The Vaal Dam water qualities are relatively good, while water obtained from the Vaal River varies in quality over time, but is generally poor.

Only two surface water outlet points exist on the site. Water from the site is predominantly discharged through the Rietspruit Canal to the Rietkuilspruit in the West. During dry weather, flows from the eastern catchment of the IVS site are captured and pumped back to process or towards the western discharge point. This means that treated effluent is only discharged towards the West. During wet weather conditions, discharges to the Eastern Leeuwspruit catchment do occur (peak rain events).

Most of the North Works surface water runoff is discharged towards the East, while the South Works storm water channels predominantly drain towards the West.

During the MP study, a mind shift was made on the handling of process **effluent streams.** This entails changing from end of pipe thinking, to handling at source or re-routing for further utilisation. In addition, numerous effluent streams ended up in the storm water drains, making proper handling impossible.

The effluent and storm water systems are now being **separated**, so that uncontaminated storm water can be checked for quality and then released. At the same time, effluent handling is being integrated and routed for re-use in other operations on site. The objective is to **reduce raw water intake**. Meanwhile Dam 10 has been emptied and water is being drawn from the maturation dams and treated for re-use.

The **Coke Oven Gas Cleaning** project provides an example of what is aimed at. A **halving** of the gas cleaning **effluent** volume is envisaged, and this effluent will be used as is within the blast furnace gas cleaning system. It will then go to the sinter plant gas scrubbing. In addition, the effluent used for coke quenching will be stripped of organic material and ammonia, with **major benefits** for air pollution and coke quality.

No unacceptable organic contamination was found in thirty-one **soil** samples within the plant perimeter. However, some of the samples displayed theoretically unacceptable inorganic contamination for both man and the environment.

Twenty-eight **waste streams** (mainly slags, sludges and dusts/fumes) were characterised for organic and inorganic content and contaminant mobilities. Twelve streams could be classified as delisted G material. The others would have to be inerted before they could be disposed of as a G material.

All evaporation and holding dams were sampled extensively for liquids and sediments and analysed for inorganic and organic content. Generally the water presented limited risk, while the sediments displayed a potentially unacceptable risk to man and the environment.

Ambient concentrations of sulphur dioxide and fine particulates are within the RSA standards/guidelines, but with little margin of safety. These results are based on an extensive **air pollution** emission inventory and a recognised air pollution dispersion model, validated by a year of actual monitoring on site. At times the hydrogen sulphide concentrations exceed the guidelines in the industrial area South of the Western part of the CPA.

Dust fallout at some of the thirty-six monitors, located in areas of intense activity displayed heavy deposition rates, however, the results along the site perimeter were within the guidelines for residential land use.

Compliance with point source statutory air pollution emission limits are monitored continuously and corrective steps are taken when equipment malfunctions.

The **terrestrial ecology** of the greater study area represents disturbed conditions, not only as a result of the IVS industrial activities, but also due to the wide range of agricultural activities (small holdings, farms and informal agriculture); residential developments (formal and informal); and other industrial activities (light and services industries). Despite being disturbed, a wide variety of **plant species** are still present, although a number of exotic and invader plant species were observed.

No endangered or rare plant species were surveyed or are expected to occur in the area. As a result of the development in the area, habitat for, and migration of, larger **animal species** are severely restricted. However, small mammals, rodents and reptiles are abundant in the area. No endangered species were found.

All the streams surveyed (Leeuwspruit up to Vaal River, Rietkuilspruit up to Rietspruit and Rietspruit up to Vaal River), are significantly impacted. However, it should be stated right at the outset that a host of contributors to the situation exist in the study area and beyond. Impacts from agricultural activities; informal settlements; formal residential areas; light industry; sewerage works; heavy industry; and mining all contribute to the existing impacted situation. Impacts identified include water abstraction; flow modification; bed modification; channel modification; inundation; indigenous vegetation removal; solid waste disposal; bank erosion; water quality impairment; and exotic vegetation encroachment.

As a result, it is deemed prudent that the management of the **aquatic ecosystem** be done on CMA (Catchment Management Agency) level. Measures to manage the aquatic ecosystems in the area have therefore not been included in the IVS MP.

Although raised **noise** levels were measured along the southern site perimeter, the Industrial Districts criteria are at present met along the whole perimeter.

The IVS plant infrastructure (more specifically the CPA area) has man-made features, which have significantly altered the natural appearance of the landscape. This has contributed to a conspicuous man-made skyline in this part of the Highveld. This is **visible** from national and other major roads passing the IVS Works, as well as from neighbouring residential areas.

The properties of the soil profile as required for the construction of certain infrastructures such as pollution control dams were investigated. Specific areas targeted for investigation included:

- Existing waste site;
- Area opposite TETP – to facilitate construction of future holding dams;
- Footprint of proposed new waste site (Dam 11 area);
- Existing Dam 10 and Dams 1 – 4;
- North-western and South-eastern perimeter areas to install sub-soil drainage systems;
- Cyferpan and farmlands west of the Works with a view to obtaining suitable rehabilitation material for IVS.

To ensure effective mitigatory measures and the construction of infrastructure, it is necessary to adhere to the recommendations from the geotechnical investigations

The **land-use** activities in the larger study area vary from **residential** (mainly in the South, North and East) to **industrial** (secondary industries, mainly to the South) and **agriculture** (mainly to the West of the Works).

