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ENVIRONMENTAL

ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PROGRAMME

CITY DEEP OPERATION

CROWN GOLD RECOVERIES (PTY) LTD

OCTOBER 2011

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Project Title: Crown: Knights EIA/EMP

Name	Responsibility	Signature	Date
Barbara Wessels	Report writer		September 2011
Grant Beringer	Reviewer		October 2011

EXECUTIVE SUMMARY

Digby Wells and Associates (DWA) has been appointed as the independent environmental consultant by Crown Gold Recoveries (Pty) Ltd (Crown) to review the existing Environmental Impact Assessment (EIA) and Environmental Management Programme (EMP) for their City Deep Operation. The existing EIA and EMP will be updated in order to comply with the Minerals and Petroleum Resource Development Act (MPRDA). This conversion document will then be submitted to the Department of Mineral Resources (DMR) for approval.

Project Description

Crown is a wholly owned subsidiary of DRDGold South African Operations (DRDSA). The company reclaims sand dumps and slime dams that were deposited as tailings by mines that once operated in the greater Witwatersrand area. The following three operating plants fall currently under DRDSA:

- Crown Mines;
- City Deep; and
- Knights.

Crown has been responsible for the successful reclamation of 23 sand dumps and slimes dams, most of which have been situated around the City of Johannesburg and Ekurhuleni Metropolitan area. In the past, the company has been able to effectively reclaim dumps in close proximity to buildings and other public infrastructure in a manner which is not significantly disruptive to society. This has allowed for the removal of a source of environmental pollution, the rehabilitation of disturbed areas, and the unlocking of key urban land for development. The City Deep plant treats material from a number of slimes dams and sand dumps in the surrounding area in order to extract gold. Through the treatment of dumps in these areas, Crown has unlocked over 205ha of land for economic development. The urban location of these dump sites makes the redevelopment of these properties highly valuable.

Baseline Environment

The City Deep operations fall within the Highveld climatic zone that is characterised by warm, wet summers and cold nights with frost. The topography is dominated by urban structures and old mine residue deposits. Quartzites and conglomerates of the Central Rand Group of the Witwatersrand Supergroup is characteristic the geology for the area. The conglomerates represent the gold bearing reefs. The Main, Bird and Kimberley Reefs have been extensively mined in the Johannesburg area. Generally the soils in the area consist of hill wash materials, alluvium along watercourses and residual soils all derived from the underlying geology.

The operations fall within the Upper Vaal catchment (quaternary catchment C22B). Mining activities have resulted in the degradation of the natural water rest level in the conventional geohydrological sense. The de-watering by the mines maintains an artificial water level.

The land use around the reclamation sites, the plant and the tailings dams are or is planned to be urban. The mine falls theoretically into Acocks Veld Type 61(b), the central variation of the Bakenveld. The air quality in the area is impacted on by the large amounts of traffic, domestic and industrial emissions. The tailings and sand dumps with a poor vegetation cover also contribute to deterioration of air quality when the wind blows.

Existing re-vegetated mine dumps, which are quiet habitats due to being on secure mine property, provide shelter, resting and breeding places for a relatively large number (for an urban area) of small mammals and birds.

Environmental Impact Assessment

The Environmental Impact Assessment (EIA) process utilised has a rigorous, numerical environmental significance rating process to determine the significance, frequency and severity of an impact. The impact rating process is designed to provide a numerical rating of the various environmental impacts identified by use of the “Input-Output” model. The process is based on the accepted impact assessment methodology that uses the probability

of an event occurring and the severity of the impact, should an event occur, as factors to determine the significance of a particular environmental risk.

Some of the key positive findings that were identified during the impact assessment include the following:

- The reclamation of the sand and slimes dams will result in a change in the topography and visual aspect of the area;
- The natural soil layer underneath the dumps will be exposed and rehabilitated; and
- Reclamation activities will create job opportunities.

Some of the key negative findings that were identified during the impact assessment include the following:

- The deposition of additional tailings on the existing tailings dams will cause an increase in piezometric water level and contaminant load to the subsurface;
- Reclamation activities will result in an increase in dust and noise levels in the vicinity of the mine; and
- The hard paved areas around the plant limit the recharge to the aquifers.

Public Participation

Crown views public participation as an important tool in the decision-making process. The interested or affected public are the only meaningful way through which to explore locally relevant conditions and dynamics. The result of an effective PPP would be enhanced and shared project benefits, an understanding of key IAP issues, and the generation of creative new alternatives and solutions to any identified challenges.

The Public Participation Process (PPP) for the project has been designed to follow a consultative approach, where Interested and Affected Parties (IAPs) are actively involved in the EIA and EMP process. A combination of various methodologies had to be

implemented to meet the needs of the different stakeholders. These methodologies will be continually evaluated and refined throughout the EIA/EMP for the life of the project.

The following activities were undertaken as part of the PPP:

- Development of a stakeholder database;
- Preparation and distribution of media notices, posters, background information documents;
- Undertaking of consultative information sharing meetings; and
- Distribution of the minutes from information sharing meetings.

The three main IAP groups that were identified included:

- Regulatory authorities, councillors and other relevant authorities;
- Other interest groups, including Non-Governmental Organisations (NGOs), Community Based Organisations (CBOs), media, environmental associations etc; and
- Affected landowners, industrial work.

Management and Monitoring

The management plan has been designed to address impacts that were identified during the impact assessment. Monitoring is required in order to check compliance with agreed standards or objectives and targets. During the operational and decommissioning phases monitoring would be used to check compliance with regulations while post closure monitoring is to ensure aftercare and maintenance of post closure objectives.

Included in this City Deep EMP are a monitoring programme, emergency response plan, environmental awareness plan and closure plan. A method of financial provision has been determined using the DMR quantum of financial provision. The figure required for closure has been estimated to be R5, 646 196.00.

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1 INTRODUCTION

Digby Wells and Associates (DWA) has been appointed as independent environmental consultant by Crown Gold Recoveries (Pty) Ltd (Crown) to review the existing Environmental Impact Assessment (EIA) and Environmental Management Programme (EMP) for their City Deep Operation. The existing EIA and EMP will be updated in order to comply with the Minerals and Petroleum Resource Development Act (Act 28 of 2002, MPRDA). This conversion document will then be submitted to the Department of Mineral Resources (DMR) for approval.

The City Deep operation is responsible for the reclamation of sand and slimes dams that were deposited as tailings during past gold mining operations in the Witwatersrand area. The slimes are either mechanically or hydraulically reclaimed and transported to the City Deep plant via pipelines. The material is then processed to produce gold which is then sold to Rand Refineries. The mining waste that is created during this process will be dumped on the Homestead/Diepkloof, Mooifontein or GMTS tailings dams.

2 METHODOLOGY

DWA has been appointed as the independent environmental consultant to investigate all environmental and social aspects related to the reclamation activities of the City Deep Operations.

This EIA/EMP report gives a full impact assessment, recommends mitigation measures and rates current and expected future impacts according to their significance.

The process followed is according to the regulations set out in the MPRDA.

2.1 Environmental Impact Assessment

The EIA uses a rigorous, numerical environmental significance rating process. Both processes are based on the accepted impact assessment methodology that uses the probability of an event occurring and the severity of the impact, should an event occur, as factors to determine the significance of a particular environmental risk.

In order to determine the severity of any potential environmental impact, the criteria that are taken into consideration are the spatial extent of the impact, the duration of the impact and the severity of the impact. The probability of an impact occurring is determined by the frequency at which the activity takes place and by how often the type of impact in question has taken place or takes place in similar circumstances. The values assigned to these factors (weighting) are discussed as part of the EIA (Section 6).

In order to clarify the purpose and limitations of the impact assessment methodology, it is necessary to address the issue of subjectivity in the assessment of the significance of environmental impacts. Even though DWA, and the majority of Environmental Assessment Practitioners (EAPs), propose a numerical methodology for impact assessment, one has to accept that the process of environmental significance determination is inherently subjective. The weight assigned to each factor of a potential impact, and also the design of the rating process itself, is based on the values and perception of risk of members of the assessment team, as well as that of the Interested

and Affected Parties (IAPs) and authorities who provide input into the process. Whereas the determination of the spatial scale and the duration of impacts are to some extent amenable to scientific enquiry, the severity value assigned to impacts is highly dependent on the perceptions and values of all involved. It is for this reason that it is crucial that all EIAs make reference to the environmental and socio-economic context of the proposed activity in order to reach an acceptable rating of the significance of impacts. Similarly, the perception of the probability of an impact occurring is dependent on perceptions, aversion to risk and availability of information.

It has to be stressed that the purpose of the EIA process is not to provide an incontrovertible rating of the significance of various aspects, but rather to provide a structured, traceable and defendable methodology of rating the relative significance of impacts in a specific context.

The EIA assesses environmental and social impacts according to different stages of the proposed project, namely: the construction, operational, decommissioning and post closure phases. Impact and benefit significance are assessed before and after the application of any mitigation measures and refer to effects on both the ecological and social environment.

Lastly, the cumulative impacts of the proposed operation on the environment, with reference to similar operations and activities in the area are discussed.

2.2 Environmental Management Programme

This document aims to address all environmental impacts likely to occur during the execution of the project and to give a description of the general environment.

As the EIA indicates the relative significance of the various environmental impacts associated with mining activities, it serves to focus the allocation of resources on environmental aspects and specific impacts requiring mitigation. The aim of the mitigation measures is to minimise the negative impacts and enhance the positive aspects of the project, as well as to inform, involve and improve the local communities in the

process. In terms of Section 39 (1) of the MPRDA, an EMP must describe the manner in which the applicant intends to:

- Modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation;
- Contain or remedy the cause of pollution or degradation and migration of pollutants; and
- Comply with any prescribed waste standard or management standards or practices.

The EMP section is divided into setting objectives and planning of management measures. The monitoring and performance assessment section of the EMP details the annual monitoring and audits that will be implemented to ensure the effectiveness of mitigation measures.

2.3 Submission of Information

In terms of the MPRDA regulations, the sequence of submission of information includes:

- Application for a Mining Right which includes, amongst others, a Mining Work Programme and a Social and Labour Plan;
- Submission of a Scoping Report as contemplated in regulation 49 of the MRPDA regulations; and
- Submission of an EIA/EMP as contemplated in regulation 50 and 51 of the MPRDA regulations.

3 PROJECT DESCRIPTION

3.1 Project Introduction

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3.2 Regional Setting

The City Deep Operations fall within the boundaries of the Johannesburg and Germiston Magisterial districts and within the Greater Johannesburg Transitional Metropolitan Council and East Rand Regional Services Council's areas of jurisdiction.

The mining/reclamation operations that form part of City Deep are located within the city limits of Johannesburg and Germiston. See Plan 1for the regional setting.

3.3 Applicant Details

Table 3.1: Contact details for the City Deep Operations

Name of applicant	Crown Gold Recoveries (Pty) Ltd
Telephone number	(011) 257 3100
Fax number	(011) 257 3304
Physical address	Crownwood Road
Postal address	Private Bag X 9, Johannesburg, 2025

Table 3.2: Contact details of mine manager

Mine manager	Mr. C.M Symons
Telephone number	(011) 835 2157/9
Fax number	(011) 835 2922

3.4 Mineral Rights Holder

City Deep owns most of the mineral rights except for 4/A/11sand dump, 4/L/26 tailings dam and Jupiter plant material. See Table 3.3.

3.5 Details of Landowners and Title Deeds

There are nine freehold owners involved City Deep, Union Property Holdings (Pty) Ltd, Geldenhuis Deep Ltd, Maretsel Estates Ltd, Pediva Investments CC, RMP, Central Warehousing and Industrial Zone Ltd. See Table 3.3.

Table 3.3: Mineral rights and land owner ship

Description	Mineral rights holder	Licence and permit no	Title deed description	Freehold owner	Remarks
Reclamation sites	**(Dumps)**				
3/A/17	City Deep	73/75	RE 1 Klipriversberg	City Deep	
4/A/7	City Deep	7/76	RE 90 Doornfontein	Geldenhuis Deep Ltd	Section 161 permit Act 20 of 1967
4/A/7	City Deep	7/76	RE 79 Doornfontein	Maretsel Estates Ltd	Section 161 permit Act 20 of 1967
4/A/8	City Deep	Licence no. 108	STN 90 Doornfontein	Geldenhuis Deep Ltd	Section 161
4/A/9	City Deep	13/76	RE 90 Doornfontein	Geldenhuis Deep Ltd	Section 161 Action 20 of 1967
4/A/11	Geldenhuis Deep Ltd	Licence no. 109 (RMT 215)	RE 1 Elandsfontein 90 IR	Geldenhuis Deep Ltd	Section 138 Act 35 of 1908
3/L/45	City Deep	73/75	RE 1 Klipriversberg 106 IR	City Deep	
4/L/1 (North)	City Deep	105/80	RE 95 Doornfontein 92 IR	City Deep	
4/L/1 (South)	City Deep	105/80	RE 86 Doornfontein 92 IR	City Deep	

Description	Mineral rights holder	Licence and permit no	Title deed description	Freehold owner	Remarks
4/L/16	City Deep	7/76	RE 90 Doornfontein 92 IR	City Deep	Section 161 permit Act 20 of 1967
4/L/16	City Deep	7/76	RE/ 79 Doornfontein 92 IR	Maretsel Estates Ltd	Section 161 permit Act 20 of 1967
4/L/17	City Deep	7/76	RE 90 Doornfontein 92 IR	Geldenhuis Deep Ltd	Section 161 permit Act 20 of 1967
4/L/17	City Deep	7/76	RE 79 Doornfontein 92 IR	Maretsel Estates Ltd	Section 161 permit Act 20 of 1967
4/L/17	City Deep	7/76	Ptn 108 Doornfontein 92 IRP	Pediva Investment CC	Section 161 permit Act 20 of 1967
4/L/26	Geldenhuis Deep Ltd	Licence no 109 (RMT 215)	RE 1 Elandsfontein 90 IR	Geldenhuis Deep Ltd	Section 138
4/L/25	City Deep	License no 175 – 13/76	Ptn 90 Doornfontein 92 IR	Geldenhuis Deep Ltd	Section 161
Rosherville Silts	City Deep		Ptn 86 & 87 Doornfontein 92 IR	City Deep	Residues originate from City Deep & Geldenhuis Deep Ltd residue dumps and mining title
Rosherville Silts	City Deep		Ptn 79 Doornfontein 92 IR	Maretsel Estates (Pty) Ltd	Residues originate form City Deep & Geldenhuis Deep Ltd

Description	Mineral rights holder	Licence and permit no	Title deed description	Freehold owner	Remarks
					residue dumps and mining title
XX	City Deep	126/78	RE 95 Doornfontein 92 IR	City Deep	Section 90
Plant site					
City Recovery Plant	City Deep	125/87	RE 83 Doornfontein 92 IR	City Deep	Holder of permit RM3
Clean-up sites					
Jupiter plant	Geldenhuis Deep Ltd	Licence no 109	Ptn 1 Elandsfontein 90 IR	Geldenhuis Deep Ltd	RMT 215 section 161
City Silts	City Deep		RE ptn 1 Klipriversberg 106 IR	City Deep	Originated from City Deep Mining Title
(Old) City Plant	City Deep		RE ptn 83 Doornfontein 92 IR	City Deep	Originated from City Deep Mining Title
Nourse Plant	City Deep	86/78	Ptn 95 Doornfontein 92 IR	City Deep	Permit for Cyanide plant & Oliver Filter
3/A/11	RMP	A 17/52	Ptn 57 Robinson 82 IR	RMP	Section 74
3/A/19	City Deep	333/79 46/87	Ptn 612 Doornfontein 92 IR	Unicorn Property Holdings (Pty) Ltd	Section 90 SRP's Mennell's Dump

Description	Mineral rights holder	Licence and permit no	Title deed description	Freehold owner	Remarks
		74/84			
3/L/23	City Deep	A 17/52	Ptn 57 Robinson 82 IR	RMP	Section 74
3/L/40	City Deep	59/75	Ptn 171 & 83 Doornfontein 92 IR	City Deep	Section 90
3/L/42	City Deep	59/75	Ptn 171, 82 & 83 Doornfontein 92 IR	City Deep	Section 90
3/L/43 (Incl. 3/L/44 material north of N17)	City Deep	1886/68	Ptn 1 Klipriversberg 106 IR	City Deep	67/77 (Section 90)
3/L/44 (South of N17)	City Deep	219/39	Ptn 1 Klipriversberg 106 IR	City Deep	Section 68 & 70
Dumps in present ore reserve, currently considered uneconomical to reclaim					
4/L/2	City Deep	294/79	Ptn 86 & 95 Doornfontein 92 IR	City Deep	Section 90
4/L/3	City Deep	A 110/44	Ptn 35 Elandsfontein 107 IRP	Central Warehousing	52/48 & 186/77 (Section 90)
4/L/4	City Deep	A 33/54	Ptn 34 Elandsfontein 107 IRP	Central Warehousing	Section 90
4/L/6	City Deep	A 49/54	RE Elandsfontein 107 IR	Industrial Zone Ltd	

Description	Mineral rights holder	Licence and permit no	Title deed description	Freehold owner	Remarks
		A 50/54 A 72/22			
41/L/17	City Deep	7/76	Ptn 125 Doornfontein 92 IR	Pediva Investment CC	Section 161
3/L/47	City Deep	333/79	Ptn 612 Doornfontein 92 IRP	Unicorn Property Holdings (Pty) Ltd	Section 90 SRP Menell's Dump
4/L/17	City Deep	7/76	Ptn 151 Doornfontein 92 IR	Pediva Investment CC	Section 161
Dump ZZ	City Deep	Licence no 181 – 6/76	Ptn 151 Doornfontein 92 IR	Pediva Investment CC	Section 161

3.6 Project Processes

The project processes followed for the City Deep EIA/EMP mining right application have been in accordance with the MPRDA Regulations of April 2004. The following processes have been followed:

- Compilation of an EIA – done in accordance with regulation 50 of GN R527 of April 2004; and
- Compilation of an EMP - done in accordance with regulation 51 of GN R527 of April 2004.

3.7 Description of the Project

3.7.1 Mineral deposit

Table 3.4 shows the sites that will be reclaimed. The deposits that will be reclaimed are historically deposited gold plant residues in the form of sand dumps, tailings dams and material naturally eroded from these in the past, which was deposited in the Natalspruit Valley (known as the "Rosherville Silts"). Plan 2 shows the dumps associated with the City Deep operation.

3.7.2 Mining method

The slimes dams are currently and will continue to be recovered through hydraulic monitoring. The slimes are then pumped from the site being reclaimed to the plant for processing.

Two options exist to reclaim the sand deposits. They can either be hydraulically monitored or mechanically reclaimed on to conveyors which feed via screening devices into hoppers where the material is pulped and pumped to the plant.

3.7.3 Mine products

Gold will be the primary product produced during the reclamation of the slimes and sand dumps. The land being cleared could be seen as a secondary or consequential product.

3.7.4 Gold markets

South Africa is one of the world's largest gold producers and gold is one of South Africa's most important commodities and makes an important contribution to the country's economy.

The gold produced during the reclamation of the tailings and sand dumps are sold to Rand Refineries.

3.7.5 Production rate

The plant throughput rate is approximately 200 000tons per month and about 130 000tons are processed monthly.

3.7.6 Life of project

See Table 3.4 for the reclamation schedule for each dump. The estimated reserve for the City Deep operation is 5.3million tonnes.

The gold extraction carbon-in-leach plant and infrastructure may however continue treating material from other sources, subject to the viability of treating these materials at the time.

Table 3.4: City Deep reclamation schedule

Reclamation site	Planned reclamation until
City silt	2011
4A11	2011
3A17	2009
Mennels sand	2009
4A9	2011
4L26	2010
4L1 west	2010
4L1 south	2010
Mennels slime	2010
3L45	2010
4L25	2011

3.8 Servitudes and Infrastructure

The City Deep operations are located within the urbanised Central Witwatersrand. This area contains a substantial amount of infrastructure such as roads, railway lines, power lines, telephone lines and water reticulation systems. Servitudes do exist to protect this infrastructure where necessary. The details of these servitudes can be requested from the mine offices.

The land use adjacent to the mining operations varies but generally comprises existing industrial, commercial or residential areas and undeveloped land. The big amount of adjacent landowners makes it impractical to provide a list of the companies and individuals.

3.8.1 Water pollution management facilities

The City Deep operations do not have a sewage plant or polluted water treatment facility. The sewerage flows into the Johannesburg municipal sewage network. Surface water is removed from the tailings dams by penstocks and conveyed via open gravity trenches to return water dams from where the water is pumped back to the plant. Spillage dams are in place to contain spillages and spillage paddocks are placed behind areas being reclaimed. Measures for the separation of clean and dirty water are also in place.

3.8.2 Potable water supply

All the potable water is supplied by Rand Water via an existing reticulation system.

3.8.3 Process water supply

Process water is received from the return water dams and the spillage dams on the reclamation sites.

3.8.4 Mineral processing plant

The City Deep plant is situated on Heidelberg Road, south of the M2, and treats approximately 130 000tons per month of material reclaimed from old sand dumps and tailings dams.

Material is pumped from the respective reclamation sites to storage tanks in the plant. The slurry is then fed to cyclone classifiers. The fine overflow product is then thickened while the coarse underflow is milled. The milled product reports to thickeners.

The thickener underflow pulps are combined and pumped to the leach section where a standard Carbon-in-leach (CIL) circuit is operated. The activated carbon is eluted using a modified Anglo American Research Laboratories (AARL) process.

The gold recovered is smelted into bullion for subsequent dispatch to the Rand Refinery.

The CIL residue slurry is pumped from the residue tank to the Crown Mines Plant residue tank. All spillage in the plant is contained within bunded areas with strategically placed spillage pumps.

3.8.5 Workshop, administration and other buildings

A collection of buildings is in place at the City Deep plant. These include amongst other the main and plant administration offices, a variety of workshops, security offices, changing/ablution facilities and stores.

3.8.6 Transport

The major transport method is via pipelines from the various operating sites to the plant and from the plant to the deposition sites. The main pipeline reticulation is shown on Plan 2.

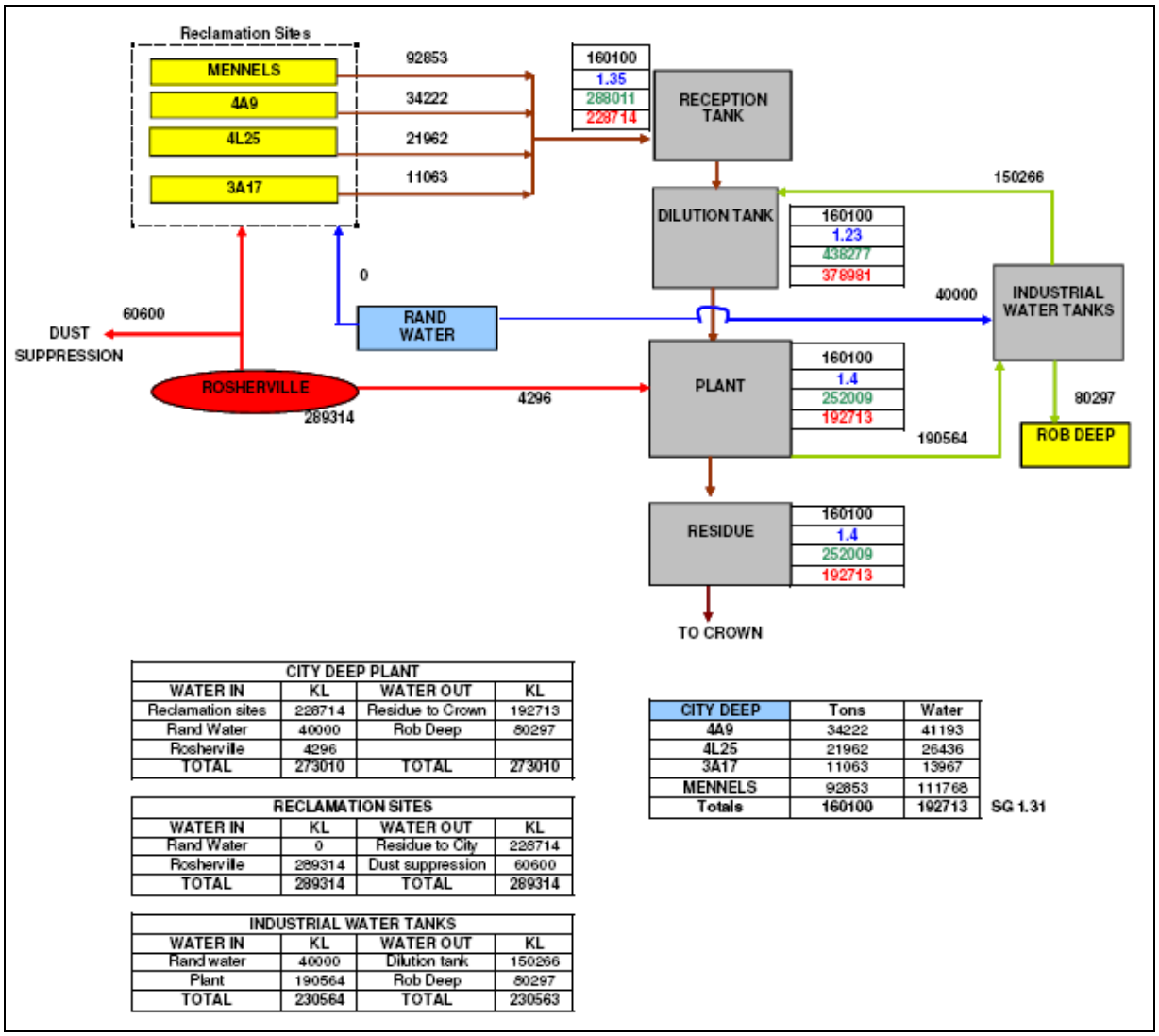
Cyanide is brought to the plant five times per week in a commercial 25 000litre capacity road tanker. The cyanide is transferred pneumatically from the tanker into a storage tank contained within a concrete bund wall. The off-loading area itself has a concrete bund wall around it.

Lime (1 500tons per month) is also brought in by commercial haulers. The majority of the lime is slurried immediately for use. A 100ton capacity storage silo contains lime as a back-up supply.

Other raw material inputs also come in by truck but they require no special environmental precautions other than those in place for safety reasons.

Screen oversize and in some cases rock will be trucked from the reclamation sites to a designated site at the City Deep plant.

3.8.7 Water balance



CITY DEEP PLANT			
WATER IN	KL	WATER OUT	KL
Reclamation sites	228714	Residue to Crown	192713
Rand Water	40000	Rob Deep	80297
Rosherville	4296		
TOTAL	273010	TOTAL	273010

RECLAMATION SITES			
WATER IN	KL	WATER OUT	KL
Rand Water	0	Residue to City	228714
Rosherville	289314	Dust suppression	60600
TOTAL	289314	TOTAL	289314

INDUSTRIAL WATER TANKS			
WATER IN	KL	WATER OUT	KL
Rand water	40000	Dilution tank	150266
Plant	190564	Rob Deep	80297
TOTAL	230564	TOTAL	230563

CITY DEEP	Tons	Water	
4A9	34222	41193	
4L25	21962	26436	
3A17	11063	13967	
MENNELS	92853	111768	
Totals	160100	192713	SG 1.31

Figure 3.1: City Deep water balance

The general layout of the major water reticulation, for Crown Mines and to City Deep, is shown in Figure 3.1. Water used for reclamation is pumped from Rosherville. The plant receives water from the reclamation sites and make up water is sourced from Rand Water. An inter-relationship exists between the Crown Mines and City Deep in that the residues from City Deep are pumped via Crown residue tanks to the tailings dams. Return water from the tailings dams is utilised by the Crown plant. This results in all make-up water at City Deep being supplied by Rand Water. A pipeline has been installed to allow excess water from the tailings dam at Crown Mines to be pumped to City Deep plant.

3.8.8 Disturbances of water courses

Reclamation at the Rosherville Silts site will involve the disturbance of the local water drainage system. Both the detailed water control to be implemented at this site and the reclamation plan will be described in a dedicated EIA/EMP.

3.8.9 Proposed river diversion

3.8.9.1 Rosherville Silts

The Rosherville Silt deposit in the old Rosherville Dam which originally retained water for mining operations is situated on the Natalspruit.

As soon as the planning is completed, an amendment to the EMPR will be submitted for approval which will provide details of how the normal flow and storm water flow in the river will be managed.

3.8.9.2 3/A/17 Sand Dump and 3/L/45 Tailings Dams

The stream that used to drain the Wemmer Pan Dam flowed through the centre of 3/A/17 dump. This was diverted in the 1920's by a drainage channel west of 3/L/44 to link up with the present stream flowing south of the 3/A/17.

