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REPORT NO.: P 02/B810/00/0708/Volume 2/Annexure A-B

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT (GLeWaP)

DRAFT

Environmental Impact Assessment

(DEAT Ref No: 12/12/20/978)

ANNEXURE A-B:
Water Quality Specialist Study
Terrestrial Ecology Specialist Study

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Department:
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REPORT NO.: P 02/B810/00/0708/Volume 2 Annexure A

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT (GLeWaP)

Environmental Impact Assessment

(DEAT Ref No 12/12/20/978)

ANNEXURE A: WATER QUALITY SPECIALIST REPORT

July 2008

ILISO CONSULTING

Compiled by: ILISO Consulting (Pty) Ltd

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DECLARATION OF CONSULTANTS' INDEPENDENCE

Dr Martin van Veelen, who conducted the water quality specialist study, is an employee of ILISO Consulting (Pty) Ltd who are independent consultants appointed by the Department of Water Affairs and Forestry. He has no business, financial, personal or other interest in the activity, application or appeal in respect of which he was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of the specialist who performed the work.

REPORT DETAILS PAGE

Project name:	***Groot Letaba River Water Development Project (GLeWaP)***
Report Title:	***Environmental Impact Assessment: Water Quality***
Author:	***Dr Martin van Veelen***
DWAF report reference no.:	***P 02/B810/00/0708/Volume 2, Annexure A***
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Environmental Assessment Practitioner
Approved for ILISO Consulting (Pty) Ltd by:

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M van Veelen *Date*
Project Director

EXECUTIVE SUMMARY

On 1 June 2006 the Department of Water Affairs and Forestry (DWAF), Directorate: National Water Resource Planning commissioned the study titled the ***Groot Letaba River Water Development Project (GLeWaP)****. The DWAF appointed ILISO Consulting (Pty) Ltd as the lead Professional Environmental Service Provider with specialist sub-consultants. The study area covers the B8 catchment. The urgent need for the study was identified by DWAF's Internal Strategic Perspective for the Luvuvhu/ Letaba Water Management Area completed in December 2004. The study estimates, at a cursory level, a significant shortfall in water supply which can be attributed to the substantial growth in water usage, as well as the impact on the catchment over the years.*

This report examines the water quality situation in the study area. However, it is not intended to provide a detailed analysis of the water quality problems and their causes, but rather to provide a broad overview of the water quality situation and the possible need for an additional water system. The water quality data provided by DWAF from 72 of their stations was systematically analysed to determine which of the data sets were complete enough to base an interpretation on. A total of 5 stations situated around the study area were selected.

The water quality is assessed in terms of electrical conductivity, ammonium, orthophosphate, chloride, sulphate, nitrate/nitrite and pH. Water quality data was assessed according to a fitness for use range (water quality criteria), which was based on the Department of Water Affairs and Forestry water quality guidelines.

A non-parametric statistic analysis was used to calculate the variability in water quality data from the river flow stations and the boreholes. With non-parametric statistics the interquartile range, which lies between the 25th and the 75th percentile, is generally used to describe the central tendency or average conditions. For the purposes of this study the 95th percentile was included as it provides an indication of variability and can be used to assess the frequency of excursions into higher and possibly unacceptable water quality conditions.

On the whole the surface water quality is still good and fit for all uses. Of concern, however, are the consistently high concentrations of chloride, nitrate/nitrite and

electrical conductivity in the boreholes from which water is supplied to some of the communities.

The water quality situation in the catchment of the proposed new dam is such that no water quality problems are expected to occur. The dam will be able to provide water of an acceptable quality to a community that is at present reliant on water from boreholes of which some of the water is not fit for human consumption. The requirements in terms of the Reserve for water quality can be met.

The only possible effect, in terms of water quality, is the release of cold and anaerobic bottom water during periods when the dam becomes stratified. This can effectively be mitigated by the installation and correct operation of multiple level outlets.

There is some risk of contamination from construction material and waste discharge during construction. This can be mitigated by the implementation of proper construction methods and effective waste management.

There is some risk of contamination by herbicides and pesticides during the filling of the dam, as well as anoxic conditions due to the decomposing of organic material. This can effectively be mitigated by clearing the dam basin and preventing the use of herbicides and pesticides once the construction of the dam starts.

In terms of water quality there is therefore no significant effect on the environment from either the construction of the proposed new dam, or the raising of the Tzaneen Dam wall.

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ABBREVIATIONS

CI	Chloride
DWAF	Department of Water Affairs and Forestry
DEAT	Department of Environmental Affairs and Tourism
EMP	Environmental Management Plan
EIA	Environmental Impact Assessment
EMP's	Environmental Management Plans
EIR	Environmental Impact Report
EMS	Environmental Management System
EC	Electrical Conductivity
GLeWaP	Groot Letaba River Water Development Project
GLEMPF	Groot Letaba Environmental Management Plan Framework
MAR	Mean Annual Runoff
NEMA	National Environmental Management Act
NH_4	Ammonia
$N0_2 + N0_3$	Nitrite and Nitrate
PSP	Professional Service Provider
PO_4	Phosphate
SO_4	Sulphate

1. STUDY INTRODUCTION

1.1 BACKGROUND TO PROJECT

The Department of Water Affairs and Forestry (DWAF) is currently undertaking an Environmental Impact Assessment (EIA) to investigate the environmental feasibility of raising the Tzaneen Dam, the construction of a storage dam in the Groot Letaba River and associated bulk water infrastructure (water treatment, pipelines, pump stations, off-takes and reservoirs) in the Limpopo province. The EIA is being undertaken by ILISO Consulting with Zitholele Consulting providing the public participation support. The EIA is conducted according to the EIA Regulations under Section 24 (5) of the National Environmental Management Act (NEMA), (Act No 107 of 1998) as amended in Government Notice R385, 386, 387 – Government Gazette No. 28753 of 21 April 2006.

Dr Martin van Veelen of ILISO Consulting undertook the Water Quality specialist report as part of the EIA.

1.2 BACKGROUND

The National Water Act, 1998 (Act 36 of 1998) (NWA) prescribes that all catchments where there are licensed and/or registered water users are to comply with all of the following conditions:

- The absence of "water stress", i.e. where the demand exceeds the supply, or where water quality is a problem;
- the need to achieve equity in water allocation;
- the need to promote beneficial water use;
- the need to facilitate efficient water management; and
- The need to protect water resource quality.

The Groot Letaba Catchment unfortunately has not been able to comply with all of these requirements due to the increasing severity in water shortages. This has resulted in the main consumptive users (domestic, irrigation, industrial, and forestry) competing for this vital resource during winter months (the low flow period), and resorting to expensive alternative measures for survival.

1.3 PURPOSE OF THE REPORT

This report provides an assessment of the water quality within the Groot Letaba Catchment in terms of electrical conductivity (EC), ammonium (NH_4), pH, nitrite and nitrate ($N0_2$ / $N0_3$), sulphate, phosphorous ($P0_4$) and chloride (Cl). The purpose of the water quality investigation is to determine the current water quality situation and the trend, and then to determine how this could be affected by the planned project. Should there be any detrimental effects, mitigation measures are suggested.

1.4 STRUCTURE OF THIS REPORT

This specialist study has been undertaken in compliance with regulation 33(2) of GN 385. The report would thus be structured accordingly **(Table 1.1).**

Table 1.1: Report Structure

Regulatory Requirements	Section of Report
(a) The person who prepared the report; and the expertise of that person to carry out the specialist study or specialised process.	Chapter 2
(b) a declaration that the person is independent	Page i
(c) an indication of the scope of, and the purpose for which, the report was prepared	Chapter 3
(d) a description of the methodology adopted in preparing the report or carrying out the specialised process	Chapter 4
(e) a description of any assumptions made and any uncertainties or gaps in knowledge	Chapter 5
(f) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Chapter 6
(g) recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority	Chapter 7
(h) a description of any consultation process that was undertaken during the course of carrying out the study	Chapter 8
(i) a summary and copies of any comments that were received during any consultation process	Chapter 9
(j) any other information requested by the competent authority.	Chapter 10

2. PROJECT TEAM

ILISO Consulting has been appointed as Independent Environmental Assessment Practitioner (EAP) to undertake the EIA. Dr Martin van Veelen is the Project Leader and also the water quality specialist.

Dr Martin van Veelen is a professional engineer with a Ph D in aquatic health. He is the Managing Director of the ILISO Environmental Management Division and a certified Environmental Assessment Practitioner with 30 years experience. He specialises in project management, environmental impact assessments and water resource planning. He specifically has extensive experience in water quality, especially water quality management, water quality monitoring and water quality assessment.

3. PURPOSE OF THE REPORT AND SCOPE OF WORK

The information provided by the Letaba Catchment Reserve Determination Study (DWAF, 2006) and the water quality data from the river flow stations and reservoirs stations that fall within the study area were used to:

- Determine the impact of the dam on the quality of the water that will be stored in the proposed new dam, and in the Groot Letaba River downstream of the dam, and

- To compile a pre-construction and construction Environmental Management Plan (EMP) for the water quality associated with the proposed dam.

4. METHODOLOGY

The key issues identified during the Scoping Phase informed the terms of references of the specialist studies. Each issue consists of components that on their own or in combination with each other give rise to potential impacts, either positive or negative and from the project onto the environment or from the environment onto the project. In the EIA the significance of the potential impacts will be considered before and after identified mitigation is implemented.

A description of the nature of the impact, any specific legal requirements and the stage (construction/decommissioning or operation) will be given. Impacts are considered to be the same during construction and decommissioning.

The following criteria will be used to evaluate significance:

Nature

The nature of the impact will be classified as positive or negative, and direct or indirect.

Extent and location

Magnitude of the impact and is classified as:

- **Local**: the impacted area is only at the site – the actual extent of the activity
- **Regional**: the impacted area extends to the surrounding, the immediate and the neighbouring properties.
- **National**: the impact can be considered to be of national importance.

Duration

This measures the lifetime of the impact, and is classified as:

- **Short term**: the impact will be for 0 – 3 years, or only last for the period of construction.
- **Medium term**: three to ten years.

- **Long term**: longer than 10 years or the impact will continue for the entire operational lifetime of the project.
- **Permanent**: this applies to the impact that will remain after the operational lifetime of the project.

Intensity

This is the degree to which the project affects or changes the environment, and is classified as:

- **Low**: the change is slight and often not noticeable, and the natural functioning of the environment is not affected.
- **Medium**: The environment is remarkably altered, but still functions in a modified way.
- **High**: Functioning of the affected environment is disturbed and can cease.

Probability

This is the likelihood or the chances that the impact will occur, and is classified as:

- **Low**: during the normal operation of the project, no impacts are expected.
- **Medium**: the impact is likely to occur if extra care is not taken to mitigate them.
- **High**: the environment will be affected irrespectively; in some cases such impact can be reduced.

Confidence

This is the level knowledge/information, the environmental impact practitioner or a specialist had in his/her judgement, and is rated as:

- **Low**: the judgement is based on intuition and not on knowledge or information.
- **Medium**: common sense and general knowledge informs the decision.

- **High**: Scientific and or proven information has been used to give such a judgement.

Significance

Based on the above criteria the significance of issues will be determined. This is the importance of the impact in terms of physical extent and time scale, and is rated as:

- **Low**: the impacts are less important, but may require some mitigation action.
- **Medium**: the impacts are important and require attention; mitigation is required to reduce the negative impacts
- **High**: the impacts are of great importance. Mitigation is therefore crucial.

Cumulative Impacts

The possible cumulative impacts will also be considered.

Mitigation

Mitigation for significant issues will be incorporated into the EMP for construction.

