ENVIRONMENTAL IMPACT ASSESSMENT
WESTERN UTILITIES CORPORATION
MINE WATER RECLAMATION PROJECT

For public comment from Tuesday, 9 June 2009 to Tuesday, 14 July 2009

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1.0 INTRODUCTION

Western Utilities Corporation (Pty) Ltd (WUC) proposes to establish a project to collect mine affected water from existing mines in the Witwatersrand mining area (which are currently pumping mine affected water to surface from underground mine voids), treat the water and distribute the reclaimed water to third parties on commercial terms.

The project team has considered various operational and technical alternatives during the pre-feasibility and feasibility studies for the proposed project. These alternatives have been categorised into water sources, Water Treatment Plant, end users, bulk reclaimed water storage facility, mine water abstraction shafts, mine water discharge shafts, and collection / distribution pipeline corridors. The various alternatives that have been considered are described in Section 2 of this report.

With regards to the site selection for the Water Treatment Plant, a detailed site selection process was undertaken. The site selection process included an independent analysis of identified alternative sites from an environmental/social, technical and financial perspective. The criteria and assessment methodology used during the Water Treatment Plant site selection process are discussed under Section 2.3.2 Pipeline route corridors were initially selected to align with areas where participating mines hold pipeline servitudes. Where no such servitudes exist, consideration was given to routing pipelines within or immediately adjacent to, other linear infrastructure (roads, railway lines, power lines etc). This process is described in Section 5.

2.0 OVERVIEW OF ALTERNATIVES CONSIDERED

This section outlines the alternatives which have been considered and indicates which is the preferred alternative.

2.1 Mine Water Sources

The Witwatersrand mining area comprises four basins, namely the Far Western, Western, Central and Eastern Basins (refer to Error! Reference source not found.). These basins are separated from one another by geological features, such as faults/dykes. In terms of the proposed project, the following alternatives regarding mine water sources have been considered:

- Western Basin only
- Western Basin and Central Basin
- Western, Central and Eastern Basins.

The project initially focused on the Western Basin of the Witwatersrand mining area. The Western Basin produces between 15 and 25 M\text{m}^3/\text{day} of mine affected water per day. In order to provide a self sustaining solution, the project has to be of sufficient volume to ensure that the unit cost per cubic meter of water produced will be low enough to compete with existing water suppliers but, at the same time, able to repay the considerable capital investment required to provide the mine water collection, treatment and distribution infrastructure. Individually, none of the basins will yield adequate water in the short term to provide a sustainable project, but collectively the critical mass will be achieved to satisfy both industrial and potable requirements.

Subsequently, the project was expanded to include the Central Basin, which produces between 45 and 65 M\text{m}^3/\text{day}. Since a large portion of the water is to be provided to mines in the study area, such as ERGO, and the availability of mine water varies according to season (i.e. higher ingress volumes report to the underground voids during the rain season), the project was subsequently expanded to include the Eastern Basin, which produces 75 to 92 M\text{m}^3/\text{day}. The inclusion of the Eastern Basin minimises the risk of not having a sufficient volume reporting to the Water Treatment Plant.
The proposed project was thus scoped and defined to include the Western, Central and Eastern Basins of the Witwatersrand mining area to secure adequate water sources to ensure benefits of scale and a financially viable project.

(It is important to note that the Far Western Basin could possibly form part of Phase 2 of the project)

2.2 Project Scheme

In terms of the greater project scheme, the following scheme configuration alternatives were considered:

- Centralised Water Treatment Plant
- Distributed Water Treatment Plants in the Western, Central and Eastern Basin
- Regional Water Treatment Plants in the Central and Western Basins
- Original Water Treatment Plants in the Central and Eastern Basins.

In order for WUC to select a preferred option, a process of scoring and ranking was implemented through which the various factors associated with each of the scheme alternatives was compared. Scoring included the following separate processes:

- A “Gravity of Issues” score was assigned to each alternative. The Gravity of Issues score relates to the risk associated with each alternative as the issues represent areas of uncertainty. Ranking criteria were developed by assigning weights to both scheme components and project aspects. Scheme components refer to physical components of the scheme infrastructure and included environmental infrastructure (e.g. pollution control dam), waste disposal facility, water source, project infrastructure, treatment technology, treatment plant, collection pipelines and water distribution infrastructure. Project aspects can be defined as those areas of specialisation or planning which may influence the overall success of the project, and included environmental, technology, legal, engineering and finance and insurance aspects.

  Each of the issues raised for the project, independent of scheme alternative, was associated with a project aspect and a scheme component. The issue was then also associated with a scheme alternative or alternatives. This allowed the accumulation of scores per scheme component, project aspect and scheme alternative. The component, aspect or configuration accumulating the least weight was then assigned the number one rank in terms of “Gravity of Issues”.

- A quantitative financial comparison.

- A qualitative assessment of scheme components.

On evaluating technical and environmental variables associated with centralised versus regional treatment plants, the alternative to have a centralised Water Treatment Plant ranked best. The financial comparison indicated that, on a capital expenditure basis, the option of having a centralised Plant ranks above the rest.

Thus, the preferred alternative in terms of the configuration of the project is to have a centralised Water Treatment Plant.
Figure 2-1: Basins of the Witwatersrand mining area
2.3 Water Treatment Plant

2.3.1 Location of By-products Recovery Plant

In terms of the location of the By-products Recovery Plant, the following alternatives are being considered:

- Regional (distributed) By-products Recovery Plant
- Centralised By-products Recovery Plant.

The assessment of a distributed sulphur recovery versus a centralised recovery option indicated that locating the sulphur recovery process at the centralised Water Treatment Plant would be more economically viable.

2.3.2 Location of Water Treatment Plant Site

As part of the pre-feasibility study, a selection process was followed for the location of the Water Treatment Plant. The infrastructure layout related to the entire mine water scheme is very sensitive to the final site selection for the centralised Water Treatment Plant and associated infrastructure. The site selection for the water treatment facility will dictate the configuration and layout of the mine water collection system as well as the reclaimed water distribution system. The Water Treatment Plant site selection was driven by a wide spectrum of engineering, environmental, land ownership, and financial aspects.

Four potential sites were identified by the project team, namely:

**Site 1:** This site is located in the Ekurhuleni Metropolitan Municipality, 2.5 km east of the Germiston CBD. The site is bordered to the north and east by Tide Street and Simon Bekker Road respectively. Access to the site is through a small township settlement. Existing infrastructure also includes a railway station and two existing clarifiers/settlers to the north. The topography is generally flat. The area is mainly surrounded by industrial activities.

**Site 2:** This site is located in the Ekurhuleni Metropolitan Municipality, 3.9 km east of the Germiston CBD. The site is bordered to the north and east by Commissioner Street, and to the west by Simon Bekker Street. Access to the site is from Commissioner Street. The topography is flat while gently sloping to the south towards a vlei and Elsburgspruit.

**Site 3:** This site is located in the Ekurhuleni Metropolitan Municipality, 3.9 km east of the Germiston CBD. The site is bordered to the north by Commissioner Street and to the west by Elsburg Road. Access to the site is either through Commissioner Street or Elsburg Road. South Western part of the site forms a dumping ground. There are few homes to the east. There is a factory to the south.

**Site 4:** This site is located in the Ekurhuleni Metropolitan Municipality, 2.5 km east of the Germiston CBD. The site is comprised of two areas, namely East Rand Proprietary Mines (ERPM) South West Vertical Shaft area and the South West Vertical High Density Sludge (HDS) Plant area. The South West Vertical HDS Plant area is bordered to the north and east by Tide Street and Simon Bekker Road respectively. Access to the site is through a small township settlement. Existing infrastructure includes two clarifiers/settlers and an old vent shaft. The topography is generally flat. The area is mainly surrounded by industrial activities.

The ERPM South West Vertical Shaft area is bordered to the north and west by Tide Street and Brammer Street respectively. Access to the site is from an unnamed street off Tide Street. Existing infrastructure includes the South West Vertical Shaft, water pipeline system, decommissioned internal railway lines, old workshop, change houses and administration buildings. The South West Vertical hostel (which is currently vacant) is located adjacent to the site.
Figure 2-2: Location of the candidate Water Treatment Plant sites
These alternative Water Treatment Plant sites were then analysed against a range of criteria in order to identify potential issues relating to each site and also to identify a preferred site. These criteria included:

- Technical,
- Engineering,
- Environmental (all relevant criteria),
- Social / socio-economic,
- Land use / end use / town and regional planning, and
- Economic (Capital investment and Operational costs).

The capital and operational costs for each candidate site had not yet been estimated at the time of the site selection. High level professional judgement, based on semi-quantitative attributes, was applied to this aspect.

The following weightings were given to the main categories of criteria:

- Technical/engineering 40
- Environmental: 20
- Public acceptance: 10
- Social: 10
- CAPEX: 10
- OPEX: 10.

The total assigned weightings accumulate to 100 when summed.

The various selection sub criteria (technical/engineering, environmental, etc.) were then developed per category as follows:

- The following technical/engineering sub-criteria were identified and used in the rating and ranking assessment:
  - Site setting
  - Accessibility to site
  - Availability of air space
  - The need of relocating services
  - Suitability of topography
  - Flexibility to accommodate Future expansion
  - Geotechnical suitability
  - Adequate geotechnical factor of safety
  - Suitability of geotechnical conditions for cut and fill
  - Excavation difficulty
  - Suitability of founding conditions
- Geohydrological and hydrological suitability
- Presence of shallow groundwater aquifer
- The need for subsurface drainage system
- Ease of stormwater runoff management from site
- Proximity to mine water decant point
- Proximity to mine water collection system
- Site constructability
- Suitability of site soils for construction purposes
- Suitability of access roads for construction purpose.

The **environmental sub-criteria** which were identified and used in the rating and ranking assessment include the following:

- Current condition of land
- Agricultural potential
- Gauteng Conservation Plan (C-Plan) area index
- Wetlands
- Rivers and riparian areas
- Protected areas
- Protected ridges
- Urban edge
- Proximity to residential areas
- Proximity to similar infrastructure
- Size/availability of air space
- Wildlife
- Vegetation.

The following **public acceptance sub-criteria** were identified and utilised in the rating and ranking assessment:

- Proximity to residential areas
- Property ownership

The following **social sub-criteria** were identified and used in the rating and ranking assessment:

- Potential future residential areas / densification
- Development corridors
- Corridors earmarked for bulk services / roads etc
- Areas within industrial development, current and future
- Open areas within industrial activity.