3.8.10 Storm water

The storm water retention structures (for example paddocks and berms constructed on cleared sites) are designed on the "rule of thumb" used for these structures on top of slimes dams which is: "build a one metre high berm for every half metre change in elevation". This ensures that a 1:100 year Witwatersrand storm event will be retained with a half metre freeboard. The original design calculations which arrived at this conclusion were done many years ago for slimes dam tops and are not traceable today.

Storm water diversion structures, to stop storm water from flowing onto the reclamation sites, are not routinely designed. They usually consist of a trench upslope of the site which is simply excavated. The main reason for this is that if the trench overflows onto

the site, the water can usually be retained in the water system and/or the berets constructed down slope of the reclamation pumps. The mine accepts the risk in this event of the site being out of production for a few days until the water can be pumped back to the plant.

3.9 Waste Management

3.9.1 Solid waste management facilities

The City Deep Operation utilises the same disposal areas for its tailings as Crown Mines. These tailings dams include 3/L/5 Homestead/Diepkloof, 3/L/7 Mooifontein and GMTS. There are no industrial or domestic waste disposal sites as this type of waste is collected and disposed of by the Johannesburg Municipal Services.

3.9.2 Mine residue

There are three residue disposal sites, 3/L/5 (Homestead / Diepkloof tailings disposal dam), 3/L/7 (Mooifontein tailings disposal dam) and 3/L/8 (GMTS tailings disposal dam).

3.9.2.1 Tailings disposal methods

Tailings disposal on the three dams follows the conventional hydraulic technique with daytime disposal being used to construct the day walls and disposal at night being into the central basins. Surface water is removed by penstocks and conveyed via open gravity trenches to return water dams from where the water is pumped back to the plant. Typical disposal tonnages for each dam are shown in Table 3.5.

Table 3.5: Typical tailings disposal tonnages

Dam	From Crown mines	From City Deep	Total tons/day
3/L/5 Homestead/Diepkloof	5 000	2 500	**7 500**
3/L/17 Mooifontein	4 000	2 000	**6 000**
3/L/8 GMTS	6 000	3 000	**9 000**
TOTAL	**15 000**	**7 500**	**22 500**

All three tailings dams were built by the original Crown Mines operation and they were therefore in existence before the current reclamation project commenced. After the project started, Homestead/Diepkloof and Mooifontein were upgraded from a stability and seepage control point of view. This involved placing a plastic lining, manufactured from 100micron thick HDPE sheeting; over the entire old dump surface and constructing a drainage and seepage collection system on top of the lining. Sliming on top of the lined dam then commenced.

Sliming on GMTS dam simply continued over the original surface of the dam. An under drained slime buttress is currently under construction against the northern and western walls of this dam to upgrade it so as to increase dam stability and intercept groundwater seepage.

3.10 Phases of the Project

3.10.1 Construction phase

The construction phase will be brief as no permanent structures will be constructed on the reclamation sites. The equipment and facilities necessary for the reclamation of the dumps will only be temporarily on site. These include security facilities, electricity sub-stations, portable toilet facilities, storm water control measures, portable water supplies and slurry pipelines from the reclamation sites to the City Deep plant.

There will be no need for the construction of a tailings facility and a plant since the existing 3/L/5 (Homestead/Diepkloof), 3/L/17 (Mooifontein) and 3/L/8 (GMTS) tailings dams will be used for the disposal of waste and the City Deep plant will be used to process the material.

3.10.2 Operational phase

During this phase the reclamation material will be removed from the sand and slimes dams and transported to the City Deep plant to be processed. The different techniques for reclamation include hydraulic reclamation and mechanised removal. Process water will be used to wet the material.

Material will be pumped from the respective reclamation sites to the storage tanks in the plant. The slurry will then be fed to cyclone classifiers. The fine overflow product will then be thickened while the coarse underflow is milled. The milled product reports to the thickeners.

The thickener underflow pulps are combined and pumped to the leach section where a standard CIL circuit is operated. The activated carbon is eluted using a modified AARL process.

The gold recovered is smelted into bullion for subsequent dispatch to the Rand Refinery.

The CIL residue slurry is pumped from the residue tank to the Crown Mines Plant residue tank. All spillage in the plant is contained within bunded areas with strategically placed spillage pumps.

The material will be processed in the City Deep plant to produce gold and its associated by-products. The waste that is produced from this process will be transported via a pipeline to the 3/L/5 (Homestead/Diepkloof), 3/L/17 (Mooifontein) and 3/L/8 (GMTS) tailings dams.

3.10.3 Decommissioning and closure phase

After all the material has been removed from a site, the temporary equipment and facilities will be removed. The site will then be rehabilitated to a status acceptable for urban development.

3.11 Mine Surface Layout

The surface layout of the whole mine is shown on Plan 3.

3.11.1 3/A/17 Sand dump and 3/L/45 Tailings dam

Both the sand dump (3/A/17) and slimes dam (3/L/45) are located south-east of the City Deep plant. The tailings dam is to the south-east of the sand dump. The only vegetated portions are the remaining north eastern slopes of the sand dump.

Reclamation of the sand dump was initially done by taking three horizontal cuts using front-end loaders and loading the sand onto conveyor belts. The material was then screened and pumped to the plant. Reclamation of the tailings is done by hydraulic monitors. Front-end-loaders are used at the "Basin" site, but due to the low working face at the "Bottom" site, an excavator is used for the reclamation. This material is currently fed onto a conveyor, screened and pumped directly to the plant. The site is used for make-up tonnages.

Both 3/A/17 and 3/L/45 were deposited on the Natalspruit tributaries which were fed by the overflow from Wemmer Pan. This stream was diverted in the 1920's, by means of a canal, excavated in a southerly direction to link up with the present stream flowing south of 3/L/44, 3/L/45 and 3/A/17.

All storm water is presently contained on site by beret walls located on the southern portion of both 3/L/45 and 3/A/17. Storm water in the northwest corner is contained by the present reclamation face. Excess water in the northern region is caught by the storm water channel and diverted eastward into the pollution pump paddock. No storm water

enters the site from the western areas as this is prevented by the Wemmer Pan embankment.

Storm water from the (Old) City Plant area is retained by berets on the site. Storm water from the City Silts area is allowed to flow out of the vlei and is discharged via a storm water trench, into the Natalspruit. This has been agreed to by the Department of Water Affairs (Recorded in an action document dated June 1993 following a site visit by DWAF and City Deep representatives). The reason for allowing this was to prevent this water flowing over the whole of the site and causing uncontrolled seepage of acid water along a wide front of the southern edge of the 3/A/17 and 3/1145 dump complex. The trench itself is cut into relatively oxidised material and therefore was not expected to generate a significant salt load.

With all the water being contained on site and the existing water within the dump, seepage is a pollution problem. Toe paddocks exist in the eastern area to catch seepage as well as a drainage trench which has been excavated around the base of the eastern slope to channel water into the main catch paddock. This water is pumped continuously into the plant water circuit.

Various trenches are excavated on an ongoing basis on site to direct all storm water and seepage to the main catch paddock and thereby assist the reclamation operation.

3.11.2 4/A/7 Sand dump and 4/L/16, 4/L/17 West tailings dam

The reclamation site is situated north of the M2, just west of the Cleveland off ramp. Reclamation started at the end of 1992 and was completed by July 1994.

The dump was sparsely vegetated before reclamation began.

Storm water from the north and west of the site is diverted into a storm water channel, through the culvert in the southwest corner and into the marshland west of 4/A/8. Storm water from the north-east flows in the storm water channel between the reclamation site and 4/L/17 East and through the culvert east of the dump "7.7," (south of the highway)

finally converging with the water from the west channel, flowing ultimately into the Rosherville Dam. Berets have been constructed to contain storm water on site.

The embankment of the eastern storm water channel has been profiled and is currently being vegetated. Permanent berets are being constructed on site. Good water control will result. Presently a large amount of rock is on site and negotiations are in progress with the freehold owner.

3.11.3 4/A/8 Sand dump

The site is located west of 4/L/2. Reclamation of both sand and slime is complete. Final clean-up will be done mechanically and is scheduled for 1995. The marshland west of the site is not affected by operations on the 4/A/8 site, as all the water is contained on site. Storm water from the north of the site flows through the marshland, into the culvert under the railway lines and finally into the Rosherville Dam. Storm water to the north-east of the site, originating from 4/A/9 is channelled into a storm water trench, fanning out to be caught in three evaporation dams.

3.11.4 4/A/9 Sand dump and 4/L/ZS Tailings dam

The sand dump and tailings dam are situated immediately south of the Cleveland off ramp and east of the 4/A/8 site. The sand dump was originally deposited on top of the tailings dam.

The dump is well vegetated, but is scarred by the presence of the excavated road. The road has been bermed off at regular intervals to prevent erosion. Vegetation is well established on the 4/L/25 tailings dam and "top" water control is good. A rock/sand cladding on the slopes of the sand dump is preventing excessive erosion.

Storm water runoff to the west of the dump flows into a storm water trench and is caught by three evaporation dams south-west of the site. The runoff from the south and eastern side of the dump is contained by paddocks on the top of 4/L/25. Runoff originating east of 4/L/25 flows into a trench through the culvert under the railway line.

Reclamation of this sand dump and tailings dam has not been planned yet and an amendment to the EMPR will be submitted prior to reclamation.

3.11.5 4/A/11 Sand dump and 4/L/26 Tailings dam

The sand and tailings deposits are situated adjacent to each other on the site. The sites are located south of the M2 and south-west of the Geldenhuis interchange. A pre-cast wall exists at the toe of the western slope of 4/A/11 and forms the boundary line of adjoining factories. The southern boundary of both 4/A/11 and 4/L/26 is on the railway reserve.

The top of 4/L/26 is well vegetated in the northern area. Vegetation towards the south gets sparse.

The 4/A/11 sand dump is well protected from erosion by rock cladding on the north-east, south, south-west and north-west slopes. Vegetation is well established on the south-east slope and on the top of the dump. The mid-western slope, where no rock cladding exists, erosion has taken place with the run-off accumulating against the western pre-cast wall.

Reclamation started in August 1994. The sand is mechanically reclaimed with front-end-loaders onto a conveyor and screening unit. The screen underflow is then pumped to the tank farm and the oversize and rock is transported by conveyor and discharged onto the rock dump. The slime is reclaimed using hydraulic monitors, screened, and pumped to the tank farm. The combined slurry of sand and slime is pumped via the 4/A/8 tank farm to the plant. Storm water on top of 4/LJ26 accumulates in the depression forming an evaporation dam. The water run-off east of 4/L/26 flows into the concrete storm water drain along the N3 highway. The run-off south of the tailings dam via the large erosion channel is contained by a retaining wall and paddocks.

Storm water run-off on the western side of 4/A/11 runs southwards along the pre-cast wall and eastwards into the storm water furrow next to Lower Germiston Road. The run-off from the southern slopes is diverted eastwards into a natural channel next to the railway line and then southwards through the culvert under the railway line.

3.11.6 "XX" Tailings dam

The dump is situated south of Nourse plant and north of 4/L/l. Rubble and rock covers the dump in certain areas. Vegetation is present on the dump. Storm water flows with the slope of the land eastwards. An amendment to the EMPR will be submitted prior to reclamation.

3.11.7 4/L/1 Tailings dam

This tailings dam is situated east of 3/A/19, west of 4/L/2 and north of the railway line. The top and sides are well vegetated, but the run-off from the top of the dump in the southern area has badly eroded the access road. A berm constructed on the road has washed away.

Storm water to the east and north-east of the site flows with the natural ground slope eastward to link with the storm water channel west of 4/L/2 and flows southwards linking with the flow into the Rosherville Dam. Any water run-off west of the site flows into the erosion channel and southwards into the railway reserve. Small paddocks exist below the southern slopes of the tailings dam. As soon as reclamation planning is completed an amendment to the EMPR will be submitted.

3.11.8 4/L/17 East tailings dam

The tailings dam is situated east of the 4/A/7 - 4/L/17 West reclamation site.

Only the north western portion of the dump has been reclaimed. It was reclaimed as an extension of the 4/A/7 - 4/L/17 West reclamation site using hydraulic monitors. The dump is poorly vegetated east of the storm water channel. Small paddocks exist on the eastern side of the dump. The storm water on the eastern side flows through the culvert under the M2 and converges with the water from the western side of the dump. The runoff from the northern and north western section discharge water directly into the stream. Prominent toe paddocks exist along the western side of the dump. Well defined berms exist on top of the tailings dam providing good "top" water control. The new faces

created as a result of the reclamation will be profiled at 26˚, stabilised and suitably vegetated.

3.11.9 Rosherville silt

This silt deposit is situated south of 2/A/9, 4/L/1 and 4/L/2 and the railway line. The silt is covered by reeds and the water flows southwards with the outflow over the old dam wall. Test work conducted shows that the water quality into and out of the area is the same. The inflow into the marshland is sourced from water runoff to the north from the areas 3/A/19, 4/L/2, 4/A/8, 4/A/9 and 4/A/7 dumps as well as on the western side from City Deep 2 Shaft area.

The railway line in the north is protected by a 3 m high embankment and the railway yard to the south-west is protected by a 2 m high embankment.

3.11.10 Jupiter plant

The site is situated south of the M2 near the Geldenhuis interchange. It lies east of the toe of 4/A/11 and north of 4/L/26. The area has been reclaimed to the original ground level as part of the site establishment for the infrastructure and rock dump of the 4/A/11 - 4/L/26 project. It was reclaimed using excavators, and trucked onto the top of 4/L/26. Reclamation of this material was completed in April 1994.

The area was well vegetated and was covered, in parts, by concrete rubble and refuse. All the trees in the area were removed, except for those in the northern area along the M2 which were left for both visual and wind protection reasons.

The 8 000t of ash on the toe of the sand dump has been used to construct the toe of the rock dump. All storm water is diverted from the site as explained for "4.3.2.6 4/A/11 Sand Dump and 4/L/26 Tailings Dam". All water on the site is contained. Runoff from the excavated material deposited on 4/L/26 will collect in the evaporation dam in the south-east corner.

The material has been dumped against the western slope of 4/A/11. This will minimise windblown dust pollution by the prevailing north-west winds.

3.11.11 City silts

The material is located south of the (Old) City Plant, east of 3/L/43 and west of 3/L/45. The material constitutes runoff from the old reduction work and the dumps in close proximity. The material is partially covered by reeds, blue gum trees and rubble. The depth varies from 1.5m to 4m.

The tonnage is estimated at 30 000tons.

Storm water runoff from 3/L/43 and 3/L/44 collects in the vlei and this water is allowed an unobstructed flow into the Natalspruit. As soon as reclamation planning is complete an amendment to the EMPR will be submitted.

3.11.12 (Old) City plant

The plant site is situated south-west of the present City Deep plant and west of 3/A/17. Most of the site is covered by remnants of the old buildings, foundations and corrugated iron clad structures.

The current deposit will be reclaimed systematically, high grade material being stockpiled and low grade processed in the metallurgical plant. Storm water is contained on site owing to the natural elevation of surrounding areas. As soon as reclamation planning is complete, an amendment to the EMPR will be submitted.

3.11.13 Nourse plant

The plant site is situated south of the M2, north of dump 3/L/47 and to the north-east of 3/A/19. The site is well vegetated with trees and natural grass. The site has been left untouched since the demolition of the old structures. Foundations and remnant concrete are still on site. Storm water from the area is uncontaminated by virtue of the fact that the

area is well vegetated. The runoff flows into a channel east of 3/A/19 and into the railway reserve.

Reclamation scheduling has not been planned as yet and an amendment to the EMPR will be submitted

3.12 Mining Restrictions

According to Regulation 17 (6) of the Mine Health and Safety Act, 1996 (Act 29. of 1996): The employer must ensure:

17(6) a: No mining operations are carried out under or within a horizontal distance of 100 (one hundred) metres from buildings, roads, railways, reserves, mine boundaries, any structure whatsoever or any surface, which may be necessary to protect, unless a shorter distance has been determined safe by risk assessment and all restrictions and conditions determined in terms of the risk assessment are complied with;

17(7): No person may erect or construct any buildings, roads, railways, or any structure within a horizontal distance of 100 (one hundred) metres from the workings of a mine, or such lesser distance and at such positions and subject to restrictions and conditions , determined by-

17(7) a: risk assessment; or

17(7) b: The Chief Inspector of Mines.

According to GN 704, regulation 4(Restrictions on locality) No person in control of a mine or activity may, 4 (b) except in relation to a matter contemplated in regulation 10, carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100m from any watercourse or estuary, whichever is the greatest).

4 DESCRIPTION OF AFFECTED ENVIRONMENT

4.1 Climate

Climate data for the Johannesburg International Weather station (station number 047 63990) was sourced from the South African Weather Bureau.

4.1.1 Description of regional climate

The area falls under the Highveld climatic zone characterised by warm summers with rainfall. Winters tend to be mild to warm during the day to cold at night with sharp frosts.

Johannesburg has an annual average of between 8 and 10 hours of sunshine per day and is 1753m above sea level.

4.1.2 Mean monthly and annual rainfall and precipitation

Figure 4.1 and Figure 4.2 show the average monthly and total annual rainfall for the period 1996 to 2006. Precipitation occurs in showers and thunderstorms with the highest rainfall occurring during December, January and February. Rainstorms are often violent with severe lightning and strong winds, sometimes accompanied by hail. The winter months are droughty with the combined rainfall in June, July and August making up only 2.44% of the annual total (759.21mm).

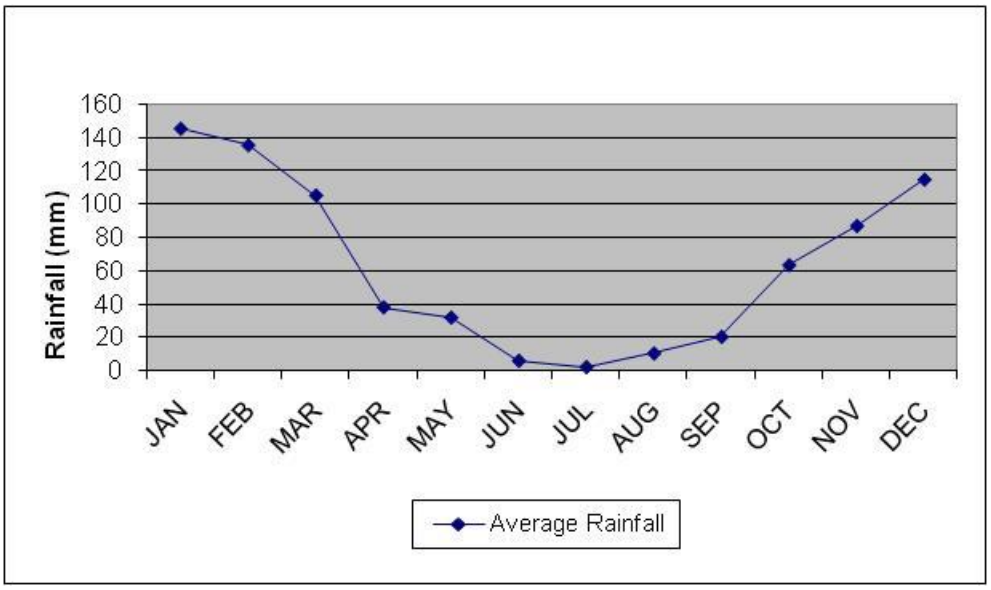


Figure 4.1: Average monthly rainfall (mm) recorded for the period 1996 to 2006 at the Johannesburg International Weather station (station number 04763990)

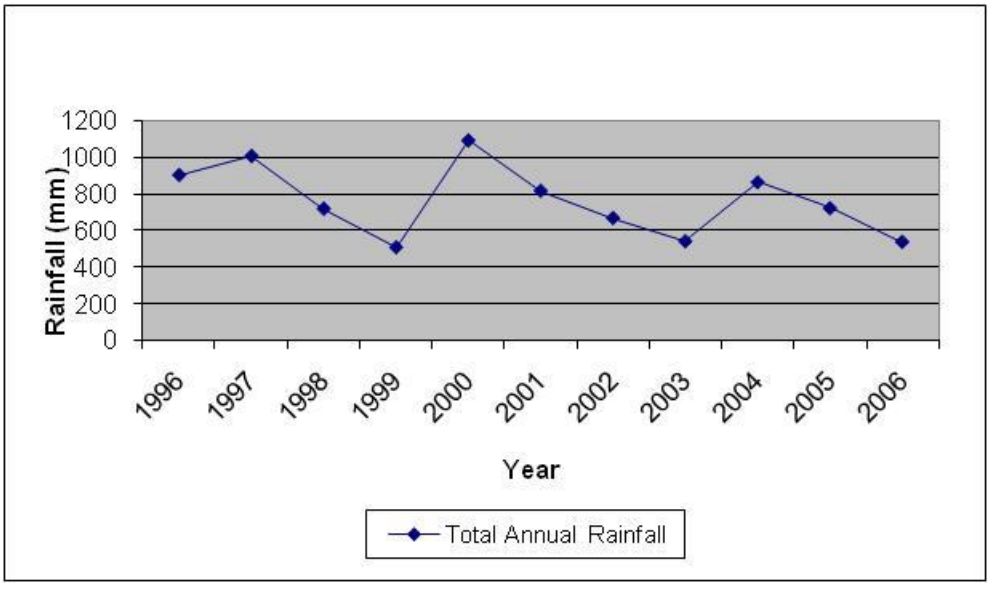


Figure 4.2: Total annual rainfall (mm) recorded for the period 1996 to 2006 at the Johannesburg International Weather station (station number 04763990)

4.1.3 Mean monthly maximum and minimum temperatures

The average daily maximum temperature in January (the hottest month) is 25˚C and in July (the coldest month) is 16.95˚C. The mean daily minimum in January was 14.32˚C and in July 3.1˚C (Figure 4.3).

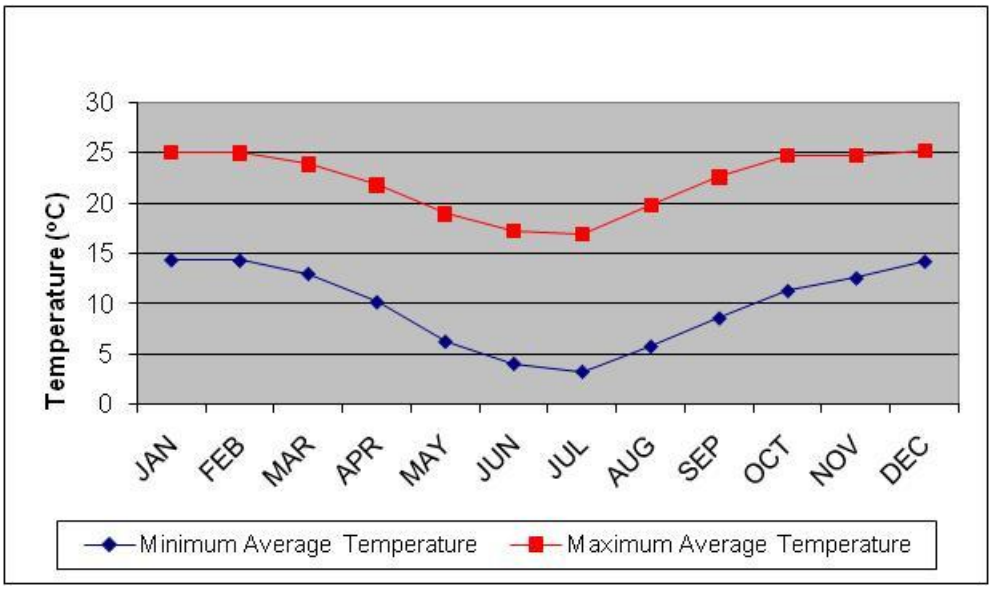


Figure 4.3: Average minimum and maximum temperature (ºC) for the period 1996 to 2006 at the Johannesburg International Weather station (station number 04763990)

4.1.4 Mean monthly wind direction and speed

Figure 4.4 shows the average wind speed throughout the year. According to this graph the wind speed increases from August to December and then slowly decreases.

No wind direction data was available for the Johannesburg International weather station. Data from the Vereeniging weather station was used. Figure 4.5 represents the annual wind frequency distribution for the Vereeniging station taking in all four seasonal fluctuations. The graph shows that the wind predominantly comes from a north-westerly direction.

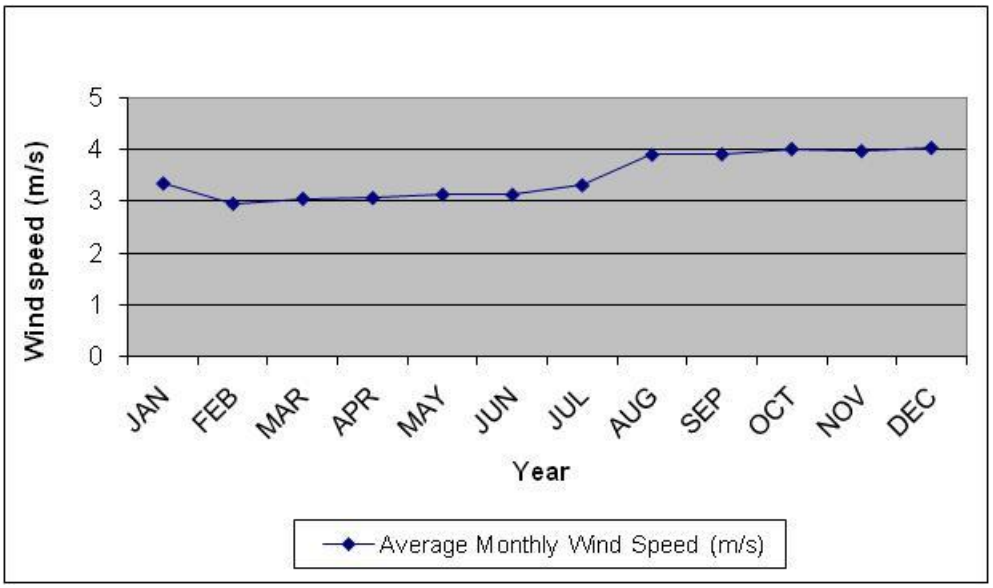


Figure 4.4: Average monthly wind speed (m/s) for the period 1996 to 2006 at the Johannesburg International Weather station (station number 04763990)

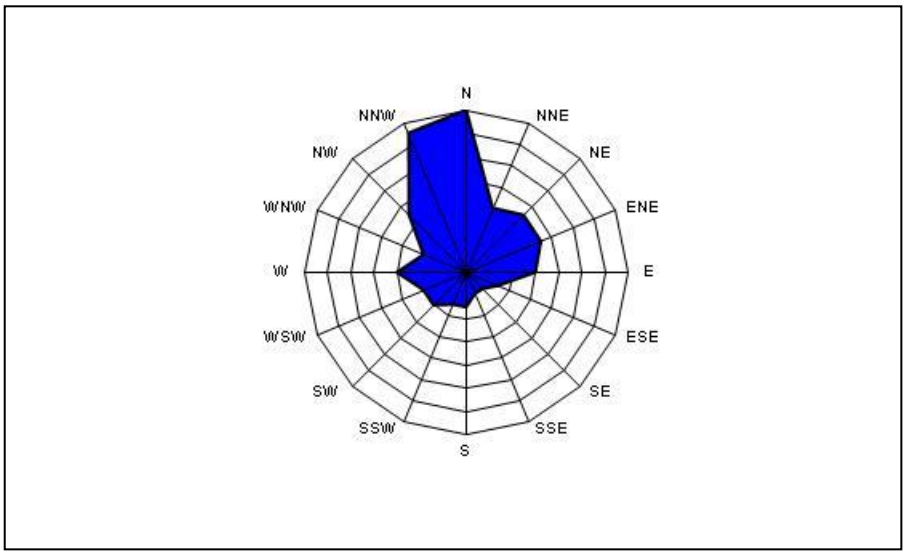


Figure 4.5: Wind direction as measured from the period 1990-2004 at the Vereeniging Climate station (station number 04387843)

4.2 Topography

Plan 3 shows the overall topography. Locally, the topography is dominated by urban structures and old mine residue deposits.

4.3 Geology

The general geology of the region is characterised by quartzite and conglomerates of the Central Rand Group of the Witwatersrand Supergroup. The conglomerates represent the gold bearing reefs and in the Johannesburg area under consideration, comprise the Main, Bird and Kimberley Reefs. These reefs have all been extensively mined during the course of this century. The regional dip of the beds is 30 to 60 degrees towards the south. Plan 4 shows the general geology of the area.