Table 4.1: Example of Impact Assessment Table

Description of potential impact		
Nature of impact		
Legal requirements		
Stage	Construction and decommissioning	Operation
Nature of Impact		
Extent of impact		
Duration of impact		
Intensity		
Probability of occurrence		
Confidence of assessment		

Level of significance before mitigation		
Mitigation measures (EMP requirements)		
Level of significance after mitigation		
Cumulative Impacts		
Comments or Discussion		

5. ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

5.1 SOURCE OF DATA

Water quality data from the selected water quality monitoring stations that fall within the study area **(Figure 5.1**) were obtained from the DWAF. The data sets include results from the late 1960's to 2007 as listed in **Table 5.1.**

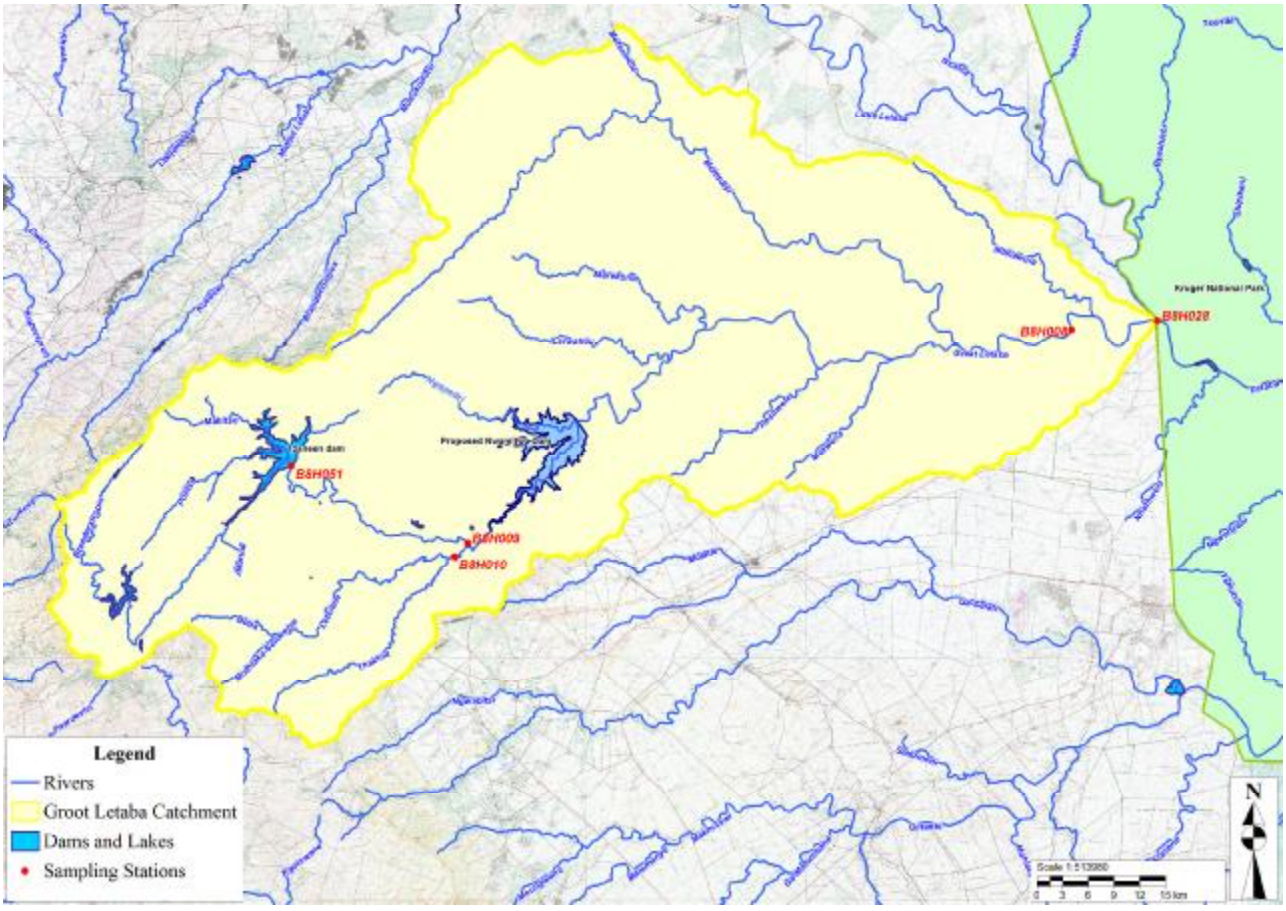

Figure 5.1: Location of River Stations

Table 5.1: Water quality monitoring stations used in study

Drainage Region	Station No.	Station Name	Date of First Sample	Date of Last Sample	No of Samples taken
B81 D	B8H010	Letsitele River	1969/11/20	2007/04/26	1011
B81 C	B8H051	Tzaneen Dam - Outlet	1985/01/30	2007/01/22	423
B81 E	B8H028	Letaba River at the Kruger National Park	1983/11/29	2007/06/20	282
B81 E	B8H009	Groot Letaba at The Junction	1969/11/20	2007/04/25	973
B81 J	B8H008	Groot Letaba at Letaba Ranch	1977/09/21	2007/04/24	1324

5.2 REASON FOR SELECTION

The river flow stations used in this study have been selected for the following reasons:

- They are within close proximity to the proposed dam at the site known as Nwamitwa;
- They are within close proximity to the Tzaneen Dam; or
- They are close to possibly impacted areas, for example the Kruger National Park.

5.3 DATA MANIPULATION

In order to analyse the water quality data provided by DWAF the data had to be prepared and any missing values had to be estimated. This was conducted using a systematic approach. The first step was to extract data for the study period (January 2003 to December 2007). This study period was chosen as being representative of the current water quality situation, but long enough to detect trends. In the second step, the datasets were filtered to monthly values in order to remove any bias due to periods of intensive sampling. In this step the first sample taken in a month was used. The third step involved calculating values missing for incomplete datasets using one of the following two methods:

(1) If there was no measured value for a single month, between two months that had values, then one of two steps was taken:

Step A: If the previous month had more than one value then the last value of that month was used as long as this value was from a sample taken on a date after the 20th of the month.

Step B: If such a value did not exist, then the value was determined by interpolation (the average of the month immediately prior and the month immediately after the month for which there was no value).

(2) If there are no measured values for two consecutive months, then the data was interpolated. The calculation for this extrapolation is as follows:
For the first month {month x} of the two months without data, the value of the month preceding the two months without data {month a} is subtracted from the first month immediately after the two months without data {month b}. This difference (month b - month a) is divided by three and added to the value of month a (month x = {month b-month a}/3+month a).
For the second month without data {month y} the difference (month b - month a) Is divided by three and multiplied by two and then added to the value of month a (month y = {month b-month a}/3 x 2 + month a).

If there are more than two consecutive months without measured data, then no attempt was made to fill in the missing months and the full period was left blank.

5.4 COMPLETENESS OF DATA

To evaluate the completeness of the data sets from each river flow station over the 5 year period of 2003 to 2007, the percentage of completeness was calculated. The percentage of completeness reflects the number of measured values after data sets have been filtered to monthly values and missing values had been filled in (see the discussion on data manipulation above describing how the data was filtered to monthly values and missing values filled in).

The percentage of completeness was then used to screen data sets to determine if there are sufficient values for statistical purposes. The percentage completeness is calculated as:

$$\%\text{Completeness} = \frac{[\text{Tot No. of Months with Data (Ts)}] \times 100}{[\text{Total No of Months}]}$$

After determining the completeness of the data sets, the following rules were applied to determine whether or not a dataset could be used:

1. Only data sets that were at least 70% complete were considered,
2. Only data sets that complied with the first rule and had data from at least 2000 onwards were selected.

For all the selected sampling points the patched data series were 100% complete over the selected period. It is therefore possible to complete a reasonably comprehensive analysis of the water quality situation.

5.5 DATA ANALYSIS

Water quality in a natural stream, which is determined by the concentrations of variables in the water body, is the result of a number of random processes, including rainfall, runoff, anthropogenic activities, geology etc. Water quality is therefore rarely static, but changes over time and space. It is seldom the instantaneous concentration that has an impact on the water user, but rather the average concentration. For this reason individual water quality measurements (or data) are of little use to water quality managers and regular measurements over a number of years is required.

To answer the questions “what is the water quality” and “how has the water quality changed” non-parametric statistics were used to calculate the variability, which is a measure of how water quality may differ over time. With non-parametric statistics the interquartile range, which lies between the 25^{th} and the 75^{th} percentile, is generally used to describe variability, while the median value (50^{th} percentile is an indication of the central tendency or average. For the purposes of this study the 95^{th} percentile was included as it can be used to assess the frequency of excursions into higher and possibly unacceptable water quality conditions.

Only data over the last five years (January 2003 to December 2007) was used to determine the current water quality. This was done in order to have a reasonable number of data points on which to base the calculated statistics, but not going back too far in time to have the assessment influenced by any trends that may be present.

The current water quality was based on the calculation of the median, 75th percentile and the 95th percentile.

5.6 WATER QUALITY ASSESSMENT

5.6.1 Variables of Concern

The objective of the study is not to perform an in-depth analysis of water quality in the study area (i.e. the objective was not to detect any pollution from other sources), but rather to determine whether or not the proposed project will affect the water quality, or *vice versa*. For this reason indicator variables were chosen that are indicative of the fitness for use of the water:

- **Electrical Conductivity (EC):** Is an indicator of the salinity of the water. This affects both domestic use as well as irrigation. The aquatic ecosystem is only affected if the salinity deviates significantly from the natural background value.

- **pH**: The pH in itself does not affect the user or use of the water, but it is an indicator of characteristics such as the acidity or alkalinity of the water, which in turn is an indication of possible aggressive or corrosive properties. Health impacts are normally limited to irritation of mucous membranes or the eyes when swimming. The aquatic ecosystem is only affected by deviations from the natural background value.

- **Nitrate/Nitrite (NO_3/NO_2)**: Has a health effect on humans (particularly babies), and is also an indication of contamination from human activities in the catchment, notably the discharge of treated waste water. Nitrite has a toxic effect on aquatic organisms, particularly those organisms that use gills to breathe under water.

- **Phosphate (PO_4)**: Has no direct effect on the use of water, but is an indicator of contamination from activities in the catchment such as waste water discharge and fertilisers from agricultural activities. Elevated concentrations of phosphate can lead to algal blooms in standing water which affect users and the aquatic ecosystem negatively.

- **Sulphate ($S0_4$):** Occurs naturally and is widely distributed in natural waters. Levels should not be more that 250mg/L in drinking water. When Sulphate levels are higher than 500mg/l it is know to contribute to the unpleasant taste of water. Sensitive users may experience diarrhoea, but most people can adapt after a period of use.

- **Ammonia (NH_4):** Ammonia is toxic to aquatic life, especially in the unionised form (NH_3). The ratio between NH_3 and NH_4 is dependent on the temperature and pH. For this reason guidelines are normally stated as total ammonia. Ammonia is reduced by natural processes to nitrate/nitrite and is therefore not persistent. Ammonia seldom occurs in concentrations that are high enough to affect human health, and as it is a fertiliser, does not affect agriculture.

- **Chloride (Cl):** Is an indicator of the nature of salinity. It is an indicator of salty taste, and also corrosivity with respect to household appliances and irrigation equipment. In some water bodies sulphate has the same effect as chloride and the two should be assessed in conjunction with each other. However, sulphate concentrations in the study area are very low, and in this case can be ignored. Effects on the aquatic ecosystem as a result of salinity will be detected long before chloride in itself becomes problematic, and chloride can therefore be ignored when assessing water quality in this respect. Some crops, specifically deciduous trees such as citrus, are sensitive to chloride as it builds up in the leaves and causes leave sclerosis. This is probably the most sensitive use with respect to chloride.

- **Pesticides and Herbicides:** There is some evidence (Heath and Claassen, 1999 and Vosloo and Bouwman, 2005) that filling of the dam could lead to contamination by pesticides and herbicides that were used in the dam basin. Pesticides and herbicides that can be legally used have a relatively short half life, and should not be a problem as long as the use of these are stopped some time before the dam is completed and filling commences. However, it is not known whether or not more persistent pesticides or herbicides were used in the past. An example would be DDT that is used against malaria. This is mostly used in and around dwellings, especially thatched roof houses. Unfortunately there is no readily available data to assess this risk quantitatively.

5.6.2 Water Quality Criteria, Guidelines and Fitness for Use

Water quality does not suddenly change from “good” to “bad”. Instead there is a gradual change between categories. This is reflected by the fitness-for-use range which is graded to indicate the increasing risk of using the water.

Water quality criteria are discrete values that describe a specific effect as a result of a particular set of conditions. An example would be the toxicity of a substance as determined in a laboratory (the LC50 value for mercury dissolved in water with respect to daphnia). These criteria are then used to develop guidelines, which describe the effect on a user who is exposed to an ever increasing concentration or changing value.

Water quality guidelines can be used to describe fitness-for-use. The fitness-for-use range can be divided into four categories, ranging from “ideal” to “unacceptable”. These categories are described as:

Ideal : the user of the water is not affected in any way;
Acceptable : slight to moderate problems are encountered;
Tolerable : moderate to severe problems are encountered; and
Unacceptable : the water cannot be used under normal circumstances.