Economic sub-criteria relate to the cost of purchasing, developing and operating the site. They include the following considerations, among others:
- Capital investment
- Earthworks required to develop the site
- The availability of on-site soil to provide construction material
- The distance of the Water Treatment Plant site to the mine water collection system/decant point
- Cost of relocating and compensation of communities
- Relocation of services (e.g. electrical powerlines)
- Availability of services
- Purchase of private property
- Cost of developing the Water Treatment Plant
- Operational cost
- Cost of operating and maintaining the Water Treatment Plant.

The capital and operational costs for each candidate site had not yet been estimated at the time of the assessment. High level professional judgement, based on semi-quantitative attributes, was applied.

Each of the defined sub-criteria was collectively ranked by the project team. The ranking was based on the scoring system indicated in Table 2-1 below:

**Table 2-1: Rating used to rate the alternative Water Treatment Plant sites**

<table>
<thead>
<tr>
<th></th>
<th>Unacceptable</th>
<th>Poor</th>
<th>Average</th>
<th>Good</th>
<th>Very Good</th>
<th>Fatal Flaw</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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<td>3</td>
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<td>4</td>
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</tr>
</tbody>
</table>

The relative acceptability of the candidate sites was obtained by adopting the following procedures:
- An average ranking was obtained for each category of selection criteria.
- The average score of category was multiplied by the weighting assumed for the category (see above).
- To obtain a numerical indication of the preference for a candidate site, the factored average scores of the various categories where summed up.
The suitability of each candidate site was assessed by comparing the overall score. The highest score representing the most acceptable site and the lower score the least acceptable site.

The outcome of the ranking and rating procedure is summarised in Table 2-2 below. The assessment shows that Sites 1 and 4 are the most acceptable sites. Alternatively, both sites could be taken as preferred sites. This approach gives a larger footprint size to accommodate possible expansion of the project beyond a 75 Ml/day Plant.

Table 2-2: Summary of the rating and ranking of the potential Water Treatment Plant sites

<table>
<thead>
<tr>
<th>Selection Criteria</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical/engineering</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site Setting</td>
<td>2.4</td>
<td>4.2</td>
<td>3.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Geotechnical Suitability</td>
<td>3</td>
<td>3.75</td>
<td>2.75</td>
<td>3.25</td>
</tr>
<tr>
<td>Geohydrological and Hydrological Suitability</td>
<td>2.4</td>
<td>3.6</td>
<td>3</td>
<td>2.6</td>
</tr>
<tr>
<td>Suitability for construction</td>
<td>2.5</td>
<td>3.5</td>
<td>3</td>
<td>3.5</td>
</tr>
<tr>
<td>Average</td>
<td>2.58</td>
<td>3.76</td>
<td>3.04</td>
<td>3.24</td>
</tr>
<tr>
<td>Weighted</td>
<td>1.03</td>
<td>1.5</td>
<td>1.22</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current condition of land</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Agricultural potential</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Gauteng Conservation Plan (C-Plan) area index</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
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<tr>
<td>Wetlands</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Rivers and riparian areas</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>5</td>
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<tr>
<td>Protected areas</td>
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<td>Protected ridges</td>
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<td>5</td>
</tr>
<tr>
<td>Urban edge</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Proximity to residential areas</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Proximity to similar infrastructure</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Size/availability of air space</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Wildlife</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Vegetation</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Average</td>
<td>3.85</td>
<td>3.54</td>
<td>4.31</td>
<td>4.62</td>
</tr>
<tr>
<td>Weighted</td>
<td>0.77</td>
<td>0.71</td>
<td>0.87</td>
<td>0.92</td>
</tr>
</tbody>
</table>
Based on the results of the analysis, the project team recommended Site 4 to be the preferred site, followed by Site 1. Alternatively, both sites could be taken as preferred sites. This approach gives a larger footprint size to accommodate possible future expansion of the project.

### 2.3.3 Treatment Technology

Various technologies, including Reverse Osmosis, Nano Filtration, Ion Exchange, Molecular Recognition Technology, Biological Treatment, chemical precipitation and Ettringite precipitation were all evaluated as part of a desk top study during the Pre-feasibility Study. It was eventually decided to construct two pilot plants based on the SAVMIN process (utilising aluminium hydroxide) which is a patented process from Mintek (South Africa’s national mineral research organisation) and the Gypslim process, utilising Barium Sulphate, which is a patented process from the Council for Scientific and Industrial Research (“CSIR”). These technologies were selected for their ability to produce acceptable quality water at the lowest capital and operating costs, as well as their ability to produce consistent results with fluctuating feed water quality.
The technologies were assessed on weighted, selection criteria which included:

- Product quality
- By-product generation
- Waste generated
- Water recovery
- Scale-ability, operability, flexibility and availability
- Capital investment, footprint and first fill requirements
- Operating cost
- Technology rights and Licence fees

The cost of the SAVMIN reclaimed water is high in relation to the other technologies under comparison. The CSIR Barium precipitation process was selected as the most appropriate technology.

2.3.4 Waste Disposal Facilities

Metal hydroxide sludge and coal ash from the thermal recovery process will be generated during the selected water treatment process and will need to be disposed of. A cost optimisation calculation was performed around the treatment and management of the waste. The alternatives considered included the trucking and transport of the waste to a central location for disposal, and the disposal of waste at the point of generation. The costs and logistics issues involved in waste transport resulted in prohibitively high operating costs for a central waste disposal facility. It was determined that waste disposal at the nearest convenient point from the generation site would provide the minimum cost solution. Consequently, the disposal of the waste will take place at a location close to the Water Treatment Plant where the waste is generated.

With regard to the disposal of the waste, three options were considered (refer to Figure 2-3). These options included:

- The transportation of the waste stream via pipeline to the Knights Process Plant and from there conveyed to DRD Gold’s Rooikraal Tailings Storage Facility (located adjacent to the Witok/Brakpan Tailings Storage Facility).
- The transportation of waste via pipeline directly to DRD Gold’s Elsburg slimes dam complex (located at ERPM and comprised of 5 slimes dams).
- The transportation of waste to DRD Gold’s Brakpan Dam (also referred to as the Witok Tailings Storage Facility) via pipeline (either using the existing return water pipeline from Knights Process Plant to Rooikraal Tailings Dam, or placing an additional pipeline along this route).

The disposal of waste at the Rooikraal Tailings Storage Facility and Elsburg slimes dam complex was assessed to be flawed as DRD Gold intends on re-mining these mine residue storage facilities in future. The preferred alternative is thus to dispose of the waste at Brakpan dam, possibly using existing return water pipelines from Brakpan Dam to the Knights Plant for the transportation of the waste.
Figure 2-3: Location of alternative waste disposal facilities and bulk treated water storage reservoirs
2.4  End Users of Treated Water
With regards to the end user, the following alternatives were considered:

- Rand Water (which is the single biggest supplier of potable water in the Gauteng Province)
- Ekurhuleni Metropolitan Municipality
- Johannesburg Water.

Subsequently, Rand Water has been selected as the preferred option, based on the outcome of various negotiations with the institutions, in terms of the scale of the project, practical feasibility, institutional capacity and the role as a bulk water services providers.

2.5  Bulk Treated Water Storage Facility
Alternatives were assessed for constructing a distribution network designed to distribute the treated water within the various basins, as opposed to distributing treated water within the basin in which the treatment occurs. Cost minimisation calculations indicated that distributing reclaimed water within the basin in which the treatment occurs was less costly than providing a distribution network from the centralised Water Treatment Plant to the various basins. It was therefore decided that the distribution of the reclaimed water will be within the basin in which the water is treated, i.e. the Central Basin.

Since the preferred end user is Rand Water, the use of existing Rand Water bulk water storage facilities is the preferred option, as opposed to constructing new facilities, particularly in terms of cost. Alternative Rand Water bulk water storage facilities that were investigated include:

- Klipriviersberg Reservoir (approximately 13 km south west of the proposed Water Treatment Plant site)
- Germiston Reservoir (approximately 5 km north of the proposed Water Treatment Plant site).

The location of these reservoirs is indicated on Figure 2-3.

The Germiston Reservoir as a receptor of treated water was assessed as flawed, since it only has a storage capacity of 100 M\(\text{m}^3\). As mentioned previously, the proposed Water Treatment Plant will produce 75 M\(\text{m}^3\) of treated per day. Should, for some reason, no off-take from the Germiston Reservoir take place over a period of 24 hours, the reservoir will not have the capacity to store any additional water, resulting in the water treatment operation to shut down. The preferred alternative is thus the Klipriviersberg Reservoir, which has more than sufficient storage capacity, i.e. in excess of 650 M\(\text{m}^3\). The Klipriviersberg Reservoir option will also allow for blending of the reclaimed water with the bulk Rand water and distribution across a large part of the Gauteng Province.

2.6  Mine Water Abstraction Shafts
Mine affected water from the Western, Central and Eastern Basins will be collected to the centralised Water Treatment Plant via abstraction shafts and collection pipelines. Alternative abstraction shafts have been considered, and are described below.

2.6.1  Western Basin
In the Western Basin, two alternative mine water abstraction shafts are currently being investigated (see Figure 2-4):

- East Chamdor Shaft.
- The existing East Chamdor Shaft (West Wits Mining SA) is located in the Mogale City Local Municipality roughly 6 to 7 km south east of Krugersdorp and 5 km north west of Roodepoort. This shaft has been mothballed and is not equipped.
- Rand Uranium (Harmony) Shaft No.8.
Rand Uranium (Harmony) Shaft No. 8 is a vertical and equipped shaft located at Randfontein Estates in the Mogale City Metropolitan Municipality area, 6.9 km south east of the Krugersdorp CBD.

Currently, investigations in terms of the preferred abstraction shaft in the Western Basin are still underway as part of the Feasibility Study. Both alternatives will therefore be carried forward into the EIA.

### 2.6.2 Central Basin

In the Central Basin, three alternative mine water abstraction shafts were considered. All three shafts are located at East Rand Proprietary Mine (ERPM) (of DRD Gold) which is situated in the Ekurhuleni Metropolitan Municipality area, 2.5 km east of the Germiston Central Business District (CBD). Refer to Figure 2-5.

- **ERPM South West Vertical Shaft**
  
  South West Vertical (SWV) Shaft is a seven (7) compartment rectangular shaft of 13 x 3 m plan dimensions and is fully equipped with 3 winders, two of which are double drum winders. It is the intention to use the single drum service winder as the man access winder and one double drum winder for pump and equipment lowering and as an emergency winder for man access. Pumping was originally from the pump chamber located at approximately 1 700 m below the surface, and latterly from 24 level pump chamber at 1080 m below surface; these pump chambers are currently flooded.

