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Ecological impact Assessment for Sandriver Sewer line Upgrading- Sandton (Gauteng Province)




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DOCUMENT SYNOPSIS

REPORT TITTLE	Atholl gardens (118 Dennis Rd) Emergency Sewer Pipe Replacement Ecological Impact Assessment Report
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STATUS	Final
REPORTING SCOPE	This report is an Ecological investigation and assessment update of the Atholl gardens (118 Dennis Rd-Sandton) Emergency Sewer Pipe Replacement. It includes a thorough evaluation and Impact Assessment on how the project implementation will affect area's ecological makeup.

DECLARATION

I, **Witness Dube**, as an appointed Ecological Impact Assessment Specialist hereby declare that i:

- ❖ Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998); the Environmental Impact Assessment Regulations, 2017 and any specific environmental management act;
- ❖ Act as an independent ecological assessment specialist in this application;
- ❖ Am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2017 (specifically in terms of regulation 13 of GN No. R. 326) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- ❖ Have and will not have no vested interest in the proposed activity proceeding;
- ❖ Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- ❖ As a registered member of the South African Council for Natural Scientific Professions, will undertake our profession in accordance with the Code of Conduct of the Council, as well as any other societies to which we are members;
- ❖ Am aware that a false declaration is an offence in terms of regulation 48 of GN No. R326; and
- ❖ Based on information provided to me by the project proponent, and in addition to information obtained during this study, have presented the results and conclusion within the associated document to the best of my professional judgement.



Field of Expertise

Terrestrial Biodiversity Assessments; Wetland Ecological Assessments, Delineations and Habitat Evaluations.

ACKNOWLEDGEMENTS

The authors acknowledge Johannesburg Water and City of Johannesburg Metropolitan Municipality (CJMM) for their assistance with project information, and the associated project BID as well as responding to technical queries related to the project.

LIST OF ABBREVIATIONS & ACCRONYMS

IWWMP	Integrated Waste Water Management Plan
CJMM	City of Johannesburg Metropolitan Municipality
POSA	Plants of South Africa, a PRECIS related database hosted by SANBI
M&R (2006)	Mucina and Rutherford (2006)
SANBI	South African National Biodiversity Institute
PRECIS	National Herbarium Pretoria (PRE) Computerised Information System;
GIS	Geographic Information System
CWB	Central Weather Bureau;
CBA	Critical Biodiversity Area
ESA	Ecological Support Area
GDARD	Gauteng Department of Agriculture and Rural Development;
SCC	Species of Conservation Concern
PES	Present Ecological State;
SEIP	Scoping and Environmental Impact Reporting
QDS	Quarter Degree Squares;
NEPAD	New Partnerships for Africa's Development;
DAFF	Department of Agriculture, Forestry and Fisheries
SAHRA	South African Heritage Resources Agency;
BAR	Basic Assessment Report
POC	Probability of Occurrence
DEAT	Department of Environmental Affairs and Tourism
VIS	Vegetation Index Score
VegMap	Vegetation Map of South Africa, as per Mucina & Rutherford (2006)
IWRM	Integrated Water Resources Management
ECO	Environmental Control Officer
EMP	Environmental Management Plan
EMPr	Environmental Management Programme
I&AP	Interested and Affected Party
uPVC	Unplasticized Polyvinyl Chloride
IWUL	Integrated Water Use License
WUL	Water Use Licence
EIA	Environmental Impact Assessment
NEMA:	National Environmental Management Act (Act No. 107 of 1998)
NEMWA:	National Environmental Management: Waste Act (Act 59 of 2008)
BAP	Biodiversity Action Plan
NWA:	National Water Act (Act No. 36 of 1998)
BPG	Best Practice Guidelines
EAP	Environmental Assessment Practitioner

GENERAL TERMS

Conservation: In relation to a water resource means the efficient use and saving of water, achieved through measures such as water saving devices, water-efficient processes, water demand management and water rationing;

Contaminate: Make something impure by exposure to or addition of a poisonous or polluting substance.

Environmental Impact: A positive or negative condition that occurs to an environmental component as a result of the activity of a project or facility. This impact can be directly or indirectly caused by the project's different phases (i.e., Construction, Operation, and Decommissioning).

Environmental Management Programme: (i) Defines the measures to be taken during the life of a project, including design, construction, and operation and decommissioning to prevent and / or manage adverse environmental impacts; (ii) defines the actions needed to implement these measures; and (iii) describes how this will be achieved.

Environmental monitoring: The process of checking, observing, or keeping track of something for a specified period of time or at specified intervals.

Interested and affected party means any person, group of persons or organization interested in or affected by an activity and any organ of state that may have jurisdiction over any aspect covered by the activity.

Operation: The time period that corresponds to any event, process, or activity that occurs during the Operation (i.e., fully functioning) phase of the proposed project or development. (The Operation phase follows the Construction phase, and then terminates when the project or development goes into the Decommissioning phase.)

Terrain Unit Morphological Classes: areas of the land surface with homogenous form and slope. Terrain may be seen as being made up of all or some of the following units: crest (1), scarp (2), mid-slope (3) foot slope (4), and valley bottom (5);

Ecosystem: An ecosystem is a working natural system, maintained by internal ecological processes, relationships and interactions between the biotic (plants & animals) and the non-living or abiotic environment (e.g. soil, atmosphere). Ecosystems can operate at different scales, from very small (e.g. a small wetland pan) to large landscapes (e.g. an entire water catchment area);

Ecosystem Goods and Services: The goods and benefits people obtain from natural ecosystems. Various different types of ecosystems provide a range of ecosystem goods and services. Aquatic ecosystems such as rivers and wetlands provide goods such as forage for livestock grazing or sedges for craft production and services such as pollutant trapping and flood attenuation. They also provide habitat for a range of aquatic biota;

Buffer zone: The strip of vegetation maintained to limit impacts to natural ecosystems from adjoining land use activities;

Catchment: A catchment is an area where water is collected by the natural landscape. In a catchment, all rain and run-off water eventually flow to a river, wetland, lake or ocean, or into the groundwater system;

Biodiversity: the number and variety of living organisms on earth, the millions of plants, animals, and micro-organisms, the genes they contain, the evolutionary history and potential they encompass, and the ecosystems, ecological processes, and landscapes of which they are integral parts;

Endemic: Refers to a plant, animal species or a specific vegetation type which is naturally restricted to a defined region (not to be confused with indigenous). A species of animal may, for example, be endemic to South Africa in which case it occurs naturally anywhere in the country, or endemic only to a specific geographical area within the country, which means it is restricted to this area and occurs naturally nowhere else in the country;

Environmental Control Officer (ECO): Person tasked with monitoring and supervision of the implementation and controlling of environmental issues;

Environmental Impact: A positive or negative condition that occurs to an environmental component as a result of the activity of a project or facility. This impact can be directly or indirectly caused by the project's different phases (i.e., Construction, Operation, and Decommissioning);

Land rehabilitation: Is the process of returning the land in a given area to some degree of its former state, after some process (industry, natural disasters etc.) has resulted in its damage; and

Watercourse: Means a river or spring; a natural channel or depression in which water flows regularly or intermittently; a wetland, lake or dam into which or from which water flows; and any collection of water which the Minister may, by notice in the gazette, declare to be a watercourse as defined in the National Water Act, 1998 (Act No. 36 of 1998).

EXECUTIVE SUMMARY

This Ecological Impact Assessment report has been prepared to address requirements of National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA), the Environmental Impact Assessment Regulations, 2017 (specifically in terms of regulation 13 of GN No. R. 326) and any other specific environmental management Act.

NKT Consulting (Pty) Ltd as the Environmental Practitioner appointed the independent specialist to conduct this Ecological Impact Assessment study for the proposed construction and operation of a uPVC (Unplasticized Poly Vinyl Chloride) Sewer Line in Sandton, Gauteng Province. This ecological impact assessment report also consists of impact management section which will assist significantly on the development of the Environmental Management Programme (EMPr) which is meant to minimise the construction and operational impacts of the development project to natural endowment. The report will also form part of the Basic Assessment Report (BAR). Based on the findings of this ecological assessment, it is the opinion of the ecologists that from a specialist viewpoint after thorough investigation of the study area's ecological composition, the proposed project be considered positively mainly because of the need to reconnect the broken link of the section of the waste water pipeline. The line has been releasing into the water course after it was swept away by the flooded water catchment. It is however a recommendation that all essential mitigation measures and commendations presented in this report should be adhered to as to ensure minimum impact on natural systems.

The major activities will be clearing of vegetation and river bank slope alteration for construction and operation of the sewerage line. All the mentioned activities above will definitely affect the catchment ecology from construction to operation of the sewer line.

A sensitivity map has been prepared and is part of this report for the whole project footprint which is dominated by affluent residential areas. In addition to the above, a list of identified species (flora and fauna) as well as the expected list for the project site forms part of this report. A proper ecological management system needs to be exercised in order to ensure that the marked sensitive areas (riparian area of Sand river) with related systems (habitat areas) are not affected by this necessary development.

The following conclusions were made by the specialist;

- ❖ No animal nor plant species of concern have been identified from ground survey done;
- ❖ Civil works should take into consideration the water course flood lines, riparian zone and consideration of possibilities of contaminating the water resource during construction, operation and maintenance;
- ❖ Mature flora to be spared as they are deep rooted and allow the rehabilitated pipeline under laying area to naturally recover after slope stabilisation by gabion rock blocks. This will also be treated as the recovering buffer zone of about 30m wide and will proliferate on the margins; and
- ❖ Recommendations from this report should be adhered to as it forms part of a working technical document that will assist significantly in the production of the Environmental Management Plan.

There is a general dominance of Eucalyptus trees, Wattle, and grass typical of the disturbed landscape. It must however be noted that the study area lies within the built-up area of the Gauteng Critical Biodiversity Area (GCBA) and from the ecological perspective, the specific area or siting is mainly located within a sensitive area of the riparian zone of a river. This can also be confirmed by South Africa National Biodiversity Institute (SANBI).

A walk through the survey area resulted in none of the CBA or ESA species being found. However, a list of the expected plant and animal species for this particular area is therefore included in this report in support of the already available sensitivity map prepared for the area of concern. In addition to the above, a proper ecological management system needs to be exercised in order to ensure that the marked sensitive areas for instance, identified watercourse and its systems (habitat areas) are not affected by this essential development.

SCOPE OF WORKS

The scope of works is mainly ecological impact assessment which encompasses the following:

- ❖ To determine the environmental impacts of the proposed development on the Terrestrial ecology within the proposed project area and to develop mitigation and management measures;
- ❖ To define the Present Ecological State (PES) of the ecological resources in the vicinity of the proposed development area;
- ❖ To conduct a Species of Conservation Concern (SCC) assessment, including potential for species occurrence within the study area; and
- ❖ To identify and consider all sensitive landscapes including wetlands and any other ecologically important features;

Sensitivity analyses

The ecological sensitivity of the study area is determined by combining the sensitivity analyses of both the floral and faunal components. The highest calculated sensitivity unit of the two categories is taken to represent the sensitivity of that ecological unit, whether it is floristic or faunal in nature (**Error! Reference source not found.**).

Table 1: Ecological sensitivity analysis model used in the studies.

Ecological community	Floristic sensitivity	Faunal sensitivity	Ecological sensitivity	Development Go-ahead
Farmland	Low	Low	Low	Go
Bushveld	Medium	Medium	Medium	Go-But
Urban	Low	Low	Low	Go
Hills	Medium / High	Medium / High	Medium / High	Go-But
Watercourses	Medium	Medium	High	Go-But

There are 'sensitive' or 'no-go' zones within the study site which are specifically the riparian area or zone for the river which should be treated with caution or certain applications to be implemented or applied for, thus the Water Use Licence (WUL). All watercourses, by default, are viewed and approached as sensitive that is a rating of 'high'. A 1:100-year flood line to be

established and maintained and if it is to be disturbed, the WULA conditions should be in place to assist in maintaining such.

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1. INTRODUCTION

NKT Consultants (Pty) Ltd was appointed by Johannesburg Water to provide professional environmental services for the proposed repair and maintenance of the sewer line at Atholl gardens (118 Dennis Rd) in Sandton, Gauteng Province. The professional services included this specialist ecological studies for the construction and operation of 75m sewer line as required in terms of Chapter 4 (Government Notice 326) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) ("NEMA"): Environmental Impact Assessment Regulations (2014) as amended ("BAR process").

The project activities will affect the natural riparian and terrestrial ecosystems which has also influenced the development of this ecological impact assessment report. This report, after consideration of the ecological integrity of the study area, must guide the Environmental Assessment Practitioner (EAP), regulatory authorities and proponent, by means of the presentation of results and recommendations, as to the ecological viability of the proposed activities. This document follows on from results obtained during a literature survey as well as utilising information from previous studies subjected to similar environmental conditions (e.g. soil form, topography, catchments and agricultural activities. Several important national and provincial conservation plans were also reviewed, with the results of those studies being included in this report.

1.1. Project Description

The scope includes pipe repair of approximately 75m long pipe from manhole to manhole and installation of approximately 85m of erosion shield using combination gabions and rip rap by conventional open trench method for normal ground works and by open trench mainly. The scope of work will also incorporate at least the following detailed activities:

- ❖ Pipe repair and Installation of a new 250mm uPVC sewer pipe approximately 75m long from manhole to manhole;
- ❖ Erosion protection of by Rip rap, gabion boxes and gabion reno mattresses;
- ❖ Earthworks excavation and compaction;
- ❖ Unsafe Material will be removed dispose to licensed dump site but some existing pipeline will be left underground as it does not cause any environmental harm; and
- ❖ Replacement of markers and dealing with live water and sewer flow during construction

It must be noted that the existing clay sewer pipe was washed away by the river/ flooding due to river bank collapse and the pipe is currently disconnected and discharging effluent to the river. A method statement on sewer pipe repair & erosion protection has been prepared by JW in line with this application for authorisation. Reference in line with project design and activity will be made in conjunction with the method statement.