The fitness-for-use range is also colour coded for ease of interpretation of information (**Table 5.2**).

Table 5.2: Colour codes assigned to fitness for use ranges

Fitness for use range	Colour code
Ideal	Blue
Acceptable	Green
Tolerable	Yellow
Unacceptable	Red

The DWAF water quality guidelines make provision for five water use categories, namely domestic, recreation, industrial, agricultural (irrigation, livestock watering, and aquaculture), and the aquatic ecosystem. For the purposes of this study only three

out of the five water use categories have been taken into account, namely domestic use, agricultural use (irrigation) and the aquatic ecology. The underlying principle is that, if the water is fit for human consumption, it is safe to swim in, and if it is fit for domestic use, industrial users should not be affected unduly.

5.6.3 Fitness for use categories

Water quality guidelines describe the fitness for use of the water. The biological, chemical or physical data is analysed and the results are compared against the guidelines to assess the water quality of a resource. It is necessary that water quality guidelines be developed for each water use and for each variable of concern. The basis of these guidelines can be found in the South African Water Quality Guidelines, Volumes 1 to 7 (*DWAF, 1996a-g*).

The DWAF guidelines are user-specific, making it possible to have many different guidelines for each of the water quality variables (depending on how many user groups are affected by the same variable). For each user group a particular set of guidelines for water quality is relevant (developed by DWAF). The guidelines provide a description of the effect that changes in water quality will have on the user, and not an interpretation of whether this is acceptable or not. From these guidelines the cut-off values for the different fitness-for-use categories have been set. A breakdown of these values is given in **Table 5.3.**

The cut-off values for the fitness for use categories are per user and per variable and can be used to assess the fitness for use of the Groot Letaba study area for individual users or user categories such as domestic, agriculture, industry, recreation and the aquatic ecosystem. The study focused on domestic and agriculture water uses. In order to determine the fitness for use of the Groot Letaba study area as a whole, the different fitness for use categories for different users affected by the same variable have been reconciled. This was done by selecting the most stringent value for each cut-off value in order to arrive at the management levels. A summary of these values are given in **Table 5.4**

The explanation of how the cut-off values for the water quality variables were decided on are as follows:

a) Electrical Conductivity (EC): The agricultural guideline for irrigation is the most stringent. The ideal range in this guideline falls between 0 and 40 mS/m.

b) pH: The fitness for use for the pH category simply represents a combination of all the user-specific guidelines to form the most stringent.

c) Nitrate and Nitrite (NO_3 / NO_2): The user group that is most sensitive is domestic use, and the guideline is therefore based on this.

d) Ammonia (NH_3/NH_4): Total Ammonia is used as an indicator of the presence of NH_3 which is highly toxic to aquatic life even in low concentrations, and is therefore difficult to measure. In most cases ammonia has no effect on human consumption or on irrigation in the concentrations in which it occurs in rivers and streams. The guideline for aquatic use therefore determines the cut-off values for the fitness for use range.

e) Sulfate ($S0_4$): The norm used on sulfate is based on human health and aesthetic effect. The domestic guideline for consumption is the most stringent. The ideal range is between 200mg/l 0 400 mg/l.

f) Phosphorous ($P0_4$): The only guideline for phosphorous is in the ecological user group.

g) Chloride (CI): The most stringent guideline is for agricultural irrigation; this guideline will be carried over to the fitness-for-use categories because it is necessary to protect the crops farmed from toxic levels of chloride.

Table 5.3: User specific guidelines

Variable	Units	Colour Ranges			
		Blue	Green	Yellow	Red
DOMESTIC					
Total Ammonia	mg/l N				
Electrical Conductivity	mS/m	< 70	70 to 150	150 to 370	>370
pH	pH units at 25^0 C	5.0 to 9.5	4.5 to 5.0 9.5 to 10	4.0 to 4.5 10.0 to 10.5	<4.5 >10.5
Nitrate/Nitrite	mg/l N	< 6.00	6 to 10	10 to 20	> 20
Phosphate	mg/l P				
Sulphate	mg/l SO_4	0 to 200	200 to 300	300 to 400	>400
Chloride	mg/l Cl	<100	100 to 200	200 to 600	< 600
AGRICULTURE					
Total Ammonia	mg/l N				
Electrical Conductivity	mS/m	< 40	40 to 90	90 to 270	>270
pH	pH units at 25^0 C	6.5 to 8.5	<6.5 >8.5		
Nitrate/Nitrite	mg/l N				
Phosphate	mg/l P				
Sulphate	mg/l SO_4	< 1000	1000 to 1500	1500 to 2000	> 2000
Chloride	mg/l Cl	< 100	100 to 175	175 to 350	>350
AQUATIC ECOLOGY					
Total Ammonia	mg/ l N	<0.140	0.140 to 0.300	0.300 to 2.00	> 2.00
Electrical Conductivity	mS/m				
pH	pH units at 25^0 C	6.5 to 8.5	5.5 to 6.5 8.5 to 9.0	5.0 to 5.5 9.0 to 9.5	< 5.00 >9.5
Nitrate/Nitrite	mg/l N				
Phosphate	mg/l P	< 0.005	0.005 to 0.025	0.025 to 0.250	> 0.250
Sulphate	mg/l SO_4				
Chloride	mg/l Cl				

Table 5.4: Combined fitness for use categories

Variable	Units	Colour Ranges			
		Blue- Ideal	Green- Acceptable	Yellow- Tolerable	Red - Unacceptable
Total Ammonia	mg/l N	<0.140	0.140 to 0.300	0.300 to 2.00	> 2.00
Electric Conductivity	mS/m	< 40.0	40 to 90	90 to 270	>270
pH	pH units at 25^0 C	6.5 to 8.5	5.5 to 6.5 8.5 to 9.0	5.0 to 5.5 9.0 to 9.5	<5.0 >9.5
Nitrate/Nitrite	mg/l N	< 6.00	6.00 to 10	10 to 20	> 20
Phosphate	mg/l P	< 0.005	0.005 to 0.025	0.025 to 0.250	> 0.250
Sulphate	mg/l SO_4	0 to 200	200 to 300	300 to 400	>400
Chloride	mg/l Cl	<100	100 to 200	200 to 600	>600

5.6.4 Fitness for use assessment

In the foregoing chapters the fitness-for-use categories have been developed. What is now needed is to assess the water quality on the basis of the statistical distribution of the measurements over the various categories. Obviously, if all the statistics (median, 75th percentile and 95th percentile) fall in the "ideal" range, then the water is ideal. The same is true for the other categories.

The rules for determining the overall fitness for use are shown in **Table 5.5** below.

Table 5.5: Fitness for use assessment criteria

Fitness for use range in which the variable falls			Water quality assessment category	Colour code
Median	75th percentile	95th percentile		
Ideal	Ideal	Ideal	Ideal	Blue 1
Ideal	Ideal	Acceptable	Acceptable	Green 2
Ideal	Acceptable	Acceptable		
Acceptable	Acceptable	Acceptable		
Ideal	Ideal	Tolerable		
Ideal	Acceptable	Tolerable	Tolerable	Yellow 3
Acceptable	Acceptable	Tolerable		
Acceptable	Tolerable	Tolerable		
Tolerable	Tolerable	Tolerable		
Any other combination			Unacceptable	Red 4

The above is a methodology to test a set of data in a consistent and unbiased manner, taking into consideration the water quality, of each of the variables of concern, for the full range of fitness-for-use (Ideal to Unacceptable) of the water quality for a specific resource. In this methodology the full time span of the water quality of the resource is checked in an acceptable scientific manner in the same way one sample would be checked for fitness-for-use.

6. RESULTS

6.1 CURRENT WATER QUALITY

The data set used to calculate the values in **Table 6.1** to **Table 6.4** are based on monthly data over a period of 5 years (2001 – 2005).

Table 6.1: Water quality assessment for the median of stations analysed

Station Name	Station No.	EC	pH	Cl	SO_4	NO_3+NO_2 - N	NH_4 -N	PO_4-P
Tzaneen Dam	B8H051	8	7.5	5	3	0.12	0.147	0.013
Grt Letaba @ The Junction	B8H009	11	7.6	10	3	0.27	0.020	0.016
Letsitele	B8H010	28	8.0	20	6	0.61	0.020	0.153
Grt Letaba @ Letaba Ranch	B8H008	58	8.2	89	18	0.06	0.020	0.024
Grt Letaba @ KNP	B8H028	71	8.3	102	19	0.04	0.020	0.022

Table 6.2: Water quality for the 75th percentile of stations analysed

Station Name	Station No.	EC	pH	Cl	SO_4	NO_3+NO_2 - N	NH_4 -N	PO_4-P
Tzaneen Dam	B8H051	8	7.6	6	6	0.19	0.270	0.018
Grt Letaba @ The Junction	B8H009	12	7.7	12	7	0.39	0.044	0.021
Letsitele	B8H010	37	8.1	33	9	1.19	0.051	0.242
Grt Letaba @ Letaba Ranch	B8H008	81	8.3	131	25	0.17	0.041	0.035
Grt Letaba @ KNP	B8H028	92	8.4	153	27	0.06	0.045	0.035

Table 6.3: Water quality for the 95th percentile of stations analysed

Station Name	Station No.	EC	pH	Cl	SO_4	NO_3+NO_2 - N	NH_4 -N	PO_4-P
Tzaneen Dam	B8H051	9	7.8	8	10	0.29	0.468	0.028
Grt Letaba @ The Junction	B8H009	23	7.9	21	11	0.66	0.072	0.036
Letsitele	B8H010	47	8.3	60	15	2.91	0.140	0.998
Grt Letaba @ Letaba Ranch	B8H008	102	8.6	194	36	0.38	0.059	0.082
Grt Letaba @ KNP	B8H028	123	8.5	243	33	0.25	0.090	0.062

Table 6.4 depicts the fitness for use category for each of the sampling points that was analysed. The water quality falls mostly in the ideal range, except in terms of phosphate. This is probably due to activities in the catchment, such irrigation return flow and treated domestic waste discharge. The lower reaches of the river are clearly more saline than the upper reaches.

Table 6.4: Concluding water quality assessment

Station Name	Station No.	EC	pH	Cl	SO_4	NO_3+NO_2 - N	NH_4 -N	PO_4-P
Tzaneen Dam	B8H051	B	B	B	B	B	Y	Y
Grt Letaba @ The Junction	B8H009	B	B	B	B	B	B	Y
Letsitele	B8H010	G	B	B	B	B	G	R
Grt Letaba @ Letaba Ranch	B8H008	Y	G	Y	B	B	B	Y
Grt Letaba @ KNP	B8H028	Y	G	Y	B	B	B	Y

6.2 TRENDS

A time series for the different variables at the different monitoring points is included as **Appendix A**. A summary of the trends is shown in the table below. A “1” denotes a decrease in concentration or value, while a “2” denotes an increase or positive trend. A “0” means that there is no change over the period under review.

Table 6.5: Trend analysis

Station Name	Station No.	EC	pH	Cl	SO_4	NO_3+NO_2 - N	NH_4 -N	PO_4-P
Tzaneen Dam	B8H051	2	1	2	1	1	2	2
Grt Letaba @ The Junction	B8H009	2	1	2	1	1	1	1
Letsitele	B8H010	2	1	2	2	0	1	2
Grt Letaba @ Letaba Ranch	B8H008	2	0	2	2	1	1	1
Grt Letaba @ KNP	B8H028	2	1	2	2	2	0	1

On the whole the water quality of the catchment is improving in terms of nutrients, but there is an increasing trend in salinity. The changes in water quality are however small, and not significant in terms of fitness for use. Even at the 95th percentile value, the water quality still falls mostly in the ideal range in the upper reaches.

Station B8H051 represents the Tzaneen Dam. The slight positive trend is not significant in terms of fitness for use, but is highly significant in terms of indicating that there are processes in the catchment of the dam that are causing changes in water quality.

6.3 BOREHOLE WATER QUALITY

Water quality data for boreholes was obtained from the DWAF database. The different boreholes were grouped according to the quaternary drainage region in which they occur, and the data analysed. The results are shown in **Table 6.6**.