- **ERPM Central Shaft**
  
  Central Shaft has been mothballed. The Central Shaft infrastructure is very similar to the SWV Shaft.

- **ERPM Cason Incline Shaft**
  
  The Cason Shaft is a compound shaft that declines firstly at an angle of 35 deg for the distance of 763 m and then subsequently alters to the steeper declination angle of 45 deg. The shaft cross section is 10.28 m x 2.28 m with the compartment height of 1.4 m. This shaft is equipped with a single double drum winder.

  From a technical and financial perspective, the SWV Shaft is the preferred option, mainly due to:
  - Minimal blasting of the excavation is required
  - It is scheduled to have the earliest re-equipment completion date
  - The shaft is closest to the preferred Water Treatment Plant site
  - The proposed pump system is familiar to mine maintenance and operating personnel.

### 2.6.3 Eastern Basin

In the Eastern Basin, one abstraction shaft has been considered, namely Shaft No.3 at Grootvlei Mine (Pamodzi Gold). This shaft is located in the Ekurhuleni Metropolitan Municipality area, 5.1 km east of the Springs CBD (see Figure 2-6). It is the preferred option as it is an existing shaft, with a fully equipped pump station with an existing pre-treatment facility.

### 2.7 Mine Water Discharge Shafts

Alternative discharge shafts for the transfer of mine affected water from the Western Basin to the Central Basin include the following (see Figure 2-7):

- **West Wits Shaft No.6**

- **DRD Shaft No.4.**

The preferred discharge shaft in the Central Basin is DRD Shaft No.4. This option will result in a shorter pipeline length (connecting the preferred abstraction shaft to the DRD Shaft No.4) and thus minimising costs and reducing the footprint in terms of environmental/social impact.
Figure 2-4: Location of alternative mine water abstraction shafts within the Western Basin
Figure 2-5: Location of alternative mine water abstraction shafts within the Central Basin
Figure 2-6: Location of mine water abstraction shaft within the Eastern Basin
Figure 2-7: Location of the alternative discharge shaft
2.8 Collection and Distribution Pipeline Corridors

The consideration of alternatives with regard to the collection pipeline corridor alignments involved the assessment of both collection and distribution pipeline corridor alternatives. The alternatives considered relate to:

- Pipeline alignments connecting the abstraction points located in the Western, Eastern and Central Basins to the centralised Water Treatment Plant (i.e. collection pipelines).
- Pipeline alignments connecting the centralised Water Treatment Plant to the Klipriviersberg Reservoir (i.e. distribution pipeline).

These pipeline alternative alignments are discussed in detail in Section 5. It is important to note that the proposed pipeline route for the transportation of sludge and ash from the proposed Water Treatment Plant to DRD Gold’s Brakpan dam (also referred to as the Withok Tailings Storage Facility) will fall within the existing return water pipeline corridor which extends from Knights Process Plant to Rooikraal Tailings Dam. No pipeline corridor selection is therefore necessary.

2.8.1 Collection Pipeline Corridors

2.8.1.1 Western Basin to Central Basin

- Rand Uranium Shaft No.8 / East Chamdor Shaft to DRD Shaft No.4 (see Figure 2-8)
  - Northern Route
  - Southern Route
  - Central Route.

2.8.1.2 Eastern Basin to Central Basin

- Grootvlei No.3 Shaft to ERGO Brakpan Plant (refer to Figure 2-9)
  - Southern Route
  - Northern Route
  - Northern Crossing Route.

- ERGO Brakpan Plant (Eastern Basin) to the preferred Water Treatment Plant site (refer to Figure 2-9)
  - Van Dyk Route
  - Windmill Park Route
  - Dalpark Route.

2.8.1.3 Central Basin

Since the SWV Shaft at ERPM is considered the preferred abstraction shaft, the existing pipeline corridor from the SWV Shaft to the old ERPM High Density Sludge Plant (which is located at the preferred Water Treatment Plant site) is the preferred pipeline corridor in the Central Basin. No corridor selection is therefore necessary.

2.8.2 Distribution Pipeline Corridor

Four alternative pipeline corridors were considered (refer to figure 2.10): a
Figure 2-8: Western Basin to Central Basin collection pipeline corridor alternatives
Figure 2-9: Eastern Basin to Central Basin collection pipeline corridor alternatives
Figure 2-10: Distribution pipeline corridor alternatives
3.0 DESCRIPTION OF THE STUDY AREA
This section briefly describes the surrounding environment as largely relevant to the alternatives considered.

3.1 Terrain
The Western Basin study area is characterised by undulating topography in the south, but more hilly terrain along the northern boundary of the mining areas (in the vicinity of Krugersdorp). The most prominent topographical feature in the Central Basin is a ridge known as the Witwatersrand, which also forms the main water divide between drainage to the north, towards the Indian Ocean and drainage to the south, to the Atlantic Ocean. The Eastern Basin study area is characterised by undulating topography and two main drainage systems, namely the Blesbokspruit, which drains the northern and eastern parts of the area, and the Riespruit, which drains the central and western portions.

3.2 Climate
The study area experiences a typical Southern African Highveld climate with warm to hot summers (October to March) and cool days with cold nights during winter. Rainfall is mainly in the form of showers and thunderstorms, which occur mainly during the summer, with maximum falls usually occurring during December to January. The mean annual precipitation ranges between 700 mm to 800 mm per annum, depending on the location of the relevant weather station. Winter months are usually dry and periodic droughts common in the study area.

3.2.1 Rainfall and Temperature
Table 3-1 below provides an indication of rainfall and temperature for the study area.

Table 3-1: Climate of the study area (Source from South African Weather Service)

<table>
<thead>
<tr>
<th>Weather Station</th>
<th>Elevation</th>
<th>Temperature (°C)</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Highest Ave daily max Ave daily min Lowest Ave annual Ave no. of rain days/year Max in 24 hours</td>
<td></td>
</tr>
<tr>
<td>Johannesburg</td>
<td>1694</td>
<td>35 22 10 -8</td>
<td>713 99 188</td>
</tr>
</tbody>
</table>

3.2.2 Evaporation
The average evaporation rate for the region ranges between 109 to 246 mm/month and this exceeds the annual average rainfall.

3.2.3 Wind
Wind speed is generally light in the study area (average 4 m/s). Winds mainly blow in a north westerly direction. Exceptions occur sometimes with turbulent high velocity winds especially during thunderstorms.

3.3 Soils
According to the Soil Classification Working Group (SCWG) (1991), the project components (collection and distribution pipelines in particular) associated with the Western and Central Basins fall into soil zone #11, while the Eastern Basin collection pipeline falls into two soil zones, namely #9 and #11. A description of these soil zones is provided in Table 3-2 below.
<table>
<thead>
<tr>
<th>Soil zones</th>
<th>Soil form</th>
<th>Form names</th>
<th>Soil families</th>
<th>Soil descriptions</th>
<th>General description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Hu26</td>
<td>Hutton</td>
<td>Lillieburn, Kelvin, Hayfield, Suurbekom, Stella, Venterdorp</td>
<td>Deep; red pedal sandy loam/ sandy clay loam mesotrophic</td>
<td>Rock with limited soils; Red, yellow and grayish soils with low to medium base status</td>
</tr>
<tr>
<td>Av16, Av26</td>
<td>Avalon</td>
<td>Blackmoor, Woodburn, Avondale, Vryheid, Kameelbos, Mafikeng</td>
<td>Moderately deep; yellowbrown apedal sandy loam/sandy clay loam, mesotrophic on soft plinthite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cv16, Cv26</td>
<td>Clovelly</td>
<td>Twyfelaar, Brereton, Buckland, Leiden, Setlagole, Mooilaagte</td>
<td>Shallow; Yellow brown uniform clay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ms11</td>
<td>Mispah</td>
<td>Myhill, Carnavon, Gulu, Steinkopf</td>
<td>Shallow; brown/grayish structurless loamy sand/sandy loam/sandy clay loam on flagy shale; in association with sandstone/quartzite with rock outcrops</td>
<td>Rock with limited soils; Red, yellow and grayish soils with low to medium base status</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Ms10</td>
<td>Mispah</td>
<td>Myhill, Carnavon, Gulu, Steinkopf</td>
<td>Shallow; brown/grayish structurless loamy sand/sandy loam/sandy clay loam on flagy shale; in association with sandstone/quartzite with rock outcrops</td>
<td></td>
</tr>
<tr>
<td>Gs18</td>
<td>Glenrosa</td>
<td>Dumisa, Keurkloof, Kilspinde, Kammievlei, Tsende, Bergsig, Maringo, Wheatland, Overberg, Inverdoorn, Botrivier, Teviot, Bisho, Kakamas, Solitude, Merwesont</td>
<td>Shallow; brown/grayish brown coarse sand/loamy sand with weak blocky structure, non-calcareous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hu24, Hu26</td>
<td>Hutton</td>
<td>Lillieburn, Kelvin, Hayfield, Suurbekom, Stella, Venterdorp</td>
<td>Deep; red pedal sandy loam/ sandy clay loam mesotrophic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4 Fauna and Flora

The proposed Western Basin collection pipeline corridor falls into the Bankenveld area of the Grassland Biome. The site is located in the Highveld Ecoregion and is comprised of Soweto Highveld Grassland.

The proposed Central Basin distribution pipeline corridor also falls into the Bankenveld area of the Grassland Biome. Although located in the Highveld Ecoregion, the pipeline traverses through five vegetation units. From the origin of the distribution pipeline at the centralised Water Treatment Plant, the proposed route crosses through Soweto Highveld Grassland, Tsakane Clay Grassland and Carletonville Dolomite Grassland before moving into Andesite Mountain Bushveld at the reservoir. In the area of the Natalspruit Vlei, the pipeline also crosses Eastern Temperate Freshwater Wetlands.

The proposed Eastern Basin collection pipeline corridor falls into both the Bankenveld and Cymbopogon-Themeda veld of the Highveld Ecoregion. The eastern collection pipelines traverses from the Eastern Temperate Freshwater Wetlands through Soweto Highveld Grassland to Tsakane Clay Grassland where it enters the centralised Water Treatment Plant. The start of the eastern to central basin pipeline is located in close proximity to the Blesbokspruit, and through its proposed route crosses the Withokspruit and Natalspruit.

A search of the IUCN (2009) database showed that two red listed animalia may occur within the study area (Western, Central and Eastern Basins), namely the White-tailed Mouse (Mystromys albicaudatus), which is listed as endangered, and the Roodepoort Copper (Aloeides dentatis), which is listed as vulnerable. For the remainder of this section, the occurrence of fish and bird species in each of the basins will be discussed.