1.2. Project Location

The project is to be located in the Atholl Gardens, Sandton area, which falls under Regions E of the City of Johannesburg (COJ) as shown in figure 1 below. The location coordinates are as follows: Start-S26°06'25.3" & E28°04'22.8"; End-S26°06'23.4" & E28°04'22.5"

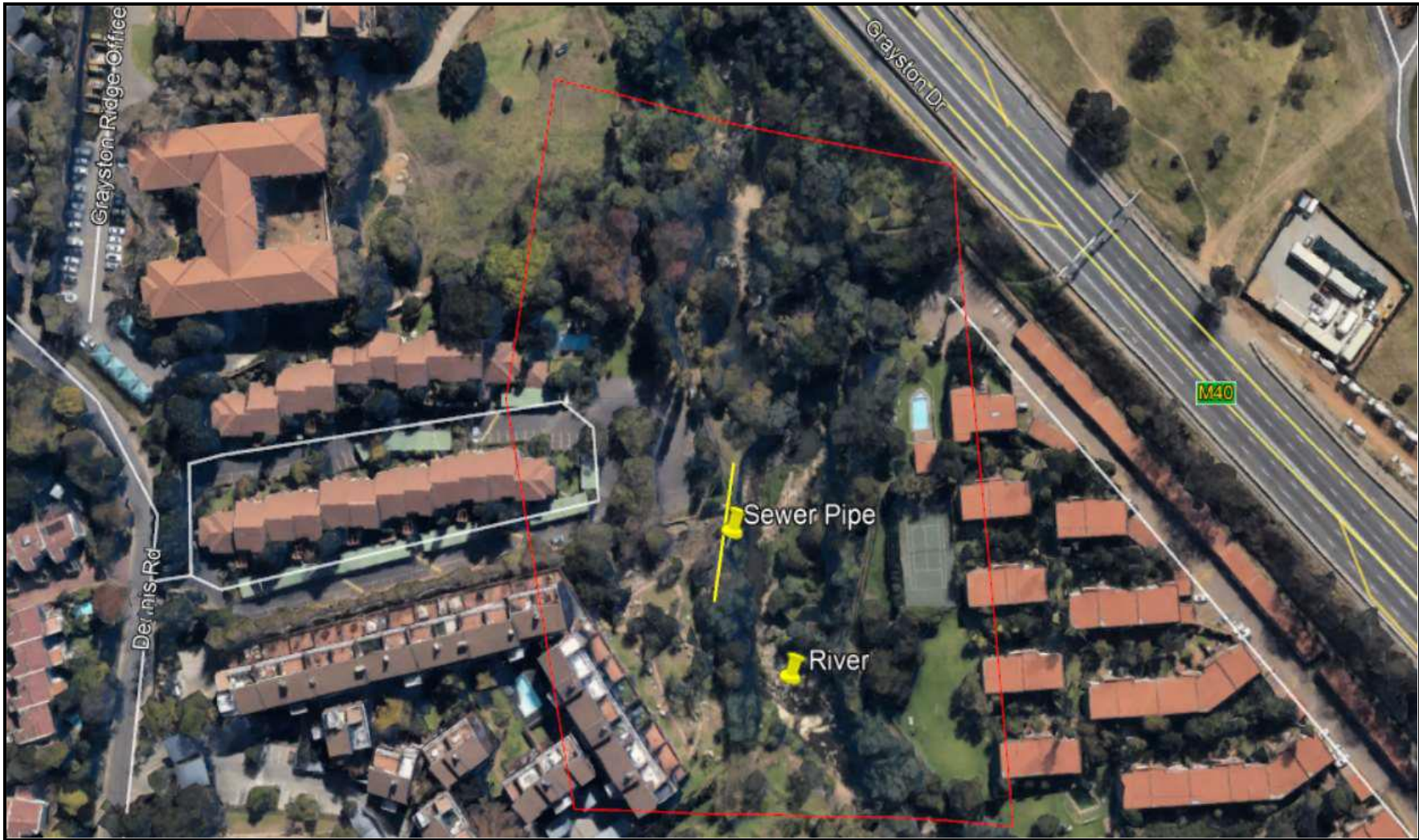


Figure 1: Location of pipeline route

1.3. Alternatives

The nature of the existing landscape (Natural Slope and elevation), housing and related infrastructure within the proposed sewer pipeline route construction catchment area leaves the proponent with no alternative option for the route alignment. In addition to the above, the landscape morphology, geology and land ownerships also contributed to fewer options for the construction and operation of the sewer pipeline.

1.4. Assumptions and Limitations

- ❖ This report considers likely impacts that can arise during the construction, operation and maintenance of the sewer pipeline. However, some unique impacts may arise that must be recorded during monitoring and appropriate corrective actions taken;
- ❖ Engineering designs and the specification of rehabilitation structures fall outside of the scope of this general ecological impact assessment report, but consideration will be given on overlaying important sections on final alignments;
- ❖ All information contained in this report is based on what the specialist discovered on site as well as what was provided to him by the project management team and Johannesburg Water in collaboration with City of Johannesburg (COJ);
- ❖ The time lapse between the phases of construction depends on the contractor's work plan; and
- ❖ There is limited information on specific availability and behavior of flora and fauna within this catchment as the assessment was done only within one season. Budgetary constraints and time limitations are some of the issues that might lead to limited assessment of the whole area;

It should be noted that findings, recommendations and conclusions provided in this report are based on the author's best scientific and professional knowledge. No part of this report may be amended or extended without prior written consent of the author. Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or refer to this report. Whenever such recommendations, statements or conclusions form part of the main report to current investigation, this report must be included in its entirety.

2. SITE BIO-PHYSICAL DESCRIPTION

2.1. Flora and Fauna

The vegetation of the area consists of mainly mature vascular plants of exotic origin which are the eucalyptus and wattle trees, with *syzygium cordatum* tree species and acacia plants typical of those found on river basins (paper barks etc.), underlying grass cover of a mix of kikuyu, thatch. A lot of the area is a built-up area with the river bed comprising of exposed bedrock and little silt or sand cover on the river bed, an indication of the stage of the river (close to the source).

The vegetation map below reflects the classification where the project site lies which is the built-up areas of Egoli granite grassland. The catchment drainage area is also depicted from the figure below.

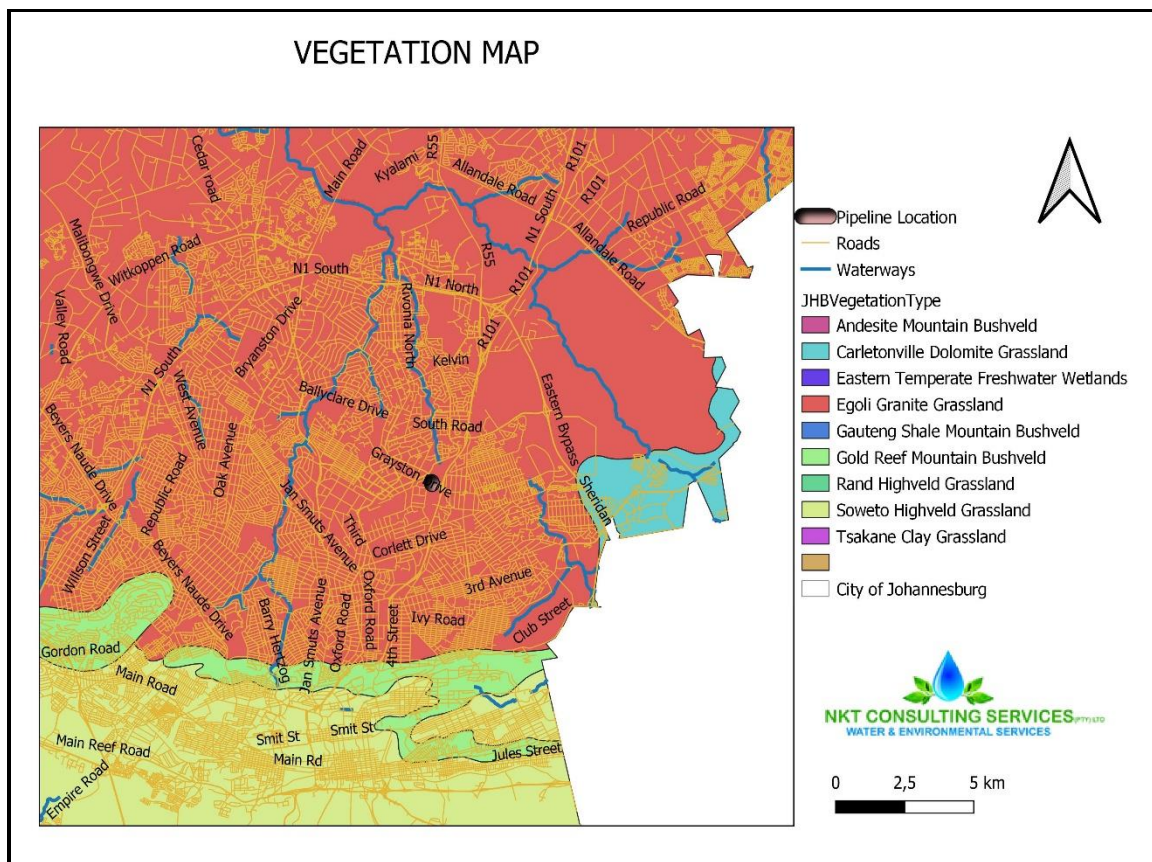


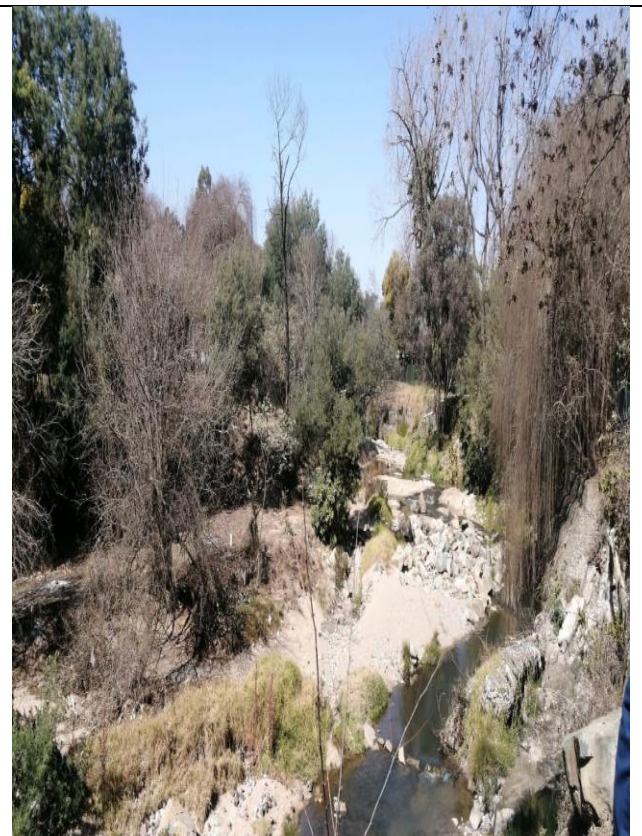
Figure 2: Project site catchment area Vegetation Map (Johannesburg Municipality)

Sewer release into the river and river load from the nearby landowners has contributed to high litter and organic silt load of the river, a characteristic which influences eutrophication if unattended. The pictures that follows are true reflectance of the current state of vegetation of the catchment.

Table 2: Pictures showing plant life of the project catchment



a) Eucalyptus tree



b) Wattle tree and almost dry grass



c) *Syzygium cordatum*

2.2. Climate

Sandton has the moderate climate prevailing. The average monthly climate data is based on data from the past 30 years and the figure below shows the position or locality of the study area within the Republic's climatic zones. The regional climate influences significantly the drainage, weather patterns as well as vegetation or landscape cover of the area of concern.

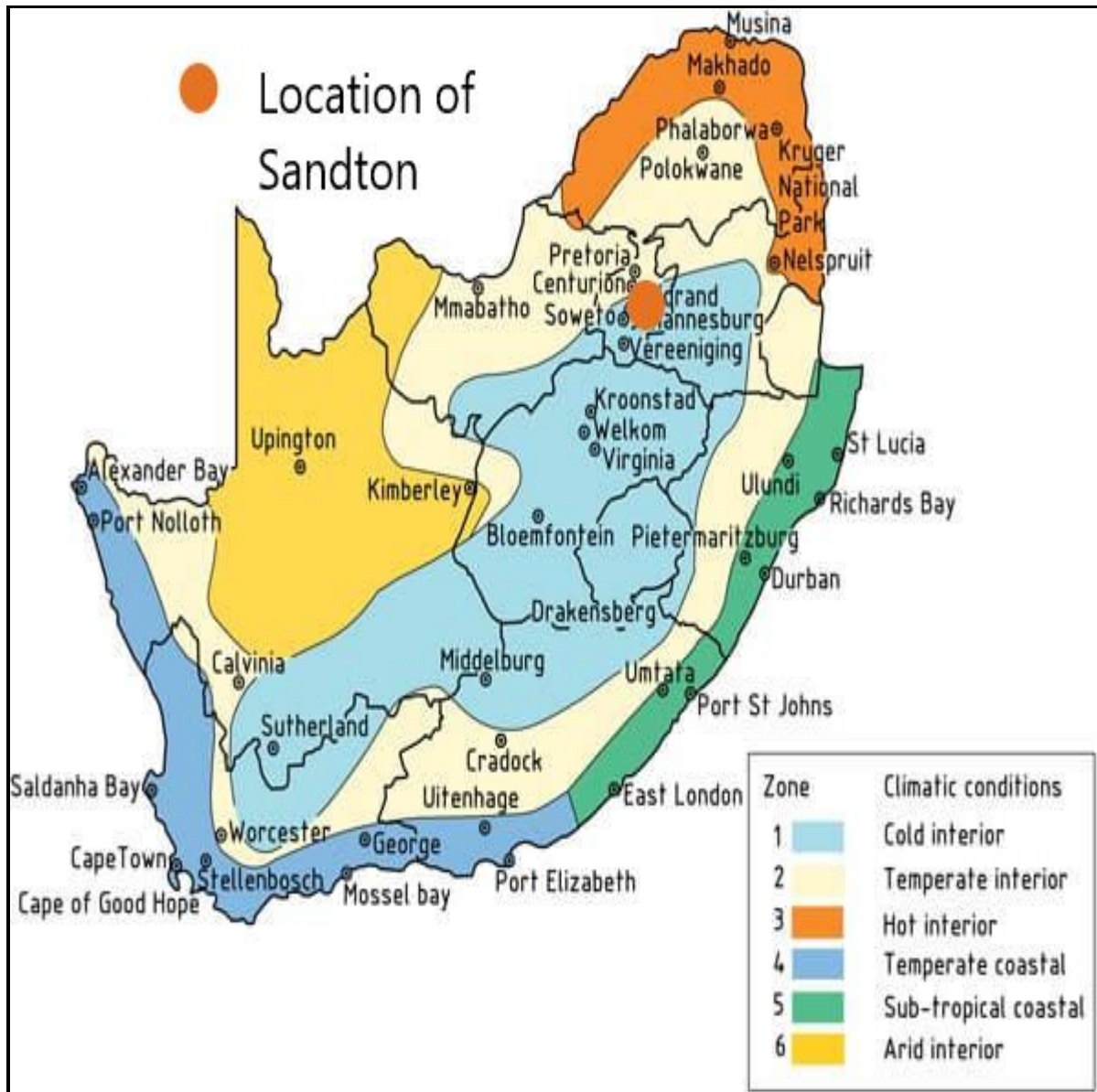


Figure 3: The South African Republic Climatic zones and Conditions

There is a lot of rainfall in the summer, and in the winter, it is quite dry again. The average annual temperature for Sandton is 25° degrees and there is about 353 mm of rain in a year. It is dry for 215 days a year with an average humidity of 52% and an UV-index of 5. The figure below shows the climate graph of Johannesburg which forms part of the whole catchment inclusive of Sandton.