4.3.1 Presence of dykes, sills and faults that occur within the operational area

The bedrock has been extensively faulted and fractured due to natural geological processes with additional fracturing resulting from stope closure and brittle failure of hanging walls due to mining activities. The bedrock has also been extensively intruded by igneous bodies (i.e. dykes and sills) of various geological ages. Obtaining more geological information was considered not necessary because groundwater moves downwards and not laterally in this area due to the historical undermining of the groundwater zone.

4.3.2 Geology of the tailings dam sites

4.3.2.1 3/L/5 HomesteadlDiepkloof tailings dam

a) **Geology**: The area around the tailings dams is underlain by sedimentary and metamorphic rocks of the Central Rand Group, Witwatersrand Sequence, comprising shales and quartzite.

Locally these rocks are represented by quartzite of the Turffontein Subgroup, striking roughly ESE/WNW and dipping at approximately 55° SSW. Local variations in the steepness of the dip are common. Associated with the quartzites are conglomeratic bands or reefs, with the major reef in the area being Kimberley which passes directly to the north of Diepkloof.

The Witwatersrand Sequence has been intruded by diabase dykes and sills along bedding planes, faults and fractures. One such intrusion was intersected on the eastern side of Homestead dam. Although only one such intrusion was intersected, more such intrusions are possible due to the faulted nature of the Witwatersrand Sequence. A zone containing vein quartz and highly fractured quartzite was encountered on the western side of Homestead/Diepkloof. This is thought to represent a shear zone, possibly extending underneath the dam, striking roughly W-E.

b) **Stratigraphy:** A fairly consistent soil profile comprising a thin layer of silty sand hill wash followed by a gravel layer overlying residual quartzite was encountered over most of the site. A typical soil profile is given below:

- 0m – 0.5m: Slightly moist, light brown, loose to medium dense, silty sand; hill wash.
- 0.5m – 0.8m: Closely packed, sub-angular quartz and quartzite gravel and ferricrete nodules in a matrix of slightly moist silty sand. Overall consistency loose to medium dense. Transported.
- 0.8m – 1.2m: Slightly moist, reddish brown mottled yellow brown, medium dense, silty sand with runnels of sand and gravel from above with ferruginised zones; reworked residual quartzite.
- 1.4m +: Slightly moist, off-white banded reddish brown, medium dense jointed, silty medium and coarse sand; residual quartzite. Consistency improves with depth. Refusal with a small back actor occurred at an approximate depth of 1.7m on very soft rock to soft rock quartzite.

Quartzite outcrops were encountered along the short northern flank of Diepkloof and on the south western corner of Homestead. On the north-eastern corner of Diepkloof the hill wash layer was also not evident with the ferruginised gravel layer occurring from surface.

Due to the proximity of the stream a thin layer of slightly clayey sand of alluvial origin was encountered instead of the silty sand hill wash. The effluent trench is however, at

some distance from the tailings dam and it is expected that the toe of the tailings dam is underlain by the normal layer of silty sand hill wash rather than alluvium.

Associated with the shear zone and the diabase intrusion striking roughly east-west through the centre of the tailings dam, a deeper horizon of silty sand hill wash has been deposited. The depth of hill wash encountered extends to approximately 1,0m and is underlain by 0.3m to 0.7m of gravel or ferricrete before residual quartzite is encountered. The shear zone is characterised by the presence of vein quartz and the highly fractured nature of the quartzite rock.

4.3.2.2 3/L/7 Mooifontein tailings dam

a) **Geology:** The area around Mooifontein tailings dam is underlain by a sequence of sedimentary and metamorphic rocks comprising shales and quartzite of the Central Rand Group, Witwatersrand Sequence.

Locally these rocks are represented by quartzite of the Turffontein Subgroup, with dip approximately 55° SSW. Local variations in the steepness of the dip are common. Associated with the quartzite are conglomeratic bands or reefs, with two major reefs being the Kimberley and Elsburg Reefs. The Elsburg Reef is located to the south of Mooifontein, while the Kimberley Reef outcrops in the northern third of the tailings dam.

The Witwatersrand Sequence has been intruded by diabase dykes and sills along bedding planes, faults and fractures. Two such intrusions were intersected during the geological investigation of the tailings dam.

b) **Stratigraphy:** Three typical profiles were identified on site:

- A quartzitic profile which underlies a large part of the site;
- A contact profile, associated with either diabase intrusion, fault planes or contact zones; and
- An alluvial profile to the east of the site along the spruit in which the north and south dams on the Russel stream have been constructed.

Quartzitic profile

This profile is characterised by hill wash layer overlying residual quartzite. The hill wash generally comprises a brown, loose to medium dense silty sand with scattered fine gravel. Along the southern and western sides of the tailings dam the hill wash layer varies in depth from 1.0m to 3.5m. With depth, abundant ferricrete nodules and concretions and fine quartzite and quartz gravels occur. A basal pebble marker comprising sub-rounded quartzite gravel was noted in a number of test pits. Along the northern and north-eastern sides of the tailings dam the hill wash layer overlying the residual quartzite is on average 0.4m thick. Outcropping quartzite occurs along the northern third of the eastern side of the tailings dam. The residual quartzite generally comprises a dense to very soft rock, highly weathered, medium grained quartzite.

Contact profile

This profile occurs at the quartzite/diabase and quartzite/shale contacts and in the areas underlain by diabase dykes.

The profile is characterised by a thick hill wash layer of loose silty sand with scattered fine gravel which grades with depth to a clayey sand with abundant ferricrete concretions and fine gravel. The depth of the hill wash layer is generally in excess of 3m. The diabase, where it occurs, is generally weathered to firm clayey silt.

Alluvial profile

Alluvial soils are located along the eastern side of Mooifontein tailings dam. The spruit appears to be structurally controlled by a diabase intruded fault. The typical profile comprises light grey, slightly clayey silty sand approximately 4m thick overlying residual diabase in the form of yellow brown or red brown stiff clayey silt.

4.3.2.3 3/L/8 GMTS tailings dam

a) **Geology:** This is not significantly different from that at the Mooifontein site.

b) **Stratigraphy:** In contrast with the Diepkloof area, the silty sand hill wash layer covering the GMTS tailings dam area is generally in excess of 0.6m thick. A representative soil profile is given below:

- 0m – 0.8m: Dry, brown, medium dense, silty sand; hill wash.
- 0.8m – 1.2m: Closely packed ferruginised quartz and quartzite gravel in a matrix of silty sand. Overall consistency dense. Pebble marker.
- 1.2m - 2,0m: Slightly moist, reddish brown, dense, jointed, medium sand; residual quartzite. With depth the consistency improves to very dense.

A deep horizon of silty sand hill wash varying from 1.0m to 2.5m occurs along the northern side of GMTS. This is possibly associated with an extension of the diabase/quartzite contact underlying Homestead dam.

4.4 Soils

In general the soil consists of mainly hill wash materials, alluvium along watercourses and residual soils all derived from the underlying geology. The major constituents of the hill wash and residual soils are sand, fine gravels and minor silt, whilst in the water courses the alluvial deposits consist primarily of sand and clay with minor gravels. Locally developed pedogenic horizons of ferricrete and ferruginous soils are to be found, particularly along the margins of water courses and the capillary fringes of perched water. These soils are typically poor and acid, stony or sandy.

A description of the agricultural characteristics of the soils and a soil map are not applicable to this project because this is not an agricultural area and no more soil than has already been affected by past mining and urban development will be disturbed.

4.5 Surface water

4.5.1 Surface water quantity

The Vaal River Barrage catchment area of approximately 8 430km^2, extends to Johannesburg in the north, Leandra in the east, Heilbron in the south and Westonaria in the west. This catchment also includes the whole East Rand and the industrial Vereeniging/Vanderbijlpark areas, as well as Sasolburg.

4.5.1.1 Catchment boundaries

The City Deep operations falls into the headwaters of the Natalspruit sub-catchment, this in turn forms part of the Vaal River Barrage catchment area.

The Natalspruit headwaters catchment area is 60km^2 in surface area (0.71% of the Barrage catchment area) and includes Wemmer Pan. This forms part of Department of Water Affairs and Forestry's catchment No C22 1.

The affected catchment area will discharge water into the Natalspruit (affected water course) north of Alberton, upstream of the confluence with the Elsburgspruit. The Natalspruit eventually discharges into the Klipriver (receiving water body) at Waterval.

4.5.1.2 Mean annual run-off

The average mean annual precipitation for the area is 829mm/year. The average annual evaporation for the area is 1 929mm/year.

The average 24 hour storm rainfall for the area for various recurrence intervals is given in Table 4.1.

Table 4.1: Storm rainfall intensities

Recurrence interval	Rainfall intensity/24hrs
1/20 years	120mm
1/50 years	160mm
1/100 years	210mm

The run-off from the sub-catchment for the above recurrence intervals is given in Table 4.2.

Table 4.2: Run-off

Recurrence interval	Runoff m^3/sec Sub-catchment
1/20 years	50
1/50 years	67
1/100 years	89

4.5.1.3 Normal dry weather flow

The normal dry weather flow cannot be calculated due to the fact that there are no gauging stations which can be used for this purpose. On the basis of visual observations, it would appear that the watercourses are seasonal in nature up to the centre of Alberton where the Natalspruit becomes perennial shortly before it joins the Elsburgspruit.

4.5.1.4 Flood peaks and regional maximum flood (RMF)

Since the size of the affected catchment area falls between that for which the rational method and the hydrograph method would be applicable, both methods have been used. Table 4.3 gives the results.

The rational method predicts consistently higher flood peaks than the RMF method in this case. Since no infrastructure is at risk, no further refinement of these calculations was considered necessary.

Table 4.3: Flood peaks and RMF

Klipspruit sub-catchment			
Recurrence interval	**Rational flood peak**	**RMF flood peak**	**RMF**
1:20 years	390m^3/sec	-	775m^3/sec
1:50 years	484m^3/sec	314m^3/sec	
1:100 years	607m^3/sec	403m^3/sec	

4.5.2 Surface water quality

Rand Water analyses water quality on a monthly basis in the catchments of the Vaal Dam and the Vaal River Barrage. Some of these monitoring points are located in the Natalspruit, Elsburgspruit, Klipspruit and the Klipriver, and the average values of results from 1981 to 1991 are shown in Table 4.4.

Table 4.4: Natalspruit Average Water Quality at Rand Water Sampling Positions (Two stations on the Elsburg included for comparison) Except conductivity and pH, all units are in mg/1

Average values 1981 to 1991								
Determinant	**N2**	**N3**	**N4**	**N6**	**N7**	**N8**	**E8**	**E9**
Conductivity, mS/m	117.9	119.1	234.6	57.5	105.4	131.9	187.9	181.1
pH	6.2	3.4	3.4	8.2	4.1	7.7	5.5	7.2
Potassium, K	12.4	7.8	16.3	4.5	8.1	17.5	10.8	14.4
Sulphate, SO_4	550.3	1332.3	1288.5	89.9	500.6	498.6	1081.7	820.9
Chloride, Cl	80.3	43.5	162.7	37.0	52.1	97.5	82.0	84.4
COD	37.2	54.7	25.5	58.0	21.2	31.2	18.7	37.0
Alkalinity	28.1	1.6	0.3	122.5	3.3	111.2	11.9	106.2
Calcium, Ca	113.2	72.8	259.9	44.0	86.1	135.3	267.7	234.3
Magnesium, Mg	41.5	66.2	121.1	24.7	41.5	43.5	83.3	66.4
Sodium, Na	66.2	38.5	72.0	39.3	40.8	107.7	98.68	108.7
Iron, Fe	27.6	174.3	21.3	0.8	21.5	0.4	1.4	0.9
Manganese, Mn	7.7	10.1	39.8	0.4	8.1	0.9	4.7	2.7
SiO_2 total	12.0	19.7	17.3	22.3	15.2	12.6	13.1	14.5
Ammonia as N	3.9	1.6	5.3	1.5	2.4	2.1	1.9	1.8
Nitrate as N	1.2	3.3	1.2	11.5	1.8	3.6	3.9	1.8
TDS	-	-	-	-	-	-	-	-
Orthophosphate	-	-	0.1	1.7	0.2	1.4	0.1	0.4
Phosphate as P	-	-	0.5	2.5	0.6	1.9	0.4	0.7

Note should be taken of the high levels of sulphates at points N3 and N4 in the Natalspruit. The Low pH at these points, with its concomitant high solubility of heavy metals, can be seen in the high levels of particularly iron and manganese at these points.

No measurements were taken in the City Deep area prior to December 1993. One set of electrical conductivity (mS/m) measurements has been taken in the Natalspruit before the 3/A/17 site and in the feed streams to the Rosherville silts area. The conductivity increased around the 3/A/17 complex, but no signs of contamination was found coming from the 4/A/7 reclamation site. Sampling points and monthly sampling procedures have since been established. Table 4.5 gives a description of each sampling point. The water quality results for August 2008 are presented in Table 4.6.

Surface water monitoring at City Deep forms part of the Crown Gold Recoveries monitoring programme that is laid out in detail in the Water Management Plan. The locations of the monitoring points are shown in Plan 5. Water quality guidelines that are followed originated from the Klipspruit Catchment Forum and include the Water quality objectives for the Klipspruit Catchment and the South African Water Quality Guidelines for Domestic Use.

Table 4.5: Locations of surface water monitoring points

Sampling number	Description of point	Monitoring reason
CD1	Upstream of Basin reclamation site.	Obtain an upstream value before the Basin impacts on the stream.
CD2	Downstream of Basin reclamation site.	Determine the impact of the Basin on the stream.
CD3	Maretzel reclamation site inlet.	Obtain an upstream value before the Maretzel site impacts on the stream.
CD4	Maretzel reclamation site outlet.	Determine the impact of the Maretzel reclamation site on the stream.
CD5	Rosherville dam outlet.	Impact of the Rosherville dam on the downstream.
CD6	South side 4A11.	Determine the impact of 4A11 on the stream.

Table 4.6: Water quality results for the City Deep Operations (August 2008)

		CD1	CD2	CD3	CD4	CD5	CD6
pH		7.15	6.49	11.86	11.32	7.11	5.81
Conductivity	mS/m	67	39	345	226	26	42
T.D.S	mg/l	445	260	2280	1490	170	275
Total suspended	solids	0.037	0.024	0.11	0.002	0.002	0.024
Alkalinity	P mg/l	NIL	NIL	NIL	NIL	NIL	NIL
Alkalinity	mgCaCO3/l	63	32	888	495	24	14
Calsium	Hardness	102	52	332	338	202	75
Magnesium	Hardness	191	67	122	73	63	106
Total	Hardness	293	119	454	411	265	181
Fluoride	mg/l	<0.01	<0.01	<0.01	0.11	0.37	0.25
Chloride	Cl mg/l	0.5	0.9	3.1	1.9	0.5	0.4
Nitrites	NO2- mg/l	0.7	0.56	1.05	0.63	0.21	0.42
Nitrates	NO3- mg/l	1	0.8	1.5	0.9	0.3	0.6
Nitrog N	mg/l	4.4	3.52	6.60	3.96	1.32	2.64
Phosphate	P mg/l	4.40	4.10	4.10	4.10	4.00	4.20
Sulphate	SO4-mg/l	260	150	550	470	20	190
Total Phosphorus	P	41	21	133	135	81	30
Arsenic	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Calsium	Ca mg/l	39	30	38	137	118	88
Chromium	mg/l	0.2	<0.01	<0.01	0.2	0.1	<0.01
Copper	Cu mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	Fe mg/l	0.1	<0.01	<0.01	<0.01	<0.01	0.2
Manganese	Mn mg/l	0.1	2.1	<0.01	<0.01	1.0	8.4
Sodium	mg/l	20	34	480	260	26	16
Nickel	N mg/l	<0.01	0.1	<0.01	<0.01	0.1	0.7
Potassium	K mg/l	5.48	3.7	5.36	3.50	2.82	1.03
Lead	Pb mg/l	<0.01	<0.01	<0.01	0.1	0.1	<0.01
Zinc	Zn mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.4
Total Cyanide	CN	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aluminium	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	Cd mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Note: The values in red indicate than the value is above the allowed limit.

4.5.3 Drainage density

The drainage density, recorded as kilometres of natural drain path per square kilometres of catchment area, is 0.58km/km^2 for the affected area. Unnatural forced storm water drainage in the built-up areas (approximately 50% of the catchment), significantly contributes to the overall runoff in the area.

4.5.4 Surface water use

Since the area is supplied with water by the local authority via Rand Water, the most significant surface water users are aquatic life and recreational use.

4.5.5 Water authority

The Department of Water and Environmental Affairs (Gauteng Region) exercises control over the catchment in terms of water rights, allocation of water and water quality management. Rand Water is responsible for water supply and assists with water quality management.

4.5.6 Wetlands

The wetlands in the affected area are either partly or completely silted up with a mixture of eroded gold tailings, urban runoff solids and silt derived from soil erosion. Aerial photographs indicated that the drainage in these areas was free-flowing prior to urbanisation. There are no significant wetlands affected by the operation at this time.

4.6 Groundwater

4.6.1 Groundwater quantity

4.6.1.1 Water levels

Due to mining activities, there is no longer a natural water rest level in the conventional geohydrological sense. Rather, the de-watering by the mines, maintains an artificial water level. The water level in the Central Witwatersrand Water Compartment is currently

maintained at approximately 586m above mean sea level (msl) or 1 122 metres below ground level, (ground level assumed to be 1 708m above msl).

The degree of infiltration through the superficial soils is expected to be high, resulting in a seasonal perched water table at the bedrock interface and/or on locally developed pedogenic horizons. The permeability of the hill wash materials can be expected to be in order of 10.4 to 10.6cm/second, whilst that of the alluvium to range from 10.6 - 10.8cm/second. This is in contrast with the permeability of the bedrock which is much lower than that of the hill wash and residual sandy soils, thereby allowing the accumulation of water at the soil/bedrock interface.

4.6.2 Presence of boreholes and springs

There is no known record of boreholes utilising the natural water table in the mining area.

4.6.3 Groundwater quality

The quality of deep level groundwater in the mining area varies considerably so a range of data is presented in Table 4.8 to Table 4.11. Table 4.7 indicates the sample location and date.

Table 4.7: Sampling details

Sample	Locality	Sampling
1a	Defunct mine "a" in the Central Wits compartment.	June 1993
4a	Defunct mine "a" in the Central Wits compartment	September 1993
1b	Defunct mine (different from "a") in Central Wits compartment	June 1993
4b	Defunct mine (different from "a") in Central Wits compartment	September 1993
2	Central Wits compartment at ERPM	June 1993
3	Kimberley Reef Basin at Crown Mines Golf Club	July 1993

Note: The Kimberley Reef Basin is not linked hydraulically to the Central Wits compartment.

(R. Scott, Institute of Groundwater Studies, Bloemfontein)

Table 4.8: Chemistry (major elements) of water in the Central Witwatersrand Compartment

N°	pH	EC mS/m	Ca mg/l	Mg mg/l	K mg/l	Na mg/l	Fe mg/l	SO_4 mg/l	Cl mg/l
1a	2.77	1 093	390	759	2.8	173	674.9	13 927	266
1b	2.68	592	376	143	11.6	356	230.0	4 132	468
2	2.84	427	421	266	9.9	172	112.6	3 719	129
3	6.92	28	24	14	1.5	15	5.9	56	20
4a	4.47	84	73	54	1.9	15	0.2	441	36
4b	2.61	572	304	302	2.5	31	491.0	5 704	-

Table 4.9: Chemistry (minor and trace cations) of the water in the Central Witwatersrand Compartment

N°	Al mg/l	Mn mg/l	Zn mg/l	Ni mg/l	Cu mg/l	Cd mg/l	Co mg/l	Ba mg/l	B mg/l	Sr mg/l
1a	1 525	273.4	38.0	54.6	3.71	0.434	29.19	0.10	<0.1	0.407
1b	230.0	49.8	16.8	13.5	1.62	0.166	7.62	0.02	0.42	0.686
2	89.7	41.9	5.4	7.2	0.32	0.052	3.63	<0.01	<0.1	0.567
3	0.3	1.5	0.1	<0.8	<0.06	<0.03	<0.06	0.04	<0.1	0.113
4a	10.2	0.8	0.2	1.2	<0.06	<0.03	0.33	<0.01	<0.1	0.223
4b	66.0	55.2	8.4	9.1	1.27	0.253		<0.01	<0.1	0.564

Table 4.10: Chemistry (minor and trace anions) of the water in the Central Witwatersrand Compartment

N°	NO_3 –N (mg/l)	NO_2 – N (mg/l)	PO_4 (mg/l)	F (mg/l)	Br (mg/l)
1a	2.1	0	0	0	0
1b	6.7	0	0	0.1	2.03
2	0.6	0	0	0.5	0.47
3	0.1	0	0	0.1	0.16
4a	3.5	0	-	0.1	0.2
4b	-	-	-	-	-

Table 4.11: Calculated parameters of the water in the Central Witwatersrand Compartment

N°	HCO_3 mg/l	CO_3 mg/l	Mg Hard mg/l	Ca Hard mg/l	Total Hard mg/l	M.Alk mg/l	Ion balance %	Langellier index	TDS Sum mg/l
1a	150	0	3 126	974	4 100	0	-11.4		18 000
1b	171	0	589	946	1 535	0	-15.09		6 029
2	116	0	1 095	1 051	2 146	0	-12.71		4 964
3	80	0	58	60	118	66	3.51	-126	204
4a	2	0	222	182	404	0	-4.34		648
4b	204	0	1 244	759	2 003	0	-14.79		7 256

4.6.4 Groundwater zone

The groundwater zone or compartment extends beyond the mining area. The compartment, known as the Central Witwatersrand Water Compartment (Central Wits Compartment) extends 27km from Rand Leases in the west to Rose Deep in the east. It is an artificial groundwater compartment defined by mining activities. Any natural groundwater aquifers defined by fractured bedrock and bound by igneous intrusive have been destroyed and probably could never recover even if the de-watering process in the mines ceased. The western compartment boundary is an 18m wide solid rock pillar between Rand Leases and CMR only breached at one point, at CMR level 11. The eastern boundary between Simmer and Jack and Rose Deep comprises a lower plugged pillar and an upper fault bound pillar intruded by a Bushveld age dyke. The water level in this compartment is artificially maintained at 586m.a.s.l. by pumping from ERPM.

Surface water from rainfall, municipal storm water discharge and surface mining activities infiltrates to the groundwater compartment by a process of gravitation and seepage through the soils, movement along the bedrock interface and then seepage again through joints and fissures in the bedrock. In a mining environment such as exists south

of Johannesburg, there are not only natural fissures and weathered dyke contacts, but also mining induced fissures or fractures. Water then flows along mined-out stopes. There will also be seepage along fractures associated with stope closure and brittle failure of hanging wall rocks where fractures radiate upwards and outwards and extend to surface in the case of shallow workings.

If one assumes a catchment of 27km x 5km with an annual precipitation of 829mm per annum there will be about 112 000mega litres p.a. of rainfall. At an infiltration rate of 5% of rainfall, (according to Wates, Meiring and Barnard) there will be about 15megalitres a day infiltration from rainfall. Again according to WM&B, the figure of 5% infiltration is higher than is normally assumed. However, a large proportion of the catchment in question is undermined at shallow depth (less than 240m) and it is reasonable to assume that the degree in infiltration is high as a result of mining induced fissures facilitating a greater influx of water. An additional 4megalitres per day is estimated from other surface mining activities. Thus 19megalitres per day of surface water may be assumed to reach the water table. The water ultimately reaches ERPM and DRD where it is pumped to the surface and is discharged into the Elsburgspruit and Klipspruit respectively, which flow into the Vaal River.

4.6.5 Groundwater use

Water from the Central Wits Compartment is pumped to surface at ERPM and Durban Roodepoort Deep (DRD). At ERPM the water is limed in a High Density Sludge (HDS) plant and the product water is used for surface mine dump reclamation by Ergo (14 000m^3/d) and ERPM (6 500m^3/d) and in the ERPM reduction plant (280m^3/d). About 5 000m^3/d of water, abstracted immediately before the HDS plant intake, is given to the Germiston City Council. They make use of the very high iron levels to assist in phosphate removal in their sewage plant. Excess water from the HDS plant is discharged to the Elsburgspruit.

At DRD, the water is limed underground and pumped to surface where it is used in the DRD reduction plant with excess water discharged into a tributary of the Klipriver.

4.6.6 Groundwater at tailings dam sites

4.6.6.1 3/L/5 Homestead/Diepkloof tailings dam

The seepage water from the tailings dam is expected to be perched on the medium weathered quartzite with transverse flow mainly confined to within the hillwash, the ferruginised gravel and the upper approximately 0.5m of weathered, fractured quartzite. Drainage will thus in general follow the topographical gradient. The convex ridge underlying the southern part of Diepkloof is expected to act as a watershed with seepage water draining in southerly and northerly directions.

The zones of deeper weathering and greater thickness of transported soils associated with the diabase/quartzite contact and the shear zone will impede seepage water draining along the topographical gradient in a southerly direction. Some of the seepage from the dam may eventually reach the permanent water table along the contact or along the fractured rock expected in the shear zone.

The existing effluent trench is, over most of the dam perimeter, reasonably effective in acting as a seepage cut-off.

Poor natural drainage occurs in the north-western and south-western corners of the Homestead/Diepkloof dam where outcropping or very shallow quartzite occurs. These two areas are also on the drainage down slope.

4.6.6.2 3/L/7 Mooifontein tailings dam

Natural surface drainage of the ground underlying Mooifontein tailings dam is predominantly in a northern direction towards the Klipspruit to the north of the tailings dam. The area underlying the eastern third of the tailings dam slopes eastward towards the Russel stream running in a north-south direction.

Seepage water from the tailings dam is expected to be perched on the quartzite bedrock at a relatively shallow depth under the tailings dam. The deep weathering along diabase dykes and contacts is however expected to impede free draining conditions. The hill wash

horizon is relatively highly pervious and will thus contribute significantly to natural drainage where it is present.

This is especially the case for groundwater draining in a northerly direction due to the presence of the diabase dyke striking east-west under the dam. Recharge of the permanent water table under the dam can be expected along faults and fractures associated in the north-eastern corner of the tailings dam, where the hill wash thickness is generally less than 0.4m.

Apart from the north-eastern corner of the tailings dam, quartzite bedrock is generally too deep for seepage cut-off trenches to be effective. A further restriction on this is the pockets of deep weathering associated with contacts and dykes.

Indications of a perched water table, generally below 4.0m, were encountered in a number of test pits. The depth of the permanent water table was not determined but is expected to occur at a depth exceeding 10m.

The permeability tests indicate that the soils underlying the dam are more permeable than the slime but that shallow quartzite impedes drainage. During inspection of the dam evidence of sloughing on the northern wall was found, indicating poor natural under drainage.

4.7 Land Capability

Agricultural land capability is not applicable. Apart from shallow undermined areas (which require special foundations) and un-rehabilitated workings, the land is generally capable of supporting urban development. This includes the land currently occupied by mine dumps which will be removed by the project. The land capability of the old dumps themselves is considered to be wilderness land.

4.8 Land Use

In general, the land use around-each reclamation site, the plant and the tailings dam sites are, or is planned to be, urban. With respect to each site, the following land uses are recorded:

4.8.1 Current reclamation sites

3/A/17; 4/A/7(Now Complete); 4/A/8; 4/A/11; 3/L/45; 4/L/16(Now Complete); 4/L/17E; 4/L/26 and Jupiter Plant.

4.8.2 Existing sand dumps and tailings dams

4/A/9; 3/L/47; 4/L/1; City Deep 2 shaft sand and slime.

4.8.3 Silted-up dams

Rosherville Silts and City Silts.

4.8.4 Mining infrastructure use

City Deep plant site; (old) City Plant and Nourse Plant.

4.8.5 Current mine tailings disposal use

3/L/5 (Homes tead/D iepkloof dams); 3/L/7 (Mooifontein dam) and 3/L/8 (GMTS dam).

4.9 Air Quality

Fallout dust has been monitored by the University of the Witwatersrand Schonland Centre for Nuclear Physics since before reclamation activities started. A network of non-directional fallout dust buckets at ground level and on top of buildings was established early in 1981. This was expanded to meet the needs of the changing focus of reclamation activities over time. Directional fallout dust samplers were added to the network in 1986.

Dust fallout is currently monitored by Annegarn Environmental Research (Pty) Ltd (AER). A dust fall-out report is attached in Plan 6.

4.9.1 Methodology

Windblown settleable dust (fall-out) was monitored using the American Society for Testing and Materials standard method for collection and analysis of dust fall (ASTM D1739). This method utilises a simple device consisting of a cylindrical five litre container half-filled with de-ionised water exposed for one calendar month (30 ±3 days). The water is treated with an inorganic biocide to prevent algae growth in the buckets. The most common reagent used for this is a 5% copper sulphate solution (approximately one millilitre per three litres of bucket water).