3.5 Sensitive Habitats / Conservation Areas

Based on the 1:50 000 map, the Western Basin collection pipeline corridor appears to pass through a non-perennial pan; on inspection it was found that an off-road track now encroaches into this area.

The Central Basin distribution pipeline corridor which originates at the centralised Water Treatment Plant traverses through the Natalspruit Vlei and moves up through the Klipriviersberg. The Klipriviersberg is an important conservation area and one of Gauteng’s ridges which is likely to contain Red Data species (GDACE, 2001).

Sensitive habitats along the Eastern Basin collection pipeline corridor include the Blesbokspruit where the Marievale bird sanctuary (Ramsar site) is located, the Withokspruit and the Natalspruit Vlei.
4.0 ASSESSMENT CRITERIA AND METHODOLOGY FOR PIPELINE CORRIDOR SELECTION

A comparative assessment of the various collection and distribution pipeline corridor alternatives was conducted. The approach to the assessment can be summarised as follows:

- Rating criteria were developed in order to compare and contrast possible route corridors for the collection and distribution pipelines. The criteria used (described below) were grouped into two broad categories – environmental / social and technical / financial.
- Various sub-criteria were identified and defined under the main categories of criteria and defined. See Section 4.1 for a description of the various environmental / social sub-criteria and Section 4.2 for the technical / financial sub-criteria.
- Each of the alternative pipeline corridor routes were rated and ranked based on the environmental / social sub-criteria and technical / financial (see Section 5).

4.1 Environmental and Social Sub-criteria

In order to facilitate comparison between the alternatives and to assess the most suitable alternatives from an environmental / social perspective, categories of potentially sensitive features were identified (see Section 4.1.1 to 4.1.14 below) and ranked in terms of significance if a ‘worst-case’ impact were to be experienced.

The selection matrix key in Table 4-1 was used to rank the various aspects relating to environmental / social sub-criteria:

Table 4-1: Values used for the ranking of environmental / social sub-criteria

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No constraint</td>
</tr>
<tr>
<td>2</td>
<td>Moderate constraint</td>
</tr>
<tr>
<td>3</td>
<td>Severe constraint</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A or cannot be determined</td>
</tr>
</tbody>
</table>

To measure what constituted an alternative with high, medium or low sensitivity, the aggregate score of each of the considered alternatives was assessed.

4.1.1 Gradient

Strong relief, and in particular long steep slopes, are a severe constraint to pipeline routing because of the risk of post-construction instability and soil erosion. Increasing slope greatly increases the risk that topsoil, fertilizer and grass seed will be lost prior to the establishment of a sustainable grass cover. Experience of rehabilitation in a variety of landscapes in South Africa has shown that slopes steeper than 1 in 5 (1 vertical : 5 horizontal) become very problematic and should be avoided where possible.

A further important issue is that a pipeline traversing long steep slopes is liable to have a high visual impact. These slopes imply prominence or visibility in the landscape. They are also generally under natural vegetation or afforestation. In the former case recovery to the undisturbed state and appearance will not happen in many decades. Rating was as follows.
1 = level ground or slope up to 1 in 20 (approximately 3 degrees or 5% slope)
2 = moderate slope from 1 in 20 to 1 in 5
3 = steeper slope than 1 in 5 (approximately 11 degrees or 20% slope).

4.1.2 Cross fall

Cross fall refers to the steepness of slope across the longitudinal axis of the pipeline (Error! Reference source not found.). The steeper the cross fall the more excavation and the more the disturbance required to build the access along which the construction train will move. While slight cross fall may be an advantage since it sheds runoff from the construction right of way, steep cross falls represent a very severe problem from both an engineering and an environmental perspective. Figure 4-2 illustrates the effect of crossfall on a construction terrain. The environmental consequences of such construction excavation are self evident. The area of disturbance increases significantly. Deep subsoil, saprolite and rock are often lost downslope. Retrieving spoil and debris from the foot slope extends the disturbance footprint. Rehabilitation is rendered more difficult through soil loss and the loss of seed and fertilizer during reestablishment.

Figure 4-1: An example of steep cross-fall. Photo shows the Mozambique-Secunda gas pipeline on Nelshoogte Pass in Mpumalanga

The same rating that was used for longitudinal gradient applies to cross gradient, as follows.
1 = no or little cross fall up to 1 in 20 (approximately 3 degrees or 5% slope)
2 = moderate cross fall from 1 in 20 to 1 in 5
3 = cross fall of 1 in 5 (approximately 11 degrees or 20% slope) or steeper.
4.1.3 Drainage
Drainage refers to surface and ground water flow. Of particular concern are routes where runoff cannot be led/trained away from the corridor, typically long steep slopes or where the downslope side of the route is bounded by a barrier such as a road, or where the corridor is aligned down a dished landscape. Water may also travel downslope subsurface in the back-filled trench although this can be mitigated by placement of trench breakers (impermeable walls in the trench). The rating applied was as follows.

1 = on flat terrain where runoff does not scour, or on cross fall or topland where runoff naturally drains away from the corridor
2 = long slopes
3 = long steep slopes or where runoff is liable to concentrate along the corridor because of a downslope barrier or dished landscape.

4.1.4 Slip zones
Ground may be unstable, such as on retreating scarps where landslides may occur especially after heavy or prolonged rain. For the purposes of the corridor screening, this analysis was done on the basis of available mapping and photography and limited field verification. The rating was as follows.

1 = no risk
2 = low risk
3 = moderate to high risk.
4.1.5 Wetlands

The recognised definition of wetlands includes all soils that were formed under permanent or seasonally wet conditions. Wetlands therefore include not only perennial marshlands, but rivers, streams, seasonally wet sedge meadows and so on. Perennial rivers and streams are significant mostly because they involve complex construction methods and care needs to be taken during construction to prevent oil contamination from equipment, undue turbidity and downstream sedimentation. After construction, well-rehabilitated river and stream crossings generally present a low risk of on-going environmental degradation or pollution.

Wetlands that are more at risk as a result of pipeline construction include seasonal hillside seeps, pans and marshes. Hillside seeps may be destroyed by a pipeline route as a result of the barrier or conduit effects that are caused. Restoration of such wetlands may be very difficult. Rating wetlands was as follows.

1 = dryland
2 = river, stream, drainage line or low sensitivity pan or vlei
3 = high sensitivity pan, vlei or hillside seep.

4.1.6 Land Condition

Land condition refers to the degree of transformation of habitat from the natural or pristine state. Pristine habitats are altered by pipeline construction activities and restoration to pristine conditions is a lengthy process which may take many decades or longer. For impact assessment purposes, the construction of a pipeline through pristine habitat must be regarded as an irreversible process - while stabilization may be possible through rehabilitation of the construction right of way, the transformed habitat is unlikely to recover to its climax state within the foreseeable future, even under conditions where the vegetation in the pipeline servitude is regularly maintained.

This applies to virtually all natural vegetation types. In the context of the present project, very little natural vegetation remains, with grassland patches along the length of the pipeline route. The International Union for the Conservation of Nature use a simple yardstick of ‘10% in formal conservation’ to indicate an acceptable conservation status for different habitats. This status can be a useful determinant for pipeline corridor selection. The status of most grasslands is critical, with only a very small proportion of the total in formal conservation.

It warrants emphasizing that the grassland transformation is not about aesthetics, but is primarily about biodiversity that supports environmental function and grazing value. Constructing a pipeline through pristine vegetation constitutes a long term impairment of biodiversity. More specifically, rangeland degradation (i.e. transforming habitat) reduces grazing value and the abundance of wild populations (plants and vertebrates) by 40-50%, whereas moderate extractive use results in only ~7% loss (Biggs, Reyers & Scholes 2006). Biggs et al (2006) estimated that, averaged over all biomes, plants and terrestrial vertebrates have undergone a 19 ± 7% decline over the past 3 centuries, and the policy with the greatest potential to limit further loss of biodiversity is to prevent degradation of grazing land (i.e. untransformed grassland habitat).

Avoidance of pristine grasslands, as far as reasonably possible, is therefore seen as an important routing criterion for a pipeline, which will cause habitat transformation of approximately 3ha per linear kilometre.

The rating used for the corridor screening was as follows:

1 = transformed land (annually cropped land, plantations, orchards, townships, alien infested, etc)
2 = semi-transformed land (some native vegetation remains and natural function largely retained)
3 = pristine land with essentially native vegetation and natural environmental function.

4.1.7 Red Data Species and Protected Area Status

Developments of most types can be a risk to plants and animals threatened with extinction. In assessing risks, it is necessary to consider the extent to which the specific project will have demographic impact on the red data species. For example, a pipeline project is likely to pose little threat to a colony of Cape Vulture whose home range is transected by the pipeline. Conversely, pipeline construction might easily damage or destroy a
specific wetland type that is habitat to the critically endangered Whitewinged Flufftail or may destroy the burrows and result in direct mortality of Sungazer lizards.

The extent of vulnerability of threatened species to pipeline construction is therefore specific to the species concerned. Nevertheless, as a general rule, the greater the degree of habitat transformation that has taken place, the less likely it is that threatened species will be encountered and this is a useful measure for initial corridor screening level studies where the details of the precise occurrence of threatened organisms may not be known. The consequences of traversing semi-transformed and transformed vegetation are less severe, partly because they are habitat for limited numbers of endangered species, and partly because they can be re-established to the per-construction vegetation (or better) by rehabilitation.

The primary approach adopted during the corridor screening has therefore been to minimize impact on endangered species by penalizing corridors traversing untransformed (pristine) habitat and to select for corridors traversing mostly transformed and semi-transformed vegetation. The following system of assessment was used.

1 = low risk of impacting on Red Data species
2 = moderate risk of impacting Red Data species because of likelihood of species occurrence and possibility of habitat loss, disturbance or hunting
3 = high risk of impacting Red Data species because of specific habitat loss or critical disturbance.

Proclaimed national parks, nature reserves and conservation areas are usually unacceptable locations for a pipeline route. Depending on their use and the location of the pipeline, local municipal parks and private nature reserves may be acceptable routes but may, alternatively, be as sensitive as proclaimed reserves. Protected areas should be avoided, and the higher the protection status the more important it would be to avoid transecting the area with a pipeline servitude. The rating system was as follows:

1 = no special protection status
2 = moderate status (game ranches, unproclaimed nature reserves)
3 = proclaimed areas (parks, other proclaimed reserves, sensitive heritage sites, national monuments).

