FerroAtlántica Group
SiliconSmelters
Rand Carbide

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

FOR

WASTE MANAGEMENT LICENSE APPLICATION FOR THE STORAGE, REUSE, RECYCLING AND RECOVERY OF WASTE AT SILICON SMELTERS (PTY) LIMITED - RAND CARBIDE, EMALAHLENI, MPUMALANGA

WITH

THE NATIONAL DEPARTMENT OF ENVIRONMENTAL AFFAIRS

AUGUST 2012

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LIST OF DEFINITIONS, ABBREVIATIONS AND ACRONYMS

AEL .... Atmospheric Emissions Licence
Al .... Aluminium
AMD .... Acid Mine Drainage
ARL .... Acceptable Risk Concentration or Level
Ba .... Barium
Baseflow .... Part of stream flow derived from groundwater and shallow subsurface storage
BHN .... Basic Human Need
BID .... Background Information Document
Ca .... Calcium
CARA .... Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983)
CBD .... Central Business District
Chargold .... now EMB
COD .... Chemical Oxygen Demand
Cr(VI) .... Hexavalent Chromium (Chrome 6)
Cu .... Copper
DAFF .... Department of Agriculture, Forestry and Fisheries
DEA .... Department of Environmental Affairs
DWA .... Department of Water Affairs
EAP .... Environmental Assessment Practitioner
EC .... Electrical Conductivity
E.C.A .... Electrically Calcined Anthracite
ECO .... Environmental Control Officer
EIA .... Environmental Impact Assessment
EIR .... Environmental Impact Report
EIS .... Ecological Importance and Sensitivity
eMalahleni .... previously known as Witbank
EMB .... Enviroserve Mineral Beneficiation (previously Chargold)
EMP .... Environmental Management Plan / Programme
EO .... Environmental Officer
EWR .... Ecological Water Reserve
Fe .... Iron
Fe-Si .... Ferrosilicon
GDP .... Gross Domestic Product
GGP .... Gross Geographic Product
GNR .... Government Notice Regulation
GPS .... Global Positioning System
GQM Index .... Groundwater Quality Management Index
IFR .... In-stream Flow Requirements
I&APs .... Interested and Affected Parties
ISO .... International Organisation for Standardisation
IWULA .... Integrated Water Use Licence Application
IWWMP .... Integrated Waste and Water Management Plan
K .... Potassium
kWh .... Kilowatt hour
MAE .... Mean Annual Evaporation
Mamsl .... Metres above mean sea level
MAP .... Mean Annual Precipitation
MAR .... Mean Annual Runoff
Mbgl .... Metres below ground level

MDEDET .... Mpumalanga Department of Economic Development, Environment and Tourism
Mg .... Magnesium
Mn .... Manganese
MoA .... Memorandum of Agreement
N .... Nitrogen
Na .... Sodium
NEM:AQA .... National Environmental Management: Air Quality Act, 2004 (Act 39 of 2004)
NEM:WA .... National Environmental Management: Waste Act, 2008 (Act 59 of 2008)
NEMA .... National Environmental Management Act, 1998 (Act 107 of 1998)
NIOSH .... National Institute for Occupational Safety and Health
NWA .... National Water Act, 1998 (Act 36 of 1998)
O_2 .... Oxygen
OHSA .... Occupational Health and Safety Act, 1993 (Act 85 of 1993)
PCD .... Pollution control dam
PES .... Present Ecological Status
PM .... Particulate Matter
PPP .... Public Participation Process
Rand Carbide .... Silicon Smelters (Pty) Ltd - Rand Carbide
REC .... Recommended Ecological Category
Recharge .... Water reaching the aquifer directly from precipitation and infiltration of surface water
Reserve .... Sum of base flow required by EWR and BHN reserve expressed as a percentage of recharge
RWQO .... Receiving Water Quality Objectives
S .... Sulphur
SANS .... South African National Standards
Si .... Silicon
SG .... Surveyor General
SHEQ .... Safety, Health, Environment & Quality
SO_4 .... Sulphate
SWCD .... Storm Water Control Dam
SWMP .... Storm Water Management Plan
TCLP .... Toxicity Characteristic Leaching Procedure
TDS .... Total Dissolved Solids
Ti .... Titanium
UST .... Underground Storage Tank
VOC .... Volatile Organic Compound
WMA .... Water Management Area
WML .... Waste Management Licence
WQO .... Water Quality Objectives
XRD .... X-ray diffraction
XRF .... X-ray fluorescence
Zn .... Zinc

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1 INTRODUCTION

1.1 Background

1.1.1 Company History

Rand Carbide Limited, which came into being in 1918 in Germiston for the production of calcium carbide, moved to Witbank in 1926 to avail itself of cheaper power (electricity) and because it envisaged the use of the coal in the Witbank area as a raw material. Since those early days, the production of carbide has been greatly expanded, and the company has diversified into the production of ferrosilicon (Fe-Si) and other products.

The site is almost 2 km from the eMalahleni (Witbank) Central Business District (CBD), but is now surrounded by residential areas surrounding the CBD.

Rand Carbide was acquired by Highveld Steel and Vanadium Limited in 1978 but was sold in February 2008 to Silicon Smelters (Pty) Ltd, a subsidiary of Ferro-Atlantica (a Spanish based company). The company is now referred to as Silicon Smelters (Pty) Ltd - Rand Carbide (hereafter referred to as Rand Carbide).

1.1.2 Operation

Rand Carbide produces ferrosilicon (Fe-Si) and other products such as silicon metal, electrically calcined anthracite (ECA), electrode paste and silica fume, both for its own use and for supply to other manufacturers employing electric furnaces.

1.1.3 Water and waste management

Rand Carbide is currently supplied with municipal water from the eMalahleni municipality for both its domestic (worker) and industrial requirements. Sewage effluent feeds into the municipal sewage management system. Storm water discharges into the municipal storm water system and is also collected within an earth dam (Harry's dam) on site. Process water from cooling circuits is contained in a closed concrete tank (on site) for recycling.

Domestic type general waste is removed off site for disposal to the municipal landfill site. Hazardous waste is removed off site by EnviroServ and Waste Giant for disposal to Holfontein. All process waste is also removed off site for disposal to Holfontein. Rand Carbide however, has a historic waste dump which is currently being reprocessed by Chargold (now EMB - Enviroserve Mineral Beneficiation).

1.2 Contact details

1.2.1 Applicant

Company: Silicon Smelters (Pty) Ltd - Rand Carbide

Registration no: 1998/19036/07

Contact person: Ms Kerry Beamish

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1.2.2 Consultant

Company: HydroScience cc

Registration no: 2008/056910/23

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1.3 Project location

Rand Carbide is situated on Portions 60 and 101 of the farm Joubertsrust 310 JS within the eMalahleni (Witbank) Municipal area of the Nkangala District, Mpumalanga Province (Figure 1-1). The site can be accessed from Voortrekker Road, also known as the old Middelburg road or R555 (P154/3). Christiaan de Wet Street and Swartbos/O.R. Tambo Road also border the property. The site, which extends over 56.2810 ha, is situated approximately 2 km north east of the eMalahleni CBD. The site is used for industrial purposes and is surrounded by industrial, commercial and residential properties (Figure 1-2). Rand Carbide operates 24-hour per day, 7 days a week.

Province: Mpumalanga

District municipality: Nkangala District

Local municipality: eMalahleni Municipality

Farm: Joubertsrust 310 JS
Farm portions: 60 & 101

Coordinates: 25° 51.738'South
29° 13.731'East

Surrounding towns:	eMalahleni CBD	(2 km south west)
	eMalahleni residential	(within 100 m south, east & north east)

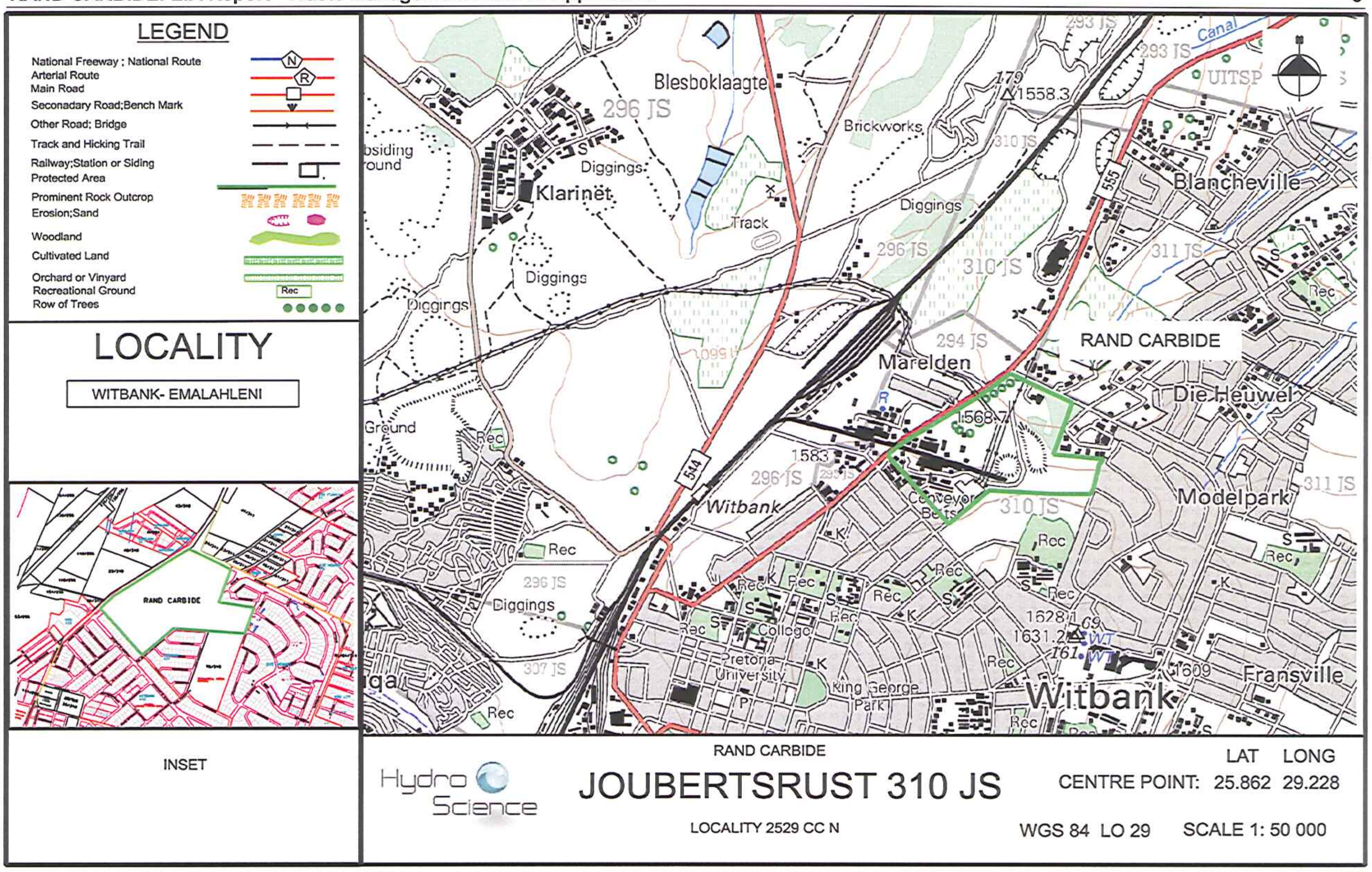

Figure 1-1: Regional locality map for Rand Carbide

Figure 1-2: Surrounding land uses

Roads: Voortrekker Road (old Middelburg road / R555) for access;
Christiaan de Wet Street on south western boundary;
O.R Tambo (previously Swartbos) - northern boundary; and
N4 - 3 km south

1.4 Property description

Farm: Joubertsrust 310 JS

1.4.1 Remaining extent of Portion 60

Surveyor General (SG) code: T0JS00000000031000060

Title Deed: T4136/2009 (Appendix A)

Registration date: 2009/05/18

Owner: Silicon Smelters (Pty) Ltd - Rand Carbide

Size: 27.4663 Ha

Land use: Industrial

Surrounding land use: Mixed

1.4.2 Portion 101

Surveyor General (SG) code: T0JS00000000031000101

Title Deed: T4137/1985 (Appendix A)

Registration date: 2009/05/18

Owner: Silicon Smelters (Pty) Ltd - Rand Carbide

Size: 28.8147 Ha

Land use: Industrial

Surrounding land use: Mixed

Please refer to Figure 1-3 for a general site layout.

1.4.3 Infrastructure

- Fe-Si furnaces: D & F furnaces
- Si metal furnace: E furnace
- Paste plant
- Calcine furnaces: 1 & 2
- Closed cooling towers for Furnaces
- Fe-Si crushing/screening plant (1926 with extensions in 1941 &1991) – was carbide
- Dust plants: Plant F (1976), Plant D & E (1980)
- Laboratory for quality control (1964)
- Canteen & First aid (1980) building

- Change room and laundry building (1980)
- Training centre (1962)
- Electrical shop, Fitting & Boiler shop (1971), Carpenter shop (1980)
- Main substation building (1949 and extended 1964). Smaller substation/transformer facilities in different areas
- Brown Boveri Substation building (1962)
- Transformer storage (2003): storage of spare transformers for furnaces and dust plants
- Compressor house: Air compressors for dust plants and instrumentation
- Garage (1960s)
- Covered parking (1980) for vehicles
- Ablution blocks across the site
- Storage buildings across the site
- Workshops (electrical services, mechanical, carpentry, paste plant, instrumentation)
- General administration and office building (1960s)
- Gas burners
- Wash bay for vehicles
- Historic waste dump (being processed by EMB since 2005)
- Engines (driving emergency circulating pumps)
- Raw material storage bunkers & conveyors
- EMB plant (2005) – previously Chargold
- Scrap metal storage area
- Underground storage tanks (UST): Petrol (14m^3; 1983); diesel (23m^3; 1979)

1.4.4 Additional business ventures operating on site

- EMB (Pty) Ltd (joint venture between Rand Carbide & EnviroServ)
- Bakwena Ready Mix Concrete
- Afrox Limited

1.4.5 Electricity supply

The Rand Carbide operations utilises electricity sourced from Eskom. 620 million KWh/annum is used.