The bucket stand comprises a ring that is raised above the rim of the bucket to prevent contamination from perching birds. The bucket holder is connected to a 2.1 meter galvanized steel pole, which is either directly attached to a fence post or can be attached to a galvanized steel base plate, which is buried to a depth of 500 mm. This allows for a variety of placement options for the fallout samplers. Exposed buckets, when returned to the AER laboratories, are rinsed with deionised water to remove residue from the sides of the bucket and the bucket contents filtered through a coarse (>1 mm) filter to remove insects and other course organic detritus.

The sample is then filtered through a pre-weighed paper filter to remove the insoluble fraction, or dust fallout. This residue and filter are dried and gravimetrically analysed to determine the insoluble fraction (dust fallout). The assessment of respirable particulates did not form part of this study.

Table 4.12 represents the respective categories for quantifying the levels of fallout dust as per the Department of Environmental Affairs and Tourism (DEAT) standard. In residential areas, a level of 200 to 300 mg/m²/day is considered to be the maximum acceptable level and in rural areas a level of 600 to 700 mg/m²/day based on standards issued to countries abroad.

Table 4.12: Dust fall categories published by the DEAT

Classification	Dust fall average over one month
Slight	< 250 mg/m^2/day
Moderate	250 – 500 mg/m^2/day
Heavy	500 – 1 200 mg/m^2/day
Very heavy	> 1 200 mg/m^2/day

These dust fall-out guidelines are descriptive without giving any guidance for action or remediation. On the basis of the cumulative South African experience of dust fall-out measurements, Standards South Africa have published two important new standards in terms of air quality underlying limits for dust fall-out rates. In terms of dust deposition standards, a four-band scale evaluation is used (Table 4.13) as well as target, action and alert thresholds (Table 4.14).

Table 4.13: Four-band scale evaluation criteria for dust deposition (After SANS 1929: 2004)

Band number	Band description level	Dust fall rate (D) (mg/m^2/day, 30 day average)	Comment
1	Residential	D < 600	Permissible for residential and light commercial.
2	Industrial	600 < D < 1 200	Permissible for heavy commercial and industrial.
3	Action	1 200 < D < 2 400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	2 440 < D	Immediate action and remediation required following the first incidence of dust fall rate being exceeded. Incident report to be submitted to the relevant authority.

Table 4.14: Target, action and alert thresholds for dust deposition (SANS 1929:2004)

Level	Dust fall rate (D) (mg/m^2/day, 30 day average)	Average period	Comment
Target	300	Annual	N/A
Action residential	600	30 days	Three within any year, not sequential months.
Action industrial	1 200	30 days	Three within any year, not sequential months.
Alert threshold	2 400	30 days	None. First incidence of dust fall rate being exceeded requires remediation and compulsory report to the authorities.

In addition to this baseline report, a report must be compiled every three months detailing all findings and includes a full assessment of the results along with conclusions and recommendations for future monitoring on site. These reports should form part of the dust monitoring programme and highlight any negative impacts on the air quality due to the mining operations as well as determine the sources of the impacts. The reports will determine possible actions which can be used to mitigate any negative impacts.

4.9.2 Dust fall-out results

The DEAT guidelines have been colour coded to highlight the areas of concern for the City Deep Operation in Table 4.15. DMR has accepted these values as the reference levels for dust deposition for the purposes of EIAs and EMPs.

Table 4.15: The colour coded dust fall categories published by the DEAT

Classification	Dust fall average over one month
Slight	< 250 mg/m^2/day
Moderate	250 – 500 mg/m^2/day
Heavy	500 – 1 200 mg/m^2/day
Very heavy	> 1 200 mg/m^2/day

A year's worth of dust fallout results (Oct '08 – Sept '09) were obtained from AER and analysed against the above-mentioned standards and classifications (AER, 2008). In terms of dust deposition standards for this study, the four-band scale evaluation will also be applicable in the assessment phase as well as target, action and alert thresholds. The City Deep Operation may submit a request to the authorities to operate within Band 3 (Action band: 1 200 < 2 400mg/m^2/day) for a limited period, yet no margin of tolerance will be granted for an operations that result in dust fall rates, which fall within Band 4 (Alert band: 2 400mg/m^2/day < D). The dust fallout levels are presented in Table 4.16.

Table 4.16: Results of the dust fallout mg/m2/day

Period	MARK	BTH	CROSS	HR	HTP	IMR	PRO C	USABCO	PP	MCC	KLL	JST	CKS	STT	GRND	RTT	HTG	SACD	ITH	DTH	TC	AGI
Oct 08	234	322	587	1 839	239	1 565	148	254	ND	307	575	311	181	458	1 594	172	214	156	1 359	41	349	1 253
Nov 08	198	108	1 216	576	221	414	300	217	472	180	268	273	104	660	664	49	119	128	403	120	149	505
Dec 08	191	220	880	578	194	652	201	171	149	297	217	271	106	471	528	79	99	304	187	96	256	989
Jan 09	69	118	612	201	124	289	37	34	215	63	182	163	59	239	352	72	108	212	147	169	118	1 114
Feb 09	93	109	936	360	281	431	90	93	306	174	105	181	128	190	1 195	111	131	195	129	102	146	266
Mar 09	139	81	127	113	140	324	37	91	84	102	173	103	140	321	1 103	86	54	80	81	114	216	220
Apr 09	215	156	798	122	159	457	103	139	218	259	442	164	130	355	501	23	52	112	93	189	223	153
May 09	175	218	987	215	239	425	185	66	1 951	246	472	158	127	372	701	99	81	185	144	149	177	279
Jun 09	130	197	826	205	189	290	165	66	119	272	382	123	55	400	856	61	45	186	103	40	170	178
Jul 09	242	292	834	172	54	257	26	100	179	103	477	144	92	409	559	105	39	115	173	94	395	190
Aug 09	177	361	876	466	450	1 421	233	324	459	493	287	295	291	345	757	181	78	383	284	406	416	188
Sep 09	858	605	999	2 989	1 033	4 205	403	339	1 144	565	374	629	311	379	1 271	449	196	605	381	493	534	283

An analysis of the City Deep Operation results indicates that 57% of the levels of dust fallout for the twelve month sampling period from October 2008 to September 2009 fell within the slight category, 25% of the levels fell within the moderate category, 14% of the levels fell within the heavy category and 4% of the dust levels fell within the very heavy category according to DEAT guidelines. Most records provided by AER for the 2008 and 2009 monitoring periods are respectively permissible for residential and light commercial activities (D<600mg/m2/day; Band 1) and heavy commercial and industrial (600<D<1,200mg/m2/day, Band 2) according to the SANS 1929:2005 guidelines.

During the monitoring period from October 2008 to September 2009, Site HR and IMR recorded levels, which falls into the Alert band threshold (2,400<D mg/m2/day; Band 4) where immediate action and remediation was required and an incident report should have been submitted to relevant authority. During the monitoring month of October 2008, Site AGI, ITH, IMR, GRND and HR recorded levels which fell into the Action band threshold (1,200<D<2,400mg/m2/day; Band 3). During the monitoring month of November 2008, Site CROSS recorded levels which fell into the Action band threshold. During the monitoring month of August 2009, Site IMR recorded levels which fell into the Action band threshold. During the monitoring month of September 2009, Site IMR and GRND recorded levels which fell into the Action band threshold. In these instances it is recommended that mitigation measures be put in place to avoid re-occurrence of such results. According to the SANS air quality classification system, the situation should be investigated and remediation undertaken if two sequential months lie in the Action band (Band 3) or if it occurs more than three times in one year.

4.10 Noise

Noise surveys were conducted between July and October 2009 in order to assess the impacts of the reclamation activities related to the City Deep Operations. The reclamation sites are primarily situated in industrial and residential areas.

The complete noise report is attached in Appendix B.

4.10.1 Methodology

Ambient noise measurements were conducted at relevant receptors in the vicinity of the slimes dams and sand dumps that is part of the City Deep Operations.

The results were compared to the rating levels established by the South African Bureau of Standards (SABS). The South African National Standard for "the measurement of environmental noise with respect to land use, health, annoyance and speech communication" (SANS 10103:2008) underwritten by SABS, which gives guidelines for acceptable rating levels for ambient noise in various districts for land use purposes.

The following legislation was considered for this survey:

- The National Environmental Management Act (Act no 107 of 1998);
- The National Environmental Management Air Quality Act (Act no 39 of 2004), NEMAQA; and
- The Environment Conservation Act, 1989 (Act 73 of 1989).

According to the SANS 10103:2008 guidelines, 'daytime' is defined as anytime between 06:00 to 22:00, and 'night time' between 22:00 to 06:00. As a result of these guidelines, measurements were taken once during the daytime and once during night time at each identified noise receptor. Measurements were taken 1.5 m above ground level, and for a minimum period of 15 minutes (SANS 10103:2008).

The acceptable rating levels according to SANS 10103:2008 for ambient noise in different districts (residential and non-residential) are presented in Table 4.17: Acceptable rating levels for noise in districts (SANS 10103, 2008)

Table 4.17: Acceptable rating levels for noise in districts (SANS 10103, 2008)

1	2	3	4	5	6	7
Type of District	**Equivalent continuous rating level ($L_{Reg.T}$) for noise** dBA					
	Outdoors			**Indoors, with open windows**		
	Day-night $L_{R,dn}$[a]	**Day-time** $L_{Req,d}$[b]	**Night-time** $L_{Req,n}$[b]	**Day-night** $L_{R,dn}$[a]	**Day-time** $L_{Req,d}$[b]	**Night-time** $L_{Req,n}$[b]
RESIDENTAIL DISTRICTS						
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
NON-RESIDENTIAL DISTRICTS						
d) Urban districts with some workshops, with business premises, and with main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50
NOTE 1 If the measurement or calculation time interval is considerably shorter than the reference time intervals, significant deviations from the values given in the table might result.						
NOTE 2 If the spectrum of the sound contains significant low frequency components, or when an unbalanced spectrum towards the low frequencies is suspected, special precautions should be taken, and specialist advice should be obtained. In this case the indoor sound levels might significantly differ from the values given in columns 5 to 7						

NOTE 3 In districts where outdoor $L_{R,dn}$ exceeds 55 dBA, residential buildings (e.g. dormitories, hotel accommodation and residences) should preferably be treated acoustically to obtain indoor $L_{Req,T}$ values in line with those given in table 1.
NOTE 4 For industrial districts, the $L_{R,dn}$ concept does not necessarily hold. For industries legitimately operating in an industrial district during the entire 24 h day/night cycle, LReq,d = LReq,n =70 dBA can be considered as typical and normal.
NOTE 5 The values given in columns 2 and 5 in this table are equivalent continuous rating levels and include corrections for tonal character, impulsiveness of the noise and the time of day.
NOTE 6 The noise from individual noise sources produced, or caused to be produced, by humans within natural quiet spaces such as national parks, wilderness areas and bird sanctuaries, should not exceed a maximum Aweighted sound pressure level of 50 dBA at a distance of 15 m from each individual source.
a The values given in columns 2 and 5 are equivalent continuous rating levels and include corrections for tonal character and impulsiveness of the noise and the time of day.
b The values given in columns 3, 4, 6 and 7 are equivalent continuous rating levels and include corrections for tonal character and impulsiveness.

The probable community/group response to levels in excess of the acceptable rating levels are presented in Table 4.18, where LReq,T is the equivalent continuous A-weighted sound pressure level, in decibels, determined over a time period of not less than 30 minutes. ‘A-weighted’ is a standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.

Table 4.18: Categories of community/group response (SANS 10103, 2008)

Excess ($\Delta L_{Req,T}$)[a] dBA	**Estimated community/group response**	
	Category	**Description**
0 – 10	Little	Sporadic complaints
5 – 15	Medium	Widespread complaints
10 - 20	Strong	Threats of action
>15	Very strong	Vigorous action
NOTE Overlapping ranges for the excess values are given because a spread in the community reaction might be anticipated.		
a $\Delta L_{Req,T}$ should be calculated from the appropriate of the following:		
1) $\Delta L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS LReq,T of the residual noise (determined in the absence of the specific noise under investigation);		
2) $\Delta L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the maximum rating level for the ambient noise given in table 1;		
3) $\Delta L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the typical rating level for the applicable district as determined from table 2; or		
4) $\Delta L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in an area because of a proposed development under investigation.		

4.10.2 Site locations and results

4.10.2.1 Site locations

The impact of the reclamation activities at each slimes dam/sand dump will be assessed individually by using the relevant baseline noise measurement levels. The reclamation sites that were considered during the survey are listed in Table 4.19. The points are also shown on Plan 7.

Table 4.19: Slimes dams/Sand dumps being reclaimed

Slimes dam/Sand dump ID	GPS coordinates	Site location
3A17	26°13’44.54’’S 28°04’10.53’’E	700m east of Wemmerpan
3L45	26°13’44.54’’S 28°04’10.53’’E	700m east of Wemmerpan
4A9	26°13’44.54’’S 28°04’10.53’’E	Heriotdale, adjacent to Cleveland rd on the eastern side and 150m south of the M2
4L25	26°13’44.54’’S 28°04’10.53’’E	Heriotdale, adjacent to Cleveland rd on the eastern side and 150m south of the M2
3A19	26°12’57.71’’ 28°05’34.60	Situated on the south east corner of Chilvers st and the M2

Noise measurements were taken at the following locations.

Table 4.20: Relevant measurement locations at 3A17 and 3L45

Noise measurements	GPS coordinates	Site locations
C1	26º 14’ 10.90” S 28º 3’ 56.41” E	Measurement was taken in the residential area of Regents Park.
C2	26º 14’ 3.08” S 28º 3’ 32.87” E	Measurement was taken at the Union Buldog R.F.C at Wemmerpan.
C3	26º 13’ 34.28” S 28º 4’ 6.38” E	Measurement was taken at the Friendly Crocer distribution centre.
C4	26º 13’ 52.14” S 28º 4’ 33.17” E	Measurement was taken at the fresh produce market.

Table 4.21: Measurement locations at 3A9 and 3L25

Noise measurement	GPS coordinates	Site location
C6	26°13'23.85"S 28° 6'48.84"E	Measurement was taken at the entrance of Heritage Park.
C7	26°12'53.26"S 28° 6'45.79"E	Measurement was taken at the industrial park west of 3A9 and3L25.
C8	26°13'12.77"S 28° 7'8.90"E	Measurement was taken at industrial park south of 3A9 and 3L25, near the PPC Cement plant.
C9	26°12'57.01"S 28° 7'16.52"E	Measurement was taken at the industrial park east of 3A9/3L25..

Table 4.22: Measurement locations at 3A19

Noise measurement	GPS coordinates	Site location
C12	26°12'41.87"S 28° 5'41.28"E	Measurement was taken at the industrial park north of 3A19, near the back entrance of the Trade Centre.
C13	26°12'50.83"S 28° 5'18.35"E	Measurement was taken the at Johannesburg depot of Kargo National (Pty) Ltd. to the west of 3A19.

4.10.2.2 Results

The results from the noise meter recordings for all the sampled points, the SANS rating limits and the in situ meteorological conditions are presented in Table 4.23: Results of the baseline noise measurements.

Table 4.23: Results of the baseline noise measurements

Sample ID	SANS rating limit			Measurement details			
	Type of district	Period	Acceptable rating level dBA	$L_{Areq,T}$	Minimum/Maximum dBA	Date/Time	Meteorological conditions
C1	Residential	Daytime	55	29.3	36.9 / 23.9	30/07/2009 12:40	Temp: 18°C Wind: North west @ 1 m/s Humidity: 28.3 %
		Night time	45	42.5	49.7 / 39.8	29/09/2009 23:35	Temp: 14.1°C Wind: North east @ 1 m/s Humidity: 68.3 %
C2	Residential	Daytime	55	29.6	44.7 / 23.9	30/07/2009 12:15	Temp: 18°C Wind: North west @ 1 m/s Humidity: 28.3 %
		Night time	45	44.7	53.6 / 41.7	29/09/2009 23:15	Temp: 14.1°C Wind: North east @ 1 m/s Humidity: 68.3 %
C3	Industrial	Daytime	70	42.9	53 / 38.3	30/07/2009 14:30	Temp: 20°C Wind: No wind Humidity: 28.3 %
		Night time	60	56.1	71.8 / 47.9	30/09/2009 00:15	Temp: 14.1°C Wind: North east @ 1 m/s

Sample ID	SANS rating limit			Measurement details			
	Type of district	Period	Acceptable rating level dBA	$L_{Areq,T}$	Minimum/Maximum dBA	Date/Time	Meteorological conditions
							Humidity: 68.3 %
C4	Industrial	Daytime	70	66.4	81.3 / 61.3	30/07/20091 3:25	Temp: 19°C Wind: North west @ 1 m/s Humidity: 28.3 %
		Night time	60	54.6	56.2 / 53.1	30/09/20090 0:00	Temp: 14.1°C Wind: North east @ 1 m/s Humidity: 68.3 %
C6	Residential	Daytime	55	45.7	66 / 31.1	06/08/20091 4:00	Temp: 30.1°C Wind: North @ 0.7 m/s Humidity: 26.4 %
		Night time	45	46.8	51.6 / 44.6	30/09/20092 3:30	Temp: 15.3°C Wind: North @ 0.9 m/s Humidity: 68.4%
C7	Industrial	Daytime	70	66.7	86.5 / 54.1	06/08/20091 2:30	Temp: 20.8°C Wind: North @ 0.5 m/s Humidity: 17.7%
		Night time	60	62.7	75.6 / 58.4	30/09/20092 3:25	Temp: 15.3°C Wind: North @ 0.9 m/s Humidity: 68.4%

Sample ID	SANS rating limit			Measurement details			
	Type of district	Period	Acceptable rating level dBA	$L_{Areq,T}$	Minimum/Maximum dBA	Date/Time	Meteorological conditions
C8	Industrial	Daytime	70	54.5	66.4 / 35.5	06/08/20091 3:30	Temp: 31.7°C Wind: North @ 0.5 m/s Humidity: 12.6 %
		Night time	60	48.8	74.8 / 46.4	30/09/20092 3:20	Temp: 15.3°C Wind: North @ 0.9 m/s Humidity: 68.4%
C9	Industrial	Daytime	70	54.2	71 / 45.6	06/08/20091 5:45	Temp: 19.3°C Wind: South south-west @ 0.7 m/s Humidity: 57.3%
		Night time	60	48.7	54 / 46.6	30/09/20092 2:40	Temp: 15.3°C Wind: North @ 0.9 m/s Humidity: 68.4%
C12	Industrial	Daytime	70	63.1	71.5 / 54.7	31/07/20091 0:40	Temp: 19.9°C Wind: North @ 0.8 m/s Humidity: 28.9%
		Night time	60	63.9	74.9 / 43.1	30/09/20092 3:50	Temp: 15.3°C Wind: North @ 0.9 m/s Humidity: 68.4%

Sample ID	SANS rating limit			Measurement details			
	Type of district	Period	Acceptable rating level dBA	$L_{Areq,T}$	Minimum/Maximum dBA	Date/Time	Meteorological conditions
C13	Industrial	Daytime	70	52.3	78.8 / 48.3	06/08/20091 6:20	Temp: 20.5°C Wind: South south-west @ 0.3 m/s Humidity: 40.4%
		Night time	60	53.8	59.5 / 44.8	01/10/20090 0:00	Temp: 15.3°C Wind: North @ 0.9 m/s Humidity: 68.4%
	Indicates $L_{Aeq,T}$ levels above either the daytime rating limit or the night time rating limit						

Note: LAeq,T is the equivalent continuous A-weighted sound pressure level, in decibels, determined over a time period of not less than 30 minutes. 'A-weighted' is a standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.

Based on the results from the baseline environmental noise measurements it is noted that the day time ambient noise levels at sites C1, C2 and C6 which was carried out in residential districts ranged between 29dB and 46dB, which is below the maximum allowable outdoor limit for ambient daytime noise in residential districts. The rest of the measurements were carried out in industrial districts in the City Deep area and the ambient noise levels ranged between 42dBA and 67dBA which is below the maximum allowable outdoor limit for ambient daytime noise in industrial districts. The main noise sources influencing the measurements in the residential districts during the daytime were the vehicular traffic on the roads and the domestic animals. The main noise sources influencing the measurements in the industrial districts during the daytime were from cargo trucks, ventilation fans as well as vehicular traffic on the main roads running through the industrial parks such as the M33 and M2.

The night time ambient noise levels at sites C1, C2 and C6 which was carried out in residential districts ranged between 42dB and 47dB, which ranges from below the maximum allowable outdoor limit for ambient night time noise in residential districts, to slightly above. The rest of the measurements carried out in industrial districts in the City Deep area measured between 48dB and 64dB which ranges from below the maximum allowable outdoor limit for ambient night time noise in industrial districts, to slightly above. The main noise sources influencing the measurements in the residential districts during the night time were the vehicular traffic on the roads such as the M33. The main noise sources influencing the measurements in the industrial districts during the night time were from cargo trucks, ventilation fans as well as vehicular traffic on the main roads running through the industrial parks such as the M33 and M2

4.11 Plant Life

A detailed description is not applicable since all sites are disturbed and have been, or are being, re-vegetated with commercially available seeds or plants. There is a significant invasion of black wattle (*Acacia mearnsii*) and blue gum (*Eucalyptus spp*) trees from historical plantings of these species as ornamental subjects and wind breaks.

Theoretically, the mine falls into Acock's Veld Type 61(b), the central variation of the Bankenveld. This comprises particularly sour, wiry grassveld of the tall tufted type, with forbs playing a major part. *Hyparrhenia hirta* (thatching grass) and *Stoebe vulgaris* (a forb) are common indigenous plants of this veld type which frequently become the dominant vegetation on tailings dams that have been stabilized by re-vegetation programmes. This indigenous "invasion" is regarded as a sign of the success of these programmes.

The water quality in streams in the area is already much degraded and therefore the aquatic plant life was not studied since there is no chance of species surviving that are not adapted to polluted.

4.12 Animal Life

4.12.1 Commonly occurring species

Existing re-vegetated mine dumps, which are quiet habitats due to being on secure mine property, provide shelter, resting and breeding places for a relatively large number (for an urban area) of small mammals and birds. Guinea fowl and owls as well as a host of other commonly occurring urban birds are often seen on these dumps while signs of jackal, rodents and moles are occasionally spotted.

The water quality in the streams is already degraded and therefore the aquatic animal life was not studied since there is no chance of species surviving that are not adapted to polluted conditions. The base line composition of benthic macro-invertebrates will be established.

4.12.2 Endangered or rare species

None of these have been observed.

4.13 Sites of Archaeological and Cultural Interest

4.13.1 Dumps

All the dumps to be reclaimed are of general historical interest in terms of their association with Johannesburg's mining past.

4.14 Sensitive Landscapes

There are no sensitive landscapes under statutory protection on the properties.

4.15 Visual Aspects

In general, all of the reclamation sites, the plant and the tailings dams are visible to passing traffic on highways, main truck roads, smaller urban streets and the railway line linking Germiston and Johannesburg. Much of the activity is also visible from industrial and residential areas. Any dust liberated from the sites is visible to anyone living or working in or travelling through the area.

4.16 Regional Socio-Economic Structure

4.16.1 Population density, growth and location

The total population of Gauteng was recorded at approximately 8.8million in 2001, with the CoJ Metropolitan representing 37% of this total at 3.3million. Region 9 recorded a population of 139 000. This population is comprised 66% black African people, and is relatively youthful with approximately 38% of people being under the age of 25.

The CoJ IDP indicates that Johannesburg does not have a pressing population problem, as is often evident in emerging markets. Lower fertility rates, stabilising migrant in-flows and the negative growth effects of HIV/AIDS suggest less than 1% population growth over the coming 10 years.

Approximately 73% of the municipal population falls within the potentially economically active age group. This indicates that there is a large job-seeking population within the

area of operation. Over 74% of the CoJ's population is comprised of Black Africans (refer to Figure 4.6). This is followed by White people with a representation of approximately 16%. The Indian and Coloured populations together comprise 10%.

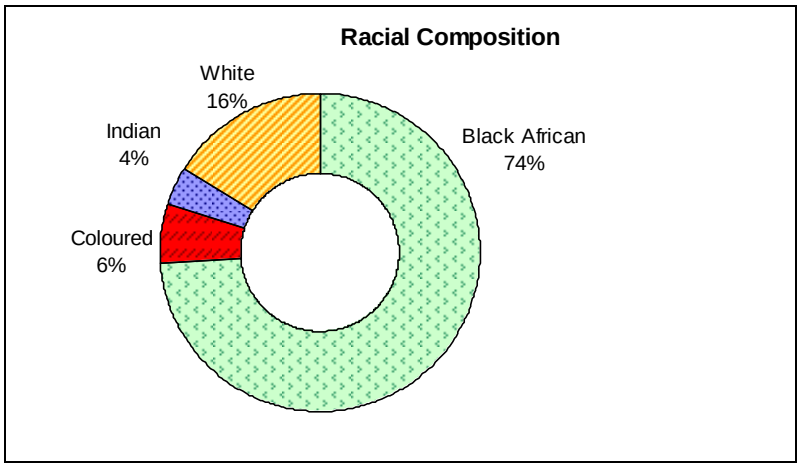


Figure 4.6: Racial composition of the CoJ metropolitan area (SLP, 2008)

The municipal population is evenly distributed in terms of gender, at a ratio of 50% males and 50% females. The main languages spoken in the CoJ are isiZulu (25%), English (20%), Sesotho (11%), and Setswana (9%).

4.16.2 Major economic activities and sources of employment

Johannesburg currently generates 16% of South Africa's wealth, and employs 12% of the national workforce. Some 74% of South African companies have their headquarters in Johannesburg. The city hosts every form of commercial activity from modern financial services to heavy industries and mining. The economy is dominated by four sectors, three of which are service sectors:

- Financial and business services
- Retail and wholesale trade
- Community and social services
- Manufacturing

The city's manufacturing sector is shrinking, and increased emphasis is now being placed on more modern sectors such as information technology, telecommunications, film and media, research and development, etc. Gauteng as a whole has made a strategic move away from traditional heavy industry and low value-added products.

Johannesburg's gold mining industry was established in around 1886 when the gold rush was triggered. Today the city is Africa's largest, ringed by the deepest gold mines in the world. There are 159 mines, 44 of them gold mines, in Gauteng that together produce a quarter of South Africa's total mineral production. Although mining currently provides thousands of jobs, this economic sector is becoming increasingly less important to the city with the rise of the manufacturing and financial sectors. Mining now produces only 6% of Gauteng's total income and 31% of export earnings.

In terms of employment opportunities in the city, 20% of the population are employed in elementary positions, while 13% are service workers and 10% work as professionals. The potentially economically active population of a region is the number of persons between the ages of 15 and 64, both employed and unemployed. Within Johannesburg the potentially economically active population was recorded at 74% in 2001. Of this potential workforce, 37% were unemployed. This indicates a significant increase in unemployment since the 1996 census where this figure stood at 29%. Unemployment within Region 9 specifically stands at 23%.

4.16.3 Basic services provision

4.16.3.1 Water and sanitation

Region 9 of the city is fully serviced with water and sanitation. In terms of water provision, reticulation piping in the Johannesburg CBD was renewed during the early 1990s and is thus in a good condition. Piping in the Inner City fringe requires maintenance and upgrading. The main bulk water pump station supplying water to the Inner City, Hector Norris pump station, will require upgrading in the near future.

It can be seen in Table 4.24: Water provision within Gauteng and the CoJ that over 92% of CoJ's residents have access to a water supply which is considered acceptable according to the Reconstruction and Development Programme (RDP) standards. This is a similar situation to that displayed for Gauteng as a whole.

Table 4.24: Water provision within Gauteng and the CoJ

Water provision	***Gauteng***	***CoJ***
Within dwelling	47%	50%
Inside yard	37%	35%
Community stand	7%	7%
Community stand over 200m	7%	6%
Borehole/spring/raintank	0%	0%
River/stream/dam/pool	0%	0%
Other	2%	2%

Acceptable in terms of RDP Standards

Figure 4.7 depicts the level of access to RDP sanitation in Gauteng Province and in the CoJ. It can be seen that only 10% of CoJ's population has access to sanitation which is below the acceptable standard according to the RDP. This is a slight improvement since the 1996 census where this figure was 13%.