4.1.8 Accessibility

Good access along a pipeline corridor is an advantage throughout the construction and operational life of the project. It aids in construction, rehabilitation, inspection, maintenance and the quick and efficient management of emergencies. Creating access in isolated rural areas extends the project footprint and is perceived by landowners as a security threat which increases the risk of veld fire, poaching, and vandalism. Because the environment adjacent to rural roads is typically disturbed as a result of their construction and the activities that take place along them, there is the added benefit that the pipeline’s construction is likely to be in transformed or partially transformed land as well. The rating used was as follows.

1 = ready access next to road, drive in
2 = moderate, no or few roads but even terrain
3 = poor, no roads, rough terrain.

4.1.9 Rate of Dispersion of Spill

The rate of dispersion of a spill as a result of a pipeline failure would be governed by a number of factors. Rapid spread is generally dictated by long steep slopes, the presence of drainage lines and streams and rivers. Prevalence of these features was penalized in the following rating system.

1 = low rate, flat land
2 = moderate rate (drainage lines, moderate slope)
3 = high rate (strong relief, large water body, large stream flow).
4.1.10 Sensitivity of Spill Area
The sensitivity of an area to a spill depends on factors such as the intensity of land-use, density of human settlement and fragility of the ecosystem. The rating was as follows.

1 = low sensitivity (extensive farming)
2 = moderate sensitivity (intensive farming including cropping, orchards and plantations, peri-urban areas)
3 = high sensitivity (urban areas, informal settlements, high production land, forest, water body, sensitive wetland, formal protected area).

4.1.11 Heritage Risk
All archaeological and historical sites are protected by various forms of legislation in South Africa. The South African Heritage Resources Management Act No 25 of 1999 protects heritage sites, and this is regulated by the South African Heritage Resources Agency. Both the heritage practitioner and WUC would need to apply for permits for the alteration, destruction, or excavation of heritage sites.

The occurrence of archaeological sites along the planned alignment of a pipeline corridor does not necessarily imply that the alignment must be altered. Most Stone Age and Iron Age archaeological sites can be avoided by careful field assessment and route adjustment during the detailed planning of a pipeline. It is at this level of investigation that detailed heritage assessment is typically necessary. At corridor screening level, heritage is relevant mainly in respect of sites that are associated with a larger area, that could affect a decision between one or other pipeline corridor. The rating was as follows.

1 = low risk (presence unlikely)
2 = moderate risk (presence likely, but impact mitigation by minor realignment of the route during detailed EIA assessment or archaeological rescue is realistic)
3 = high risk (presence is definite, prospects for mitigation limited or nil).

4.1.12 Public Health and Safety Risk
It has been recognised for many years that safety is an important consideration when making decisions about mining/industrial installations where there is a possibility of a major fire, explosion or toxic release. Throughout the world, these installations are known as major hazards as an accident has the potential to harm people beyond the industrial site boundary. The term is also used to include pipelines that convey toxic or flammable materials between sites and installations.

Engineers generally design pipelines in accordance with Codes of Practice that minimize risk to public health and safety and which have low impact on existing and future surrounding land uses. Typical Codes of Practice provide guidelines in this regard. While the impact it mine water and waste is being transported by these pipelines reflects a lower degree of public consequence, a sound principle of route location is still to minimize, where possible, the proximity of such pipelines to human settlement. Obviously, in urban areas it is not possible to avoid proximity to settlement and in such cases the risk assessment prepared for the project would need to demonstrate whether any special measures were necessary to ensure that the risks to the public were within acceptable limits. Notwithstanding the ability to minimize risk to acceptable levels, for the purposes of a corridor screening study, a reasonable routing criterion would be to rank more favourably the route that is in least proximity to risk - sensitive land uses and members of the public in general. The rating was as follows:

1 = rural
2 = peri-urban
3 = urban.
4.1.13 Land Capability

4.1.13.1 Agriculture

Agricultural land capability concerns the capacity of the land to support different intensities of agricultural land use. With the exception of limited instances, crop performance should not be affected by the construction of a pipeline. While there may be temporary disruption and crop losses for which compensation is required, the pipeline should have no material effect on the future productivity of land under most types of cultivation. This includes cultivation under irrigation.

For cultivation that is not restricted, soil overturning and compaction are considered to be the two main problems that could result from the construction of a pipeline. By overturning is meant the risk of mixing topsoil with subsoil in the backfill covering the pipeline with a consequent reduction in agricultural capability. If this is accompanied by changes in the landform and drainage over the pipeline, causing channelling of water, production could be significantly affected. There is little evidence of reduction in land productivity over pipelines in South Africa, but cases where small scale farmers, particularly vegetable farmers, are affected would be of greater concern. In such cases, where the pipeline could affect the entire production of a grower, topsoil replacement and reinstatement of natural drainage patterns would need to be very carefully done in order to prevent permanent loss. For the purposes of the corridor screening, the ranking has been as follows:

1= Grazing and cultivated lands (extensive and irrigation)
2= Cultivated lands (small scale farming, including vegetable farmers)
3 = Intensive crops (orchards etc).

4.1.13.2 Urban Development

Where a pipeline is routed through an existing urban area there is little effect on land capability since the urban fabric around the pipeline servitude is already developed. Conversely, in developing of future urban areas, land use may be constrained because of restrictions placed on service crossings of the pipeline.

WUC and other pipeline operators have specific requirements for sewer, storm water, electrical power and other service crossings of its pipelines, although these are typically not insurmountable obstacles. Landowners with existing or future development plans may also be concerned about potential losses that could result from the effect of a pipeline on township layouts, and market perceptions that proximity to a pipeline warrants reduced prices. In cases where a new pipeline is routed along an existing pipeline servitude, then the new line would probably not add significantly to the existing constraint.

4.1.13.3 Mining

Pipelines conflict with opencast mining and with shallow underground mining where there is a likelihood of subsidence (e.g. Figure 4-3: Pipeline servitude in urban areas

The photo shows a 750-unit development, Plantations, constructed recently astride the existing pipeline servitudes at Hillcrest in Ethekwini. New pipelines alongside existing ones through urban areas, as opposed to a new separate pipeline servitude, would minimize additional development constraints.
coal mining). For the purposes of pipeline corridor screening, mineral resources and undermining should be regarded as severe constraints unless it can be demonstrated that the alignment can be accommodated within the area without sterilizing resources or causing risk.

### 4.1.13.4 Eco-tourism

Where the qualities of land make it suitable for game ranching, nature conservation or other tourism functions which depend on the intrinsic natural value of the landscape and its vegetation, there is the potential for conflict with a pipeline route, particularly in areas where the pipeline is likely to leave a vegetation scar which will remain visible for the life of the pipeline. Such areas are typically severe constraints to a pipeline corridor.

### 4.1.13.5 Wetlands

Wetlands are included as a socio-economic constraint as well as biophysical constraint because of their functional importance - they not only conduct water but also store and purify it, providing a vital environmental resource. In a water-scarce country wetlands are therefore not passive landscapes but have important use and capability value. With care, pipeline construction teams can reinstate the use and capability value of wetlands, but on the basis of experience of previously constructed pipelines in South Africa, there is a risk that construction will impair wetland function, particularly in cases of hill slope wetlands. In the present screening exercise, land capability was considered only in broad terms, as follows.

1 = no risk of lowering land capability  
2 = moderate risk of lowering land capability  
3 = significant risk of lowering the land capability (including all wetlands).

### 4.1.14 Pipeline Length

Generally, it is true that the longer a pipeline the greater the construction and operating cost associated with the pipeline, the larger the total pipeline footprint, and potentially the higher will be the collective environmental and social impacts. In this assessment corridor length was measured simply in kilometres and was not rated. This was done due to the fact that even though a corridor may be longer, there can be the strong possibility that it runs within an existing servitude and therefore would be favourable to a corridor that runs in untransformed land.

### 4.2 Technical and Financial Sub-criteria

The preliminary comparative ranking analysis was based on technical (engineering) and financial criteria as described below.

The selection matrix key below was used to rank the various aspects of the technical and financial criteria:

**Table 4-2: Values used for the rating of technical / financial sub-criteria**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>2</td>
<td>Poor</td>
</tr>
<tr>
<td>3</td>
<td>Average</td>
</tr>
<tr>
<td>4</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>Very Good</td>
</tr>
<tr>
<td>F</td>
<td>Fatal Flaw</td>
</tr>
</tbody>
</table>
4.2.1 Site Suitability

- Accessibility of the site and pipeline
- Availability of air space for Water Treatment Plant
- Proximity to the mine workings and other existing infrastructure
- Proximity bulk services access (road, water, electrical power and telephone) (financial impact)
- The need for relocating of bulk services (financial impact)
- Suitability of using existing servitudes
- Suitability of topography for the development of a pipeline
- Suitability of topography for the construction of a Water Treatment Plant
- Flexibility to accommodate possible future changes to planning such as an increase in the capacity and life of project.

4.2.2 Geotechnical Suitability

- Adequate geotechnical and rock mechanics factor of safety, if previously undermined or planned to be undermined
- The suitability of the geotechnical conditions for cut to fill earthworks operations
- Excavation difficulty
- Suitability of the founding conditions.

4.2.3 Hydraulic Suitability

- Optimisation of horizontal and vertical alignment (financial impact)
- Optimisation of pipe length (financial impact)
- Optimisation of hydraulic suitability.

4.2.4 Geohydrological and Hydrological Suitability

- Presence of shallow groundwater aquifer
- The need for subsurface drainage system
- Ease of runoff (dirty and clean water system) management from the site
- Proximity to mine water collection systems
- Proximity to retain water distribution system.

4.2.5 Constructability

- Suitability of site soils for construction purposes
- Sufficient space to construct
- Suitability of access roads for construction purposes (financial impact).
5.0 COMPARITIVE ASSESSMENT OF PIPELINE CORRIDORS

5.1 Collection Pipeline Corridors

5.1.1 Western Basin to Central Basin

5.1.1.1 Rand Uranium (Harmony) Shaft No.8 / East Chamdor Shaft to DRD Shaft No.4

5.1.1.1.1 Current location

Three alternative routes from Rand Uranium (Harmony) Shaft No.8 / East Chamdor Shaft (Western Basin) to DRD Shaft No.4 (Central Basin) were identified (refer to Figure 2-8):

- **Northern Route**
  The Northern Route mostly follows existing mining, power line, railway line servitudes. The area around Wes Rand train station is occupied by an informal settlement which may result in the need for relocation.

- **Southern Route**
  The Southern Route follows Randfontein Road and passes through Kagiso. In the area where Randfontein Road crosses Adcock Street, houses were built very close to the road making it very difficult to install a pipeline along this route.

- **Central Route**
  The Central Route follows the same alignment as the Northern Route, except that instead of going north of West Village, the pipeline can cross the railway line and Main Reef Road at Millsite Station, and follow Main Reef Road on the eastern side to join the Northern Route again at Tom Muller Street.

