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Department of Water Affairs

Chief Directorate: Integrated Water Resource Planning
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MOKOLO AND CROCODILE (WEST) WATER AUGMENTATION PROJECT (MCWAP) FEASIBILITY STUDY: TECHNICAL MODULE

Project No. WP9528

PRE-FEASIBILITY STAGE REPORT 7 ENVIRONMENTAL AND SOCIAL SCREENING

Lead Consultant: Africon

In association with: KV3, VELAVKE

LIST OF REPORTS

REPORT NO	DESCRIPTION	REPORT NAME
FEASIBILITY STAGE		
P RSA A000/00/8109	Main Report	MCWAP FEASIBILITY STUDY TECHNICAL MODULE SUMMARY REPORT
P RSA A000/00/8409	Supporting Report 8A	GEOTECHNICAL INVESTIGATIONS PHASE 1
P RSA A000/00/8709	Supporting Report 8B	GEOTECHNICAL INVESTIGATIONS PHASE 2
P RSA A000/008509	Supporting Report 9	TOPOGRAPHICAL SURVEYS
P RSA A000/00/8609	Supporting Report 10	REQUIREMENTS FOR THE SUSTAINABLE DELIVERY OF WATER
P RSA A000/00/8209	Supporting Report 11	PHASE 1 FEASIBILITY STAGE
P RSA A000/00/8309	Supporting Report 12	PHASE 2 FEASIBILITY STAGE
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P RSA A000/00/8809	Supporting Report 1	WATER REQUIREMENTS
P RSA A000/00/8909	Supporting Report 2	WATER RESOURCES
P RSA A000/00/9009	Supporting Report 3	GUIDELINES FOR PRELIMINARY SIZING, COSTING AND ECONOMIC EVALUATION OF DEVELOPMENT OPTIONS
P RSA A000/00/9109	Supporting Report 4	DAMS, ABSTRACTION WEIRS AND RIVER WORKS
P RSA A000/00/9209	Supporting Report 5	MOKOLO RIVER DEVELOPMENT OPTIONS
P RSA A000/00/9309	Supporting Report 6	WATER TRANSFER SCHEME OPTIONS
P RSA A000/00/9409	**Supporting Report 7**	**SOCIAL AND ENVIRONMENTAL SCREENING**
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REPORT DETAILS PAGE

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PREFACE

The Mokolo (Mogol) River catchment is part of the Limpopo Water Management Area (WMA). The Mokolo River originates close to Modimolle (Nylstroom) and then drains to the north into the Limpopo River. The Mokolo Dam (formerly known as the Hans Strijdom Dam) is the largest dam in the catchment. The dam was constructed in the late 1970s and completed in July 1980, to supply water to Matimba Power Station, Grootegeluk Mine, Lephalale (Ellisras) Municipality and for irrigation downstream of the dam. Based on the water infrastructure, the current water availability and water use allows only limited spare yield existing for future allocations for the anticipated surge in economic development in the area.

There are a number of planned and anticipated consequential developments in the Lephalale area associated with the rich coal reserves in the Waterberg coal field for which additional water will be required. These developments include inter alia the development of further power stations by Eskom, the potential development of coal to liquid fuel facilities by Sasol and the associated growth in mining activities and residential development.

The development of new power stations is of high strategic importance with tight timeframes. Commissioning of the first generation unit will start in September 2010 and additional water needs to be available by mid 2011 according to the expected water requirements. A solution addressing the water needs of the Lephalale area must be pursued. The options to augment existing water supplies include transferring surplus effluent return flows from the Crocodile River (West) / Marico WMA to Lephalale and the area around Steenbokpan shown on the map indicating the study area on the following page.

The Department of Water Affairs (DWA) commissioned the Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP) to analyse the options for transferring water from the Crocodile River (West). In April 2008, the Technical Module of this study was awarded to Africon in association with Kwezi V3, Vela VKE and specialists. The focus of the Technical Module is to investigate the feasibility of options to:

- **Phase 1:** Augment the supply from Mokolo Dam to supply in the growing water requirement for the interim period until a transfer pipeline from the Crocodile River (West) can be implemented. The solution must over the long term, optimally utilise the full yield from Mokolo Dam.
- **Phase 2:** Transfer water from the Crocodile River (West) to the Lephalale area. Options to phase the capacity of the transfer pipeline (Phase 2A and 2B) must be investigated.

The Technical Module has been programmed to be executed at a Pre-feasibility level of investigation to identify different options and recommend the preferred schemes, which was followed by a Feasibility level investigation of the preferred water schemes. Recommendation on the preferred options for Phase 1 and Phase 2 Schemes were presented to DWA during October 2008 and draft reports were submitted during December 2008. The Feasibility Stage of the project commenced in January 2009 and considered numerous water requirement scenarios, project phasing and optimisation of pipeline routes. The study team submitted a draft Feasibility Report during October 2009 and Main Report in November 2009.

This report (Report 7 – Environmental and Social Screening, P RSA A000/00/9409) cover the potential environmental and Social impact (including cost estimates) for water requirement augmentation options considered.

LIST OF ABBREVIATIONS & ACRONYMS

CSB	Central Sandy Bushveld
DT	Dwaalboom Thornveld
DWA	Department of Water Affairs
HA (ha)	Hectare
LSB	Limpopo Sweet Bushveld
MCWAP	Mokolo and Crocodile River (West) Water Augmentation Project
R	Rand
WMB	Waterberg Mountain Bushveld
WSB	Western Sandy Bushveld

MOKOLO CROCODILE (WEST) WATER AUGMENTATION PROJECT FEASIBILITY STUDY

TECHNICAL MODULE

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1. BACKGROUND

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There are a number of planned and anticipated consequential developments in the Lephalale area associated with the rich coal reserves in the Waterberg coal field for which additional water will be required. These developments include:

- Construction of Eskom's Medupi Power Station;
- Development of possible further power stations;
- Extension of the Grootegeluk mining operations and possible further mines;
- Possible petrochemical industries to be developed;
- Possible exploitation of gas; and
- Accelerated growth in the population in the area.

The development of new power stations is of high strategic importance with tight timeframes. The first units will be commissioned by the end of 2010 and additional water needs to be available by mid 2011. The project is of high priority and the timeous completion of the water augmentation is not negotiable.

The focus of this component of the study is on the transfer of water from the Crocodile River to the Lephalale area, as well as from the Mokolo Dam to the various end users. A Reconnaissance Study to investigate options to transfer additional water from the Crocodile River (West) to the Lephalale area was completed in 2006. This study will take this proposed project to a Pre-Feasibility level of investigation.

A transfer pipeline from the Crocodile River (West), to augment the water requirements of the Mokolo catchment, will be investigated. The options will include inter alia the construction of a pipeline along various possible routes, from a point downstream of the confluence of the Moretele and the Crocodile Rivers, to a terminal point still to be finalised. From the terminal point the water needs to be distributed to the users.

One of the challenges is to minimise the risk of non-supply and to provide acceptable reliability and redundancy in the system. It is preferable to be able to supply water to strategic water users, such as power stations, from more than one source. This will reduce the probability of failure of non-supply significantly.

Various options and the possible phasing of the development will therefore be investigated, such as utilising the Crocodile River from Boschkop to Thabazimbi, or a canal, versus a pipeline conveyance system. The raising of the Mokolo Dam remains an option to consider as a further phase of the MCWAP project. Interim measures that can deliver water from the Mokolo Dam or ground water sources also need to be investigated. The interim measures investigated will have to be totally reliable as there will be no redundancy in the system until the completion of the transfer pipeline.

1.1 Study Area

The MCWAP Study area comprises the areas on the Crocodile River (West) downstream of Hartbeespoort Dam as well as the Mokolo River. Figure 1-1 indicates the geographical location of the project.

1.2 Project Brief

The purpose of this component of the study is to identify the environmental feasibility for various options for transfer pipeline routes from the Crocodile River (West)/Marico WMA to the balancing dams at the end of the existing rising main from Mokolo Dam (Limpopo WMA) on the basis of 1:50 000 topographical maps. The study was undertaken at a reconnaissance level of detail and no detailed environmental investigations were undertaken. Information was obtained from desktop analysis of the area and online resources.

The current perspective that the most suitable intake point is somewhere between the Klipvoor Dam (tertiary catchment A23) situated on the Moretele River (tributary of the Crocodile River) and the confluence of the Crocodile and Moretele Rivers was investigated. This is a stretch of about 30 km. The investigation included this section, as well for a suitable abstraction point along the Crocodile River after the confluence of the two rivers.

The brief calls for the investigation to end the pipe routes at the balancing dams close to the Mokolo Dam. A requirement of DWA is that the existing system and the new system must be a combined system and therefore the optimal system needs to be established. The existing balancing dams are at an elevation of 1100 m and delivering to the mine and power of station at an elevation 200 m lower under gravity. The capacity of this pipeline is limited and would not be able to accommodate a further 45 Million m^3/a. This study was extended to include a scoping on the most optimal delivery point assuming that the water would be required in the area of Lephalale, the existing mine and the power station. The study for this section was done at a more superficial level than the main study.

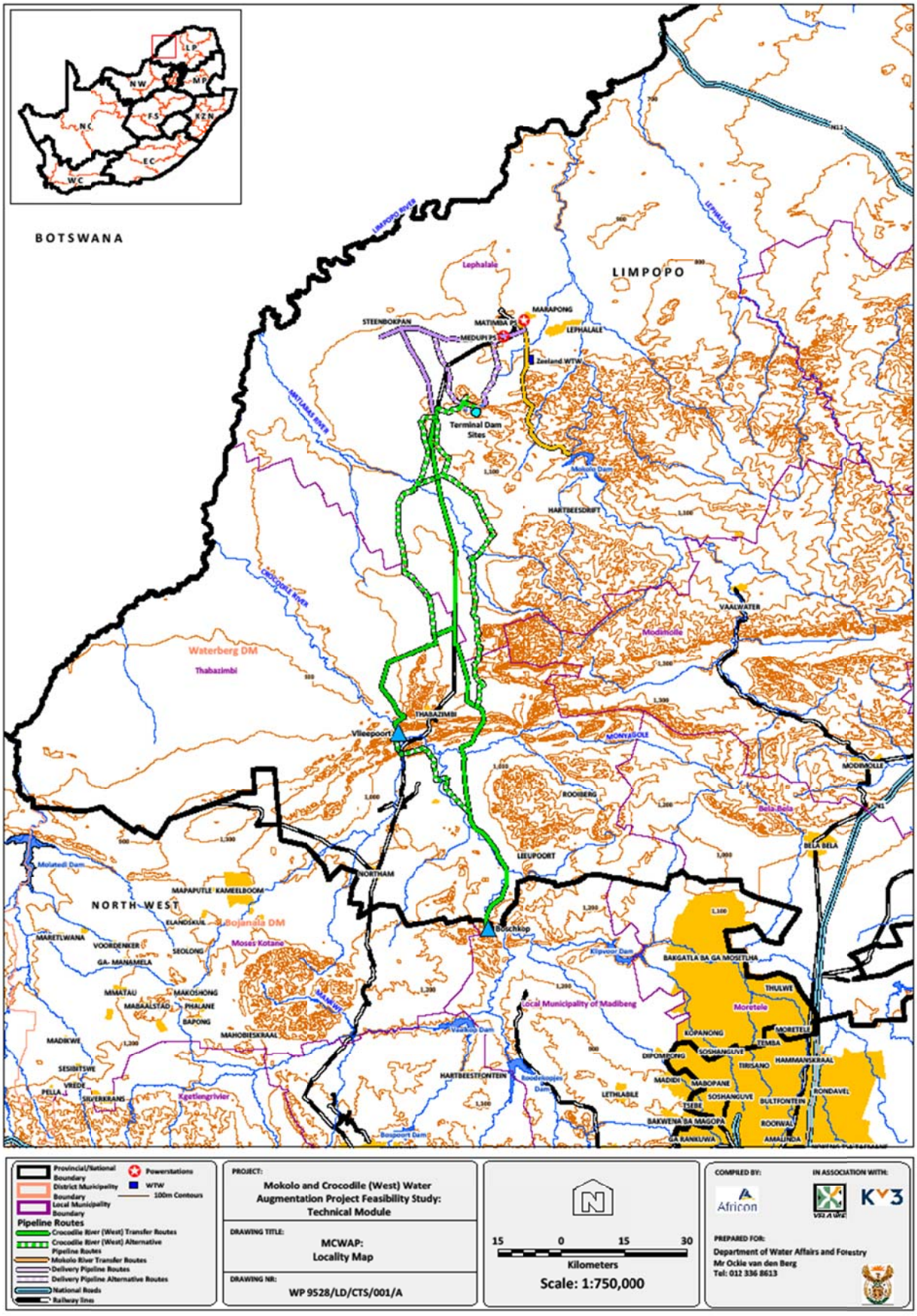


Figure 1-1: MCWAP Locality Map

2. ENVIRONMENTAL OVERVIEW OF LIMPOPO PROVINCE

2.1 Physical Environment

Limpopo covers an area of 123 910 km^2, which is 10.2% of the surface area of South Africa. It has a diverse topography, with many interesting and valuable environmental features. The broad terrain patterns of the province are characterised by the Limpopo Plain forming the northern half of the province and the Bushveld basin surrounded by the Central Highland, which is bordered to the east by the Great Escarpment and the Eastern Plateau slope.

Looking at the landscape in more detail, specific features stand out as significant scenic areas. These include the tablelands and escarpments of the Waterberg complex, the low mountains of the Soutpansberg range and the Blouberg with the extensive plains towards the Limpopo River in the north. To the east are the very scenic high mountains of the Drakensberg range.

The mountainous areas of the province are of high scenic value and together with the Lowveld and northern plain areas have great eco-tourism potential for initiatives such as the African Ivory Route.

Limpopo falls in the summer rainfall region with the western part semi-arid, and the eastern part largely sub-tropical. The western and far northern parts experience frequent droughts. Winter throughout Limpopo is mild and mostly frost-free.

The province has limited surface and groundwater resources. Most of the water management areas are severely stressed and many people still do not have access to the accepted minimum supply of water. Most of the province relies on groundwater as a source of supply.

Water requirements for development (especially agriculture, mining and rural areas) are placing severe stress on the available water supply in the province.

Table 2-1: Surface Water Resources in Limpopo

River	Catchment (km^2)	MAP (mm)
Mokolo	14 409	533
Lephalale	6 725	469
Mogalakwena	19 314	481
Sand, Nzelele	19 972	453
Luvuvhu	5 941	627
Letaba	18 979	584
Olifants	54 563	631

The pressures on the physical and scenic resources include:

- Indiscriminate development in scenic and sensitive landscapes that could have a significant impact on tourism;
- Inappropriate development that could undermine the eco-tourism potential; and
- Land degradation that is increased by the pressure of human activities, which reduces the natural production capacity of the province with severe long-term consequences.

2.2 Key Water Management Issues

The key issues affecting water management in the province include:

- the imbalance between the supply and demand for water;
- inappropriate land uses in the river valleys;
- the impact of fertilisers and pesticides;
- inadequate monitoring;
- high concentrations of pit latrines in certain areas; and
- flood events and droughts.

2.3 Biological Environment

Limpopo falls within the greater savannah biome, commonly referred to as Bushveld, with a small representation of grassland and forest biomes. The rich biodiversity of Limpopo can be attributed to its biogeographical location and diverse topography. Three regions unique to the province (centres of endemism) occur in Limpopo. They are the Drakensberg Escarpment (including Wolkberg), Sekhukhuneland and Soutpansberg.

The natural forests occurring in Limpopo include about 19 000 ha of northern mist belt forest and a few small pockets of Afromontane forest. Turf thornveld and Pietersburg false grassveld are also important and threatened vegetation types that occur in Limpopo. There are about 170 identified rare and threatened plants in the province, many of which are used as medicinal plants.

There are currently 52 provincially protected areas in Limpopo Province totalling 335 601 ha, which, excluding the South African National Parks areas of the Kruger National Park, Vembe-Dongola and Marakele National Parks, accounts for 5.06% of the total area of the province.

There are two established biosphere reserves in the province: the Kruger to Canyons Biosphere Reserve and the Waterberg Biosphere Reserve. Significant private conservation initiatives such as Western Soutpansberg Conservancy, Limpopo Valley Conservancy, and Makapans Valley Conservancy are also under way.

In addition, there are 28 registered natural heritage sites in Limpopo as well as numerous private conservation areas which contribute significantly to environmental management in the province.

Ridges and mountains are considered to have a high conservation value for a number of reasons. Varied topography is recognized as one of the most powerful influences contributing to the high biodiversity of Southern Africa. Ridges are characterized by high

spatial heterogeneity due to the range of differing aspects (north, south, east, west and variations thereof), slopes and altitudes all resulting in differing soil (e.g. depth, moisture, temperature, drainage, nutrient content), light and hydrological conditions. The temperature and humidity regimes of micro sites vary on both a seasonal and daily basis, while variation in soil drainage and elevation has been found to be especially important predictors of biodiversity.

A list of species in need of special protection is listed in the **Transvaal Ordinance of 1983**. Many of these species occur in the study area and would need a special permit in terms of the ordinance for removal or transportation of such species.

Most of the larger mammal species are well represented in Limpopo. Some habitat-specific mammal species are more vulnerable and are restricted to small distribution ranges, such as Gunning's Golden Mole, *Amblysomus gunningi***,** which is endemic to Limpopo.

There are several important bird areas in Limpopo, including the renowned Nylsvlei floodplain.

The total number of amphibians species found in Limpopo is 46 species. The Transvaal forest rain frog, *Breviceps sylvestris,* is endemic to the Province.

Limpopo supports 148 species of reptiles, which is indicative of high diversity. Ten endemic reptile species occur in Limpopo, some of which are range restricted to the centres of endemism. The only known extinct South African reptile, Eastwood's Longtailed seps, *Tetradactylus eastwoodi*, occurred here.

The following faunal species, amongst others, occur in Limpopo and are of particular conservation concern:

Table 2-2: Faunal Species of Particular Conservation Concern

Class	Common Name	Scientific Name	Threat Status	Picture
Mammalia	Black Rhinoceros	Diceros bicornis	CR	
Mammalia	African Wild Dog	Lycaon pictus	EN	

Class	Common Name	Scientific Name	Threat Status	Picture
Reptilia	Striped Harlequin Snake	Homoroselaps dorsalis	NT	
Mammalia	Ground Pangolin	Manis temminckii	NT	
Mammalia	White Rhinoceros	Ceratotherium simum	NT	
Aves	Pallid Harrier	Circus macrourus	NT	
Aves	Corn Crake	Crex crex	NT	
Aves	Taita Falcon	Falco fasciinucha	NT	
Aves	Great Snipe	Gallinago media	NT	

Class	Common Name	Scientific Name	Threat Status	Picture
Aves	Latakoo Lark	Mirafra cheniana	NT	
Mammalia	Wood's Slit-faced Bat	Nycteris woodi	NT	
Aves	Lesser Flamingo	Phoenicopterus minor	NT	
Mammalia	Cheetah	Acinonyx jubatus	VU	
Mammalia	Percival's Trident Bat	Cloeotis percivali	VU	
Aves	Lesser Kestrel	Falco naumanni	VU	
Aves	Cape Griffon	Gyps coprotheres	VU	

Class	Common Name	Scientific Name	Threat Status	Picture
Mammalia	African Elephant	Loxodonta africana	VU	
Mammalia	Lion	Panthera leo	VU	
Aves	Lappet-faced Vulture	Torgos tracheliotus	VU	

CR – Critical; EN – Endangered; NT – Near Threatened; VU – Vulnerable

The province hosts a rich invertebrate diversity in all habitat niches. Many relict species that are very specific range restricted are associated with the centres of endemism in the province. Invertebrates are currently a core focus of the Provincial River Health Programme initiative.