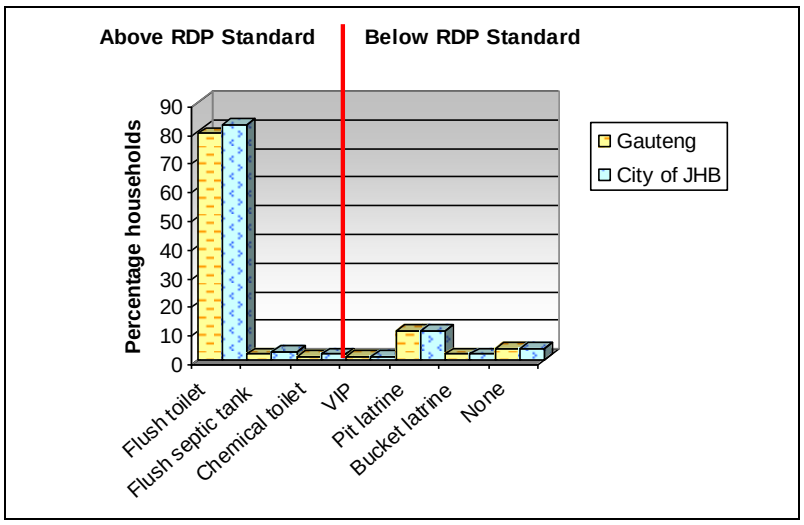


Figure 4.7: Level of available sanitation in Gauteng and CoJ

4.16.3.2 Electricity

City Power is the main supplier of electricity to Region 9. There are currently no backlogs of connections in this region, although the networks are fully loaded and there is thus no spare capacity. System reliability is also a challenge due to the age of a large portion of the network. Many of the areas were not designed to cater for the rate of development which is currently being experienced. Financial restrictions over the past several years have created a backlog in maintenance and refurbishment of existing networks.

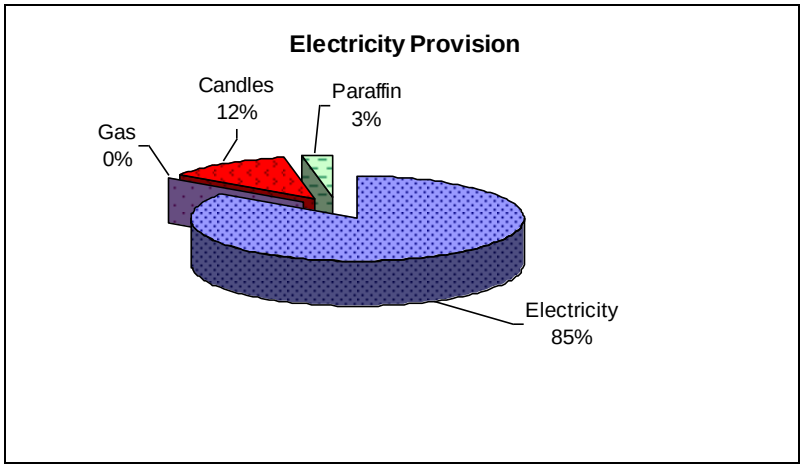


Figure 4.8: Electricity provision within the CoJ, 2001

It can be seen in Figure 4.8 that over 85% of the CoJ's residents have access to some form of electricity, while 12% are still reliant on the use of candles for lighting. The level of electricity provision has, in fact, decreased since the 1996 census from 86% to 85%, indicating that service delivery is not yet keeping up with population fluctuations.

4.16.4 Social services provision

4.16.4.1 Housing

Region 9 is currently an area of active housing development. The area has become attractive to homeowners in that it has better houses and higher land values than nearby surrounding areas. It is also in close proximity to the Johannesburg Central Business District (CBD) and other places of employment within the industrial and mining belt.

Within the CoJ as a whole, the housing backlog was verified most recently in 2004. It was found that approximately 209 308 informal structures are spread throughout the city's landscape. The national government annually dedicates R250million to the city's housing development fund. Each household qualifying for a housing subsidy is provided with R25 000 of this fund. This translates to approximately 10 000 dwellings per annum being constructed – practically, then, it would take the Department over 21 years to eradicate the existing informal settlements.

The figure below depicts the type of housing that is available within the CoJ:

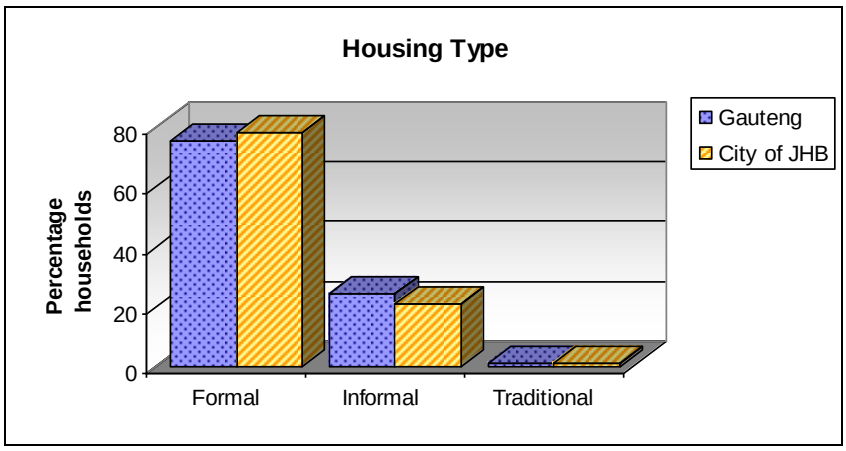


Figure 4.9: Housing analysis within the CoJ area, 2001

4.16.4.2 Transport

Johannesburg's major international airport serves 2.5million international passengers a year, while the City Deep freight terminal handles 30% of South Africa's exports and is classified as the fifth largest port in the world. The major national highways and rail routes radiate outwards from Johannesburg, making it strategically located for businesses that require a distribution chain.

Johannesburg has some of the most sophisticated transport infrastructure in Africa, including multi-lane highways and four bustling airports. Work has also begun on the continent's fastest underground train service, the Gautrain. There are over 9000km of

road in the city, with the M1 highway being the busiest route in the southern hemisphere accommodating over 300 000 commuters each week day.

Johannesburg fares well with respect to commuter transport. The World Bank specifies that emerging markets should aim for a 60 minute average travel time one way, and aim to have less than 10% of disposable income spent on transport. In Johannesburg, the average one-way travel time is 72 minutes, while only 11% of the population spend more than 10% of their income on transport. Furthermore, only 0.8% of residents are categorised as 'stranded' (isolated from transport routes), while this figure is 13% for the national average.

4.16.4.3 Education

Although Johannesburg has the most skilled and educated workforce in the country, many of city's residents do not have the type of education or skills that businesses in the area require. This is primarily due to the changing nature of business in the city, and the limitations of the education system. Poor educational provision in maths and science has made it difficult to provide the economy with these skills. The changing composition of the economic sectors of Johannesburg, and technology advancements in business activity have also contributed to the widening of the skills gap. The educational levels for residents in CoJ can be seen in Figure 4.10.

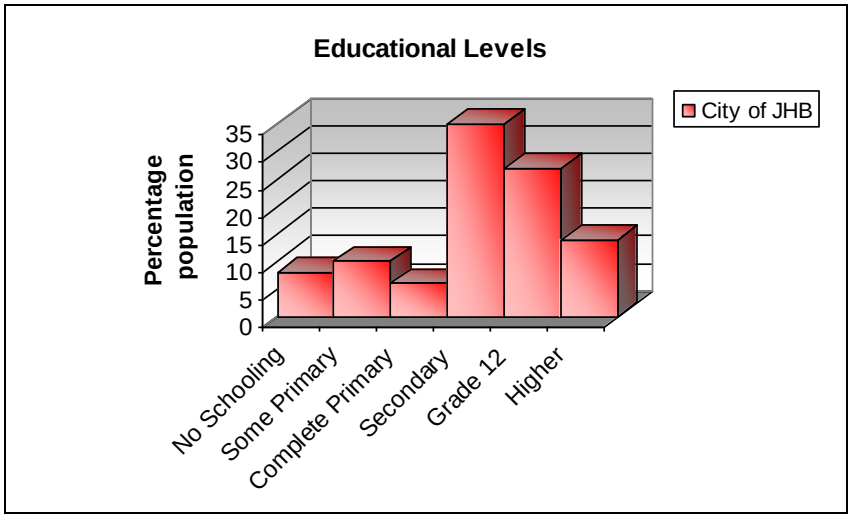


Figure 4.10: Educational levels within CoJ, 2001 (SLP, 2008)

It can be seen from the above that the educational levels of the municipal population are fairly good, and fare well in comparison with national averages. The city has a 20% advantage over the rest of the country in terms of literacy and numeric skills. Within the city, only 8% of the population have received no formal education, while over 27% have completed their Grade 12 qualification. These relatively good educational levels, however, are not reflective of the high level skills base in the area, but rather only indicate good levels of literacy amongst the population.

4.17 Interested and affected parties

Not all the IAPs in the vicinity of the reclamation activities have been identified since there are numerous. The following bodies representing IAPs have or do influence planning and operating decisions.

- The Department of Mineral & Energy Affairs;
- The Department of Water Affairs and Forestry;
- The Department of Health and Population Development;
- The Department of Environment Affairs;
- The Department of Agriculture;
- Greater Johannesburg Metropolitan Council;
- The Booysens Industrial Association;
- The Soweto Civic Association;
- Riverlea Civic Association;
- The TPA Roads Department;
- Rand Water (was the Rand Water Board);
- The Schonland Centre for Nuclear Physics;
- Transnet;
- Department Of Transport;

- Eskom;
- Nasrec;
- Johannesburg Metropolitan Transport (JOMET); and
- Wadeville Investment Company.

5 ASSESSMENT OF ENVIRONMENTAL IMPACTS RESULTING FROM IDENTIFIED ALTERNATIVE LAND USE AND DEVELOPMENTS

In accordance with the MPRDA, alternative land uses in the area must be identified and their potential impacts on the environment identified.

5.1 Identified alternative land use and developments

No alternative land use is possible while the reclamation activities continue. Alternative land use will be possible after rehabilitation of the different slimes dam/sand dump footprint areas and metallurgical plant footprint. In the case of the tailings dams the facilities will be regarded as a mine waste disposal facility that will have no other purpose and should be regarded as wilderness land. The permit is issued for mining and will remain as such until the project is complete after which the land would become available for alternative uses again.

An alternative to the project is to leave the dumps as they are but that would mean that the gold would not be recovered and the land use would not be optimised.

5.2 The “no-project” option

If reclamation of the tailings/slimes is not allowed then the environmental and socio-economic benefits of the project will be lost to the area. Some of the benefits include a potential increase in income to the community, potential for job creation and a decrease in the negative effects that these dumps have on the environment as well as the people living in the vicinity of it.

The gold reserves which are located in the slime dams will be available for future projects but the immediate economic contribution of the mine to the community, municipality and the region will not occur.

6 ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Impact Identification

Impact identification is performed by use of an "Input –Output Block Diagram" model which serves to guide the assessor in assessing all the potential instances of ecological and socio-economic change, pollution and resource consumption that may be associated with the activities required during the construction, operational, decommissioning and post-closure phases of the project. Inputs include personnel and machines, resources such as fuels, lubricants, explosives, chemicals, electricity and water.

Outputs may generally be described as any changes to the biophysical and socio-economic environments, both positive and negative in nature, and may also include the product produced by the activity, where such product(s) may cause environmental impacts. Negative outputs typically include gases, effluents, dust, noise, vibration, other pollution and changes to the bio-physical environment such as damage to habitats or reduction in surface water quantity. Positive impacts may include the removal of invasive vegetation or benefits to the socio-economic environment.

During the determination of outputs, the effect of outputs on the various components of the environment, e.g. topography, water quality, is considered.

6.2 Impact Rating

The impact rating process is designed to provide a numerical rating of the various environmental impacts identified by use of the "Input-Output" model. As discussed in Paragraph 2.1 above, it has to be stressed that the purpose of the EIA process is not to provide an incontrovertible rating of the significance of various aspects, but rather to provide a structured, traceable and defendable methodology of rating the relative significance of impacts in a specific context.

The significance rating process follows the established impact/risk assessment formula:

"*Significance = Consequence x Probability*"

Where:

"*Consequence*" = *Severity + Spatial Scale + Duration*"

And

"*Probability*" is determined with reference to industry knowledge and instances of impacts happening in similar or same circumstances

The weight assigned to the various parameters for positive and negative impacts in the formula is presented in the tables below:

Severity (Positive and Negative Impacts)

	Severity - Environmental	Severity - Social/Cultural/Heritage
5	Very significant impact/total destruction of a highly valued species, habitat or ecosystem or Extremely positive impact over baseline environmental condition*	Irreparable damage to/destruction of highly valued items of great cultural significance or complete breakdown of social order or Extremely positive impact on social, economic and cultural environment.
4	Serious impairment of ecosystem function or Greatly positive impact over baseline environmental condition	Serious social issues/Permanent damage to items of cultural significance or Greatly positive impact on social, economic and cultural environment.
3	Moderate negative alteration of ecosystem functioning or Moderately positive impact over baseline environmental condition	Moderately important social issues and/or moderately significant damage to items of cultural significance or Moderately positive impact on social, economic and cultural environment.
2	Minor effects not affecting ecosystem functioning or Slightly positive impact over baseline environmental condition	Minor Impacts on the local population, repairable over time. Temporary impairment of the availability of items of cultural significance or Minor positive impact on social, economic and cultural environment
1	Insignificant effects on the biophysical environment or Insignificantly positive impact over baseline environmental	Insignificant social issues / low-level repairable damage to commonplace structures. positive impact on social, economic and cultural environment

	Severity - Environmental	Severity - Social/Cultural/Heritage
	condition	or Insignificant positive impact on social, economic and cultural environment

* I.e. Positive impacts over baseline conditions only and not e.g. positive improvements due to rehabilitation.

Spatial Scale

5	National/International
4	Provincial/Regional
3	Regional (substantially beyond site boundary)
2	Local (beyond site boundary and affects neighbours
1	Site (does not extend beyond site boundary)

Duration

5	Permanent/Irreversible (more than 50 years)
4	Long Term (25 to 50 years or beyond closure)
3	Medium Term (5-25 years)
2	Medium-Short Term (1-5 years)
1	Short term (Less than a year)

Probability

5	Certain/ Normally happens in cases of this nature (80-100% chance of happening
4	Will more than likely happen (60-80% chance)
3	Could happen and has happened here or elsewhere (40-60% chance)
2	Has not happened yet, but could (20-40% chance)
1	Conceivable, but only in a set of very specific and extreme circumstances (0-20% chance)

* For purposes of the post-mitigation impact significance rating the duration of the impact is assumed to be the same as for the pre-mitigation assessment.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in the EMP. The significance of an impact is one of four broad categories, as indicated in the table, below:

Significance Threshold Limits (%)		
High	**76 %- 100%**	
Medium – High	**51% – 75%**	
Medium – Low	**26% – 50%**	
Low	**0% - 25%**	

In accordance with Regulation 51 of the MPRDA, management actions will be assigned for all impacts, irrespective of significance, but the scale of significance serves to focus attention and resources on critical environmental impacts

For the impact assessment related to the impact of each activity on a specific environmental parameter, refer to Appendix C. The paragraph number of each environmental parameter is cross-referenced in the Impact Assessment table in the column marked “EIA Reference”.

6.3 Construction Phase

Table 6.1 gives a summary of the anticipated impacts for the construction phase. During this phase temporary equipment and facilities will be put on site.

Table 6.1: Summary of the EIA for the construction phase

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
RECLAMATION SITES									
Construction of infrastructure and roads	*Archaeology & heritage resources*: The mine dump and related heritage resources will be impacted when reclaimed.	N	2	1	1	4	3	16	Proper documentation of mine dumps and related mining heritage resources for archival and tangible conservation purposes.
Operation of construction machinery	*Groundwater quality*: Spillage of hydrocarbons in the event of accidents will pollute groundwater resources.	N	2	1	1	4	4	21	Hydrocarbon spillages should be contained and cleaned up immediately.
Construction of infrastructure	*Soil:* The construction of infrastructure could cause soil compaction.	N	2	1	1	4	5	27	The areas that could be impacted by infrastructure should be minimised.

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
and roads									
Construction of infrastructure and roads	*Socio-economic*: Creation of contractor opportunities.	P	2	2	1	5	5	33	Attempt to produce goods and services from local businesses who are BEE compliant.
Construction of infrastructure and roads	*Air quality*: Movement of construction vehicles will result in an increase in dust levels on and around the site.	N	2	2	1	5	5	33	Dust suppression techniques should be used to limit the amount of dust created during construction.
Construction of infrastructure and roads	*Noise*: Construction activities will result in an increase in noise levels.	N	2	2	1	5	5	33	Construction equipment should be fitted with silencers and properly maintained.
Removal of vegetation	*Flora*: Removal of invasive species from the dump.	P	1	1	4	6	5	40	Ensure that seeds from the invasive species do not disperse to the surrounding environment.

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
Removal of vegetation	*Fauna*: Removal of vegetation will result in the destruction of habitats.	N	1	1	4	6	5	40	Mitigation will be required if large mammals are found on the dumps.

6.4 Operational Phase

Table 6.2 gives a summary of the anticipated impacts for the operational phase. During this phase the reclamation material will be transported from the site to the City Deep plant for processing. The waste created during the processing will be dumped on the Homestead/Diepkloof, Mooifontein or GMTS tailings dams.

Table 6.2: Summary of the EIA for the operational phase

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
RECLAMATION SITES									
Removal of mine dumps	*Archaeological & heritage resources*: The mining resources will be removed from its context, together with all associated mining heritage resources.	N	2	1	1	4	3	16	Proper documentation of mine dumps and related mining heritage resources for archival and intangible conservation purposes. Contribute towards mining heritage awareness.
Transport reclaimed material via pipe lines/trucks	*Groundwater quality*: Breakage in pipelines of accidental spillages of reclaimed material.	N	2	2	1	5	3	20	Pipelines should be maintained and breakages repaired. Truck drivers should receive adequate training to limit/prevent spillages.
Reclamation activities	*Land capability*: The land capability will improve with the removal of the material.	P	4	1	3	8	3	32	Ensure that all the mine material is removed from the site.
Reclamation activities	*Flora*: Removal of invasive species during reclamation of dumps.	P	1	1	4	6	5	40	Ensure that seeds from invasive species are not dispersed to the surrounding environment.
Reclamation	*Fauna*: Removal of vegetation will result in the	N	1	1	4	6	5	40	Mitigation will be required should any large mammals be found on the

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
activities	destruction of habitats.								dumps.
Reclamation activities	*Air quality*: The movement of materials from the dump to the plant will increase dust levels.	N	3	2	2	7	5	47	Dust suppression methods should be put in place to prevent an increase in dust levels.
Reclamation activities	*Groundwater quality*: Wetting of tailings/slurry.	N	3	2	2	7	5	47	Wet slurry should be removed as quickly as possible to prevent groundwater contamination.
Reclamation activities	*Flora*: Removal of natural vegetation during reclamation.	N	2	1	4	7	5	47	Ensure that the sites are rehabilitated with natural vegetation.
Reclamation activities	*Traffic & safety*: Machinery and vehicles used on the site could lead to an increase in road and pedestrian accidents.	N	5	2	2	9	4	48	Adequate signs should be in place and drivers and machinery operators should be made aware of the possible dangers.
Reclamation activities	*Socio-economic*: Creation of employment opportunities.	P	3	3	2	8	5	53	Train and recruit people to access job opportunities. Allow small BEE companies to access procurement opportunities and provide mentorship where possible. Implement HR programmes with

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
									employees to encourage career development.
Reclamation activities	*Land use*: Land use will change to an active mine reclamation site.	P	3	2	3	8	5	53	No mitigation required.
Reclamation activities	*Noise:* The reclamation activities especially the water cannons (if used) will increase noise levels in the area.	N	4	2	2	8	5	53	Measures should be put in place to limit the generation of noise from reclamation activities.
Reclamation activities	*Soil*: Removal of dumps will expose the natural soil layer and allow for natural vegetation to re-establish itself.	P	5	1	5	11	5	73	Ensure that all the mine material is removed from the site.
Reclamation activities	*Topography*: Removal of dumps will result in a change in the topography.	P	3	3	5	11	5	73	No mitigation required.
Reclamation activities	*Visual*: Removal of dumps will cause a change in the visual aspect of the area.	P	4	2	5	11	5	73	No mitigation required.
TAILINGS DAM									
Operation of tailings dam	*Groundwater quality*: Possible leachates from the tailings dam will deteriorate the groundwater	N	3	2	3	8	3	32	Ensure that the tailings dam is maintained according to design and

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
	quality.								that it does not leach.
Operation of tailings dam	*Surface water*: Possible leachates from the tailings dam will deteriorate the surface water quality.	N	3	2	3	8	3	32	Ensure that the tailings dam is maintained according to design and that it does not leach.
Operation of tailings dam	*Surface water quality*: Possible overflows from the return water dams and trenches during continuous rainfall will contaminate the surface water resources.	N	3	2	2	7	4	37	The surface water reticulation system should be maintained to ensure that it operates according to design.
Operation of tailings dam	*Noise*: There will be an increase in noise levels due to cycloning and the movement of vehicles on site.	N	1	2	3	6	5	40	Machinery should be maintained to minimise the creation of noise.
Operation of tailings dam	*Visual aspect*: The height increase of the tailings dam will change the visual aspect of the area.	N	1	2	5	8	5	53	The tailings dam should be vegetated to improve its appearance.
Operation of tailings dam	*Socio-economic*: Possible health impacts on the local community due to an increase in dust levels.	N	3	2	4	9	5	60	Ensure that vegetation cover is established on the slopes. The dry beach on the tailings dam should be minimised.

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
Operation of tailings dam	*Air quality*: An increase in tailings material on the tailings dam will result in an increase in dust levels.	N	2	2	5	9	5	60	The slopes of the tailings dam should be covered with vegetation. Dust monitoring should take place.
Operation of tailings dam	*Topography*: The height of the tailings dam will increase causing a change in the topography of the area.	N	2	2	5	9	5	60	No mitigation is possible.
Operation of tailings dam	*Soil*: Degradation of the soil structure of the soil underneath the tailings dam.	N	3	1	5	9	5	60	No mitigation is possible.
Operation of tailings dam	*Land capability*: The tailings dam will cause a decrease in the land capability of the site and the immediate area surrounding it.	N	2	1	5	8	5	53	No mitigation is possible on site. Monitoring and management should take place to ensure that the impacts on the surrounding area is minimised.
Operation of tailings dam	*Groundwater quality*: An increase in the piezometric water level and contaminant load to the subsurface can be expected because of the additional tailings that will be deposited on the existing tailings dam.	N	4	2	5	11	5	73	Mitigation can be achieved, to a limited extent, by removing return water to lined return water dams as soon as possible.

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
KNIGHTS PLANT									
General plant operations	*Groundwater quality*: Accidental spillages of hydrocarbons and hazardous materials will result in groundwater contamination.	N	2	1	1	4	4	21	Spillages should be contained and cleaned up immediately.
General plant operations	*Groundwater quality*: The incorrect handling and disposal of sewerage, domestic and hazardous waste will result in groundwater contamination.	N	2	2	1	5	4	27	A waste management plan should be followed to ensure that waste is disposed of according to the correct procedure.
General plant operations	*IAPs*: The increase in noise levels and the movement around the plant will have an impact on the IAPs living in the vicinity of the plant.	N	1	2	1	4	5	27	Measures should be put in place to minimise the impacts on the IAPs.
Transportation of reclaimed material	*Soil*: Leakages/breakages in the pipeline or spillages from trucks will cause soil contamination.	N	3	2	4	6	4	32	The pipelines should be inspected regularly to prevent major leakages/breakages from occurring. Truck drivers should receive adequate training and made aware of the consequences of spillages.
Storage of	*Surface water quality*: Failure of hydrocarbon and	N	3	2	2	7	4	37	All the storage facilities should be

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
hazardous materials	hazardous material storage facilities will cause surface water pollution.								bunded and properly maintained to prevent failure of infrastructure from occurring.
General plant operations	*Groundwater quality*: Failure of hydrocarbon and hazardous material storage facilities will cause surface water pollution.	N	3	2	2	8	4	37	All the storage facilities should be bunded and properly maintained to prevent failure of infrastructure from occurring.
General plant operations	*Traffic & safety*: Traffic to and from the site will increase due to materials being transported to the site (in the case of mechanised removal). This could lead to an increase in vehicle and pedestrian accidents.	N	5	2	1	8	4	43	Adequate signs should be in place and drivers and machinery operators should be made aware of the possible dangers.
General plant operations	*Air quality*: Plant operations will cause air pollution in the form of CO, CO_2 and NO_x emissions.	N	2	2	3	7	5	47	Machines will be serviced, inspected and maintained properly to minimise the greenhouse gasses, such as CO, CO_2 and NO_x emitted.
General plant operations	*Noise*: All the activities on the plant will contribute to an increase in noise levels on and around the site.	N	2	2	3	7	5	47	All the machinery should be fitted with silencing systems and maintained to limit noise creation.

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
General plant operations	*Socio-economic*: The operations at the plant will create employment opportunities.	P	3	3	3	9	5	60	Train and recruit local people to access job opportunities. Allow small BEE companies to access procurement opportunities and provide mentorship where possible. Implement HR programmes with employees to encourage career development.
General plant operations	*Groundwater quantity*: Existing, hard paved areas limits recharge to local aquifers.	N	2	2	5	9	5	60	No mitigation is possible.

6.5 Decommissioning Phase

Table 6.3 gives a summary of the anticipated impacts for the decommissioning phase. During this phase all the equipment and facilities will be removed from the site and it will be rehabilitated to a level acceptable for further urban development

Table 6.3: Summary of the EIA for the decommissioning phase

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
RECLAMATION SITES									
Rehabilitation	*Noise*: The movement of machinery will increase noise levels in the vicinity of the site.	N	2	2	1	5	5	33	Management measures should be put in place to limit the amount of noise being generated from rehabilitation activities.
Rehabilitation	*Soil*: Rehabilitation activities on the cleared area.	P	4	1	4	9	3	36	Ensure that rehabilitation is done properly and that vegetation is re-established to prevent soil erosion.
Decommissioning	*Socio-economic*: Decommissioning will lead to a loss of procurement opportunities.	N	3	3	4	10	3	40	Undertake mentorship with smaller procurement companies throughout the life of mine so as to encourage dependence on other sectors of the economy and other players within mining.
Rehabilitation	*Land capability*: Rehabilitation of the cleared area will improve the land capability of site and its surroundings.	P	4	2	4	10	3	40	Ensure that rehabilitation is done properly to allow for the development of the land.