5.1.1.1.2 Assessment

The tables below (Table 5-5 and Table 5-6) represent the assessment for the alternative corridors for both the environmental / social as well as the technical / financial sub-criteria.

**Table 5-1: Comparison of Northern, Central and Southern route corridors – environmental / social sub-criteria**

<table>
<thead>
<tr>
<th>PIPELINE CORRIDORS</th>
<th>Northern Route</th>
<th>Central Route</th>
<th>Southern Route</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td>15.6 km</td>
<td>15.5 km</td>
<td>18.3 km</td>
</tr>
<tr>
<td><strong>Rating Values</strong></td>
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<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>All criteria</strong></td>
<td>147</td>
<td>24.1</td>
<td>7.1</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>101.5</td>
<td>23.2</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td>45.5</td>
<td>0.9</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Rating p/km</strong></td>
<td>9.4</td>
<td>1.5</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Gradient</strong></td>
<td>14.8</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td><strong>Cross fall</strong></td>
<td>15</td>
<td>0.6</td>
<td>0</td>
</tr>
<tr>
<td><strong>Drainage</strong></td>
<td>13.3</td>
<td>2.3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Slip zone</strong></td>
<td>14.7</td>
<td>0.9</td>
<td>0</td>
</tr>
<tr>
<td><strong>Wetland</strong></td>
<td>14.5</td>
<td>1.1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Land capability</strong></td>
<td>14.3</td>
<td>0.9</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Land condition</strong></td>
<td>13.6</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 5-2: Comparison of Northern, Central and Southern route corridors – technical / financial sub-criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Pipeline Corridors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Setting</td>
<td>Northern Route</td>
</tr>
<tr>
<td>Accessibility to site</td>
<td>3.0</td>
</tr>
<tr>
<td>The need of relocating services</td>
<td>2.0</td>
</tr>
<tr>
<td>Suitability of using existing servitudes</td>
<td>3.0</td>
</tr>
<tr>
<td>Suitability of Topography</td>
<td>3.0</td>
</tr>
<tr>
<td>Flexibility to accommodate Future Planning</td>
<td>3.0</td>
</tr>
<tr>
<td>Average</td>
<td><strong>2.8</strong></td>
</tr>
<tr>
<td>Geotechnical Suitability</td>
<td>Northern Route</td>
</tr>
<tr>
<td>Suitability of Geotechnical Conditions for cut and fill</td>
<td>3.0</td>
</tr>
<tr>
<td>Excavation Difficulty</td>
<td>3.0</td>
</tr>
<tr>
<td>Suitability of Founding conditions</td>
<td>3.0</td>
</tr>
<tr>
<td>Average</td>
<td><strong>3.0</strong></td>
</tr>
<tr>
<td>Hydraulic Suitability</td>
<td>Northern Route</td>
</tr>
<tr>
<td>Optimisation of horizontal and vertical alignment</td>
<td>3.5</td>
</tr>
<tr>
<td>Optimisation of pipe length</td>
<td>3.0</td>
</tr>
<tr>
<td>Optimisation of hydraulic suitability</td>
<td>3.0</td>
</tr>
<tr>
<td>Average</td>
<td><strong>3.2</strong></td>
</tr>
<tr>
<td>Site Constructability</td>
<td>Northern Route</td>
</tr>
<tr>
<td>Suitability of site soils for construction purposes</td>
<td>3.0</td>
</tr>
<tr>
<td>Suitability of space to construct</td>
<td>3.0</td>
</tr>
<tr>
<td>Suitability of access roads for Construction Purposes</td>
<td>3.0</td>
</tr>
<tr>
<td>Average</td>
<td><strong>3.0</strong></td>
</tr>
</tbody>
</table>
Both the Northern and Central Route corridors are considerably shorter than the Southern Route corridor.

The Central Route has the following disadvantages:

- The route runs through very degraded mine area which could pose a risk in terms of accessibility as well as pipeline safety.

The Southern Route has the following disadvantages:

- The alignment runs through numerous informal settlements
- The length of the pipeline which would need to be constructed is longer.

The preferred corridor in the Western Basin is therefore the Northern Route corridor.

5.1.2 Eastern Basin to Central Basin

5.1.2.1 Grootvlei Shaft No.3 to ERGO Plant

5.1.2.1.1 Corridor location

Three alternative routes from Grootvlei No.3 Shaft to the ERGO Brakpan Plant were identified (refer to Figure 2-9):

- Southern Route
  - The Southern Route mainly follows existing mining, power line, railway line servitudes. Following the Southern Route, however, poses some serious problems:
    - Relocation of informal settlement at the 7L1 Slimes Dam
    - The congested power line servitude at Selcourt.
  - The existing servitude runs through Kwa-Thema where the residential settlement has encroached on the corridor.

- Northern Crossing Route
  - The Northern Crossing Route follows existing mining, power line, railway line servitudes. This route was used for a pipeline from 6L13 Slimes Dame at Cowles Dam to the ERGO Plant site. It became redundant a few years ago and many of the steel pipes have been removed. Some of the major service crossings and pipe plinths are still intact. After the first 4 km of the Northern Crossing Route, the route crosses over the Blesbokspruit.

- Northern Route
  - The Northern Route follows the same alignment as the Northern Crossing Route; however, in order to avoid crossing the Blesbokspruit, an alternative was considered to run the pipeline along the toe of the nearby slimes dam towards the Welgedacht area, running along the shoulder of the river bank in a northerly direction. The Northern Route runs along the opposite bank to the Northern Crossing Route. These two alignments then rejoin 3.5 km north of the wetland and continue on the same alignment to the ERGO Plant.
5.1.2.1.2 Assessment

Tables 5-1 and 5-2 represent the assessment for the alternative corridors for both the environmental and social criteria as well as the technical and financial criteria.

Table 5-3: Comparison of Southern, Northern and Northern Crossing route corridors – environmental / social sub-criteria

<table>
<thead>
<tr>
<th></th>
<th>PIPELINE CORRIDORS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Southern Route</td>
<td>Northern route</td>
<td>Northern Crossing Route</td>
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<tr>
<td>Length</td>
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<td>23.5 km</td>
<td>23.2 km</td>
</tr>
<tr>
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<td>1 2 3</td>
<td>1 2 3</td>
</tr>
<tr>
<td>All criteria</td>
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<td>234.5 25.6 45.4</td>
<td>229.6 25 47.2</td>
</tr>
<tr>
<td>Environmental</td>
<td>161.3 22.1 40.1</td>
<td>196.1 20.2 42.2</td>
<td>191.8 20.1 43.5</td>
</tr>
<tr>
<td>Social</td>
<td>55.8 7.7 20.1</td>
<td>67.8 5 21.2</td>
<td>65.7 5 22.1</td>
</tr>
<tr>
<td>Rating p/km</td>
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<td>10.0 1.1 1.9</td>
<td>9.9 1.1 2.0</td>
</tr>
<tr>
<td>Gradient</td>
<td>20.1 1.6 0</td>
<td>19.1 3.4 1</td>
<td>18.1 3.6 1.5</td>
</tr>
<tr>
<td>Cross fall</td>
<td>20.5 1.2 0</td>
<td>18.6 4.1 0.8</td>
<td>18.3 4.1 0.8</td>
</tr>
<tr>
<td>Drainage</td>
<td>21.2 0.5 0</td>
<td>22.2 1.3 0</td>
<td>22.2 1 0</td>
</tr>
<tr>
<td>Slip zone</td>
<td>20.1 1.6 0</td>
<td>18.4 2.7 2.4</td>
<td>18.1 2.2 2.9</td>
</tr>
<tr>
<td>Wetland</td>
<td>20.7 0.6 0.4</td>
<td>22.4 1.1 0</td>
<td>20.9 1.1 1.2</td>
</tr>
<tr>
<td>Land capability</td>
<td>15.7 3.2 2.8</td>
<td>22.4 1.1 0</td>
<td>22.1 1.1 0</td>
</tr>
<tr>
<td>Land condition</td>
<td>10.6 7 4.1</td>
<td>19.1 4.4 0</td>
<td>18.8 4.4 0</td>
</tr>
<tr>
<td>Red Data spp and</td>
<td>21.7 0 0</td>
<td>23.5 0 0</td>
<td>23.2 0 0</td>
</tr>
<tr>
<td>protected area status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heritage risk</td>
<td>18.4 3.3 0</td>
<td>21.8 1.7 0</td>
<td>21.5 1.7 0</td>
</tr>
<tr>
<td>Public health and</td>
<td>1.2 4.6 15.9</td>
<td>1.3 2.6 19.6</td>
<td>1.3 2.6 19.5</td>
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<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>Accessibility</td>
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<td>23.5 0 0</td>
<td>23.2 0 0</td>
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<tr>
<td>Dispersion</td>
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<td>21 2.1 0.4</td>
<td>20.7 2.1 0.4</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>4.2 0.6 16.9</td>
<td>1.2 1.1 21.2</td>
<td>1.2 1.1 20.9</td>
</tr>
</tbody>
</table>
Table 5-4: Comparison of Southern, Northern and Northern Crossing route corridors – technical / financial sub-criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Pipeline Corridors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Northern Route</td>
</tr>
<tr>
<td>Site Setting</td>
<td></td>
</tr>
<tr>
<td>Accessibility to site</td>
<td>3.0</td>
</tr>
<tr>
<td>The need of relocating services</td>
<td>3.0</td>
</tr>
<tr>
<td>Suitability of using existing servitudes</td>
<td>4.0</td>
</tr>
<tr>
<td>Suitability of Topography</td>
<td>4.0</td>
</tr>
<tr>
<td>Flexibility to accommodate Future Planning</td>
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</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>3.4</strong></td>
</tr>
<tr>
<td>Geotechnical Suitability</td>
<td></td>
</tr>
<tr>
<td>Suitability of Geotechnical Conditions for cut and fill</td>
<td>3.0</td>
</tr>
<tr>
<td>Excavation Difficulty</td>
<td>3.0</td>
</tr>
<tr>
<td>Suitability of Founding conditions</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>3.0</strong></td>
</tr>
<tr>
<td>Hydraulic Suitability</td>
<td></td>
</tr>
<tr>
<td>Optimisation of horizontal and vertical alignment</td>
<td>3.0</td>
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<tr>
<td>Optimisation of pipe length</td>
<td>3.0</td>
</tr>
<tr>
<td>Optimisation of hydraulic suitability</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>3.3</strong></td>
</tr>
<tr>
<td>Site Constructability</td>
<td></td>
</tr>
<tr>
<td>Suitability of site soils for construction purposes</td>
<td>3.0</td>
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<tr>
<td>Suitability of space to construct</td>
<td>4.0</td>
</tr>
<tr>
<td>Suitability of access roads for Construction Purposes</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>3.7</strong></td>
</tr>
</tbody>
</table>

The Northern Route is very similar to the Northern Crossing Route with the exception of approximately 4 km where the Northern Crossing Route runs along the eastern bank of the Blesbokspruit. Although the Northern Route is slightly longer than the other two routes and in particular the Southern Route, it is less constrained than the Southern Route. There is no major difference when comparing the environmental / social impacts for the three alternatives. However, the Southern Route is very unfavourable with regards to technical / financial criteria, mainly as a result of the two northerly routes predominantly lying within existing servitudes. However, all three corridors have confined working space, canals and roads and railways to cross, as well as other difficulties described below.
The Northern Crossing Route has the following disadvantages:

- Although following an existing pipeline corridor, this route could cause significant construction and environmental impacts in terms of crossing the Blesbokspruit.