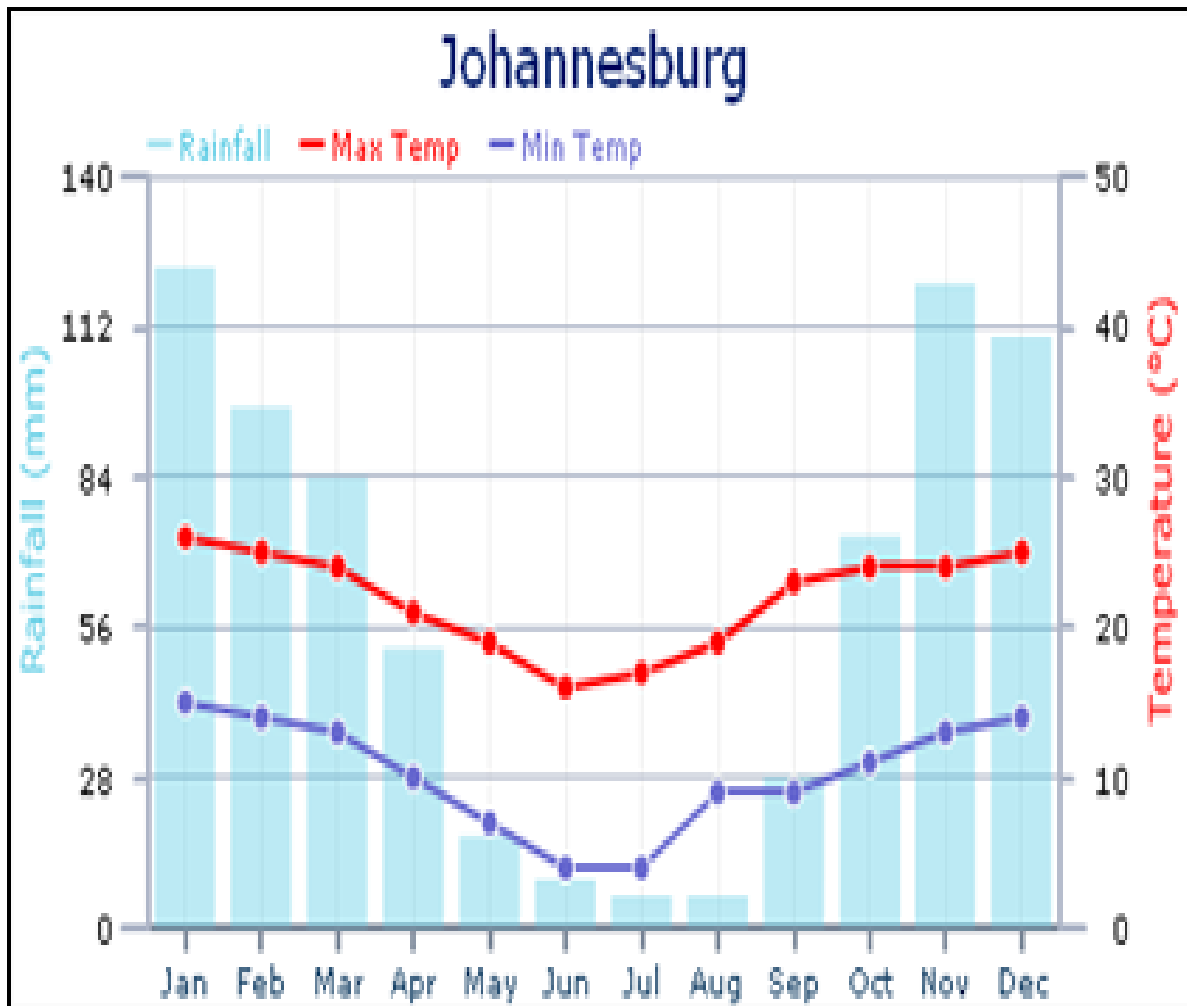


Figure 4: Climate graph for the Project site Catchment

2.3. Catchment Drainage System

The only significant watercourses close to the study area is the Sand-river which can be classified as semi-perennial river occurring in the well built-up area of the High-veld plateau of the Republic of South Africa's Johannesburg catchment area. It drains towards the North Eastern direction.

3. APPLICABLE LEGISLATION

3.1. Local Legislation

An identification of all legislation, policies, plans, guidelines, spatial tools, municipal development planning frameworks, and instruments that are applicable to this activity and have been considered in the preparation of this comprehensive ecological impact assessment report are given in the table below.

Table 3: Legislation applicable to Project Development Gauteng and the Republic

Legislation	Applicable Requirements	Administering Authority	How the Proposed Activity Complies with and Responds to the Legislation and Policy Context, Plans, Guidelines and Frameworks
<p>Constitution of the Republic of South Africa (Act No 108 of 1996)</p>	<ul style="list-style-type: none"> ❖ Chapter 2 – Bill of Rights; ❖ Section 24 – environmental rights. 	<p>Government of South Africa</p>	<ul style="list-style-type: none"> ❖ Obligation to ensure that the proposed development will not result in pollution and ecological degradation; and ❖ Obligation to ensure that the proposed development is ecologically sustainable, while demonstrating economic and social development. The proposed project can be considered as a sustainable development that will prevent pollution and ecological degradation whilst promoting justifiable economic and social development.

Legislation	Applicable Requirements	Administering Authority	How the Proposed Activity Complies with and Responds to the Legislation and Policy Context, Plans, Guidelines and Frameworks
National Environmental Management Act (Act No 107 of 1998)	<ul style="list-style-type: none"> ❖ Section 24 - Environmental Authorisation (control of activities which may have a detrimental effect on the environment); and ❖ Section 28 - Duty of care and remediation of environmental damage. Environmental management principles. 	Department of Environmental Affairs (DEA)	<ul style="list-style-type: none"> ❖ The EIA Regulations, 2014 as amended, were published on 07 April 2017 in terms of the NEMA and came into effect on 07 April 2017; ❖ In terms of these EIA Regulations, the following listed activities within Government Notice 327,325 and 324 (of 07 April 2017) are triggered by the proposed development, thereby requiring environmental authorisation from the GDARD; ❖ GN. No. 327, List Notice 1: Activities 12, 19, 24 & 56; ❖ GN No. 325, Listing Notice 2: Activity 27; ❖ GN No. 324, Listing Notice 3: Activities 4, 14 & 18.
National Water Act, 1998 (Act No. 36 of 1998)	<p>Chapter 3 - Protection of water resources.</p> <ul style="list-style-type: none"> ❖ Section 19 - Prevention and remedying effects of pollution; ❖ Section 20 - Control of emergency incidents; ❖ Section 21 - Water Uses under Section 21 of the Act must be licensed, unless such water use 	Department of Water and Sanitation (DWS)	<ul style="list-style-type: none"> ❖ A water use license (WUL) is required to be obtained for the construction of sewer line on the watercourse riparian zone in terms of Section 21 (c) and (i) of the Act.

Legislation	Applicable Requirements	Administering Authority	How the Proposed Activity Complies with and Responds to the Legislation and Policy Context, Plans, Guidelines and Frameworks
	<p>falls into one of the categories listed in Section 22 of the Act or falls under the general authorisation (and then registration of the water use is required);</p> <ul style="list-style-type: none"> ❖ Non-consumptive water uses may include impeding or diverting of flow in a water course – Section 21(c); and altering of bed, banks or characteristics of a watercourse – Section 21(i). 		
<p>National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)</p>	<p>Air Quality Management:</p> <ul style="list-style-type: none"> ❖ Section 32 – dust control; and ❖ Section 34 – noise control. <p>The Act provides for the protection of air quality in South Africa. Amongst others, no person may without a provisional atmospheric emission license, or an atmospheric license conduct an activity that is listed in the Act. The Act also makes provision for ambient air quality standards related to criteria air pollutants in SA.</p>	<p>Gauteng Department of Agriculture and Rural Development (GDARD)</p>	<p>The proposed projects do not require an air emission license but will be required to ensure that air quality is not deteriorated to the levels beyond these standards and where associated health impacts can occur.</p>

Legislation	Applicable Requirements	Administering Authority	How the Proposed Activity Complies with and Responds to the Legislation and Policy Context, Plans, Guidelines and Frameworks
National Forests Act (Act No. 84 of 1998)	Section 15 – authorisation required for impacts to protected trees.	Department of Agriculture, Forestry and Fisheries (DAFF)	The ecological survey will be conducted to determine any protected plant species on the subject properties.
Conservation of Agricultural Resources Act, 1983 (Act No 43 of 1983)	<ul style="list-style-type: none"> ❖ Control measures for erosion; and ❖ Control measures for alien and invasive plant species. 	Department of Agriculture, Forestry and Fisheries (DAFF)	<p>This Act will find application throughout the life cycle of the project. In this regard, soil erosion prevention and soil conservation strategies must be developed and implemented. In addition, a weed control and management plan must be implemented. The permission of agricultural authorities will be required if the project requires the draining of wetlands, marshes or water sponges on land outside urban areas.</p> <p>Measures will be included in the EMPr to curb the spread of declared weeds and to prevent soil erosion.</p>
National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004)	Management and conservation of the country’s biodiversity. Protection of species and ecosystems.	DEA	Under this Act, a permit would be required for any activity that is of a nature that may negatively impact on the survival of a listed protected species. An ecological study will be undertaken as part of the S & EIR Process.

Legislation	Applicable Requirements	Administering Authority	How the Proposed Activity Complies with and Responds to the Legislation and Policy Context, Plans, Guidelines and Frameworks
National Environmental Management Waste Act (Act 59 of 2008)	<p>The objects of this Act are to protect health, well-being and the environment by providing reasonable measures for:</p> <ul style="list-style-type: none"> ❖ Minimising the consumption of natural resources; ❖ Avoiding and minimising the generation of waste; ❖ Reducing, re-using, recycling and recovering waste; ❖ Treating and safely disposing of waste as a last resort; ❖ Preventing pollution and ecological degradation. 	DEA	There are no activities associated with the proposed project that requires a Waste Management License Application. A Waste licence could be required in the event that more than 100m ³ of general waste or more than 80m ² of hazardous waste is to be stored on site at any one time. The volumes of waste generated during construction and operation of the facility are not expected to be larger enough to require a waste license.
National Heritage Resources Act No 25 of 1999 (Act No 25 of 1999 as amended)	<ul style="list-style-type: none"> ❖ Securing ecologically sustainable development while promoting justifiable economic and social development -Section 35- protection of heritage resources. 	South African Heritage Resources Agency (SAHRA)	A permit may be required should identify cultural/heritage sites onsite be required to be disturbed or destroyed as a result of the proposed development. A HIA has been undertaken as part of the Scoping & Environmental Impact Reporting Process to identify potential heritage sites.
<p style="text-align: center;">GUIDELINES</p> <p>Each province develops own guidelines which should be in line with the national goals or strategies, thus localising the national goals and or plans. The main ones are highlighted below and are inclusive of the main GDARD biodiversity assessment requirements and these guidelines have played a major role in the production of this report and are referenced.</p>			

Legislation	Applicable Requirements	Administering Authority	How the Proposed Activity Complies with and Responds to the Legislation and Policy Context, Plans, Guidelines and Frameworks
COJMM Integrated Development Plan 2011/16	The aim of the IDP is to provide a 'coherent plan' for the improvement of quality of life for people living in the City of Johannesburg. The IDP specifically seeks to align the priorities of the municipality with the national and provincial priorities, policies and strategies.	COJMM	The Johannesburg IDP indicates a commitment by the City of Johannesburg to the eight Millennium Development Goals and as such, the integration of principles of sustainable development into policies and programmes. In addition, the COJMM is a signatory to Agenda 21 (which was adopted at the United Nations Conference on Environment and Development in 1992). Under this agreement, the City of Johannesburg is further obligated to incorporate Local Agenda 21 into all of its developmental activities.
Gauteng Conservation Plan Version 3.3 (C-Plan 3.3)	<ul style="list-style-type: none"> ❖ Serve as the primary decision support tool for the biodiversity component of the Environmental Impact Assessment (EIA) process; and ❖ Inform protected area expansion and biodiversity stewardship programmes in the province. 	GDARD	Serve as a basis for development of Bioregional Plans in municipalities within the province.

Legislation	Applicable Requirements	Administering Authority	How the Proposed Activity Complies with and Responds to the Legislation and Policy Context, Plans, Guidelines and Frameworks
COJMM Spatial Development Framework (SDF) 2012	<p>The Johannesburg SDF outlines a spatial mission and vision for the City to support the overall vision and mission in becoming the “African Capital City of Excellence”. The goal of the document is as follows:</p> <ul style="list-style-type: none"> ❖ To map the spatial realities of the City; ❖ To map the vision for the spatial fabric of the City; and ❖ To map the gaps that permeate the current spatial reality and how, through strategic spatial intervention, the City of Johannesburg can begin to realize the ambition of becoming an African Capital City of Excellence. 	COJMM	Spatial Development Frameworks are created as a provision of basic guidelines for a land use Management system for municipalities. It forms a part of a municipality’s Integrated Development Plan (IDP).

3.2. International Agreements & Policies

The international community has agreed to treat and attend to environmental and water management with one voice. Regional and individual nations have developed their own policies and legislation in line with international agreements, policies as well as protocols. This is meant to save the biodiversity, ecosystem and environment at large. The list below is international agreements and policies:

- ❖ Convention Concerning the Protection of World Cultural and Natural Heritage (1972);
- ❖ Agenda 21 regarding sustainable development at global and national levels (1992);
- ❖ United Nations Framework Convention on Climate Change (1994);
- ❖ Convention on Wetlands of International Importance, especially as Waterfowl Habitat (1975)-Ramsar;
- ❖ Convention on the Conservation of Migratory Species of Wild Animals (1983), - Bonn;
- ❖ Convention on Biological Diversity including eco-systems and genetic resources (1992);
- ❖ Convention on International Trade in Endangered Species of Wild Fauna and Flora (1975); and
- ❖ Copenhagen Accord on climate change (2009).

3.3. Regional Agreements

The following lists of agreements are from the sub-tropical and continental as in the African way of co-operating:

- ❖ Action Plan of the Environmental Initiative of NEPAD for sustainable development in Africa (2003); and
- ❖ African Convention on the Conservation of Nature and Natural Resources (1969).

4. PRACTICAL ASSESSMENT TECHNIQUES

4.1. Desktop Assessment

A literature review was conducted regarding the main vegetation types and fauna of the general region and of the specific study area. The primary guidelines used were those of Mucina & Rutherford (eds) (2006), Low & Rebelo (1996) and Acocks (1988). Background data regarding soils, geology, climate and general ecology were also consulted. These are useful in determining what species of fauna and flora can be expected or possibly present within the different habitats of the study area.

Lists of plant species for the relevant 1:50 000 base map grid references within which the proposed project is situated, were obtained from the South Africa National Biodiversity Institute's (SANBI) database. The lists represent all plant species that have been identified and recorded within the designated grid coordinates. The main aim was to initially determine if any protected species or Red Data species were known to occur in the study area or in the immediate vicinity of the study area.

Red data and protected species listed by the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) as well as in other authoritative publications were consulted and taken into account. Alien invasive species and their different Categories (1, 2 & 3) as listed by the Conservation of Agricultural Resources Act (Act No. 43 of 1983) and the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) were also consulted.

4.2. Field surveys

Digital photographs and GPS reference points of importance were recorded during field investigations and used throughout the specialist report. Also, during field surveys or investigations, cognisance was taken of the following environmental features and attributes:

- ❖ Biophysical environment;
- ❖ Regional and site-specific vegetation;
- ❖ Habitats ideal for potential red data fauna species;
- ❖ Sensitive floral habitats;
- ❖ Red data fauna and flora species;
- ❖ Protected fauna and flora species; and
- ❖ Watercourses and water bodies

4.3. Floristic Sensitivity

The methodology used to estimate the floristic sensitivity is aimed at highlighting floristically significant attributes and is based on subjective assessments of floristic attributes. Floristic sensitivity is determined across the spectrum of communities that characterize the study area. Phytosociological attributes (species diversity, presence of exotic species, etc.) and physical characteristics (human impacts, size, fragmentation, etc.) are important in assessing the floristic sensitivity of the various communities. The criteria employed in assessing the floristic sensitivity vary in different areas, depending on location, type of habitat, size, etc. The following factors were considered significant in determining floristic sensitivity:

- ❖ Habitat availability, status and suitability for the presence of Red Data species;
- ❖ Landscape and/or habitat sensitivity;
- ❖ Current floristic status;

- ❖ Floristic diversity; and
- ❖ Ecological fragmentation or performance.

Floristic Sensitivity Values are expressed as a percentage of the maximum possible value and placed in a particular class or level as shown in the table below.