IVS is situated within an industrial type 2 area, which permits industrial activity including the disposal of resultant residue.

The bulk of the IVS infrastructure was established and constructed during the last five to six decades on the farm Cyferpan. The infrastructure includes the older Southern Works (ca 1940's and onwards) and the more modern Northern Works (established 1970's). No **heritage** resources of outstanding significance occur in either of the IVS Southern or Northern Works areas. The older IVS infrastructure (± 60 years), including the Coke and Sinter Plant at the South Works, has been conserved.

The **public participation** process was generally limited to information-sharing. Through this it was established that a low level of awareness exists. Environmental, ecological, health and socio-economic issues were included as topics of concern identified during the process.

The social environment was not investigated by participatory methods. A risk-based communication approach has been incorporated in the planning and design of the public participation process for IVS.

On account of decline in the industrial sector a 10% decline was found in the Vaal Triangle's industrial output in terms of **GDP.** , This resulted in the following:

- Decline of 7% in the local economy's GDP;
- Loss in household income of approximately 10%;
- Loss of 9 300 formal employment opportunities;
- Less household expenditure on water and electricity;
- Less personal income tax to be gained by the state;
- ± 2.6% increase in poverty.

It was found that economic regeneration in the area is urgently required.

4.3 Main impacts

The main **ground water** impacts relate to both inorganic and organic contamination. Impacts are both of a primary nature (direct infiltration at source) or secondary nature (reticulation away from primary source with subsequent infiltration). Primary sources of ground water contamination are all contained within the IVS perimeter, e.g. unlined facilities which are hydraulically inter-connected. These include the existing slag dump; coke and coal stockpiles; product stockpiles; evaporation ponds; slurry ponds; maturation ponds; and unlined sumps and canals. All these contribute to inorganic contamination of the ground water. The primary sources of organic contamination are two-fold in nature. Coal tar entered the subsurface primarily in two areas: the Coke Ovens/Suprachem area, and from old redundant tar disposal pits located immediately West of the Northwestern tip of
Dam 10.

Dissolved phase organics are present in sediments and, in certain instances, in water in dams and the maturation ponds. A secondary free phase pool also exists on and beyond the western Works perimeter, with an associated dissolved phase plume.

Inorganic contamination plumes exist beyond the Works perimeter in five areas: to the West opposite the TETP Area; to the West opposite Dam 10 and the Existing Waste Dump; across the Northern perimeter to the West opposite Dams 1 – 4; to the East opposite the Kiewiet Area; and to the East opposite the South Eastern Slag Processing and Open Veld Area. The distance of impact beyond the Works perimeter varies between 200 metres and 1200 metres. Secondary inorganic plumes exist in the areas between the TETP canal and the La Mont Park and Louisrus South Small Holdings. All these plumes have reached a steady state and in some instances only represent residual impacts. This is because irrigation practices and the sources of active impact have been stopped.

An organic plume (free phase and dissolved phase) exists beyond the Works perimeter in only one locality, that is, to the West opposite Dam 10. The distance of the free phase plume across the perimeter is some 100 metres and the dissolved phase plume some 310 metres.

The baseline study pertaining to **surface water** focused on assimilating flow volume and quality data for the various flows into, within and from the Works. Meteorological data was also collated. The study focused on the surface water discharges from the Works in the Western and Eastern catchments. For the Western catchment, the analysis indicates that the Works is generally capable of complying with the requirements of the water license for most the parameters tested until the achievement of Zero Effluent Discharge (ZED) in 2005. Elements that are currently difficult to control are fluorides, sulphates and iron.

For the eastern catchment, the analyses indicated that a number of elements exceed the water qualities as stated in the IVS water license. Some of the exceedences occur as a result of very strict standards being set in the water license. However, a number of elements exceeded the realistic standards set in the water license. Specific reference is made to iron, sulphates, calcium and magnesium. A search for the source of these elements in the discharge waters was traced back to groundwater seepage emanating from the Steelserv slag handling area in the Southeastern corner of the Works. Although not significant, management measures to eliminate this source have been proposed.

An evaluation of the results in the receiving environment indicated that water from a ground water source is entering the Rietkuilspruit, thereby compromising the water qualities in the stream. The volume of water in the Rietspruit downstream of this river's confluence with the Rietkuilspruit is approximately 4.3 times greater than the flow in the Rietspruit Canal. As far as water qualities are concerned, the flow from Rietspruit Canal increases the electrical conductivity (EC) value in the Rietspruit by approximately 33.7%. This situation will change significantly after ZED implementation in 2005.

The **CRMF** area in general is underlain by a 2 metres unsaturated zone, a perched aquifer of some 2 to 3 metres and a shallow weathered aquifer of about 18 metres. Below the solid material deposits and dams there is a mounding of the perched aquifer of 1 to 2 metres. The general drainage direction is towards the west for both surface and ground water.

The ground water chemistry confirms elevated concentrations of Ca, Mg, SO_4, Cl, K, Na, NO_3, F, Fe and Mn in both the perched and shallow aquifers, with the shallow aquifer concentrations generally less elevated. Organic ground water chemistry found both free phase and dissolved phase NAPL in some boreholes. The contaminated ground water flows westward at a rate of about 10 to 15 meters per year. No evidence was found that the dolerite dyke and faults underlying the area have accelerated the flow within their structures.