The Southern Route experiences the following substantial constraints:

- Although also following existing servitudes for most of the way, as well as trying to avoid river crossings, numerous densely populated areas and informal settlements are on the route. Through the area of KwaThema, moving of people and existing services and restricted space for construction made this corridor unfavourable.

- Large portions of untransformed land are found along this route when compared to the other two alternatives.

The Northern Route is thus the preferred corridor. As previously mentioned, although it is the longest route it is the best aligned running within existing servitudes. Within the northern route however there remain opportunities to refine this route. As technical studies progress, the favoured route may be further refined. These refinements will be clearly documented and reflect in future project documentation. A good example would be where the route commences in close proximity to the Blesbokspruit. This initial Route section continues to receive focused attention to minimise contact with the Blesbokspruit system.

5.1.2.2 ERGO Brakpan Plant to Central Reclamation Plant

5.1.2.2.1 Current location

Three alternative routes from the ERGO Brakpan Plant to the centralised Water Treatment Plant were identified (refer to Figure 2-9):

- Van Dyk Route
  The Van Dyk Route follows existing mining and power line servitudes.

- Windmill Park Route
  The Windmill Park Route follows existing railway line, power line and mining servitudes. This route was previously used for a pipeline from the ERPM Central Shaft and Elsburg Slimes Dam to the ERGO Plant site. An additional pipeline is currently being constructed along this route.

- Dalpark Route
  The Dalpark Route leaves ERGO Plant and runs along the Windmill Park Route, then north on Heidelberg Road. The alignment then turns left and runs along Dinghy Road and around the north side of a Slimes Dam, crossing over North Boundary Road and rejoining the Van Dyk Route on Aloe Street. On the north east corner of 5L29 Slimes Dam, the Dalpark Route splits from the Van Dyk Park Route and runs along the eastern side of Reigerpark, where it runs along Commissioner Street and around the back of Angelo Pan before once again tying into the Windmill Park Route and through to the centralised Water Treatment Plant site.
5.1.2.2.2 Assessment

Tables 5-3 and 5-4 below represent the assessment for the alternative corridors for both the environmental / social criteria as well as the technical / financial sub-criteria.

Table 5-5: Comparison of Van Dyk, Dalpark and Windmill Park route corridors – environmental / social sub-criteria

<table>
<thead>
<tr>
<th>PIPELINE CORRIDORS</th>
<th>Van Dyk Route</th>
<th>Dalpark Route</th>
<th>Windmill Park Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>23.1 km</td>
<td>27.6 km</td>
<td>25.9 km</td>
</tr>
<tr>
<td>Rating Values</td>
<td>1 2 3</td>
<td>1 2 3</td>
<td>1 2 3</td>
</tr>
<tr>
<td>All criteria</td>
<td>244.1 10.3 45.9</td>
<td>290.4 16.8 55.8</td>
<td>274.4 13 48.3</td>
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<tr>
<td>Environmental</td>
<td>175.8 22.1 40.1</td>
<td>196.1 20.2 42.2</td>
<td>191.8 20.1 43.5</td>
</tr>
<tr>
<td>Social</td>
<td>68.3 7.7 20.1</td>
<td>67.8 5 21.2</td>
<td>65.7 5 22.1</td>
</tr>
<tr>
<td>Rating p/km</td>
<td>10.6 0.4 2.0</td>
<td>10.5 0.6 2.0</td>
<td>10.6 0.5 1.9</td>
</tr>
<tr>
<td>Gradient</td>
<td>20.7 2.4 0</td>
<td>25.3 2.3 0</td>
<td>22.8 3.1 0</td>
</tr>
<tr>
<td>Cross fall</td>
<td>21 2.1 0</td>
<td>25.8 1.8 0</td>
<td>22.9 3 0</td>
</tr>
<tr>
<td>Drainage</td>
<td>22.3 0.8 0</td>
<td>26 1.6 0</td>
<td>24.6 1.3 0</td>
</tr>
<tr>
<td>Slip zone</td>
<td>20.7 2.4 0</td>
<td>25.3 2.3 0</td>
<td>25.9 0 0</td>
</tr>
<tr>
<td>Wetland</td>
<td>22.6 0.5 0</td>
<td>25.8 1.8 0</td>
<td>25.1 0.8 0</td>
</tr>
<tr>
<td>Land capability</td>
<td>22.1 0.5 0.5</td>
<td>25.4 0.8 1.4</td>
<td>22.6 2.5 0.8</td>
</tr>
<tr>
<td>Land condition</td>
<td>22.2 0.9 0</td>
<td>27.2 0.4 0</td>
<td>24.6 1.3 0</td>
</tr>
<tr>
<td>Red Data spp and protected area status</td>
<td>23.1 0 0</td>
<td>27.6 0 0</td>
<td>25.9 0 0</td>
</tr>
<tr>
<td>Heritage risk</td>
<td>23.1 0 0</td>
<td>27.6 0 0</td>
<td>25.9 0 0</td>
</tr>
<tr>
<td>Public health and safety risk</td>
<td>0.8 0 22.3</td>
<td>0.8 0 26.8</td>
<td>2.7 0.6 21.6</td>
</tr>
<tr>
<td>Accessibility</td>
<td>23.1 0 0</td>
<td>27.6 0 0</td>
<td>25.9 0 0</td>
</tr>
<tr>
<td>Dispersion</td>
<td>22.4 0.7 0</td>
<td>26 1.6 0</td>
<td>25.5 0.4 0</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>0 0 23.1 0</td>
<td>4.2 27.6 0</td>
<td>0 0 25.9</td>
</tr>
</tbody>
</table>
### Table 5-6: Comparison of Van Dyk’s, Dalpark and Windmill Park route corridors – technical / financial sub-criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Windmill Park Route</th>
<th>Van Dyk's Route</th>
<th>Dalpark Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Setting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessibility to site</td>
<td>3.0</td>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td>The need of relocating services</td>
<td>3.0</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Suitability of using existing servitudes</td>
<td>4.0</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Suitability of Topography</td>
<td>4.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Flexibility to accommodate Future Planning</td>
<td>3.0</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>3.4</strong></td>
<td><strong>2.2</strong></td>
<td><strong>2.2</strong></td>
</tr>
<tr>
<td>Geotechnical Suitability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suitability of Geotechnical Conditions for cut and fill</td>
<td>3.0</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Excavation Difficulty</td>
<td>3.0</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Suitability of Founding conditions</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>3.0</strong></td>
<td><strong>2.8</strong></td>
<td><strong>2.7</strong></td>
</tr>
<tr>
<td>Hydraulic Suitability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optimization of horizontal and vertical alignment</td>
<td>3.0</td>
<td>4.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Optimization of pipe length</td>
<td>3.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Optimisation of hydraulic suitability</td>
<td>4.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>3.3</strong></td>
<td><strong>3.7</strong></td>
<td><strong>3.2</strong></td>
</tr>
<tr>
<td>Site Constructability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suitability of site soils for construction purposes</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Suitability of space to construct</td>
<td>4.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Suitability of access roads for Construction Purposes</td>
<td>4.0</td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>3.7</strong></td>
<td><strong>2.8</strong></td>
<td><strong>3.0</strong></td>
</tr>
</tbody>
</table>

Following the Van Dyk Park Route poses the following challenges:

- Close proximity to the 5L29 Slimes Dam.
- The congested corridor through Van Dyk Park. It is associated with a well established suburb, with many services which will need to be relocated or crossed. Many new developments taking place in this area.
- The pipeline will run next to the N17 highway and construction and permission to use the road reserve might pose a problem.

The Dalpark Route has the following disadvantages:

- Densely populated areas are on the route. It runs along a well established suburb with many services that will need to be relocated or crossed. Many new developments are taking place in this area.
- This route is also considerably longer than the other two alternatives under investigation.
The preferred corridor both in terms of environmental / social as well as technical / financial sub-criteria is the Windmill Park Route. Densely populated areas are on the route and although it is not the shortest route it is the best aligned in terms of following existing servitudes.

5.2 Distribution Pipeline Corridor

5.2.1 Current location

Four alternative routes from the centralised Water Treatment Plant to the Klipriviersberg Reservoir were identified (refer to Figure 2-10):

- **Freeway Route**
  
  The Freeway Route follows the eastern side of an existing railway line from the Plant site all the way past the following stations:
  - Kutalo
  - Elsburg
  - Dallas
  - Wattles.

  At the N17 Freeway, the route follows the southern side of the N17 Freeway and then the N12 Freeway to a point north of the Klipriviersberg Reservoir. From this point, the route swings south to connect to the reservoir. This route has to cross numerous rock outcrops and wetlands.

- **Southern Route**
  
  The Southern Route follows the eastern side of an existing railway line from the Plant site all the way past the following stations:
  - Kutalo
  - Elsburg
  - Dallas
  - Wattles
  - Union.

  At Natalspruit, the route swings west along Juyn Street, Dan Jacobs Street, Potgieter Street and Swartkoppies Road. Crossing the R59 Freeway, it follows an existing power line servitude. At Hennie Alberts Street, it turns north towards the Klipriviersberg Reservoir. This route is very long and has to pass through Alrode, Brackenhurst and Meyersdal.

- **Alberton Route**
  
  The Alberton Route follows the eastern side of an existing railway line from the Plant site all the way past the following stations:
  - Kutalo
  - Elsburg
  - Dallas
  - Wattles
  - Union.