1.4.6 Water supply

Rand Carbide is supplied with municipal water from eMalahleni municipality for its domestic (worker) and industrial uses. Additionally, Rand Carbide also uses water abstracted from three (3) springs located on the property since 2011 (previously the water was just discharged). Additionally, Rand Carbide also intends to effectively capture and utilise stormwater runoff for dust suppression. Cooling water is contained within a closed concrete tank which is situated on site for recycling purposes. Rand Carbide has installed three (3) booster pumps on the municipal water supply line to provide adequate water supply and pressure during emergency situations.

1.4.7 Sewage management

Sewage effluent feeds into the municipal sewage management system.

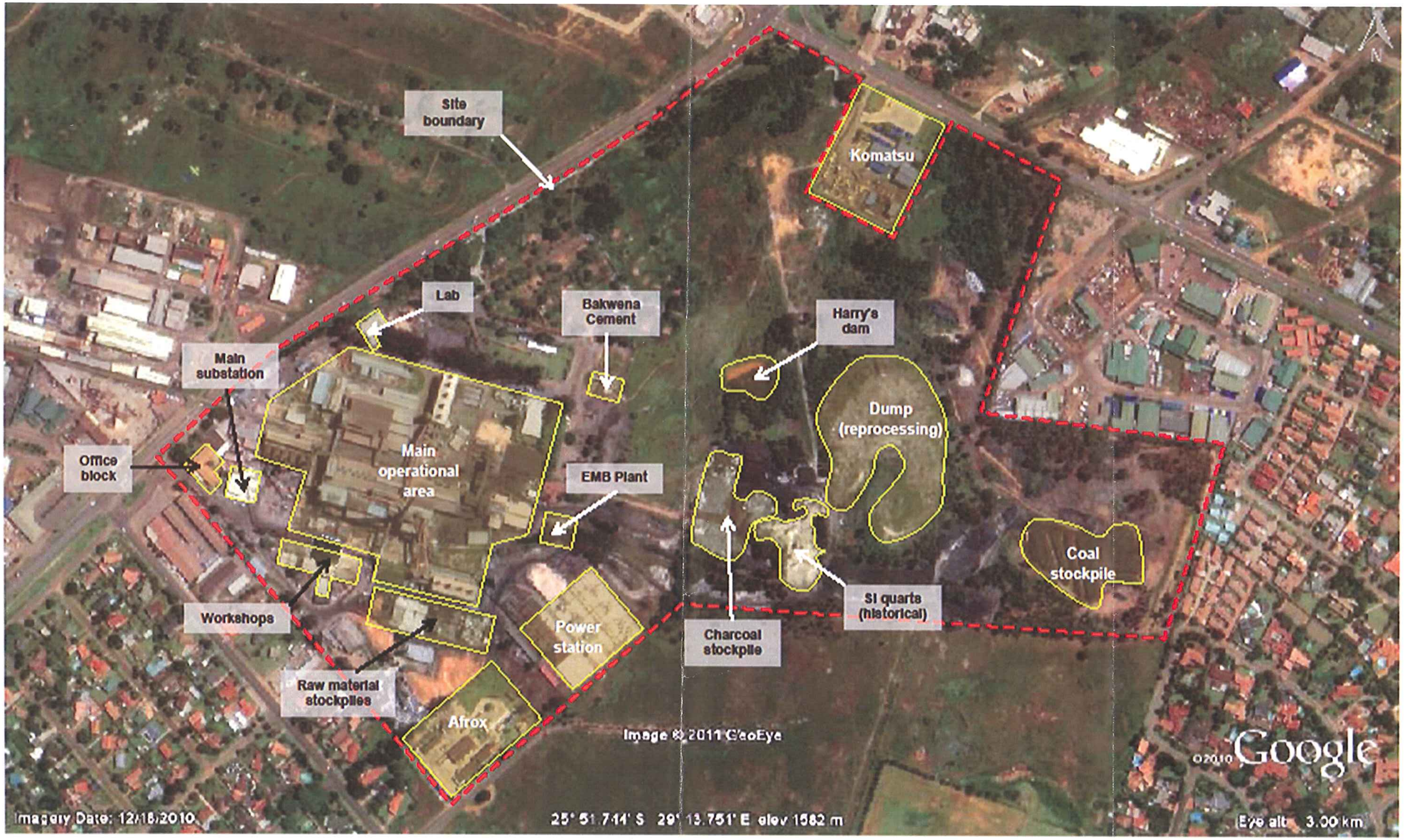

Figure 1-3: General site layout using Google Earth™ image

2 PROJECT DESCRIPTION

2.1 Industrial process description

Extent of operation: **Site:** 56.281 ha
Plant: 13 ha
Waste dump: 2.25ha

Production rates: **Fe-Si:** 60(D) + 60(E) + 120(F) = 240 tons/day
Si metal: 45 tons/day
E.C.A: 148 tons/day
Paste: 100 tons/day

Table 2-1: Raw materials

Type:	Maximum consumption rate (tons/day)
Furnace D:	
Quartzite	100
Coal / charcoal	65
Woodchips	45
Millscale	20
Barium sulphate ($BaSO_4$), Silicon (Si); Manganese (Mn), Zircon (Zr) sand	2
Furnace E: (Fe-Si)	
Quartzite	100
Coal / charcoal	65
Woodchips	45
Millscale	20
Furnace E: (Si metal)	
Quartzite	103
Coal / charcoal	48
Woodchips	56
Limestone	1
Furnace F:	
Quartzite	200
Coal / charcoal	150
Woodchips	85
Millscale	40
Barium sulphate ($BaSO_4$), Silicon (Si); Manganese (Mn), Zircon (Zr) sand	2
Fe-Si / Si refining:	
Molten metal (Fe-Si / Si)	200
Silica sand	10.4
Lime	20.5
Oxygen (O_2)	18
Nitrogen (N_2)	10.4
Fe-Si / Si fines	20
Calciners 1 & 2:	
Raw Anthracite	120
Paste plant:	
E.C.A.	100
Tar pitch	25

2.1.1 Ferro-silicon (Fe-Si) production

Infrastructure: Fe-Si is produced in three furnaces (Furnaces D, E & F).

Raw materials: Coal, charcoal, quartzite, woodchips, millscale and ad hoc, in small quantities – Barium sulphate ($BaSO_4$), Manganese (Mn), zircon sand (Zr).

Process: Fe-Si is produced via the carbothermic reduction of quartz in a sub-merged arc furnace (3 phase) requiring approximately 8 000kWh to produce 1 ton of product. Liquid metal is tapped (intermittently) from a taphole at $\pm$ 1 600^{0}C into a ladle lined with refractory material. The metal is then cast into a casting dam lined with ferrosilicon fines. The solidified product is then crushed and packed.

Use: Fe-Si raises the hardness of steel, increases tensile strength, elasticity, oxidation resistance and flow limits all the while reducing its ductility.

2.1.2 Silicon (Si) metal production

Infrastructure: Silicon metal is produced in Furnace E.

Raw materials: Coal, charcoal, quartzite, woodchips, limestone.

Process: For silicon metal production, composite electrodes are used versus the paste or Soderburg electrodes used for Fe-Si production. Si is produced via the carbothermic reduction of quartz in a sub-merged arc furnace (3 phase) requiring approximately 12 000kWh to produce 1 ton of product. Liquid metal is tapped (continuously) from a taphole at $\pm$ 1 600^{0}C into a ladle lined with refractory material. Silicon metal is refined during and after tapping in order to oxidise impurities like Aluminium (Al) and Calcium (Ca). The metal is then cast into a casting pan lined with silicon fines. The solidified product is then crushed and packed.

2.1.3 E.C.A production

Infrastructure: E.C.A is produced in Calciners 1 & 2

Raw material: Raw Anthracite

Process: Anthracite is graphitised in two (2) calcining electrical furnaces. The process of calcining entails the heating of high-grade anthracite to a temperature required to yield a material with a content of volatile matter not exceeding 0.5%. The main reason for calcining anthracite is to increase its conductivity.

Use: E.C.A is used in the production of electrode paste and is sold to the local and international market.

2.1.4 Electrode paste production

Infrastructure: Electrode paste is produced in the paste plant

Raw materials: E.C.A; tar pitch

Process: Anthracite is graphitised in two (2) calcining electrical furnaces after which liquid tar pitch binder is added. Electrode paste therefore consists of a mixture of carefully sized electrically calcined anthracite and pitch binder. Carefully controlled conditions of many factors are necessary in order to ensure the optimum properties of the paste regarding fluidity, strength and current carrying capacity.

2.2 Historic waste dump

Rand Carbide has a historic waste disposal dump which was started around 1926 and was actively used until 2006 for the dumping of most unwanted materials on site. Currently, no additional waste is disposed of onto the dump. All waste currently generated on the site is removed off site for disposal. The objective is to reprocess the dump and completely remove the current source of pollution impacting the groundwater and surface water in and around the project area.

2.2.1 Size of waste dump

The waste disposal area extends over 2.25 ha (length of 225 m; width of 100 m and height of 30 m) and contained about 500 000 tonnes of dry waste material in 2006.

2.2.2 Waste materials on dump

Material on the historic dump includes the following:

- Contaminated Ferro-silicon (40 tons/annum)
- Amorphous silica fume
- Tarry materials
- Oil soaked calcined anthracite
- Paste
- Char (80 tons/annum)
- Slag (64 tons/annum)
- Coal fines/dust (52 tons/annum)
- Aluminium (18 tons/annum)
- Silica/Quartz fines
- Char/coal fines
- Anthracite fines/dust
- Sweepings (coal dust etc.)
- Stoker refractory (large lumps)
- Stoker ash (fly ash)
- Ladle refractory
- Carbon stoker mix fines
- Refractory bricks
- Paper/wood

2.3 Reprocessing

In 2005, Highveld Steel and Vanadium Corporation Limited entered into a Memorandum of Agreement (MoA) with Chargold (Pty) Ltd (now EMB) to reduce the volume of the unlicensed waste dump in the course of the rehabilitation process. In terms of the MoA signed in 2007, Rand Carbide (as part of Highveld) appointed Chargold (now EMB) as its agent to not only recover, but also to market and sell the recovered material on behalf of Rand Carbide.

EMB (EnviroServe in a joint venture with Rand Carbide) is currently processing the Rand Carbide plant residues as well as the historic waste material. According to Mr Franco Boot (EMB site manager), it will take approximately another eight (8) years to fully process the dump at the current processing rate. EMB currently extracts about 50% of the material on the dump for placement back into the Rand Carbide process. The entire dump will be processed and material that cannot be utilised will be disposed off-site at suitable facilities.

2.3.1 Plant for reprocessing

The plant is a small mobile pre-fabricated 15 ton per hour jigging plant which uses recirculated water to separate the various fractions (Figure 2-1). The process uses the density of the material and gravity to separate the fractions. The plant has a footprint size of approximately 50 m^2 installed on a concrete slab next to the paste plant (approximately 250 m from the waste dump).

Size of plant: 50m^2
Throughput capacity: 15 ton/hour

Figure 2-1: EMB plant

2.3.2 Process

Material is loaded into a feed bin, conveyed to a slurry tank, where it is mixed with water and washed over a de-sliming screen. The slimes (<1mm) is then pumped through a dewatering cyclone onto an existing draining pad, alongside the plant. Water drains off into the sump, from where it is pumped into a recirculation water tank. The residual moisture in the slimes material is expected to be about 10%. Slimes is either sold or taken to a landfill site.

The coarse material (>1 mm) passes from the screen to a jib and is separated into coal, quartz, refractory/slag and ferro-silicon fractions. The coal and quartz are reused as raw material in the Rand Carbide plant process. The slag/refractory is sold as aggregate and the ferro-silicon is mixed with current Rand Carbide product. Please refer to Figure 2-2.