The **soils** within the CRMF are contaminated mainly by inorganic salts. These contaminate rainwater which in turn penetrates the soil and contributes to ground water contamination.

The **dust** fallout rates monitored during 2000 and 2001 indicated insignificant levels along the western perimeter. They did, however, increase during the six-month period in 2002 while the dump was being shaped. The same tendency was measured for the respirable dust component.

The **geological** structure below the **CPA** is very similar to that of the CRMF, with the shallow aquifer thickness slightly less than 14 metres. Chemical analysis of borehole water confirmed elevated concentrations of Ca, Mg, SO_4, Cl, Na, NO_3, F, Fe and Mn in both the perched and shallow aquifers. No indication was found of accelerated flow along the fault under the Northern boundary of the North Works. The ground water flow splits along the ridge of high ground running South from the middle of the Kiewiet area, flowing either East or West. The presence of both free phase and dissolved phase DNPL was detected in 18 of the 44 boreholes within the CPA.

Due to the **soil** contamination by dusts and spillages, rainwater is contaminated. Further intermixing with minor effluent streams has aggravated the position. The predominantly impermeable nature of the surface reduces penetration and direct contamination of ground water. Nevertheless, it increases the run-off volumes.

The modelling of ambient **air** pollution concentrations outside the plant perimeter has not disclosed any significant impact on human health or the environment. It has, however, indicated periodic exceedence of the odour threshold for hydrogen sulphide in the industrial area south of the CPA. Some elevated dust fallout levels were monitored within the plant area. These translate to dust build-up with rain run-off and ground water contamination potential. However, the dust fallout levels at the site perimeter were at or below the guideline for residential land-use.

Under the Southeastern slag and surrounding **open veld** areas, an unsaturated zone of 1 to 4 metres; a perched aquifer of 1 to 4 metres; and a shallow weathered aquifer of some 16 metres exist. Within this regime, the flow is from Southeast to Northwest towards the origin of the Leeuwspruit, at about 10 to 12 metres per year, but as low as 2 to 4 metres per year under the actual slag processing area. The ground water chemistry confirms the elevated concentrations of Ca, Mg, SO_4, Cl, Na, Fe and Mn in the perched aquifer and to a lesser degree in the shallow aquifer. Organic chemistry also indicates the presence of dissolved phase in low to high concentrations.

The **soils** in the area recorded high contamination levels of Ca, Mg and SO_4, which correspond with the analysis of the dust fall-out within the operational zone. The above dust is a significant source for both surface and ground water contamination, which is particularly noticeable under the operational areas but with a narrow plume towards the Leeuwspruit ground water discharge zone.

The unsaturated zone and aquifers under the Southwestern slag area are similar to those under the CPA with flow from the southeast to the Northwest / West towards the Terminal Effluent Treatment Plant (**TETP**) at 10 to 15 metres per year. Analysis of the ground water indicates elevated concentrations of Ca, Mg, SO_4, Cl, Na, Fe and Mn in both aquifers, but no organic contamination.

The **soils** in the area are contaminated with inorganic salts, derived from the slags and windblown dust, and contributing to both surface and ground water contamination. Percolation of ground water due to a raised water table results in salt deposition on the surface Southwest of the slag handling, which in turn contaminates rainwater run-off from the area. The TETP area West of the Southern section of the CPA has a similar ground water regime to the CPA. The ground water flows westwards and has a similar composition to that of the CPA.

It is difficult to isolate the holding dam contributions from those of the CPA activities, notably the direct reduction; coke ovens; blast furnace; and arc furnace plants. The soils in the TETP area display high contamination of particularly Zn, Ca, SO_4 and Cl.

The **geology** of the **Kiewiet** site is complex and both a fault and a dolerite dyke cut through the area. The unsaturated zone varies from 4 to 5 metres with a thin-perched aquifer of 1 metre and a shallow weathered aquifer of some 13 metres. A watershed traverses the area from North to South with drainage towards both East / Southeast and West.

The ground water flow velocity is in the order of 40 to 60 metres per year. Analysis of both the aquifers indicated contamination of Mg, Na, NO_3, Cl, SO_4, Fe and Mn, while the shallow aquifer also had raised concentrations of Ca and F. Five of the 21 boreholes contained low levels of organic contamination. The soils in the area are slightly contaminated with Al and Fe, while Ca, SO4 and Cl concentrations are negligible.

When considering the **economic** picture of the Vaal Triangle area and particularly the Emfuleni Municipal area, it must be noted that the decline in the industrial sector lead to overall deterioration of the economic situation in the area. The impact is felt across the board – from the economy of individual households to local authorities (sales of services) and through to a national level (in terms of smaller tax gains.)

5. KEY RISKS

5.1 Air

No risks to either human health or the environment outside the IVS perimeter, due to air pollution, could be identified using a year of dust fallout monitoring and a comprehensive source emission inventory and atmospheric dispersion modelling for gasses and respirable particulates, validated by on-site ambient monitoring.

However, the solubles leached from dust fallout contribute to the contamination of both surface and ground water. Thus, they indirectly contribute to any risks arising from water in general. In addition, a very large mass of air pollution, mainly particulates with soluble components is being captured in air pollution abatement equipment. This has to be disposed of in such a manner as not to contribute to risks.