Table 4: Floristic Sensitivity Values Table

Classification	Percentage Index Values (%)
High	80-100
Medium -High	60-80
Medium	40-60
Low - Medium	20-40
Low	0-20

- ❖ **High Sensitivity Index Values** indicate areas that are considered pristine, unaffected by human influences or generally managed in an ecological sustainable manner. Nature reserves or even well managed game farms typify these areas; and
- ❖ **Low Sensitivity Index Values** indicate areas of poor ecological status or importance in terms of floristic attributes, including areas that have been negatively affected by human impacts or poor management.

Each vegetation unit is subjectively rated on a scale of 1 to 10 (Sensitivity Values) in terms of the influence that the particular Sensitivity Criterion has on the floristic status of the plant community. Separate Values are multiplied with the respective Criteria Weighting, which emphasizes the importance or triviality that the individual Sensitivity Criteria have on the status of each community.

4.4. GO, NO - GO Criteria

The sensitivity analysis is also expressed in terms of whether the “Go Ahead” has or has not been given for development in a specific area or ecological unit, with regards to the ecological sensitivity along with mitigating measures. The criteria are directly linked to all the other analyses used in the study and can be expressed as follows:

- ❖ **GO:** Areas of low sensitivity-These would typically be areas where the veld has been totally or mostly transformed;
- ❖ **GO-SLOW:** Areas of medium/low sensitivity-These would typically be areas where large portions of the veld has been transformed and/or is highly infested with alien vegetation and lacks any real faunal component. Few mitigating measures are typically needed, but it is still always wise to approach these areas properly and slowly;

- ❖ **GO-BUT:** Areas of medium sensitivity and medium/high sensitivity-These are areas that are sensitive and should generally be avoided if possible. But, with the correct implementation of mitigating and management measures can be entered if need be.; and
- ❖ **NO-GO:** Areas of high sensitivity-These are areas of high sensitivity and should be avoided at all cost. In these areas mitigating measures are typically futile in limiting impacts.

It should be noted that “The Precautionary Principle” is applied throughout this investigation.

4.5. Floral Assessment – Species of Conservation Concern

Baseline data for the quarter degree grids in which the study area is situated were obtained from the SANBI database and was compared to the Interim Red Data List of South African Plant Species (Threatened Species Programme, 2004) to compile a list of Floral Species of Conservation Concern (which include all Red Data flora species) that could potentially occur within the study area.

A snapshot investigation of an area presents limitations in terms of locating and identifying Red Data floral species. Therefore, particular emphasis is placed on the identification of habitats deemed suitable for the potential presence of Red Data species by associating available habitat to known habitat types of Red Data floral species. The verification of the presence or absence of these species from the study area is not perceived as part of this investigation as a result of project limitations.

4.6. The Gauteng Biodiversity and Conservation Plan

Conservation planning was started in Gauteng in the year 2000 and the aim was to revise C-Plan at least every 5 years. C-Plan Version 1 was produced in 2001 and was followed by version 2 in 2005. Version 2 was refined in 2007 and was named Version 2.1. The small size of the province made it feasible to conduct an extensive biodiversity survey, named Biodiversity-GAP, which aimed to provide the information on spatial occurrence of biodiversity necessary for rigorous conservation planning. C-Plan 3 represents priority areas for biodiversity conservation in the Gauteng province. C-Plan 3 is based on the systematic conservation protocol developed by Margules & Pressey (2000) and is based on the principles of complementarity, efficiency, defensibility and flexibility, irreplaceability, retention, persistence and accountability. Systematic conservation planning is an iterative process. Knowledge of the distribution of biodiversity, the status of species, approaches for dealing with aspects such as climate change, methods of data analysis, and the nature of threats to biodiversity within a planning region are constantly changing, especially in the Gauteng province which is developing at an extremely rapid rate. This requires that the conservation plan be treated as a living document with periodic review and updates. The products have been the basis of the decision support process to the EIA process in the department, and together with a standardized set of decision-making guidelines have allowed for consistent, scientifically justified and defensible recommendations on development applications submitted to GDARD

Information from the Provincial Conservation Plan was also used in the assessment criterion for the ecological impact assessment of the study area and of special concern is the CBA or ESA data from the main plan as shown in the figure below. In addition to the above guide, a sensitivity map which is part of this report is also developed using the Critical Biodiversity Area (CBA). With the list of expected vegetation and animal species in mind, it becomes very easy to search within habitats, some of which have high chances of being found within the study area. Incorporation of

the findings and expected findings are however done in the tables that follow. Construction and operation of the sewer pipeline should be guided by the findings as well as recommendations from this report.

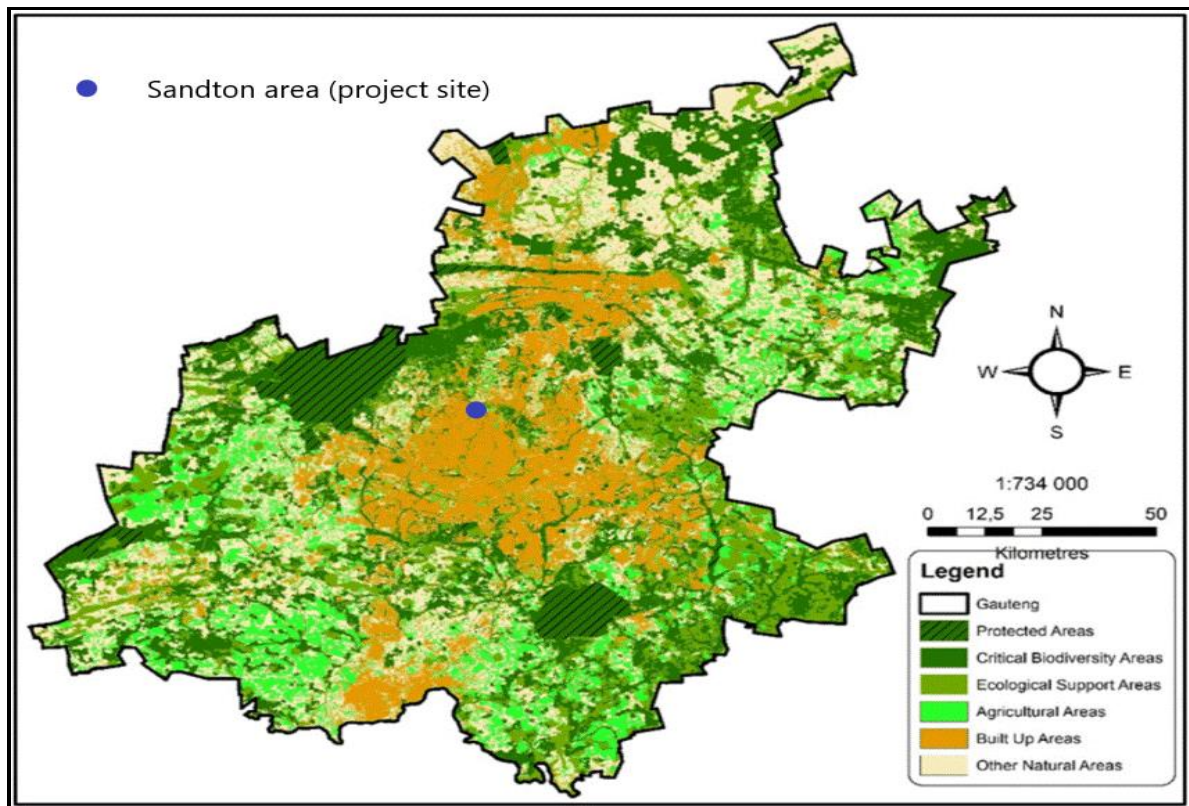


Figure 5: Gauteng Biodiversity Map indicating the Project Site (Sandton)

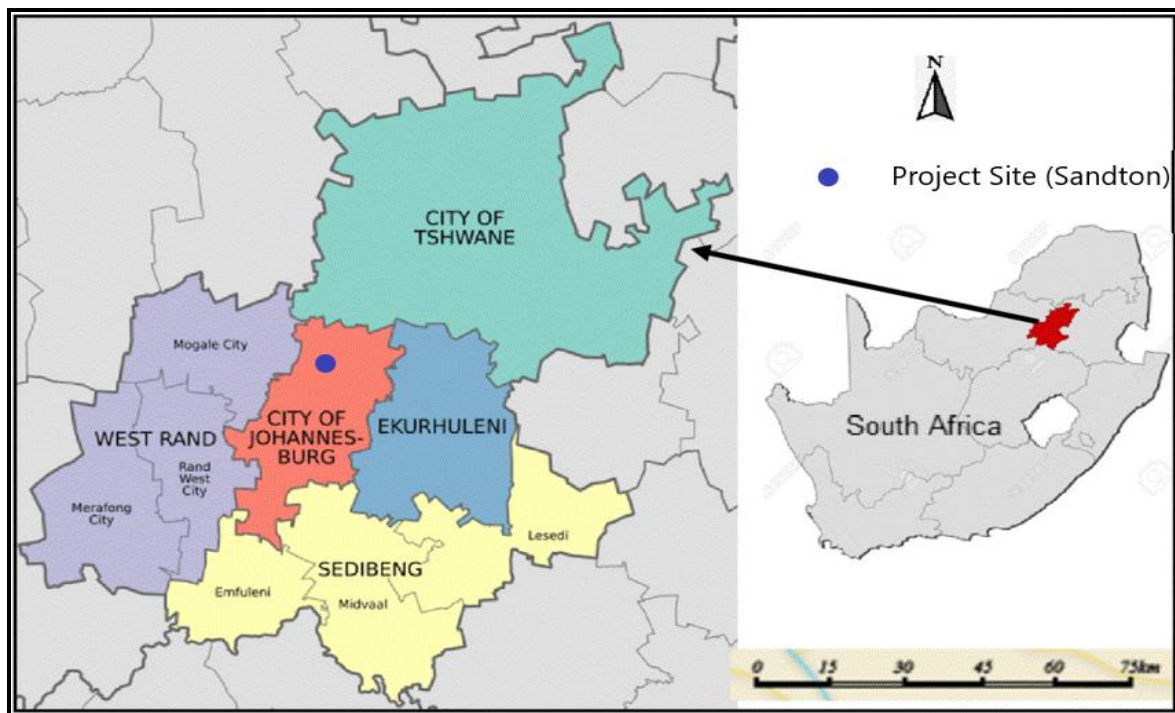


Figure 6: Regional Municipalities of Gauteng Province

The figure below indicates the wastewater pipeline catchment area's vegetation map which is mainly dominated by the Egoli granite grassland type as shown and please note that the whole ecosystem is within a built-up area. Most of the natural systems have been altered to pave way for infrastructural development.

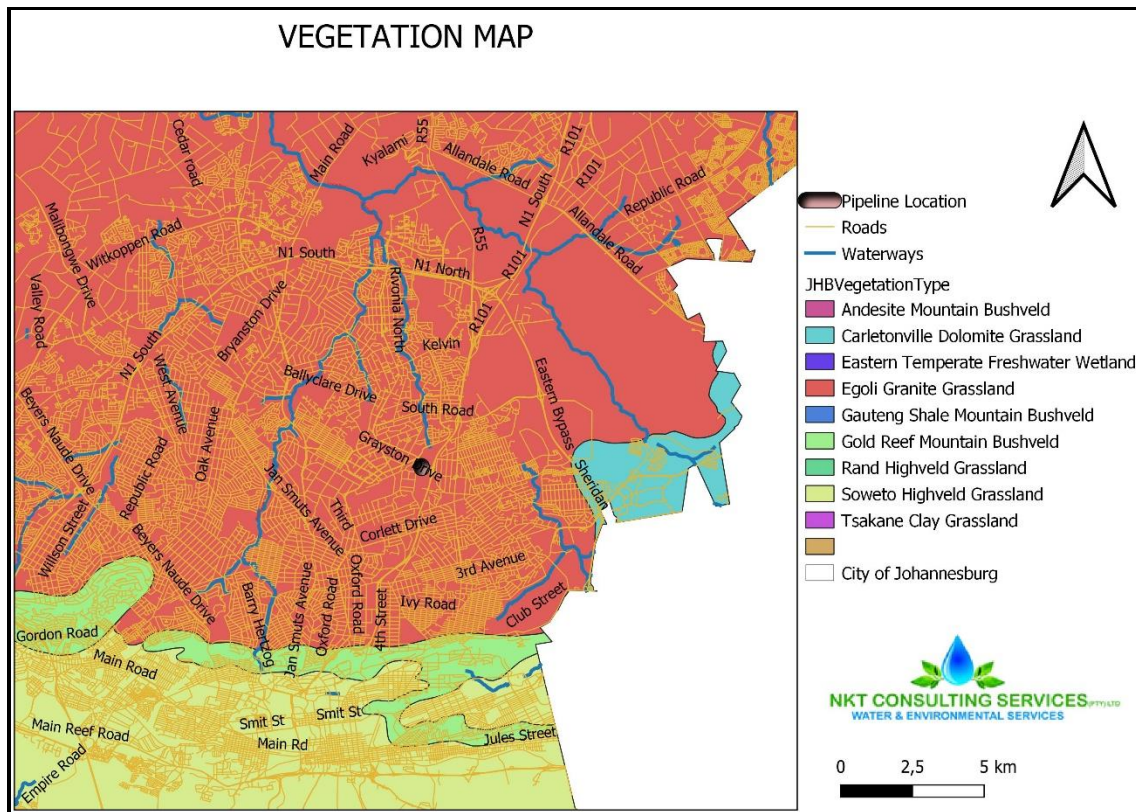


Figure 7: Pipeline Catchment Vegetation map

4.7. Faunal Sensitivity

Determining the full faunal component of a study area during a short time scale of a few field trips can be highly limiting. Therefore, the different habitats within the study area and nearby surrounding areas were scrutinized for attributes that are deemed to be suitable for high diversity of fauna, as well as for Red Data species. Special consideration was given to habitats of pristine condition and high sensitivity. Areas of faunal sensitivity were calculated by considering the following parameters:

- ❖ **Habitat status** – the status or ecological condition of the habitat. A high level of habitat degradation will often reduce the likelihood of the presence of Red Data species;
- ❖ **Habitat linkage** – Movement between areas used for breeding and feeding purposes forms an essential part of ecological existence of many species. The connectivity of the study area to surrounding habitats and adequacy of these linkages are evaluated for the ecological functioning of Red Data species within the study area; and
- ❖ **Potential presence of Red Data species** – Areas that exhibit habitat characteristics suitable for the potential presence of Red Data species are considered sensitive.

The same rating scale and indices that are used for the floral sensitivities are used for the faunal sensitivities.

4.8. Faunal Assessment – Species of Conservation Concern

Literature was reviewed and relevant experts contacted to determine which faunal species of conservation concern (which include all Red Data species) are present, or likely to be present, in the study area. A snapshot investigation of an area presents limitations in terms of locating and identifying Red Data fauna species. Particular emphasis was therefore placed on the identification of habitat deemed suitable for the potential presence of Red Data fauna species by associating available habitat to known habitat types of Red Data species. The verification of the presence or absence of these species from the study area is not perceived as part of this investigation as a result of project limitations.

4.9. Fauna Red Data Sensitivity Index Score (RDSIS)

Field investigations limited to a few days can seldom, if ever be comprehensive in terms of identifying all faunal species, let alone Red Data Listed (RDL) Species and/or priority species. Included is the reality that many faunal species are highly mobile and might be moving in and out of an area, which makes observing these species sometimes incidental and fortunate, depending largely on time and chance. Added to this are the species that are primarily nocturnal in nature. For the above reasons, the Red Data Sensitivity Index Scoring (RDSIS) method for fauna is widely used by specialists involved in Environmental Impact Assessment (EIAs), specialist studies, etc. The RDSIS methodology provides a calculated indication for the potential of certain red data or priority species occurring in the study area. The index is based on historical data, present presence of ideal habitat and food sources, general extrapolations on the land-uses of the region and the specialist's knowledge and experience.