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
Rehabilitation	*Flora*: Final clearance of vegetation from the site from the site will be necessary to prepare it for future development.	N	1	1	4	6	5	40	Should the site be re-vegetated during this phase, the natural vegetation should be restored.
Rehabilitation	*Fauna*: Final clearance from the site will result in the complete destruction of habitats on the site.	N	1	1	5	7	5	47	Should the site be re-vegetated it will create new habitats for fauna and it will thus move back into the area.
Rehabilitation	*Air quality*: Rehabilitation of the cleared area will decrease the amount of dust blown from the site.	P	3	2	4	9	4	48	Ensure that rehabilitation is done properly to minimise the amount of dust blown from the site.
Rehabilitation	*Traffic & safety*: The increase in movement of vehicles and machinery on and around the sites could lead to an increase in vehicle and pedestrian accidents.	N	5	2	2	9	4	48	Adequate signs should be put in place and drivers and machinery operators should be made aware of the possible dangers.
Rehabilitation	*Groundwater* quality: Rehabilitation of the tailings footprint area will lead to the improvement of the groundwater quality.	P	2	2	4	8	5	53	No mitigation is required. Groundwater monitoring should continue.
Rehabilitation	*Visual aspect*: Rehabilitation of the cleared area	P	2	3	5	10	4	53	Ensure that rehabilitation of the site

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
	will result in a change in the visual aspect of the surrounding area.								is done properly
Rehabilitation	*Topography*: Rehabilitation of the cleared area will result in a changed topography with drainage lines being restored etc.	P	4	3	4	11	4	59	Rehabilitation should be done properly to allow for the land to be developed.
Downscaling of workforce	*Socio-economic*: During the decommissioning phase there will be downscaling of employment opportunities if there are no new dumps that will be reclaimed.	N	4	2	5	11	5	73	Ensure that employees are redeployed to the Knights operation, or other reclamation sites nearby. Integrate employees into LED projects and equip them with skills to locate employment outside of mining.
KNIGHTS PLANT									
All activities	*Soil*: Potential of soil contamination due to the incorrect handling and disposal of industrial and hazardous waste.	N	2	1	1	4	3	16	Hazardous waste should be disposed of at an appropriate authorised landfill site.
All activities	*Soil*: Potential of soil contamination due to the incorrect handling of sewerage and the removal	N	2	1	1	4	3	16	Sewerage should be handled and disposed of in a manner that will not

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
	of sewerage infrastructure.								cause soil contamination.
All activities	*Soil*: Potential of soil contamination by spillages from earth moving machinery.	N	2	1	2	5	4	27	Hydrocarbons should be stored correctly to prevent spillages. Spillages that do occur should be contained and remediate immediately.
All activities	*Air quality*: Decommissioning activities will result in an increase in dust levels.	N	2	2	1	5	4	27	Dust abatement techniques should be applied during the dismantling of infrastructure.
All activities	*Air quality*: Construction machines will cause air pollution in the form of CO, CO_2 and NO_x.	N	2	2	1	5	4	27	Construction machines should be serviced, inspected and maintained properly to minimise the amount of greenhouse gasses being emitted.
All activities	*Noise*: Decommissioning activities will cause an increase in noise levels in the surrounding area.	N	1	2	1	4	5	27	Vehicles and machinery should be equipped with standard silencing systems and serviced regularly.
All activities	*Soil*: Movement of vehicles and machinery could result in soil compaction of unaffected	N	3	1	3	7	3	28	Equipment that minimises soil compaction should be used and movement of vehicles on unaffected

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
	areas.								areas should be avoided.
All activities	*IAPs*: The increase in dust and noise levels during decommissioning will have a negative impact on the IAPs living in the vicinity of the site.	N	3	1	1	5	5	33	Dust and noise will be managed and monitored according to the relevant management plans.
Decommissioning	*Topography*: Dismantling of the plant will result in a change in the topography of the area.	P	3	3	4	10	3	40	Ensure that the entire infrastructure associated with the plant is removed and that the whole area is rehabilitated.
Rehabilitation	*Flora*: Final clearance of vegetation from the site from the site will be necessary to prepare it for future development.	N	1	1	4	6	5	40	Should the site be re-vegetated during this phase, the natural vegetation should be restored.
All activities	*Surface water quality*: Possible spillages of hydrocarbons from earth moving machinery will pollute surface water resources.	N	3	2	3	8	4	43	Hydrocarbon spillages should be contained and remediate immediately.
All activities	*Surface water quality*: Possible contamination of surface water due to the incorrect handling and disposal of hazardous, industrial and domestic	N	3	2	3	8	4	43	The waste management system should be followed to ensure that waste is handled and disposed of in

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
	waste.								an appropriate manner.
All activities	*Surface water quality*: Possible surface water contamination due to the incorrect handling and disposal of sewerage.	N	3	2	3	8	4	43	The waste management system should be followed to ensure that the sewerage is handled and disposed of in and appropriate manner.
All activities	*Groundwater quality*: Possible spillages of hydrocarbons from earth moving machines will pollute surface water resources.	N	3	3	2	8	4	43	Hydrocarbon spillages should be contained and cleaned up immediately.
All activities	*Groundwater quality*: Possible contamination due to the incorrect handling and disposal of sewerage.	N	3	3	2	8	4	43	The waste management system should be followed to ensure that the sewerage is handled and disposed of in an appropriate manner.
All activities	*Traffic & safety*: Traffic to and from the site will increase due to material being transported from the site. Vehicle movement on site will also increase. This could lead to an increase in road and pedestrian accidents.	N	5	2	1	8	4	43	Adequate signs should be in place and drivers and machinery operators should be made aware of the possible dangers.
Decommissioning	*Socio-economic*: The decommissioning of the plant will lead to a loss of procurement	N	3	3	5	11	3	44	Undertake mentorship with smaller procurement companies throughout

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
	opportunities.								the life of mine so as to encourage dependence on other sectors of the economy and other player within mining.
Rehabilitation	*Fauna*: Final clearance from the site will result in the complete destruction of habitats on the site.	N	1	1	5	7	5	47	Should the site be re-vegetated it will create new habitats for fauna and it will thus move back into the area.
Rehabilitation	*Visual*: Removal of all the infrastructure and rehabilitation of the impacted areas will result in a change of the visual aspect of the area.	P	3	3	3	9	4	48	Ensure that rehabilitation is done properly and effectively.
Downscaling of workforce	*Socio-economic*: Closure of the plant will lead to the retrenchment of employees.	N	4	2	5	11	5	73	Investigate opportunities to redeploy employees to other operations or extend the current life of mine. Integrate employees into LED projects and equip them with skills to locate employment outside of mining.

Activity and impact description		Positive/Negative	Impact significance before mitigation						
Activity	**Impacted Environment & Impact**		**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Mitigation**
TAILINGS DAM									
Closure of tailings dam	*Fauna:* Vegetation of the tailings dam will create habitats for small animals.	P	3	2	5	10	3	40	Ensure that the tailings dam is properly covered with vegetation.
Closure of tailings dam	*Air quality*: Vegetation the tailings dam will result in a decrease in dust being blown from the tailings dam.	P	2	2	5	9	4	48	Ensure that the tailings dam is properly covered with vegetation to limit the amount of dust blown from the tailings dam.
Closure of tailings dam	*Surface water quality*: There will be an increase in the amount of surface water run-off since water will not infiltrate into the tailings dam.	N	3	2	5	10	5	67	The trench around the tailings dam should be maintained to ensure that the run-off from it do not enter the environment.
Closure of tailings dam	*Groundwater quality*: It is anticipated that the groundwater quality around the tailings dam will deteriorate because of the additional contaminant load available to seep into the underlying aquifer.	N	3	2	5	10	5	67	Monitoring of groundwater in the vicinity of the tailings dam should continue for compliance purposes, until the groundwater system has recovered to specific catchment objectives.

7 CUMULATIVE IMPACTS

Cumulative effects are caused by the accumulation and interaction of multiple stresses affecting the parts and the functions of ecosystems. Of particular concern is the knowledge that ecological systems sometimes change abruptly and unexpectedly in response to apparently small incremental stresses. For purposes of this report, cumulative impacts have been defined as "**the changes to the environment caused by an activity in combination with other past, present, and reasonably foreseeable human activities**".

Where cumulative impacts are expected to be significant, these have been discussed.

7.1 Topography

The reclamation of the dumps will result in the complete removal of the dumps. These areas will then be available for further development in the area. Even though the dumps will be removed and the area rehabilitated, it will result in an altered topography. The City Deep plant is an existing structure and no further impacts are expected from it. The cumulative impact of the tailings dams used for disposal of mining waste will have a significant negative impact on the topography of the area.

The change in topography could result in a change in drainage patterns, surface water streams, groundwater recharge and visual aspects.

7.2 Geology

The geology has been altered to a great extent due to gold mining activities on the east rand. The reclamation of the dumps and the use of the City Deep plant will not contribute to current or past impacts on the geology.

7.3 Soil

The areas surrounding the dumps and plant have in most cases been fully developed. The soils in these areas have thus already been impacted on to a great extent. The reclamation

of the dumps and the rehabilitation of these areas will result in positive impacts on the soils under the dumps in terms of rehabilitation of the areas post reclamation.

7.4 Surface Water

The removal of the slimes and sand dumps will have a positive effect on the surrounding areas as the quality of the surface water resources will increase which will have a positive effect on the downstream water quality and the catchment.

It is not expected that the City Deep plant will make a significant contribution to degradation of surface water resources in the area. The cumulative impacts on surface water resources should be managed according to the relevant river catchment objectives.

7.5 Groundwater

The slime and sand dumps are sources of contamination to the water resources and related ecosystems and removal of this will result in positive impacts on these systems. Overall, the water levels and water quality of groundwater resources in the immediate vicinity of the dumps will recover over time. Groundwater dependant ecosystems will not be able to recover to natural conditions, because of other existing tailings dams and other sources of pollution in the area, but less contamination will occur in the weathered zone, which will lead to less pollution of the groundwater resources and an overall improvement of the aquatic environment within which these ecosystems exist.

The City Deep plant and the tailings dams used during this operation will contribute to contamination of groundwater resources. These operations are however crucial for the viability of the project.

7.6 Land Capability

The region is largely used for housing and mining activities, and thus land capability has already been affected significantly. Removal of the dumps and proper rehabilitation of these sites will open up alternative options for the land capability of the areas. The tailings dams also contribute to the degradation of the land capability.

7.7 Air Quality

Dust mostly settles within a 500m radius and impacts on that area more severely. If other mines open in the area and/or reclamation of neighbouring dumps occur cumulative impacts can become more significant. Wind can transport dust several kilometres and deposit it in sensitive areas such as on crops, residential areas and in rivers. Dust levels must therefore be monitored on a regular basis to determine potential sources of dusts, increases and decreases in dust levels, and determine level of mitigation required.

7.8 Noise

The factors contributing to the noise levels in the area is typical of that found in urban areas. The reclamation of the dumps and processing of the materials at the plant would slightly contribute to the noise levels in the area.

7.9 Natural Vegetation

Cumulative impacts on natural vegetation are very significant but could be mitigated properly with the correct measures. The natural vegetation has already been impacted on, on a national level, by mining, agriculture and urban development. Urban development could also lead to the introduction of alien invasive species. The cumulative impacts on flora could thus be highly significant.

7.10 Animal Life

Fauna in the area have been disturbed extensively by mining activities and urban development since their habitat has removed. During the reclamation of the dumps there will be a negative impact on the animals living on site because their habitat will be destroyed. After rehabilitation animals will move back to the site.

7.11 Sensitive Landscapes

It is not expected that the reclamation activities will have an impact on the sensitive areas in the vicinity of the dumps.

7.12 Visual Aspects

The visual aesthetic of the area will change significantly when the dumps are removed. This will have a positive impact since the dumps are unnatural structures and lies within close proximity to urban developments.

7.13 Regional Socio-Economic Structure

During reclamation of the slime and sand dumps, cumulative impacts on the regional socio-economic structure are expected to result from the commissioning of other operations in the nearby area. The operation of other mines, in combination with the initiation of businesses (to provide services to the mines) will result in the creation of additional employment opportunities throughout these phases. These cumulative impacts will have a positive spin-off effect on the local economic structure as higher order businesses and services become operational in the area. Due to the existing presence of many operations and big businesses in the area, it is not expected that this impact will be highly significant.

7.14 Interested and Affected Parties

Communities near the dumps will be affected negatively by the operation; however, this will not have a cumulative effect. Once the dumps have been removed the impact will be positive and the cumulative effect of this will be the increase in surrounding land values as well as a healthy environment in which to live as a source of pollution has been removed. IAPs in the vicinity of the plant will not experience highly significant impacts from the activities at the plant.

7.15 Sites of Archaeological and Cultural Interest

Mining heritage in South Africa is currently under threat due to the cumulative impacts of industrial development. The two major influencing factors are (1) the mining of old resources, and (2) the closure of historic mining companies. The mining of historic tailings, sand and rock dumps are the most visible impacts on historic landscapes and tangible elements are generally removed from the development site. However,

cumulative impacts can also be positive if valuable contributions are made towards research through effective documentation and mitigation of relevant heritage sites in the area. The City Deep operations should aim to optimise positive cumulative impacts and minimize (or avoid) potential negative impacts on heritage resources in the area.

8 PUBLIC PARTICIPATION PROCESS

Crown views public participation as an important tool in the decision-making process. The interested or affected public are the only meaningful way through which to explore locally relevant conditions and dynamics. The result of an effective PPP would be enhanced and shared project benefits, an understanding of key IAP issues, and the generation of creative new alternatives and solutions to any identified challenges.

The seven steps followed during the PPP are as follows:

1. Identify stakeholders;
2. Announce opportunity for involvement;
3. Consult with stakeholders;
4. Obtain issues for evaluation and suggestions for alternatives;
5. Verify that issues have been considered in specialist studies;
6. Present findings for comment and review by stakeholders; and
7. Announce authority decision and appeals procedure.

8.1 Process of Engagement

The City Deep PPP required a combination of various methodologies to be implemented to meet the needs of different stakeholders. These methodologies will be continually evaluated and refined throughout the EIA/EMP for the life of the project. The process undertaken to date is discussed below.

The PPP served to assist in the two-way dissemination of information on the different aspects of the proposed project. It also aimed to highlight stakeholder attitudes, expectations and the need for ongoing levels of information sharing.

Information dissemination with stakeholders included both verbal and written public notification and formal consultation with the regulatory authorities concerned.

8.1.1 Stakeholder identification

The initial stakeholder identification process comprised of a site visit and a comprehensive desktop study including:

- Maps to identify residential and industrial sites in the project area;
- Reference books and internet sites;
- Title deed searches; and
- A site visit.

This phase represented the primary research phase of the PPP.

In June 2007 members of the DWA PPP team conducted a site visit with the intention of gaining a broad overview of the geographical area and identifying land uses in close proximity to the project area to assist in developing an appropriate PPP approach for the project.

Specifically, this phase involved the identification of stakeholders who would be directly or indirectly affected by the project (see Appendix D for the full list of IAPs).

Three IAP groups were identified including:

- Regulatory authorities, councillors and other relevant authorities;
- Other interest groups, including Non-Governmental Organisations (NGOs), Community Based Organisations (CBOs), media, environmental associations etc; and
- Affected landowners, industrial workers and residents surrounding the project area.

Regulatory Authorities

Authorities that were identified for the project consisted of national, provincial and local government bodies. Elected representatives were included in this group of stakeholders.

Some representatives identified from this group of controlling authorities consisted of:

- Department of Mineral Resources (DMR) – Gauteng regional division;
- Department of Water Affairs and Forestry (DWAF) – Gauteng regional division;
- City of Johannesburg Affairs, Environmental Health Department
- City of Johannesburg Affairs, Environmental Department; and
- Local authorities such as ward councillors, to name a few.

The authorities were identified from existing databases, liaison with government officials, prior project experience and consultation, government databases and telephone directories.

Interested and Affected Groups

Other important IAPs included local businesses and NGOs operating in the nearby area. Community organisations were also identified in this regard.

Throughout the PPP the electronic database was updated to include the contact details of all registered stakeholders and other affected parties that were identified at meetings or information-sharing sessions. A detailed contact list of the IAPs that were consulted is contained in Appendix D.

8.1.2 Documentation developed

Various communication documents were compiled to disseminate information regarding the proposed project, public participation and information sharing meetings with stakeholders. Often a combination of media was used to ensure the greatest possibility of wide notification.

The various media that were used included:

Background Information Documents (BIDs) served to inform stakeholders about the proposed project, the area involved, initial issues identified by the project team and the PPP that would be followed.

Letters of Invitation invited relevant authorities and IAPs to meetings.

Registration and comments sheets were developed and dispatched to authorities, interested parties and the general public. The comments sheets gave IAPs an opportunity to register for the project and raise their concerns, issues or suggestions. Response sheets were also a method by which IAPs who were unable to attend meetings could become part of the PPP.

Notification posters advised the general public and about the proposed project and public meetings. These notices were placed in and around the project area, including road intersections and along the roads leading to these sites on 3 August 2007.

Media releases were placed in the "The Star" and "The Sowetan" and published on 3 August 2007. These advertisements notified the general public about the proposed project and the public meeting that would be held. These papers were chosen due to their wide circulation in the area.

Email, telephone and fax services were used where appropriate in contacting authorities, organisations and individual stakeholders. Follow-up telephone calls were made where possible to confirm attendance at meetings. Information dissemination and follow-up telephone calls were undertaken three weeks prior to the meeting until the date of the meeting

8.2 Outcomes of Meetings

One authorities' meeting and public information sharing meeting were held during this phase of the City Deep project.

The authorities were provided with detailed project information and were given the opportunity to comment and make suggestions. Authority issues and concerns were recorded and addressed as required, and were taken into consideration during the planning of the City Deep EMPR upgrade process.

The general public meeting aimed to identify further IAPs for the project, disseminate detailed project information, as well as to gather public issues and concerns. IAPs were notified 30 days in advance of the meeting. The meeting described the specialist studies that were being undertaken for the project, and the impacts that the City Deep operation has had to date. IAPs were provided with the opportunity to ask questions relating to the project, and to have their issues and suggestions recorded and addressed by project specialists.

No one-on-one consultations were deemed necessary during this phase of the PPP as no significant issues and concerns were uncovered.

The minutes from the meetings held in September 2007 was distributed to ensure that an accurate account of the meetings was kept and could be ratified by IAPs from each meeting. All concerns, issues and suggestions raised were documented in the minutes. The minutes from the meetings were distributed on 23 October 2007.

Most of the issues were derived from meetings with stakeholders, whether authorities (national, provincial or local), private individuals or affected community members. These issues are listed in Table 8.1

Table 8.1: Issues, concerns, comments and suggestions raised

Reference	Name & organisation	Issue raised	Response
1. PROJECT SPECIFIC			
Operational			
Authorities meeting	Nic Van Deventer: City of Johannesburg, Health Department	What process is usually followed with regard to the material that remains after the extraction of gold is complete?	The remains are transported to the existing tailings dam complex through pipe lines.
Authorities meeting	Samukelisiwe Mdlalose: City of Johannesburg, Environmental Department	Are the slimes in tailing dams at all re-usable and could this perhaps be dealt with in the EIA document?	There are areas where it can be used but only in very small quantities - research on the potential uses of this by-product is ongoing. These studies do not form part of the EIA process.
Authorities meeting	Beverly Turk: City of Johannesburg, Ward Councillor	Could bricks be manufactured out of the tailings dam material?	This would not be permitted due to radiation.
Authorities meeting	Nic Van Deventer: City of Johannesburg, Health Department	Nic Van Deventer: City of Johannesburg, Health Department	The final product is deposited on the Crown Mines tailings facility. The sludge is deposited on the tailings complex, where water is extracted and returned to the plant for re-use.

Reference	Name & organisation	Issue raised	Response
Authorities meeting	Nic Van Deventer: City of Johannesburg, Health Department	Is the soil on the dumps fertile?	The soil on the dumps is not at all fertile and this is the reason that CGR uses lime and fertilisers to increase soil fertility for rehabilitation purposes.
Authorities meeting	Beverly Turk: City of Johannesburg, Ward Councillor	There is currently a huge problem with the Bosmontspruit, and when it rains, the sand/slime causes water levels that can be 1m higher than is usual. This scenario also causes a problem to the West of the N1 highway. Is the Bosmont area located under the CMR mining license?	CMR's mining license is separate to these discussions but a note will be made regarding the problems experienced in the area. CGR is dealing with this and other similar issues and will investigate this problem further, but the meeting at hand will need to focus on the City Deep operations in particular.
Public meeting	Brian Dawson: EMPR Services	All environmental management issues should be addressed and management plans implemented.	Environmental issues will be addressed in the management plans implemented.
Public meeting	Andrew Barker: iProp Development Consultant	The project Hloekisa needs to be recognised and acknowledged in principle with respect to the environmental cleanup of the mining land and its contribution to urban development. It is also important that the various land and mining companies involved in the area worked closely together to ensure the coordinated cleanup of the mining land and look for opportunities for working together with respect to the realisation of this project.	Point noted.
Authorities meeting	Floris Visser: City of Johannesburg, Health	Why could the slimes from the tailings facilities not be put back into the defunct mines considering rehabilitation is an expensive exercise?	This issue has being considered and it is an ongoing debate. After treatment the volume of the rock increases. For every 1 tonne of rock treated, 1.5 tonnes of slime is produced. There

Reference	Name & organisation	Issue raised	Response
	Department		is also the natural closure of tunnels and underground workings. Underground water can be recovered but it is very expensive. One cubic metre of rock, which will need be milled, is equal to two cubic metres after milling. There would not be sufficient space underground and other pollution issues would arise from depositing the slimes underground. Approximately six to seven hundred thousand tonnes of slimes is placed on the tailings facility per month. Discussions with Department of Water and Forestry are ongoing to find a way forward.
Decommissioning and closure			
Authorities meeting	Floris Visser: City of Johannesburg, Health Department	Concerned about the rehabilitation methodology that is used for the dumps and the length of time that it will takes to grass the area. Enquired why this takes so long, and what can perhaps be done to speed up the process.	The process is very slow, but the rehabilitation process has been escalated. The intention of CGR is to rehabilitate approximately 15-17 hectares per year. CGR have made a formal application to be exempt for using alien species such as pampas grass, as this grows well on the dumps. Further investigations are being undertaken into methodologies for speeding up the process of rehabilitation and vegetating the dumps with various other plant species.
Authorities	Floris Visser: City	The suppliers of water are very expensive - can CGR perhaps	Water is one of the main problems. Vegetating

Reference	Name & organisation	Issue raised	Response
meeting	of Johannesburg, Health Department	investigate other forms of irrigation for the vegetation on the dumps?	on the mine dump slopes is difficult due to erosion and the vegetation being used as a dust mitigation measure. Point noted for further consideration.
Authorities meeting	Douglas Wood: City of Johannesburg, Environmental Health Department	Rehabilitated areas are generally not suitable for construction purposes. The local metropolitan council currently plans to construct low cost housing on the portions of rehabilitated ground.	According to the law, construction (industrial, commercial etc) can in fact be undertaken on rehabilitated sites, e.g. Gold Reef City. However, no residential units may be constructed in these areas. Hazards such as acidic soil, radiation from the soil, etc can be dangerous. Samples of the soil can be taken to analyse and see if results show the viability to construct on a rehabilitated area.
Public meeting	Brian Dawson: EMPR Services	When will the reclamation of the Mennels dump be completed?	The intention is that operations will be completed by the year 2009. This 36 month period may, however, be extended.
Public meeting	Brian Dawson: EMPR Services	Would there be a tapering off of activities towards closure, and if so, is this based on the price of gold?	There will be a tapering off period of approximately 12 months – this estimate is based on the City Deep reserves.
2. BIOPHYSICAL IMPACTS			
Surface and groundwater			
Authorities meeting	Floris Visser: City of Johannesburg, Health	Water supplies are very expensive in terms of irrigating vegetation on the dumps - the whole area must be suitably rehabilitated in order to reduce the dust impact on the surrounding region.	Point noted. The vegetation issue will be accelerated. The Government also contributes to delays in the process with issues regarding

Reference	Name & organisation	Issue raised	Response
	Department		DWAF's regulations.
Authorities meeting	Nic Van Deventer: City of Johannesburg, Health Department	Is there a way for cyanide and heavy metals to be taken out of water as this causes pollution issues when left in dams?	This has been a long term issue arising out of the legacy of mining in the Johannesburg area. Generally, this situation is controlled by the DWAF, and long-term processes are being considered to find ways of removing substances such as cyanide and any other heavy metals in water. Cyanide has a limited short term impact and does not persist in the environment. The majority of such issues are due to the lack of control of 20 or 30 years ago, there has been poor management of mining regulations.
Authorities meeting	Lizette van Zyl: City of Johannesburg, Health Department	How will water seeping into the ground water system be controlled? The polluted water has a yellowish substance - is this cyanide which can be a very poisonous?	Cyanide is in fact blue in colour. The yellowish substance that is referred to is an iron related substance and is not poisonous to animal life.
Authorities meeting	Lizette van Zyl: City of Johannesburg, Health Department	Is there any system in place for the monitoring of polluted water?	There is a monitoring system which involves regular inspections. CGR also participates in Water Forums around the Johannesburg area. LK can provide all of the information about the forums as well as any information concerning water monitoring issues.
Authorities	Samukelisiwe Mdlasose: City	What mitigation measures are in place for water monitoring, and	CGR has identified 54 areas for in-stream, up-stream and down-stream monitoring. Water

Reference	Name & organisation	Issue raised	Response
meeting	of Johannesburg, Environmental Department	how often this monitoring takes place?	monitoring is done regularly and the process is operating very well. Results are provided to DWAF.
Authorities meeting	Lizette van Zyl: City of Johannesburg, Health Department	There is an area near the N17 highway where the level of ground water is very high. How will this be affected during the rainy season?	The first phase of the geohydrological investigations has already been undertaken as part of the water monitoring system. Some ground water is very high even in winter. The deeper aquifer, water is 900m below surface flows in the central mining basin. The East and West of Johannesburg have a large amount of soil with approximately 40-50 g of uranium, (Wits slime dams). Constant water monitoring and control of water levels occur.
Fauna and flora			
Authorities meeting	Samukelisiwe Mdlasose: City of Johannesburg, Environmental Department	Has CGR considered planting trees as part of rehabilitation instead of focusing only on grass?	The company had considered this, especially with regard to Bluegums which grow easily on the dumps. CGR has also considered planting indigenous plants, which the company has found do not grow as well as the alien Bluegums and pampas grasses. CGR has applied to the Department of Agriculture and Land Affairs (DALA), to approve the planting of trees with a height of no more than 2-3m on the last lift of the tailings dams. The company must conduct further research to see if there are other Bluegum species that are suitable.

Reference	Name & organisation	Issue raised	Response
			Another issue to consider is that the blue gum is often chopped down by nearby residents for the purpose of making fires. CGR would not have any control over a dump once it has been rehabilitated and decommissioned.
Authorities meeting	Samukelisiwe Mdlasose: City of Johannesburg, Environmental Department	Instead of concentrating only on alien plants for rehabilitation, perhaps research on other indigenous species, and the usage of correct compost and chemicals of indigenous plants could be considered.	Suggestion noted for the record. For the past 10 years, CGR has undertaken investigations, which are still ongoing, and realised that other indigenous plants grow extremely slowly on the dumps. Bluegum trees seem to be the only trees that grow quickly, but the height of 4-5m is unacceptable according to the DALA regulations.
Authorities meeting	Samukelisiwe Mdlalose: City of Johannesburg, Environmental Department	What measures are taken to alleviate dust pollution problems? What mechanisms are used for this problem, and how often is sampling undertaken?	Dust is monitored on a monthly basis. CGR is known to have one of the best monitoring programs. Dust buckets are normally used before and after the commencement of each operation.
Authorities meeting	Nic Van Deventer: City of Johannesburg, Health Department	With reference to dust suppression techniques, what are CGR's intentions for the upcoming 2010 World Cup, especially with regard to the FNB Stadium?	CGR is fully aware of these challenges and is currently working towards finding alternative methods to ensure that this event it not badly affected.

Reference	Name & organisation	Issue raised	Response
SOCIAL IMPACTS			
Social responsibility			
Authorities meeting	Beverly Turk. City of Johannesburg, Ward Councillor	A full Social and Labour Plan must be compiled for the company's City Deep operations. The directly affected ward's residents should be given preference for job opportunities at the operations.	Every South African citizen is entitled to a job, housing etc. according to the country's policies. CGR has a full Black Economic Empowerment (BEE) policy in place. With existing mine operations and skilled employees, CGR will not employ any additional people and most employees that have been sourced were drawn from the local area surrounding the operations..
Public meeting	Andrew Barker: iProp Development Consultant	Have discussions been initiated with the City of Johannesburg with respect to the integration of the Social and Labour Plan into the City of Johannesburg IDP?	Point noted. CGR is aware that this is an important legislative requirement which they would adhere to. One consultation with the IDP manager at the City of Johannesburg has been undertaken, further consultation is still ongoing.
Public meeting	Andrew Barker: iProp Development Consultant	The initiation of the Regional Mining Forums by the DMR and the importance of participation and engagement with respect to Social and Labour Plan development and implementation are essential. For the DMR, it is imperative for municipalities and the land and mining companies to coordinate and integrate investment for local social and economic development to ensure substantive contribution to sustainable human settlement.	The initiation of the Regional Mining Forums by the DMR and the importance of participation and engagement with respect to Social and Labour Plan development and implementation are essential. For the DMR, it is imperative for municipalities and the land and mining companies to coordinate and integrate

Reference	Name & organisation	Issue raised	Response
			investment for local social and economic development to ensure substantive contribution to sustainable human settlement.
Public meeting	Andrew Barker: iProp Development Consultant	iProp need the mining right owners to keep contact in with them: iProp recognised that environmental management issues are vital; Social Labour Plan should be implemented in conjunction with the Council/Metro; iProp initiated the East to West Corridor and was going to submit this document to the Council to approve or at least make them aware of its existence; The Riverlea area is mainly residential and redevelopment should be conducted in such a manner that the suburb will be rejuvenated and the final land should include functions which will attract further investment in keeping with the City of Johannesburg's Development Plans; and The SLP should be integrated following the legislation requirements and the approach must include the Council (City of Johannesburg). The concept and principle need to be included in the process and there must also be a capacity of giving back to the communities. I-Prop, as the freehold owners of the land below the reclaimed dams and sand dumps as well as surrounding land, are offering themselves as interested stakeholders and are willing to participate	Point noted.