Table 6.6: Borehole water quality in catchment B8

Variable		B8H008	B8H009	B8H010	B8H014	B8H018	B8H050	B8H051	B8H064
Chloride (mg/l Cl)	Median	10.7	22.3	28.2	46.4	113	16.4	16.4	23.3
	75th Perc	12.7	29.7	60.8	252	125	19.4	19.4	29.7
	95th Perc	20.6	120	269	409	402	29.5	29.5	34.8
Electrical Conductivity (mS/m)	Median	40.0	36.9	58.9	112	113	18.7	18.7	78.2
	75th Perc	42.3	48.4	96.6	219	118	20.6	20.6	81.1
	95th Perc	45.8	124	194	391	237	37.0	37.0	83.5
NO3+NO2 (mg/l N)	Median	3.58	0.040	10.8	18.9	3.88	0.02	0.02	10.0
	75th Perc	5.73	1.36	15.5	20.0	4.75	4.10	4.10	10.49
	95th Perc	9.08	20.0	46.8	101	5.98	0.08	0.08	10.8
NH4 (mg/l N)	Median	0.03	0.02	0.02	0.02	0.07	0.02	0.02	0.02
	75th perc	0.05	0.03	0.05	0.02	0.06	0.03	0.03	0.05
	95th Perc	1.17	0.01	0.11	0.04	0.02	0.08	0.08	0.08
PO4 (mg/l P)	Median	0.01	0.01	0.02	0.01	0.01	0.05	0.05	0.02
	75th Perc	0.06	0.02	0.03	0.03	0.02	0.08	0.08	0.03
	95th Perc	0.02	0.05	0.12	0.06	0.07	0.33	0.33	0.04
S04 (mg/l)	Median	5.8	7.53	10	33.8	8.20	2	2	8.01
	75th Perc	8.36	12.2	14.6	49.5	9.92	4.11	4.11	9.23
	95th Perc	9.28	22.1	62.7	78.0	74.8	10.7	10.7	10.21
pH	Median	7.53	8.08	7.95	8.18	8.51	7.41	7.41	8.23
	75th Perc	7.70	8.22	8.06	8.13	8.62	7.65	7.65	8.32
	95th Perc	7.84	8.46	8.26	9.33	8.88	8.23	8.23	8.40

The salinity of the borehole water is such that in most areas it is unfit for human consumption due to the high salinity, or will impart an unpleasant taste to the water. Of most concern is the elevated nitrate/nitrite concentration in the water of some of the boreholes. This is indicative of serious contamination, and it can be expected that there will be some bacterial pollution as well. The borehole water is also not suitable for irrigation of citrus, except in an emergency over a short period of time.

6.4 ASSESSMENT OF POTENTIAL IMPACTS

The issues with respect to water quality centre around two effects. The first is the storage of a large quantity of water in the proposed dam, which can lead to eutrophic conditions and an increase in salinity due to the concentrating effect of evaporation losses. These problems tend to be accentuated during periods of prolonged low inflow.

The second issue is a possible change in water quality in the river downstream of the dam. The change can be far-reaching, such as a cumulative change in salinity as a result of reduced flows, or it can be of a local nature, such as changes in temperature directly downstream of the dam due to the release of colder bottom water.

In both cases the impact should be assessed in terms of fitness for use to the users of the water (including the aquatic ecosystem). In this respect the possible positive effect on future users who currently use borehole water should not be neglected.

6.4.1 Expected water quality in the dam

The water quality in the dam is dependent on two aspects, namely the quality of the water that flows into the dam, as well as the size of the dam. The water quality of the dam will be less variable than that of the river, as the volume of water stored in the dam will act as a buffer to sudden changes.

The proposed dam will have a capacity of more than the mean annual runoff of the river, and the quality of the water in the dam can therefore be expected to be equal to the median value of t**he river water. This is** a conservative assumption, as most of the inflow (in terms of volume) into the dam occurs during flood events when the concentrations are low. However, the median value makes provision for prolonged periods of low flow and the concentrating effect of evaporation losses.

The water quality in the dam will be a combination of the water quality at B8H009 and B8H010. According to the hydrological analysis the present day flow at B8H009 represents 58% of the flow below the confluence of the Groot Letaba River and the Letsitele River, and the flow at B8H010 represents 42%. The contribution from the Nwanedzi is relatively small (11% of the flow at the dam site) and as it can be accepted that it does not differ significantly from the rest of the catchment, will therefore have very little effect on the overall quality. The values depicted in **Table 6.7** were calculated from the observed values at B8H009 and B8H010 as the predicted 95^{th} percentile concentrations in the dam.

Table 6.7: Predicted water quality in the dam (95th percentile)

EC	pH	Cl	SO_4	$NO_3 + NO_2$ - N	NH_4 - N	PO_4 - P
18	7.8	14	4	0.41	0.020	0.074

Apart from phosphate, the water quality falls in the ideal range. In terms of domestic use it represents a vast improvement over the borehole quality, while it is also eminently suitable for irrigation.

The water quality in the dam will represent a significant improvement in the water quality that is currently available, especially for domestic users that are currently dependent on borehole water. No mitigation is required.

The trophic classification is determined by the mean annual concentration of TP (Total phosphate) and chlorophyll (Walmsley and Butty, 1980). **Table 6.8** below demonstrates the different trophic classification and **Table 6.9** provides a definition of each trophic level.

Table 6.8: Trophic Classification

Trophic Status	TP concentration (µg/l)	Chlorophyll concentrations (µg/l)
Oligotrophic	<15	<3
Mesotrophic	15-47	3-9
Eutrophic	>47	>9

Source: (Walmsley and Butty, 1980)

Table 6.9: Trophic Definition

Oligotrophic Mesotrophic	Low in nutrients and not productive in terms of aquatic animal and plant life.
Eutrophic	Rich in nutrients, very productive in terms of aquatic animal and plant life and showing an increasing signs of water quality problems.
Hypertrophic	Very high nutrient concentrations where plant growth is determined by physical factors. Water quality problems are serious and can be continuous.

Source: http://www.dwaf.gov.za/iwqs/eutrophication/NEMP/nempdam.htm (DWAF 2002)

The predicted phosphate concentration is 0.074 mg/l P (74 µg/l). This puts it in the eutrophic range, but as a concentration of less than 0.16 mg/l P will result in nuisance conditions occurring for less than 20% of the time, this is seen as tolerable. Nonetheless, the situation will warrant close monitoring at the least.

The predicted phosphate concentration in the dam will put it in the range of eutrophic. This means that nuisance conditions with respect to algal blooms will occur, but for less than 20% of the time. No mitigation is required, but it is suggested that the source of phosphate in the catchment is located and reduced.

Stratification often occurs in large water bodies during the spring and summer periods. It is essentially the development of distinct layers of different temperature, density and/or water quality at various depths in a water body and the restriction of mixing throughout the water column.

During winter and early spring, most water bodies are well mixed throughout their water column. Thermal stratification develops in late spring or summer when the upper layers of the dam are heated by solar radiation. The surface water layer heats up faster than the heat can disperse into the lower depths of the dam. The resultant difference in the density of the surface and bottom layers retards circulation within the water column and can lead to the top and bottom layers having significantly different water temperature and water qualities.

Oxygen input into a water body normally occurs by diffusion at the interface between air and water and by photosynthesis in the photic zone. Oxygen is consumed largely at the bottom of a dam by the decomposition of organic material on the dam floor. In a stratified water body, water circulation is restricted and oxygen is therefore not carried from the surface layer to the bottom layer, resulting in a rapid depletion of oxygen in this layer during the summer months.

There are three defined depth layers that develop as a water body becomes stratified:

- Epilimnion - the surface layer of warm, generally well oxygenated water, circulated by wind action and minor currents;
- Hypolimnion - the bottom water layer of cooler water, generally anoxic and isolated from wind and thermal effects;
- Metalimnion - the layer between the epilimnion and the hypolimnion, a zone of steep decline in temperature and dissolved oxygen with depth.

The thickness and depth of the epilimnion, metalimnion and hypolimnion layers in a stratified storage are influenced by many factors, such as temperature variation, wind mixing and flow through a dam. Once the dam has stratified, a large amount of energy is often required to break down the layers while summer conditions persist. In autumn, stratification is normally naturally broken down (a process called "turnover" of the water body) by a decrease in surface temperatures and by wind induced mixing. Isothermal conditions are normally present in dams during winter and into spring, until a rise in ambient temperatures may initiate the next season's stratification.

In South Africa the metalimnion is normally found at a depth of about 8 meters, while the layer itself is between 1 meter and 2 meters thick. It is highly probable that the proposed dam will become stratified in summer, especially at the dam wall, as the depth of the dam at the wall is more than 30 meters. This means that any bottom outlets will release cold (14° C to 18° C), anoxic water into the river where the temperature in summer is around 28° C, to the detriment of the aquatic life. The effect would disappear a short distance downstream of the dam, and is therefore fairly localised and seasonal.

It is difficult to predict how far downstream the effect will persist. The water will become aerated quickly, especially if the water is released in the form of a jet from

valves in the dam wall. The effect of temperature may persist for some kilometres, depending on the flow rate and depth. The Groot Letaba below the proposed dam is relatively shallow and the flow is slow. The effect of temperature is expected to be effectively dissipated about 15 km downstream of the dam wall, at which point the temperature will only differ slightly from the natural background temperature.

Stratification is predicted to occur in the proposed new dam, and the release of cold, anoxic bottom water will have a detrimental effect on the aquatic life up to a distance of about 15 km below the dam wall. To overcome the effect it is recommended to install a multiple level outlet structure, with oulets at approximately 5 meter intervals from 6 meters below the full supply level of the dam, to be confirmed in the design phase.

Table 6.10: Impact assessment table for water quality (users)

Description of potential impact	Better quality water for users	
Nature of impact	Positive	
Legal requirements		
Stage	Construction and decommissioning	Operation
Nature of Impact		Positive
Extent of impact		Regional
Duration of impact		Long term
Intensity		Medium
Probability of occurrence		High
Confidence of assessment		High
Level of significance before mitigation		High
Mitigation measures (EMP requirements)		None, the impact is positive and desired
Level of significance after mitigation		

Cumulative Impacts		
The water from the dam will obviate the current situation where people are dependent on borehole water that is not always fit for human consumption.		

Table 6.11: Impact assessment table for water quality (downstream effects)

Description of potential impact	Water quality changes (temperature and oxygen) in the river downstream of the proposed dam.	
Nature of impact	Negative	
Legal requirements		
Stage	Construction and decommissioning	Operation
Nature of Impact		Negative
Extent of impact		Regional
Duration of impact		Long term
Intensity		Medium
Probability of occurrence		High
Confidence of assessment		Medium
Level of significance before mitigation		Medium
Mitigation measures (EMP requirements)		Multiple level outlets at the dam
Level of significance after mitigation		Low (totally mitigated)
Cumulative Impacts		
The installation of multiple level outlets and proper operation will completely mitigate the effect of water quality changes downstream of the proposed dam.		

The raising of the Tzaneen Dam will have no water quality effects with respect to the current situation.

6.4.2 Impacts during construction

Some impacts on water quality may occur during construction. These have to do with possible contamination of the river by construction materials, as well as the discharge of waste from the construction site. These occurrences are governed by the National Water Act, and as long as this is adhered to, the effect will be minimal. This applies at both sites, namely the proposed new dam as well as the possible raising of the Tzaneen Dam.

Table 6.12: Water quality impacts during construction

Description of potential impact	Contamination of river water from construction materials and the discharge of waste from the construction site.	
Nature of impact	Negative	
Legal requirements	National Water Act	
Stage	Construction and decommissioning	Operation
Nature of Impact	Negative	
Extent of impact	Regional	
Duration of impact	Short	
Intensity	Low	
Probability of occurrence	Medium	
Confidence of assessment	Medium	
Level of significance before mitigation	Medium	
Mitigation measures (EMP requirements)	Adhere to requirements of the National Water Act, and good house-keeping on site.	
Level of significance after mitigation	Low	
Cumulative Impacts		
As long as the construction site and the construction activities are managed properly in accordance with accepted practice, incidences of contamination should only occur under extraordinary circumstances.		

6.4.3 Impacts during filling of the dam

As mentioned before, there is some concern that there may be some contamination by pesticides and herbicides that were used in the dam basin, and that this could pose a threat to human health as well as the aquatic ecology. Although the effect would last only for a short period of time (the pesticides and herbicides would be leached out and effectively diluted by the inflow into the dam once it is full), it does pose a risk should the dam only fill slowly over the initial years after completion. The most effective way to mitigate this risk is to remove all standing crops and to break down and remove all buildings in the dam basin before filling commences.