The biodiversity of Limpopo is a strategic resource. It provides the livelihood for many rural households, which include material for shelter, fire wood, medicinal plants, and food. The growing ecotourism industry also relies on the biodiversity of Limpopo. The potential for sustainable utilisation of biodiversity is still largely untapped. With appropriate policies and management the untapped wealth of the province can be converted into sustainable income through activities that capture the value of resource utilisation. Such activities may include; bio-prospecting for medicinal products, the sustainable trade in faunal species, game farming and trophy hunting.

Pressures

The following pressures threaten biodiversity:

- the impact of irresponsible human activities on natural habitats;
- the conflict between conservation and development needs;
- unsustainable use of biodiversity;
- poverty;
- inadequate collective strategic thinking and planning; and
- ignorance regarding the importance of biodiversity.

Table 2-3: Conservation Status of Veld Types (Acocks) in the Province

Veld Type	Size (ha)	Size of veld type in Limpopo (ha)	% of veld type in Limpopo	% modified	% total conserved (Nationally	% conserved in Limpopo
North-Eastern Mountain Sourveld	952 840	752 474	78.97	45	18.39	6.89
Lowveld Sour Bushveld	1 194 180	790 337	66.18	76	8.45	0.59
Lowveld	2 379 110	178 369	7.49	23	20.26	0.28
Arid Lowveld	1 900 450	1 147 683	60.39	22	31.73	1.75
Arid Sweet Bushveld	**1 822 050**	**1 720 890**	**94.44**	**23**	**0.59**	**0.59**
Mopanie Veld	2 086 800	2 027 848	97.17	7	43.54	2.67
Kalahari Thornveld	13 008 190	19 078	0.14	2	0.38	0.0046
Mixed Bushveld	**3 986 720**	**2 895 218**	**72.62**	**36**	**3.88**	**2.00**
Sourish Mixed Bushveld	**3448 180**	**995 065**	**28.85**	**27**	**1.35**	**0.52**
Sourish Bushveld	**1 301 870**	**1 117 523**	**85.83**	**28**	**5.1**	**3.56**
Turf Thornveld	**587 900**	**494 137**	**84.05**	**94**	**0,27**	**0.27**
Pietersburg False Grassveld	248 900	248 900	100	88	0.62	0.62
North-Eastern Sand Highveld	1 475 200	92 934	6.29	52	0.05	0.04

The veld types specifically relevant to the study area have been highlighted above. A more detailed description will follow later.

A list of species in need of special protection is listed in the **Transvaal Ordinance of 1983**. Many of these species occur in the study area and would need a special permit in terms of the ordinance for removal or transportation of such species. Some of these species are listed below.

Table 2-4: Endangered Vegetation Types

Common Name	Scientific Name
All species of tree moss	Genera *Porothamnium, Pilotrichella* and *Papillaria*
All species of ferns other than the bracken fern	Division Pteridophyta, except *Pteridium aquilinum*
All species of yellowwood	Genus *Podocarpus*
All species of wild cypress	Genus *Widdringtonia*
Borassus palm	*Borassus flabellifer*
All species of arum lilies	Genus *Zantedeschia*
All species of Agapanthus except improved plants	Genus *Agapanthus*

Common Name	Scientific Name
All species of cycads	Genus *Encephalartos*

Endangered Species		
Family	**Scientific Name**	**Common Name**
Zamiaceae	*Encephalartos cupidus*	
	Encephalartos inopinus	Lydenburg Cycad
	Encephalartos laevifolius	Kaapsche Hoop Cycad
Orchidaceae	*Nervilia purpurata*	
Euphorbiaceae	*Euphorbia barnardii*	
	Euphorbia perangusta	

Vulnerable Species		
Family	**Scientific Name**	**Common Name**
Zamiaceae	*Encephalartos eugene-maraisii*	Waterberg Cycad
	Encephalartos heenanii	Wooly Cycad
	Encephalartos humilis	
	Encephalartos ngoyanus	
	Encephalartos paucidentatus	Barberton Cycad
Liliaceae	*Aloe albida*	White Grass Aloe
	Aloe monotropa	
Iridaceae	*Gladeolus pretoriensis*	
Proteaceae	*Protea curvata*	Barberton Lowveld Protea
Crassulaceae	*Kalanchoe crundallii*	
Euphorbiaceae	*Euphorbia groenewaldii*	
	Euphorbia knobelii	
	Euphorbia rowlandii	
	Euphorbia tortirama	
Canellaceae	*Warburgia salutaris*	Pepper-bark Tree
Asclepiadaceae	*Orbea maculata*	
	Stapelia clavicorona	
	Huernia nouhuysii	

2.4 Social Environment

Limpopo is divided into six (6) districts and 26 local municipalities. Polokwane is the capital of the province, and the centre of government and commerce in the province. It serves as the regional service hub for a wide area, which includes parts of Zimbabwe and Botswana. Phalaborwa, Thabazimbi, Burgersfort and Lephalale are centres closely associated with mining activities, while Tzaneen is surrounded by subtropical fruit, tea and coffee plantations. The towns of Bela-Bela, Modimolle, Mokgopong, Groblersdal and Marble Hall are associated with mixed dryland agriculture. Mokopane is cattle country while Vaalwater is fast becoming a major service centre for a growing eco-tourism industry in the Waterberg Biosphere Reserve. Thohoyandou and Giyani are important centres that service vast areas of rural settlements in the north of Limpopo.

There are about 2 450 settlements with approximately 1 180 000 households in Limpopo. The majority of these settlements are in the former homeland areas namely, Gazankulu, Venda and Lebowa. Most of these settlements are not natural settlements (from an economic and demographic point of view) and very few of these settlements have developed a sustainable local economic base. Households survive mainly on grants, contributions from breadwinners who migrate to urban centres and on income generated from commuting to farms or towns. Most of the household purchasing, consequently, takes place in the towns and migrant destinations outside the rural communities.

Most of the households (69%) in the province live in formal houses or brick structures while a significant portion (20%) lives in traditional houses. A relatively small number of households live in informal dwellings (6.6%). The rest of the households live in other forms of housing.

Piped water in dwellings is available in 11% of households and in the yards of 34% of households in Limpopo. Community standpipes within 200 m of dwellings serve 18.5% of households while 28% of households are served by standpipes, which are further than 200 m away from dwellings. The rest of the households obtain water from other sources such as boreholes, springs, rivers and dams.

The majority of households (59%) use pit latrines for sanitation. Flush toilets are available in 16% of households most of which are connected to municipal sewage systems. A large number of households (23%) do not have access to toilet facilities. The rest use either bucket latrines or chemical toilets.

The possible pipeline routes and other associated works will occupy mostly agricultural areas comprising a mixture of cultivated lands, livestock farms and game farms.

3. BACKGROUND TO TRANSFER SCHEME

3.1 Background for Pipeline Options and Design

The primary purpose of the MCWAP is to investigate the options to transfer water from the Mokolo and Crocodile River (West) to the Lephalale area to supply the primary and industrial users in this fast developing area.

Various options have been identified to convey water to the end users. These include the Crocodile River (West) Transfer System, as well as the Mokolo Conveyance System. The latter is intended to supply the immediate short-term before water requirements the Crocodile River (West) Transfer System has been constructed and to support the reliability and redundancy requirements once the Crocodile River (West) Transfer System is operational. The combined Mokolo and Crocodile River (West) scheme is illustrated by Figure 3-1, showing the different components making up the total scheme options. The infrastructure components associated with the different systems are described later in this report, as well as in other supporting reports listed in the front of this document.

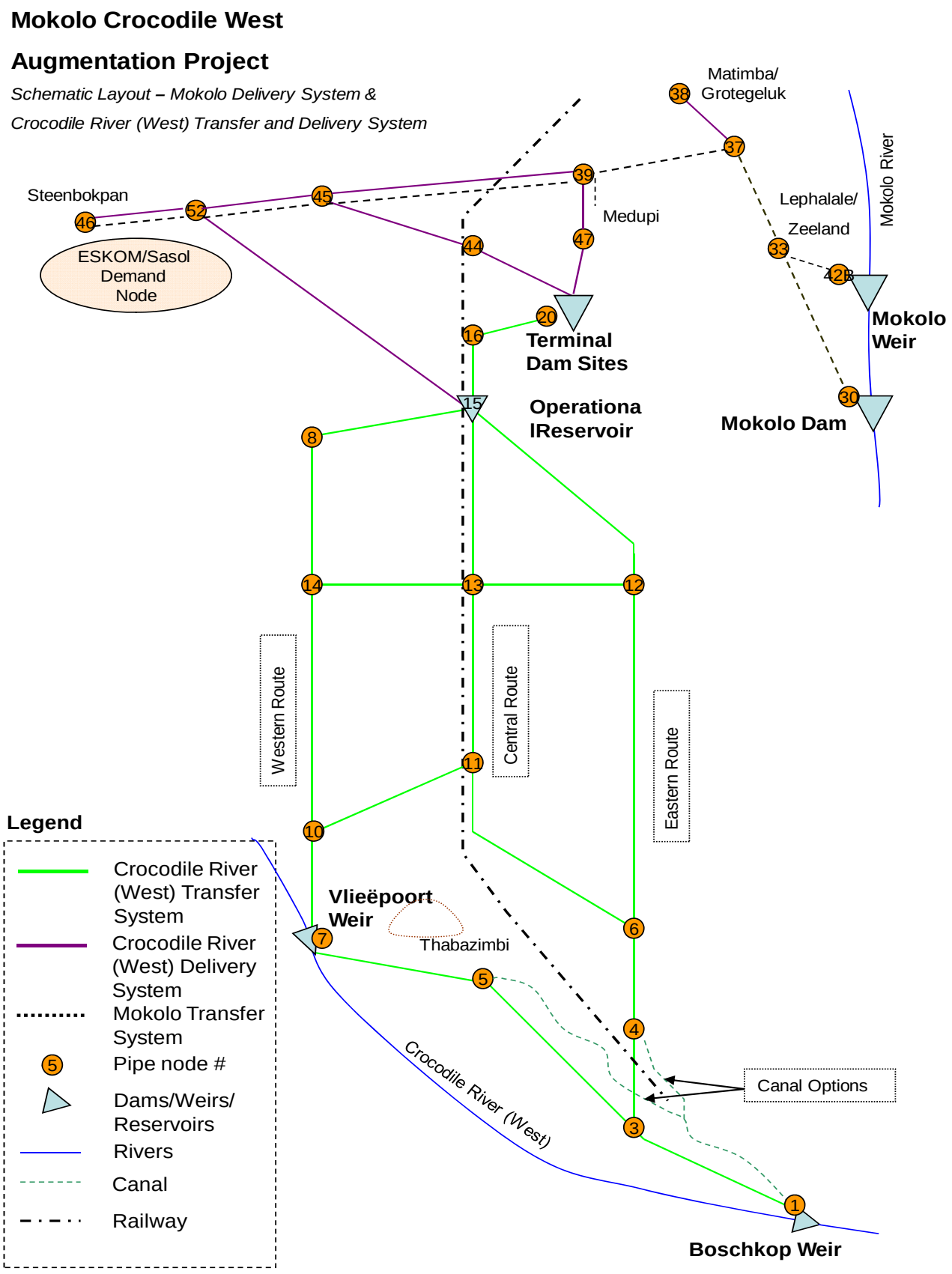


Figure 3-1: MCWAP Project - Scheme Components

The MCWAP Project will be implemented in phases with a number of sub-options as follows:

- **Phase 1:** Augment the supply from Mokolo Dam:
  - Phase1A – Provide a net annual average delivery capacity of 53,4 Million m^3/a by implementing either one of the following options:
    - Option 1 – Pipeline from Mokolo Dam to the Lephalale and Steenbokpan demand areas.
    - Option 2 – Weir in the Mokolo River downstream of the dam and pipeline to Lephalale and Steenbokpan.
- **Phase 2:** Transfer scheme from the Crocodile River (West) to the demand area via a system consisting of:
  - Various potential pipeline routes. Three general routes have been identified – East, Central and West.
  - A number of different weir and abstraction work sites.
  - Terminal and/or on-site storage:
    - Terminal dam options providing 18 days storage together with Balancing Reservoirs at the end user sites with minimum nine (9) days storage plus additional user requirements to achieve the required balancing capacity and emergency storage; this is to provide for the reliability required for the gravity pipeline from the Terminal Dam.
    - Alternatively, an operational reservoir at, Node 15 supplying water to end user Terminal Reservoirs consisting of seven (7) on-site reservoirs with 18 days storage capacity plus additional user requirements to achieve the required balancing capacity and emergency storage.
  - Two approaches:
    - Un-phased (full capacity) scheme implemented in a single construction phase with an ultimate net transfer capacity of 191 Million m^3/a (excluding system losses).
    - Phased approach where the capacity is provided through two parallel pipelines constructed during two consecutive construction phases.
      1) Phase 2A – First phase pipeline from the abstraction site weir with a net transfer capacity of 110 Million m^3/a.
      2) Phase 2B – Second phase pipeline from the abstraction site weir to achieve ultimate required total net transfer capacity of 191 Million m^3/a.
- **Phase 3:**
  - Third construction phase during which a pipeline is built from Boschkop to Vlieëpoort weirs to link with the infrastructure built during Phase 2 in order to reduce river losses between the Boschkop and Vlieëpoort Weir sites.

Transfer of water from the Klip River to the Crocodile River (West) is being investigated under other DWA assignments. For the purposes of this investigation it was confirmed

by DWA that sufficient flow would be made available at the planned abstraction sites at an acceptable assurance of supply.

The conveyance system options for each of the afore-mentioned schemes will be investigated by taking into consideration various environmental aspects. There are highlighted hereinafter.

3.2 Potential Environmental Impacts: Pipeline, Canal and Weir Construction

3.2.1 Pipeline Construction

The construction of a pipeline could have numerous environmental impacts, including the following (construction and operational phase), if not adequately addressed:

- Destruction of vegetation
- Faunal habitat loss
- Soil erosion
- Hydrocarbon pollution of soil, ground and surface water
- Air pollution (dust during blasting and drilling)
- Noise pollution

3.2.2 Canal Construction

The construction of a canal has much of the same impacts as a pipeline. Contrary to a pipeline, however, the canal is a permanent open structure that will not allow for the re-growth of all the natural vegetation. The initial removal of vegetation is also bigger than the construction of a pipeline. The canal also limits the utilisation of the full extent of farming areas, should it bisect farming areas. The biggest environmental impact, especially in this intensive game farming area, is the fragmentation of habitat and limiting the migration of faunal species. The natural movement of faunal species for foraging and breeding purposes will be restricted due to the inability to cross the canal. Although the construction of game crossing bridges may solve the migration for the larger mammal species, smaller mammal, reptile and amphibian species will be isolated and be at risk of drowning. This may potentially lead to a decline of the population numbers. Additional impacts to pipeline construction therefore include:

- Habitat fragmentation;
- Restriction of migration and foraging routes; and
- Injuring or Drowning of animals.

3.2.3 Weir and Abstraction Works Construction

The construction of a new weir or the enlargement of an existing one will have an impact on the flow of the river and therefore affect the ecosystem upstream and downstream of the weir. Although it is not the intention of the weir to act as a storage method, the water levels will be raised for a distance upstream. The peak flows during flood conditions have the potential to overflow the normal floodplain of the river more frequently damaging the surrounding ecosystems. The migration of fish species will also be disrupted due to the construction of a weir, while the siltation caused by the reduction in flow speed may significantly alter the natural habitat of certain fish species in the area affected upstream of the weir. The reduction in flow speed may also contribute to the introduction of wetland floral species such as reeds. Additional impacts to the pipeline construction may include:

- Flooding of upstream terrestrial ecosystems; and
- Altering riverine ecosystem.

3.2.4 Study Area Vegetation Types

The Study Area is characterised by five (5) distinct vegetation types of which one is listed as vulnerable (Central Sandy Bushveld) and the other four as least threatened. The vegetation types include: Western Sandy Bushveld (Mixed Bushveld, Acocks), Dwaalboom Thronveld (Turf Thornveld; Acocks), Waterberg Mountain Bushveld (Sourish Bushveld; Acocks), Central Sandy Bushveld (Sourish Mixed Bushveld; Acocks) and Limpopo Sweet Bushveld (Arid Sweet Bushveld; Acoks). A description of the vegetation type is provided below to prevent repetition for every pipeline or canal section.

- The **Central Sandy Bushveld (CSB)** exist in low undulating areas, sometimes between mountains, and sandy plains and catenas supporting tall, deciduous *Terminalia sericea* and *Burkea africana* woodland on deep sandy soil and low, broadleaved Combretum woodland on shallow, rocky or gravely soil. The most important taxa, endemic to this region are *Mosdenia leptostachys* and *Oxygonum dregeanum*. The veld type in general is classified as vulnerable and poorly protected with only approximately 4.5% conserved. Approximately 24% of the veld type is transformed, including 19% agriculture and 5% urban and built up areas.
- The **Waterberg Mountain Bushveld (WMB)** generally occurs on rugged mountains with vegetation ranging from *Faurea seligna – Protea Caffra* bushveld on the higher slopes through broad leaved deciduous bushveld on rocky mid- and footslopes to *Burkea Africana – Terminalia sericea* savannah in the lower lying valleys, as well as on deeper sands on the plateau. The grass layer is moderately or well developed. Endemic taxa to this veld type include tall shrub *Grewia rogersii, Pachystigma triflorum* and herb *Oxygonum dregeanum*. This veld type is regarded as least threatened with about 9% statutorily conserved. Only about 3% of the veld type is transformed.
- The **Limpopo Sweet Bushveld (LSB)** occurs mainly on plains and sometimes undulating or irregular topographical area. The veld type is characterised by short open woodland with previously disturbed areas dominated by thickets of *Acacia erubescens*, *Acacia Mellifera* and *Dichrostachys cinerea* that are almost impenetrable. The veld type has no endemic taxa and is considered least threatened. Although only about 1% is statutorily conserved, the abundance of games farms in the area adds to the low transformation figure of about 5%.
- The **Western Sandy Bushveld (WSB)** vegetation type varies from tall open woodland to low woodland with broad-leaved, as well as microphylous tree species being dominant. Dominant species include *Acacia erubences* on the flatter areas, *Combretum apiculatum* on shallow gravely soils and *Terminalia sericea* on deep sandy areas. This vegetation type does not have any endemic species and is about 4% transformed.
- The **Dwaalboom Thornveld (DT)** occurs on plains with layers of scattered, low to medium high, deciduous microphyllous trees and shrubs with a few broad-leaved tree species and an almost continuous herbaceous layer dominated by grass species. *Acacia tortilis* and *Acacia nilotica* dominate in area with a medium clay percentage. On heavier clay areas most woody species are excluded or diminutive. The vegetation type does not contain any endemic species with about 14% transformed. On the clays, woody plant biomass is generally low and productivity of woody plants is generally lower than herbaceous plants. This area with ultramafic soils is low in species diversity and endemic species.