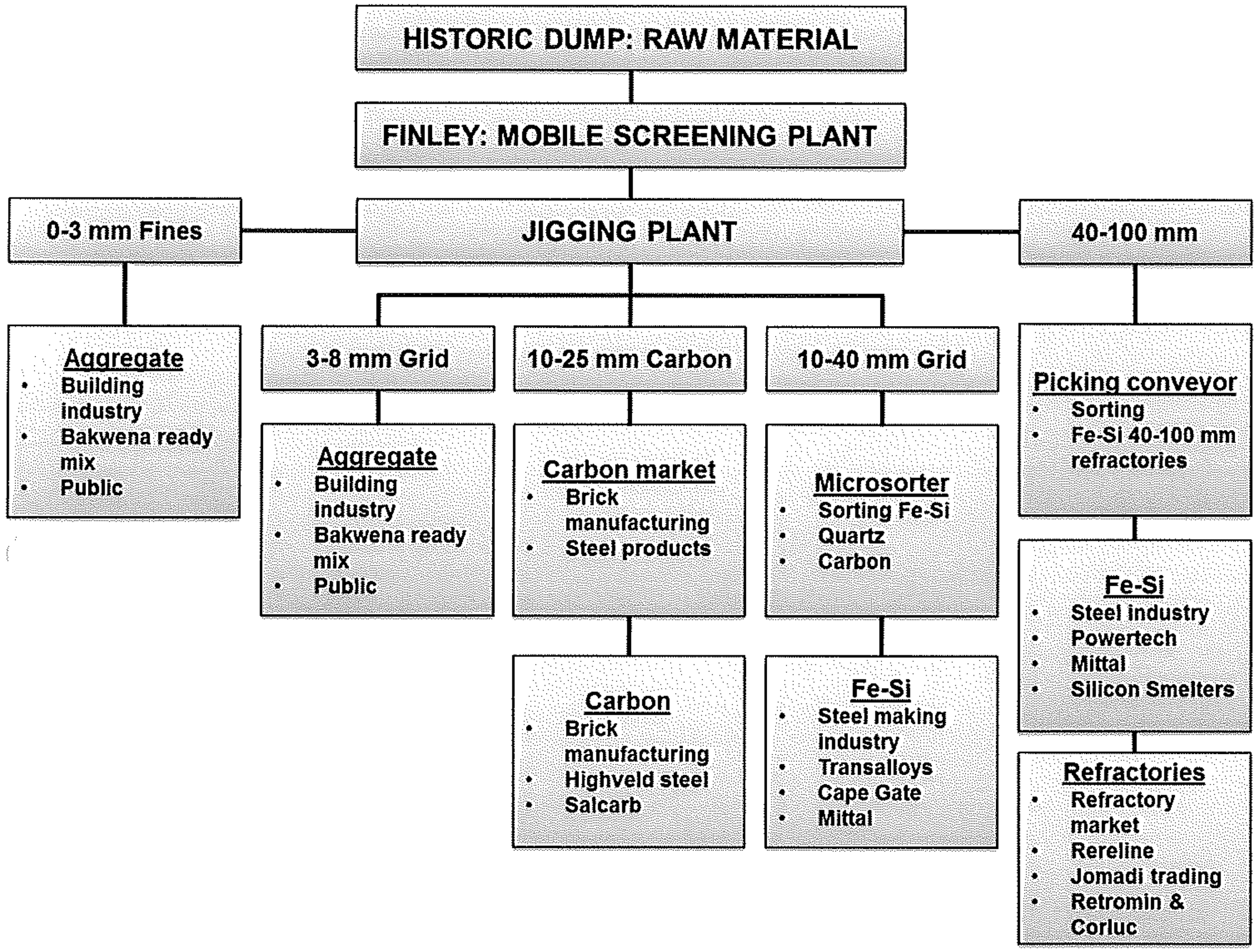

Figure 2-2: Process flow diagram for reprocessing of waste dump

2.3.3 Water use

Apart from residual water/moisture remaining in the product, all water is circulated with make-up water (approximately 30 – 50 m^3/day).

2.3.4 Recovery

The quantities of material recovered by EMB and sold to various clients are summarised in Table 2-2 below.

Table 2-2: Recovery of materials by EMB

Type:	Monthly average (ton):	Annual average (ton):
Sand	241	2 892
Fe-Si	254	3 048
Anthracite	50	600
Dust pellets	1 900 (once in six months)	22 800
Scrap metal	1 633 (once in six months)	19 596

2.4 Additional operational waste streams

Additional waste streams on site is summarised in Table 2-3 below.

Table 2-3: Waste streams and management summary

Type	Quantity (annual)	Handling on site	Destination
General solid			
Non-hazardous	42 m^3 6 tons	Collect in bins/skips	Removed off site by Waste Giant and taken to municipal landfill site at Witbank (eMalahleni).
Compactable	1 176 m^3 42 tons		
Hazardous solid			
Compactable	42 m^3 24 tons	Collected in skips	Removed off site by Waste Giant and taken to Rietfontein site (delisted).
Fluorescents	0.2 m^3 0.05 tons	Crushed	Removed off site by Waste Giant and taken to hazardous landfill site (Holfontein).
Oil	1 155 m^3 5.5 tons	Collect in 210 litre drums with lids in bunded area	Removed off site by OIL-X/Oilkol and taken to refinery for recycling.
Oil & grease contaminated material	23 m^3 47 tons		Removed off site by Waste Giant and taken to Rietfontein waste disposal site.
Process waste	3 700 m^3	EMB reprocess	Re-used (Rand Carbide)/ disposed (Holfontein)
Emissions			
Dust (PM)		Baghouses & dust plants at furnaces	
Silica fumes	23 743 tons	Emissions from furnaces (D, E, F) and refining.	

Figure 2-3: Waste separation, recycling and handling

3 ALTERNATIVES

3.1 Site alternatives

No site alternatives have been considered as the historic waste dump currently resides on the Rand Carbide site.

3.2 Activity alternatives

3.2.1 Reprocessing of dump as part of rehabilitation (preferred activity)

The reprocessing of the historic waste dump, as described in Chapter 2, is the preferred option/alternative as this will result in positive gains for the industries involved as well as the environment.

Rand Carbide benefits:

- The historic waste dump will be removed through reprocessing of material in the dump.
- Removal of the historic waste dump has the following benefits:
  - Overall aesthetics of the site will improve.
  - A large surface area of 2.25ha will become available for other uses.
  - Fugitive dust reduction as dust from the dump will no longer be a problem to neighbours.
  - Any hazardous materials will either be reprocessed or removed off-site for disposal.
  - Any potential liability associated with the historic waste dump will be removed.
  - Potential risk of soil, storm water and groundwater contamination is removed.
  - Groundwater pollution source is largely reduced.
  - Remove legal liability and risk.
- Recovery of valuable materials for processing and selling.
- Up to 50% of the reprocessed materials are reintroduced into the Rand Carbide processes.
- Financial benefits in terms of profits from material sold.
- More sustainable and cost effective operation.
- Compliance with waste management hierarchy and hierarchy for resource protection.

EMB benefits: Financial gain as they are the company responsible for the reprocessing of the dump and the selling of valuable products recovered as a result of the reprocessing.

Environmental benefits:

- Improve aesthetics of the area and site.
- Clean and rehabilitate 2.25ha of surface area.
- Remove a potential source of air (dust) and water (leachate from unlined facility) pollution.
- No on-site hazardous waste disposal.

Legal benefits:

- Removal of an unlicensed facility.
- Removal of a facility not designed in line with the latest legal requirements for environmental protection.

3.2.2 Rehabilitation

As an alternative to reprocessing the historic waste dump, the dump could be closed, covered and rehabilitated as is. Rehabilitation measures will include contouring the dump and stabilising the side walls, establishing some cover (store-and-release cover) and re-vegetating the dump. However, reprocessing and removing all waste materials before footprint rehabilitation is preferred as the dump is not lined and an unlined dump still poses environmental pollution risks.

3.2.3 Off-site disposal

The option of transporting the material from the entire dump to a hazardous waste disposal facility such as Holfontein was also considered. However, this would be an extremely costly exercise and therefore not possible.

3.3 No-go option

The no-go option would be to leave the existing dump as is, without reprocessing, rehabilitation or disposal. This option will result in no financial gain by either Rand Carbide or EMB and could potentially lead to the underlying soil and groundwater resource being further polluted, consequently harming the environment. The no-go option is therefore not considered due to the following impacts:

- Legal non-compliance and legal liability.
- Not in line with best practice.
- No recovery of valuable materials from the dump for processing or selling.
- Aesthetic impact - 30m high and 2.25ha dump.
- Pollution source remains and groundwater contamination continues.
- Dust nuisance source remains.

4 LEGAL ASSESSMENT

South African legislation that Rand Carbide will have to comply with includes, but is not limited to:

- Constitution of the Republic of South Africa, 1996 (Act 108 of 1996) in terms of the people of South Africa's right to an environment that is not harmful to people's health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures.
- Conservation of Agricultural Resources Act (CARA), 1983 (Act 43 of 1983), all alien invasive species on site must be eradicated or controlled as per Department of Agriculture, Forestry and Fisheries (DAFF) guidelines;
- National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010 in terms of activities requiring environmental authorisation from the provincial authority and duty of care (Section 28);
- National Environmental Management: Waste Act (NEM:WA), 2008 (Act 59 of 2008) in terms of waste management licences required for the historic waste dump and its processing by EMB;
- National Environmental Management: Air Quality Act (NEM:AQA), 2004 (Act 39 of 2004) in terms of the furnace activities which require an Atmospheric Emissions Licence (AEL);
- National Water Act (NWA), 1998 (Act 36 of 1998) in terms of water use licences required;
- Occupational Health and Safety Act (OHSA), 1993 (Act 85 of 1993);
- Municipal bylaws; and
- International treaties and conventions.

4.1 NEM:WA

An application has been submitted to the Department of Environmental Affairs (DEA) in terms of NEM:WA (2008) for a waste management licence (WML) for the storage, recycling and/or recovery and treatment (through reprocessing) of waste material as per Government Notice Regulation (GNR) 718 of 3 July 2009. This includes the historic waste dump and its reprocessing by EMB. A full Environmental Impact Assessment (EIA) process, consisting of a Scoping Report (submitted in May 2012) and an Environmental Impact Report (EIR) are being compiled.

The following listed activities which require environmental authorisation and a waste management licence have been identified in terms of NEM:WA Government Notice Regulation 718 (3 July 2009), Category A:

Activity 2: The storage including temporary storage of hazardous waste at a facility that has the capacity to store in excess of $35m^3$ of hazardous waste at any one time, excluding the storage of hazardous waste in lagoons.

The following listed activities which require environmental authorisation and a waste management licence have been identified in terms of NEM:WA Government Notice Regulation 718 (3 July 2009), Category B:

Activity 2: The reuse and recycling of hazardous waste.

Activity 3: The recovery of hazardous waste including the refining, utilisation or co-processing of waste at a facility with a capacity to process more than 500kg of hazardous waste per day excluding recovery that takes place as an integral part of an internal manufacturing process within the same premises or unless the Minister has approved re-use guidelines for the specific waste stream.

Activity 5: The treatment of hazardous waste using any form of treatment regardless of the size or capacity of such facility to treat such waste.

Rand Carbide did apply for a waste disposal site permit (16/2/7/B100/B34/Z1) in terms of section 20 of the Environmental Conservation Act, 1989 (Act 73 of 1989) but the permit was never issued by DWA due to insufficient information.

4.2 NEM:AQA

Rand Carbide has an AEL in terms of NEM:AQA (2004). Licence number 17/4/AEL/MP312/11/02 (Appendix A) issued by Mpumalanga Department of Economic Development, Environment and Tourism (MDEDET) on 14 April 2011.

4.3 NWA

An Integrated Water and Waste Management Plan (IWWMP) has been compiled in support of an Integrated Water Use Licence Application (IWULA) in terms of Section 21 of the NWA. The documents were submitted to Department of Water Affairs (DWA) in September 2012.

Existing: Permit 282N (29 March 1989; ref B33/2/210/34) from the Department of Water Affairs (DWA) authorises Rand Carbide the use of municipal water for industrial purposes at the premises (see Appendix A). A quantity of 515 000m^3/annum (1 411 m^3/day) is authorised in terms of the repealed Water Act of 1956. Rand Carbide has used between 79 000 m^3/annum and 113 000 m^3/annum over the past five (5) years (2007 – 2011) which is well below the 515 000m^3/annum authorised. No water use licence from DWA in terms of the NWA, 1998 is required for the use of water supplied by a water services provider such as a municipality. Rand Carbide has no agreement with the eMalahleni Municipality in terms of a guaranteed continued water supply, though it pays the municipality on a monthly basis for the water and has never experienced an interruption in its water supply (see municipal account attached - Appendix A).

Registrations: Rand Carbide did submit NWA Section 21(g) water use registrations to DWA on 31 March 2011.

5 BASELINE ENVIRONMENT

5.1 Climate

5.1.1 Regional climate

Rand Carbide is situated in eMalahleni in the western part of the Mpumalanga Highveld. Moderate summers and cold winters characterize the climate of the area. The annual rainfall, which falls mainly during summer, varies between 550 and 800 mm.

5.1.2 Rainfall

The average monthly rainfall, in mm, provided by the South African Weather Services (Witbank Municipality Station No 0515412-2) is given below in Table 5-1. The rainfall season starts in September and lasts to April but the wet season is considered to be October to March (higher rainfalls). Extreme rainfall events occur from November to January and can result in up to 300 mm/month of rain. Zero rainfall has also been recorded for all months of the year in drought periods.