4.10. Probability of Occurrence (POC)

Known distribution range (D), habitat suitability of the site (H) and availability of food sources (F) on site is determined for each of the species. Each of these variables is expressed a percentage (where 100% is a perfect score). The average of these scores provides a POC score for each species.

The POC is calculated as follows:

$$\text{POC} = (D+H+F) / 3$$

The POC value is then categorized as follows:

- ❖ 0-20% = Low;
- ❖ 21-40% = Low / Medium;
- ❖ 41-60% = Medium;
- ❖ 60-80% = Medium/High; and
- ❖ 81-100% = High

4.11. Total Species Score (TSS)

Species with a POC score of more than 60% (Medium/High) are considered when applying the RDSIS. A weighting factor is assigned to the different IUCN categories providing species with a higher conservation status, a higher score. This weighting factor is then multiplied with the POC to calculate the total species score (TSS) for each species. The weighting assigned to each category rating is shown in the table below.

Table 5: Total Species Score for Fauna

Status Category	Abbreviation	Weighting
Data deficient	DD	0,2
Rare	RA	0,5
Near Threatened	NT	0,7
Vulnerable	VU	1,2
Endangered	EN	1,7
Critically Endangered	CR	2,0

The TSS is calculated as follows:

$TSS = (IUCN \text{ weighting} \times POC)$ where POC is > 60%.

4.12. Average Total Species & Average Threatened Taxa Score

The average of the Total Species (TSS) potentially occurring on the site is calculated. The average of all the Threatened Taxa (TT) (Near threatened, Vulnerable, Endangered and Critically Endangered) TSS scores are also calculated. The average of these two scores (Av.TSS and Av.TT) is then calculated in order to add more weight to threatened taxa with POC higher than 60%.

The average is calculated as follows:

$Average = (Av.TSS [TSS / Tot.Species] + Av.TT [TT TTS / No. of species]) / 2$

4.13. Red Data Sensitivity Index Score (RDSIS)

The average score obtained above and the sum of the percentage of species with a POC of >60% of the total number of Red Data Listed species listed for the area is then calculated. The average of these two scores, expressed as a percentage, gives the RDSIS for the area investigated.

The RDSIS is calculated as follows:

$RDSIS = (Average + [Spp. \text{ with POC } >60\% / Total \text{ No. of Spp} * 100]) / 2$; and is simplified below.

Table 6: The RDSIS Category Ratings

RDSIS Score	Category Rating
0 – 20%	LOW
21 – 40%	LOW / MEDIUM
41 – 60%	MEDIUM
61 – 80%	MEDIUM / HIGH
81 – 100%	HIGH

4.14. Biodiversity Impact Assessment

The impact assessment takes into account the nature, scale and duration of the effects on the natural environment and whether such effects are positive (beneficial) or negative (detrimental). A rating/point system is applied to the potential impact on the affected environment and includes an objective evaluation of the mitigation of the impact. In assessing the significance of each issue, the following criteria are used and points awarded as shown:

- ❖ Extent: National - 4; Regional – 3; Local – 2; Site – 1;

- ❖ Duration: Permanent – 4; Long term – 3; Medium term – 2; Short term – 1;
- ❖ Intensity: Very high – 4; High – 3; Moderate – 2; Low – 1; and
- ❖ Probability of Occurrence: Definite – 4; Highly probable – 3; Possible – 2; Impossible – 1.

4.15. Criteria for the classification of an impact

4.15.1. Nature

A brief description of the environmental aspect being impacted upon by a particular action or activity is presented.

4.15.2. Extent (Scale)

Considering the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment phase of a project in terms of further defining the determined significance or intensity of an impact.

- ❖ Site: Within the construction site;
- ❖ Local: Within a radius of 2 km of the construction site;
- ❖ Regional: Provincial (and parts of neighboring provinces); and
- ❖ National: The whole of South Africa

4.15.3. Duration

Indicates what the lifetime of the impact will be.

- ❖ Short-term: The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase;
- ❖ Medium-term: The impact will last for the period of the construction phase, where after it will be entirely negated;
- ❖ Long-term: The impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter; and
- ❖ Permanent: The only class of impact, which will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient.

4.15.4. Intensity

Describes whether an impact is destructive or benign.

- ❖ Low: Impact affects the environment in such a way that natural, cultural and social functions and processes are not affected;
- ❖ Medium: Effected environment is altered, but natural, cultural and social functions and processes continue albeit in a modified way;
- ❖ High: Natural, cultural and social functions and processes are altered to extent that they temporarily cease; and
- ❖ Very high: Natural, cultural and social functions and processes are altered to extent that they permanently cease.

4.15.5. Probability

Probability is the description of the likelihood of an impact actually occurring.

- ❖ Improbable: Likelihood of the impact materializing is very low;
- ❖ Possible: The impact may occur;
- ❖ Highly probable: Most likely that the impact will occur; and
- ❖ Definite: Impact will certainly occur.

4.15.6. Significance

Significance is determined through a synthesis of impact characteristics. It is an indication of the importance of the impact in terms of both the physical extent and the time scale and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact. Using the scoring from the previous section, the significance of impacts is rated as follows:

- ❖ Low impact: 4-7 points. No permanent impact of significance. Mitigating measures are feasible and are readily instituted as part of a standing design, construction or operating procedure;
- ❖ Medium impact: 8-10 points. Mitigation is possible with additional design and construction inputs;
- ❖ High impact: 11-13 points. The design of the site may be affected. Mitigation and possible remediation are needed during the construction and/or operational phases. The effects of the impact may affect the broader environment; and
- ❖ Very high impact: 14-16 points. The design of the site may be affected. Intensive remediation as needed during construction and/or operational phases. Any activity, which results in a “very high impact”, is likely to be a fatal flaw.

4.15.7. Status

Status gives an indication of the perceived effect of the impact on the area.

- ❖ Positive (+): Beneficial impact;
- ❖ Negative (-): Harmful or adverse impact; and
- ❖ Neutral Impact (0): Neither beneficial nor adverse.

It is important to note that the status of an impact is assigned based on the *status quo*. That is, should the project not proceed, thus not all negative impacts are equally significant. The suitability and feasibility of all proposed mitigation measures will be included in the assessment of significant impacts. This will be achieved through the comparison of the significance of the impact before and after the proposed mitigation measure is implemented.

4.16. Sensitivity Mapping & Assessment

An ecological sensitivity map of the site was produced by integrating the information collected on-site with the available ecological and biodiversity information available in the literature and various spatial databases. This includes delineating the different vegetation and habitat units identified in the field and assigning sensitivity values to the units based on their ecological properties, conservation value and the potential presence of species of conservation concern as highlighted in the information supplied by sections mentioned earlier in the chapter. The ecological sensitivity of the different units identified in the mapping procedure was rated according to the following scale:

- ❖ **Low:** Units with a low sensitivity where there is likely to be a negligible impact on ecological processes and terrestrial biodiversity. This category is reserved

specifically for areas where the natural vegetation has already been transformed, usually for intensive agricultural purposes such as cropping. Most types of development can proceed within these areas with little ecological impact;

- ❖ **Medium:** Areas of natural or previously transformed land where the impacts are likely to be largely local and the risk of secondary impact such as erosion low. Development within these areas can proceed with relatively little ecological impact provided that appropriate mitigation measures are taken;
- ❖ **High:** Areas of natural or transformed land where a high impact is anticipated due to the high biodiversity value, sensitivity or important ecological role of the area. Development within these areas is highly undesirable and should only proceed with caution as it may not be possible to mitigate all impacts appropriately; and
- ❖ **Very High:** Critical and unique habitats that serve as habitat for rare/endangered species or perform critical ecological roles. These areas are essentially “no-go” areas from a developmental perspective and should be avoided at all costs. Usually represented in “red”.

Under normal circumstances, a map is then created to represent the area’s sensitivity to any type of development and will be shown in the chapter that follows.

5. ECOLOGICAL ASSESSMENT FINDINGS

5.1. Floral Species

The table below shows the kind of plants observed as well as those expected to be seen, during the walk through the investigation site and note that some of the plants observed are classified as alien or invasive plant species and are therefore categorized accordingly. The table below was generated after taking into consideration the Gauteng vegetation map for the expected versus the observed and the map is highlighted below in figures 4, 5 and 6. Please note that some plant species can be recorded as not observed while they are grown within areas or zones which were difficult to penetrate and dominance affected, therefore all-season's observation might be required to fully exhaust the list of plants or even animals likely to be seen on site.

Table 7: List of Plant Species Observed and Expected on Site

Common name	RSA Tree Number	Scientific name	Conservation status (RED List)	Observed or Not (O/N)
Paper bark acacia	187	<i>Vachellia siebriana</i>	Least concern & indigenous	O
River bushwillow	536	<i>Combretum erythrophyllum</i>	Least concern	O
Kamdeboo stinkhout	450	<i>Rhammus prinoides</i>	Least concern	O
Wild currant	392	<i>Searsin pyroides</i>	Least concern	O
Buffalo thorn	447	<i>Ziziphus mucronata</i>	Least concern	O
Black wattle		<i>Acacia mearnsii</i>	Invasive	O
Water berry	555	<i>Syzygium cordatum</i>	Least concern	O
Bulrush	Grass	<i>Typhae capensis</i>	LC	O
Mace Sedges	Grass	<i>Currex greyii sedges</i>	LC	O
Red river gum		<i>Eucalyptus camaldulensis</i>	Invasive	O
Jacaranda tree		<i>Jacaranda mimosifolia</i>	Vulnerable	O
Wild Syringa	197	<i>Burkea africana</i>	Not listed	N
Weeping willow		<i>Salix babylonica</i>	LC	N
Velvet Bushwillow	537	<i>Combretum molle</i>	LC	N
Large-fruited Bushwillow	546	<i>Combretum zeyheri</i>	Least threatened	O
Wild Mango	216	<i>Cordyla africana</i>	LC	N
Lavender Feverberry	328	<i>Croton gratissimus</i>	Least threatened	N
Jackal-berry	606	<i>Diospyros mespiliformis</i>	Not specifically protected	N
Wild Pear	471	<i>Dombeya rotundifolia</i>	Least Threatened	N
Transvaal Milkplum	581	<i>Englerophytum magalimontanum</i>	LC	N
Large-leaved Rock Fig	63	<i>Ficus abutilifolia</i>	LC	N

Sycamore Fig	66	<i>Ficus sycomorus</i>	LC	N
Red-leaved Rock Fig	55	<i>Ficus ingens</i>	LC	N
Lavender Tree	455	<i>Heteropyxis natalensis</i>	LC	N
Wild Pride-of-India	523	<i>Galpinia transvaalica</i>	LC	N
Transvaal Red Milkwood	585	<i>Mimusops zeyheri</i>	LC	N
Weeping Wattle	215	<i>Peltophorum africanum</i>	Not threatened	N
Kiaat	236	<i>Pterocarpus angolensis</i>	LC	N
Weeping Boer-bean	202	<i>Schotia brachypetala</i>	LC	N
Marula	360	<i>Sclerocarya birrea</i>	Protected	N
Toad Tree	644	<i>Tabernaemontana elegans</i>	LC	N
Date Palm tree		<i>Phoenix rupicola</i>	LC	O
Kikuyu grass		<i>Pennisetum Clandestinum</i>	Invasive	O



Figure 8: River-bed with small bushy vascular plants (*Acacia mearnsii*)



Figure 9: Climbers and mature red river gum on the edges of the river (riparian zone)



Figure 10: Mature Vascular Black Wattle trees lining the riparian zone



Figure 11: State of the river-bed and flow rate as of end of July 2021



Figure 12: Less grass cover on the river channel indicating the river stage

5.2. Conservation status

The conservation status of the study area's catchment is best described by the GDARD (Gauteng Department of Agriculture and Rural Development as Least threatened although activities that have an impact on the river basin or riparian zone are considered or classified to be requiring permission from legal authorities. There are riparian belts and aquatic habitats in the vicinity (www.bgis.sanbi.org/LUDS). The table below gives a basic description of the status categories. The Biodiversity Act (Act 10 of 2004) provides for listing of threatened or protected ecosystems, in one of four categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or protected. The main purpose for the listing of threatened ecosystems is an attempt to reduce the rate of ecosystem and species destruction and habitat loss, leading to extinction. This includes preventing further degradation and loss of structure, function and composition of threatened ecosystems (SANBI).

The first national list of threatened terrestrial ecosystems has been gazetted, together with supporting information on the listing process. This includes the purpose and rationale for listing ecosystems, the criteria used to identify listed ecosystems, the implications of listing ecosystems, and summary statistics and national maps of listed ecosystems (National Environmental Management: Biodiversity Act: National list of ecosystems that are threatened and in need of protection, (G 34809, GN 1002), 9 December 2011) (SANBI).

Table 8: Ecosystem Status: Simplified Explanation of Categories used

Status	Percentage Transformed (%)	Effect on Ecosystem
Least Threatened (LT)	0-20% (<20% loss)	No significant disruption of ecosystem functions
Vulnerable (VU)	20-40% (>20% loss)	Can result in some ecosystem functions being altered
Endangered (EN)	40-60% (>40% loss)	Partial loss of ecosystem functions
Critically Endangered (CR)	>60% or BT Index for that specific veld-type	Species loss. Remaining habitat is less than is required to represent 75% of species diversity

Source: South African National Spatial Biodiversity Assessment Technical Report. Volume 1: Terrestrial Component. 2004. SANBI. Mucina & Rutherford (eds) (2010).

Note: BT stands for the Biodiversity Threshold and is an index value that differs for each veld-type. In other words, because the composition, recovery rate, etc. differs for each veld-type there will be a different threshold (in this case percentage transformed) at which species become extinct and ecosystems breakdown. That is, at which point the veld-type is critically endangered. The major plant species identified during field investigations are listed in the photographs that follow. During field investigations no red data listed (RDL) species were observed. A final and comprehensive walk through will be required prior to commencement with the construction of the sewer pipeline project activities to conduct a search and rescue operation since the area of concern is considered a sensitive ecosystem.

5.3. Alien plants identified in the Study Area

The Department of Environmental Affairs defines invasive alien plants as plant species that are exotic, non-indigenous or non-native to an ecosystem. Due to the lack of natural enemies and the resistance to local diseases, these plants tend to spread aggressively, which then threatens biodiversity, reduce water availability and increase the risk and intensity of wildfires. The Alien and Invasive Species Regulations of the National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) regulates all invasive organisms in South Africa and categorizes invasive plant species into four different categories: Category 1a & 1b, Category 2 and Category 3. These categories of IAP's need to be controlled or removed from areas where they may cause harm to the environment or where they are prohibited. In South Africa there is a total of 383 invasive plant species that must be controlled and these species are listed in the NEMBA Alien and Invasive Species list of 2016.

A few alien invasive plant species common to the area and province are present in the study area. The alien plant species encountered in the study area are recorded, along with their category rating, in table below. Although there are invasive alien species present there are not many areas of significant encroachment or serious infestation. Most invasive species are within disturbed areas. A specific invasive species monitoring and management programme should be designed and followed to enable the management of these plants especially during construction and operation of the student accommodation area.