  At the Heidelberg Road (R554), the route swings west along Heidelberg Road to Swartkoppies Road. At Swartkoppies Road, it swings south to Phantom Street where it turns west along Phantom Street and then Joyce Street. At the corner of Joyce Street and Jacqueline Avenue, it turns north to follow Jacqueline Avenue to the southern side of the sports fields of Marais Viljoen High School. Here the route turns west along the edge of the sports fields and crosses the R59 Freeway. Following the R59 Freeway
to Fore Street, it turns west and follows Fore Street to a point north of the Klipriviersberg Reservoir. From this point, the route swings south to connect to the Reservoir.

Victoria Lake Route

The Victoria Lake Route follows the eastern side of an existing railway line from the Plant site all the way past the following stations:

- Kutalo
- Elsburg
- Webber.

The route then runs west along Rhodes Avenue, Morne Road and then south west down Chapman Road. From here it turns south of Victoria Lake, follows Rand Airport Road around the northern side of Elandshaven where it links, once again onto the Freeway Route. The Victoria Lake Route then splits from the Freeway Route at the R59 interchange and continues along the N12 along the Klipriviersberg Reservoir.

5.2.2 Assessment

Table 5-7 and 5-8 below represent the assessment for the alternative corridors for both the environmental / social sub-criteria as well as the technical / financial sub-criteria.

Table 5-7: Comparison of Freeway, Southern, Alberton and Victoria Lake route corridors – environmental / social sub-criteria

<table>
<thead>
<tr>
<th>PIPELINE CORRIDORS</th>
<th>Freeway Route</th>
<th>Southern Route</th>
<th>Alberton Route</th>
<th>Victoria Lake Route</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td>17.9 km</td>
<td>22.1 km</td>
<td>19.9 km</td>
<td>17.3 km</td>
</tr>
<tr>
<td><strong>Rating Values</strong></td>
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<td>1 2 3</td>
<td>1 2 3</td>
<td>1 2 3</td>
</tr>
<tr>
<td><strong>All criteria</strong></td>
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<td>18.5</td>
<td>27.4</td>
<td>28.4</td>
</tr>
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<td>18.2</td>
<td>27.4</td>
<td>161.2</td>
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<tr>
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<td>0.3</td>
<td>0</td>
<td>63.9</td>
</tr>
<tr>
<td><strong>Rating p/km</strong></td>
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<td>1.0</td>
<td>1.5</td>
<td>10.2</td>
</tr>
<tr>
<td><strong>Gradient</strong></td>
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<td>1.6</td>
<td>0</td>
<td>19.9</td>
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<tr>
<td><strong>Cross fall</strong></td>
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<td>1.4</td>
<td>0</td>
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<tr>
<td><strong>Drainage</strong></td>
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<td>1.3</td>
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<tr>
<td><strong>Slip zone</strong></td>
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<td>1.6</td>
<td>0</td>
<td>19.9</td>
</tr>
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<td><strong>Wetland</strong></td>
<td>16.9</td>
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<td>0</td>
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<tr>
<td><strong>Land capability</strong></td>
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<td>0.3</td>
<td>0</td>
<td>19.7</td>
</tr>
<tr>
<td><strong>Land condition</strong></td>
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<td>0.8</td>
<td>0</td>
<td>20.3</td>
</tr>
<tr>
<td><strong>Red Data spp and protected area status</strong></td>
<td>17.1</td>
<td>0.8</td>
<td>0</td>
<td>19.9</td>
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<tr>
<td><strong>Heritage risk</strong></td>
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<tr>
<td><strong>Public health and safety risk</strong></td>
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<td>12.6</td>
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<tr>
<td><strong>Accessibility</strong></td>
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<td>0</td>
<td>22.1</td>
</tr>
<tr>
<td><strong>Dispersion</strong></td>
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<td>1.3</td>
<td>0</td>
<td>20.2</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
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<td>14.8</td>
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### Table 5-8: Comparison of Freeway, Southern, Alberton and Victoria Lake route corridors – technical / financial sub-criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Pipeline Corridors</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freeway</td>
<td>Southern</td>
<td>Alberton</td>
<td>Victoria Lake</td>
</tr>
<tr>
<td>Site Setting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<tr>
<td>The need of relocating services</td>
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<td>3.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Suitability of using existing servitudes</td>
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<td>4.0</td>
<td>4.0</td>
<td>2.0</td>
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<tr>
<td>Suitability of Topography</td>
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<td>3.0</td>
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<tr>
<td>Flexibility to accommodate Future Planning</td>
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<td>3.0</td>
<td>2.0</td>
</tr>
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<td><strong>3.1</strong></td>
<td><strong>3.4</strong></td>
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<tr>
<td>Geotechnical Suitability</td>
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<td></td>
</tr>
<tr>
<td>Suitability of Geotechnical Conditions for cut and fill</td>
<td>2.0</td>
<td>3.0</td>
<td>3.0</td>
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<tr>
<td>Excavation Difficulty</td>
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<td>1.0</td>
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<td>Suitability of Founding conditions</td>
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<td>2.5</td>
<td>1.0</td>
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<td><strong>2.5</strong></td>
<td><strong>2.8</strong></td>
<td><strong>1.3</strong></td>
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<tr>
<td>Hydraulic Suitability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optimization of horizontal and vertical alignment</td>
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<td>2.5</td>
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<tr>
<td>Optimisation of pipe length</td>
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<td>4.0</td>
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<tr>
<td>Optimisation of hydraulic suitability</td>
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<td>2.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>2.8</strong></td>
<td><strong>2.7</strong></td>
<td><strong>3.0</strong></td>
<td><strong>2.8</strong></td>
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<tr>
<td>Site Constructability</td>
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<td></td>
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<tr>
<td>Suitability of site soils for construction purposes</td>
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<td>3.0</td>
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<tr>
<td>Suitability of space to construct</td>
<td>2.0</td>
<td>2.5</td>
<td>2.5</td>
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<tr>
<td>Suitability of access roads for Construction Purposes</td>
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<td>2.5</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
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<td><strong>2.7</strong></td>
<td><strong>2.7</strong></td>
<td><strong>2.2</strong></td>
</tr>
</tbody>
</table>

Based on the environmental / social sub-criteria, the preferred route is the Freeway Route. However, based on the technical / financial sub-criteria, this route is not favourable. The Freeway Route runs along the N12 and this will make accessibility, both during construction and operation, as well as acquiring a servitude difficult. Following the Freeway Park Route poses the following challenges:

- Densely populated areas are associated with the route. As a result the moving of existing services and permission to use existing servitudes will need to be requested.
- The space to construct next to the Freeway is limited.
- Construction of a pipeline will be difficult due to the rock outcrops on the route.

The Southern Park Route has the following disadvantages:

- Densely populated areas are associated with the route. As a result, the moving of existing services and permission to use existing servitudes will need to be requested.
- The space to construct next to the Freeway is limited.
Construction of a pipeline will be difficult due to the rock outcrops on the route.
The length of the route is considerably long.
The Victoria Lake Route has the following disadvantages:
- Densely populated areas are associated with route. As a result, the moving of existing services and permission to use existing servitudes will need to be requested.
- The space to construct next to the Freeway is limited.
- Construction of a pipeline will be difficult due to the rock outcrops on the route.
- This alternative runs through major interchanges and construction will be difficult in these sections.
- This route also runs directly south of Victoria Lake and this is an increased risk in the event of a spill or a burst pipe.

As a result of the above and the fact that it runs for the most part in an existing mine servitude, the preferred corridor is the Alberton Route. This route mostly follows existing servitudes, although much like the other three alternatives, the alignment runs through certain densely populated areas on route. The moving of existing services and subsequent permission to use existing servitudes will need to be negotiated. Although this alternative is not the shortest, it is preferred.

5.3 Conclusions
5.3.1 Collection Pipeline Corridors
5.3.1.1 Western Basin to Central Basin

<table>
<thead>
<tr>
<th>Summary</th>
<th>Pipeline Corridor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Northern</td>
<td>Central</td>
</tr>
<tr>
<td>Rank – Environmental / social</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Rank - Technical / financial</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

The preferred Western Basin collection pipeline from a technical / financial as well as an environmental /social perspective is the Northern Corridor. This is mostly due to the corridor being predominantly located within existing mining, power line and railway line servitudes, in areas away from degraded mine areas (which could pose a risk in terms of accessibility and pipeline safety), and not being located in close proximity to informal settlements.

5.3.1.2 Eastern Basin to Central Basin

<table>
<thead>
<tr>
<th>Summary</th>
<th>Pipeline Corridor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Northern</td>
<td>Northern Crossing</td>
</tr>
<tr>
<td>Rank - Environmental / social</td>
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<td>3</td>
</tr>
<tr>
<td>Rank - Technical / financial</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
Subsequent to the assessment, the preferred corridor between Grootvlei No. 3 Shaft and the ERGO Brakpan Plant from an environmental / social perspective is the Southern Corridor. This is mostly due to the first few kilometres of the Southern Corridor not being in close proximity to, or crossing, the Blesbokspruit, unlike the Northern and Northern Crossing corridors. From a technical / financial perspective, the preferred corridor is the Northern Corridor. This is mainly due to the Northern Crossing Corridor potentially being associated with significant construction constraints in terms of crossing the Blesbokspruit, and restricted space for construction along the Southern Corridor. The Southern Corridor would also require relocation of people. Since impacts associated with the routing of the pipeline in close proximity to the Blesbokspruit can be mitigated/managed, and the relocation of people and insufficient space for construction are significant constraints to construction, the technical / financial ranking outweighs the environmental / social ranking. The overall preferred corridor is thus the Northern Corridor.

The Windmill Park Corridor connecting the ERGO Brakpan Plant and the central Water Treatment Plant is the Windmill Park Corridor from both the technical / financial and environmental / social perspectives mainly since the corridor is mostly located within existing servitudes.

### 5.3.2 Distribution Pipeline Corridor

<table>
<thead>
<tr>
<th>Summary</th>
<th>Freeway</th>
<th>Southern</th>
<th>Alberton</th>
<th>Victoria Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rank - Environmental / social</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Rank - Technical / financial</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

After the evaluation, it can be established that the preferred corridor from an environmental / social perspective is the Freeway Corridor. However, based on the technical / financial sub-criteria, this route is not feasible, mostly due to construction constraints in terms of space and rock outcrops associated with the route. The Southern Corridor (the second highest ranking alternative for an environmental / social perspective) is also not feasible from a technical / financial perspective for the same above-mentioned reasons, in addition to the length of the corridor being considerably long. From a technical / financial point of view, the Alberton Corridor is preferred, mainly due to the majority of the corridor being located within existing servitudes, and the corridor not having any significant construction constraints associated with it. Since the Alberton Corridor is the preferred corridor from a technical / financial point of view, and it has no significant environmental / social negative aspects associated with it, the overall preferred corridor is the Alberton Corridor.
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