Table 5-1: Climatic data

Month	Temperature ^{0}C		Rainfall mm/month		Evaporation mm/month	
	Min	*Max*	*Witbank *(mean)*	*Fraction of annual (%)*	*Bethal 0478867 (1968-1987)*	*Witbank Dam B1E001*
January	15.3	26.2	138.4	19.7	179.8	178
February	15.1	24.9	97.1	13.9	151.1	149
March	12.5	22.7	87.2	12.4	147.8	147
April	9.2	20.9	37.1	5.3	111.1	113
May	7	18.7	9.6	1.4	94.8	95
June	4.3	18.2	5.8	0.8	79.2	77
July	3.8	17.2	3.5	0.5	89.0	84
August	6.5	20.8	7.2	1.0	132.0	112
September	10.1	24.3	26.6	3.8	167.0	145
October	12	25	77.8	11.1	186.6	175
November	13.4	24.8	111.8	15.9	167.6	165
December	14.3	25.5	98.8	14.1	195.9	182
Average	*10.3*	*22.4*	*58.4*	-	*141.8*	*135.2*
ANNUAL	-	-	***700.9***	-	***1 701.9***	***1 622***

*Witbank Municipality Station No 0515412-2; 1970 – 2002

5.1.3 Evaporation

Evaporation data has been received from the SA Weather Services for Station number 0478867 at Bethal and B1E001 near the Witbank Dam. The annual average evaporation for the period 1968 to 1987 is 1 702 mm/year. The minimum evaporation of 59.6 mm was recorded in March 1976, while the maximum of 264.4 mm was recorded during December 1972. Monthly evaporation is presented above in Table 5-1. It is important to note here that evaporation exceeds rainfall for all months of the year and the area could therefore be classified as water deficit.

The mean annual S-pan evaporation is indicated in WR2005 to range between 1 600 and 1 700 mm/annum, whilst the A-pan evaporation is indicated to range between 1 800 and 2 000 mm/annum. Mean monthly evaporation is also highly seasonal with the majority of evaporation occurring during the summer months Figure 5-1.

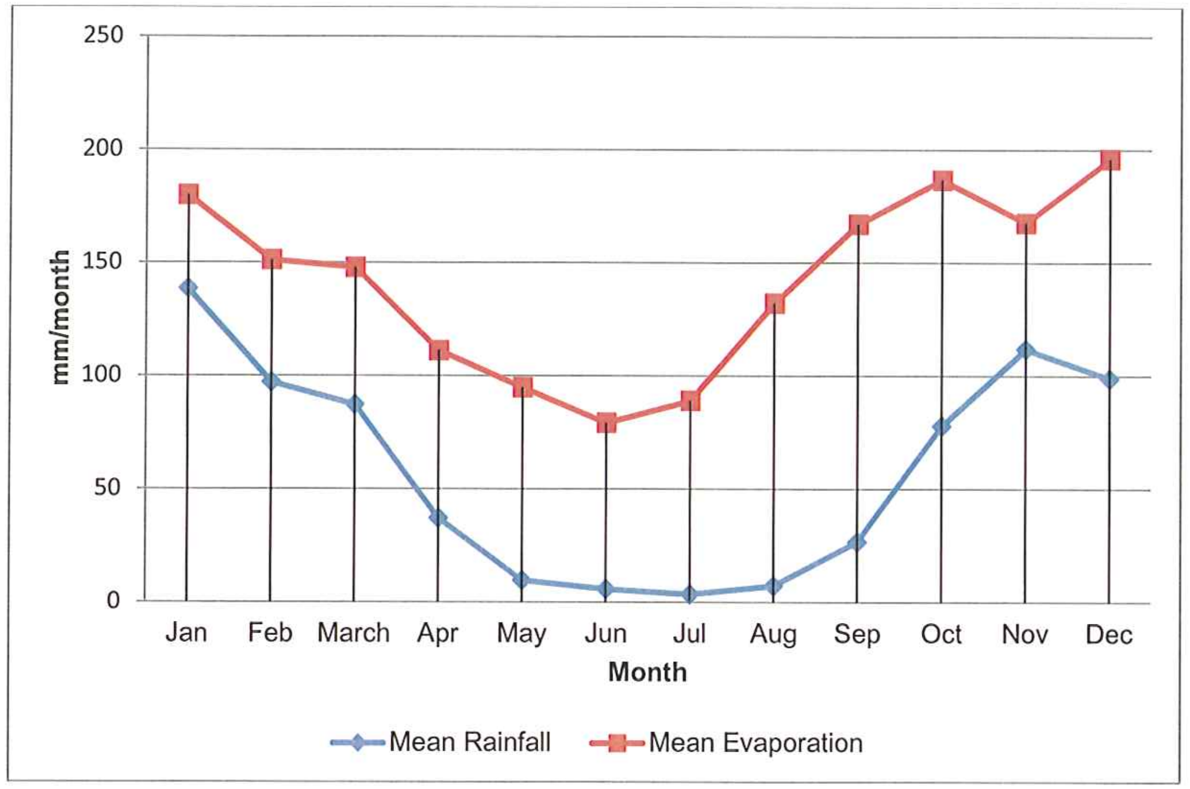

Figure 5-1: Rain and evaporation

5.1.4 Temperature

Monthly minimum and maximum temperatures recorded (in degrees Celsius) for the area is provided in Table 5-1 above. According to the table, July was the coldest on average with a minimum of 3.8°C while January had the highest average temperature with a maximum average of 26.2°C.

5.2 Soil and land capability

5.2.1 Soils

The surface at Rand Carbide consists initially of a brownish orange to light brown slightly clayey soil. Large areas of the soil have been removed during the construction of the plant area and several other surface activities. The soil across the northern extent of the site varies between 1 and 3m thick and is underlain by a brownish-red to brown clay layer of varying thickness. The clay layer varies between 0 m (not penetrated during drilling) and 9 m as recorded at borehole RCG-B5.

The soil and clay layers at Rand Carbide are underlain by fine to mostly medium grained reddish brown rhyolites of the Selons River Formation of the Rooiberg Group. The geochemistry of the rhyolite drill chips sampled from borehole RCG-B3 was analysed and is given in Table 5-2.

Table 5-2: Geochemistry of Rhyolite sampled from borehole RCG-B3 (JMA, 2012)

RCG-B3	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	H_2O	Total
Weight %	76.63%	0.25%	11.45%	4.18%	0.15%	0.39%	0.33%	2.17%	4.86%	0.05%	100.46%

The geochemical analysis indicates that the rhyolite is significantly rich in SiO_2 as well as Al_2O_3. The chemical composition is important, as this will have an effect on the chemical image of the groundwater itself.

Gijima Ast took samples and had the soil around the EMB plant analysed using the NIOSH (National Institute for Occupational Safety and Health) method 7300. The conclusion was made that the risk of soil and groundwater pollution at the EMB plant is low based on the low levels of contaminants detected in the sampled soils. The soils contained no poly aromatic hydrocarbons, volatile organic compounds (VOC), cyanide or hexavalent Chromium (Cr(VI)).

The soils contained high concentrations of Aluminium (Al), Calcium (Ca), Iron (Fe), Potassium (K), Magnesium (Mg), Manganese (Mn), Sodium (Na) with the following in lower quantities: Barium (Ba), Chromium (Cr), Sulphur (S), Titanium (Ti) and Zinc (Zn). A detailed soil assessment may be required to establish any localised contamination on the site which may require clean-up during rehabilitation.

5.2.2 Land use

Current land use for the Rand Carbide property is industrial (1926 – current), predominantly for ferrosilicon and silicon metal production.

Surrounding land use includes industrial and commercial uses as well as residential areas (refer to Figure 1-2).

5.3 Topography and surface water

5.3.1 Topography

Rand Carbide is located in the Highveld Region of the Mpumalanga Province. The regional topography slopes in both a north-westerly as well as north-easterly direction away from the topographical higher southern extent of the study area. The surrounding landscape is dominated by slight to moderately undulating plains, including some low hills and pan depressions.

The site itself generally slopes towards the north east, with the highest elevation being 1 608 metres above mean sea level (mamsl) in the south western corner of the site and the lowest elevation being 1 556 mamsl in the north eastern corner of the site. The gradient was calculated at approximately 1:20 over roughly 1.1 km (average gradient of 0.05). The south-eastern extent of Rand Carbide has the steepest gradient (0.14) in a northerly direction, whilst the western region has the gentlest gradient (0.03) towards the north-east.

The natural surface topography at Rand Carbide has been altered within the plant area in order to build on level surface foundations. This is evident by the rock cuttings seen to the south of the furnaces as well as other localities within the plant area.

5.3.2 Surface water environment

Water Management Area (WMA): Olifants (WMA 4)

Sub-catchment: Upper Olifants River (Loskop Dam); 12 285 km^2

Catchment Area: 269 km^2

Mean Annual Precipitation (MAP): 682 mm for catchment
701 mm for Witbank area

Mean Annual Runoff (MAR): 46 million m^3

Mean Annual Evaporation (MAE): 1 650 mm

Quaternary catchment: B11J

Surface water resources: Olifants River (4 km north east)
Doornpoort Dam (7.5 km east)

Closest surface water body: Spring (300m north east from site boundary)
Feeds into Olifants 5km north

5.3.3 Surface water hydrology

The site generally drains towards the north east towards the Olifants River. Various catchment ponds are located on the site which collects stormwater runoff (Figure 5-2).

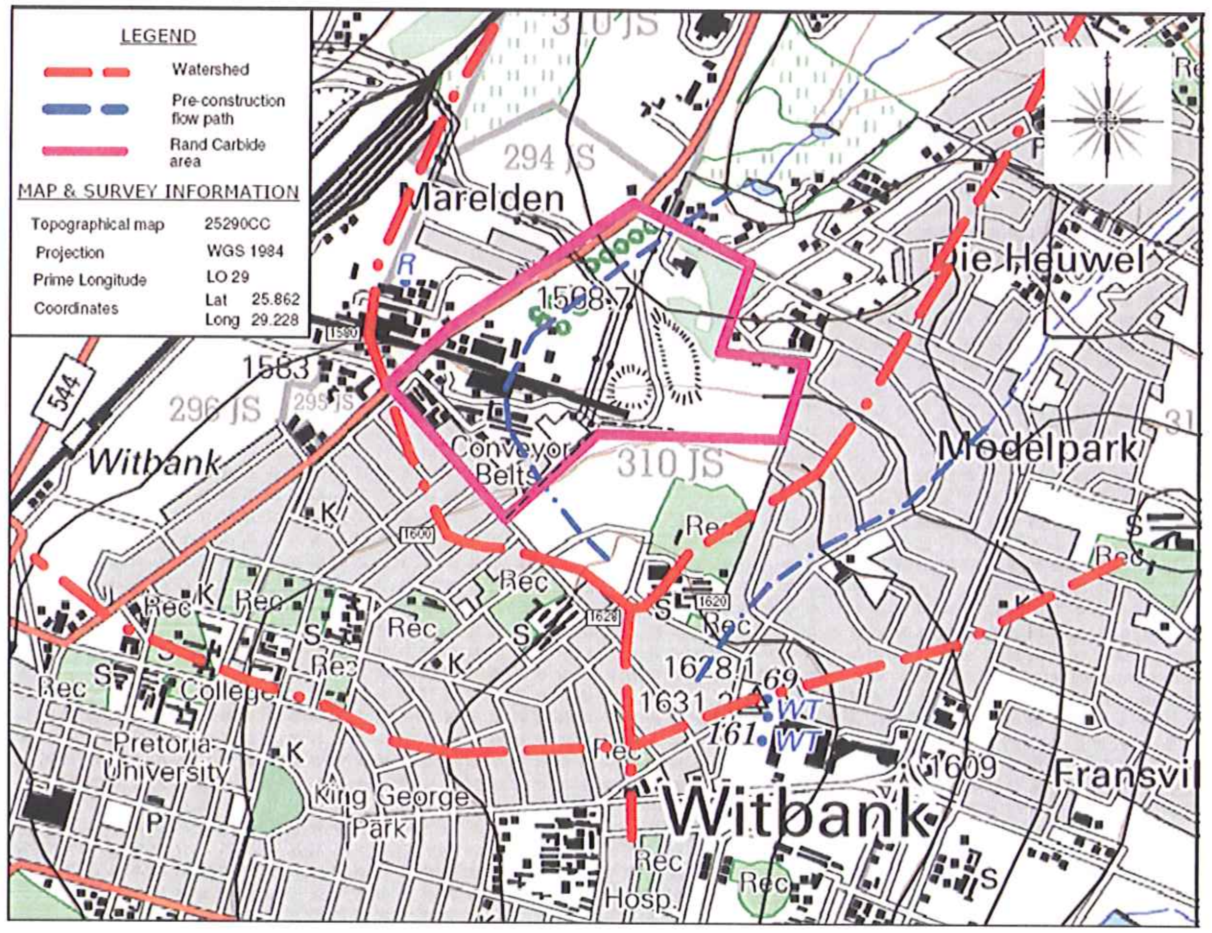

Figure 5-2: Surface hydrology around Rand Carbide (E-Tek, 2011)

5.3.4 Surface water quality

Selected surface water samples were analysed between April 2007 and January 2011 (Tables 5-3 to 5-6).

Table 5-3: Water quality for water supply source

Constituents:	eMalahleni municipal water from Witbank Dam*
pH	7.3
EC (mS/m)	50
TDS (mg/l)	336
Suspended Solids (mg/l SS)	1.2
Calcium (mg/l Ca)	36
Magnesium (mg/l Mg)	22
Sodium (mg/l Na)	23
Potassium (mg/l K)	5.8
Ammonium (mg/l NH_4 as N)	0.01
Nitrate (mg/l NO_3 as N)	0.11
Sulphate (mg/l SO_4)	151
Chloride (mg/l Cl)	14
Fluoride (mg/l as F)	0.37
Iron (mg/l as Fe)	0.02
Manganese (mg/l as Mn)	0.03
Aluminium (mg/l as Al)	0.01
Quantity used (m^3/month)	7 500
Cost (R/m^3)	7.30

Notes: Municipal water quality was determined from a number of information sources.