4. ENVIRONMENTAL FEASIBILITY OF CROCODILE TRANSFER SYSTEM

4.1 Boschkop Abstraction to East West Alternative Split (Sections 1 - 2)

The Boschkop Weir is the first alternative abstraction site for the transfer scheme. Two sites have been identified as possible sites namely Lower Boschkop and Nooitgedacht. There is an existing stone weir at Boschkop that may be upgraded for the abstraction works or a new weir will have to be built.

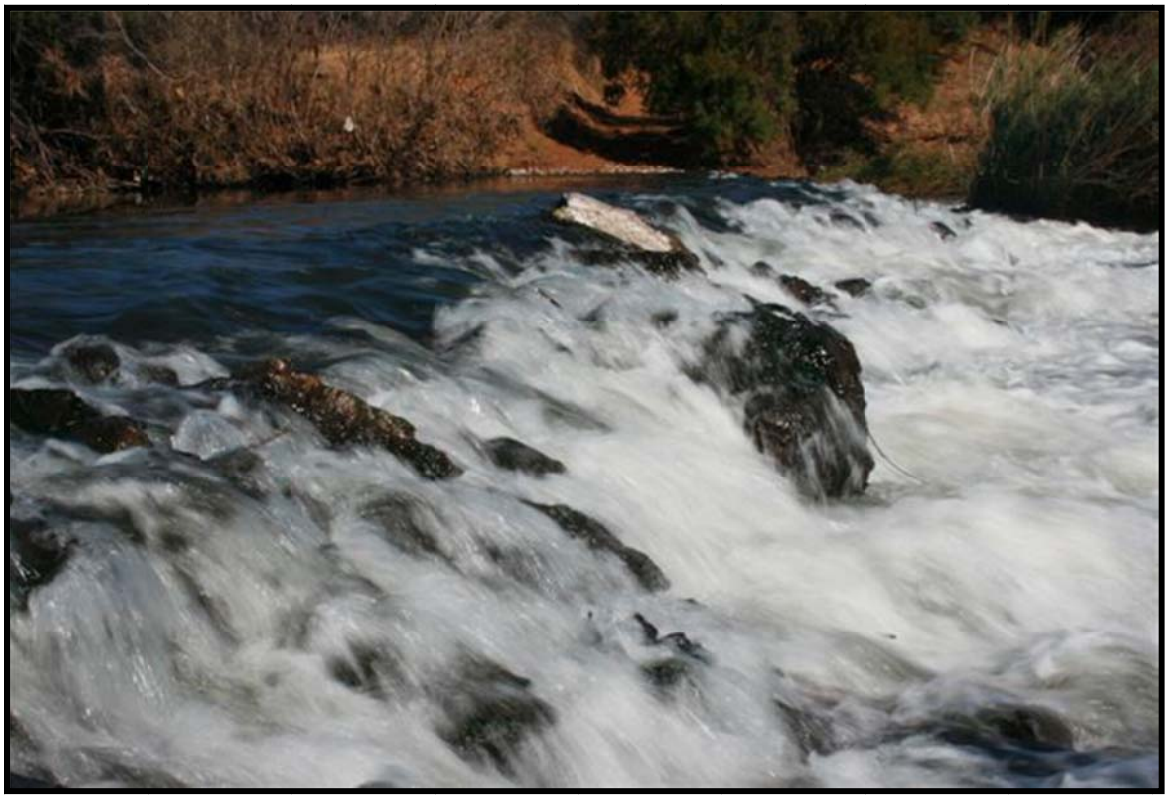


Figure 4-1: Stone Weir at Boschkop

The main impacts of the construction or the upgrading of a weir have been indicated earlier in the document.

The pipeline from there continues north for approximately 20 km to where the western and eastern alternatives split on the Farm Rietfontein. The alignment of the pipeline is mainly on the eastern side of the R511 to avoid the large number of centre pivots irrigation installations located in the floodplain area on the western side of the R511.

4.1.1 Floral Feasibility

The natural vegetation on this section of the pipeline has been mainly transformed to agriculture with a large number of centre pivots evident along the route. Most of these are however located on the western side of the R511. The land use on the eastern side is a mixture of game farms, livestock farming and agricultural activities.

Due to the large percentage of transformed vegetation along the pipeline route it is not expected to contain any sensitive habitats or threatened or endangered species.

4.1.2 Faunal Feasibility

The transformation of the floral habitat along this section of the route has diminished the possibility of the occurrence of a large number of faunal species. This is especially the case where domesticated animals have been introduced into the area. Most of the faunal species will occur on the game farms along the route. The alignment of the pipeline is such that it will have minimal impact on the faunal species. The disturbance caused by the pipeline is also short term. The construction of a canal will have the same short-term impacts as the pipeline, but a lasting operational impact due to the exposed nature of the canal.

4.1.3 Hydrological Feasibility

This section of the pipeline does not cross any significant water features along the proposed alignment. The construction of a weir will however have an impact on the flow characteristics of the river that may in turn alter the riverine ecology. The provision of fish ladders at the weir will reduce the impact on fish migration in the river.

4.2 Western Alternative (Sections 3 - 4) and Vlieëpoort Abstraction Works

This section of the western route maintains its course to the east of the R511 till the Farm Grootkuil where it veers to the west along the farm boundaries. It continues North West along farm boundaries and roads to the Vlieëpoort pump station site.

The land use in this area is dominated by agricultural activities, in the form of crop production, especially along sections 1 - 2 with large numbers of centre pivots along the alignment. Most of these centre pivots are distributed in close proximity to the R511 and the Crocodile River. This can be attributed to the availability of water abstraction from boreholes close to the river. The remainder of this section is dominated by game and livestock farming.

4.2.1 Floral Feasibility

The southern part of this section is dominated by transformed agricultural lands under irrigation. This makes the occurrence of sensitive floral habitats unlikely. The remainder of the route is predominantly livestock and game grazing areas. Certain areas show distinct signs of overgrazing. Both vegetation types along this section namely DT and WMB are described as least threatened.

4.2.2 Faunal Feasibility

The presence of game farms along this section has introduced several mammal species into the area. There is a relatively high species richness that may be affected during the pipeline construction. The pipeline alignment will however mostly follow existing farm boundaries limiting the potential impact on the faunal habitat.

The construction of a canal will have the same short-term impacts as the pipeline, but a lasting operational impact due to the exposed nature of the canal.

4.2.3 Hydrological Feasibility

The proposed pipeline route crosses the Crocodile River on the Farm Haakdoringdrift 374 KQ, as well as on the Farms Grootfontein 352 KQ and Mooivallei 342 KQ. Although the crossing of a river does not present a fatal flaw in the route it should be noted that river ecosystems are more sensitive than a terrestrial ecosystems. More care should therefore be given to the design of the crossing to minimise disturbance to these areas.

4.3 Western Route (Sections 24, 7, 9 & 5)

This section of the route does not maintain its alignment with either the road or the farm boundaries in certain sections. It will therefore have a more significant impact on both the fauna and flora in the area. The area is also dominated by game farming that is more vulnerable to fragmentation of their natural habitat. Although the construction activities will be short term, the faunal species will have their migration, feeding and breeding habits affected.

4.3.1 Floral Feasibility

The proposed pipeline route runs through three different vegetation types namely, WSB, DT and LSB. All three the veld types have been listed as Least Threatened (LT), meaning that the veld type is not considered as threatened. This can be attributed to the fact that the veld is relatively conserved due to the number of game farms in the area.

There are several sections where the pipeline alignment strays from the farm boundaries and roads. In these areas alignments must take into account the size and location of the fragmented land when construction starts.

4.3.2 Faunal Feasibility

This section once again mainly traverses game farms and therefore has relatively high species richness. As indicated previously the short duration of the disturbance during the construction activities will result in the faunal species returning after construction.

4.3.3 Hydrological Feasibility

There is one river significant crossing in this section of the pipeline on the Farm Inkerman 10 KQ. Although the crossing of a river does not present a fatal flaw in the route, it should be noted that river ecosystems are more sensitive than a terrestrial ecosystems. More care should therefore be given to the design of the crossing to minimise disturbance to these areas.

4.4 Central Route (Sections 19, 21, 18, 16 &19)

The central route runs along the railway line from Thabazimbi to Lephalale. The railway line has a maintenance road running adjacent to the railway line. The Central Option also includes small sections of connecting pipelines options between the Central, Western and Eastern Options, respectively. Section 16 leads from the proposed Terminal Dams to the transfer scheme pipeline, as well as the delivery system from the Mokolo Dam.

4.4.1 Floral Feasibility

The maintenance track running next to the railway line has resulted in most of the vegetation having been cleared in this area. The pipeline will however run outside the rail reserve. The vegetation types along the route consist of WSB and LSB. Both these vegetation types are listed as least threatened. Due to the pipeline alignment with the railroad line it does not bisect any significant farm areas and therefore the pipeline will not lead to further fragmentation. The small connection pipeline sections do traverse current agricultural land that may lead to disturbance of existing vegetation. Due to the relatively small length of the connecting pipelines and the nature of the pipeline these disturbances should however be of a temporary nature.

Figure 4-2: Railway Line and Maintenance Road

4.4.2 Faunal Feasibility

The railway corridor has been cleared of much of the natural habitat reducing the occurrence of faunal species in the area. Although much of the natural vegetation has re-established itself, the proposed pipeline will be on the boundary of the surrounding game farms and therefore will have a minimal impact. The regular passing of a train will further prevent the occurrence of many faunal species.

4.4.3 Hydrological Feasibility

The central route crosses only one significant hydrological feature along its alignment. The crossing of the river by the pipeline should where possible coincide with the crossing of the river by the railway. The area has already been disturbed and the river crossing for the pipeline should not be that significant.

4.5 Eastern Route (Sections 23, 22, 20 &14)

The Eastern Route runs to the east of Thabazimbi and strives to run along road and farm boundaries as much as possible. This is evident from the relatively twisty alignment of the route. The route runs along the Hoopdaal dirt road that bisects the Marakele Nature Reserve.

4.5.1 Marakele Nature Reserve

Approximately 55% of the park is characterized by the WMB vegetation type (veld type 12). This vegetation type occurs in the intermediate to high lying areas in the southern and south-eastern portions of the park. This area is characterized by relatively high rainfall (about 719 mm) and the resultant leaching of the soils results in a fairly low soil

nutrient status. This limiting factor in turn results in a fairly low carrying capacity and only ubiquitous species such as kudu and common reedbuck are common in these areas. This vegetation type is characterized by Transvaal beechwoods (*Faurea salinga*), proteas (*Protea caffra*) and stem fruit trees (*Englerophytum magaliesmontanum*). The vegetation along the tarred road leading to the towers is typical of the vegetation type.

Another major vegetation type is the Mixed Bushveld, which covers approximately 42% of the park. This vegetation type is mainly found in the north-western and isolated south-western pockets of the park. It occurs predominantly on the undulating to flat plains and the soils are generally clayey, deeper and more nutrient-rich. Most of the charismatic game species such as black rhino, elephant and wild dog will be associated with this vegetation type. This vegetation type is characterized by species such as silver cluster leaf (*Terminalia sericea*), sickle bush (*Dichrostachys cinerea*) and round-leaved teak (*Pterocarpus rotundifolias*).

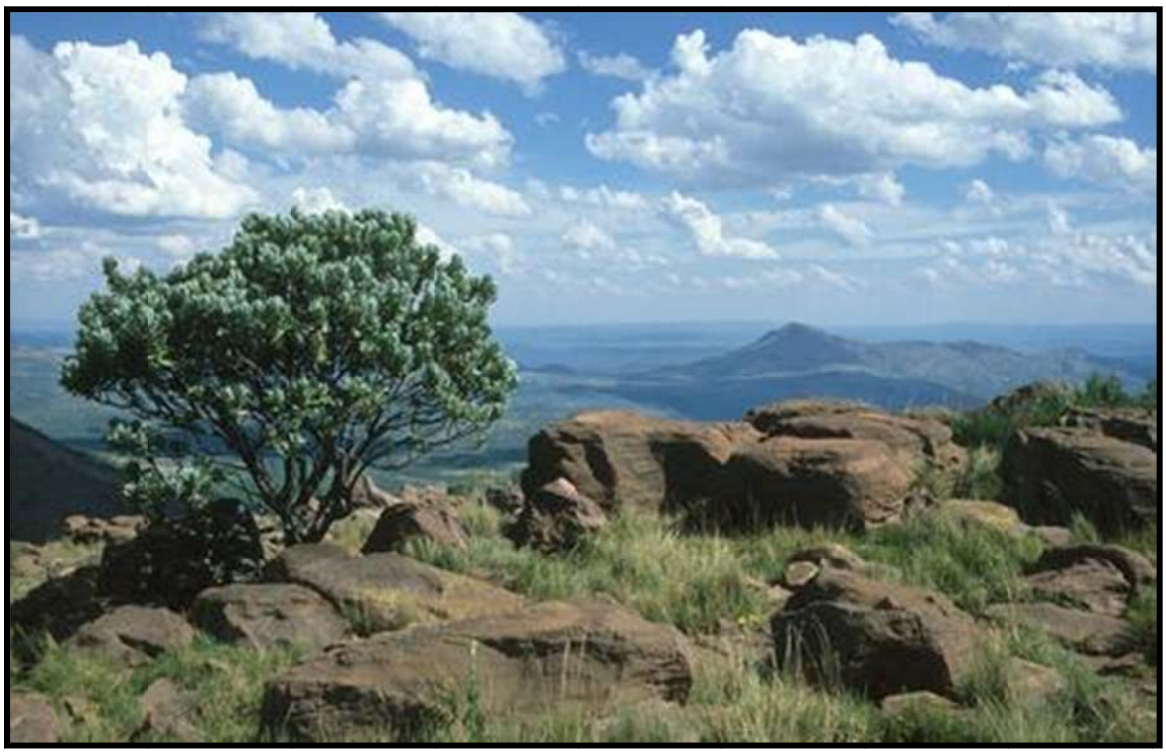


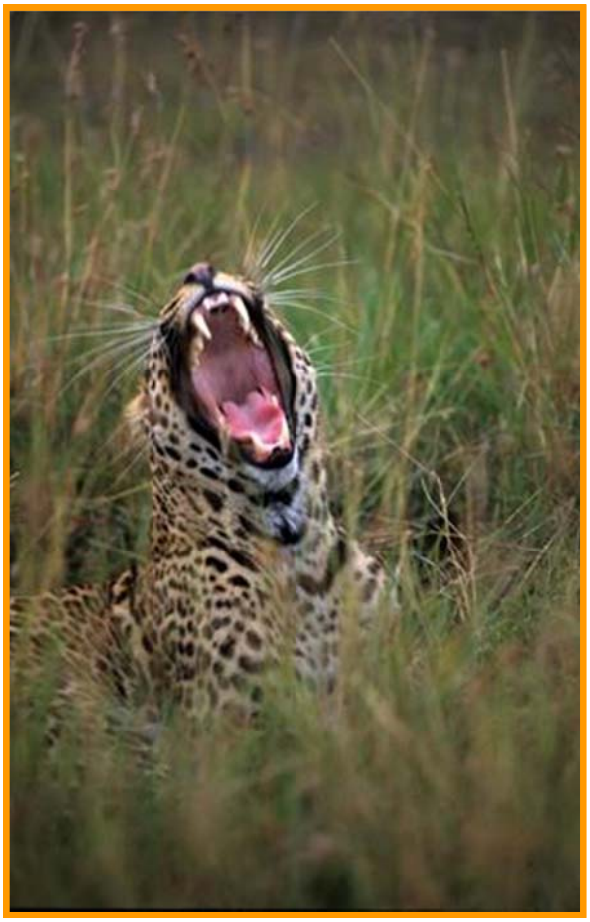
Figure 4-3: Marakele Nature Reserve

The vegetation around the camping site and tented camp is typical of this vegetation type.

Less than 3% of the park is comprised of Arid Sweet Bushveld. This vegetation type is mostly found along the banks of the Matlabas River and forms an important winter refuge area for game particularly during limited periods at the end of the dry season. The planned western expansion of the park will include more of this vegetation type, which is crucial to sustain adequate numbers of prey species for large predators such as lion and spotted hyena.

One of the rare and threatened plant species of Marakele is the Waterberg cycad (Waterbergbroodboom) *Encephalartos eugene-maraisii*. The naturalist, author and poet Eugene Marais lived in the Waterberg for 16 years and this cycad was named in his

honour. This cycad is endemic to the Waterberg region and grows to 5 m tall among low shrubs at an altitude of 1 450 m.



From its Waterberg Cycads to Yellow-woods and Camel Thorns, Marakele National Parks supports about 765 plant species (Sanparks).

Marakele is home to most of the large mammals synonymous with the African bush, including elephant, black and white rhino, buffalo, leopard and cheetah.

4.5.2 Floral Feasibility

The proposed Eastern Route runs through several vegetation types namely, CSB, LSB, WMB and WSB. The CSB is listed as vulnerable due to the low conservation percentage nationally.

The Marakele National Park is home to several cycad species that are protected by legislation. They occur generally in the more rocky areas of the reserve. Although these cycads have been documented within the park they in all likelihood also occur in similar areas outside the park. The proposed pipeline route will pass in close proximity to some of these rocky areas. It is extremely difficult to transplant cycads due to their specific habitat requirements.

Due to the status of the national park it will also be more difficult with stringent requirements to get the approval from SANParks or the National Department of Environmental Affairs and Tourism for a pipeline and maintenance track.

The remainder of the pipeline to the north runs through relatively flat areas where there is not such a distinct habitat definition. Vegetation along the pipeline route will be able to be removed and transplanted if required.

4.5.3 Faunal Feasibility

There is high faunal species diversity, especially in the Marakele National Park. Due to the fact that the Nature Reserve is not divided into camps as many game farms are, there is also the problem of preventing the game from leaving the reserve should some of the fences be removed for construction purposes without providing temporary barriers. Most of the endangered or threatened species are also present within the Nature Reserve.

4.5.4 Hydrological Feasibility

The Eastern Route twice crosses tributaries of the Motlhabatsi River. Due to the relatively flat floodplain the river is prone to the development of potential wetland areas. These areas are highly sensitive to disturbance and should be avoided.

4.6 Pipeline Connection to Terminal Dam Sites (Sections 11 – 12 and 26 - 30)

Four terminal dam sites have been identified for the transfer scheme. There are various connection pipeline options for connecting the terminal dams with the transfer pipeline. Section 26 and 16 will transfer the water from the terminal dam sites to the various pipeline options.

4.6.1 Floral Feasibility

The vegetation is predominantly WSB and LSB. The area has several rocky outcrops that can be regarded as especially sensitive. This is due to the fact that many cycad species prefer rocky outcrop areas as their habitat. Special authorisation needs to be obtained to remove some of these species as indicated earlier in the report. These species may include:

- *Encephalartos dolomiticus*
- *Encephalartos dyerianus*
- *Encephalartos middelburgensis*
- *Encephalartos Eugene maraisii*
- *Encephalartos heenanu*
- *Encephalartos inopinus*
- *Encephalartos laevifolius*
- *Encephalartos lanatus*
- *Encephalartos lebomboensis*
- *Encephalartos ngoyanus*
- *Encephalartos villosus*
- *Encephalartos cupidus*
- *Encephalartos humilis*

4.6.2 Faunal Sensitivity

The rocky outcrops located within this portion of the pipeline route options are also a sensitive environment for many faunal species. These include klipspringers and many rodent and snake species. As indicated previously, the construction of a pipeline will have only short-term disturbance impacts where after most of the faunal species will return.