Another potential problem is that any vegetation that is left in the dam basin will begin to decompose once the dam basin is filled with water. This will create anoxic conditions that may persist for a considerable period of time, and will pose a risk to downstream aquatic life, will render the dam basin itself unfit to support aquatic life, and will cause problems at the water treatment plant. The anoxic zone may consist as close as two meters from the surface.

For the above reasons, it is strongly recommended that the dam basin is cleared, and that the use of pesticides and herbicides is stopped when dam construction commences, irrespective of whether or not the present land owners are allowed to continue farming until the dam starts filling up.

Table 6.13: Water quality impacts during filling of the dam

Description of potential impact	Contamination of water by pesticides and herbicides, and the creation of anoxic conditions due to decomposition of organic material.	
Nature of impact	Negative	
Legal requirements	National Water Act	
Stage	Construction and decommissioning	Operation (Filling of dam)
Nature of Impact		Negative

Extent of impact		Local
Duration of impact		Short term
Intensity		Low/Medium (depends on how fast the dam fills up)
Probability of occurrence		Medium
Confidence of assessment		Medium
Level of significance before mitigation		Medium
Mitigation measures (EMP requirements)		Clear the dam basin Prevent the use of herbicides and pesticides in the dam basin once construction starts
Level of significance after mitigation		Low
Cumulative Impacts		

6.5 COMPLIANCE TO THE RESERVE

Information regarding the Reserve was obtained from the Department of Water Affairs and Forestry (File Reference 26/8/3/3/190, 332, 659, 334, 1049, 1050, 1051).

The Preliminary Reserves for each of seven Ecological Water Requirement (EWR) sites in the Groot Letaba River and its main tributaries were determined during 2006. The Reserve was duly signed off by the Director-General: Water Affairs and Forestry on 27 December 2006. It thereby is applicable to the authorization of all water use activities in the Groot Letaba River Catchment, which includes the storing of water.

Nine ecologically distinct Resource Units (RUs) were identified in the Letaba River catchment. However, eco-classification was conducted only for the 7 EWR sites selected in the study area (**Figure 6.1**). The Ecological Importance and Sensitivity and Socio-cultural Importance of these EWR sites are provided in **Table 6.13**. They range from low to high importance at EWR4, on the Groot Letaba River, as it enters the KNP.

The Present Ecological State (PES) of each EWR site is also given in **Table 6.13** and ranges from category C at EWR 1 (upper catchment of Groot Letaba River), EWR 5 (Klein Letaba) and EWR 6, and 7 (in the KNP) to category D in the Letsitele River. The Recommended Ecological Category for each EWR site is to remain unchanged from the PES.

The EWR site that will be applicable to the proposed new dam is EWR Site 3 (Groot Letaba River at Die Eiland). Although this site is somewhat downstream from the proposed dam site, there are no significant inflows that could influence the water quality along this stretch of the river. It can therefore be accepted that, as long as the requirements of the Reserve are met in the proposed new Dam, they can be met at EWR Site 3 as well. This would then constitute compliance with the Reserve.

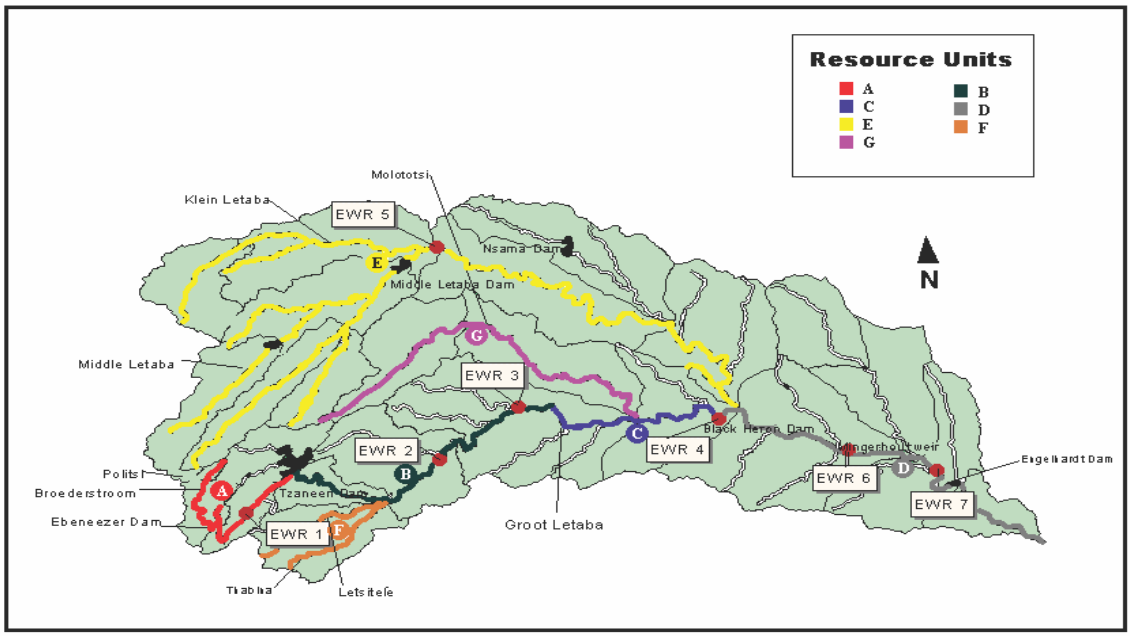

Figure 6.1: EWR Sites in the Groot Letaba River Catchment

Table 6.5: Summary of the Present Ecological Status (PES), Ecological Importance and Sensitivity (EIS) and Socio-cultural Importance (SI) of each Site in the Letaba River Catchment, the Recommended Ecological Category (REC) suggested by the specialists and used to determine the EWR, and the most likely alternative ECs, where applicable.

Site	PES	Importance		Ecological Category		
		EIS	SI	REC	Alternatives	
1	C	Mod	Low	C	N/A	D
2	D	Mod	Low	D	N/A	N/A
3	C/D	High	Mod	C/D	C	D
4	C/D	High	High	C/D	N/A	D
5	C	Mod	Mod	C	D	N/A
6	C	High	Low	C	D	B
7	C	High	Low	C	D	B

Quality ecospecs are related to attaining the recommended water quality category of the overall Recommended Ecological category (REC), and are presented as 95th percentiles, i.e. values not to be exceeded more than 5% of the time, for inorganic salts, physical variables and toxics; and 50th percentiles for nutrients, i.e. TIN and SRP (**Table 6.14**). Biotic community composition (invertebrates) should not drop below the indicated values. Percentiles should be calculated within the framework of the current assessment method, i.e. using the PES monitoring point as shown on the table for the relevant EWR site, and the most recent 3 to 5 years of data, equivalent to a minimum of 60 data points. This approach is consistent with that to be used for the design of a monitoring programme for water quality.

Table 6.6: EWR 3: Die Eiland on the Groot Letaba River

River	Groot Letaba River	DWAF Water Quality Monitoring points		
WQSU	4	RC	B8H009Q01 (1976 – 1977)	
EWR Site	3	PES	B8H009Q01 (2000 - 2004)	
Water quality constituents		Present state	Quality ecospecs	Improvements required
Inorganic salts	MgSO4	B	23 mg/L	N/A
	Na2SO4	A	20 mg/L	N/A
	MgCl2	A	15 mg/L	N/A
	CaCl2	A	21 mg/L	N/A
	NaCl	B	191 mg/L	N/A
	CaSO4	A	351 mg/L	N/A
Nutrients	SRP	B (0.019)	0.015 mg/L	N/A
	TIN	A/B - B (0.416)	0.79 mg/L (B category)	N/A
Physical variables	pH (pH units)	A	5thpercentile: 6.5 to 8.0	N/A
	Temperature	Impacts expected due to low flows	Moderate change allowed. Vary by no more than 2°C (Rating of 2, C category).	N/A
	Dissolved oxygen	for 4 months of the year.	Moderate change allowed: 6 – 7 mg/L (Rating of 2, C category)	
	Turbidity (NTU)	High turbidities temporary	Small change allowed – largely natural and related to natural catchment processes such as rainfall runoff (Rating of 1, B category).	N/A
Response variables	Chl-a: periphyton	C – C/D: WQ Site 6: 45.77 WQ Site 7: 31.71	21 mg/m² (C category)	Slight improvement required
	Chl-a: phytoplankton	-	20 µg/L (C category)	No data
	Biotic community composition - macroinvertebrate	D (habitat + flow related)	ASPT: 5 (C category)	Moderate improvement requited
	In-stream toxicity	Evidence of acute and sub-lethal toxicity	In-stream toxicity may occur (Rating of 2, C category)	Improvements required
	Fluoride	A	1500 µg/l (A category)	N/A
	Al	-	20 µg/l (A category)	No information

	Ammonia	-	15 µg/l (A category)	No information

River	Groot Letaba River	DWAF Water Quality Monitoring points		
WQSU	4	RC	B8H009Q01 (1976 – 1977)	
EWR Site	3	PES	B8H009Q01 (2000 - 2004)	
Water quality constituents		Present state	Quality ecospecs	Improvements required
Toxics	As	-	20 µg/l (A category)	No information
	Atrazine	-	19 µg/l (A category)	No information
	Cd soft*	-	0.2 µg/l (A category)	No information
	Cd mod**	-	0.2 µg/l (A category)	No information
	Cd hard***	-	0.3 µg/l (A category)	No information
	Chorine (free)	-	0.4 µg/l (A category)	No information
	Cr(III)	-	24 µg/l (A category)	No information
	Cr(VI)	-	14 µg/l (A category)	No information
	Cu soft*	-	0.5 µg/l (A category)	No information
	Cu mod**	-	1.5 µg/l (A category)	No information
	Cu hard***	-	2.4 µg/l (A category)	No information
	Cyanide	-	4 µg/l (A category)	No information

Unfortunately the quality ecospecs are not translated into concentrations of the individual ions. Nonetheless, the predicted sulphate and chloride concentrations in the dam (**Table 6.6**) are so low, that the requirements of the ecospecs can be easily met. The same is true for the total inorganic nitrogen (TIN) concentration and the pH.

The only variable that remains is the phosphate. The predicted value of .074 mg/l P in the dam exceeds the 0.015 mg/l that is required at Site 3. However, on the basis of the analysis performed as part of this study, the reported concentration of 0.019 mg/l at Site 3 is questioned. It is suspected that the PES is far higher than determined as part of the Reserve study, and consequently that the quality ecospec is not correct. The earlier conclusion with respect to the condition of the dam, namely that the situation will be acceptable, is therefore maintained.

The construction of the dam will therefore not compromise the reserve in terms of quality.

7. RECOMMENDED MITIGATION MEASURES

7.1 WATER QUALITY FROM THE PROPOSED DAM

No water quality problems are expected, and no mitigation is required.

7.2 WATER QUALITY EFFECTS DOWNSTREAM OF THE DAM

Some effects as a result of stratification, namely the release of cold and anaerobic water, can be expected. This can effectively mitigated by the installation of a multiple level outlet structure. It is recommended that the outlets are positioned at 4 meter intervals, starting 6 meters below full supply level.

7.3 IMPACTS DURING CONSTRUCTION

Baseline monitoring

- Water samples for water quality analysis will be taken weekly for the first four weeks before construction is initiated, thereafter, and during construction a sample will be taken once a month. The samples will be analysed for all substances that can be expected to emanate from the construction site and/or the construction activities.

Washing

- No surface run-off of oils, cement, litter, paints etc. which could pollute or alter current water quality are to be deposited into the river system or nearby streams and rivers.
- Any abstraction of water for construction purposes must be approved by DWAF.
- Prevention and mitigation measures must be implemented to ensure water quality is not adversely affected by such abstraction.

Instrumentation

- Water samples must be analysed in a recognised, accredited laboratory.

Data recording

- All water quality and quantity data must be recorded at a central point together with the sampling positions and the dates and times of the sampling.

Reporting

- Water quality and quantity data must be presented in a report, which will include an overview of the state of all water courses, including water quality and hydrological integrity.

Waste discharge

- Water quality results from all waste discharge must comply with and shall be compared to the "GA general limit" and a compliance report prepared.

7.4 IMPACTS DURING FILLING OF THE DAM

The water quality in the dam may be affected by the presence of herbicides and pesticides in the dam basin. The water quality will also be affected by decomposing vegetation once the dam starts to fill. Both these problems can be effectively mitigated by clearing the dam basin of all vegetation and structures, and by prohibiting the use of pesticides and herbicides in the dam basin once construction starts.