5.2 Water

Generally, it can be stated that the degree of **ground water** contamination within the IVS perimeter is such that it poses an unacceptably high risk to both human health, if available for human consumption, and the environment. The key risk in this regard relates to human health as a result of inorganic, and to a much lesser extent, organic contamination. The potentially unacceptable risk to human health (if available for human consumption) and the environment extends across the IVS perimeter into the receiving environment in the five areas discussed in section 4.3. The aerial extent to which the risk is unacceptably high, is located within the impacted area.

However, water samples available for current users located within impacted areas, indicate an acceptable risk to human health in these boreholes. Of importance is the fact that the risk profile is unlikely to improve as a result of technical management measures over the short and medium terms. Institutional controls are therefore indicated to address risk profile which could include legislative measures.

Surface water risks determinations were performed for human health and the environment, for water discharged to the Leeuwspruit as well as to the Rietspruit Canal. Risk assessments were also done for water qualities in the Vaal River as well as in the Rietspruit, both upstream and downstream of this river's confluence with the Rietkuilspruit. The risk quantification for the Rietspruit Canal and Frikkie Meyer weir discharges indicate that there is a potentially unacceptable risk to both human health and the environment under certain wet weather conditions. The risk assessments for the Rietspruit and Vaal River flows indicate that there is an acceptable risk to both human health and the environment in these flows.

5.3 Waste / Land / Soils

Waste currently generated by IVS is classified as hazardous according to the Minimum Requirements with resultant potential risk to man and the environment. These risks (due to mobile contaminants and associated volumes) will have to be mitigated by treatment to reach General Waste quality, which would reduce potential risk.

Potential risk by soils (inorganic) to ground water, specifically with regard to the more potent contaminants, is limited and should not warrant remediation actions. No potential risk due to organic contaminants in soils was observed.

5.4 Source characterisation

Sediments of all evaporation dams and the maturation ponds indicate unacceptable potential risk for ground water contamination, both with regard to inorganic and organic contaminants.

6. PRIORITIZATION, FINANCIAL CONSIDERATIONS AND SCHEDULED IMPLEMENTATION

6.1 Prioritization

The key objective of the prioritization process was to identify and formulate environmental management measures for implementation in a logical sequence. This would reduce the risk profile over a reasonable and realistic timeframe.

The prioritization step, which was conducted during the MP **integration process,** was complex but vital.

A clear understanding had to be developed during the prioritization process of the nature, magnitude and extent of the impacts and risks. Due consideration had to be given to the IVS manufacturing and processing activities; characterization of all sources; pathway analysis; identification of potential points of exposure; and associated consequence and effect levels.

A matrix evaluation process was conducted and the seventeen environmental management areas were rated and ranked in terms of health and environmental criteria.

Secondary criteria were considered and applied to each environmental management area. These included, among others:

- Risk based management criteria of a site specific nature
- Criteria to ascertain that the best practicable environmental option is pursued
- Criteria to ensure the promotion of sustainable development and continued operations of the IVS works
- Regulatory requirements enforced by the regulatory authorities
- Criteria applicable to enhance informed decision making

The methodology followed, which included the rating and ranking matrices and results, is described and reflected in the Integration Report.

As a result of the three level screening and prioritisation process, the **main focus points** of the study area were clearly identified and measured against regulatory requirements; the presence of high risks; and operational efficiency.

The priorities are listed in the following summary table:

Priority	Management Area	Proposed Measures
1.	TETP and MTP area	MTP Main Treatment Plant to achieve ZED (Water management)
2.	Consolidated Plant Area	Coke oven gas cleaning (Air quality management)
3.	Consolidated Plant Area	Sinter pilot plant **and** Sinter plant (full scale) (Air quality/Operational efficiency)
4.	Perimeter and surrounding areas	Institutional control measures (groundwater management) and regulatory measures
5.	Existing waste dump	Remediation, surface and groundwater management measures
6.	Dam 10	Decommissioning and rehabilitation with the view to closure

Priority	Management Area	Proposed Measures
7.	South eastern slag and open veld areas	Surface and groundwater management measures, source control and remediation
8.	Overall CRMF	Installation and upgrading of associated residue management facilities (Infrastructure)
9.	Rietkuilspruit and Rietspruit canal	Remediation, surface and ground water control measures
10.	Maturation ponds	Decommissioning, remediation and rehabilitation with the view to closure
11.	TETP and MTP area	Associated infrastructural requirements to manage effluent and surface water
12.	Dams 1 to 4	Decommissioning, remediation and rehabilitation with the view to closure
13.	Consolidated Plant Area	Upgrading of various water surface management measures
14.	Redundant blast furnace sludge dams	Remediation, clean-up and rehabilitation
15.	Sludge dams (CETP)	Remediation, clean-up and rehabilitation
16.	South western slag area	Bunding and upgrading of water management measures
17.	Dam 11 (Proposed New Waste Site)	Decommissioning, rehabilitation and preparation work for a new waste site facility
18.	Processed materials stockpiles	Pollution control measures at source
19.	Raw materials stockpiles	Pollution control measures at source
20.	Kiewiet Area	Surface and groundwater management measures

Note: Priorities 1 to 3 are labelled elsewhere as A – priorities; A_1, A_2 A_3 and A_4
Priorities 4 to 20 are labelled elsewhere as P – priorities; $P_1 - P_{17}$

Alternative options were identified and alternative solutions considered and evaluated. Preferred options and solutions were conceptualised.