4.6.3 Hydrological Feasibility

This pipeline route options does not cross any significant hydrological features.

4.7 Supply Line to Proposed Water Users (Sections 31, 25A & 25B)

This portion of the pipeline route options will provide water to the prospective water users in the area. Most of the farm land in the area is the property of various mining companies or is in the process of being bought by them. The result is that there will be less fragmentation of habitat due to the consolidation of the farms. The proposed pipeline runs along the proposed road for the users in the area.

4.7.1 Floral Feasibility

The pipeline route is located within the LSB vegetation type that is listed as least threatened. The construction of a mine in the delivery area will in all likelihood be accompanied by the development of extensive infrastructure such as road and other services. The alignment of the pipeline should where possible coincide with the alignment of the other services to minimise the impact on the natural vegetation.

4.7.2 Faunal Feasibility

Due to the proposed mine development in the area, it is foreseen that there will be a severe change in the communities and population of faunal species that will occur. The area is currently used for game and livestock farming. The mining activities will in all likelihood reduce the faunal diversity significantly.

4.7.3 Hydrological Feasibility

This pipeline section does not cross any significant hydrological features.

4.8 Terminal Dams (Sites 1 – 4)

Four potential Terminal Dam sites have been identified and are mainly located on the Farm Witvogelfontein 362 LQ. The farm is mainly used as a game lodge and tourism. Site 1, however, will also inundate a portion of the farm Weidhoek 354 LQ. The sites have been specifically selected due to their location in valleys to maximise storage capacity. An alternative to the Terminal Dams is the construction of terminal reservoirs at the various end users.

4.8.1 Floral Feasibility

The vegetation is predominantly WSB and LSB. Both these vegetation types are listed as least threatened.

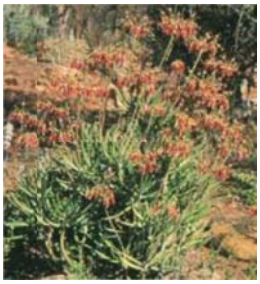
The area has several rocky outcrops in this specific study area that can be regarded as especially sensitive. This is due to the fact that many cycad species prefer rocky outcrop areas as their habitat. Special authorisation needs to be obtained to remove some of these species as indicated earlier in the document. These species may include:

- *Encephalartos dolomiticus*
- *Encephalartos dyerianus*
- *Encephalartos middelburgensis*
- *Encephalartos Eugene maraisii*
- *Encephalartos heenanu*
- *Encephalartos inopinus*
- *Encephalartos laevifolius*
- *Encephalartos lanatus*
- *Encephalartos lebomboensis*
- *Encephalartos ngoyanus*
- *Encephalartos villosus*
- *Encephalartos cupidus*
- *Encephalartos humilis*

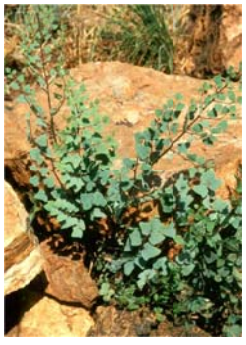
Communications with the owner of the Farm Weidhoek, Mr JK Koekemoer, indicated that a study was conducted by the CSIR[(1)] with regards to the occurrence of medicinal plants on the Farm Weidhoek and Van der Lindens Bult in 1972. The report indicated that several medicinal plant species do occur on the Farm Weidhoek and Van der Lindens Bult. Although the study area for the investigation did not include the Farm Witvogelfontein, it is expected that due to the relative similar nature of the topography and vegetation, that similar species may occur on the farm. The plants are at present not actively harvested. Species that have been noted in the area and may be present in the study area include:

The presence of the medicinal plants listed below will have to be verified at the sites during detailed investigations. Although not necessarily a fatal flaw in the positioning of a dam, the presence of these plants may cause some delays due to the authorisation process to remove and replant them. A relevant specialist in medicinal plants must be consulted as to which plants to relocate and where an appropriate place of relocation should be. The development of storage dams at the various end users would prevent the destruction of the relatively sensitive floral vegetation and is therefore the preferred option.

Table 4-1: Medicinal Plant Species

Species	Photo
Datura stramonium L	
Acacia karroo	
Hayne Cotyledon orbiculata	

Species	Photo
Crinum macowanii var. gratissimus	
Dicoma anomala	
Dombeya rotundifolia	
Euclea undulata var. undulata	
Eucomis autumnalis	

Species	Photo
Elephantorrhiza elephantina	
Gomphocarpus fruticosus	
Helichrysum coriaceum	
Olea europaea L. ssp. africana	
Pellaea calomelanos var. calomelanos	

Species	Photo
Scabiosa columbaria	
Scadoxus puniceus	
Sclerocarya birrea. ssp. caffra (Sond.) Kokwaro	
Typha capensis	

Species	Photo
Vernonia oligocephala	
Aloe marlothii subsp. Marlothii	
Ricinus communis L.	
Ziziphus mucronata Willd.	

4.8.2 Faunal Feasibility

The terminal dams are located on the Farm Witvogelfontein that is currently being operated as a game lodge and hunting farms. Several mammal species have therefore been introduced into the area.

The rocky outcrops located within the dam area are also a sensitive environment for many faunal species. These include klipspringers and many rodent and snake species. The construction of the dam will have major impacts on the surrounding environment. It will inundate the surrounding terrestrial environment thereby destroying the habitat for faunal species. Most faunal species will relocate by themselves. The area designated

for the dam should be walked and animal species removed. This is especially the case for reptilian species.

4.8.3 Visual Impact

The Farm Witvogelfontein is presently used as a game farm with a private game lodge. The construction of the terminal dams may have a significant visual impact depending on which of the dam sites are proposed. Due to the poor quality of the water there is a distinct possibility that the dam may be subject to algae growth. This will result in a severe visual impact.

4.9 Crocodile River Water Quality

The water from the Crocodile River (West) comes via the Hartebeespoort Dam that is highly polluted. Due to rapid urban development and industrial growth in the Hartebeespoort area, the volumes of water loaded with plant nutrients reaching the dam have increased. This results in the deterioration of the water quality and biodiversity due to a lack of oxygen. The dam acts as a nutrient trap in the presence of other environmental factors such as low rainfall and hot, windless weather.

The World Health Organisation provides the following information on the algae in the Hartebeespoort Dam (2005)[(2):]

The term algae refer to microscopically small, unicellular organisms, some of which form colonies and thus reach sizes visible to the naked eye as minute green particles. These organisms are usually finely dispersed throughout the water and may cause considerable turbidity if they attain high densities. Cyanobacteria are organisms with some characteristics of bacteria and some of algae. They are similar to algae in size and, unlike other bacteria they contain blue-green and green pigments and can perform photosynthesis. Therefore, they are also termed blue-green algae (although they usually appear more green than blue). Human activities (e.g., agricultural runoff, inadequate sewage treatment, runoff from roads) have led to excessive fertilization (eutrophication) of many water bodies. This has led to the excessive proliferation of algae and cyanobacteria in fresh water and thus, has had a considerable impact upon recreational water quality. In temperate climates, cyanobacterial dominance is most pronounced during the summer months, which coincides with the period when the demand for recreational water is highest.

Livestock poisonings led to the study of cyanobacterial toxicity, and the chemical structures of a number of cyanobacterial toxins (cyanotoxins) have been identified and their mechanisms of toxicity established. In contrast, toxic metabolites from freshwater algae have scarcely been investigated, but toxicity has been shown for freshwater species of Dinophyceae and also the brackish water Prymnesiophyceae and an ichthyotoxic species (Peridinium polonicum) has been detected in European lakes (Pazos *et al*; Oshima *et al*, 1989)[(3)]. As marine species of these genera often contain toxins, it is reasonable to expect toxic species among these groups in fresh waters as well. Although many species of freshwater algae proliferate quite intensively in eutrophic waters, they do not accumulate to form dense surface scums (often termed blooms) of extremely high cell density, as do some cyanobacteria. The toxins that freshwater algae may contain are therefore not accumulated to concentrations likely to become hazardous to human health or livestock. For these reasons, this chapter will focus primarily on the health impacts of cyanobacteria. More detailed coverage of cyanobacteria and human health is available in Toxic Cyanobacteria in Water (Chorus & Bartram, 1999)[(4)].

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The initial desktop analysis revealed that although there will be some difficulties in parts of the various alternatives routes, there seem no outright fatal flaws in the various alternatives. The Eastern Route, of the pipeline route alternatives, has potentially the biggest problem as it will run through a section of the Marakele National Park.

The Terminal Dams are mostly located on the Farm Witvogelfontein with some inundation of the Farm Weidhoek by a terminal dam. Several medicinal plant species have been found on the Farm Weidhoek. However, there is a distinct possibility that the medicinal plants will also occur on the Farm Witvogelfontein due to the similarity in topographical features.

From an environmental perspective, it would seem that the Central and Western Routes would have less of an environmental impact. The Central Route along the railway line should have the least environmental impact.

5.1.1 Crocodile River Water Quality

The increase in releases from the Hartebeespoort Dam or the introduction of the highly polluted water into the ecological system downstream may have severe negative impacts, including the losses of domesticated and wild game due to poisoning. Should the water be stored in dams, it is also possible that the algae may increase and bloom. Treatment of the water should be considered.

5.2 Recommendations

There are several environmental recommendations with regards to alignment planning that need to be considered to ensure that the most sensitive habitats and species be conserved or avoided:

- Rocky outcrop areas should be avoided where feasible to minimise the impact on this sensitive ecosystem.
- Endemic, endangered and medicinal plant species should be identified and relocated to suitable areas.
- Pipeline routes should follow existing transport infrastructure where possible. This will minimise further disturbance of natural vegetation.
- Farm boundaries should be followed where possible to avoid further fragmentation of faunal habitats.
- River crossings should occur in areas not prone to wetland formation where possible.
- Faunal species, especially reptile and rodent species should be relocated from the Terminal Dam sites.
- It is essential to have extensive Public Participation with affected landowners, community groups and government organisations during the planning process.

PART 2: SOCIAL IMPACTS OF CROCODILE TRANSFER SYSTEM

6. BACKGROUND AND PURPOSE

This social impact assessment is undertaken by Kayamandi Development Services (Pty) Ltd.

The purpose of this report is to provide an indication of the potential social impacts of the proposed conveyance systems for the MCWAP Project. Prominence will be placed on identifying possible social impacts of each proposed option, as well as providing an indication of the severity in order that a comparison of the different options can be undertaken. A comparison amongst all proposed options needs to be made to see which one has fatal flaws in order to make a decision where only the most cost effective option along with lesser negative social impacts will be selected for further investigation and analysis.

6.1 Report Outline

Part 2 of the report consists of four sections (7 – 10), excluding the introduction section, namely:

- **Section 7** presents the foremost social impacts that are more of a generalised impact on all conveyance systems.
- **Section 8** determines the estimated compensation and social impacts of each option.
- **Section 9** reviews the social impacts from the previous section and a brief comparison is made.
- **Section10** provides recommendations and conclusions with respect to the comparative analysis of the delivery options and transfer options.

7. GENERAL SOCIAL IMPACTS

7.1 Introduction

By "social impacts" we mean the consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society. The term also includes cultural impacts involving changes to the norms, values, and beliefs that guide and rationalize their cognition of themselves as well as their society.

This section provides the latent impacts that would be associated with the proposed abstraction, transfer and delivery schemes. These general social impacts relate to all the route options in roughly the same degree.

7.2 Loss of Agricultural Land

The loss of agricultural land has both social plus economic impacts. In a social perspective, some of the commercial farmers have upgraded as well as improved their land; therefore losing their farms or a portion thereof would not be in their greatest interest. Other social reasons for not being willing to lose the farm or a portion thereof may be that the farm has been in the family for generations and it is desirable to pass the farm on to the younger generation within the family.

Farmers that would be prepared to lose portions of their land should be remunerated in such a way that they should be in an enhanced position after being compensated when compared to before. The compensation of agricultural land should differ depending on the land use. It is expected that land covered with natural pastures, bushes and shrubs, to be less costly than that of cultivated land. Irrigated land is expected to be the most costly to compensate, as it would mean compensating the farm owners for the loss of their land, loss of agricultural production and their loss of preparation of irrigation.

7.3 Loss of Improvements

Most farm portions do not only constitute plain land but also have some improvements on them; these include: farm houses, worker houses, outside buildings, sheds, windmills, reservoirs, kraals, et cetera. The loss of each of these improvements has a dissimilar impact but they are all significant to the normal running of a farm along with the social life of people on the farm.

Care should be taken when selecting the most feasible pipeline route in order to ensure that there are minimum losses of improvements on the farm. Where it is impossible to avoid the demolishing of an improvement, the farm owners should be compensated accordingly.

7.4 Relocation of Households

If a pipeline has to pass through an area with houses, it would mean that the households have to be relocated and their houses are to be demolished. The relocation of households means a disruption of the family life, as well as social structures and networks. It is a major issue when an entire settlement has to be relocated especially in tribal areas where it is a tight community. Relocation programmes should by all means attempt to cause minimum disruption to households and communities.

7.5 Employment

Care should be taken that the project does not cause any unemployment sourcing from the loss of part of a farm. A large capital project of this nature could provide employment

benefits to the communities in the affected areas. It can be seen as preferable to use local labour for the project as this has greater benefits for relevant stakeholders.

The impending employment opportunities that could arise could be mostly of a temporal nature during the construction process, but it would reduce unemployment and infuse an economic boost to the community. The most permanent employment opportunities that would arise will be at the pump stations and weirs; mainly related to dredging.

7.6 Community Benefits

The scheme would provide a more steadfast source of water to the targeted consumers, which consist of communities and industries in the Lephalale area. Communities can have water access for indispensable needs like household consumption, as well as irrigation. Increased water supply will help to address the potential problem of water shortages that could result from increased consumption levels by industries in the area.

The benefit of improved water supply to the targeted areas should outweigh the cost to be incurred at the water source. Possible effects that could be imposed by the project in the process of improving water supply to the upstream users can include:

- Reducing downstream water supply; and
- Restricting future expansion for irrigation.

8. DETERMINATION OF SOCIAL IMPACTS

During the initial stages of the project in which the potential social impacts of the respective conveyance systems were ascertained, a desktop analysis was conducted in order to identify probable social impacts and potential fatal flaws that could be associated with each route option.

A desktop analysis entails using the most basic methods of gathering and analysing information. In this case a desktop analysis was conducted by using 1:50 000 maps, ortho-photos and satellite images.

In order to avoid unnecessary expenditure on this study, a sequential "fatal flaw" approach was adopted. This means that key issues are identified and investigated to sufficient detail in order to determine whether they in fact result in a "fatal flaw" for the proposed pipeline route. A "fatal flaw "is defined as an influence or an issue that is sufficiently severe and which will make the practical execution of the route insurmountable.

A reconnaissance was conducted for each of the proposed route options where the entire route was followed and analysed. Identified features along each route were recorded and an analysis of the social impacts of the pipeline on them.

None of the features (i.e. buildings, improvements and land uses) have been verified on the ground; therefore the results presented in this report may not be 100% accurate. The findings included in this report should serve as a good indication of the potential social impacts that the proposed pipeline route options may inflict.

Site visits should be conducted in the next phase in order to have a more inclusive understanding.

8.1 Determination of Compensation Costs

The purpose of determining approximate compensation costs for each route option is to be able to compare the relative costs associated with each of the options, rather than assigning fixed absolute values to all farms. Thus, the possible compensation cost has to be verified and refined in later stages of the study through the help of a qualified value.

8.1.1 Method Statements

The following provides a synopsis of the basic method utilised to determine the possible compensation cost of each route options:

- Each farm portion was analysed where the pipeline would pass through. This involved studying the type of land uses and the size of each land use.
- In each farm portion, improvements on the farm that could be lost were taken into consideration.
- Different farm prices (R/ha) were used for the different farms. The price used for each farm was informed by the area, size and land use of the farm. The different prices used were based on information obtained from estate agents in the different areas. The farm prices utilised should be viewed as estimates and not the real value of the land due to the influence of many factors on the value such as the type and size of each farm portion.
- 20m Servitude was used as a basis to calculate the area necessary for the pipeline route and the cost of the land. Pipelines next to existing servitudes (road or railway line) could result to reduced land loss and cost.

- Developments on the farm that could be affected by the pipeline were taken into consideration and estimates of their value were made. This involved counting the number of buildings, number and type of improvements.
- A standard compensation cost for different buildings and developments was used.

8.1.2 Assumptions

The following assumptions need clarification:

- The larger the size of the farm, the less the price per hectare and therefore, the price of a small portion of a farm is high.
- The price of a farm with irrigated land will be higher than that of game farm.
- The price of an agricultural holding is expected to be more costly than a farmland.
- Farms that have a river or stream on them could have a higher value for land.

8.1.3 Constrains

Limitations and constraints in the process of identifying the improvements and types of land uses:

- In some cases, clarity on the type of building that was identified was poor, but it was taken into account.
- The differentiation between the types of land use was not obvious, especially the distinction between irrigated and cultivated land; an assumption was made that all land with cultivation is irrigated since the study area appeared to be mostly dry land. Other land uses like grazing, game farming, bushes and dry land were all categorised as natural pastures.

In the **Appendix A**, Figure A-1 illustrates the transfer pipeline route options and in **Appendix B**, Table B-1 provides a list of estate agents that were contacted to get a general idea of the prices of land.

8.2 Transfer Scheme

8.2.1 Vlieëpoort Weir Abstraction Options

8.2.1.1 Option 1

a) Description

This option is a western route option to the terminal dam site and is expected to be 111.3 km. Conveyance to the terminal dam site would be through the following pipe sections:

- 24-7-8-9-5-10-11

b) Possible Social Impacts

From the desktop analysis no impacts were identified that could disqualify this route option as a possible future option. In some cases the pipeline follows the same route as the main road and therefore, this could minimize the impacts, as some of these farms will lose a portion of their farms that is probably not used efficiently.

c) Areas of concern relating to this option include the following:

- On the east of Thabazimbi, the farms are small and therefore a high price of land per hectare can be expected.
- The crossing of the main road (R510) and railway a number of times has the potential to cause a disruption of traffic.
- A significant number of improvements that could be lost.
- High potential agricultural land could be lost.

d) Estimated compensation

The estimated compensation costs, based on the aforementioned limitations and assumptions, are summarized below.