The water in the dam must be monitored for DDT and its derivatives, as well as the presence of Lindane, Mercaption, Pirimiphos and Aldicarb on a monthly basis over the first three years of operation.

8. CONSULTATION PROCESS

8.1 PUBLIC PARTICIPATION

Engagement with Interested and Affected Parties (I&APs) forms an integral component of the EIA process. I&APs have an opportunity at various stages throughout the EIA process to gain more knowledge about the proposed project, to provide input into the process and to verify that their issues and concerns have been addressed.

The proposed project was announced in July 2007 to elicit comment from and register I&APs from as broad a spectrum of public as possible. The announcement was done by the following means:

- the distribution of Background Information Documents (BIDs) in four languages,
- placement of site notices in the project area,
- placement of advertisements in regional and local newspapers,
- publishing information on the DWAF web site,
- announcement on local and regional radio stations; and
- hosting five focus group meetings in the project area.

Comments received from stakeholders were captured in the Issues and Response Report (IRR) which formed part of the Draft Scoping Report (DSR). The DRS was made available for public comment in October 2007. A summary of the DSR (translated into four languages) was distributed to all stakeholders and copies of the full report at public places. Two stakeholder meetings were held in October to present and discuss the DSR. The Final Scoping Report was made available to stakeholders in December 2007.

The availability of the Draft Environmental Impact Assessment Report, its summary (translated in four languages), the various specialist studies, the Environmental Management Plans and Programmes will be announced by way of personalized letters to stakeholders and the placement of advertisements in regional and local newspapers. The draft documents will be made available to I&APs for their inputs and comments. Two stakeholder meetings are planned to present the contents of the documents and to discuss the findings of the study.

A public review period of thirty (30 days) will be available for stakeholders to comment on the Draft Environmental Impact Assessment Report, its summary (translated in four languages), the various specialist studies, the Environmental Management Plans and Programmes. Stakeholder comments will be taken into consideration with the preparation of the final documents. The availability of the final documents will be announced prior to submission to the decision-making authority.

9. COMMENTS RECEIVED

The following issues were sourced from the Issue and Response Report (Version 2) as submitted to the Department of Environmental Affairs and Tourism with the Scoping Report.

9.1 ISSUES RELATED TO THE ECOLOGICAL RESERVE AND WATER QUALITY

Issue	Person submitted by	When received	Response
That the ecological reserve is immediately implemented and monitored – pre, during and post development monitoring of the water quality and riverine ecology both up and downstream of the dam.	MK (Mick) Angliss, Limpopo Dept Economic Dev, Env & Tourism. CA (Chantal) Matthys, DWAF: WA&IU (Environment & Recreation).	Written submission (BID comment sheet). Written submission (BID comment sheet).	The Reserve in terms of water quality will not be compromised by the proposed dam. See Section 6.5 of the specialist report.
That all parties recognise from the outset that it is insufficient to state that the "ecological Reserve will be maintained". Clarity must be obtained on why existing ecological reserves of water are not being maintained (e.g. in the Olifant's River system even before construction of the De Hoop Dam, and in the Nyl River system and if this cannot be undertaken then this must be regarded as a fatal flaw.	Luke Perkins, Wildlife and Environment Society of SA (WESSA).	Written submission (BID comment sheet).	The Reserve in terms of water quality will not be compromised by the proposed dam. See Section 6.5 of the specialist report.
That the ecological reserve and downstream users be considered.	Dr TK (Thomas) Gyedu-Ababio	Written submission (BID comment sheet)	The Reserve in terms of water quality will not be compromised by the proposed dam. See Section 6.5 of the specialist report.
That pollution of the water from the squatter area runs into the river through the Tzaneen Dam and it is affecting the quality of the existing water.	Jan de Lang, Greater Tzaneen Chamber of Business.	Attended meeting at Fairview Country Lodge, 31 July 2007, Tzaneen.	The contamination of water in the catchment area was taken into account when determining the quality of the water in the dam. Although not ideal, the water quality will not be affected unduly by the current situation.

10. OTHER INFORMATION REQUESTED BY THE AUTHORITY

No other information was requested by the Authority.

11. CONCLUSION

The water quality situation in the catchment of the proposed new dam is such that no water quality problems are expected to occur. The dam will be able to provide water to a community that is at present reliant on water from boreholes of which some of the water is not fit for human consumption. The requirements of the Reserve in terms of water quality can be met.

The only possible effect, in terms of water quality, is the release of cold and anaerobic bottom water during periods when the dam becomes stratified. This can effectively be mitigated by the installation and correct operation of multiple level outlets.

There is some risk of contamination from construction material and waste discharge during construction. This can be mitigated by the implementation of proper construction methods and effective waste management.

There is some risk of contamination by herbicides and pesticides during the filling of the dam, as well as anoxic conditions due to the decomposing of organic material. This can effectively be mitigated by clearing the dam basin and preventing the use of herbicides and pesticides once the construction of the dam starts.

In terms of water quality there is therefore no significant effect on the environment from either the construction of the proposed new dam, or the raising of the Tzaneen Dam wall.

12. REFERENCES

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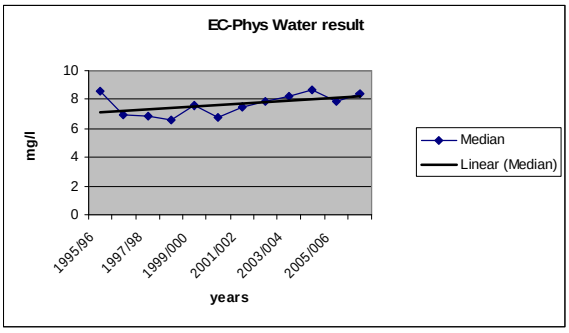
Appendix A: Graphs

- **Time series: 2003 – 2005**
- **Annual Median Concentration vs Time (Yearly)**

B8H051 Tzaneen Dam on Great Letaba River Left canal



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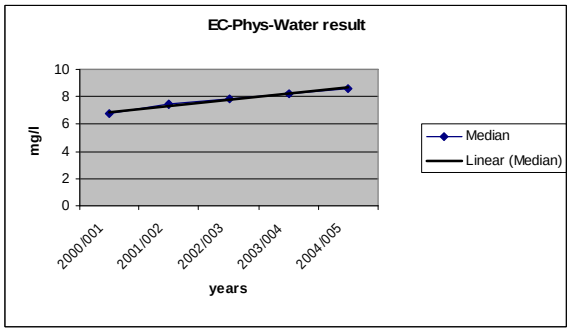

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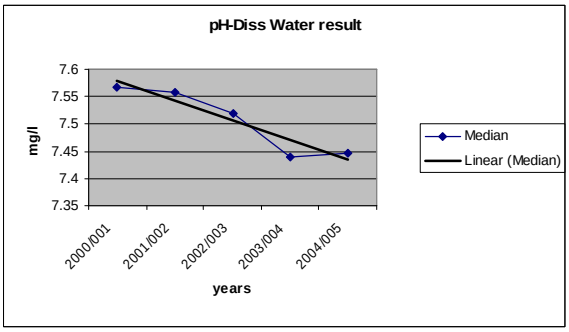

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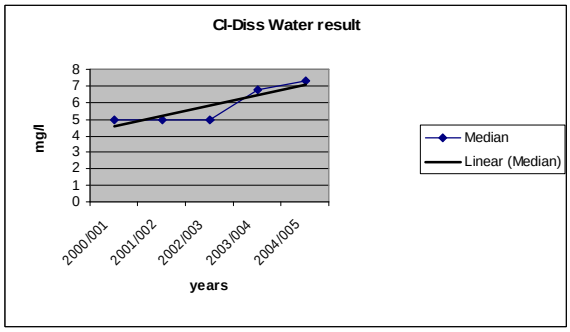
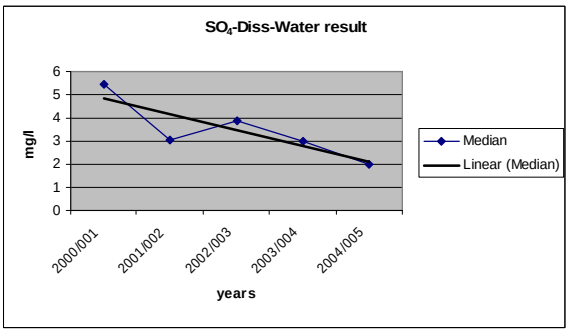


Cl 2000 – 2005



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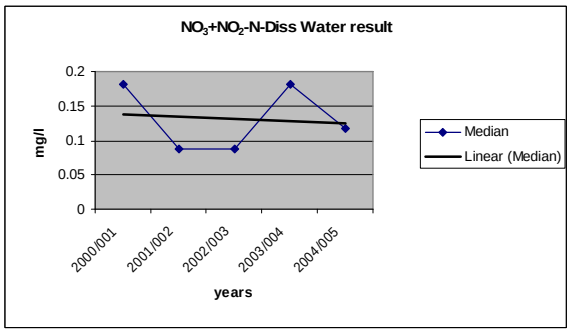

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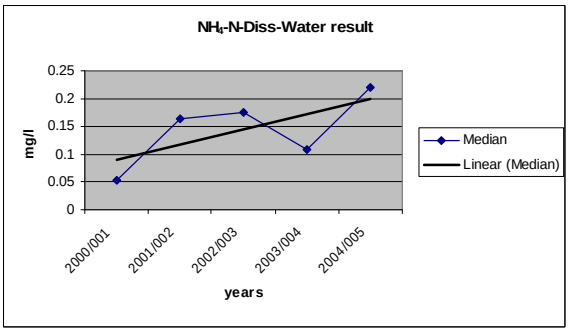

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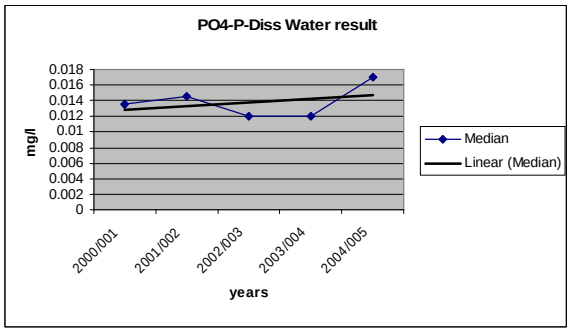
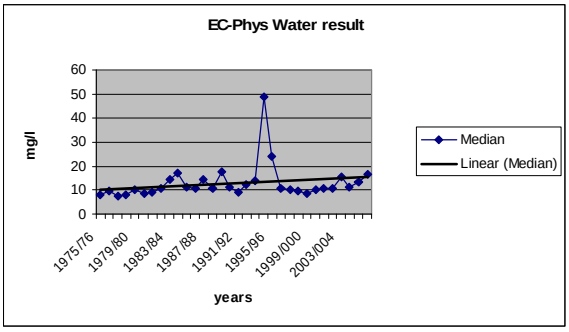
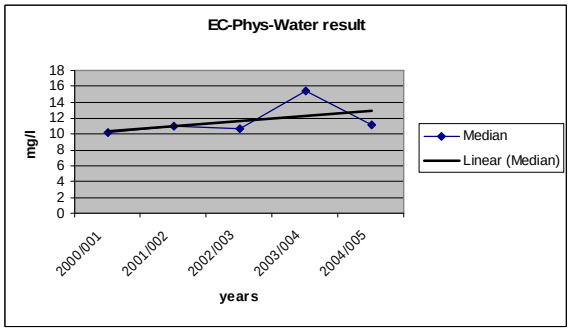


PO_4 2000 – 2005

B8H009 @ Letaba on Groot Letaba



Long Term EC



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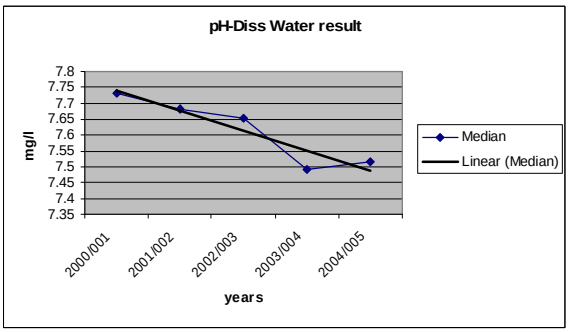