Table 9: Alien Plant Species Observed on Site

Botanical Name	Common Name	Category
<i>Mexican merigold</i>	Marigold	1b
<i>Bidens pilosa</i>	Black jack	1b
<i>Acacia mearnsii</i>	Black wattle	1b
<i>Eucalyptus camaldulensis</i>	Red river gum	1b
<i>Pennisetum Clandestinum</i>	Kikuyu grass	1b

5.4. Fauna

During field investigations only a few birds were observed, small mammals' holes and droppings were seen on site. The table below indicates the animals seen on site and those expected to be seen. A detailed table with a list of other faunal species found and/or expected within study area is on appendix 1

Table 10: Fauna Observed on Site

Biological Name	Common Name	Red Data Status	Habitat Type	Habitat Restrictions
Mammals				
<i>Rodentia rattus</i>	Rats	Pests	Not specific (organic waste areas)	None
Avifauna				
<i>Streptopelia roseogrisea</i>	African Collared-Dove	Least concern	Tree branches	On Mature vascular trees

Biological Name	Common Name	Red Data Status	Habitat Type	Habitat Restrictions
				found on dry landscape
<i>Red-billed weaver</i>	Quillea birds	Least concern	Grass seed producing plants	None

5.5. Sensitivity Mapping

The sensitivity mapping system is used to mark areas which are perceived to be sensitive around or in the vicinity of the project development area. These zones which are deemed sensitive should be avoided when project implementation and operation occur, or some precautionary measures need to be partaken in order to minimise the impacts of the project development (Construction and operation). Some of the mitigation measures are therefore highlighted in this report as well as the Environmental Management Programme (EMPr). Some of the areas to be avoided or treated with care are watercourses, wetlands, riparian belts, granite rock outcrops and buffer zones as they are classified and/ or deemed sensitive. These are areas with sensitive species (biodiversity), sensitive habitats and their disturbance or human interference can destabilise the natural ecological recovery patterns or its natural system of operation. If operations or activities are to proceed, some mitigation measures should then be implemented.

Information from the following maps (threatened species map, vegetation map and regional biomes map) were very crucial in the development of the detailed sensitivity map for the sewer project.

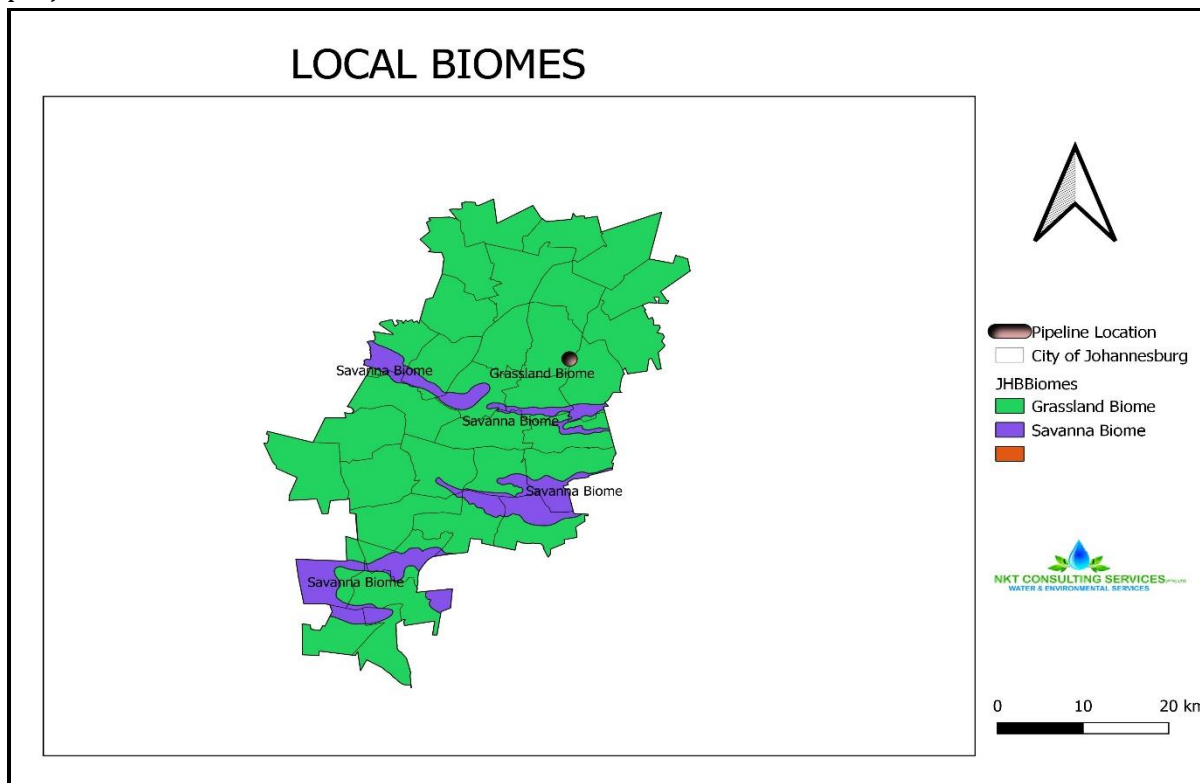


Figure 13: Biomes Map for the Gauteng Province indicating the Grassland Biome for the Site

Within the province are areas that are protected mainly because of their existing ecosystems and the figure that follows show the current position of the project site in relation to the other areas considered or classified as protected areas in line with the governing regulations.

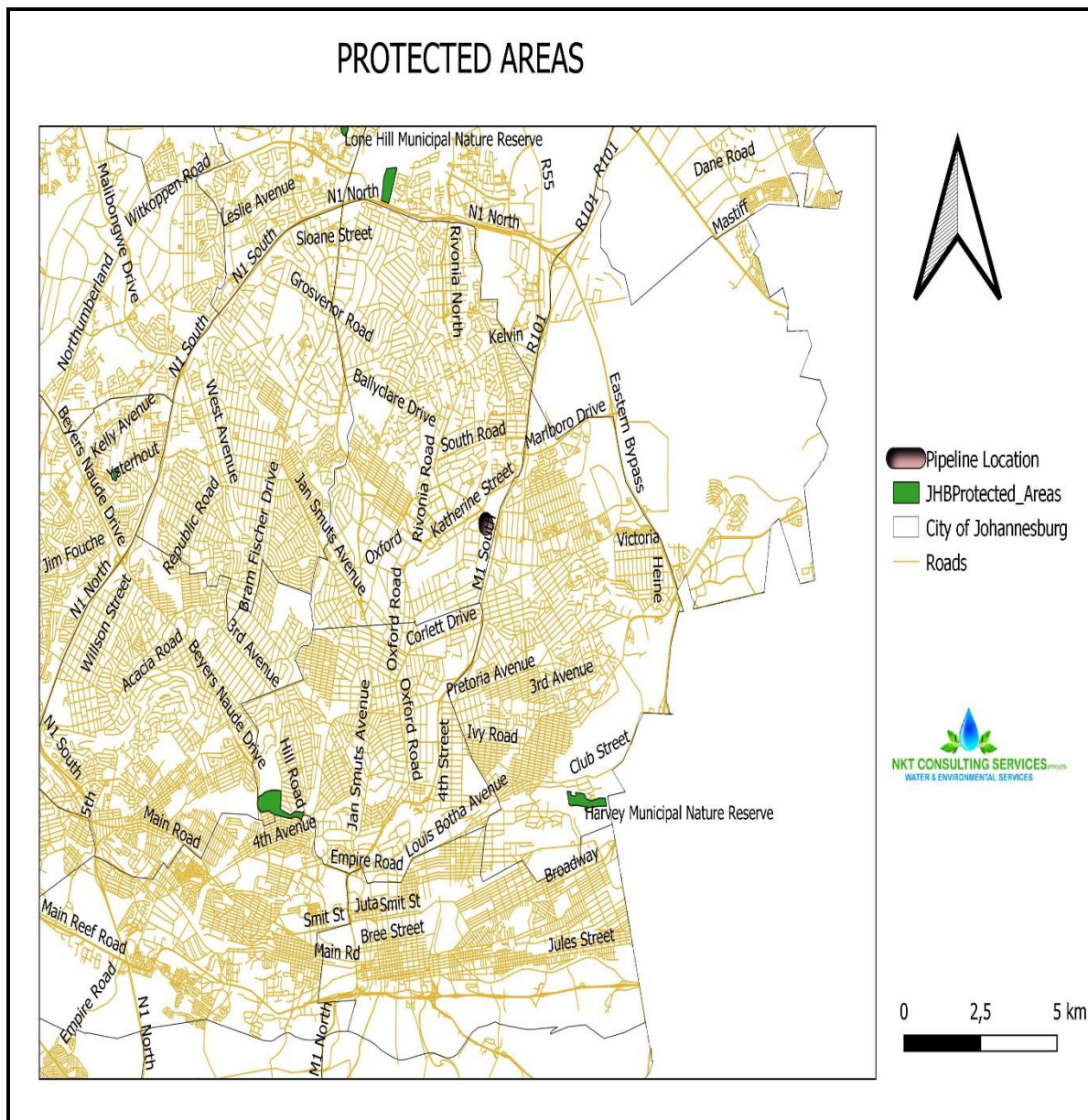


Figure 14: Project Site in relation to protected ecosystems of Johannesburg Municipality

There are also various ecosystems that have been classified as threatened within Johannesburg Municipality catchment and the threat has emanated from infrastructural development of most areas, industrial encroachment and urbanization of the city. The figure below also contributed to the development of the sensitivity map for the study area.

The pipeline location is mainly in the built-up areas of Sandton catchment as shown in the figure

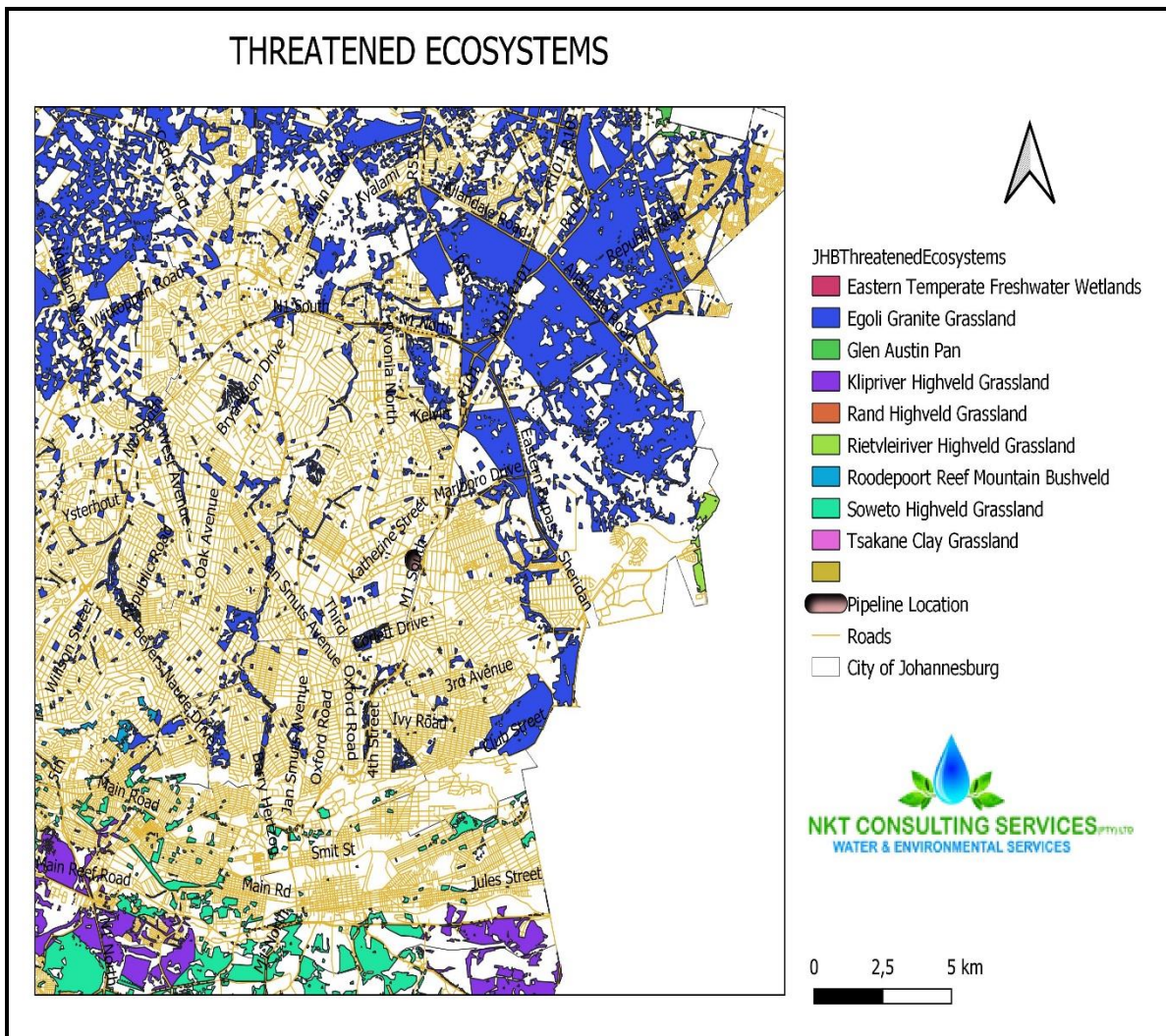


Figure 15: Threatened Ecosystems of the Johannesburg Municipality where the pipeline will be constructed

The following figure is a view of the pipeline project site from the satellite with marking of the areas of influence. This figure represents the sewer line’s sensitivity map. The brown marks are the boundaries of the riparian belt which is considered a very sensitive area of the catchment inclusive of the river itself. There is need for Water Use Licence Application (WULA) to use the protected area or watercourse.



Figure 16: Athol Sewer Pipeline Sensitivity Map

6. IMPACT ASSESSMENT

The aim of this section is to identify the potential ecological impacts that are likely to arise as a result of the proposed construction and operation of the sewer pipeline. The major impacts affect the main two phases of development (Construction and operation) though they should be noted during the planning stage.

6.1. Impact Assessment Methodology

The impact assessment was done according to the following methodology:

- ❖ Direction of an impact may be positive, neutral or negative with respect to the particular impact (e.g., a habitat gain for a key species would be classed as positive, whereas a habitat loss would be considered negative);
- ❖ The magnitude and outline the rationale used. Appropriate, widely recognised standards are used as a measure of the level of impact;
- ❖ Magnitude is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, is therefore, classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed;
- ❖ Duration refers to the length of time over which an environmental impact may occur i.e. transient (less than 1 year), short-term (0 to 5 years), medium term (5 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project) or permanent;
- ❖ Scale/Geographic extent refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international;
- ❖ Probability of occurrence is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40 % to 60 % chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur); and
- ❖ Impact significance was rated by the specialist using the scoring system shown in the table below.

Table 11: Model Scoring System for Assessment of Significance

Magnitude	Scale	Duration	Probability
10-Very high	5-International	5-Permanent	5-Definite
8- High	4-National	4-Long-term (impact ceases after closure of activity)	4-Highly probable
6-Moderate	3-Regional	3-Moderate (5 to 15years)	3-Medium probability

Magnitude	Scale	Duration	Probability
4-Low	2-Local	2-Short-term (0 to 5 years)	2-Low probability
2-Minor	1-Site only	1-Transient	1-Improbable
0-None			0-None
Maximum SP is 100 points SP > 75 High Environmental Significance SP 30 to 75 Moderate Environmental Significance SP < 30 Low Environmental Significance			

After ranking these factors for each impact, the significance of the two aspects, occurrence and severity were assessed using the following formula:

$$\text{SP (Significance Points)} = (\text{Magnitude} + \text{Duration} + \text{Scale}) \times \text{Probability}$$

The maximum value is 100 significance points (SP). The potential environmental impacts were then rated as of High (SP >75), Moderate (SP 30 – 75) or Low (SP <30) significance, both with and without mitigation measures on the following basis:

Table 12: Significance Points Table

SP > 75	Indicates high environmental Significance	Where it would influence the decision regardless of any possible mitigation. An impact which could influence the decision about whether or not to proceed with the project.
SP 30 to 75	Indicate moderate environmental significance	Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged.
SP < 30	Indicate Low Environmental Significance	Where it will not have an influence on the decision. Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation.
+	Positive	An impact that is likely to result in positive consequences / effects.