Table 8-1: Estimated Losses and Compensation Costs for Option 1

TYPE	NUMBER	PRICE	AMOUNT (R)
BUILDINGS			
Farm Houses	2	800,000	1,600,000
Worker Houses	3	80,000	240,000
Outbuildings	4	400,000	1,600,000
Sheds	2	400,000	800,000
Sub-Total			4,240,000
OTHER IMPROVEMENTS			
Reservoirs	1	120,000	120,000
Windmill and borehole	1	150,000	150,000
Sub-Total			270,000
RELOCATION COSTS			
Households	5	200,000	1,000,000
SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			5,510,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	14,000	16.4	229,880
	16,000	5.2	83,226
	18,000	76.8	1,383,139
	20,000	79.5	1,589,469
	23,000	10.9	250,897
Sub-Total			3,536,612
Irrigated land			
	55,000	0.1	5,770
	65,000	5.2	338,692

	70,000	15.7	1,101,477
Sub-Total			1,445,939
SUB-TOTAL: LAND		210	4,982,551
LAND AND IMPROVEMENTS			10,492,551

Based on the above analysis, it is estimated that the approximate compensation cost of land and improvements be R10.5 Million. Utilising the estimated area of the route and the estimated price per hectare, the average cost per hectare is estimated to be R23 726 per hectare.

It can be anticipated that about ten (10) buildings would need to be demolished in order to give way for the pipeline route. The number of household to be relocated is not too large but the impact thereof is significant. It can also be seen that a considerable portion of the land is used for productive agricultural purposes.

8.2.1.2 Option 2

a) Description

This weir abstraction option is a western central route option to the terminal dam site. The pipeline distance is 106.1 km and would constitute of these pipe sections: 24-7-19-18-16-10-11.

b) Possible Social Impacts

A large distance of the pipeline runs parallel to a railway line. This has the potential to reduce costs and social impacts since the pipeline could be within an existing servitude. No adverse impacts that would disqualify this route option from being the preferred option.

c) Areas of concern relating to this option and to be considered include the following:

- Traffic flow disturbances as the pipeline route would cross the main road several times; and
- The crossing of the railway could also cause some interruptions.

d) Estimated compensation

The estimated compensation costs thereof are shown below.

Table 8-2: Estimated Losses and Compensation Costs for Option2

TYPE	NUMBER	PRICE	AMOUNT (R)
BUILDINGS			
Farm Houses	2	800,000	1,600,000
Worker Houses	1	80,000	80,000
Outbuildings	0	400,000	0
Sheds	0	400,000	0
Sub-Total			1,680,000
OTHER IMPROVEMENTS	0	120,000	0
Reservoirs	0	150,000	0

Windmill and borehole			0
Sub-Total			
RELOCATION COSTS			
Households	3	200,000	600,000
SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			2,280,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	14,000	16.4	229,884
	15,000	10.1	152,214
	16,000	14.5	232,532
	18,000	40.5	729,456
	20,000	83.3	1,666,205
	23,000	10.9	250,897
	25,000	28.7	718,716
Sub-Total			3,979,905
Irrigated land			
	65,000	3.4	222780.3
	70,000	9.1	634868.7
Sub-Total			857,649
SUB-TOTAL: LAND		217.1	4,837,554
LAND AND IMPROVEMENTS			7,117,554

Based on the above analysis, it is estimated that the approximate compensation cost for land and improvements will be R7.1 Million. Utilising the estimated area of the route and the estimated prices per hectare, the average price of land per hectare is estimated to be R22 282.

It is seen from the table above that the pipeline could directly impact the minority of households. This may in turn mean that the pipeline would have less of an impact. A small fragment of irrigated land could be lost.

8.2.1.3 Option 3

a) Description

Option 3 is a west-central route option from the Vlieëpoort Weir to node 15 and is expected to be 97.9 km long. This route would constitute the following pipe sections: 24-7-19-18-16.

b) Possible Social Impacts

A very large section of the pipeline runs parallel to the railway line and this has the potential to impose a lower social impact. It can be expected that portions of the farm next to a railway line be not utilized to their fullest potential as they could be

within an existing servitude. From the investigation no impacts were identified which could disqualify this route as a possible future option.

c) The potential social impacts to be anticipated with this route are:

- Traffic flow disturbances as the pipeline route would cross the main road several times.
- The crossing of the railway line could increase costs.
- A number of smallholdings that could be unfavourably impacted upon by this option near the Vlieëpoort Weir.

d) Estimated compensation

The estimated compensation costs based on the aforementioned limitations and assumptions are summarized below.

Table 8-3: Estimated Losses and Compensation Costs for Option 3

TYPE	NUMBER	PRICE	AMOUNT (R)
BUILDINGS			
Farm Houses	1	800,000	800,000
Worker Houses	0	80,000	0
Outbuildings	0	400,000	0
Sheds	0	400,000	0
Sub-Total			800,000
OTHER IMPROVEMENTS			
Reservoirs	0	120,000	0
Windmill and borehole	0	150,000	0
Sub-Total			0
RELOCATION COSTS			
Households	1	200,000	200,000
SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			1,000,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	16,000	14.5	232,532
	18,000	40.5	729,456
	20,000	83.3	1,666,205
	23,000	10.9	250,897
	25,000	28.7	718,716
Sub-Total			3,597,806
Irrigated land			
	65,000	3.4	222,780

	70,000	9.1	634,869
Sub-Total			857,649
SUB-TOTAL: LAND		190.5	4,455,455
LAND AND IMPROVEMENTS			5,455,455

Based on the desktop analysis on this pipeline route, no adverse social impacts were determined. One (1) farmhouse can be expected to be demolished and therefore this can be seen as a minimal social impact as this may mean that one (1) household would relocate. No other improvements were identified that could be lost as a result of the development of the pipeline.

The estimated compensation costs for land and improvements will be R5.4 Million. It is estimated that the average price of land per hectare for the entire area of the route will be R23 388.

8.2.2 Boschkop Weir Abstraction Options

8.2.2.1 Option 4

a) Description

This is an eastern route option from the Boschkop Weir to the terminal dam site. The pipeline is planned to be 161.8 km long and it will be made up of these pipe sections: 1-2-23-22-20-14-10-11.

b) Possible Social Impacts

Route option 4 is the longest route option and therefore has the potential to have a larger social impact. The pipeline runs mostly across farms and this has the potential to have a large impact.

This route option has the potential to have a very large social impact. Most of the farms next to the Crocodile River are small farmlands and therefore it is assumed that more farms will be affected. **Potential problem areas that were identified and should, if possible, be avoided:**

- A large portion of the land is under intensive irrigation; especially near the Crocodile River; and
- The land under intensive irrigation can be more expensive.

c) Estimated compensation

The estimated compensation thereof is summarized below.

Table 8-4: Estimated Losses and Compensation Costs for Option 4

TYPE	NUMBER	PRICE	AMOUNT (R)
BUILDINGS			
Farm Houses	5	800,000	4,000,000
Worker Houses	6	80,000	48,000
Outbuildings	4	400,000	1,600,000
Sheds	0	400,000	0
Sub-Total			5,648,000
OTHER IMPROVEMENTS			
Reservoirs	4	120,000	480,000
Windmill and borehole	0	150,000	0
Sub-Total			480,000
RELOCATION COSTS			
Households	11	200,000	2,200,000
SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			8,328,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	14,000	11.8	164,608
	16,000	7.3	117,294
	18,000	40.1	722,658
	20,000	91.4	1,828,478
	23,000	119.6	2,751,851
	30,000	29.8	892,747
Sub-Total			6,477,636
Irrigated land			
	55,000	1.0	54,315
	60,000	0.1	5,512
	70,000	8.6	599,737
	75,000	11.5	861,740
Sub-Total			1,521,304
SUB-TOTAL: LAND		321.2	7,998,940
LAND AND IMPROVEMENTS			16,326,940

Based on the desktop analysis, this route is expected to impact eleven (11) buildings and four (4) reservoirs. The associated social impact thereof is the relocation of families and loss of water supply.

It appears that in all probability, this route will affect the most number of households in terms of social impacts and relocation.

Apart from the large number of households that will be affected, no other major social impacts were identified. The estimated compensation costs of land and improvements for this route will be R16.3 Million. The estimated average price of land per hectare for the route is R24 903.

8.2.2.2 Option 5

a) Description

Option 5 is an eastern – central route option from the Boschkop Weir to the terminal dam site. The pipeline is expected to be 152.8 km. The pipeline will constitute of the following pipe sections: 1-2-23-22-21-18-16-10-11.

b) Possible Social Impacts

This route option is expected to have an average social impact since part of the pipeline runs parallel to the railway line and the rest of the pipeline runs through farms.

From the investigation, no adverse impacts were identified which could disqualify this route as a possible future option.

c) The following potential impacts were identified and should be taken into consideration:

- A large portion of the land is under intensive irrigation, especially around near the Crocodile River.
- Impact of the pipeline is large on smaller farms that are next to the Crocodile River.
- The price of a smaller farm can be expected to be more expensive.
- The pipeline crosses the main road and this will have an impact on the interference of traffic and infrastructure.

d) Estimated compensation

Table 8-5: Estimated Losses and Compensation Costs for Option 5

TYPE	NUMBER	PRICE	AMOUNT (R)
BUILDINGS			
Farm Houses	2	800,000	1,600,000
Worker Houses	2	80,000	160,000
Outbuildings	2	400,000	800,000
Sheds	0	400,000	0
Sub-Total			2,560,000
OTHER IMPROVEMENTS			
Reservoirs	3	120,000	360,000
Windmill and borehole	0	150,000	0
Sub-Total			360,000
RELOCATION COSTS			
Households	4	200,000	800,000

SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			3,720,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	14,000	16.4	229,880
	15,000	10.1	152,214
	16,000	14.5	232,532
	18,000	40.5	729,456
	20,000	42.7	853,100
	23,000	119.4	2,747,334
	25,000	18.6	465,026
	30,000	29.8	892,747
Sub-Total			6,302,290
Irrigated land			
	65,000	3.4	222,780
	75,000	11.1	832,770
Sub-Total			1,055,550
SUB-TOTAL: LAND		306.6	7,357,840
LAND AND IMPROVEMENTS			11,077,840

Based on the above analysis it is estimated that the approximate compensation costs of the land and improvements will be R11 Million. Utilising the estimated area of the route and the costs of land, the average price for land per hectare is estimated to be R23 998.

Possible social impacts to be brought by this route include the relocation of families, cut in water supply as a result of the reservoirs that could be demolished. Four (4) families are expected to relocate. A large area of the land is covered with natural pastures.

8.2.2.3 Option 6

a) Description

Option 6 is an eastern route to Node 15. The pipeline is planned to be 153.6 km and would run through these sections: 1-2-23-22-20-14.

b) Possible Social Impacts

The pipeline runs mostly across farm and this has the potential to have a high social impact. Farmers may be more unwilling to loose portions of their farms for the reason that they would not like to have complicated farm shapes. Distortion of the farm shapes and size could result to administration problems of the farm. The impact of this route can be expected to be high.

c) Areas of concern:

- Land under intensive irrigation next to the Crocodile River.

d) Estimated compensation

Table 8-6: Estimated Losses and Compensation Costs for Option 6

TYPE	NUMBER	PRICE	AMOUNT (R)
BUILDINGS			
Farm Houses	4	800,000	3,200,000
Worker Houses	5	80,000	400,000
Outbuildings	4	400,000	0
Sheds	0	400,000	1,600,000
Sub-Total			5,200,000
OTHER IMPROVEMENTS			
Reservoirs	4	120,000	480,000
Windmill and borehole	0	150,000	0
Sub-Total			480,000
RELOCATION COSTS			
Households	9	200,000	1,800,000
SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			7,480,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	16,000	7.3	117,294
	18,000	40.1	722,658
	20,000	91.4	1,828,478
	23,000	119.6	2,751,851
	30,000	29.8	892,747
Sub-Total			6,313,028
Irrigated land			
	55,000	1.0	54,315
	60,000	0.1	5,512
	70,000	8.6	599,737
	75,000	11.5	861,740
Sub-Total			1,521,304
SUB-TOTAL: LAND		309.4	7,834,332
LAND AND IMPROVEMENTS			15,314,332

Based on the above analysis it is estimated that the approximate compensation costs of land and improvements will be R15.3 Million. Utilising the estimated area of the route and the estimated cost of land, the estimated cost of land per hectare is R25 321.

Potential social impacts that can be expected with this option include the loss of thirteen (13) buildings, as well as four (4) reservoirs. The buildings to be lost include residential buildings. An estimated number of nine (9) households would have to be relocated if this route is the proffered option.

A significant portion of land that could be lost is mostly covered with natural pastures, therefore minimising the impact.

8.2.2.4 Option 7

a) Description

This option is an eastern-central route to node 15. The pipeline distance of this option is planned to be 144.6 km and would constitute of these pipe sections: 1-2-23-22-21-18-16.

b) Possible Social Impacts

This route option is expected to have an average impact since part of the pipeline is parallel to the railway line and the other part of the pipeline runs through farms. The impact on a pipeline that is parallel to a railway line is low, as the pipeline could fall within an existing servitude.

No adverse impacts were identified which could disqualify this route as a possible future option.

c) The following problem areas were identified and should be taken into consideration:

- Near the Crocodile River, a large portion of the land is under intensive irrigation.
- The price of a small farm can be expected to be more expensive than a large one.
- Interruption of traffic can be expected since the pipeline would cross the main road.

d) Estimated compensation

The potential costs that can be anticipated with this option are summarized below.

Table 8-7: Estimated Losses and Compensation Costs for Option 7

TYPE	NUMBER	PRICE	AMOUNT (R)
BUILDINGS			
Farm Houses	2	800,000	1,600,000
Worker Houses	2	80,000	160,000
Outbuildings	2	400,000	800,000
Sheds	0	400,000	0
Sub-Total			2,560,000
OTHER IMPROVEMENTS			
Reservoirs	3	120,000	360,000
Windmill and borehole	0	150,000	0

Sub-Total			360,000
RELOCATION COSTS			
Households	4	200,000	800,000
SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			3,720,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	15,000	10.15	152,214
	16,000	14.5	232,000
	18,000	40.53	729,456
	20,000	42.66	853,100
	23,000	119.45	2,747,334
	25,000	18.60	465,026
	30,000	29.76	892,747
Sub-Total			8,230,341
Irrigated land			
	65,000	3.43	0
	75,000	17.06	622,684
Sub-Total			622,684
SUB-TOTAL: LAND		296.12	6,694,562
LAND AND IMPROVEMENTS			10,414,562

Based on the above analysis, it is estimated that the approximate compensation cost of land will be R10.4 Million. Utilising the estimated area for the pipeline route and the cost of land, the estimated average price of land per hectare is R22 607.

An estimate of four (4) households is expected to relocate. The number households to be relocated can be seen as very small number, but yet significant as the cases that they will be affected by the pipeline.

No adverse impacts were identified which could disqualify this route as a possible future option.

8.2.3 Boschkop/Vlieëpoort Weir Abstraction Option

8.2.3.1 Option 8

a) Description

Option 8 is a western route to Vlieëpoort Weir. This pipeline is planned to be 70 km and will consist of the following pipe sections: 1-2-3-4. This option involves the abstraction at Boschkop and conveyance to Vlieëpoort Weir for transfer to node 15.

b) Possible Social Impacts

A large section of the pipeline runs parallel to the main road therefore the impact is low. Furthermore, most of the farms that the pipeline will be crossing are small; as a result the social impact could be augmented.

c) Areas of concern with this alternative include:

- The loss of a large area that is under irrigation near the Crocodile River.
- Increased compensation costs due to a large number of small farms.
- The main roads and railway line that will be crossed could cause disturbances to traffic and infrastructure.

d) Estimated compensation

The estimated compensation costs based on the aforementioned limitations and assumptions are summarized below.

Table 8-8: Estimated Losses and Compensation Costs for Option 8

TYPE	NUMBER	PRICE	AMOUNT (R)
BUILDINGS			
Farm Houses	1	800,000	800,000
Worker Houses	1	80,000	80,000
Outbuildings	2	400,000	800,000
Sheds	0	400,000	0
Sub-Total			1,680,000
OTHER IMPROVEMENTS			
Reservoirs	4	120,000	480,000
Windmill and borehole	0	150,000	0
Sub-Total			480,000
Relocation costs			
Households	2	200,000	400,000
SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			2,560,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	20,000	25.9	517,663
	23,000	51.8	1,191,283
	30,000	31.6	948,255
Sub-Total			2,657,201
Irrigated land			
	70,000	14.7	1,029,901
	75,000	14.5	1,088,876

	80,000	3.7	292,661
	85,000	13.4	1,140,720
Sub total			3,552,158
SUB-TOTAL: LAND		155.6	6,209,359
LAND AND IMPROVEMENTS			8,769,359

Based on the above analysis, it is estimated that the approximate compensation costs of land and improvements will be R8.8 Million. Utilising the estimated area of the pipeline route and the price of land, the estimated average cost of land per hectare for the entire route is R39 905.

The route could have an impact on 2 households. The two (2) outside buildings that are identified could not be determined what their current use is.

A considerable portion of land that is irrigated land would be lost as a result of the pipeline. No other impacts could be identified along this route.

8.2.4 Terminal Dam Abstraction

8.2.4.1 Terminal Dam Site 1 (Option 2A)

a) Description

This option involves the abstraction from the Terminal Dam Site and conveyance of water to consumers. This route option is expected to be 68.6 km and would constitute of these pipe sections: 15-23-25A-25B-24-14-8-13.

b) Possible Social Impacts

From the investigation, it appears that the there are no adverse social impacts that could be expected with this option. In most cases, the pipeline runs adjacent to the farm boundary therefore minimizing the social impact thereof.

c) Areas of concern include:

- Interruption on the railway line infrastructure.

d) Estimated compensation

The table below provides a summary of the estimated losses and compensations costs for these options based on the aforementioned limitations and assumptions.

Table 8-9: Estimated Losses and Compensation Costs for Option 2A

TYPE	NUMBER	PRICE	AMOUNT(R)
BUILDINGS			
Farm Houses	1	800,000	800,000
Worker Houses	2	80,000	160,000
Outbuildings	1	400,000	400,000
Sheds	1	400,000	400,000
Sub-Total			800,000
OTHER IMPROVEMENTS			

Reservoirs	0	120,000	0
Windmill and borehole	0	150,000	0
Sub-Total			0
RELOCATION COSTS			
Households	3	200,000	600,000
SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			1,400,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	14,000	29.0	405,977
	16,000	78.6	1,257,314
	18,000	15.8	283,818
Sub-Total			1,947,109
Irrigated land			
	50,000	6.3	315,378
	55,000	4.1	226,216
Sub-Total			541,594
SUB-TOTAL LAND		133.8	2,488,704
LAND AND IMPROVEMENTS			3,888,704

It is estimated that three (3) households could be relocated. Other buildings that could be lost include an outside building and a shed.

The potential losses to be brought by this route can be said to be average as there were no major losses that could be experienced as a result of this option. The estimated compensations cost of land and an improvement for this option is R3.9 Million.

8.2.4.2 Terminal Dam Site 3 (Option 2B)

a) Description

This option involves the conveyance of water from Terminal Dam Site to the users. The pipeline is expected to be 67.5 km and would constitute the following pipe sections: 30-29-17-11-12-13-14-8-24-25A-25B.

b) Possible Social Impacts

The pipeline seems as if it will be passing through the Grootegeluk Mine (that is pipe section 8), and it is not certain what the extent of the social impact of this route is, but it appears that the pipeline will be crossing over land with natural pastures.

From the desktop analysis it appears that there are no major social impacts along the route which could disqualify this route as a possible future option.

c) Areas of concern:

- The pipeline could have an impact on the a railway infrastructure.

d) Estimated compensations costs

The estimated losses and compensation costs to be associated with this option is summarized below.