The site-specific measures for each environmental management area were also listed in order of priority.

The timeframe requirements for authorisation processes; logical sequence of construction execution; and the inter-relationship of time related activity planning, would have to be initiated as a next step to refine the prioritisation process.

The detailed planning of the implementation could proceed once IVS communicated and agreed on the priorities with key stakeholders.

Some of the listed priorities may have to be re-scheduled to accomplish the logical sequence of timeframe requirements i.e. Priority 11 needs to be aligned with Priority 1.

6.2 Financial Considerations

The measures proposed for the preferred options were conceptualised and costed. These measures are reflected on a series of maps and plans.

The measures were costed to an order-of-magnitude (± 25%) level of accuracy.
The costs represent all the measures for each environmental management area, which resulted from the Integration Process step.

The cost figures are indicative and the implementation of measures is subject to the approval of the authorities and key stakeholders; the fulfilment of authorisation processes; feasibility studies of the preferred options and detailed designs.

The cost estimates are market related costs, with a base date of November 2002.

The cost summary of all the Environmental Management areas is summarised in the Table on the next page.

COST SUMMARY TABLE

Priority	Estimated costs per Management Area	Total (R mil)
1	MTP treatment plant to achieve ZED	150.0
2	Coke oven gas cleaning	189.2
3	Sinter pilot plant and Sinter Plant (full scale)	167.0
4	Institutional control measures on perimeter and surrounding areas	25.0
5	Existing waste dump	105.4
6	Dam 10	37.5
7	South eastern slag and open veld areas	95.3
8	Overall CRMF	49.3
9	Rietkuilspruit and Rietspruit canal	8.7
10	Maturation ponds	17.4
11	TETP and MTP area: Infrastructural requirements for ZED	25.0
12	Dams 1 to 4	34.4
13	Consolidated Plant Area (upgrading of measures)	164.5
14	Redundant blast furnace sludge dams	36.4
15	Sludge dams	16.0
16	South western slag area	10.6
17	Dam 11 (Proposed/preferred new waste site)	128.2
18	Processed materials stockpiles	16.2
19	Raw materials stockpiles	4.0
20	Kiewiet area	8.4
	SUB-TOTAL	**1 288.5**

Cost Summary

• Projects already committed (Priorities P1 to P3)	:		**R506.2 mil**
• Measures associated with Priorities P4 to P20	:	R782.5 mil	
• Feasibility studies, detailed design, supervision, project management, authorisation processes (10% provision)	:	R78.3 mil	
• Contingency allowance (10% provision)	:	R78.3 mil	
SUB-TOTAL	:		**R939.1 mil**
ESTIMATED TOTAL PROVISION			**R1 445.3 mil**

6.3 Scheduled implementation

The MP implementation programme was developed as a result of the prioritization process and the listed measures were scheduled over a timeframe of 20 years. However, IVS started (during the MP development phase) to implement intermediate measures and actions i.e. the CETP treatment plant upgrade and Coke Ovens bunding.

The implementation programme reflects the following project categories as high priority measures. These are aimed at improving the status quo and reducing the impact and risk profile:

- **Process water projects** – MTP treatment plant and associated ZED infrastructure
- **Air quality projects** – Coke Oven gas cleaning and Sinter Plant projects
- **Solid waste projects** – Rehabilitation, clean-up, pollution control and closure measures for various listed priority areas inside the CRMF area
- **Surface water related projects** – Pollution control measures inside the CRMF, on the perimeter of the IVS works, at the Southeastern and Southwestern slag areas, etc. It includes holding dam facilities, drainage facilities, cut-off trenches, pipelines and pump station facilities
- **Ground water related projects** – Abstraction borehole system, mainly on the IVS perimeter and intermediate surrounding areas
- **Institutional controls, authorizations, environmental awareness and training** – Provision is made for IVS to initiate formal processes which relates to institutional measures and controls, to obtain the necessary authorizations and to conduct environmental and training programmes

The proposed 20-year implementation programme is summarised into **two schedules:**

- **Schedule 1** – Major projects already committed:
  - Estimated start date: 2003
  - Estimated end date: 2007

- **Schedule 2** – Master Plan implementation schedule over a 20-year timeframe.

  See next two pages for **Schedule 1** and **Schedule 2.**

6.4 Cost and cashflow distribution

The proposed 20-year implementation schedule was analysed in terms of:

- Estimated cashflow requirements and cost distribution over a 20 year period
- Financial provisions for the major projects already committed over the financial years 2003 up to 2007
- The relevant cost distribution between the listed P-Priorities
- Proposed cost allocations to:
  - Water
  - Air
  - Waste
  - Rehabilitation related projects

The cost distribution, financial provisions and capital / cash flow schedules are graphically presented on the next few pages.