Table 5-4: Water quality for storm water runoff (April 2011)

Constituents:	Catchment ponds		Main dam
	1	4	Harry's dam
pH	8.0	7.71	7.97
EC (mS/m)	79	78	75
TDS (mg/l)	600	596	544
Calcium (mg/l Ca)	112	108	95
Magnesium (mg/l Mg)	27	27	22
Sodium (mg/l Na)	37	37	38
Potassium (mg/l K)	12	12	20
Nitrate & Nitrite (mg/l N)	1.3	1.2	-
Sulphate (mg/l SO_4)	193	183	180
Chloride (mg/l Cl)	28	32	47
Fluoride (mg/l as F)	0.40	0.68	0.59
Iron (mg/l as Fe)	0.09	0.07	-
Manganese (mg/l as Mn)	0.32	0.02	-
Aluminium (mg/l as Al)	0.08	0.12	0.01
Zinc (mg/l as Cd)	0.03	0.09	0.02
Copper (mg/l as Cu)	< 0.01	< 0.01	0.02
Chemical Oxygen Demand (mg/l COD)	30	30	34

Table 5-5: Spring water quality

Constituents:	Springs		
	E furnace	F furnace	B Conveyor sump (embankment)
pH	8.35	8.13	8.01
EC (mS/m)	108	455	67.4
TDS (mg/l)	750	3 542	452
Calcium (mg/l Ca)	101	331	82.5
Magnesium (mg/l Mg)	33.6	138	20.6
Sodium (mg/l Na)	83.5	475	27.3
Potassium (mg/l K)	12.8	125	12.7
Nitrate & Nitrite (mg/l NO_3 as N)	3.9	7.2	1.8
Sulphate (mg/l SO_4)	287	1 740	144
Chloride (mg/l Cl)	56	356	23
Fluoride (mg/l as F)	0.34	4.5	< 0.2
Iron (mg/l as Fe)	0.01	4.05	0.04
Manganese (mg/l as Mn)	0.27	0.29	< 0.01
Aluminium (mg/l as Al)	< 0.01	0.54	< 0.01
Chemical Oxygen Demand (mg/l COD)	24	112	20
Water quantity (m^3/month)	3.6	3.6	14.4

Table 5-6: Other surface water qualities (April 2007 - January 2011)

Monitoring point:	TDS (mg/l):	SO_4 (mg/l):	Cl (mg/l):	Ca (mg/l):	Mg (mg/l):	Fe (mg/l):	Mn (mg/l):	pH (range)
Wash bay	526	193	31	66	27.1	0.88	0.27	6.4 – 8.0
Panorama	312	70	60	36	13.9	0.01	0.05	6.5 – 7.9
Swartbos	1 059	418	99	132	47.1	0.01	0.22	6.6 – 7.5

5.3.5 Mean annual runoff (MAR)

Hydrological Evaporation Zone:	4A
Hydrozone:	J
Area of quaternary catchment B11J:	269 km^2
Area under investigation:	0.162km^2
Mean Annual Precipitation (MAP):	645 mm
Mean Annual Evaporation (MAE):	1 621 mm
Mean Annual Runoff (B11J):	13 100 000 m^3
MAR into Rand Carbide storm water control dam:	7 889 m^3

Table 5-7: Mean Annual Runoff in m^3 (E-Tek, 2011)

Month:	Stockpile area: (0.0169km^2)	Waste Dump: (0.52km^2)	Storm water dam: (0.162km^2)	Affected areas:
October	35	106	331	472
November	119	366	1 142	1 627
December	115	354	1 103	1 573
January	139	428	1 334	1 901
February	150	463	1 442	2 055
March	100	309	963	1 373
April	57	174	542	772
May	38	116	360	514
June	24	73	226	322
July	18	55	172	245
August	15	45	141	201
September	14	43	133	190
TOTAL	**824**	**2 532**	**7 889**	**11 245**

5.3.6 Surface water users

Major water users in the Upper Olifants Catchment include:

- Irrigation;
- Urban and industrial uses;
- Rural uses; and
- Mining.

Municipal water is supplied to the area and no surface water users in close proximity to Rand Carbide were identified.

5.4 Sensitive areas

No sensitive areas in close proximity to the site were identified. A drainage line originates 300 m north east of the site and feeds into the Olifants River.

Ten (10) wetland areas are located in the quaternary catchment but not in close proximity to the site (Aurecon, SANBI, Department of Environmental Affairs, Department of Water Affairs, Department of Agriculture, Forestry and Fisheries; Working for Wetlands, Phase 1 – Planning; Report 5146a/105782; Ref 2010/Phase 1/Report/05-MPU-Final; August 2010) (Table 5-8).

Table 5-8: Wetlands in quaternary catchment B11J

Wetland Number	Wetland Name	Longitude	Latitude
B11J-01	Kalbasfontein 01	29° 16' 27"	-25° 45' 56"
B11J-02	Kalbasfontein 02	29° 16' 29"	-25° 45' 56"
B11J-03	Kalbasfontein 03	29° 15' 44"	-25° 47' 34"
B11J-04	Erfdeel Pan	29° 21' 54"	-25° 46' 44"
B11J-05	Elandspruit	29° 21' 32"	-25° 47' 50"
B11J-06	Kromdraai	29° 15' 31"	-25° 50' 11"
B11J-07	Doringpoort	29° 19' 51"	-25° 51' 40"
B11J-08	Witbank NR 01	29° 17' 00"	-25° 53' 09"
B11J-09	Elandspruit Pan	29° 23' 29"	-25° 48' 13"
B11J-10	Witbank NR 02	29° 19' 26"	-25° 52' 43"

5.5 Geology and geohydrology

5.5.1 Geology (adapted from JMA, 2012)

The Witbank area is underlain by a basement complex of porphyritic ryolite of the Selons River Formation, Rooiberg Group of Proterozoic rocks. This is unconformably overlain by the Vryheid Formation, Ecca Group of sedimentary rocks, comprising sandstone, shale and coal seams. To the South of Witbank, the Vryheid Formation is extensively intruded by Jurassic age dolerite dykes and sills, emplaced between 150 and 190 million years ago.

The regional geology is discussed with reference to the 1:250 000 geological map series of South Africa (Sheet 2528 Pretoria, 1978) as per clipped region in Figure 5-3.

The occurrence and movement of groundwater, as well as the groundwater quality, are functions of the geological host rock in which the groundwater occurs, including the alteration thereof as a result of human activities, such as industrial activities.

Rand Carbide is underlain by porphyritic red rhyolite of the Selons River Formation of the Rooiberg Group. The volcanic Rooiberg group is part of the Bushveld Magmatic Province, a voluminous suite of Precambrian magmatic rocks that also includes the Lebowa Granite Suite as well as the laterally extensive Rustenburg Layered Suite.

The Rooiberg Group comprises of volcanic units that are up to 400 m thick (Harmer and Von Gruenewaldt, 1991), together with interbedded, thin, laterally extensive sediment strata. Most of the volcanic units of the Rooiberg Group are composed of a fine-grained groundmass with variable proportions of phenocrysts, porphyroblasts and amygdales. The general Geochemistry of the Rooiberg is associated with an increase in SiO_2 and a decrease in MgO, whilst moving upward in the Succession. The increase in SiO_2 can rise to values of average 74.9 weight % in the upper most Formation of the Rooiberg Group (Buchanan, 2006).

The surface geology to the north-east of Rand Carbide consists of shales, sandstones and conglomerates of the Loskop Formation. It is indicated that the Loskop Formation has later been intruded by predominantly north-west striking diabase dykes. The surface geology to the west and north-west of Rand Carbide consists of sedimentary rocks of the Vryheid Formation, which forms part of the Ecca Group of the Karroo Supergroup.

The Vryheid Formation sedimentary lithologies lie unconformably on top of the Rooiberg Group and generically consist of gritty sandstone mudstone, shale and coal layers within the study area. The Vryheid Formation has been extensively mined for coal by both opencast and underground mining operations

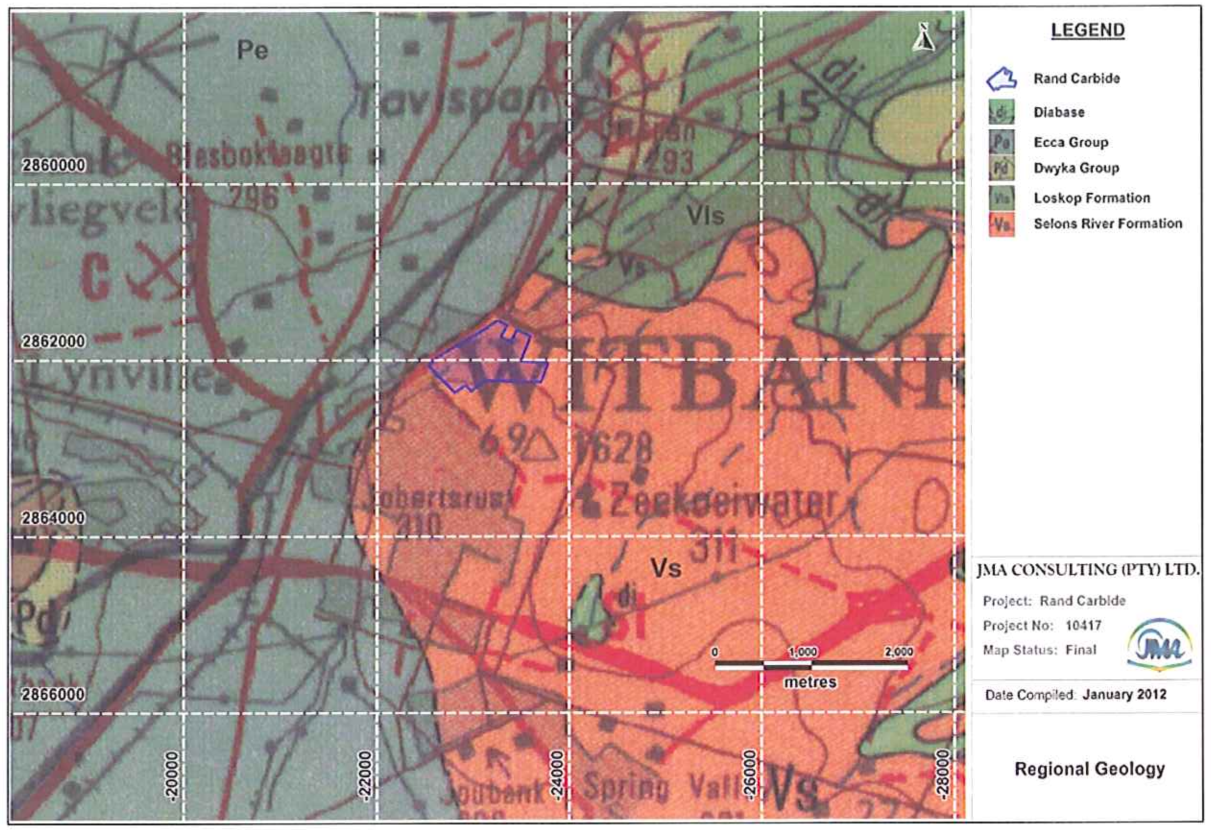

Figure 5-3: Regional geology (JMA, 2012)

5.5.2 Geohydrology (JMA, 2012)

The regional geohydrology of the study area is addressed with reference to the available information relevant clipped region of the published 1:500 000 Hydrogeological Map Series of the Republic of South Africa – Sheet 2526 Johannesburg, 1999, depicted as Figure 5-4.

The regional geohydrological attributes of the study area are clearly a function of the geological formation distribution. Two (2) distinctly separate stratigraphic sequences (Pe and Vb) occur within the groundwater management area, each with their own geohydrological manifestations.

<u>Geohydrological Zone 1: Ecca Group</u>

The western extent of the regional study area is underlain by the sedimentary lithologies of the Ecca Group - denoted by Pe on the map.

Within this zone the groundwater occurs primarily within the weathered zone as well as in joints and fractures of the competent arenaceous rocks, related to tensional or compressional stresses and offloading.

Figure 5-4: Regional geohydrology (JMA, 2012)

The borehole yielding potential within this geohydrological zone is classified as d3, which implies a median yield which varies between 0.5 l/s and 2.0 l/s. No large scale groundwater abstraction is indicated to occur from these intergranular and fractured aquifers within the bounds of the study area. The groundwater potential for the western area is between 40 and 60%, which indicates the probability of drilling a successful borehole (yield > 0.1 l/s) whilst the probability of obtaining a yield in excess of 2 l/s is between 10% and 20%.

The mean annual recharge (MAR) to the groundwater system in the western parts of the study area is estimated to be between 50 mm and 70 mm per annum, which relates to about 8% of the mean annual precipitation (MAP). The groundwater contribution to surface stream base flow is relatively low, estimated at between 10 mm to 25 mm per annum (Vegter, 1995).

The aquifer storativity (S) for the intergranular fractured Karroo aquifers in this part of the study area is estimated to be less than 0.001. The saturated interstice types (storage medium) are fractures which are restricted principally to the zone directly below the groundwater level. The groundwater is classified to be of the hydrochemical type B, with dominant cations Ca^{2+} and Mg^{2+} and dominant anion being HCO_3^- (Vegter, 1995).