Table 8-10: Estimated Losses and Compensation Costs for Option 2B

TYPE	NUMBER	PRICE	AMOUNT(R)
BUILDINGS			
Farm Houses	0	800,000	0
Worker Houses	0	80,000	0
Outbuildings	1	400,000	400,000
Sheds	0	400,000	0
Sub-Total			400,000
OTHER IMPROVEMENTS			
Reservoirs	0	120,000	0
Windmill and borehole	0	150,000	0
Sub-Total			0
RELOCATION COSTS			
Households	0	200,000	0
SUBTOTAL: BUILDINGS AND IMPROVEMENTS			400,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	14,000	29.0	405,977
	16,000	80.0	1,279,261
	18,000	15.8	283,818
Sub-Total			1,969,057
Irrigated land			
	50,000	6.3	315,378
	55,000	3.6	199,561
Sub-Total			514,939
SUB-TOTAL LAND		134.7	2,483,996
LAND AND IMPROVEMENTS			2,883,996

Based on the above analysis, it is estimated that the approximate compensation cost of land and improvements will be R2.9 Million. By utilising the estimated area of the pipeline route and the estimated prices of land, the approximated average cost of land per hectare is R21 113.

No residential buildings are expected to be lost as a result of this option. The pipeline is expected to have a direct impact on one (1) outside building, as well as land.

8.2.4.3 Balancing Dam Abstraction (Option 3)

a) Description

This option will entail the abstraction of water from the balancing dam to the users. This pipeline is expected have length of 73.2 km and would be made up of the following pipe sections: 31-25B-25A-24-14-8-13.

b) Possible Social Impacts

The pipeline runs across farm, therefore the impact is expected to be high. But it can be mentioned that from the investigation, it appears that there are no major social impacts along the route that could disqualify this route as a possible future option.

c) Estimated compensation

The estimated losses and compensation costs based on the aforementioned limitations and assumptions are summarized below.

Table 8-11: Estimated Losses and Compensation Costs for Option 3

TYPE	NUMBER	PRICE	AMOUNT(R)
BUILDINGS			
Farm Houses	0	800,000	0
Worker Houses	0	80,000	0
Outbuildings	1	400,000	400,000
Sheds	0	400,000	0
Sub-Total			400,000
OTHER IMPROVEMENTS			
Reservoirs	0	120 000	0.00
Windmills	0	150,000	0.00
Sub-Total			0.00
RELOCATION COSTS			
Households	0	200,000	0
SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			400,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	14,000	61.9	865,944

	16,000	49.1	785,800
	18,000	15.8	283,818
Sub-Total			1,935,562
Irrigated land			
	50,000	7.4	369,729
	55,000	3.6	199,561
Sub-Total			569,290
SUB-TOTAL: LAND		137.8	2,504,852
LAND AND IMPROVEMENTS			2,904,852

Based on the above analysis, the pipeline is expected to have a direct impact on one (1) building, as well as on land. It is estimated that the approximate compensation cost of land and improvements will be R2.9 Million. Utilising the estimated area for the pipeline route and estimated prices for land, the approximated average cost of land is R18 177 per hectare.

8.3 Terminal Dam Sites

There are four terminal dam sites that have been proposed. Sites 2, 3 and 4 are proposed to be on Witvogelfontein 362LQ farm and site 1 will lie on both farms Witvogelfontein 362LQ and Weidehoek 364LQ.

Seeing that a desktop analysis is conducted, no direct contact was made with the any individual or groups that are situated in the basins of any of the proposed dam sites. Possible social impacts of the proposed dams were thus mostly obtained directly from 1:50 000 maps, as well as ortho-photos. None of the land uses or improvements has been verified on the ground.

Each of the terminal dam sites is analysed in the following sub section.

8.3.1 Site 1

a) Description

The land surface where terminal dam site 1 is proposed to be located appears to be plain land covered with natural pastures. There are a number stream flows that will be inundated by the proposed terminal dam. The land to be acquired for Terminal Dam Site 1 is expected to be 175.25 hectares.

b) Potential Social Impacts

The impact of this site is expected to be high since a very large area of the land would need to be acquired and prepared for the terminal dam.

c) Estimated compensation costs

The estimated losses and compensation costs based on the aforementioned limitations and assumptions are summarized below.

Table 8-12: Estimated Losses and Compensation Costs for Terminal Dam Site 1

LAND	AREA	PRICE	MARKET LAND VALUE
	(HA)	(R)	(R)
Natural pasture	175.25	20,000	3,505,008.00
LAND			3,505,008.00

On the area proposed for this terminal dam site, no buildings or improvements were identified that could be lost. The 175.5 ha of land to be acquired for this site can be seen as a large portion of land that would be used for the dam and other supporting developments. Due to limited information about the area, certainty on the current use of land is not determined. No other adverse impacts could be identified that could disqualify this terminal dam site from being preferred.

8.3.2 Site 2

a) Description

The proposed terminal dam site 2 is to be located almost in the middle of the Witvogelfontein farm. The land to be acquired for this site is estimated to be116.7 hectares.

b) Potential Social Impacts

The information that could be gathered from the desktop analysis, suggests that the dam site could have a high social impact as it might be covering a large surface area. The land that could be lost might be currently used for game farming and/or grazing. The precise use of land is not verified on the ground, but it is anticipated that the impact could be high.

c) Areas of Concern

- A large building that appears to be a Lodge or Factory could be lost.
- Interruption of the current economic activity on the farm.

d) Estimated compensation costs

The table below provides a summary of the estimated losses and compensation costs for the proposed Terminal Dam Site 2 based on the aforementioned limitations and assumptions.

Table 8-13: Estimated Losses and Compensation Costs for Terminal Dam Site 2

TYPE	NUMBER	PRICE	AMOUNT
BUILDINGS		(R)	(R)
Lodge	1	30,000,000.00	30,000,000
LAND	**AREA**	**PRICE**	**MARKET LAND VALUE**
	(HA)	(R)	(R)
Natural pasture	116.71	20,000.00	2,334,134
LAND AND IMPROVEMENTS			32,334,134

This terminal dam site is expected to inundate a hefty building. This has the potential to have a high impact, as well as compensation costs. A large area of natural pastures would be inundated. The estimated compensation cost of land and improvements is R32.3 Million.

8.3.3 Site 3

a) Description

The land to be acquired for proposed Terminal Dam Site 3 is 71.76 hectares. This site is by far the smallest in area.

b) Potential Social Impacts

It is assumed that the land is covered with natural pastures; as a result the potential social impact is low. The small land area proposed for acquisition has the potential to reduce impact.

c) Areas of concern:

- Improvements that could be lost should the access to the terminal dam site 3 be from the east of the dam site and through pipe section pipe section 27, include two (2) outside buildings and two (2) large buildings that appear to be barns, therefore potential compensation cost can be expected to be slightly higher.

d) Estimated compensation costs

Table 8-14: Estimated Losses and Compensation Costs for Terminal Dam Site 3

TYPE	AREA	PRICE	MARKET LAND VALUE
LAND	(HA)	(R)	(R)
Natural pasture	71.76	20,000	1,435,246
LAND			1,435,246

No improvements were identified that are directly on the proposed area for the terminal dam site. The land to be acquired for the terminal dam is assumed to be covered with natural pastures. The estimated compensation cost of land is R1.4 Million.

8.3.4 Site 4

a) Description

The proposed terminal dam site 4 is on the upper end of the farm boundary and it appears to be closest to the end users. The land proposed for acquisition of the site is expected to be 91.59 hectares.

b) Potential Social Impacts

The area to be acquired for this terminal dam appears to be currently land covered with natural pastures. Farm access roads could be potentially relocated.

No adverse social impacts are anticipated that could disqualify this option from being opted for.

c) Estimated compensation costs

The estimated compensation costs based on the aforementioned limitations and assumptions are summarized below.

Table 8-15: Estimated Losses and Compensation Costs for Terminal Dam Site 4

TYPE	AREA	PRICE	MARKET LAND VALUE
LAND	(HA)	(R)	(R)
Natural pasture	91.59	20,000	1,831,754
LAND			1,831,754

Based on the above analysis, no developments have been identified that could be lost as a result of the proposed terminal dam. The impact could be more environmental in nature. The estimated compensation cost of land is R1.8 Million.

9. SUMMARY OF IMPACTS

In this section a comparison is conducted on the improvements and land uses that could be affected by the proposed pipeline route options. This is meant to serve as indications which of the pipeline route options can the most impact be expected.

9.1 Summary of Improvements along the Transfer Route Options

Since the transfer scheme is expected to have longer routes, the possibility of a high impact can be expected from each of the proposed options; however, the impacts would be at different levels. The table below provides a summary of existing improvements along the proposed transfer route options, independently.

Table 9-1: Improvements along the Transfer Route Options

OPTIONS	1	2	3	4	5	6	7	8
BUILDINGS								
Farm Houses	2	2	1	5	2	4	1	1
Worker Houses	3	1	0	6	2	5	1	1
Outbuildings	4	0	0	4	2	4	2	2
Sheds	2	0	0	0	0	0	0	0
OTHER IMPROVEMENTS								
Reservoirs	1	0	0	4	3	4	3	4
Windmill and borehole	1	0	0	0	0	0	0	0
TOTAL	**13**	**3**	**1**	**19**	**9**	**17**	**7**	**8**

From the above table it is evident that Option 4, which is the eastern route to the terminal dam site, will have a greater impact on farm buildings and other improvements. Approximately eleven (11) households will have to relocate if Option 4 is selected. Option 6 will also have more or less the same impact as Option 4.

Among the Vlieëpoort Weir Abstraction Options (1, 2 & 3), Option 3 appears to have low impact.

Between the Boschkop Weir Abstraction options, Option 7 appears to have less of an impact on improvements.

Option 8 could not be compared to the other options, but it can be mentioned that the pipeline route will have a low impact on of farm improvements.

9.2 Summary of Land Uses on the Transfer Route Options

Table 9-2: Transfer Route Land Uses

OPTIONS	1	2	3	4	5	6	7	8
LAND								
Natural Pastures (ha)	188.84	204.59	178.03	300.06	292.09	288.31	275.64	109.29
Irrigated land (ha)	21.05	12.50	12.50	21.14	14.53	21.14	20.49	46.31

	218.79	215.83	199.41	325.85	312.57	309.43	296.14	155.58
Percentage distribution of land use								
Natural Pastures	90.0 %	94.2 %	93.4 %	93.4 %	95.3 %	93.2 %	93.1 %	70.2 %
Irrigated land	10.0 %	5.8%	6.6%	6.6%	4.7%	6.8%	6.9%	29.8 %
	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %

It can be highlighted that the abstraction at Boschkop and conveyance to Vlieëpoort Weir (Option 8) will have a high impact on irrigated land. Approximately 30% of the land is irrigated. This may suggest that the will be a loss of agricultural produce and a loss of benefits that come with this economic activity (i.e. food and income).

Amongst the Vlieëpoort Weir Abstraction Options (1, 2 & 3), Option 1 that is the western route to the terminal dam site will have a high impact (10.0%) on land under irrigation.

The Boschkop Weir Abstraction Options (4, 5, 6 & 7) are all longer pipeline routes and have the potential to have a high impact. Option 7 which is the eastern central route to node 15 seems to have a little more of the land that is irrigated when compared to the other routes. In terms of the impact on land use, all proposed options have relatively the same impact.

9.3 Summary of Improvements along the Delivery Route Options

In the process of delivering water through the different proposed route options to the conveyance users, social impacts would be imposed on certain parts of the routes. The table below serves as an indication of the potential social impacts that could be imposed through the different routes.

Table 9-3: Improvements on the Delivery Route

OPTIONS	1A	1B	2A	2B	3
BUILDINGS					
Farm Houses	2	5	1	0	0
Worker Houses	0	2	2	0	0
Outbuildings	1	3	1	1	1
Sheds	0	0	1	0	0
OTHER IMPROVEMENTS					
Reservoirs	1	0	0	0	0
Windmills	0	1	0	0	0
TOTAL	**4**	**11**	**5**	**1**	**1**

It can be said that none of the options have a very high impact, as only a small number of developments and families would be affected. The table above indicates that more improvements could be affected should Option 1B be preferred, that is the abstraction at Lephalale Weir. This would mean that approximately seven (7) households would have to relocate to other areas, as their houses would be demolished as a result of the

pipeline. In this case Option 1A, which is an interim measure that involves abstraction at the Mokolo Dam, appears to be more favourable in terms of minimising the impact on farm improvements.

Option 2B is involves the abstraction at the Terminal Dam Site, can be perceived to have a low impact. No residential buildings were identified along this route; therefore this route can be seen as acceptable in terms of minimising the potential social impacts that would be imposed by the pipeline.

Option 3, which comprises the abstraction at the balancing dam and conveyance to the users, is expected to have a low impact as only 1 building was identified along the route.

9.4 Summary of Land Uses on the Delivery Route Options

As social impacts also include the loss of agricultural land, in the table below it is indicated how much land will be lost between the different options.

Table 9-4: Delivery Route Land Uses

OPTIONS	1A	1B	2A	2B	3
Land use					
Natural Pastures (ha)	181.68	139.90	123.35	124.72	126.73
Irrigated land (ha)	12.11	12.39	10.42	9.94	11.02
	193.79	152.29	133.77	134.66	137.76
Percentage distribution of land use					
Natural Pastures	93.8%	91.9%	92.2%	92.6%	92.0%
Irrigated land	6.2%	8.1%	7.8%	7.4%	8.0%
	100.0%	100.0%	100.0%	100.0%	100.0%

From the table above it can be seen that Option 1B could have a high of an impact on irrigated land (8.1%). The land that Option 1A will have an impact on is predominantly natural pastures; this could imply that it is land used for game farming and/or grazing. The loss of grazing land would have a social impact to animals as they will have lesser land for grazing. Due to the fact that the level of detail on the land is limited, it was impossible to ascertain the actual portion of land that is being used for grazing.

Between the Terminal Dam Abstraction Options (2A & 2B), there is not a large variation between the land uses that could be impacted.

The Balancing Dam Option (Option 3) will impact 8% of land that is irrigated and 92% of natural pastures.

10. CONCLUSION

10.1 Introduction

The purpose of this section is to combine all the results of the previous sections in order to draw conclusions in a comparative manner. Recommendations are also included in order to inform relevant stakeholders on what to look out for in the process of the project.

10.2 Recommendations

10.2.1 Information Issues

Households in the affected areas should be well informed about the project. This should include the timing of construction, as well as detailed plans for compensation. Certain local officials should be positioned to deal with all queries about the project.

10.2.2 Positive Effects

Among the most common positive effects that households and stakeholders hope the pipeline will bring are improvements to the local economy and infrastructure, employment opportunities and improved access to water.

A second cluster of positive hopes about the project, could relate to compensation. If compensation is generous and fair, the complete scheme will be a positive project. Some households could prefer to receive cash, while others would prefer to have new houses, both these preferences should be accommodated for.

10.2.3 Negative Effects

Among the negative effects that could concern households and stakeholders is pipeline safety, degradation of the environment, and damage to local roads and other infrastructure during construction.

The most prevalent uncertainties about the complete scheme (transfer, delivery and dams) could relate to the losses of land, houses, other buildings, soil fertility, and crops. Other concerns that could emanate may include compensation issues (i.e. compensation would not be transparent, fair, or equitable, or received in full).

Negative impacts of the complete scheme should be minimized and, if not avoidable, should be corrected as promptly as possible, ideally by the construction companies before they move on with the project.

An in depth inventory has to be undertaken of heritage sites, natural parks and reserves, temples and tombs, so that these can be avoided along the pipeline routes and dams. This practice could be seen as an excellent example of prevention. Every effort should be made to be sure that all such sites are identified and avoided if possible.

In this, and in other aspects of prevention and quick mitigation, there should be a special potential role to be executed by the construction teams and companies – that will actually construct the pipelines and dams

We recommend that the contracts signed with these firms include clauses, incentives, and penalties to encourage:

- Further identification of sensitive sites that the pipeline can still avoid, and immediate notice to be given of any sites uncovered during construction;

- Other preventive measures such as minimizing dust and other environmental degradation, minimizing damage to local roads, and assuring careful restoration of topsoil when the pipeline is covered;
- Prompt mitigation of negative impacts such as restoration of breaks in irrigation systems or paddy dikes, and repair of local roads; and
- Active and transparent participation – as and when required—in the process of compensation.

Finally, it is recommended that the project team together with related local authorities monitor closely the work of the construction companies and assist them to undertake these additional tasks successfully. Experts from the project team should oversee prevention and mitigation of negative impacts. Good community relations are important for construction companies, as they would want to get along with the local people, if for no other reason than to avoid problems with them.

10.2.4 Compensation

It is certain that the way compensation will be handled will determine how households and stakeholders view the project. Mismanagement of compensation is a large threat to goodwill, and thus to how people will view other government development projects in the future.

Certain standards for compensation should be followed. The following standards could serve as a guideline:

- Valuation of losses should be at replacement cost, and not depreciated cost.
- Any administrative fees should not to be subtracted from the compensation to the affected households.
- Restoration (in real terms) of pre-construction living standards.
- A grievance procedure for resolving disputes should be set.

It is recommended that the stakeholders that will be involved in the project make a commitment to monitor the compensation process and to follow-up with affected households and communities.

10.3 Conclusion

In order to compare and summarise each of the proposed options between the transfer, delivery scheme and terminal dams a table format has been utilised.

The following general major conclusion can be drawn from this report:

- Land that is near the Mokolo Dam is mostly irrigated and is very expensive.
- A large portion of productive agricultural land will be lost from the banks of the Crocodile River.
- No rural settlements will need to be relocated other than possibly the owner and workers on particular farms.

Based on the previous analysis, the options have been ranked in the following order from the lowest to highest impact:

10.3.1 Transfer Pipeline Options

10.3.1.1 Vlieëpoort Weir Abstraction Options

3- West-Central Route to Node 15

2- West-Central Route to Terminal Dam site

1- Western Route to Terminal Dam site

10.3.1.2 Boschkop Weir Abstraction Options

5 - Eastern-Central Route to Terminal Dam

7- Eastern-Central Route to Node 15

6- Eastern Route to Node 15

4- Eastern Route to Terminal Dam site

10.3.1.3 Boschkop / Vlieëpoort Weir Abstraction Option

8 - Western-Route to Vlieëpoort Weir

Table 10-1: Summary of Transfer Scheme Route Options

OPTIONS	1	2	3	4	5	6	7	8
TYPE								
Buildings								
Farm Houses	2	2	1	5	2	4	1	1
Worker Houses	3	1	0	6	2	5	1	1
Outbuildings	4	0	0	4	2	4	2	2
Sheds	2	0	0	0	0	0	0	0
Farm improvements								
Reservoirs	1	0	0	4	3	4	3	4
Windmills	1	0	0	0	0	0	0	0
Productive resources								
Natural pasture	188.84	204.59	178.03	300.06	292.09	288.31	275.64	109.29
Irrigated land	21.05	12.50	12.50	21.14	14.53	21.14	20.49	46.31
Estimated Compensation Cost in R' million	10.5	7.1	5.5	16.3	11.1	15.3	10.4	8.8

10.3.2 Terminal Dam Sites

Site 3

Site 4

Site 1

Site 2

Table 10-2: Summary Table of Estimated Compensation Cost

TERMINAL DAM	COMPENSATION COST IN R' MILLION
Site 1	3.5
Site 2	32.3
Site 3	1.4
Site 4	1.8

PART 3: ENVIRONMENTAL SCREENING MOKOLO CONVEYANCE SYSTEM

11. BACKGROUND

The development of new power stations is of high strategic importance and the construction of the first new power station, Medupi, is already underway. The first units will be commissioned by the end of 2010 and additional water needs to be available by mid-2011. The Crocodile and Mokolo Transfer System will not be completed in time to meet these dates and it will be necessary to implement interim bridging arrangements to achieve this. The interim arrangements must supply in the requirements until the transfer scheme becomes operational. This is expected by middle 2012, or perhaps by 2014.