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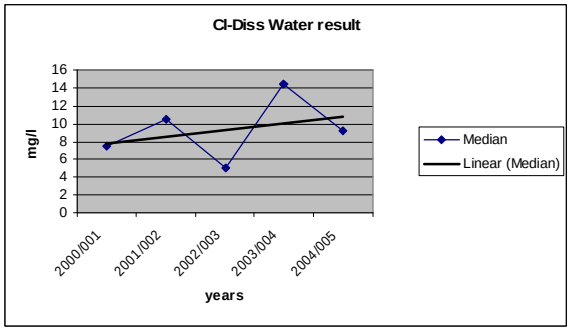

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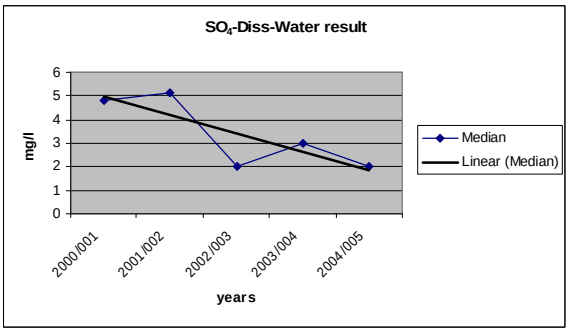

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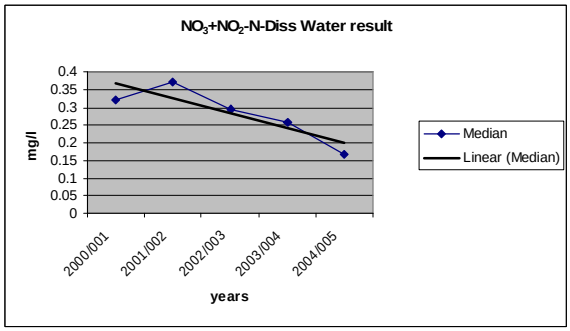

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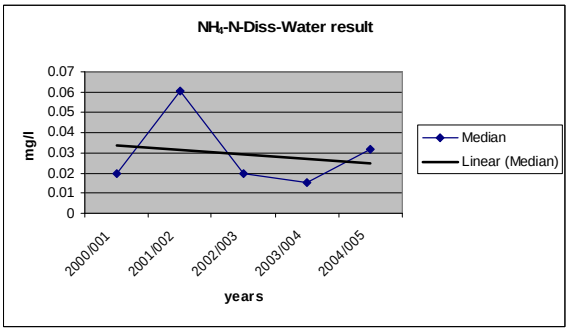

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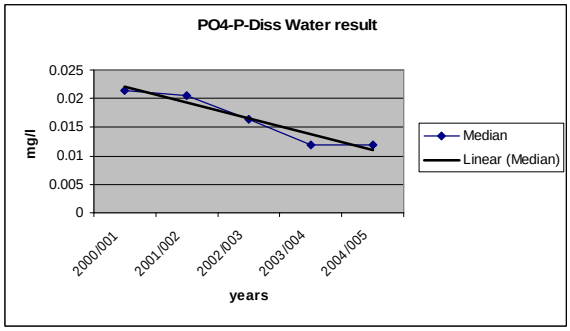

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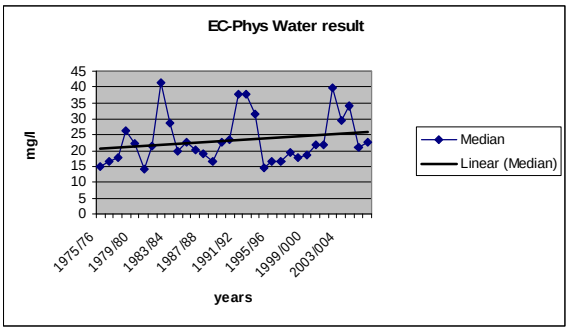
B8H010 Letsitele River @ Mohlaba's Reserve



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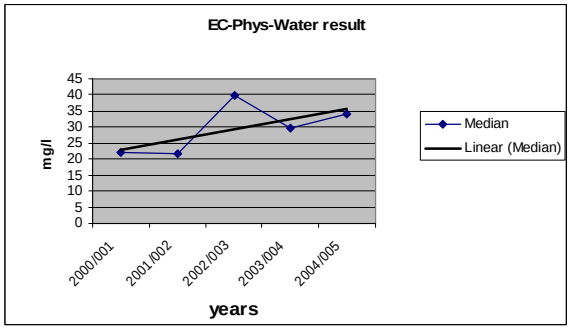

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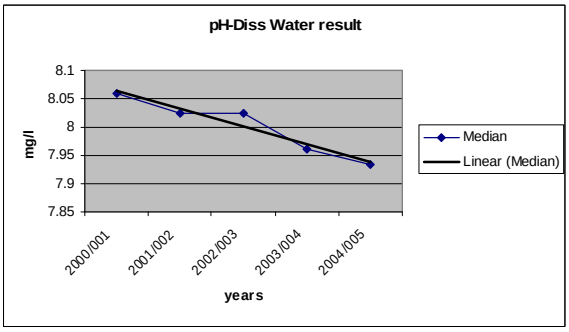

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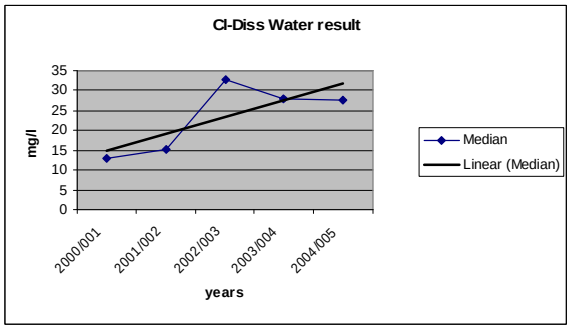

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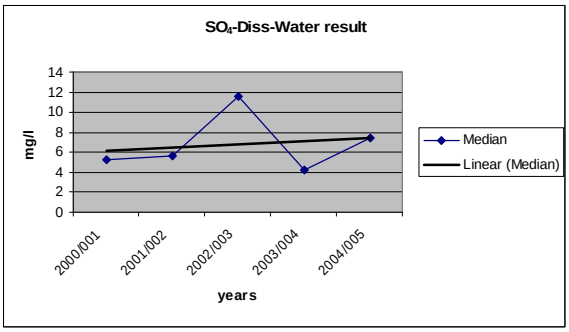

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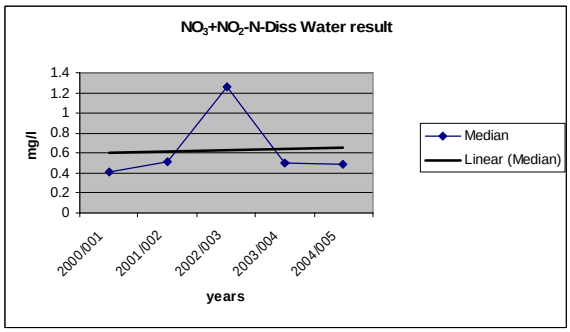

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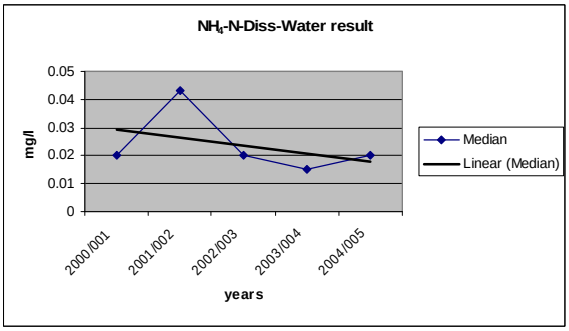

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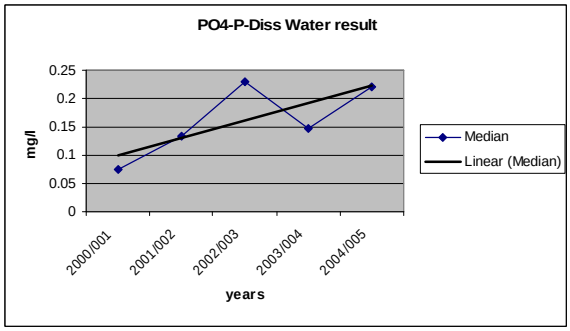

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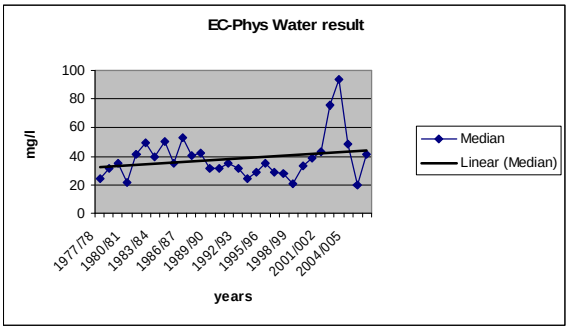
B8H008 @ Letaba Ranch on Groot Letaba



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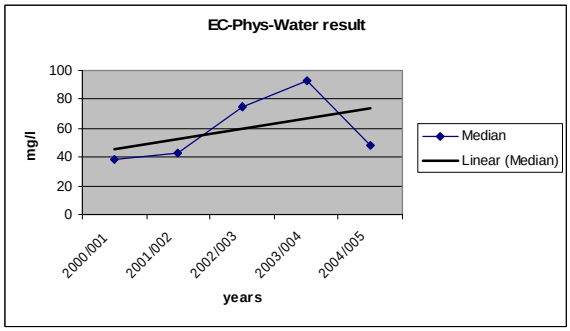

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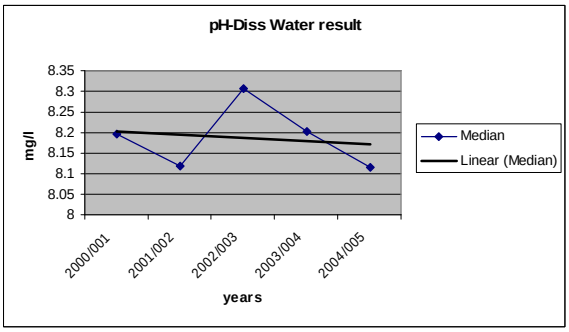

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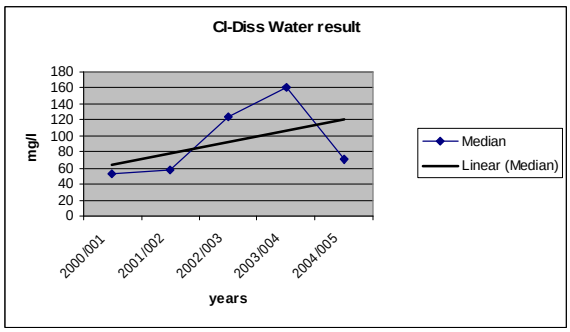

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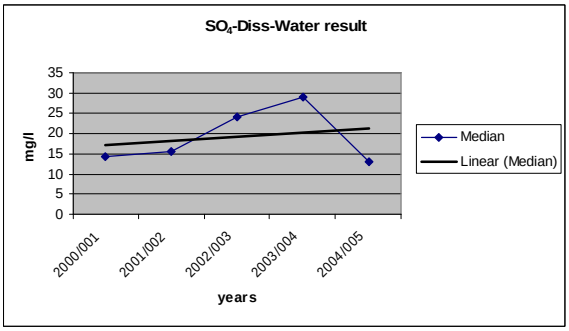

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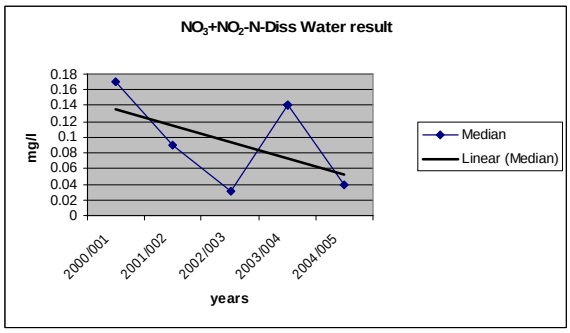

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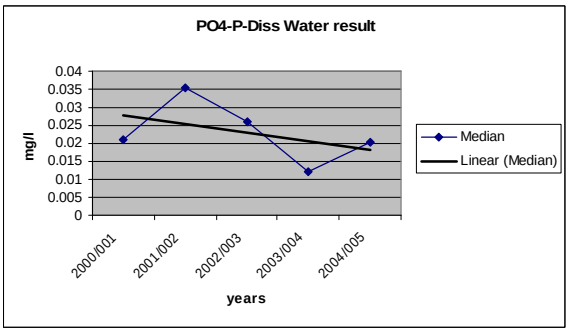