6.2. Impacts Rating Matrix

The Impact rating matrix for the project is shown below. Please refer to the table above for the Impact Rating Matrix scoring system.

6.3. Cumulative Environmental Impacts

Cumulative environmental impacts, can be defined as changes to the environment caused by the combined impact of past, present and future human activities and natural processes. Cumulative impacts to the environment are the result of multiple activities whose individual direct impacts may be relatively minor but in combination with others. The multiple impacts of different activities may have an additive, synergistic or antagonistic effect on one another and with natural processes. Cumulative impacts can be difficult to predict and manage due to inadequate environmental baseline data, complex ecological processes, and the large scale at which human development occurs. Many human activities result in direct and indirect impacts that collectively impact the environment. The impacts of activities in combination with natural processes can result in cascading responses in ecosystems that can become unpredictable. The construction and operation of the sewer pipeline project also contribute significantly to the cumulative environmental impacts as highlighted in the table below. The major impacts being waste management, sewer line leakage incidences contributing to pollution of the ground and surface water resources, encroachment of invasive plant species, scavenger animals being attracted to leak areas as well as littering attracting rodents and leading to multiplier effect on disease outbreaks like cholera, malaria, rabies etc.

Table 13: Cumulative Impacts of the JW Sewer Pipeline Project in Sandton

Project Phase	Potential Impact and/or Aspect	Significance rating of Impact before Mitigation	Mitigation	Significance rating after mitigation
Operation	<ul style="list-style-type: none"> ❖ Poor waste management by service personnel for the pipeline resulting in littering of some places; ❖ Sewer lines and treatment plant blockages and choking leading to contamination of all water resources and disease outbreaks; ❖ Exacerbated erosion of 	Extent: Local (2) Duration: Medium-term (2) Intensity: Moderate (2) Probability: Possible (2) Significance: Medium (8)	<ul style="list-style-type: none"> ❖ Workers environmental awareness on waste management will assist significantly; ❖ Municipality and ECO to monitor the site frequently; ❖ Plant erosion abating by planting on drain ways sides and bed; and ❖ Ensure reported leaks 	Extent: Site (1) Duration: Medium-term (2) Intensity: Low (1) Probability: Possible (2) Significance: Low (6)

Project Phase	Potential Impact and/or Aspect	Significance rating of Impact before Mitigation	Mitigation	Significance rating after mitigation
	<p>unlined surfaces or drainage channels as well as chocking of the areas;</p> <ul style="list-style-type: none"> ❖ Unattended leakages leading to invasive plant encroachment and attraction of scavenger animals; and ❖ Pollution of surface and ground water resources (organic pollution) 		<p>and blockages are attended to as quickly as possible.</p>	

Table 14: Ecological Impact Assessment Matrix for the JW Sewer pipeline- Sandton.

Project Development Phase	Potential Impact and/or Aspect	Significance rating of Impact before Mitigation	Mitigation	Significance rating after mitigation
Construction	<ul style="list-style-type: none"> ❖ Irresponsible construction practices could lead to the pollution of the surface and groundwater resources from hydrocarbon contamination, construction debris, petrochemicals leakages, cement dust and litter material); ❖ Poor storm-water management in the construction area, and in the context of soil stockpiles could lead to the siltation and/or pollution of the area of residual hydromorphic soils or of the sensitive riparian corridor as well as sediments 	<p>Extent: Local (2) Duration: Medium-term (2) Intensity: Moderate (2) Probability: Possible (2) Significance: Medium (8)</p>	<ul style="list-style-type: none"> ❖ Construction to be guided by the EMPr and the mitigation measures stipulated in this report; ❖ Construction to be monitored by an ECO according to the stipulations of the EMPr; ❖ No batching or chemical / fuel storage areas to be laid on unprotected ground; ❖ All waste from the construction site to be deposited into marked and protected areas like skip bins for construction debris, wooden or 	<p>Extent: Site (1) Duration: Medium-term (2) Intensity: Low (1) Probability: Possible (2) Significance: Low (6)</p>

Project Development Phase	Potential Impact and/or Aspect	Significance rating of Impact before Mitigation	Mitigation	Significance rating after mitigation
	<p>being washed into the river channel;</p> <ul style="list-style-type: none"> ❖ The movement of machinery within the area could cause compaction or physical disturbance of these soils. 		<p>organic waste bins etc;</p> <ul style="list-style-type: none"> ❖ Construction-phase storm-water controls to be implemented along the stretch of the construction zones adjacent to the area and around all stockpiles. 	
Operation Phase	<ul style="list-style-type: none"> ❖ Waste management from service crew can choke the riverine water systems as well attracting scavenging animals like birds, rats and dogs to the campsites as well as to the waterway itself; ❖ Increased possibilities of having uncontrolled 	<p>Extent: Local (2) Duration: Medium term (2) Intensity: High (3) Probability: Possible (2) Significance: Medium (9)</p>	<ul style="list-style-type: none"> ❖ Ensure that service routes are draining and surface drainage systems are protected by concrete lining to reduce contamination of soils and pollution from dripping oils; the ECO should assist on how best to rehabilitate the affected areas; ❖ Ensure that service routes and existing 	<p>Extent: Local (2) Duration: Medium term (2) Intensity: Low (1) Probability: Possible (2) Significance: Medium (7)</p>

Project Development Phase	Potential Impact and/or Aspect	Significance rating of Impact before Mitigation	Mitigation	Significance rating after mitigation
	sprouting of invasive plant species.		<p>operational route are having silt trapping mechanisms on their sides; and</p> <ul style="list-style-type: none"> ❖ Mark the existing invasive plant species for destruction on a continuous process via use of a monitoring plan. 	

6.4. Ecological Management Plan

The JW sewer pipeline project's construction and operation if properly managed will have almost insignificant impacts to the existing riverine ecosystem especially during operation. In most cases, ecological management plans are designed for once off projects it would be advisable to develop an ecological monitoring schedule and/or system to frequently check and advice on the condition of the ecologically sensitive parts within the peripheries of the project for instance water quality of the water-way and drainage system. The area requires development of an active ecological buffer zone which should be managed with an active invasive species eradication, monitoring and management plan. This ecological management guideline will assist in setting up a proper management system for the project. The area's rehabilitation plan is discussed properly in the subsection that follows.

6.5. Rehabilitation Plan

As for rehabilitation, this activity should not wait until operational stage of the project but should continue as a concurrent activity from construction stage right through to operation. This stage is mainly meant to ensure that as the construction process will be taking place, there will be minimum impacts on the environment till the operational stage. After each stage of construction, the affected area should therefore be cleared of rubble and if heavily compacted, it must be ripped and a seed-mix is broadcast on top to allow regeneration (secondary succession) the area should also drain to minimise stagnation of water during construction as well as operation. The above sensitivity map will assist significantly when trying to identify the zones which should not be impacted by both construction and operational activities.

The riparian area is a sensitive habitat for sensitive species, there proper handling of such is of uttermost importance during all stages of the project. Flood lines should also not be affected in this instance.

In real terms, all affected areas within project development site should be rehabilitated to suit the original state before development thus to blend the new environment with the old and surrounding environs. The project budget under most cases includes the rehabilitation planning and costs. This report defines rehabilitation as the reinstatement of the temporarily disturbed areas affected by project development and in this case "construction or construction related activities" to a state that resemble the conditions prior to the disturbances. The ECO will also assist in identifying other areas that might require rehabilitation and include them during the process so as to ensure that all the footprints (external) caused by the project are addressed. These additional points will definitely affect budget and should be expected, therefore when planning for every development, the rehabilitation related costs should be flexible.

It is highly recommended that rehabilitation around the construction footprint takes place immediately after disturbances in order to limit detrimental effects resulting from for example, rainfall events after removal or clearing of the existing material especially storm-water drainage towards the existing stream. They are supposed to blend well with the existing ecological buffer of the area as proposed in the above chapters or sub-sections. It is therefore imperative that rehabilitation of disturbed areas takes places after each construction phase. This will minimise costs and time at the end.

The final stage of rehabilitation requires that local and/or indigenous plant species be planted to enable the area to naturally recover (natural succession) as well as blending with the already existing

natural vegetation for the area. Sloping areas will be terraced or benched and top-soil covered (at least 30cm) to assist in encouraging natural growth of plants, a local agricultural expert will be consulted to assist in the determination of what plant species seed-mix should be applied. Proper care and maintenance should therefore be done with independent supervision from the ECO. Monitoring of the rehabilitation process from each phase should be emphasised and the ECO should assist with the blending mechanisms as promulgated in this report. The table below lists the rehabilitation measures that should be undertaken when monitoring post-construction with corrective actions. Please note that each impact is followed by the corrective measure which in this instance is the rehabilitation and the time frames will act as a guide, which can be altered depending on the on-site activities.

Table 15: Impact Related Rehabilitation Plan Table for the Student Accommodation Project

Impact	Rehabilitation Measures	Time Frame
<p>Compacted Surfaces (batching areas, pipeline backfilled trench areas, stockpile areas)</p>	<ul style="list-style-type: none"> ❖ Clear the affected area of waste materials (debris, litter etc), please note that the material should be disposed of properly, put top soil that would have been cleared at the beginning; ❖ The top soil filled area should be ripped in a way to allow plant regeneration, an indigenous seed-mix should be broadcast on top of the ripped top soil; and ❖ All cement contaminated soil should be removed from site for safe disposal so as to minimise the panning of the affected soil. 	<ul style="list-style-type: none"> ❖ Immediately after backfilling of trenches; and ❖ As and when monitoring indicates degradation of the footprint area for the accommodation project.
<p>Accelerated Erosion and Slope attenuation on construction site.</p>	<ul style="list-style-type: none"> ❖ Minimise uncontrolled slope attenuation and heavy erosion by construction of storm-water control berms, gabion rock blocks as velocity dissipaters and installing culverts to spread the flowing surface run-off especially on the service road route-sides. 	<ul style="list-style-type: none"> ❖ Seasonally and as soon as signs of erosion are noticeable from the area
<p>Pollutants release during service and construction: (construction activity can expose hydrocarbons to surface and groundwater resources and vegetation through</p>	<ul style="list-style-type: none"> ❖ In case of emergencies or unforeseen events, the problem must be remediated immediately and any spillage into any watercourse be reported to the Department of Water Affairs. In addition, the soil must be stabilised (import additional topsoil if necessary) and re-vegetate as soon as possible. Re-vegetation should include seeds from the adjacent grassland and any rescued protected plants and/or plants of conservation concern that might have been impacted upon by the emergency / unforeseen event; and 	<ul style="list-style-type: none"> ❖ Immediately after a construction phase; ❖ Anytime during operational phase of the project, especially when maintenance activities might have resulted in pollution.

Impact	Rehabilitation Measures	Time Frame
<p>machinery leaks, biogeochemical reactions of bedrock resulting in disturbed sensitive environs)</p>	<ul style="list-style-type: none"> ❖ Remove all project-related material / support equipment immediately on completion of any of the construction phases. Drip trays and spill kits to be part of the soil contamination amelioration and should be on site all the time. 	
<p>Invasive and alien species spreading:</p>	<ul style="list-style-type: none"> ❖ Appoint a specialist in invasive species control, eradication, management and monitoring and identified invasive species should be removed prior to construction related soil disturbances. This will prevent seed spreading into disturbed soils or to downstream areas; ❖ Mechanical removal is the most preferred control mechanism using machinery depending on how congested the area is and this should be a continuous programme, biological eradication mechanisms will also work but this require an ecological specialist for population blooming management; and ❖ A register of the methods used, dates undertaken, as well as herbicides (if used) and dosage used must be kept and available on site. The register must also include incidents of poisoning or spillage. 	<ul style="list-style-type: none"> ❖ Immediately after vegetation clearing, project commissioning and during progression of the project; and ❖ Should be an on-going process.

7. CONCLUSIONS AND RECOMMENDATIONS

Temporary variations to the abundance and distribution of faunal and floral species may occur during the construction phase but should be insignificant with many species re-occupying the area when construction activities have ceased especially during natural succession. Rehabilitation and mitigation measures should be, as far as possible be done concurrently throughout the duration of the project (project lifecycle), thus resulting in minimal effort to apply final rehabilitation approaches. Any monitoring program as suggested in the EIA/EMPr must be adhered to, both during the construction and operational stages. The following are the recommendations from the ecological perspective;

- ❖ From the ecological perspective, the proposal is to proceed with construction and operation of the project but highlighted impact monitoring schedule, from the Environmental Management Plan/or programme (EMPr) should be followed extensively. The ecological management and rehabilitation from this report should however be followed as well to assist in the sustainable project development for the area of concern;
- ❖ No identified endangered species but working within the riparian zones should be done with care and permission from relevant authorities like seeking informed advice or applying for the WUL with DWS;
- ❖ An invasive species monitoring plan should prepared to assist in the control of such species; and
- ❖ A qualified and competitive Environmental Control Officer (ECO) should be employed to assist in ensuring that all is done in accordance with the conditions set in the Environmental Authorisation.

8. REFERENCES

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9. APPENDIX 1

Table 16: Plant List Recorded in and around the proposed JW Sewer Pipeline

Family Name	Scientific name	Observed/Not
Acanthaceae	<i>Justicia flava</i>	
Amaranthaceae	<i>Achyranthes aspera</i> *	
	<i>Gomphrena celosioides</i> *	
Anacardiaceae	<i>Rhus gueinzii</i>	
	<i>Sclerocarya birrea</i>	
Apiaceae	<i>Centella asiatica</i>	
Asclepiadaceae	<i>Gomphocarpus physocarpus</i>	
Asteraceae	<i>Ageratum conyzoides</i> *	
	<i>Bidens Pilosa</i> *	
	<i>Conyza bonariensis</i> *	
	<i>Pseudognaphalium luteo-album</i>	
	<i>Lactuca serriola</i> *	
	<i>Tagetes minuta</i> *	
	<i>Vernonia colorata</i>	
Bignoniaceae	<i>Tecoma stans</i> *	
Celastraceae	<i>Gymnosporia senegalensis</i>	
Convolvulaceae	<i>Ipomoea crassipes</i>	
	<i>Ipomoea purpurea</i> *	
Cyperaceae	<i>Cyperus dives</i>	
	<i>Cyperus longus</i>	
	<i>Cyperus latifolius</i>	
	<i>Kyllinga alba</i>	
	<i>Pycreus nitidus</i>	
	<i>Pycreus polystachyos</i>	
	<i>Mariscus congestus</i>	
	<i>Schoenoplectus corymbosa</i>	
Ebenaceae	<i>Euclea crispa</i>	
	<i>Euclea divinorum</i>	
Aphyllanthaceae	<i>Bridelia mollis</i>	
Euphorbiaceae	<i>Phyllanthus reticulatus</i>	
	<i>Spirostachys africana</i>	
	<i>Ricinus communis</i> *	
	<i>Phyllanthus reticulatus</i>	
Fabaceae	<i>Caesalpinia decapetala</i> *	
	<i>Eriosema psoraleoides</i>	
	<i>Senna didymobotrya</i> *	
	<i>Sesbania punicea</i> *	
	<i>Sesbania sesban</i>	
	<i>Caesalpinia decapetala</i>	
Lamiaceae	<i>Leucas neuflyzeana</i>	