As the only possible interim measure, the utilization of the water from Mokolo Dam will be investigated. The yield of the dam, as well as all the current and envisaged requirements in the interim period will be determined. Scenarios to make more water available for the industrial use will be investigated. These will include the utilization on a temporary or permanent basis of the current downstream and if required upstream water rights. The possibility of utilizing the Mokolo Dam at an abstraction rate higher than the firm yield for a short period will also be investigated. The probability of having the required water available (start date of leasing of water rights) in the dam and the impact on the long term yield will be determined. In this study these options will be examined first at the reconnaissance level to assess the mitigation measures and costs in order to establish the viability, where after more detailed investigations will be performed. It will be particularly important to establish the potential socio-economic implications and associated leasing / compensation costs of such measures. All the yield analysis will be performed by the nominated sub-consultant, WRP Consultants.

The existing pump station / pipeline conveyance system belonging to Exarro supplying water to the town of Lephalale and the industrial users, will be investigated to determine the possibility of upgrading the system to supply the interim requirements. Should this not be possible or adequate, then a new parallel system will be investigated. Another alternative will be to release the water from Mokolo Dam and transport it downstream via the river to a to be constructed weir where the water will be abstracted and pumped via a new pipeline to supply the additional water to the users requiring the interim demands. The management of the river section will form part of this alternative.

Priority will be given to the identification and feasibility of interim bridging arrangements under this module.

11.1 Potential Environmental Impacts of Interim Measures

11.1.1 Pipeline Construction

The construction of a pipeline could have numerous environmental impacts, including the following:

- Destruction of vegetation
- Faunal habitat loss
- Soil erosion
- Hydrocarbon pollution of soil, ground and surface water
- Air pollution (dust during blasting and drilling)
- Noise pollution

Most of the potential impacts could, however, be negated or minimised through proper construction management.

Each section of the proposed pipeline's environmental sensitivity will be assessed in terms of:

- Vegetation types and sensitivity
- Occurrence of faunal species
- Water bodies, streams and wetlands

11.1.2 Pipeline Route Section

11.1.2.1 Nodes 30 – 38; Pipe Sections 1 – 8

Section 1 is approximately 15 km long and starts at the existing pump station at the Mokolo Dam. The proposed alignment follows the main access from the dam to the road due to the limited space available next to the existing Exxaro pipeline that supplies water to the town of Lephalale.

Figure 11-1: Mokolo Dam

Section 2 is approximately 20 km long and starts at the northern most point of the Farm Sterkfontein 542 LQ. The proposed alignment follows the existing Exxaro pipeline that supplies water to the town of Lephalale with the exception of a 3 km section near the northern end of the pipeline. The deviation from the existing route allows the proposed pipeline to circumvent a wetland area.

Section 3 is approximately 6 km long and stretches from the Farm Fourieskloof 557 LQ to the Farm Zeeland 526 LQ. The route still follows the existing Exxaro pipeline.

Section 4 – 6 is approximately 4 km long starting at the northwester part of the farm Zeeland, at the existing water purification works to the western portion of the Farm Eendrach 585 LQ.

Figure 11-2: Existing Pipeline Servitude

Section 8 starts at the western portion of the Farm Eendrach 585 LQ and stretches for approximately 8 km to the Grootegeluk Mine.

Vegetation type and sensitivity

The vegetation types for the sections are classified as CSB, WMB and LSB.

The CSB exist in low undulating areas, sometimes between mountains, and sandy plains and catenas supporting tall, deciduous Terminalia sericea and Burkea africana woodland on deep sandy soil and low, broadleaved Combretum woodland on shallow, rocky or gravely soil.

Figure 11-3: Central Sand Bushveld (CSB)

The most important taxa, endemic to this region are Mosdenia leptostachys and Oxygonum dregeanum.

The veld type in general is classified as vulnerable and poorly protected with only approximately 4.5% conserved. Approximately 24% of the veld type is transformed, including 19% agriculture and 5% urban and built up areas.

The WMB generally occurs on rugged mountains with vegetation ranging from Faurea seligna – Protea Caffra bushveld on the higher slopes through broad leaved deciduous bushveld on rocky mid- and footslopes to Burkea Africana – Terminalia sericea savannah in the lower lying valleys as well as on deeper sands on the plateau. The grass layer is moderately developed or well developed.

Endemic taxa to this veld type include tall shrub Grewia rogersii, Pachystigma triflorum and herb Oxygonum dregeanum.

This veld type is regarded as least threatened with about 9% statutorily conserved. Only about 3% of the veld type is transformed.

Figure 11-4: Waterberg Mountain Bushveld (WMB)

The LSB occur mainly on plains and sometimes undulating or irregular topographical area. The veld type is characterised by short open woodland with previously disturbed areas dominated by thickets of Acacia erubescens, Acacia Mellifera and Dichrostachys cinerea that are almost impenetrable.

The veld type has no endemic taxa and is considered least threatened. Although only about 1% is statutorily conserved the abundance of games farms in the area adds to the low transformation figure of about 5%.

Floral Feasibility

The proposed pipeline route will follow the existing Exxaro pipeline that is currently maintained by Exxaro. The area is therefore kept relatively clear of vegetation for inspection purposes. Although the proposed pipeline traverses the CSB vegetation type that is described as vulnerable the already disturbed nature of the proposed pipeline route makes it highly unlikely that threatened species have re-established themselves on the route.

The clearance of vegetation for the construction of the pipeline route will be approximately 60 – 100 meters depending on the accessibility of the site. This is a relatively small area of disturbance with most species recovering after the rehabilitation of the site. Endemic species found within the specific pipeline servitude, during the detailed floral investigation later in the process, will have to be removed and planted in a similar area. One of the rare plant species found in the area is Encephalartos eugene-maraisii or the Waterberg Cycad. These plants must be clearly identified and the proper authorisations obtained to be removed and replanted.

Figure 11-5: Waterberg Cycad

The occurrence of endemic species on the proposed pipeline route will have to be verified during the detailed floral investigations. Due to the relatively small area of disturbance for the construction of the pipeline any endemic or threatened species can be replanted after construction or moved away from the construction area. The proposed pipeline route can therefore be considered feasible from a floral perspective.

Faunal Species

No animal species were observed during the site investigation of the area below the dam. Due to the presence of ridges and mountains in the area surrounding the dam it is however expected that several birds, mammal and reptile species will occur in the area. The wetland area below the dam will also be an ideal habitat for water fowl.

Figure 11-6: Klipspringer

The rocky outcrops in the area also makes ideal habitat for several retile, rodent and mammal species such as:

- Striped Harlequin Snake (rare)
- Least Dwarf Shrew (vulnerable)
- Klipspringer (data deficient)

The area below the dam is intended for a residential development that will incorporate several antelope species.

The construction of the pipeline will disturb the faunal species in the area for a limited time. Once construction activities have ceased and the working area rehabilitated most faunal species will return. Blasting activities, however, may potentially destroy breeding areas and nests for certain species.

The remainder of the proposed pipeline route traverses a variety of land uses, including game farms, livestock farming and agricultural lands. It is expected that due to the large number of game farms in the area, several species of vulnerable or threatened mammal, reptile and bird species will occur in the area.

Bird species of special concern expected in the area include:

- Cape Vultures (vulnerable)
- Martial Eagle (vulnerable)
- African Whitebacked Vulture (vulnerable)
- Tawny Eagle (vulnerable)
- African Marsh Harrier (vulnerable)
- Lesser Kestrel (vulnerable)
- Grass Owl (vulnerable)
- Pallid Harrier (Near Threatened)
- Corn Crake (Near Threatened)
- Taita Falcon (Near Threatened)
- Great Snipe (Near Threatened)
- Cape Griffon Vulture (Vulnerable)
- Latakoo Lark (Near Threatened)
- Lesser Flamingo (Near Threatened)
- Lappet Face Vulture (Vulnerable)

The study area is also home to several reptile species that are more susceptible to the destruction of habitat due to their smaller foraging range. Species of special concern are:

- Southern African Python (Vulnerable)
- Striped Harlequin Snake (Rare)

- Blunt-tailed worm lizard (Data Deficient)
- Nile Crocodile (Vulnerable)
- Giant Bullfrog (Near Threatened)

Several species of mammals have been introduced into the area due to the game farming and hunting activities. These have contributed to the number species of concern within the study area.

They include:

- Cheetah (Vulnerable)
- White Rhino (Near Threatened)
- Black Rhino (Critical)
- African Wild Dog (Endangered)
- Wood's Slit Faced Bat (Near Threatened)
- Blasius's Horseshoe Bat (Near Threatened)
- South Africa Hedgehog (Rare)
- Aardwolf (Rare)
- Brown Hyena (Rare)
- Leopard (Rare)
- Honey badger (Vulnerable)
- Oribi (Vulnerable).

Faunal Feasibility

The construction of the pipeline will disturb the faunal species in the area in the short term. Most will, however, return once the floral habitat establishes itself. The working area in close proximity to rocky outcrops should be kept to a minimum.

Wetland and dam areas must be treated as areas of special concern due to the large variety of bird, reptile and amphibian species they support. The presence of the threatened Giant Bullfrog must be specifically noted as they are very sensitive to a change in their breeding habitat.

The construction of the pipeline will have a short term effect on the faunal species in the area. After construction activities the veld will recover and no permanent feature will remain obstructing the movement and foraging of faunal species.

The proposed pipeline route can therefore be considered feasible from a faunal perspective.

Water Bodies, Streams and Wetlands

After exiting the pump station the proposed route does not traverse any significant hydrological features till near the end of the section on the Farm Sterkfontein 542 LQ where it crosses a tributary of the Mokolo River. Several non-perennial tributaries need to be crossed for the proposed pipeline route.

Hydrological Feasibility

The crossing of the tributary does not present any fatal flaws due to the proper engineering designs and environmental management. The proposed pipe line also does not pose a significant environmental risk in the event that a leak should occur.

11.1.2.2 Nodes 32 – 43; 42 – 41; 41 – 40; 40 – 39; 39 – 37; Pipe Sections 9 - 14

Section 9 is approximately 4 km long and splits from the main pipeline as an alternative at the start of section G3. Sections 10 – 13 continues northwards crossing the railway line leading to Grootegeluk Mine. Section 14 runs directly east for approximately 8 km where it returns to the existing Exxaro pipeline route.

Sections 20 to 22 serve as linkages between the existing Exxaro route and the alternative section H1 – H6. Section 20 is approximately 5 km long and stretches in a south westerly direction between the existing pipeline and the alternative alignment. Sections 21 and 22 are approximately 7 km long and run in a westerly direction.

The above mentioned sections have similar floral and faunal characteristics.

Vegetation type and sensitivity

The WMB generally occurs on rugged mountains with vegetation ranging from Faurea seligna – Protea Caffra bushveld on the higher slopes through broad leaved deciduous bushveld on rocky mid- and footslopes to Burkea Africana – Terminalia sericea savannah in the lower lying valleys, as well as on deeper sands on the plateau. The grass layer is moderately developed or well developed.

Endemic taxa to this veld type include tall shrub Grewia rogersii, Pachystigma triflorum and herb Oxygonum dregeanum.

Figure 11-7: Waterberg Mountain Bushveld (WMB)

This veld type is regarded as least threatened with about 9% statutorily conserved. Only about 3% of the veld type is transformed.

The LSB occurs mainly on plains and sometimes undulating or irregular topographical area. The veld type is characterised by short open woodland with previously disturbed areas dominated by thickets of Acacia erubescens, Acacia mellifera and Dichrostachys cinerea that are almost impenetrable.

The veld type has no endemic taxa and is considered least threatened. Although only about 1% is statutorily conserved the abundance of games farms in the area adds to the low transformation figure of about 5%.

Floral Feasibility

The proposed pipeline route traverses the WMB and the LSB. Both these vegetation types are listed as least threatened.

The clearance of vegetation for the construction of the pipeline route will be approximately 60 – 100 meters depending on the accessibility of the site. This is a relatively small area of disturbance with most species recovering after the rehabilitation of the site. Endemic species found within the specific pipeline servitude, during the detailed floral investigation later in the process, will have to be removed and planted in a similar area.

The occurrence of endemic species on the proposed pipeline route will have to be verified during the detailed floral investigations. Due to the relatively small area of disturbance for the construction of the pipeline any endemic or threatened species can be replanted after construction or moved away from the construction area. The proposed pipeline route can therefore be considered feasible from a floral perspective.

Faunal Species

The proposed pipeline route traverses a variety of land uses including game farms, livestock farming and agricultural lands. It is expected that due to the large number of game farms in the area, several species of vulnerable or threatened mammal, reptile and bird species will occur in the area.

Bird species of special concern expected in the area include:

- Cape Vultures (vulnerable)
- Martial Eagle (vulnerable)
- African Whitebacked Vulture (vulnerable)
- Tawny Eagle (vulnerable)
- Lesser Kestrel (vulnerable)
- Pallid Harrier (Near Threatened)
- Corn Crake (Near Threatened)
- Taita Falcon (Near Threatened)
- Great Snipe (Near Threatened)
- Cape Griffon Vulture (Vulnerable)

- Latakoo Lark (Near Threatened)
- Lappet Face Vulture (Vulnerable)

The study area is also home to several reptile species that are more susceptible to the destruction of habitat due to their smaller foraging range. Species of special concern are:

- Southern African Python (Vulnerable)
- Striped Harlequin Snake (Rare)
- Blunt-tailed worm lizard (Data Deficient)

Several species of mammals have been introduced into the area due to the game farming and hunting activities. These have contributed to the number species of concern within the study area. They include:

- Cheetah (Vulnerable)
- White Rhino (Near Threatened)
- Black Rhino (Critical)
- African Wild Dog (Endangered)
- Wood's Slit Faced Bat (Near Threatened)
- Blasius's Horseshoe Bat (Near Threatened)
- South Africa Hedgehog (Rare)
- Aardwolf (Rare)
- Brown Hyena (Rare)
- Leopard (Rare)
- Honey badger (Vulnerable)
- Oribi (Vulnerable).

Faunal Feasibility

The construction of the pipeline will disturb the faunal species in the area in the short term. Most will, however, return once the floral habitat establishes itself.

The construction of the pipeline will have a short term effect on the faunal species in the area. After construction activities the veld will recover and no permanent feature will remain obstructing the movement and foraging of faunal species.

The proposed pipeline route can therefore be considered feasible from a faunal perspective.

Water Bodies, Streams and Wetlands

None of these alternatives traverse and significant hydrological features.

Hydrological Feasibility

The crossing of small drainage channels does not present any fatal flaws due to the proper engineering designs and environmental management. The proposed pipe line also does not pose a significant environmental risk in the event that a leak should occur.

11.1.2.3 Mokolo Weir and Section 18

The proposed Mokolo Weir is situated within the Mokolo River approximately 6 km south of the town of Lephalale. The weir is situated in a broad stretch of river where slow flowing water makes for the formation of reedbeds and wetland type habitats.

Vegetation type and sensitivity

The LSB occurs mainly on plains and sometimes undulating or irregular topographical area. The veld type is characterised by short open woodland with previously disturbed areas dominated by thickets of Acacia erubescens, Acacia Mellifera and Dichrostachys cinerea that are almost impenetrable.

The veld type has no endemic taxa and is considered least threatened. Although only about 1% is statutorily conserved the abundance of games farms in the area adds to the low transformation figure of about 5%.

Floral Feasibility

The pipeline route from the weir to the delivery area traverses mainly flat areas that have been transformed into agricultural areas, as well as several game farms. The clearance of vegetation for the construction of the pipeline route will be approximately 60 – 100 meters depending on the accessibility of the site. This is a relatively small area of disturbance with most species recovering after the rehabilitation of the site. Endemic species found within the specific pipeline servitude, during the detailed floral investigation later in the process, will have to be removed and planted in a similar area.

The occurrence of endemic species on the proposed pipeline route will have to be verified during the detailed floral investigations. Due to the relatively small area of disturbance for the construction of the pipeline any endemic or threatened species can be replanted after construction or moved away from the construction area. The proposed pipeline route can therefore be considered feasible from a floral perspective.

The weir construction will have an impact on the riverine flora due to the alteration of the flow dynamics of the river. The decrease in the flow speed may result in an increase in the number of reed beds and wetland habitat. This is, however, not considered a significant impact.

Faunal Species

The river habitat and specifically the reed beds is an ideal habitat to several bird species. The construction of the weir will in all likelihood contributes to the increase in reed beds and therefore establish additional habitat for these birds. The weir will, however, have a negative impact on the migration of fish species in the river. It is therefore vitally important that the weir should accommodate the migration of fish species.

Mammal faunal species also frequent the river and there is an abundance of other faunal species along the proposed pipeline route. The pipeline will, however, only has a limited impact on these species during the construction period.

Faunal Feasibility

The most significant impact about the construction of the weir is the fact that it will disrupt fish migration along that specific stretch of the river. The construction of fish ladders will mitigate this specific problem. With regards to the construction of the pipeline, the disturbance will be temporary and the faunal species will return after the construction period.

12. CONCLUSION AND RECOMMENDATIONS

12.1 Conclusion

The initial desktop analysis revealed that although there will be some difficulties in parts of the various alternatives, there seem no outright fatal flaws in the various alternatives. The alignment along the access road from the Mokolo Dam is preferred to the alignment along the existing pipeline due to the sensitivity of the original alignment.

The pipeline option is also preferred to the weir option due to the permanent impact the construction of the weir will have on the riverine system.

12.2 Recommendations

There are several environmental recommendations with regards to alignment planning that needs to be considered to ensure that the most sensitive habitats and species be conserved or avoided.

- Rocky outcrop areas should be avoided to minimise impact on this sensitive environment.
- Endemic, endangered and medicinal plant species should be identified and relocated to suitable areas.
- Pipeline routes should follow existing transport infrastructure where possible. This will minimise further disturbance of natural vegetation.
- Farm boundaries should be followed where possible to avoid further fragmentation of faunal habitats.
- River crossings should occur in areas not prone to wetland formation where possible.
- Faunal species, especially reptile and rodent species should be relocated from the terminal dam sites.
- It is essential to have extensive Public Participation with affected landowners, community groups and government organisations during the planning process.