Geohydrological Zone 2: Rooiberg Group

The Rand Carbide site is underlain by the rhyolites of Selons River Formation of the Rooiberg Group - denoted by Vb on the map. Within this zone the groundwater occurs primarily within the shallow weathered zone as well as in localized fractures of the competent lithological units.

The borehole yielding potential within this geohydrological zone is classified as d2, which implies a median yield that varies between 0.1 l/s and 0.5 l/s. No large scale groundwater abstraction is indicated to occur from these intergranular and fractured aquifers within the bounds of the study area. The groundwater potential for the western area is given as between 40 and 60%, which indicates the probability of drilling a successful borehole (yield > 0.1 l/s) whilst the probability of obtaining a yield in excess of 2 l/s is given as between 10% and 20%.

The mean annual recharge (MAR) to the groundwater system in the western parts of the study area is estimated to be between 45 mm and 60 mm per annum, which relates to between 6% and 7% of the mean annual precipitation (MAP). The groundwater contribution to surface stream base flow is relatively low, estimated at between 10 mm to 25 mm per annum (Vegter, 1995).

The aquifer storativity (S) for the intergranular and fractures Rooiberg Group aquifers in the study area is estimated to be less than 0.001. The saturated interstice types (storage medium) are pores and fractures restricted principally to the zone directly below the groundwater level. Groundwater rest levels in the Rooiberg Group are typically between 10 and 30 mbgl and the groundwater quality is typically excellent with average EC values of 34 mS/m and a pH of 7.1. The groundwater is classified to be of the hydrochemical type B, with dominant cations Ca^{2+} and Mg^{2+} and dominant anion being HCO_3^- (Vegter, 1995).

5.5.3 Aquifer characterisation

Aquifer types: With reference to the local geology of the site, it is regarded that the primary aquifer type present at Rand Carbide is a laterally extensive weathered zone aquifer. This weathered zone aquifer occurs within the weathered and weathering related fractured zone of the rhyolites and extends across the entire study area. Although clay was penetrated in several of the boreholes drilled at Rand Carbide, a laterally extensive perched aquifer system is not indicated to be developed on site.

The thickness of the weathering and related fracturing zone recorded at the eleven (11) boreholes drilled at Rand Carbide varies between 4 m and 18 m with an average vertical thickness of 10.68 m. This aquifer zone will store and transport the bulk of the groundwater in this area. This aquifer will display unconfined to semi-unconfined piezometric conditions and may as a result, potentially be highly susceptible to surface induced activities and impacts.

Fractures below the weathered zone / fresh bedrock interface were intersected in four of the boreholes drilled at Rand Carbide. These fractured zones may be highly transmissive zones and show confined to semi-confined piezometric conditions.

Aquifer zones: Due to the absence of laterally extensive perched aquifer conditions, the aquifer zones within the shallow weathered zone aquifers penetrated at Rand Carbide are comprehensively described in terms of unconfined to semi-unconfined unsaturated and saturated aquifer zones.

Unsaturated Zone:
Due to the nature of the shallow weathered zone aquifer at Rand Carbide, the top of the unsaturated zone is defined by the land surface, whilst the bottom of the unsaturated zone is defined by the groundwater table/level. The thickness of the unsaturated zone is therefore defined as the depth to the groundwater level recorded at the boreholes. The thickness of the unsaturated zone was calculated using the groundwater levels recorded at the 11 groundwater monitoring boreholes during December 2011. The vertical thickness of the unsaturated zone ranges between 0.00 m (artesian groundwater level) and 14.70 m with a calculated average vertical thickness of 5.72 m.

Saturated Zone:
The saturated zone of the shallow weathered zone aquifer at Rand Carbide is defined at the top by the groundwater table/level and at the bottom by the weathered/fractured and fresh bedrock interface. The saturated aquifer thickness of the shallow weathered zone aquifer is therefore calculated by subtracting the measured groundwater level depth from the weathered or weathering related fractured depth as recorded at the groundwater monitoring boreholes during December 2011. The thickness of the saturated zone is calculated to vary between 0.00 m and 15.53 m with an average vertical thickness of 8.33 m.

Aquifer permeability: The hydraulic conductivity or permeability (k-value) of an aquifer is a measure of the ease with which groundwater can pass through the aquifer system. The permeability is defined as the volume of water that will move through a porous medium in unit time under a unit hydraulic gradient through a unit area measured perpendicular to the flow direction and is expressed in m/day. The bulk permeability for the shallow weathered zone aquifer at Rand Carbide was optimized during the numerical groundwater modelling and was verified to be 0.04 m/day.

Aquifer transmissivity: The transmissivity (T) of an aquifer represents the groundwater flow potential through the entire saturated zone. The transmissivity is defined as the rate at which water is passed through a unit width of an aquifer under a unit hydraulic gradient. It is expressed as the product of the average permeability and the thickness of the saturated portion of the aquifer (D). The transmissivity is thus calculated as **T=k*D** (m^2/day). The bulk transmissivity for the shallow weathered zone aquifer at Rand Carbide was determined from the optimized aquifer permeability during the numerical groundwater modelling and is calculated to range between 0.02 m^2/day and 3.65 m^2/day with an expected bulk transmissivity of 0.60 m^2/day.

Aquifer storativity: The storativity (S) of an aquifer is defined as the volume of water that an aquifer releases from, or takes into, storage per unit surface area of the aquifer per unit hydraulic gradient. The bulk storativity of the shallow weathered zone aquifer at Rand Carbide was taken as 0.002. The optimized storativity as determined from the groundwater model is 0.002.

Aquifer porosity: The porosity of an aquifer is the ratio of the void space to the total volume of the aquifer. The porosity gives an indication of the amount of water in the subsurface, but does not represent the volume that can be released from or taken into storage. Effective porosity is a measure of total volume of interconnected pores and is important as it plays a governing role in groundwater flow velocity. The effective porosity is the same as the specific yield for the unconfined shallow weathered zone aquifer at Rand Carbide. The effective porosity within the weathered zone aquifers within the study area vary between 0.01 and 0.07, with a bulk probable value of 0.03.

Aquifer boundary: The aquifer boundary (in this case based on hydraulic barriers) determines the extent of the groundwater zone that could potentially be affected by surface activities. See Figure 5-5 and Figure 5-10 where it was used as input to the model.

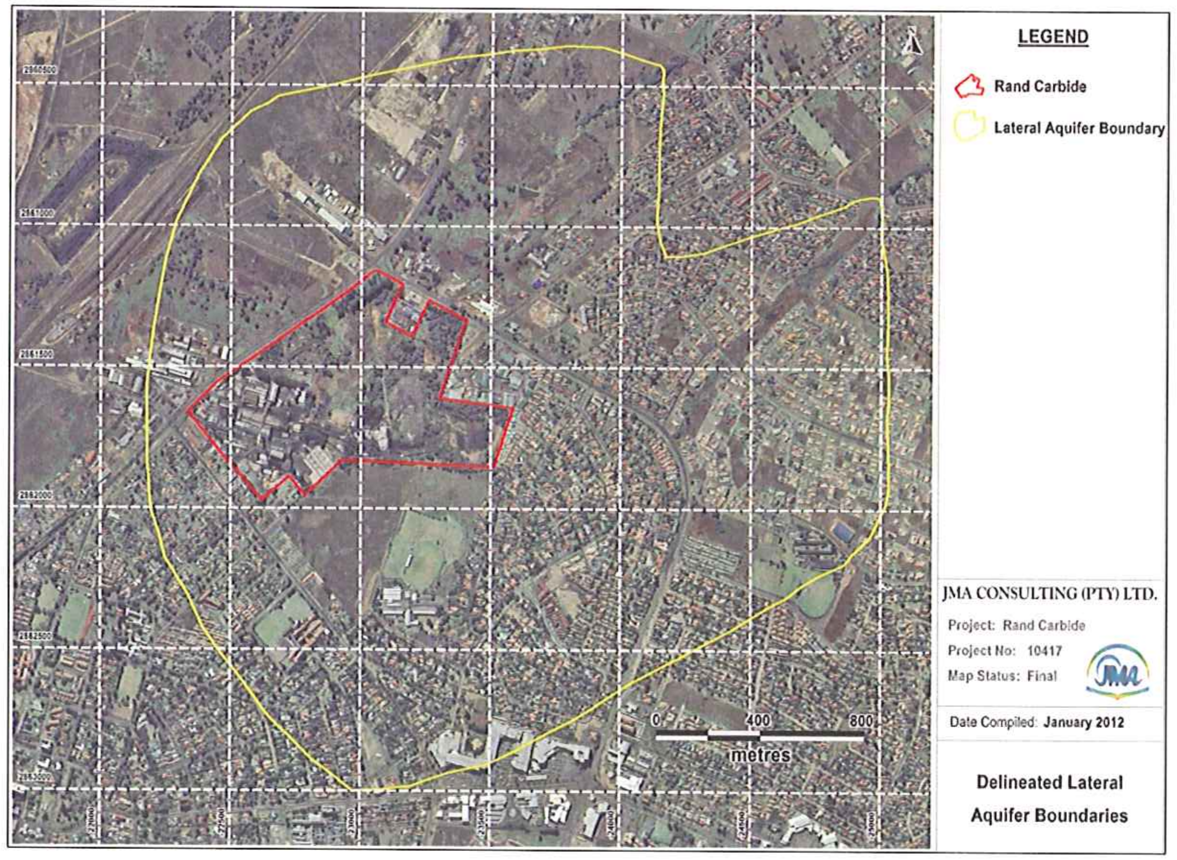

Figure 5-5: Aquifer boundary (JMA, 2012)

Rainfall recharge: Recharge to the shallow weathered zone aquifers within the study area occurs annually as a result of the infiltration of precipitation and is expressed in terms of a percentage of the mean annual precipitation (MAP). The mean annual recharge to the groundwater system at Rand Carbide is estimated to be between 1% and 3% of the MAP and is calculated as between 7 mm and 21 mm per annum.

Groundwater level depths and fluctuations: The groundwater levels recorded at Rand Carbide during December 2011 ranged between 0.00 mbgl, in which case the groundwater level is artesian, and 14.70 mbgl, with an average groundwater level depth of 5.72 mbgl. At a bulk storage value of 0.002, the groundwater level response to 1 mm of rainfall would be 0.50 m. The maximum possible fluctuation in groundwater level would then of course be in the order of between 3.5 m and 10.5 m for Rand Carbide. In view of the fact that all the recharge will not take place at the same time but more spread out over the summer months, natural groundwater level fluctuations in excess of 2 m/annum to 5 m/annum is not expected.

Borehole yields: Borehole blow yields were recorded for 7 of the 11 boreholes drilled during the two drilling programmes (1989 and 2011) conducted at Rand Carbide. The remaining four (4) boreholes were "dry" and blow yields could thus not be recorded at these boreholes.

The blow yields recorded varied between 0.10 l/s and 1.10 l/s, with an average blow yield of 0.43 l/s. The yields from six (6) of the boreholes were obtained from within the weathered zone of the shallow weathered zone aquifer. The blow yield recorded at borehole RCG-B7 (1.10 l/s) was however from a water strike intersection from a fracture below the weathering depth of the borehole at a depth of between 23 m and 26 m.

Aquifer classification: The shallow weathered zone aquifer at Rand Carbide is conservatively classified as a Minor Aquifer System due to its low permeability and limited use for abstraction. The shallow weathered zone aquifer system is therefore assigned 2 points, according to the Aquifer System Management Classification (DWAF, 1995).

There are no special structural aquifer attributes at Rand Carbide associated with the Second Variable Classification of the shallow weathered zone aquifers. The total points assigned to the shallow weathered zone aquifer system therefore remains 2.

Although weathered zone aquifers are normally highly vulnerable to surface induced impacts, no severe impacts could be delineated within the weathered zone aquifers at Rand Carbide. The vulnerability of the aquifer with regards to contamination thereof resulting from a surface induced source, in terms of the above and given the current groundwater qualities, is assigned a value of 1, indicating a low aquifer vulnerability.

The groundwater quality management classification is made with regards to the aquifer vulnerability. The indicated level of groundwater protection is derived from the Groundwater Quality Management Index (GQM Index) and is calculated as follows:

GQM Index = Aquifer System Management x Aquifer Vulnerability Classification
= 2 x 1
= 2

The GQM Index is used to determine the level of groundwater protection that is required for the shallow weathered zone aquifer systems present at Rand Carbide and is indicated as a low level groundwater protection required.