Family Name	Scientific name	Observed/Not
	<i>Pycnostachys reticulata</i>	
Malvaceae	<i>Dombeya rotundifolia</i>	
	<i>Sida cordifolia</i>	
Meliaceae	<i>Melia azedarach*</i>	
Menispermaceae	<i>Cissampelos mucronata</i>	
	<i>Cocculus hirsutus</i>	
Mimosaceae	<i>Acacia ataxacantha</i>	
	<i>Acacia karroo</i>	
	<i>Acacia nilotica</i>	0
	<i>Acacia sieberana</i>	
	<i>Acacia tortillis</i>	
	<i>Dichrostachys cinerea</i>	
Moraceae	<i>Ficus burkei</i>	
	<i>Ficus ingens</i>	
	<i>Ficus sycomorus</i>	
	<i>Morus alba*</i>	
Myrtaceae	<i>Psidium guajava*</i>	
	<i>Syzygium cordatum</i>	0
Poaceae	<i>Andropogon eucomus</i>	
	<i>Cymbopogon plurinodis</i>	
	<i>Cynodon dactylon</i>	
	<i>Digitaria eriantha</i>	
	<i>Echinochloa colona</i>	
	<i>Eragrostis capensis</i>	
	<i>Eragrostis racemose</i>	
	<i>Hyparrhenia cymbaria</i>	
	<i>Hyparrhenia filipendula</i>	
	<i>Imperata cylindrica</i>	
	<i>Paspalum dilatatum*</i>	
	<i>Panicum natalense</i>	
	<i>Phragmites mauritianum*</i>	
	<i>Setaria sphacelate</i>	
	<i>Sorghum bicolor</i>	
	<i>Sporobolus Africana</i>	
	<i>Sporobolus fimbriatus</i>	
	<i>Sporobolus pyramidalis</i>	
	<i>Themeda triandra</i>	
<i>Trichopteryx dregeana</i>		
Polygalaceae	<i>Persicaria senegalensis</i>	
Rhamnaceae	<i>Ziziphus mucronate</i>	
Scrophulariaceae	<i>Trichellia emetica</i>	
Typhaceae	<i>Solanum mauritianum *</i>	
	<i>Solanum nigrum*</i>	
	<i>Typha capensis</i>	

Family Name	Scientific name	Observed/Not
Verbenaceae	<i>Lantana camara*1b</i>	
	<i>Stachytarpheta urticifolia*</i>	
	<i>Verbena bonariensis*1b</i>	
Vitaceae	<i>Rhoicissus tridentata</i>	

Table 17: Birds likely to be found in and adjacent to the study area

Please use the following key for the list of Aves.

Rob	English Name	Scientific	Map Status	Study Area
V - = very common; R = resident; A - = Abundant; R(n) = resident nomadic; LA - = Locally abundant; BM = breeding migrant		C - = common; NBM = non breeding migrant; U - = Uncommon; LC - = Locally common VC - = Locally very common R - = Rare O- = Observed on site		
159	Little Banded Goshawk	<i>Accipiter badius</i>	R-U	
158	Black Sparrowhawk	<i>Accipiter melanoleucus</i>	R-U	
157	Little Sparrowhawk	<i>Accipiter minullus</i>	R-U	
155	Redbreasted Sparrowhawk	<i>Accipiter rufiventris</i>	R-U	
160	African Goshawk	<i>Accipiter tachiro</i>	R-C	
628	Great Reed Warbler	<i>Acrocephalus arundinaceus</i>	NBM-U	
631	African Marsh Warbler	<i>Acrocephalus baeticatus</i>	R-C	
635	Cape Reed Warbler	<i>Acrocephalus gracilirostris</i>	R-C	
633	Eurasian Marsh Warbler	<i>Acrocephalus palustris</i>	NBM-U	
854	Orangebreasted Waxbill	<i>Amandava subflava</i>	R-C	
213	Black Crake	<i>Amaurornis flavirostris</i>	R-C	
807	Thickbilled Weaver	<i>Amblyospiza albifrons</i>	R-C	
819	Redheaded Weaver	<i>Anaplectes rubriceps</i>	R-C	
108	Redbilled Teal	<i>Anas erythrorhyncha</i>	R-U	
107	Hottentot Teal	<i>Anas hottentota</i>	R-U	
112	Cape Shoveller	<i>Anas smithii</i>	E-U	
264	Common Sandpiper	<i>Actitis hypoleucos</i>	NBM-C	
240	African Jacana	<i>Actophilornis africanus</i>	R-VC	
431	Malachite Kingfisher	<i>Alcedo cristata</i>	R-U	
430	Halfcollared Kingfisher	<i>Alcedo semitorquata</i>	R-U	
102	Egyptian Goose	<i>Alopochen aegyptiacus</i>	R-VC	
855	Cutthroat Finch	<i>Amadina fasciata</i>	R-C	
105	African Black Duck	<i>Anas sparsa</i>	R-C	
104	Yellowbilled Duck	<i>Anas undulata</i>	R-U	
87	Openbilled Stork	<i>Anastomus lamelligerus</i>	R-C	

572	Sombre Bulbul	<i>Andropadus importunus</i>	R-VC	
820	Cuckoofinch	<i>Anomalospiza imberbis</i>	BM-U	
558	Grey Penduline Tit	<i>Anthoscopus caroli</i>	R-U	
794	Bluethroated Sunbird	<i>Anthreptes reichenowi</i>	Rare	
724	Shorttailed Pipit	<i>Anthus brachyurus</i>	NBM-U	
723	Bushveld Pipit	<i>Anthus caffer</i>	R-U	
716	Grassveld Pipit	<i>Anthus cinnamomeus</i>	R-VC	
720	Striped Pipit	<i>Anthus lineiventris</i>	R-U	
717	Longbilled Pipit	<i>Anthus similis</i>	R-U	
719	Buffy Pipit	<i>Anthus vaalensis</i>	R-U	
648	Yellowbreasted Apalis	<i>Apalis flavida</i>	R-VC	
649	Rudd's Apalis	<i>Apalis ruddi</i>	E-C	
645	Barthroated Apalis	<i>Apalis thoracica</i>	R-U/VC	
427	Narina Trogon	<i>Apaloderma narina</i>	R-C	
360	Cinnamon Dove	<i>Aplopelia larvata</i>	R-U	
417	Little Swift	<i>Apus affinis</i>	R-VC	
411	Eurasian Swift	<i>Apus apus</i>	NBM-U	
412	Black Swift	<i>Apus barbatus</i>	BM-U	
415	Whiterumped Swift	<i>Apus caffer</i>	BM-C	
416	Horus Swift	<i>Apus horus</i>	BM-U	
133	Steppe Eagle	<i>Aquila nipalensis</i>	NBM-U	
134	Lesser Spotted Eagle	<i>Aquila pomarina</i>	NBM-U	
132	Tawny Eagle	<i>Aquila rapax</i>	R-VC	
131	Black Eagle	<i>Aquila verreauxii</i>	R-C	
135	Wahlberg's Eagle	<i>Aquila wahlbergi</i>	BM-C	
65	Purple Heron	<i>Ardea purpurea</i>	R-C	
72	Squacco Heron	<i>Ardeola ralloides</i>	NBM-U	
395	Marsh Owl	<i>Asio capensis</i>	R-U	
128	Cuckoo Hawk	<i>Aviceda cuculoides</i>	R-U	
700	Cape Batis	<i>Batis capensis</i>	R-VC	
65	Purple Heron	<i>Ardea purpurea</i>	R-C	
64	Goliath Heron	<i>Ardea goliath</i>	R-C	
63	Blackheaded Heron	<i>Ardea melanocephala</i>	R-U	
80	Bittern	<i>Botaurus stellaris</i>	R-U	
696	Pallid Flycatcher	<i>Bradornis pallidus</i>	R-C	
638	African Sedge Warbler	<i>Bradypterus baboecala</i>	R-C	
798	Redbilled Buffalo Weaver	<i>Bubalornis niger</i>	R-VC	
401	Spotted Eagle Owl	<i>Bubo africanus</i>	R-C	
402	Giant Eagle Owl	<i>Bubo lacteus</i>	R-U/C	
80	Bittern	<i>Botaurus stellaris</i>	R-U	
696	Pallid Flycatcher	<i>Bradornis pallidus</i>	R-C	
638	African Sedge Warbler	<i>Bradypterus baboecala</i>	R-C	
798	Redbilled Buffalo Weaver	<i>Bubalornis niger</i>	R-VC	
401	Spotted Eagle Owl	<i>Bubo africanus</i>	R-C	
402	Giant Eagle Owl	<i>Bubo lacteus</i>	R-U/C	

80	Bittern	<i>Botaurus stellaris</i>	R-U	
696	Pallid Flycatcher	<i>Bradornis pallidus</i>	R-C	
638	African Sedge Warbler	<i>Bradypterus baboecala</i>	R-C	
798	Redbilled Buffalo Weaver	<i>Bubalornis niger</i>	R-VC	
401	Spotted Eagle Owl	<i>Bubo africanus</i>	R-C	
402	Giant Eagle Owl	<i>Bubo lacteus</i>	R-U/C	
80	Bittern	<i>Botaurus stellaris</i>	R-U #	
696	Pallid Flycatcher	<i>Bradornis pallidus</i>	R-C	
71	Cattle Egret	<i>Bubulcus ibis</i>	R-VC/A	
463	Southern Ground Hornbill	<i>Bucorvus leadbeateri</i>	R-U	
772	Redbilled Oxpecker	<i>Buphagus erythrorhynchus</i>	R-VC	
298	Water Dikkop	<i>Burhinus vermiculatus</i>	R-C/VC	
152	Jackal Buzzard	<i>Buteo rufofuscus</i>	E-U	
74	Greenbacked Heron	<i>Butorides striatus</i>	R-C	
455	Trumpeter Hornbill	<i>Bycanistes bucinator</i>	R-VC	
659	Stierling's Barred Warbler	<i>Calamonastes stierlingi</i>	R-U	
498	Sabota Lark	<i>Calendulauda sabota</i>	E-VC	
281	Sanderling	<i>Calidris alba</i>	NBM-U	
272	Curlew Sandpiper	<i>Calidris ferruginea</i>	NBM-C	
274	Little Stint	<i>Calidris minuta</i>	NBM-C	
657	Greenbacked Bleating	<i>Camaroptera brachyura</i>	R-VC	
538	Black Cuckooshrike	<i>Campephaga flava</i>	R-C	
483	Goldentailed Woodpecker	<i>Campethera abingoni</i>	R-C	
481	Bennett's Woodpecker	<i>Campethera bennettii</i>	R-U	
404	Eurasian Nightjar	<i>Caprimulgus europaeus</i>	NBM-U	
409	Mozambique Nightjar	<i>Caprimulgus fossii</i>	R-U	
407	Natal Nightjar	<i>Caprimulgus natalensis</i>	R-U	
405	Fierynecked Nightjar	<i>Caprimulgus pectoralis</i>	R-C	
408	Freckled Nightjar	<i>Caprimulgus tristigma</i>	R-U	
391	Burchell's Coucal	<i>Centropus burchellii</i>	R-VC	
388	Black Coucal	<i>Centropus grillii</i>	BM-U	
589	Familiar Chat	<i>Cercomela familiaris</i>	R-C	
613	Whitebrowed Robin	<i>Cercotrichas leucophrys</i>	R-VC	
617	Bearded Robin	<i>Cercotrichas quadrivirgata</i>	R-U	
428	Pied Kingfisher	<i>Ceryle rudis</i>	R-VC	
384	Emerald Cuckoo	<i>Chrysococcyx cupreus</i>	BM-U	
385	Klaas's Cuckoo	<i>Chrysococcyx klaas</i>	BM-U	
85	Abdim's Stork	<i>Ciconia abdimii</i>	NBM-U	
83	White Stork	<i>Ciconia ciconia</i>	NBM-C	
86	Woollynecked Stork	<i>Ciconia episcopus</i>	R-C	
84	Black Stork	<i>Ciconia nigra</i>	R-C	
761	Plumcoloured Starling	<i>Cinnyricinclus leucogaster</i>	BM-VC	
780	Purplebanded Sunbird	<i>Cinnyris bifasciata</i>	R-C	

779	Marico Sunbird	<i>Cinnyris mariquensis</i>	R-VC	
787	Whitebellied Sunbird	<i>Cinnyris talatala</i>	R-VC	
142	Brown Snake Eagle	<i>Circaetus cinereus</i>	R-C	
143	Blackbreasted Snake Eagle	<i>Circaetus pectoralis</i>	R-C	
164	Eurasian Marsh Harrier	<i>Circus aeruginosus</i>	NBM-U	
166	Montagu's Harrier	<i>Circus pygargus</i>	NBM-U	
165	African Marsh Harrier	<i>Circus ranivorus</i>	R-U	
679	Lazy Cisticola	<i>Cisticola aberrans</i>	R-U	
665	Desert Cisticola	<i>Cisticola aridulus</i>	R-U	
667	Ayres' Cisticola	<i>Cisticola ayresii</i>	R-U	
672	Rattling Cisticola	<i>Cisticola chinianus</i>	R-VC	
674	Redfaced Cisticola	<i>Cisticola erythropis</i>	R-C	
681	Neddicky	<i>Cisticola fulvicapillus</i>	R-C	
664	Fantailed Cisticola	<i>Cisticola juncidis</i>	R-C	
678	Croaking Cisticola	<i>Cisticola natalensis</i>	R-U	
677	Levaillant's Cisticola	<i>Cisticola tinniens</i>	R-U	
380	Great Spotted Cuckoo	<i>Clamator glandarius</i>	BM-U	
382	Jacobin Cuckoo	<i>Clamator jacobinus</i>	BM-C	
381	Striped Cuckoo	<i>Clamator levaillantii</i>	BM-U	
424	Speckled Mousebird	<i>Colius striatus</i>	R-VC	
350	Rameron Pigeon	<i>Columba arquatrix</i>	R-U/C	
348	Feral Pigeon	<i>Columba livia</i>	R-U/C	
447	Lilacbreasted Roller	<i>Coracias caudata</i>	R-VC/A	
446	Eurasian Roller	<i>Coracias garrulus</i>	NBM-C	
449	Purple Roller	<i>Coracias naevia</i>	R-C	
540	Grey Cuckooshrike	<i>Coracina caesia</i>	R-U	
539	Whitebreasted Cuckooshrike	<i>Coracina pectoralis</i>	R-U	
735	Longtailed Shrike	<i>Corvinella melanoleuca</i>	R-VC	
550	Whitenecked Raven	<i>Corvus albicollis</i>	R-VC	
548	Pied Crow	<i>Corvus albus</i>	R-C/A	
598	Chorister Robin	<i>Cossypha dichroa</i>	E-C	
599	Heuglin's Robin	<i>Cossypha heuglini</i>	R-VC	
602	Whitethroated Robin	<i>Cossypha humeralis</i>	E-C	
600	Natal Robin	<i>Cossypha natalensis</i>	R-VC	
200	Common Quail	<i>Coturnix coturnix</i>	R-U	
201	Harlequin Quail	<i>Coturnix delegorguei</i>	BM-U	
760	Wattled Starling	<i>Creatophora cinerea</i>	R-VC	
212	African Crake	<i>Crexopsis egregia</i>	BM-U	
211	Corncrake	<i>Crex crex</i>	NBM-U	
374	Eurasian Cuckoo	<i>Cuculus canorus</i>	NBM-U	
598	Chorister Robin	<i>Cossypha dichroa</i>	E-C	
378	Black Cuckoo	<i>Cuculus clamosus</i>	BM-U	
375	African Cuckoo	<i>Cuculus gularis</i>	BM-U	
377	Redchested Cuckoo	<i>Cuculus solitarius</i>	BM-C	