PART 4: SOCIAL IMPACTS MOKOLO CONVEYANCE SYSTEM

13. SOCIAL IMPACTS

13.1 Delivery Pipeline Options

13.1.1 Interim Measure at Mokolo Dam

a) Description

Option 1A is an interim measure; it involves the abstraction from the Mokolo Dam and conveyance to the users. The pipeline is expected to be 91.1 km long. The route of this option is through the following pipe sections: 1-2-3-4-5-6-7-8-14-13-24-25A-25B.

b) Possible Social Impacts

The pipeline runs across farms in an unfavorable manner and this has the potential of causing an elevated social impact. Most of the affected farms appear could be game farms, therefore we can expect that the impact could be more environmental in nature.

c) Areas of Concern Associated with this Option include the following:

- Social impact on the Hans Strijdom Nature Reserve.
- A crossing of the main road (R510) would cause disturbances of traffic.
- The crossing of a railway could have an impact on infrastructure.
- A Sub-Station that is partially on the route of the pipeline (that is pipe Section 7) should be avoided or the alternative of going around it should be chosen.

d) Estimated compensation

The estimated compensation costs based on the aforementioned limitations and assumptions are summarized below.

Table 13-1: Estimated Losses and Compensation Costs for Option 1A

TYPE	NUMBER	PRICE	AMOUNT(R)
BUILDINGS			
Farm Houses	2	800,000	1,600,000
Worker Houses	1	80,000	80,000
Outbuildings	1	400,000	400,000
Sheds	0	400,000	0
Sub-Total			2,080,000
OTHER IMPROVEMENTS			
Reservoirs	1	120,000	120,000
Windmill and borehole	0	150,000	0
Sub-Total			120,000
RELOCATION COSTS			
Households	3	200,000	600,000

SUBTOTAL BUILDINGS AND IMPROVEMENTS			2,800,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	14,000	63.3	886,411
	16,000	102.6	1,641,541
	18,000	15.8	283,818
Sub-Total			2,811,770
Irrigated land			
	50,000	7.2	360,519
	55,000	4.8	269,343
Sub-Total			629,862
SUB-TOTAL: LAND		193.8	3,441,632
LAND AND IMPROVEMENTS			6,241,632

From the above table it is indicated that this option is expected to impact more on land covered with natural pastures than irrigated land, roughly two (2) farmhouses, one (1) outside building and a reservoir.

It is estimated that the approximate compensation costs of the land improvements will be R6.2 Million. Utilising the estimated area for this pipeline route and the estimated costs of land, the price of land for the entire route is estimated to be R17 758.

13.1.2 Interim Measure at Lephalale (Rivers Bed) Weir

a) Description

Option 1B is an interim measure; it entails the abstraction at the Lephalale weir and conveyance to the clients. This option is expected to be 75.4 km. The designed route is expected to constitute the following pipe sections: 18-4-5-6-7-8-14-13-24-25A-25B.

b) Possible Social Impacts

The potential social impact that could be imposed by this pipeline is expected to be lofty since the pipeline runs across farms and this may cause complications in the administration of the farms.

c) Areas of Concern Associated with this Option Include:

- Irrigated land that could be lost at the banks of the Mokolo River.
- A crossing of the main road (R510) would cause strife of traffic.
- Impact on the infrastructure of a railway line.
- Impact on smaller farms near the Mokolo River can be high
- A Sub-Station that is partially on the route of the pipeline (pipe Section 7) should be avoided or the option of going around it should be chosen.

d) Estimated compensation

The estimated losses and compensation costs for along this option are summarized below.

Table 13-2: Estimated Losses and Compensation Costs for Option 1B

TYPE	NUMBER	PRICE	AMOUNT(R)
BUILDINGS			
Farm Houses	5	800,000	4,000,000
Worker Houses	3	80,000	240,000
Outbuildings	3	400,000	1,200,000
Sheds	0	400,000	0
Sub-Total			5,440,000
OTHER IMPROVEMENTS			
Reservoirs	0	120,000	0
Windmill and borehole	1	25,000	25,000
Sub-Total			25,000
RELOCATION COSTS			
Households	8	200,000	1,600,000
SUB-TOTAL: BUILDINGS AND IMPROVEMENTS			7,065,000
	PRICE	**AREA**	**MARKET LAND VALUE**
LAND	(R)	(HA)	(R)
Natural pasture			
	14,000	31.8	445,287
	15,000	10.3	155,143
	16,000	70.6	1,129,058
	18,000	15.8	283,818
	20,000	11.4	228,408
Sub-Total			2,241,714
Irrigated land			
	50,000	6.3	315,378
	55,000	4.5	248,719
	75,000	1.6	117,049
Sub-Total			681,147
SUB-TOTAL: LAND		152.3	2,922,861
LAND AND IMPROVEMENTS			9,987,861

Based on the above analysis, it is estimated that the approximate compensation costs of land and improvements will be R10 Million. Utilising the estimated area for the pipeline route and the estimated prices of land, the approximated average cost of land for the entire are for the route is R19 191.

It is estimated that approximately eight (8) families will need to be relocated. In addition, three (3) more building could be lost.

The potential impact on improvements that could be experienced from this route can be seen as high; as a result the compensation costs thereof will be high.

14. CONCLUSION

14.1 Introduction

The purpose of this section is to combine all the results of the previous sections in order to draw conclusions in a comparative manner. Recommendations are also included in order to inform relevant stakeholders on what to look out for in the process of the project.

14.2 Recommendations

14.2.1 Information Issues

Households in the affected areas should be well informed about the project. This should include the timing of construction as well as detailed plans for compensation. Certain local officials should be positioned to deal with all queries about the project.

14.2.2 Positive Effects

Among the most common positive effects that households and stakeholders hope the pipeline will bring are improvements to the local economy and infrastructure, employment opportunities and improved access to water.

A second cluster of positive hopes about the project, could relate to compensation. If compensation is generous and fair, the complete scheme will be a positive project. Some households could prefer to receive cash, while others would prefer to have new houses, both these preferences should be accommodated for.

14.2.3 Negative Effects

Among the negative effects that could concern households and stakeholders, is pipeline safety, degradation of the environment, and damage to local roads and other infrastructure during construction.

The most prevalent uncertainties about the complete scheme (transfer, delivery and dams) could relate to the losses of land, houses, other buildings, soil fertility, and crops. Other concerns that could emanate may include compensation issues (i.e. compensation would not be transparent, fair, or equitable, or received in full).

Negative impacts of the complete scheme should be minimized and, if not avoidable, should be corrected as promptly as possible, ideally by the construction companies before they move on with the project.

An in depth inventory has to be undertaken of heritage sites, natural parks and reserves, temples and tombs, so that these can be avoided along the pipeline routes and dams. This practice could be seen as an excellent example of prevention. Every effort should be made to be sure that all such sites are identified and avoided if possible.

In this, and in other aspects of prevention and quick mitigation, there should be a special potential role to be executed by the construction teams and companies – that will actually construct the pipelines and dams

We recommend that the contracts signed with these firms include clauses, incentives, and penalties to encourage:

- Further identification of sensitive sites that the pipeline can still avoid, and immediate notice to be given of any sites uncovered during construction;

- Other preventive measures such as minimizing dust and other environmental degradation, minimizing damage to local roads, and assuring careful restoration of topsoil when the pipeline is covered;
- Prompt mitigation of negative impacts such as restoration of breaks in irrigation systems or paddy dikes, and repair of local roads; and
- Active and transparent participation – as and when required—in the process of compensation.

Finally, it is recommended that the project team, together with related local authorities, monitor closely the work of the construction companies and assist them to undertake these additional tasks successfully. Experts from the project team should oversee prevention and mitigation of negative impacts. Good community relations are important for construction companies, as they would want to get along with the local people, if for no other reason than to avoid problems with them

14.2.4 Compensation

It is certain that the way compensation will be handled will determine how households and stakeholders view the project. Mismanagement of compensation is a large threat to goodwill, and thus to how people will view other government development projects in the future.

Certain standards for compensation should be followed. The following standards could serve as a guideline:

- Valuation of losses should be at replacement cost, not depreciated cost.
- Any administrative fees should not to be subtracted from the compensation to the affected households.
- Restoration (in real terms) of pre-construction living standards.
- A grievance procedure for resolving disputes should be set.
- It is recommended that the stakeholders that will be involved in the project make a commitment to monitor the compensation process and to follow-up with affected households and communities.

14.3 Conclusion

In order to compare and summarise each of the proposed options between the transfer, delivery scheme and terminal dams a table format has been utilised. Table 14-1 provides a summary table of the delivery scheme options.

The following general major conclusion can be drawn from this report:

- Land that is near the crocodile dam is mostly irrigated and is very expensive.
- A large portion of productive agricultural land will be lost from the banks of the Crocodile River.
- No rural settlements will need to be relocated other than possibly the owner and workers on particular farms.

Based on the previous analysis, the options have been ranked in the following order from the lowest to highest impact:

14.4 Delivery pipeline options

14.4.1 Mokolo Dam Abstraction

1A- Interim Measure Mokolo Dam

1B - Interim Measure Lephalale Weir

14.4.2 Terminal Dam Abstraction

2B - Terminal Dam Site 3

2A - Terminal Dam Site 1

14.4.3 Balancing Dam Abstraction

3- Balancing Dam

Table 14-1: Summary of the Delivery Scheme Route Options

OPTIONS	1A	1B	2A	2B	3
TYPE					
Buildings					
Farm Houses	2	5	1	0	0
Worker Houses	1	3	2	0	0
Outbuildings	1	3	1	1	1
Sheds	0	0	1	0	0
Farm improvements					
Reservoirs	1	0	0	0	0
Windmills	0	1	0	0	0
Productive resources					
Natural pasture	181.68	139.90	123.35	124.72	126.73
Irrigated land	12.11	12.39	10.42	9.94	11.02
Estimated Compensation Cost in R' million	6.2	10.0	3.9	2.9	2.9

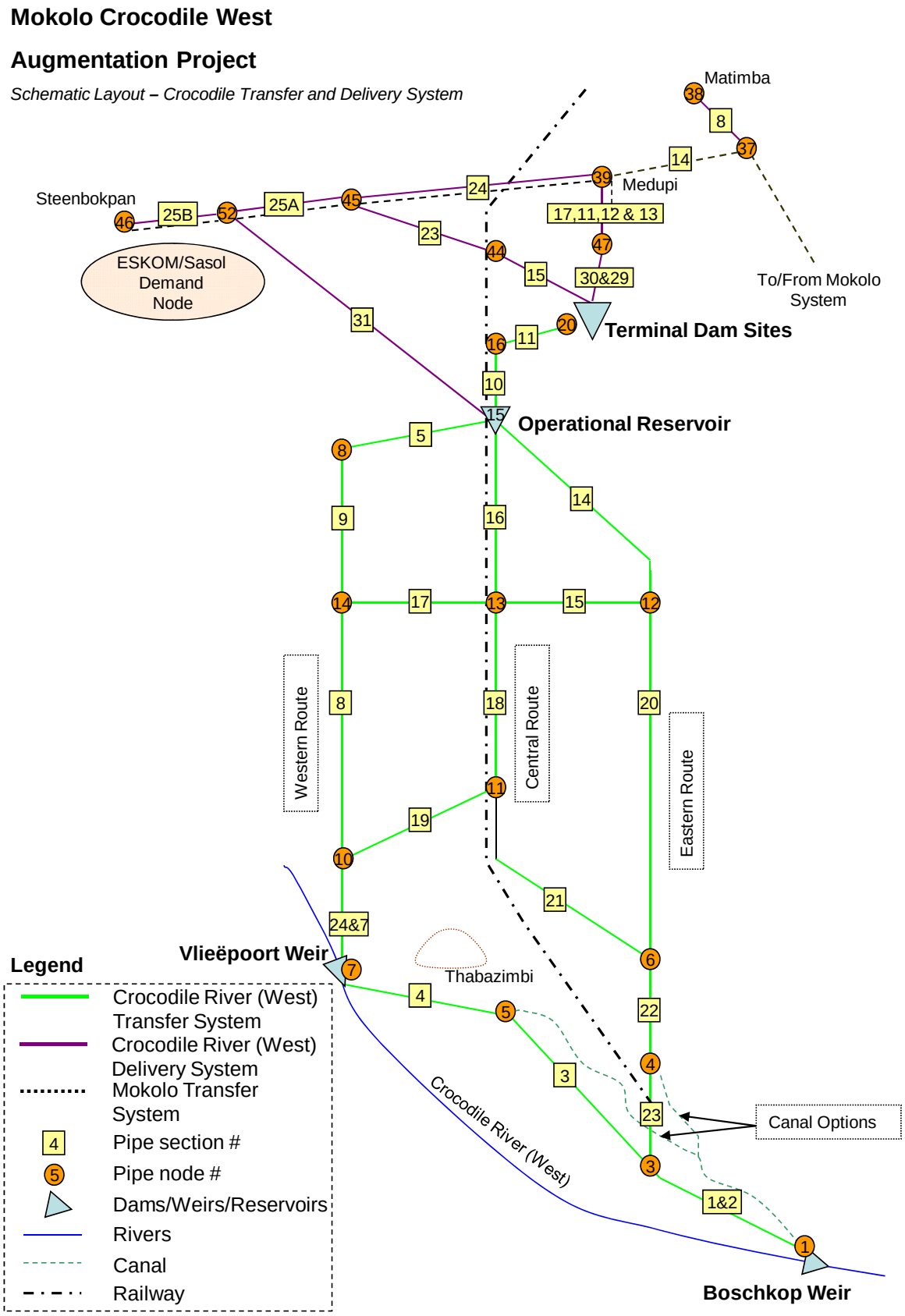


Figure 14-1: Schematic Diagram of the Crocodile River (West) Transfer and Delivery System

15. REFERENCES

(1) CSIR
(2) The World Health Organisation provides the following information on the algae in the Hartbeespoort Dam (2005)
(3) Pazos *et al*; Oshima *et al*., 1989)
(4) Toxic Cyanobacteria in Water (Chorus & Bartram, 1999)

APPENDIX A

TRANSFER PIPELINE ROUTE OPTIONS

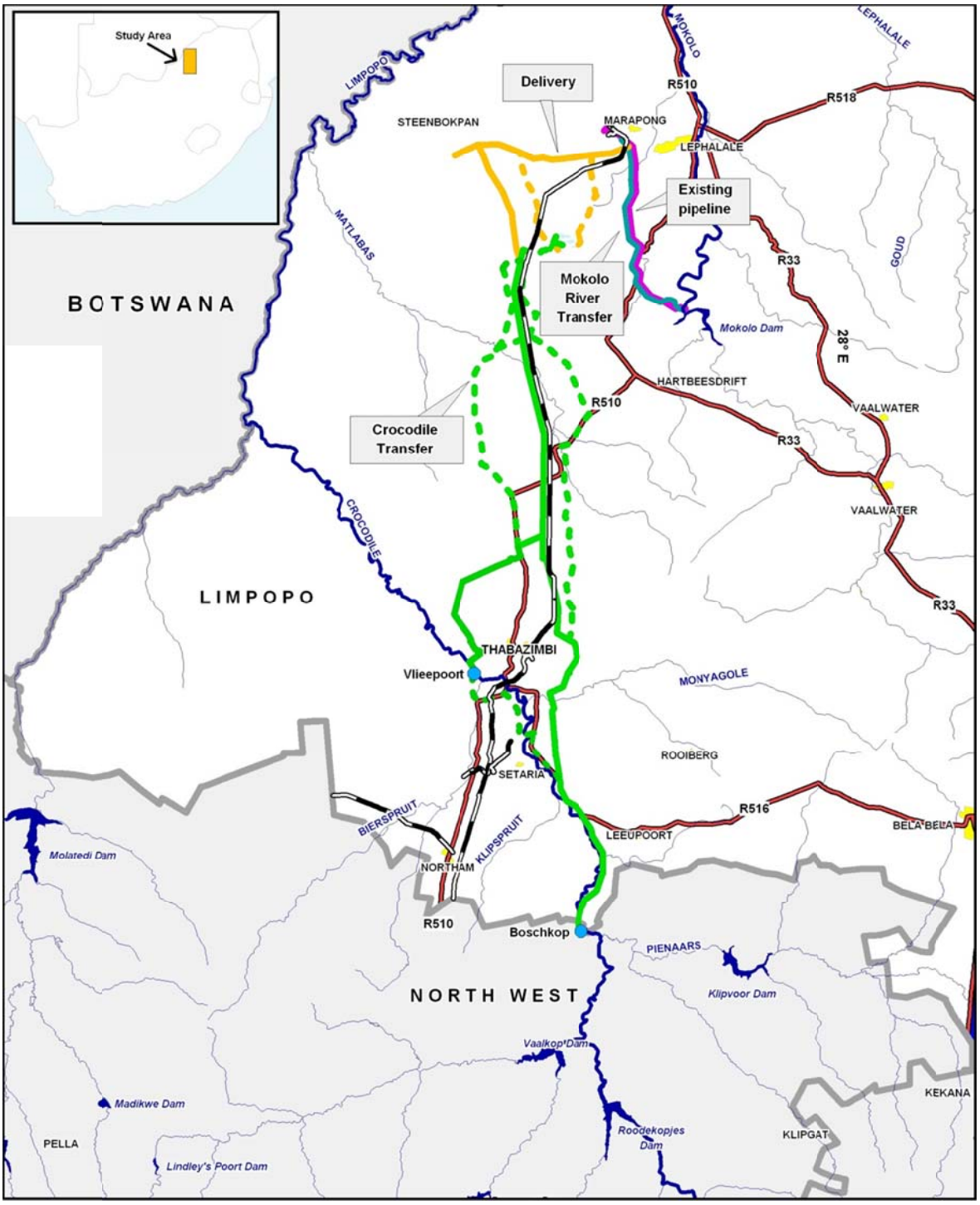


Figure A-1: Transfer Pipeline Route Options

APPENDIX B

LIST OF ESTATE AGENTS

Table B-1: List of Estate Agents

NAME OF ESTATE AGENT	COMPANY	PLACE
Assis Pontes	Pam Golding Properties	Lephalale
Margie Geyster	Remax	Lephalale
Hennie Lee	Obberholzer Estate	Lephalale
Hester Viljoen	Africa Properties	Thabazimbi
Barry de Lange	Era Real Estate Thabazimbi	Thabazimbi
Hannelie Lotter	Pam Golding Properties	Thabazimbi
Marina Van der Wateren	Van Graan & Van Der Wateren Eiendoms Agente En Waardeerders	Thabazimbi
Jannie Kruger	Mulder Estate Agents	Modimolle
Marthie Mare	Brits Herman Prokureurs	Modimolle
Santi Britz	Homenet Potchefstroom	Potchefstroom
Hester Fourie	Anglo Saxon Properties	Brits
Wannes van Aardt	Aida Brits	Brits
Hannelie van Zyl	Jurina Eiendoms Konsultante	Mookgopong
SP Burger	Pretorius Eiendomme	Mookgopong
Hannelie van Zyl	Jurina Eiendoms Konsultante	Vaalwater
John Rosich	Geyer Eiendomme Noordwes Bk	Rustenburg
Mr Hoffman	Impala Property Developers & Agents (PTY) LTD	Rustenburg
Abie Beyneveldt	Real Net	Rustenburg
Pikkie Roos	Pikke Prop	Koster
Pikkie Roos	Pikke Prop	Swartruggens
Waldo Nel	help u sell jacaranda real estate	Boschkop
Toni Mc Donald	Cyberprop	Boschkop

REPORT DETAILS PAGE

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