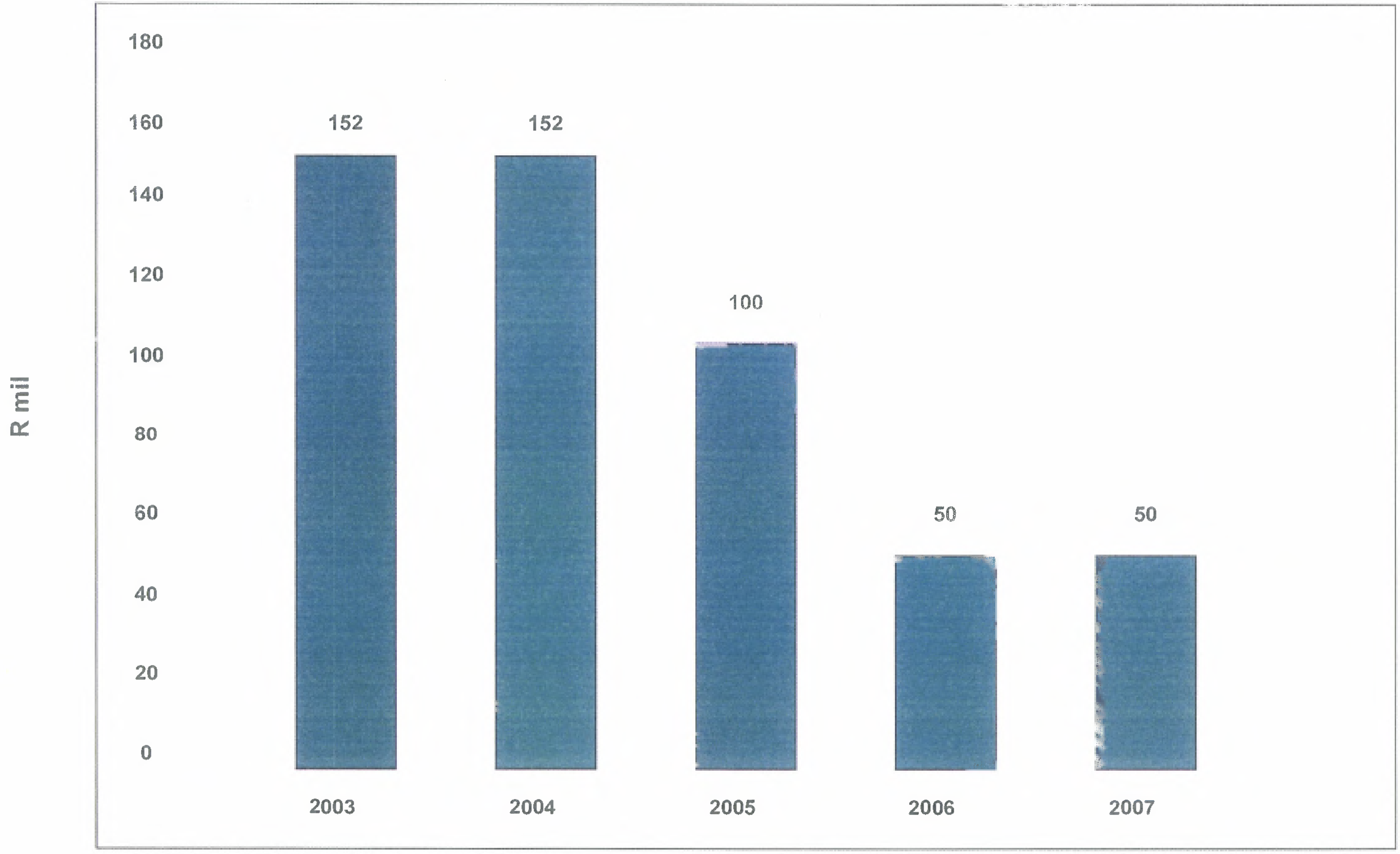
The proposed capital requirements for environmental projects will enable IVS management to weigh-up these financial requirements against the overall business plan of IVS.

Priority	Major projects already committed	Total R mil	2002 R mil	2003 R mil	2004 R mil	2005 R mil	2006 R mil	2007 R mil
A1	MTP treatment plant	150.0		50.0	50.0	50.0		
A2	Coke oven gas cleaning	189.2		94.6	94.6			
A3	Sinter pilot plant	15.0		7.5	7.5			
A4	Sinter plant full scale	152.0				50.0	50.0	52.0
	TOTAL	506.2		152.1	152.1	100.0	50.0	52.0