Reference	Name & organisation	Issue raised	Response
		in the whole operations.	
PROCESSES			
EIA			
Authorities meeting	Samukelisiwe Mdlalose: City of Johannesburg, Environmental Department	Do the three mines under CGR have existing EMPs and mining licences?	There are existing approved EMPRs for the operations, but due to the new MPRDA regulations, a public consultation process had to be undertaken and the EMPR upgraded into an EIA/EMP document. The final submission date for the updated EIA/EMP documentation is 20 December 2007.
Authorities meeting	Nic Van Deventer: City of Johannesburg, Health Department	Previous mines as well as the DMR regularly did not include the municipality as a stakeholder in environmental issues. Expressed gratitude that they are now part of the process as this makes things easier in terms of being able to address any problems experienced by the communities.	It is important to include all the stakeholders as well as local authorities. CGR wants to build a transparent relationship with all IAPs in their operations with the assistance of the authorities. For any further information IAPs are welcome to contact the company's Environmental Manager. LK.
Authorities meeting	Nic Van Deventer: City of Johannesburg, Health Department	Will a copy of the EIA/EMP be sent to the attendees when it is completed? Will there be a website containing the relevant information, and how will people living in townships be given access to the documents?	The public will be sufficiently notified once the documents were completed. Letters will be distributed to inform people as to where the draft documents are on display for public comment. CGR as well as DWA will consider placing the documents on their respective websites.
Authorities	Nic Van	What would happen if CGR ceased to exist? Is a closure plan in	There is a closure plan in place, and CGR is

Reference	Name & organisation	Issue raised	Response
meeting	Deventer: City of Johannesburg, Health Department Environment	place for the projects that are currently ongoing?	committed to its responsibility to rehabilitate the areas that it disturbs. The company would have to apply to the DMR for a Closure Certificate. The DMR ensures that the necessary trust funds are available and the disturbed areas will have to be completely rehabilitated before a Closure Certificate can be obtained. CGR will be on track with this process by the year 2011.
Authorities meeting	Nic Van Deventer: City of Johannesburg	The entire area was polluted with cyanide, what is the lifespan of cyanide?	Although cyanide is hazardous, it has a very short lifespan because the sun's UV rays break it up.
Authorities meeting	Nic van Deventer: City of Johannesburg	Guidelines with regard to cyanide and heavy metals should be given in the EIA/EMP documents so that the public can have an understanding of the facts relating to these substances as people perceive them to be hazardous.	Point noted for further consideration.
Public consultation			
Authorities meeting	Beverly Tuck: City of Johannesburg; Ward Councillor	It is very important for the City of Johannesburg to be involved in these processes, especially the councillors. The local residents often lodge their various complaints with the councillors, e.g. dust around the Heriotdale business area. The councillors are the representatives of the people and would thus like to be closely involved in CGR's operations. Knowledge enables the councillors to address the issues and concerns of the people.	The suggestion was noted.
Authorities	Samukelisiwe Mdlalose: City of	Informed CGR that there is a new unit of compliance officers in the City of Johannesburg Municipality. These representatives are	Commitment and transparency are vital to building an ongoing and continuous

Reference	Name & organisation	Issue raised	Response
meeting	Johannesburg, Environmental Department	responsible for conducting follow-ups on IAP's issues and concerns. This is the reason that this unit must have a good relationship with mining sectors so that it may easily work together with CGR and reach required environmental regulations and standards.	relationship.
Public meeting	Andrew Barker: iProp Development Consultants	There was a lack of direct notification and invitation to become an IAP as holders of freehold and prospecting rights in the areas. This also applied to the Crown Mines area which had been applied for previously in 2006 of which no notification was received. In view of the fact that there are overlapping rights it will be of critical importance that the involved companies worked closely together with regards to the various land and mining resources that are available.	All identified stakeholders are kept informed about the progress of the whole operation from outset to the finish. iProp's continued participation would be greatly appreciated to ensure that the operation is a success. Regular liaison meetings will be held with IProp.
Public meeting	Andrew Barker: iProp Development Consultants	Made apologies for the meeting for the Knights application that was to take place the following evening (Thursday 06 September 2007) and requested that the above issues be noted for that application also.	
GENERAL			
Authorities meeting	Mr Lee: iProp Limited	Who are land owners of the Mennels dump?	CGR and Grinrod are the owners of the land.

9 ENVIRONMENTAL OBJECTIVES

The environmental and social objectives are set to allow the reclamation of the sand and tailings resources in an environmental and socially responsible fashion while ensuring that sustainable closure can be achieved.

9.1 Environmental Objectives and Goals

The environmental objectives for the construction and operational phases are:

- Optimal utilization and maintenance of existing mine facilities in a well-planned manner;
- To take care that no new land surface, habitats of vegetation and animals are destroyed, disturbed or alienated unnecessarily;
- To contain and prevent any pollution (physical and chemical) from the reclamation activities within structures, facilities provided therefore;
- To ensure an effective surface run-off control system in order to deal with the separation of clean and dirty water environment;
- The sustainable and responsible utilization (re-use) of all water resources and the prevention of pollution thereof; and
- The sustainable rehabilitation of the crusher/waste rock dump site in order to address all environmental impacts as far as practical.

9.2 Socio-economic objectives and goal

The following socio-economic objectives should be attained during the operational, decommissioning and post closure phases of the City Deep operation.

- Adhere to an open and transparent communication procedure with stakeholders at all times;
- Ensure that accurate and regular information is communicated to IAPs;

- Ensure that information is communicated in a manner which is understandable and accessible to IAPs;
- Enhance project benefits and minimise negative impacts through intensive consultation with stakeholders;
- Assemble adequate, accurate, appropriate, and relevant socio-economic information relating to the context of the operation;
- Ensure that recruitment strategies for the mine prioritises the sourcing of local labour, and share in gender equality;
- Ensure an atmosphere of equality and non-discrimination among the workforce;
- Contribute to the development of functional literacy and numeracy among employees;
- Empower the workforce to develop skills that will equip them to obtain employment in other sectors of the economy;
- Contribute to the development of a self-reliant (not dependent on the mine) community surrounding the area of operation;
- Ensure that decommissioning and retrenchments take place in a legally compliant and humane manner; and
- Adhere to principles of international best practice in all socio-economic activities.

9.3 Historical and Cultural Aspects

The objectives to be met are:

- To instil a sense of value in the local inhabitants for the relevant artefacts and structures by the treatment afforded to them by the mining operation;
- To protect cultural and heritage resources from the adverse impacts of project related activities,
- To manage and monitor activities during construction, operational and decommissioning phases;

- To promote the overall conservation of natural and cultural resources;
- To avoid potential damage to items of mining heritage significance as result of earthworks undertaken as part of construction, operation, maintenance, inspections in the proposed project;
- To avoid looting and/or unauthorised excavation of heritage and cultural resources; and
- To avoid vandalism and/or deliberate destruction of mining heritage resources

10 MANAGEMENT OF IDENTIFIED ENVIRONMENTAL IMPACTS

Those impacts identified during the impact assessment must be mitigated to reduce or eliminate negative effects of the project.

Each phase of the project has been considered and management measures for each impact have been discussed below.

10.1 Construction Phase

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
RECLAMATION SITES									
Topography	No	-	-	No	-	-	-	-	-
Geology	No	-	-	No	-	-			
Soil	Yes	- To prevent any soil loss through erosion and through mobilising soils. - To prevent loss of soil quality through contamination with other substances such as hydrocarbons. - To prevent loss of soil structure through compacting of soil. - To prevent loss of soil fertility.	- Slopes should be vegetated to aid surface water runoff and prevent soil erosion, and aid with stabilising soils. - Erosion control measures such as contour banks and down drains should be constructed and vegetated in rehabilitated areas. - A monitoring system should be implemented which will include inspecting soil for any degradation or erosion, and ensure immediate action if these are noted.	Yes	Bi-annually	R36 000.00			
Surface water	Yes	- To prevent contamination of the surface water resources on and around the site.	- All possible sources of pollution should be stored in bunded areas.	No					
			- Spillages of hazardous substances should be contained and cleaned up immediately.	Yes	When occurred				
			- A monitoring system should be in place to continuously monitor the quality of the surface water resources in the area.	Yes	Quarterly	R31 488.00			
Groundwater	Yes	- To protect existing users of groundwater from impacts on water quality and quantity. - To prevent construction material and construction wastes becoming a source for pollution to the local aquifers. - To ensure effective management of any accidental spills.	- Hydrocarbon or chemical spills shall be contained and remediated as soon as possible to prevent leaching into the groundwater.	Yes	When spill occur				
			- An emergency spill response plan will be developed and shall form part of the environmental awareness training.	No					
			- A monitoring system should be in place to continuously monitor the quality of the groundwater resources in the area	Yes	Quarterly	R50 080.00			
Land capability	No	-		No	-	-			
Air quality	Yes	- To minimise the risk of air pollution from fugitive dust caused by traffic, reclamation activities and material handling.	- Roads will be kept wet by means of a water tanker. - Construction areas will be sprayed with water whenever necessary.	Yes	Monthly				
Noise	Yes	- To minimise noise from the reclamation area.	- Equipment will be fitted with silencing systems and maintained according to standard. - A noise survey should be conducted annually to monitor noise levels in the areas where	Yes	Monthly	R17 500.00			

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
			reclamation and processing is taking place.						
Natural vegetation	Yes	- Eradicate invasive species completely. - To prevent the unnecessary destruction, damage or loss of any vegetation.	- Remove vegetation when they are not producing seeds. - Plants that grow back quick should be uprooted.	Yes	Annually	R22 500.00			
Animal life	Yes	- Not to alienate, other than by reclamation, the wildlife in the area or to harm any animal life found on the property and to prevent the unnecessary destruction of natural habitat for animal life.	- Any pollution of water, soil and vegetation which can cause harm to animal life will be prevented.	No	-				
Archaeology	No	-	-	No	-				
Sensitive landscapes	No	-	-	No	-				
Visual	Yes	- To minimise the visual impacts of reclamation mining activities.	- Screens will be erected from soil and material	No	-				
Traffic & safety	No	- To ensure safety on all road in and around the construction areas.	- Traffic control signs will be used where necessary. - Speed around sites will be enforced.	No	-				
Socio-economic	No	- To enhance positive impacts associated with the use of contractors to undertake maintenance and upgrade activities.	- Recruit local service providers and contractors to undertake necessary maintenance and upgrade activities during construction.	No	-				
IAPs	Yes	- To ensure minimum dust and noise disturbance during construction activities.	- Dust emissions will be controlled through the use of spray systems and frequent monitoring of conditions. - Dust on surrounding roads will be prevented through the use of vehicle wash bays. - The movement of trucks and heavy vehicles will be limited on surrounding roads as far as possible.	No	When necessary				

10.2 Operational Phase

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
RECLAMATION SITES									
Topography	Yes	- To recreate a topography which blends in with the surrounding landscape and to prevent significant alteration of the drainage densities and slopes found in the area prior to mining.	- The original topography will be restored by means of the removal of the sand. - If reclamation should cease before the dump is completely removed, the exposed sides will be shaped down to the same slope as the rest of the dump and will be vegetated.	No					
Geology	No	-	- Rock strata will not be disrupted, excavated or blasted.	No	-				
Soil	Yes	- To protect the biological activity within the exposed soils and minimise the loss of soil due to erosion. - To increase the nutrient levels in these soils to increase re-vegetation growth on the rehabilitated areas.	- The topsoil stockpile will be sealed to prevent dust generation until the stockpile is reclaimed. - The exposed soil that remains on the site will be protected from erosion by the construction of upslope storm water diversion berms. Paddocks will be constructed and repaired on exposed areas. - If necessary, any mounds of soils to be stockpiled, will be less than 1.5 m high and will be vegetated to maintain the biological activity within the soils to keep it aerobic.	Yes	Bi-annually	R36 000.00			
Surface water	Yes	- No significant impact on the suitability of surface water for use downstream. - To fulfil statutory requirements. - To maximise the re-use of water while mining. - To minimise the contamination of clean water through the separation of clean and dirty water.	- Rainwater falling upslope of the operational site will be diverted around the site by means of berms and diversion trenches. - Rainwater falling on the site will be contained and re-used in the plant processes where possible, by means of spillage paddocks. - As surface areas are exposed by reclamation, these areas will be paddocked off. - All spillage water from the screens will be captured and recycled. - The pollution control facilities will be de-silted as necessary so that they can continue to perform the function for which they were designed. - All water control measures will conform to the National Water Act (Act 36 of 1998).						

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
			- Water monitoring will be undertaken at all the sites.	Yes	Quarterly	R31 488.00			
Groundwater	Yes	- To protect existing users of groundwater from impacts on water quality and quantity. - To ensure that adequate monitoring points exist to allow the monitoring of impacts on water quality and quantity during the operational phase. - To prevent the pollution of the surrounding aquifers due to mining or mining related activities.	- A hydrocarbon management system will be introduced to minimise the potential of spillage of hydrocarbons which can impact on the groundwater quality. Chemicals and hydrocarbons capable of causing groundwater pollution shall be transported, loaded and unloaded, and stored appropriately. - Hydrocarbon or chemical spills shall be contained and remediated as soon as possible to prevent leaching into the groundwater. - An emergency spill response plan will be developed and shall form part of the environmental awareness training. - Keep paddocks clean from tailings material. - Dirty and clean water on site will be kept separate. - Remove dirty water to Catchment dams to limit groundwater residence time in situ and therefore limit contamination to groundwater. - Maintain pipes from reclamation sites to the City Deep plant. Clean-up of any spills that might occur should be treated as an emergency and included in emergency response plan. - A monitoring system should be in place to continuously monitor the quality of the groundwater resources in the area	Yes	Quarterly				
Land capability	No	-		No	-				
Air quality	Yes	- To minimise the risk of air pollution from fugitive dust caused by traffic, reclamation activities and material handling.	- Roads will be kept wet by means of a water tanker. - A sprinkler system will be installed on the slimes dam to keep the exposed face wet to minimise dust generation whenever there are winds or when winds are expected. - As little vegetation as possible will be removed from the dump. The vegetation on the sides of the dump that is not being reclaimed will be left intact for as long as possible, so that the vegetation can act as a wind and dust barrier. - The active face will be limited to as small an area	Yes	Monthly				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
			as possible during reclamation. - As much use as possible will be made of advance warnings regarding high wind conditions to initiate preventative spraying. - Monitoring of air quality will take place on a monthly basis through the dust monitoring programme. - Vehicles will be confined to specifically demarcated roadways. - If reclamation operations cease for longer than a month before completion, the face of the slimes dam will be sealed using a dust sealant and the slimes dam face will be shaped. If reclamation ceases for longer than a year without all the material having been removed, the slimes dam will be shaped and management measures will be used to prevent any dust generation and erosion from occurring. If reclamation operations do not recommence within three years, the area will be vegetated.					
Noise	Yes	- To comply with the Noise Control Regulations and SABS standards. - To reduce noise levels at source as far as possible. - To reduce noise annoyance to the surrounding community as far as possible	- All vehicles will be well maintained and specific attention will be given to exhaust system maintenance. - Mining machinery will be fitted with standard silencing systems to limit noise production and such systems will be maintained as specified by the original equipment manufacturer (OEM).	Yes	Monthly				
Natural vegetation	Yes	- Eradicate invasive species completely. - To prevent the unnecessary destruction, damage or loss of any vegetation.	- Remove vegetation when they are not producing seeds. - Plants that grow back quick should be uprooted.	Yes	Bi-annually				
Animal life	Yes	- Not to alienate, other than by reclamation, the wildlife in the area or to harm any animal life found on the property and to prevent the unnecessary destruction of natural habitat for animal life.	- Any pollution of water, soil and vegetation which can cause harm to animal life will be prevented.	No	-				
Archaeology	No	-	-	No	-				
Sensitive landscapes	No	-	-	No	-				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
Visual	Yes	- To minimise the visual disturbance of reclamation activities of the dump and related infrastructure.	- Bare areas will be re-vegetated and regularly inspected to ensure good cover and erosion prevention. - Buildings will be painted in a manner which does not cause unnecessary visual impacts.	No	-				
Traffic & safety	Yes	- To ensure safety on all road in and around the reclamation sites.	- Traffic control signs will be used where necessary. - Speed around sites will be enforced.	No	-				
Socio-economic	Yes	- To enhance positive impacts associated with job creation - To enhance positive impacts associated with local and HDSA procurement - To reduce employee and business dependence on the mine	- Train and recruit people from the local area so that they are able to access job opportunities - Where possible, procure goods, services and consumables from local BEE companies - Allow small local BEE companies access to tender requirements and criteria so that they may adequately prepare to provide the required goods and services - Transparently advertise opportunities associated with the mine in a way that encourages local participation - Source appropriate numbers of female and HDSA candidates at the operation to ensure that employment equity objectives are met - Implement the Local Economic Development (LED) projects of the Social and Labour Plan in a manner which encourages self reliance and equips local businesses to provide services/goods to other sectors	No	-				
IAPs	No	- To adequately address all reasonable concerns by IAPs. - To minimise disturbances caused by the reclamation activities. - To minimise the effects caused by increased dust and noise levels in the area.	- A communication mechanism will be established and publicised to all IAPs for the project. Concerns and queries will be dealt with promptly by dedicated project communications staff, in consultation with the relevant technical staff. Communication will also take place through existing forums, and through the distribution of project update information. Project decisions will take into account the perceptions of stakeholders and will attempt, where possible, to ensure that mutually agreeable project options are selected. - Any issues and concerns that arise during the project will be recorded in an IAP comments register.	No	When necessary				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
			- Dust and noise impacts will be mitigated as per the relevant environmental sections of this report.						
TAILINGS DAM									
Topography	Yes	- To mimic the natural topography of the area as far as possible. - Continuation of mine residue re-vegetation programme to mitigate the visual impact, including the assessment of the long-term.	- Stability of slopes will be monitored and managed on a regular basis. - The discard dump will be constructed in such a way that it will blend in well with the surrounding topography. - The design criteria for the discard dump should be strictly adhered to. - The dump should be rehabilitated as soon as possible.	Yes	Monthly				
Geology	No	-	-	No	-				
Soil	Yes	- To prevent any soil loss through erosion and through mobilising soils. - To prevent loss of soil quality through contamination with other substances such as hydrocarbons. - To prevent loss of soil structure through compacting of soil. - To prevent loss of soil fertility.	- Slopes should be vegetated to aid surface water runoff and prevent soil erosion, and aid with stabilising soils. - Erosion control measures such as contour banks and down drains should be constructed and vegetated in rehabilitated areas. - A monitoring system should be implemented which will include inspecting soil for any degradation or erosion, and ensure immediate action if these are noted.	Yes	Quarterly				
Surface water	Yes	- To have an insignificant impact on water suitable for use downstream. - To minimise water consumption from external sources. - To adhere to statutory requirements. - Minimise the risk of discharging contaminated water in the short- and long-term.	- Seepage water will enter the process water system. - Erosion of the topsoil will be prevented by using vegetation to control the surface flow velocity. - Water consumption will continually be scrutinised in order to avoid wastage. - Excess water will only be discharged if it meets statutory requirements. - Water monitoring from streams, dams and pollution facilities will take place at regular intervals and record will be kept to ensure that standards are being met and the tailings dam is not impacting negatively on the surrounding water courses. - Any oil and lubricants stored on the site will be stored in bunded areas in order to contain any spillages and disposed of at a reputable facility.	Yes	Quarterly				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
Groundwater	Yes	- To prevent infiltration and run-off from the tailings dam polluting the groundwater environment. - To protect existing users of groundwater from impacts on water quality and quantity. - To ensure effective management of any accidental spills	- Run-off and infiltration from the tailings dam will be collected and transported into a pollution control dam. - Lining of dump to be inspected regularly - Monitoring of surrounding groundwater quality.	Yes	Quarterly				
Land capability	No	-	-	No	-				
Air quality	Yes	- To reduce dust emissions from proposed operational activities as much as possible; - To monitor dust levels in the area and on site; and - To track progress of air pollution control measures	- Working areas will be sprayed with water whenever necessary. - Dust levels will be measured monthly. - Road surfaces, especially those used by heavy vehicles, will be treated with a dust binding agent. The form of dust-binding agent will determine the type of watering; but allowance will be made for sufficient road spraying. - Vehicle speeds will be kept below the critical speed required to raise excess dust within the vicinity of the mine. - The dust-monitoring programme will assess ambient dust levels and the amount of dust generated by operations. - A directional dust monitoring programme will be implemented that also incorporate respiratory dust monitoring. - The air quality management plan will determine whether dust-mitigation measures in place are proving effective. If not, upgrading will be required.	Yes	Monthly				
Noise	Yes	- To reduce noise levels at the source as far as possible.	- Noise levels at the dump will be low; however, attempts to reduce the noise at the source if possible will be made. This includes ensuring silencers on vehicles, using rubber linings, enclosing sources if possible, etc.	Yes	Monthly				
Natural vegetation	Yes	- To re-vegetate areas in which erosion could occur. - To prevent alien and invader species spreading from establishing and spreading to disturbed areas.	- Re-vegetation of eroded areas to protect soils and their characteristics. - Disturbed surfaces will be re-vegetated as soon as they become available, by seeding or grass planting. A wide range of growth forms and habits is included to achieve a good long term	Yes	Bi-annually				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
		- To minimise the disturbance of natural vegetation during the operational phase.	cover. - An exotic and invader control programme will be implemented. All disturbed areas are inspected at least annually in spring and any invader species are eradicated by slashing or the application of prescribed herbicides.						
Animal life	Yes	- To prevent the unnecessary destruction of natural habitat and animal life. - To prevent animals being killed by speeding trucks, hunting of any kind by any worker, contractor or visitors to the tailings dam.	- Not to disturb the movement of any mammals, birds, amphibians insects or reptiles, which tend to move out of the undisturbed and disturbed areas. - Visitors and workers will be informed that the killing of fauna is prohibited within the boundaries of the tailings dam, as well as neighbouring areas.	No	-				
Archaeology	No	-	-	No	-				
Sensitive landscapes	No	-	-	No	-				
Visual	Yes	- To minimise the unnecessary negative visual aspects such as dust and stockpiles.	- Dust suppression will be ongoing during operations to reduce the clouds of dust that can be generated from large machinery and wind. This will be implemented via a water cart. - The side slopes of the tailings dam will be dressed with soil and vegetated as soon as is practical.	No	-				
Traffic & safety	Yes	- To ensure safety on all road in and around the reclamation sites.	- Traffic control signs will be used where necessary. - Speed around sites will be enforced.	No	-				
Socio-economic	Yes	- To enhance the positive impact associated with the creation of job opportunities. - To enhance boosting effect of the mine on the local economy. - To ensure the Social and Labour Plan is implemented, resulting in local and regional benefits.	- The procurement policy for the mine should focus on utilising service providers from the local area so as to encourage the growth of business.	No	-				
IAPs	Yes	- To minimise disturbances caused to IAPs due to operations on the tailings dam. - To reduce negative impacts associated with the increased traffic and road degradation.	- A communication mechanism will be established and publicised to all IAPs for the project. Concerns and queries will be dealt with promptly by dedicated project communications staff, in consultation with the relevant technical staff. Communication will also take place through existing forums, and through the distribution of project update information. Project decisions	No	When necessary				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
			will take into account the perceptions of stakeholders and will attempt, where possible, to ensure that mutually agreeable project options are selected. - Any issues and concerns that arise during the project will be recorded in an IAP comments register. - Dust and noise impacts will be mitigated as per the relevant environmental sections of this report.						
CITY DEEP PLANT									
Topography	No	-	-	No	-				
Geology	No	-	- Rock strata will not be disrupted, excavated or blasted	No	-				
Soil	No	-	-	No	-				
Surface water	Yes	- To fulfil statutory requirements. - To maximise the re-use of water while mining. - To minimise the contamination of clean water through the separation of clean and dirty water.	- Rainwater falling on the site will be contained and re-used in the plant processes where possible. - The pollution control facilities will be de-silted as necessary so that they can continue to perform the function for which they were designed. - All water control measures will conform to the National Water Act (Act 36 of 1998).	Yes	Quarterly				
Groundwater	Yes	- To protect existing users of groundwater from impacts on water quality and quantity. - To ensure that adequate monitoring points exist to allow the monitoring of impacts on water quality and quantity during the operational phase. - To prevent the pollution of the surrounding aquifers due to mining or mining related activities.	- A hydrocarbon management system will be introduced to minimise the potential of spillage of hydrocarbons which can impact on the groundwater quality. Chemicals and hydrocarbons capable of causing groundwater pollution shall be transported, loaded and unloaded, and stored appropriately. - Hydrocarbon or chemical spills shall be contained and remediated as soon as possible to prevent leaching into the groundwater. - An emergency spill response plan will be developed and shall form part of the environmental awareness training. - Domestic and hazardous waste will be disposed of in appropriately authorised landfill facilities. - Sewerage will be disposed of in appropriately authorised municipal facilities. - Facilities that store wet slurry from reclamation dumps and metallurgical process catalysts must	Yes	Quarterly				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
			be lined. - Dirty and clean water on site must be separated and dirty water stored in lined facilities. - Implement water management plan.						
Land capability	No	-	-	No	-				
Air quality	Yes	- To limit the amount of CO, CO_2 and NO_x emissions. - To minimise dust	- Machines will be serviced, inspected and maintained properly to minimise the greenhouse gasses, such as CO, CO_2, NO_x, emitted from these vehicles. - Dust abatement and watering to take place	Yes	Monthly				
Noise	Yes	- To reduce noise levels at source as far as possible. - To reduce noise annoyance to the surrounding community as far as possible.	- Machinery will be fitted with standard silencing systems to limit noise production and such systems will be maintained as specified by the original equipment manufacturer.	Yes	Monthly				
Natural vegetation	No	-	-	No	-				
Animal life	No	-	-	No	-				
Archaeology	No	-	-	No	-				
Sensitive landscapes	No	-	-	No	-				
Visual	No	-	-	No	-				
Traffic & safety	Yes	- To ensure safety on all roads on and around the plant.	- Traffic control signs will be used where necessary. - Speed limits around sites will be enforced.	No	-				
Socio-economic	Yes	- To enhance positive impacts associated with job creation. - To enhance positive impacts associated with local and HDSA procurement. - To reduce employee and business dependence on the mine.	- Train and recruit people from the local area so that they are able to access job opportunities. - Where possible, procure goods, services and consumables from local BEE companies. - Allow small local BEE companies access to tender requirements and criteria so that they may adequately prepare to provide the required goods and services. - Transparently advertise opportunities associated with the mine in a way that encourages local participation. - Source appropriate numbers of female and HDSA candidates at the operation to ensure that employment equity objectives are met. - Implement the Local Economic Development	No	-				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
			(LED) projects of the Social and Labour Plan in a manner which encourages self reliance and equips local businesses to provide services/goods to other sectors.						
IAPs	No	- To ensure minimum noise disturbance during operational activities.	- Noise levels will be limited as far as possible.	No	When necessary				