5.5.4 Groundwater quality

Table 5-9: Historic chemical groundwater quality (Apr 2007 - Jan 2011)

Monitoring point:	TDS (mg/l):	SO_4 (mg/l):	Cl (mg/l):	Ca (mg/l):	Mg (mg/l):	Fe (mg/l):	Mn (mg/l):	pH (range)
Lab borehole	289	82	40	27	11.8	7.14	0.28	6.0 – 6.6
BH 1	348	150	9	76	12.9	0.19	1.73	6.5 – 7.3
BH 2	188	14	9	40	2.9	0.17	0.06	6.9 – 8.1
BH 3	150	13	4	29	2.2	0.36	0.11	7.4 – 8.2
BH 4	560	245	65	40	29.8	0.01	0.36	7.1 – 8.0
BH 5	720	349	65	85	47.5	0.17	0.23	6.9 – 8.0
BH 6	520	142	103	46	23.5	0.01	0.41	7.0 – 7.9
Standard for comparison purposes								
SANS 241 Class I	1 000	400	200	150	70	0.2	0.1	5.0 – 9.5

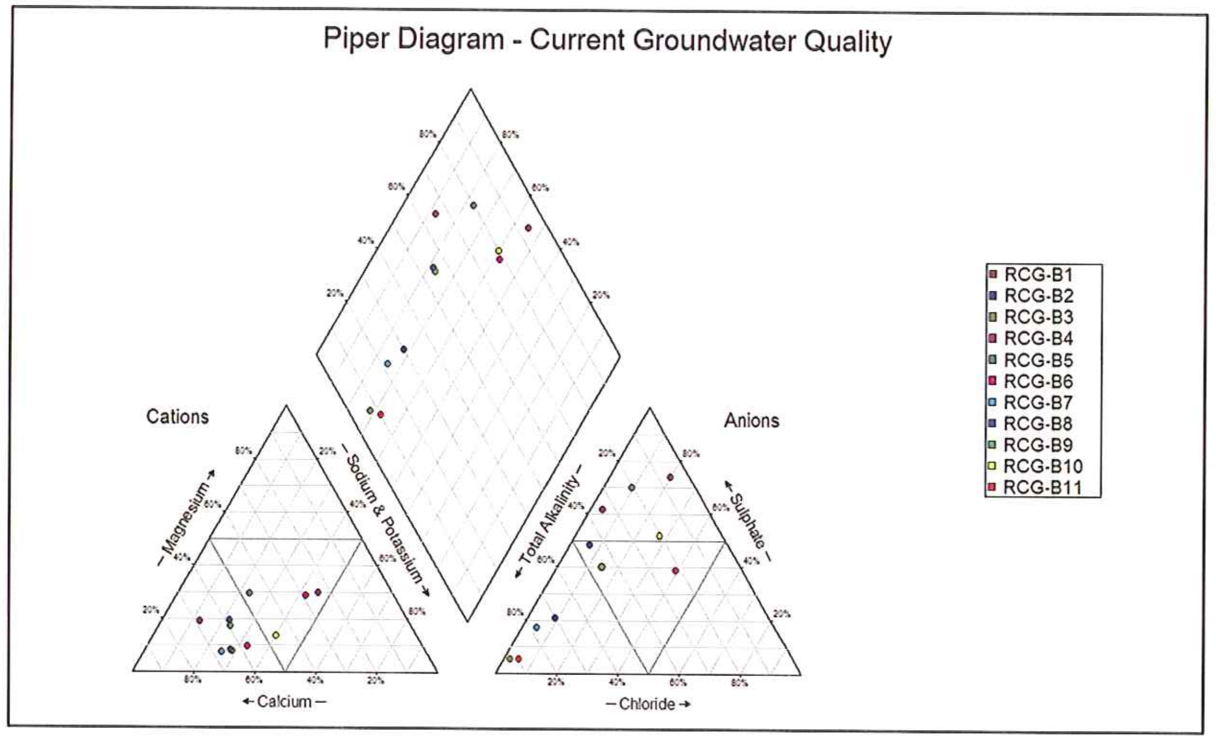

Figure 5-6: Current (Dec 2011) groundwater quality (JMA, 2012)

The Piper Diagram indicates that the current groundwater quality has a scattered hydrochemical image, with 7 of the groundwater samples collected at Rand Carbide characterised as having a Type-A hydrochemical image, whilst 4 samples have Type-B hydrochemical images (Figure 5-6). Interesting to note is that the groundwater sampled from the two boreholes with artesian water levels (RCG-B7 and RCG-B11) are both classified as having a Type-B hydrochemical image. The dominant (milliequivalent) cations within the groundwater is Ca^{2+} followed by Na^+ and K^+ whilst the dominant anions range between HCO_3^- and SO_4^{2-}.

The pH of the current groundwater quality at Rand Carbide ranges between 6.35 and 7.87 with an average of 7.25. The EC ranges between 23.2mS/m and 141mS/m with an average of 69.2 mS/m and an average TDS of 463 mg/l.

It is observed in the geochemistry of the groundwater sampled during December 2011 that the TDS concentrations show a positive correlation with an increase in the SO_4 and Ca concentrations. The elevated TDS observed in the shallow weathered zone aquifer across the northern extent of the Rand Carbide site appears to be related to localised increases in the SO_4 and Ca concentrations. Na and Cl also show good positive correlations in the groundwater samples collected during December 2011.

It is suspected that the slight increases in the Ca and SO_4 concentrations recorded at the spring/fountain as well as in boreholes RCG-B5, RCG-B6 and RCG-B10 may be related to surface induced contamination sources. This will however, need to be verified during future groundwater monitoring at Rand Carbide.

The variables TDS, Cl and SO_4 are deemed to be conservative in the sense that they cannot further break down and elevated concentrations may depict surface induced impacts on the natural (background) groundwater quality.

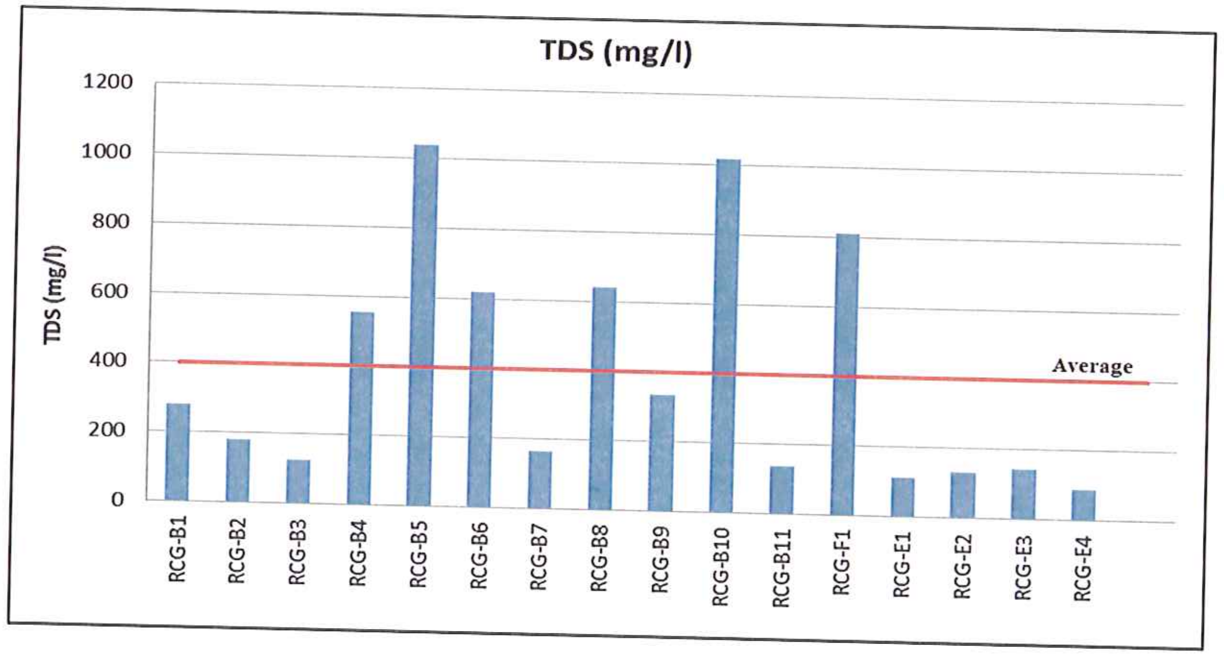

Figure 5-7: Current groundwater quality – TDS concentrations in December 2011 (JMA, 2012)

The boreholes and fountain that exceed the average (red line in Figure 5-7) are all located down-gradient from potential surface sources of contamination on the Rand Carbide site. Although not fully quantified, it potentially indicates that the historic waste dump and raw material stockpile areas may be viewed as potential surface sources from which impacts on the groundwater systems may originate. This condition can however, only be verified through the continual monitoring of the groundwater quality down gradient from these facilities. In terms of the worst case scenario adopted, these areas are viewed as potential surface contamination sources and are incorporated as such in the groundwater model during the groundwater impact assessment.

5.5.5 Hydro-census

A groundwater hydrocensus was performed within a 500m radius from the Rand Carbide site. During the hydrocensus, 1 fountain/spring and six (6) boreholes were located. Two (2) of the identified boreholes (RCG-E5 & RCG-E6) were blocked/destroyed and groundwater samples could therefore not be collected from these. Samples were however, collected at the fountain/spring (RCG-F1) and the four (4) boreholes (RCG-E1 to RCG-E4).

The fountain/spring is located down-gradient (north-east) from the Rand Carbide site and the six (6) boreholes identified are situated to the north-east and east of the site. No boreholes were identified within a 500m radius to the south and west of the Rand Carbide site. The fountain and boreholes identified during the hydrocensus are shown on Figure 5-8.

Groundwater uses: No large scale groundwater abstraction is indicated to occur from the intergranular and fractured aquifers within the bounds of the study area. Only three (3) of the six (6) boreholes identified were in use. Groundwater abstracted from these three (3) boreholes is used for domestic and gardening purposes but no information of quantities abstracted was available. This use will continue indefinitely.

The fountain/spring is the source of a small stream which eventually (5km north east) drains into the Olifants River.

Groundwater quality: The water quality gives an indication of background groundwater quality; due to the fact that Rand Carbide is a "brown fields" site and the groundwater quality may potentially already have been impacted. The pH of the background groundwater quality is on average 6.73 with an average EC of 42.2mS/m and TDS of 257 mg/l – all within Class 0 of SANS 241:2006 Drinking Water Standard.

Potential groundwater use: Due to the low permeability's of the shallow weathered zone aquifer and low probability of drilling boreholes with yields in excess of 2 l/s as well as the availability of municipal water, the abstraction of groundwater within the study area is limited, despite the good background groundwater quality.

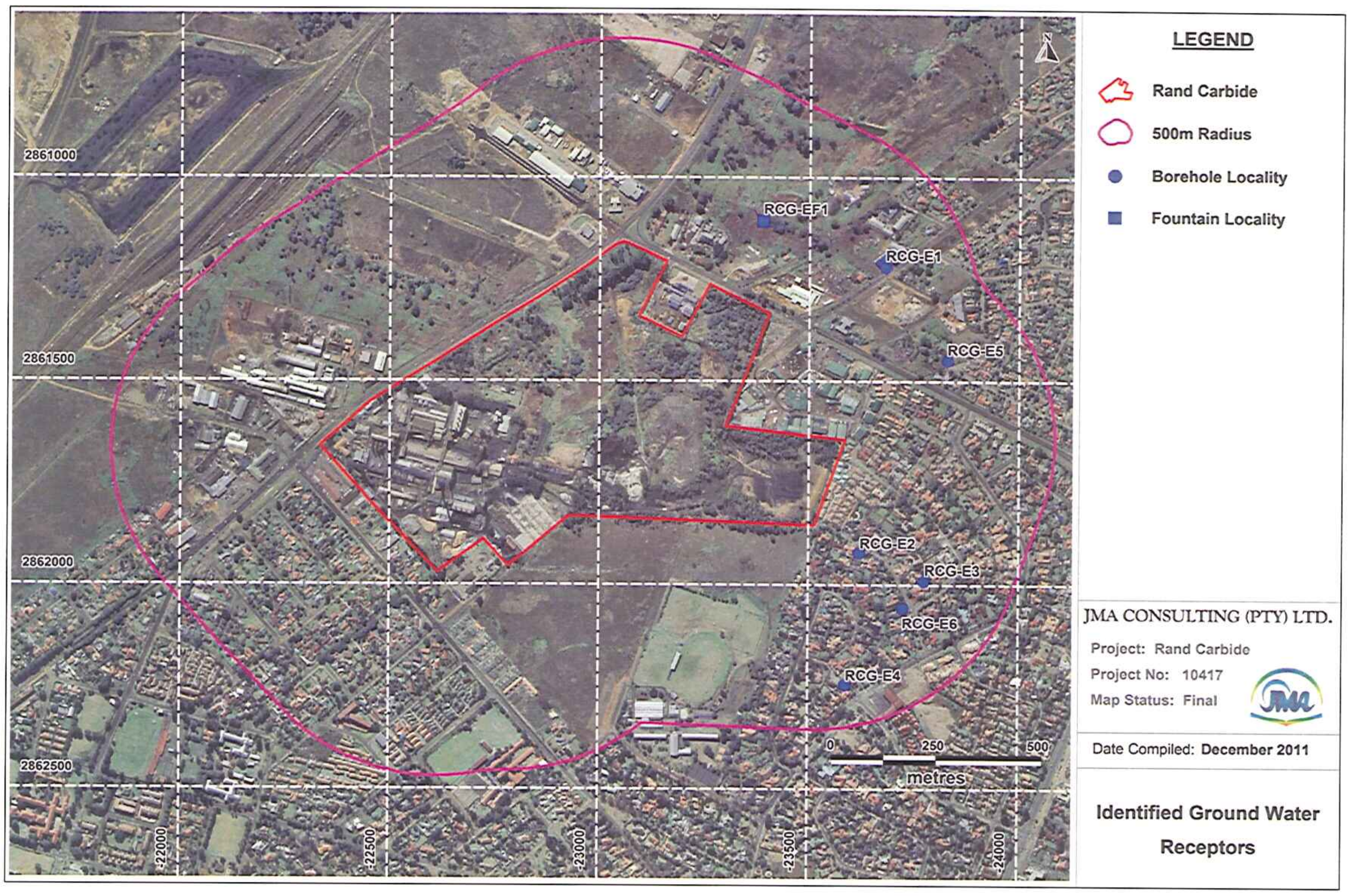

Figure 5-8: Hydrocensus (JMA, 2012)

5.6 Socio-economic environment

5.6.1 General

Rand Carbide is situated within the eMalahleni municipal area in the Nkangala District of the Mpumalanga Province. The eMalahleni Local Municipality represents one of six (6) local municipalities in the Nkangala District.