SCHEDULE 1: MAJOR PROJECTS ALREADY COMMITTED TIMEFRAME AND CASHFLOW PROJECTION

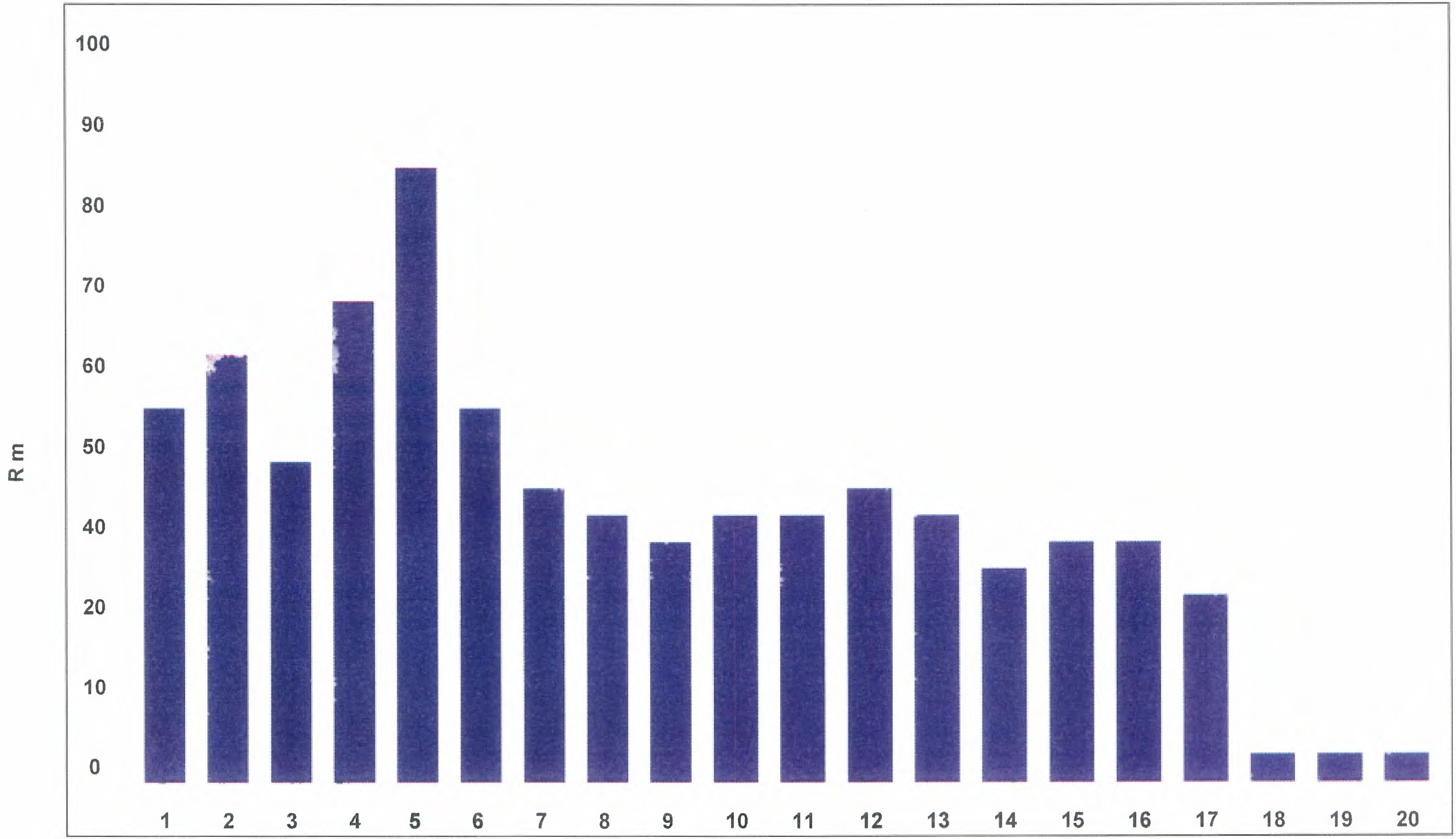
Priority	Management area	Total Area Rm	Total Mea-sures Rm	Year 1 Rm	Year 2 Rm	Year 3 Rm	Year 4 Rm	Year 5 Rm	Year 6 Rm	Year 7 Rm	Year 8 Rm	Year 9 Rm	Year 10 Rm	Year 11 Rm	Year 12 Rm	Year 13 Rm	Year 14 Rm	Year 15 Rm	Year 16 Rm	Year 17 Rm	Year 18 Rm	Year 19 Rm	Year 20 Rm
P1	Perimeter & surrounding areas	25.0	25.0	12.5	12.5																		
P2	Existing waste dump	105.6	105.6	5.0	6.0	7.7	14.6	8.8	11.3	6.4	5.5	5.5	5.5	7.5	7.5	6.1	4.2	4.3					
P3	Dam 10	37.5	37.5	0.1	1.7	3.6	7.0	10.9	8.6	5.6													
P4	S/E slag & open veld area	95.3	95.3	8.7	11.9	14.7	20.7	22.1	2.8	7.1	5.2	1.6	0.5										
P5	Overall CRMF	49.3	49.3	6.8	5.2	4.5	4.5	10.6	11.7	1.5	1.5	1.5	1.5										
P6	Rietkuilspruit & Rietspruit canal	8.9	8.9			0.3	0.8	2.3	2.0	1.5	1.0	1.0											
P7	Maturation ponds	17.6	17.6							5.5	5.8	1.5	0.3	2.2	0.7	0.1	1.5						
P8	TETP & MTP area	25.0	25.0	9.6	8.7	3.2	3.5																
P9	Dams 1-4	34.5	34.5				Opex	Opex	Opex	Opex	3.0	3.0	3.0	4.0	4.0	7.4	2.0	2.0	5.8	0.3			
P10	CPA	164.1	164.1	13.5	13.5	14.5	16.8	28.5	11.5	7.5	6.5	3.3	3.5					15.0	15.0	15.0			
P11	Redundant blast furnace sludge dams	36.4	36.4										4.0	4.0	8.0	4.0	5.1	2.5	4.0	4.8			
P12	Sludge dams (CETP)	16.1	16.1					Opex	Opex	Opex	Opex	Opex	Opex	1.5	1.8	4.8	5.7	2.3					
P13	S/W slag area	10.6	10.6					0.6							5.0	5.0							
P14	Dam 11 Proposed new waste site	128.3	128.3	0.1	0.1	0.3	0.5	0.6	4.2	5.2	4.9	14.2	16.5	15.7	15.7	13.7	10.7	10.7	11.6	0.9	0.9	0.9	0.9
P15	Processed materi-als stockpiles	16.3	16.3						3.0	4.0	5.6	1.1	1.1	1.1	0.4								
P16	Raw materials stockpiles							1.1	1.3	0.5	0.4	0.4	0.4										
P17	Kiewiet area	8.4	8.4										1.3	1.0	1.5	1.0	1.0	1.0	1.0	0.6			
	TOTAL	**783.3**	**783.3**	**56.3**	**60.0**	**48.8**	**68.4**	**85.5**	**56.4**	**44.8**	**39.4**	**33.1**	**37.6**	**37.0**	**44.6**	**42.1**	**30.2**	**37.8**	**37.4**	**21.6**	**0.9**	**0.9**	**0.9**