10.3 Decommissioning Phase

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
RECLAMATION SITES									
Topography	Yes	- To rehabilitate the area to blend in with the surroundings as much as possible. - To ensure natural drainage lines are restored.	- Profiling the final topography by means of the establishment of drainage ridges or canals in a manner which will ensure that areas which used to drain to the streams surrounding the site continue too.	Yes	Monthly				
Geology	No		- Rock strata will not be disrupted, excavated or blasted.	No	-				
Soil	Yes	- To reinstate the affected areas to "as close as possible" to their pre-mining land capability status.	- Compaction will be limited and areas where compaction has occurred will be ripped. - Vehicles will be restricted to designated areas in order to reduce compaction. - Infrastructure will be removed prior to rehabilitation. - Erosion controls should be installed to limit uncontrolled run-off - Rehabilitated areas will be assessed and maintained for at least three years after closure.	Yes	Bi-annually				
Surface water	No	- To ensure that adequate monitoring points exist to allow the monitoring of impacts on water quality and quantity during the decommissioning phase.	- Water samples will continue to be taken after the operation has ceased. This data will be used for closure objectives	Yes	Quarterly				
Groundwater	Yes	- To protect existing users of groundwater from impacts on water quality and quantity.	- Total removal of pump house and associated infrastructure to remove possible pollution sources from site.	Yes	Quarterly				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
		- To ensure that adequate monitoring points exist to allow the monitoring of impacts on water quality and quantity during the decommissioning phase. - To prevent the pollution of the surrounding aquifers due to mining or mining related activities.	- Total removal of pipes and associated infrastructure from reclamation sites to Knights plant and clean-up of any spills. - Rehabilitation and remediation of topsoil to enable re-vegetation similar to in situ veldt types. This will cause groundwater recharge to stabilise and the piezometric water level to reach a balance with infiltration from rainfall.						
Land capability	Yes	- To rehabilitate the area in order to suit the final land use.	- It will be assessed if the addition of fertiliser is required in order to improve the soil nutrient status.	Yes	Bi-annually				
Air quality	Yes	- To minimise the impact on air quality during decommissioning and closure.	- Dust abatement techniques, such as the watering of roads and rubble piles, will be applied during the dismantling of infrastructure. - Construction machines will be serviced, inspected and maintained properly to minimise the greenhouse gasses, such as CO, CO_2, NO_x, emitted from these vehicles.	Yes	Monthly				
Noise	Yes	- To minimise the noise impacts of decommissioning and closure operations.	- Vehicles and equipment used during decommissioning will be equipped with standard silencing systems and will be serviced to OEM specifications to reduce noise generation.	Yes	Monthly				
Natural vegetation	Yes	- To establish a good indigenous vegetative cover and to encourage natural biological succession to a climax status. - To prevent alien and invader species establishing and spreading to rehabilitated areas, and to eliminate them from un-mined land. - To create the most favourable growth habitat for plants	- Vegetation monitoring should be introduced to ensure good vegetation cover and monitor plant succession and biodiversity. - Disturbed surfaces will be re-vegetated. - Soil depth, soil type, soil compaction, slope, must be favourable.	Yes	Bi-annually				
Animal life	No	- To follow mitigation measures set out for flora to recreate habitat and encourage animals to move back into the area.	- The ongoing and long term commitment to successfully re-establish the vegetation of the opencast areas will establish a habitat that will encourage animal life to return to the rehabilitated land.	No	-				
Archaeology	No			No	-				
Visual	Yes	- Restoration of visual integrity.	- Full rehabilitation of site.	Yes	Once of site visit				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
Traffic & safety	Yes	- To ensure road safety during decommissioning.	- All traffic and safety procedures implemented during operation will still be adhered to during decommissioning.	No	-				
Socio-economic	Yes	- To avoid job losses where practically possible - To equip employees to access opportunities in other sectors of the economy	- Transfer employees to other Crown sites after closure - Investigate opportunities to exploit additional mining resources and thus extend the life of the operation - Undertake portable skills programmes with employees as the operation approaches closure - Integrate employees into LED projects that are implemented as part of the mine's Social and Labour Plan - Where retrenchments are unavoidable, these should be managed humanely and in accordance with the Department of Labour's guidelines	No	-				
IAPs	Yes	- To ensure the I&APs are kept informed about the final use of the land.	- Keep communication channels open.	No	When necessary				
TAILINGS DAM									
Topography	Yes	- To landscape the tailings dam to blend in with the surrounding topography.	- The design criteria for the tailings dam should be strictly adhered to. - Soil profiling should be done in such a way so as to avoid erosion.	Yes	Monthly				
Geology	No	-	- No impacts that require mitigation were identified for the decommissioning phase.	No	-				
Soil	Yes	- To prevent future soil erosion on the rehabilitated site. - To prevent loss of soil quality through contamination with other substances such as hydrocarbons. - To prevent loss of soil structure through compacting of soil. - To prevent loss of soil fertility.	- Rehabilitated areas should not be compacted more than is necessary, and activity, particularly that of heavy machinery and vehicles, on these areas should be limited. - Where the soil is placed on the dump it must be vegetated soon thereafter to prevent the possibility of soil erosion occurring. - Vegetation growth will be monitored and re-seeding will be done where necessary to ensure that the area is well vegetated. - Where erosion has occurred, the area should be re-vegetated in order to establish a good cover that will bind the soil and prevent further erosion.	Yes	Bi-annually				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
Surface water	Yes	- To restore the water resources to their natural quality and quantity. - To prevent further negative impacts. - To rehabilitate the pollution control dam. - To monitor for seepage.	- Water will be encouraged to flow off the rehabilitated surface, as surface flow, as quickly as possible without causing erosion. - The rehabilitated areas will be free-draining unless otherwise stated. - Monitoring will continue to ensure the rehabilitated mine site is not polluting the water sources. - The rehabilitation of the pollution control dam should take place during winter once the majority of the water has evaporated. The contaminated soil and impermeable layer should be removed and disposed of at an appropriate facility. The area should then be top soiled and vegetated.	Yes	Quarterly				
Groundwater	Yes	- To prevent infiltration from the discard dump after rehabilitation and polluting the groundwater environment. - Prevent pollution of groundwater by hydrocarbons used by heavy machinery conducting the rehabilitation. - To protect existing and future users of groundwater from impacts on water quality and quantity due to incorrect rehabilitation work. - To define points for monitoring purposes.	- Accidental hydrocarbon spillages will be remediated in situ using appropriate microbial technologies. - Rehabilitation of the tailings dam needs to be done in such a way that infiltration of rainwater into the dump is minimised. - A dense vegetative cover will be established and maintained on the rehabilitated tailings dam to assist with the evapo-transpiration of rain water in an effort to reduce infiltration of water. - The boreholes should remain on site to allow monitoring to take place, and for domestic use.	Yes	Quarterly				
Land capability	Yes	- To maintain the desired land capability after closure. - To improve the land capability after the tailings dam operations have ceased.	- Re-vegetate rehabilitated areas as soon as possible to prevent soil loss through erosion. - Mitigation techniques relating to surface water, soils and topography should be followed.	Yes	Bi-annually				
Air quality	Yes	- To reduce dust emissions from proposed decommissioning activities as much as possible. - To monitor dust levels in the area and on site. - To ensure air pollution control measures are effective.	- Samples will be taken from the monitoring dust buckets. - Road surfaces, especially those used by heavy vehicles, will be wet during the decommissioning phase. - Vehicle speeds will be kept below the critical speed required to raise excess dust within the	Yes	Monthly				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
			vicinity of the mine. - The dust-monitoring programme will continue through the decommissioning phase in order to assess ambient dust levels. - This programme will have a directional dust monitoring and also incorporate respiratory dust monitoring.						
Noise	Yes	- To minimise noise levels during decommissioning.	- All vehicles and machinery involved in the decommissioning and rehabilitation work should be properly maintained to reduce the risk of unnecessary noise generation. - Operations should be limited to daylight hours where possible.	Yes	Monthly				
Natural vegetation	Yes	- To establish a sustainable vegetation cover on the dump that will develop with time. - To prevent alien and invader species from establishing and spreading to rehabilitated areas.	- The soil layer should be prepared for optimal vegetation establishment. These measures should include suitable contouring of the surface and fertilising the soil. - The fertiliser and lime requirements should be recommended once chemical analyses have been performed on the soil. - A mixture of grasses that can establish it relatively quickly should be used. - Grass establishment should be done in late spring or early summer (October and November). - All eroded areas should be vegetated to protect the soils and their characteristics. - No unnecessary clearing of natural vegetation should take place. The neighbouring vegetation should provide a source of seeds which should aid the development of the vegetation on the rehabilitated sites. - All vegetated areas should be monitored and maintained for a period of three years after decommissioning activities have ceased.	Yes	Bi-annually				
Animal life	No	- To encourage the return of natural fauna species. - To prevent injury or harm to all animals in the area. - To encourage the return of small mammals and birds to the site.	- The required habitats are to be reinstated and maintained by monitoring vegetation carefully.	No	-				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
Archaeology	No	-	-	No	-				
Sensitive areas	No	-	-	No	-				
Visual	Yes	- To reduce the visual impact as far as possible.	- The tailings dam will not be removed, but re-vegetated to look more like the surrounding landscape.	Yes	Once of site visit				
Traffic & safety	Yes	- To ensure road safety during decommissioning.	- All traffic and safety procedures implemented during operation will still be adhered to during decommissioning.	No	-				
Socio-economic	Yes	- To avoid job losses where practicably possible. - To mitigate to an acceptable level the impact of unavoidable job losses associated with mine closure. - To ensure that employees are adequately equipped to locate alternative employment positions after closure of the operation.	- Knights should attempt to redeploy employees to its other operations. - Additional reserves should be investigated in an attempt to extend life of the plant. - The workforce should undergo a multi-skill process during the operation of the mine so that they may be productively absorbed into the locally economy after mine closure. - Where retrenchments are unavoidable, they should be managed humanely according to legislative requirements.	No	-				
IAPs	Yes	- To enhance the positive impacts on IAPs associated with the decommissioning of the tailings dam.	- Ensure that rehabilitation activities are carried out according to legislative requirements.	No	When necessary				
CITY DEEP PLANT									
Topography	Yes	- To ensure that the entire infrastructure associated with the plant is removed. - To rehabilitate the area to blend in with the rest of the surroundings. - To restore the natural drainage lines.	- All building rubble should be removed and disposed of according to the correct procedures. - Profiling the final topography by means of the establishment of drainage ridges or canals in a manner which will ensure that areas which used to drain to the streams surrounding the site, continue too	No	-				
Geology	No	-	- Rock strata will not be disrupted, excavated or blasted	No	-				
Soil	Yes	- To reinstate the affected areas to “as close as possible” to its original land capability status.	- Compaction will be limited and areas where compaction has occurred will be ripped. - Vehicles will be restricted to designated areas in order to reduce compaction. - Infrastructure will be removed prior to rehabilitation. - Erosion controls should be installed to limit	Yes	Bi-annually				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
			uncontrolled run-off. - Rehabilitated areas will be assessed and maintained for at least three years after closure.						
Surface water	Yes	- To prevent impacts on water quantity and quality. - To ensure no further contamination of surface water.	- Accidental hydrocarbon spillages will be contained and remediate in situ using appropriate microbial technologies. - A waste management system will be implemented which will make sure that domestic and hazardous waste, including sewage, generated during decommissioning and closure is disposed of in a manner that will not cause surface water contamination. - Profiling the final topography by means of the establishment of drainage ridges or canals in a manner which will ensure that areas which used to drain to the streams continue too.	Yes	Quarterly				
Groundwater	Yes	- To protect existing users of groundwater from impacts on water quality and quantity. - To ensure that adequate monitoring points exist to allow the monitoring of impacts on water quality and quantity during the decommissioning phase. - To prevent the pollution of the surrounding aquifers due to mining or mining related activities.	- Knights plant to keep to the emergency response plan and this will form part of the compliance auditing of the Knights Plant area. - Domestic and hazardous waste will be disposed of in appropriately authorised landfill facilities. - Sewerage will be disposed of in appropriately authorised municipal facilities. - Total removal of infrastructure and associated pollution sources not deemed viable, since plant might be used in future for mineral processing.	Yes	Quarterly				
Land capability	Yes	- To maintain the desired land capability after closure.	- Re-vegetate rehabilitated areas as soon as possible to prevent soil loss through erosion. - Mitigation techniques relating to surface water, soils and topography should be followed.	Yes	Bi-annually				
Air quality	Yes	- To minimise the impact on air quality during decommissioning.	- Dust abatement techniques, such as the watering of roads and rubble piles, will be applied during the dismantling of infrastructure. - Construction machines will be serviced, inspected and maintained properly to minimise the greenhouse gasses, such as CO, CO_2, NO_x, emitted from these vehicles.	Yes	Monthly				
Noise	Yes	- To minimise the noise impacts of decommissioning and closure operations.	- Vehicles and equipment used during decommissioning will be equipped with standard silencing systems and will be serviced to OEM	Yes	Monthly				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
			specifications to reduce noise generation.						
Natural vegetation	Yes	- To establish a good indigenous vegetative cover and to encourage natural biological succession to a climax status. - To prevent alien and invader species establishing and spreading to rehabilitated areas. - To create the most favourable growth habitat for plants.	- Visual assessments of the site will be conducted on a regular basis to monitor potential soil erosion on site and to assess the status of the vegetation cover on rehabilitated areas. - Vegetation monitoring should be introduced to ensure good vegetation cover and monitor plant succession and biodiversity. - An exotic and invader control programme will be implemented. All disturbed areas will be inspected at least annually (in spring) and any invader species will be eradicated using appropriate control measures. - Soil depth, soil type, soil compaction, slope, must be favourable.	Yes	Bi-annually				
Animal life	No	- To follow mitigation measures set out for flora to recreate habitat and encourage animals to move back into the area.	- The rehabilitation of the tailings facility could facilitate the creation of habitats for local fauna.	No	-				
Archaeology	No	-	-	No	-				
Sensitive landscapes	No	-	-	No	-				
Visual	Yes	- To return the visual aspect of the area to a state "as close as possible" to the original state.	- All disturbed areas should be rehabilitated to reduce visual scarring.	Yes	Once off site visit				
Traffic & safety	Yes	- To ensure safety on all roads on and around the plant.	- Traffic control signs will be used where necessary. - Speed limits around sites will be enforced.	No	-				
Socio-economic	Yes	- To avoid job losses where practically possible - To equip employees to access opportunities in other sectors of the economy	- Investigate opportunities to exploit additional mining resources and thus extend the life of the operation - Undertake portable skills programmes with employees as the operation approaches closure - Integrate employees into LED projects that are implemented as part of the mine's Social and Labour Plan - Where retrenchments are unavoidable, these should be managed humanely and in accordance with the Department of Labour's guidelines	No	-				
IAPs	No	- To minimise the impact of decommissioning operations on	- Noise pollution will be kept to a minimum during the decommissioning phase of the project to ensure that surrounding neighbours and	No	When necessary				

Aspect	Mitigation Required	Objectives	Management Measures	Monitoring	Frequency	Annual Cost	Immediate Closure Cost	End of Life of Mine Cost	Post Closure Cost
		interested and affected parties.	farmers are not affected more than necessary.						

11 EMERGENCY RESPONSE PLAN

The environmental management programme and associated management options are intended to minimise environmental risk as far as possible. Should, however, circumstances lead to unacceptable risks, emergency systems and procedures have been designed and will be implemented in the case of an emergency to prevent or minimise the consequential environmental damage. The environmental emergency contingency plan addresses any reasonably anticipated failure (most probable risk) for the entire mining area and focuses on incidents that could cause environmental emergencies.

The most crucial aspect of the emergency system is the identification and communication of the emergency to the appropriate persons. Consequently, the names of the appropriate contact person together with their contact numbers would be prominently displayed around the facility. The contact details will be updated on a regular basis. First-party employees (such as security, safety superintendents, mine overseers, environmental officers) will be trained to respond to the responsible personnel in the event of an emergency.

The following emergency situations and action plans are proposed for the Crown operation.

Possible environmental related emergency	Action plan/remediation	Time/period	Responsible person/party
Over turning of trucks conveying slimes material and calcine on site, roads or undisturbed environment.	Removal of slimes material and transport to original destination or crusher site.	Immediately	Crown Gold Recoveries (Pty) Ltd
Spillage of hydrocarbons by vehicles, tankers, etc.	The spillage should be contained (bund earth walls). Depending on the amount of spillage it could be remediated in situ or in the case of large amounts of spillage that is contained, could be removed by Oilkol, etc. The leakage from the vehicle should be stopped. The vehicle, tanker etc. that caused the spill, should be removed to the workshop for repairs. In all cases of spillages, irrespective of the chemical, remove or extinguish any fire (naked flame) within 10 m from the spill. - Cover the spills with absorbent material. - Obtain Material Safety Data Sheet (MSDS) if the substance is known. - The person who reported the spill must fill out an incident report and forward it to the Environmental Department after a thorough investigation.	Immediately	Crown Gold Recoveries (Pty) Ltd.
Failure of the slimes dam, i.e. the dam wall has failed causing a large quantity of slurry flowing from the dam	The following steps must be taken: - Immediately assess the situation and notify the Operations Manager and the Environmental Department. - Notify the contractors (Fraser Alexander).	Immediately	The Operations Manager and the Environmental Manager

Possible environmental related emergency	Action plan/remediation	Time/period	Responsible person/party
	- Do not attempt to try to stop the flow of the slurry. - Withdraw all persons in the vicinity and in the path of the flow. - The Environmental Department must notify the Governmental Department concerned. Keep employees and the public away from the affected area. Reconstruction, clean-up, reinstating containment paddocks, rehabilitation would follow on this, once the material has dried out.		
Slime pipe failure	- Locate the failure point (if not visible). - Fill out an incident report and investigate the cause of the failure. - Forward the incident report form to the Environmental Department. - Repair the pipe immediately. - Rehabilitate the area concerned.	Immediately	Report it to the Surface Engineer, Operations Manager for that Plant, the Contractors (Fraser Alexander) and the Environmental Manager.
Fires	All fires in the veld, buildings, diesel tanks, chemical fires, etc. should be extinguished and prevented to spread to any other piece of land, building, etc. During the winter months adequate fire breaks should be put in	Immediately	Environmental manager, Safety officer, Fire Brigade

Possible environmental related emergency	Action plan/remediation	Time/period	Responsible person/party
	place around the property. The necessary equipment should be in place and ready for use in case of emergency.		
Sinkhole formation	In the case of sinkhole formation the area should immediately be fenced off and barricaded to prevent entrance. The location should be indicated on the surface plan. The formation of the sinkhole should be monitored and once some stability has been reached the necessary measures could be taken to prevent any surface runoff ending up in the sinkhole by constructing an earth wall around the sinkhole. Rehabilitation of the sinkhole will start once it has reached stability.	Immediately Months	Environmental Manager, Geologist

12 ENVIRONMENTAL MONITORING PROGRAMMES AND PERFORMANCE ASSESSMENTS

Monitoring is required in order to check compliance with agreed upon standards or objectives and targets. During the construction, operation, decommissioning and closure phases, monitoring would be used to check compliance with regulations while post closure monitoring is to ensure aftercare and maintenance of post closure objectives. Monitoring helps to establish trends and patterns, assist in predicting non-compliance and describe remedial measures to address non-compliance.

There are a number of social and environmental aspects which require monitoring during the phases of the project. Those social and environmental aspects that act as environmental indicators and are most common have been detailed in Table 12.1.

Table 12.1: Monitoring programmes

Aspect	Issue	Purpose	Monitoring points	Monitoring method	Frequency	Variables
Vegetation	Vegetation cover at tailings dams, reclamation sites, rehabilitated areas.	Ensure that a self-sustaining well-established indigenous vegetation cover is obtained on disturbed areas.	Tailings dams, reclamation sites and all rehabilitated areas.	Survey.	Bi-annually (wet and dry season).	Basal and crown cover, species diversity and vitality of vegetation.
Soil	Erosion.	Obtain a stable waste rock dump footprint area and other flat open surface areas, without erosion. Ensure roads are maintained.	All rehabilitated areas and roads.	Observation.	Bi-annually (wet and dry season).	Signs of erosion, bare patches, dongas etc. Stability of surface run-off containment structures.
Noise	Noise created on site.	Monitor noise levels and create a safe working environment.	Refer to Plan 7 for monitoring points.	As specified by the Mine Health and Safety Act, 1996 and COP.	Bi-annually.	Noise measured in dB.
Air quality	Dust fallout.	To determine the levels of dust outfall as a result of the reclamation activities.	Refer to Plan 6 for monitoring points.	As specified by the Mine Health and Safety Act, 1996 and the applicable mandatory code of practice on	Monthly.	Respiratory and fallout dust levels.

Aspect	Issue	Purpose	Monitoring points	Monitoring method	Frequency	Variables
				exposure to airborne pollutants.		
Surface water	Surface water quality.	To determine the impact of reclamation activities on surface water quality.	Refer to Plan 5 for the monitoring points.	Grab sample.	Quarterly.	TDS, pH, $CaCO_3$, Mg, Ca, Na, K, SO_4, Cl, F, Fe (dissolved), Mn (dissolved), Al (dissolved).
Groundwater	Groundwater quality.	To determine the impact on the groundwater quality as a result of reclamation.	Refer to Plan 5 for the monitoring points.	Composite sampling.	Quarterly.	TDS, pH, $CaCO_3$, Mg, Ca, Na, K, SO_4, Cl, F, Fe (dissolved), Mn (dissolved), Al (dissolved).
	Groundwater levels.	To determine any impact on the groundwater quantity as a result of mining.	Refer to Plan 5 for the monitoring points.		Quarterly.	

12.1 Description of Monitoring Methods

12.1.1 Noise

Due to the low significance of the noise impact from the reclamation activities, it is recommended that ambient noise monitoring be conducted on a bi-annual basis throughout the operational and decommissioning phase to ensure the levels do not impact in the future. Components to be included in the proposed monitoring plan are discussed below:

The measurement locations should be taken at the locations shown in Plan 7. A report must be compiled bi-annually and submitted to management to ascertain compliance with the required standards. Mine management should be advised of any significant increase in the ambient sound level as operations continue. The measurement points must take into account noise sensitive receptors, such as farmsteads, schools, hospitals, churches and workshops.

- The A-weighted equivalent sound pressure level (LAeq) for duration not less than 15 minutes per monitoring point.
- Measurements to be taken during both daytime (06:00 to 22:00) and the night time (22:00 to 06:00).

12.1.2 Air quality

Air quality will be measured constantly throughout the life of the mine. The samples will initially be collected on a monthly basis.

In order to measure the air quality, a number of dust buckets will be used. They are half filled with deionised water treated with a 5% copper sulphate solution (biocide) to prevent algal growth in the buckets. The buckets are then raised 2.1m above the ground and left for one calendar month. After this period the exposed buckets are removed and taken to a reputable laboratory for gravimetric analysis.

A report on the air quality measurements collected will be submitted to management on a monthly basis. These reports will highlight any potential air quality impacts, and make recommendations. These reports will be in the public domain and are subject to revision by the authorities.

12.1.3 Surface water

The following measures have to be in place:

- The sample bottle must be kept closed and in a clean condition up to the point where it has to be filled with water to be analysed.
- The sample bottles (empty or filled with the water sample) must never be left unprotected in the sun.
- After the sample has been collected the sample bottle should be placed directly in a cool container.

All the samples must be submitted to a reputable laboratory with a quality management plan. Analysis of samples should take place within one day of collection to ensure the accuracy of the results.

12.1.4 Groundwater

Composite water sampling is usually done by pumping water from a borehole. Procedures for composite sampling are as follows:

- Measure the water level in the borehole.
- Activate the pump and remove (purge) at least three times the volume of water contained in the hole.
- Rinse the sampling container three times before collecting the sample
- Collect a water sample, fill the sampling container to the brim and close with the lid.
- Preserve sample according to the requirements of the laboratory to which the samples are sent to. Check that it is a reputable analytical facility.

13 ENVIRONMENTAL AWARENESS PLAN

The purpose of an Environmental Awareness Plan is to outline the methodology that will be used to inform the mine's employees of any environmental risks which may result from their work and the manner in which the risks must be dealt with in order to avoid pollution or the degradation of the environment. The awareness plan is primarily a tool to introduce and describe the requirements of the range of environmental and social plans to the construction and operational personnel.

13.1 Communication Strategy

Environmental awareness will be included as part of the mine's internal communication strategy. The promotion of environmental awareness amongst all levels of staff will be achieved by the following means:

- Including contributions on the environmental management activities of the operation in the internal newsletter,
- Producing "Environmental Talk Topics" which will be posted on notice boards throughout the organisation on a monthly basis. These will address topics such as pollution prevention, resource conservation, waste management and spill clean-up and will be made appropriate to the working and home environments of employees,
- Posting the Environmental Policy of the organisation on notice boards throughout the organisation and discussing the implications of the policy during appropriate meetings, and
- Including environmental management as a standing agenda item in all safety and production meetings. Topics for discussion during such meetings should include current Environmental Talk Topics, recent environmental incidents and environmental action plans of interest. Discussions of applicable legislation and changes to legislation, where this affects the operation's activities may also be discussed at such meetings.

13.2 Management Sector

The building of environmental awareness and management capacity at management level will be focussed on ensuring that management is aware of their responsibility and accountability for the management of the environmental aspects of their activities. Communication and training interventions will focus on the applicability of legislation and legislative changes to their activities, the content of regulatory instruments, such as licences, permissions and exemptions, the importance of leading in environmental management by setting examples and environmental management tools and techniques, such as environmental impact assessment and current environmental best practice.

13.3 Administrative Sector

Environmental awareness building in the administrative sector will be appropriate to the level of impact associated with administrative activities, such as resource consumption and waste separation, but also includes the generation of general environmental awareness principles, such as may apply in the purchasing of products, services and consumables, the use of which may have an impact on the environmental performance of the organisation.

13.4 Mine Workers Sector

Environmental awareness in the lower worker categories will be achieved by, firstly, including an environmental awareness module in all engagement and ex-leave induction material. The content of such a module will include the mine's environmental policy, its significant impacts on the environment, the basics of mitigation measures employed and organisational environmental rules relating to waste management, spill clean-up, resource consumption and the like.

Where training modules for specific worker categories exist, such training modules will include a discussion of the real and potential environmental impacts of their activities and their responsibilities relating to the mitigation and avoidance of such impacts. The training modules will also elaborate on the real and potential consequences of deviation from procedures aimed at managing environmental impacts.

13.5 Evaluation of the Environmental Awareness Plan

The effectiveness of environmental management training and awareness building interventions will be gauged by:

- The performance of annual audits aimed at testing the environmental awareness of employees directly, and
- Analysing the root causes of environmental incidents, including non-conformance to legal requirements, to determine which incidents were caused by a lack of environmental awareness and training.

14 FINANCIAL PROVISION AND CLOSURE

14.1 Land Use Post Closure

It is expected that the most likely land use after mining will be housing or industry. This will, therefore, be the rehabilitation objective.

14.2 Activities for Closure

14.2.1 Infrastructure areas

The following activities will take place at closure:

- All surface plant, buildings and equipment will be removed from site;
- Foundations will be removed to a metre below surface and placed in the final void;
- The surface areas will be levelled and vegetated; and
- All haul roads will be ripped and vegetated.

14.2.2 Pollution control dam

The pollution control dam will be removed.

14.2.3 Access roads

Roads required for other activities will be left. All others will be ripped and vegetated.

14.2.4 Power line and electrical infrastructure

These will be removed from site where there is not reasonable prospect they will be needed for other activities.

In accordance with the requirements of the MPRDA, the policy of the DMR, CGR places funds in a Trust Fund to cover financial costs related to the demolition and rehabilitation activities associated with the City Deep Plant.

The calculation of the financial provision is according to the DMR quantum of financial provision and associated guidelines.

The calculated cost for financial provision is R5, 646, 196.00.

It is recommended that the closure cost is updated on an annual basis to account for possible changes in the mine plan and rehabilitation requirements of the mine, as well as macro-economic factors, such as inflation and depreciation.

15 CONCLUSION

The City Deep operations will have both positive and negative impacts on the surrounding social and environmental aspects of the area.

The majority of the impacts associated with the removal of sand and slimes dams will be positive. The most significant negative impact that was identified is the possible increase in dust and noise levels during the reclamation of a site. The most significant positive impacts include:

- A change in topography and the visual aspect of the area;
- Creation of employment opportunities; and
- The natural soil layer will be exposed and rehabilitated.

The operations of the tailings facilities will have mostly negative impacts on the environment. The most significant once are listed below:

- An increase in the height of the tailings dams will result in a change in the topography and visual aspect of the area;
- An increase in dust levels;
- Decrease in the land capability; and
- An increase in peizometric water level and containment load to the subsurface can be expected because of the additional tailings that will be deposited on the existing tailings dams.

The existing, hard paved areas around the plant will limit the amount of water that could recharge to the aquifers. The creation of job opportunities is also a significant positive impact of the project.

16 STATUTORY REQUIREMENTS

The operation will need to comply with the following legislation of the Republic of South Africa:

- The Minerals and Petroleum Resource Development Act, Act 28 of 2002;
- The National Water Act, Act 36 of 1998;
- The Mine Health and Safety Act, Act 29 of 1998;
- The National Heritage Resources Act, Act 25 of 1999;
- The National Air Quality Act, Act 39 of 2004;
- National Environmental Management Act, Act 107 of 1998;
- Explosives Act, Act 26 of 1956;
- Conservation of Agricultural Resources Act, Act 43 of 1983; and
- And the National Road Traffic Act, Act 93 of 1996.

17 UNDERTAKING

Undertaking by applicant to comply with the provisions of the act and the regulations thereto and the commitments within the EMP

I,....., the undersigned and duly authorised thereto by ..... have studied and understand the contents of this document in its entirety and hereby duly undertake to adhere to the conditions as set out therein.

Signed at .....on this.....day of.....

....

Signature of applicant **Designation**

18UNDERTAKING

Undertaking by applicant to comply with the provisions of the act and the regulations thereto and the commitments within the EMP

I, HENRY GOUWS, the undersigned and duly authorised thereto by CROWN GOLD RECOVERIES (PTY) LTD have studied and understand the contents of this document in its entirety and hereby duly undertake to adhere to the conditions as set out therein.

Signed at JOHANNESBURG on this 3RD day of OCTOBER 2011.

Signature of applicant

General Manager

Designation

18 REFERENCES AND SUPPORTING DOCUMENTATION

DRD Gold, 2008: **Social and Labour Plan; ML18/1996 Authorisation**.

APPENDIX A

AIR QUALITY REPORT

APPENDIX B

NOISE REPORT

APPENDIX C

ENVIRONMENTAL IMPACT ASSESSMENT MATRIX

APPENDIX D

PUBLIC PARTICIPATION