The eMalahleni Municipality is strategically located in provincial context and in relation to the national transport network. It is situated in close proximity to the City of Johannesburg, City of Tshwane and Ekurhuleni Metropolitan Municipality in Gauteng, and it is connected to these areas by the N4 and N12 freeways and a railway network. These freeways converge in eMalahleni Municipality, from where the N4 extends to Nelspruit, the provincial capital and ultimately to Maputo in Mozambique. The N4 freeway and the railway line which runs parallel with and adjacent to it from Gauteng to Mozambique constitute the Maputo Corridor. The corridor forms part of a transcontinental corridor initiative, aimed at linking Walvis Bay on the west coast of Africa with Maputo on the east coast, thereby creating strategic linkages for trade and tourism between Namibia, Botswana, South Africa and Mozambique.

The southern parts of the eMalahleni Municipality form part of the precinct referred to as the Energy Mecca of South Africa, due to its rich deposits of coal reserves and power stations such as Kendal, Matla, Duvha and Ga-Nala. The southward road and rail network connect the eMalahleni area to the Richards Bay and Maputo harbours, offering export opportunities for the coal reserves.

In 2001, the total population of the eMalahleni Municipality amounted to 276 412 persons, which constituted 27% of the total Nkangala District's population (1 020 589 persons) and 9% of Mpumalanga's population (3 122 988 persons). The latest population estimate (2007) is 435 217 persons and the 2011 census results are still outstanding. The towns of eMalahleni and Middelburg (situated in the adjacent Steve Tshwete Municipality) are the highest order settlements in the Nkangala District. These towns offer the full spectrum of business and social activities and both towns have large industrial areas. They also fulfil the function of service centres to the smaller towns and settlements as well as farms in the District.

5.6.2 Spatial structure

The eMalahleni Municipality can be described as an urban and rural area, consisting of large farms, dispersed urban settlements, coal mines and power stations. eMalahleni (Witbank) is seen as the main urban centre in the municipality, with the other activity nodes/towns in the municipal area represented by:

- Ogies and Phola;
- Ga-Nala and Thubelihle;
- Rietspruit;
- Van Dyksdrift; and
- Wilge.

5.6.3 Business activities

The primary business centre in eMalahleni is the eMalahleni Central Business District (CBD), which includes offices, retail, general business and commercial uses. There are also decentralised nodes in the eMalahleni area with mainly retail uses, like the Highveld Mall, Safeway Shopping Centre and Klipfontein Shopping Centre. Shopping centres are also planned in Kwa-Guqa Extensions 9 and 15. The casino in eMalahleni (The Ridge) adjacent to the Highveld Mall offers a hotel, restaurants and entertainment centre.

5.6.4 Industrial activities

There are nine (9) major industrial areas in eMalahleni, mostly concentrated in and around eMalahleni City. This also represents the largest concentration of industrial activity in the Nkangala District. Undermining, however, poses a major constraint to the expansion of these areas, which is problematic in view of the fact that there is a need for industrial land in eMalahleni, both in terms of land for heavy industries (approximately 20 to 50 hectares) and for light industries, service industries and high-tech industries.

5.6.5 Mining

Mining occurs throughout the central and southern portions of the eMalahleni area, with large sections of the municipal area affected by shallow undermining and/or mineral rights. Many of the mines have closed down for a variety of reasons.

This has had a significant impact on the environment, resulting in sinkhole formation, subsidence, underground fires, and seepage of water and Acid Mine Drainage (AMD) from underground workings. It has also had a significant economic impact, with some of the mining towns closing down and people being retrenched.

5.6.6 Electricity

Due to the rich coal reserves in the eMalahleni Municipality, Eskom developed the Kendal, Ga-Nala, Matla, Wilge and Duvha power stations during the 1970's and 1980's to provide in future electricity needs. This has led to the establishment of towns at Ga-Nala, Thubelihle and Wilge and the growth of these townships. Wilge is no longer operational.

Kendal is the largest power station with capacity of 4 032 MW. The chimneys at the Duvha power station are the highest manmade structures in Africa. These smoke stacks are each 300 metres tall, 30 metres higher than the Hillbrow tower in Johannesburg. Coal is a limited resource and there are plans to convert to gas in future to feed the power stations.

5.6.7 Agriculture

The non-urban areas of the eMalahleni Municipality consist mainly of farms and agricultural holdings. The agricultural holdings are found on the periphery of the urban settlements. In terms of agriculture, stock farming (sheep and cattle) and maize farming occur through the area and especially along the river drainage basins.

5.6.8 Economic profile

The eMalahleni economy is dominated by electricity as the main contributor to the Gross Geographic Product (GGP) of the area. The electricity sector dominates the local economy whilst the mining activities contribute significantly. The manufacturing and community services sectors are respectively the third and fourth most important sectors in the local economy.

During 1996-1999 only the finance sector and the electricity sector recorded significant growth rates. However, 1999-2002 was a period of expansion in the local economy with the aggregate economy expanding by 2.7%.

The key sectors that drove this expansion were:

- Mining;
- Manufacturing;
- Transport; and
- Finance.

5.6.9 Economic activity

Approximately 45% of the population is economically active, which is considerably higher than the Nkangala District (34%). The highest number of unemployed people reside in Hlalanikahle (23.5%), followed by Lynnville (22.6%), Phola (22.1%) and Kwa-Guqa (20.9%). Employment of the population according to the major types of industry in the area is as follows:

- 23% in mining and quarrying;
- 13.2% in community, social and personal services;
- 13.1% in wholesale and retail trade;
- 10% in manufacturing; and
- 3.1% in agriculture, hunting, forestry and fishing combined.

From this breakdown, it is clear that most people in the area are employed in the primary and secondary sectors, with very few people employed in the tertiary sector (only 5.7% as professionals and 4.1% as legislators; senior officials and managers).

The average monthly household income in the area amounted to approximately R3 721 in 2001, which was significantly higher than the averages for the District (R2 531.27) and Mpumalanga Province (R2 286.61)

5.6.10 Rand Carbide's socio-economic contribution

Jobs: Rand Carbide currently employs 292 permanent staff of which 229 is African, 3 is Coloured, 1 is Indian and 59 are White (of which one person is disabled and none are foreign nationals). This translates into 80% of the workforce being people of colour. Only 7% of the workforce is female.

Support industries: Rand Carbide currently utilises more than 400 vendors for projects ranging from air conditioning installations and maintenance to winch repairs.

Further job creation and skills development: Silicon Smelters is the biggest charcoal producer in Southern Africa and due to the nature of the business approximately 6 000 jobs are created for people in the rural areas. Various charcoal plants exist but small producers are assisted by providing them with kilns to char wood for Silicon Smelters. Silicon Smelters further provides the training in the rural areas to teach people how to produce charcoal.

Economic: Rand Carbide's turnover in 2010 was approximately R528 million. This translates into a significant contribution to the Gross Domestic Product (GDP). Furthermore, Rand Carbide's products (predominantly ferrosilicon, silicon metal and electrode paste) are purchased by almost twenty (20) major industries in South Africa (including Columbus Steel and Highveld Steel) which, in turn, generates additional employment opportunities and further growth potential in both local and national GDP. Columbus Steel is considered as one of South Africa's largest stainless steel producers. Rand Carbide also exports to Europe and America.

Environmental management: Rand Carbide spent the following on environmental management in 2011:

- Water monitoring: R 124 612
- Air quality monitoring and reducing impacts: R1 600 000

6 PUBLIC PARTICIPATION

6.1 Introduction

The Public Participation Process (PPP) forms an integral part of the Environmental Impact Assessment (EIA) process for a waste management licence application. It is one of the important aspects of any process to obtain environmental authorisations and waste management licences. Its aim is to provide all interested and affected parties (I&APs) with clear, accurate and comprehensible information about the project/operations, its alternatives, the possible environmental impacts and the management thereof. In addition, the process seeks to provide I&APs with the opportunity to indicate their viewpoints on issues and concerns regarding the project/operations, alternatives and/or decisions.

This process therefore enhances transparency and accountability in decision-making as it allows all I&APs to suggest ways of avoiding, reducing or mitigating potential negative impacts as well as enhance positive impacts of the project. All inputs from I&APs are considered in the planning of the project and consequently clear recording of all issues and concerns raised has been maintained in a comments and response register. This register has been updated when new issues or concerns were raised.

This document and section provides a methodical description of the PPP followed for this project. It also contains a complete record of any public notices, details of all registered I&APs and all communications to and from I&APs pertaining to the application.

6.2 Applicable legislation

The Public Participation Process was conducted in accordance with Sections 54 to 57 of Regulation 543 of the National Environmental Management Act (NEMA), 1998 (Act 107 of 1998), as amended. As such, identified I&APs were notified that Rand Carbide was in the process of applying for a waste management licence in terms of the National Environmental Management Waste Act (NEM:WA), 2008 (Act 59 of 2008), as well as a water use licence in terms of Section 21 of the National Water Act (NWA), 1998 (Act 36 of 1998).

6.3 Approach

The aim of the PPP is not only to adhere to the required legislation, but also to give as many stakeholders and I&APs as possible an opportunity to be actively involved in this process.

The PPP has been carried out in accordance with Chapter 6 of the NEMA, 1998 as amended and in support of the EIA Regulations, 2010 and the NWA, 1998. Based on Sections 54 to 57 of Regulation 543 of NEMA (18 June 2010), the following steps were undertaken:

- Potential I&APs were identified during a site visit (20 July 2011) and via an existing I&AP database provided by Rand Carbide based on previous projects for the site, through notices placed on site (Plate 6-1 and Plate 6-2) and through placing a notice in the local newspaper (Witbank News).
- Further notice of the applications was given to all identified I&APs (Table 6-1) through the distribution of written notices (Appendix E), in the form of Background Information Documents (BIDs), via e-mail and hand delivery.
- A stakeholder register of I&APs was compiled, in terms of Regulation 57 that includes national, provincial and local authorities, government departments, organisations and neighbours that may have an interest in the project. BIDs were distributed to all these stakeholders (Table 6-1).

- I&APs were given at least 40 days to comment on the application (20 July to 3 September 2011). Any concerns that have been raised by I&APs were acknowledged, noted and addressed (Table 6-2) by the Environmental Assessment Practitioner (EAP).
- Furthermore, all registered I&APs had been given an opportunity to comment, in writing, on the Reports and documentation produced as part of this project prior to submission to the competent authorities, the Department of Environmental Affairs (for waste management licence) and Department of Water Affairs (for water use licence) during 2011 (water use licence application) and 2012 (waste licence application).
- A recorded summary of concerns raised by I&APs, as well as the responses from the EAP, have been kept throughout the entire process.
- The Scoping report was made available for public review at the Witbank Public Library (eMalahleni), and I&APs were given at least 40 days to comment on the application (19 January 2012 to 29 February 2012). A copy of the report was also provided to DWA – Bronkhorstspruit regional offices on 19 January 2012 and DWA acknowledged receipt on 30 January 2012.
- The Scoping report and plan of study for EIA was approved by Department of Environmental Affairs on August 2012
- The Environmental Impact Report (EIR) was made available for public review at the Witbank Public Library (eMalahleni), and I&APs were given at least 40 days to comment on the application (24 August 2012 to 19 October 2012). A copy of the report was also provided to DWA – Bronkhorstspruit regional offices in September 2012.

6.4 Public awareness

6.4.1 Site notices

Three (3) notices (measuring 600mm x 500mm) were placed on 20 July 2011 where they would be most visible to the public concerned. These locations included the main entrance to the Rand Carbide premises as well as a service entrance (Voortrekker Road). Each notice contained details regarding the applicant (Rand Carbide), the nature of the activity to take place (application for a waste management licence and water use licence), the locality of the project and the contact details of the EAP (HydroScience), please refer to Plate 6-1. The placement of the site notices were recorded by taking photographs of the placed notices on site as well as by recording the Global Positioning System (GPS) coordinates of these positions. See Plate 6-2 and Plate 6-3. These notices will remain on the site throughout the duration of the process.

6.4.2 Newspaper advertisement

A detailed newspaper advertisement regarding the project was placed in the Witbank News, page 33, published on 21/22July 2011 (see Appendix E). The aim of placing an advertisement in the local newspaper was to create a greater awareness of the project and to invite a broader range of I&APs to register and be part of the process.

6.4.3 Background Information Document

BIDs, containing information regarding the project, were distributed to adjacent land owners as well as all other I&APs (Table 6-1) via e-mail and hand delivery as part of the notification process. Furthermore, BIDs were also distributed to local, provincial as well as national authorities, applicable government departments such as the Department of Water Affairs (DWA), the Department of Agriculture, Forestry and Fisheries (DAFF) and the Department of Environmental Affairs (DEA), and the Ward Councillor for the area. The BIDs were distributed between the 20th and 25th of July 2011. The BID that was distributed to all I&APs, including a locality map, as well as the registration/response form is included in Appendix E.