SCHEDULE 2: IMPLEMENTATION SCHEDULE FOR MEASURES IN THE ENVIRONMENTAL MANAGEMENT AREAS TIMEFRAME AND CASHFLOW PROJECTION



YEAR

CAPITAL CASHFLOW DISTRIBUTION: A PRIORITIES
PRIORITIES A1, A2, A3 AND A4



TIME IN YEARS

IMPLEMENTATION SCHEDULE FOR MEASURES IN THE ENVIRONMENTAL MANAGEMENT AREAS

TIMEFRAME AND CASHFLOW PROJECTION

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Conclusions can be drawn from the outcome of the Master Plan development process by means of formulating the following key statements:

7.1.1 "The overarching objectives of the Master Plan study have been met"

The following actions resulted from the MP study in line with the overarching objectives of the study:

- The environmental status quo was comprehensively described for the study area;
- Environmental impacts and risks were identified, quantified and integrated;
- Options to reduce the risk profile were identified and formulated; and
- An integrated plan of action was developed.

7.1.2 "All the MP process steps have been successfully followed-through"

The follow-through on the MP process steps conclude that:

- The MP process was conducted inside a well defined and structured environmental study framework; and
- The interaction with key stakeholders to firm-up on the process of participatory decision-making require further enhancement.

7.1.3 "All the risks and impacts have been identified and quantified"

The impacts and risks for the majority of the environmental components have been identified and quantified. They also include burning issues raised by the key stakeholders.

The key impacts and risks relate mainly to:

- Process and surface water practices;
- Solid waste disposal practices;
- Air quality related practices;
- Residual impacts, mainly related to ground water and impacts on the eco-aquatic system in the receiving water environment.

7.1.4 "The primary and secondary measures as proposed for the Consolidated Plant Area, the Consolidated Residue Management Facility and the surrounding IVS perimeter areas, have been identified and formulated"

- The process of considerating alternatives and prioritizating resulted in a **comprehensive list** of **mitigatory** actions and measures;
- The implementation of the prioritised measures will result in a **reduction** of the profile of risks and impacts, through implementation of a risk based management approach.

7.1.5 "The schedule and approach for the implementation of the Master Plan have been achieved"

The MP outlines an implementation programme based on a timeframe, which is linked to a profile of reduction of risks and impacts.

- The initiation of authorisation processes to underpin the implementation steps, forms an integral part of the implementation schedule;
- The implementation schedule as proposed is coupled to financial requirements.

7.1.6 "The MP development is coupled to an Environmental Monitoring programme"

The following results regarding environmental monitoring can be seen from the MP study:

- An environmental monitoring system was formalised and commissioned;
- Protocols were developed for ongoing monitoring to establish compliance profiles.

7.1.7 "IVS has achieved alignment of its practices to meet international environmental standards through initiation of the MP process"

- The findings of the MP investigative work were measured against local and international standards to ensure international benchmarking. Targets were set to achieve long-term sustainable development.

7.2 Recommendations

From the MP development, the following key recommendations were formulated:

7.2.1 Implementation of the measures in a structured manner as outlined in the report i.e. authorisation processes, detailed feasibility studies, detailed design and development of operational procedures.

7.2.2 Initiation of authorisation processes to underpin the implementation of measures, should get the **highest priority** attention from IVS.

7.2.3 The high rated and ranked **priority projects** should be implemented, namely:

- The Main Treatment Plant to achieve Zero Effluent Discharge (ZED);
- Air quality improvement projects namely: The Coke Oven Gas Cleaning and Sinter Plant projects;
- Remediation, surface and ground water control measures at the priority areas in the CRMF and CPA.

7.2.4 Continuation of a well planned and structured consultative and participatory process with all key stakeholders.

7.2.5 Communication of the outcome of the Master Plan with the regulatory authorities and key stakeholders to ensure a participatory approach and informed decision-making regarding the findings, priorities, authorisation processes and implementation schedules.

7.2.6 Continuation and expansion of the continuous improvement principles, objectives and targets as outlined in the Master Plan reports i.e. waste minimisation, reduction and re-use practices and reclamation opportunities.

7.2.7 Initiation of an environmental awareness and training programme, which should include the workforce and stakeholders and integrating it with educational and empowerment programmes.

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