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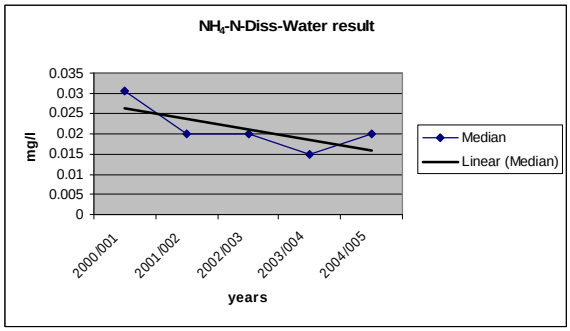
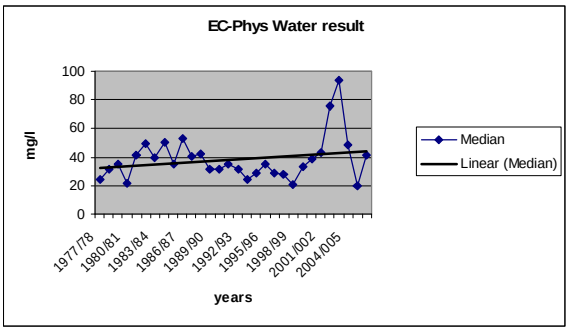


NH_4 2000 - 2005

B8H028 Great Letaba @ Mahlangene/Kruger Nat Park



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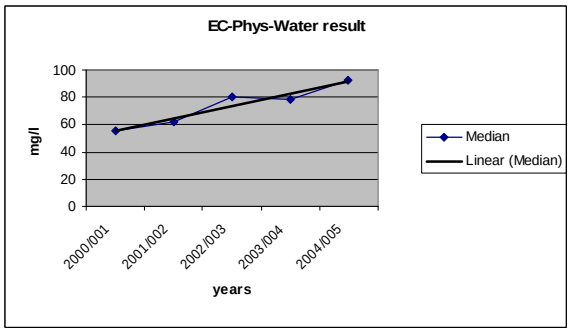

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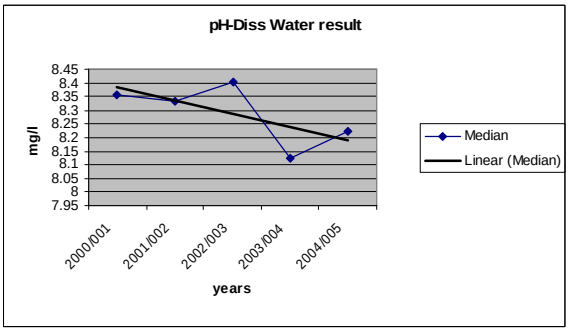

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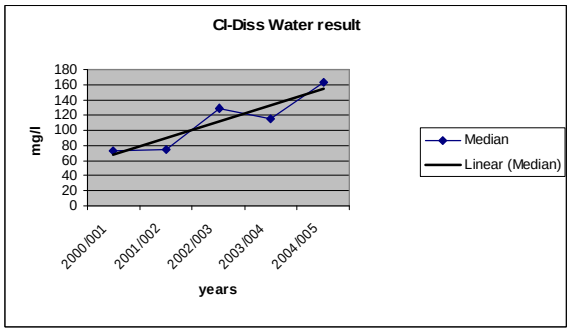

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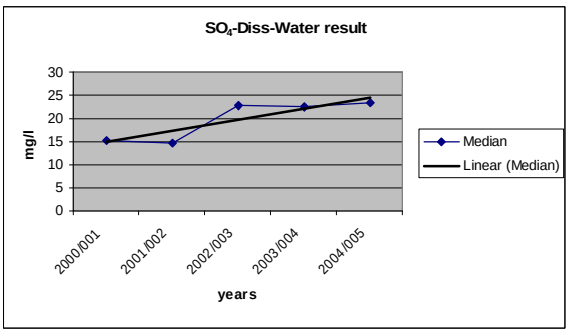

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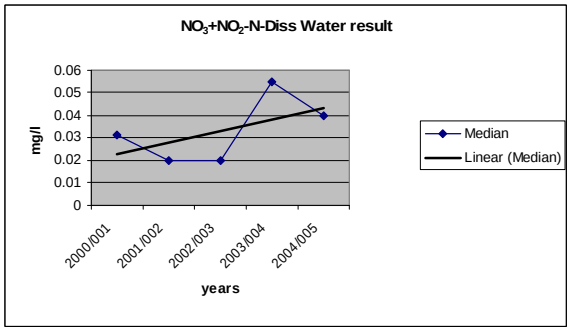

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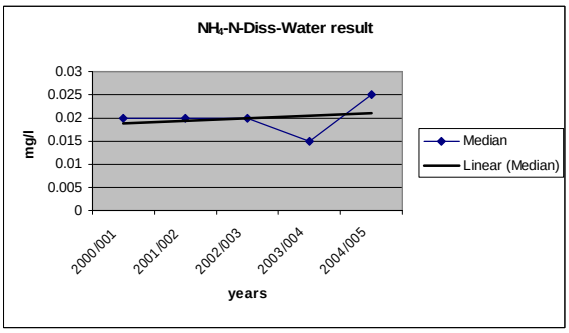

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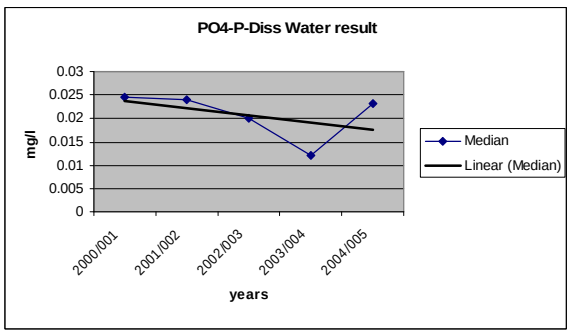

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water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT (GLeWaP)

Environmental Impact Assessment

(DEAT Ref No 12/12/20/978)

ANNEXURE B: TERRESTRIAL ECOLOGY SPECIALIST STUDY

JULY 2008

Compiled by:

ECOREX Consulting Ecologists
PO Box 57
White River
1240

ECOREX

DECLARATION OF CONSULTANTS' INDEPENDENCE

Graham Deall, Warren McCleland, Peter Hawkes and Anthony Emery, as specialists operating under ECOREX Consulting Ecologists, are independent consultants to ILISO Consulting (Pty) Ltd (for the Department of Water Affairs and Forestry), i.e. they have no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of these specialists performing such work.

REPORT DETAILS PAGE

Project name:	***Groot Letaba River Water Development Project***
Report Title:	***Environmental Impact Assessment Appendix B: Terrestrial Ecology Specialist study***
Authors:	***Graham Deall, Warren McCleland & Peter Hawkes***
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SPECIALIST
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EXECUTIVE SUMMARY

A desktop terrestrial ecology study of part of the Groot Letaba Catchment area was completed in August 2007. The objective of that study was to inform the Scoping Assessment being undertaken in support of an application by DWAF for a proposed new storage dam (Nwamitwa Dam), just below the confluence of the Groot Letaba and Nwanedzi Rivers, as well as Bulk water supply infrastructure from the dam to communities to the north. That study recommended further site-specific ecological field studies, in order to make a more objective assessment of conservation importance of various untransformed vegetation communities.

Field visits were conducted from November 2007 to January 2008, focussing on the area likely to be impacted by the Nwamitwa Dam and bulk storage scheme. Two national vegetation types are represented within this area, namely Granite Lowveld and Tsende Mopaneveld. At a finer scale, three vegetation communities were identified and described: Acacia – Combretum Riparian Woodland, Colophospermum – Dichrostachys Plains Woodland and Combretum – Bridelia Rocky Outcrop Woodland. Fifteen conservation-important plant species were found during fieldwork, of which two have a status of Least Concern (Declining) and the rest are protected under provincial or national legislation. A floristic importance assessment of the three vegetation communities revealed that Plains Woodland and Rocky Outcrop Woodland have Medium-High importance for plants, while Riparian Woodland has Low-Medium importance. Thirty-one plant species were pointed out by local traditional healers as being used by the local communities. Most of these are widespread and common species in the area, although three are protected under the National Forest Act.

Only three conservation-important mammals were recorded during fieldwork, two of which are protected under the Limpopo Environmental Management Act, and one which has a Red Data status of Data Deficient. Two of the 186 bird species recorded in the field have Red Data status of Near Threatened. Fourteen reptiles were recorded, including one Vulnerable species and one Limpopo Province endemic lizard. Fourteen frog species were recorded, although only one has any conservation importance. Thirteen conservation-important invertebrates were recorded in the dam basin and along the bulk supply route. The most significant of these was Dromica oberprieleri, which was only discovered in 1981 and is currently known from very few sites in the Lowveld.

The flora and fauna values of each vegetation community were integrated to provide intrinsic biodiversity values for each community. The vegetation community with the highest intrinsic biodiversity value is Colophospermum – Dichrostachys Plains Woodland, which has High-Medium importance for terrestrial biota, followed by Combretum – Bridelia Rocky Outcrop Woodland (Medium-High) and Acacia – Combretum Riparian Woodland (Medium-Low).

Potential impacts are summarised as follows:

Proposed Impact	***Nwamitwa Dam***	***Tzaneen Dam***
A.Flora		
Transformation and fragmentation of habitat for plants	*Medium*	*Low*
Increased harvesting pressure on vegetation	*Medium*	*Low*
Increased invasion by alien plants	*Medium*	*Not applicable*
Impoverishment of populations of important plants	*Medium*	*Low*
Dam acts as a barrier to seed dispersal	*Medium-Low*	*Not applicable*
Disruption of natural fire regime across river	*Low*	*Not applicable*
Increased soil erosion	*Medium*	*Not applicable*
B.Vertebrate Fauna		
Transformation and fragmentation of habitat for animals	*Medium*	*Low*
Increased poaching of animals	*Medium*	*Low*
Impoverishment of populations of important animals	*Medium*	*Low*
Dam acts as a barrier to terrestrial fauna movement along riparian corridor	*Medium*	*Not applicable*
C.Invertebrate Fauna		
Transformation and fragmentation of habitat for protected invertebrates	*High*	*Low*
Death of populations or individuals of protected invertebrate species	*High*	*Low*

Suggested measures to mitigate impacts are as follows:

Impact	***Proposed Mitigation Measures***
A.Flora	
Transformation and fragmentation of habitat for plants	*All pipeline routes through untransformed vegetation should be regarded as least favourable options; routes should whenever possible traverse transformed habitats.*
	Establish a holding nursery for local plants suitable for re-planting on rehabilitated surfaces after closure (construction camp, borrow pits).
	Rehabilitate borrow pits and construction camp according to DWAF's Integrated Environmental Management Series No.6: Environmental Best Practice Specifications (Construction).
Increased harvesting pressure on vegetation	*Construction teams should not be allowed access to areas of untransformed vegetation for collection of firewood, etc; construction camps and work sites should be fenced off. Penalties should be levied on any construction teams that transgress.*
	Allow local communities access to plant resources below full supply level, but not before plant rescue has been completed.
	All pipeline routes through untransformed vegetation should be regarded as last resorts; routes should whenever possible traverse transformed habitats.

Increased invasion by alien plants	*Once dam construction is completed, control measures targeting alien plants within the construction areas and surrounding disturbed sites should be implemented, preferably using Working for Water teams.*
	Conduct annual monitoring of dam surface for invasion by exotic aquatic plants. Any detection of target species to be followed up by rapid remedial action.
	Rehabilitate disturbed sites through ripping of soil surface and hydroseeding with a seed mix slurry of relevant indigenous grasses.
Impoverishment of populations of important plants	*A major plant rescue operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species where possible; scientific institutions should also be invited to collect live specimens.*
	Establish a holding nursery for local plants suitable for re-planting on rehabilitated surfaces after closure (construction camp, borrow pits).
	All pipeline routes through untransformed vegetation should be regarded as least favourable options; routes should whenever possible traverse transformed habitats.
Dam acts as a barrier to seed dispersal	*No suitable mitigation.*

Increased soil erosion	*Topsoil from the construction camp and borrow pits should be stored for post-construction rehabilitation work and should not be disturbed more than is absolutely necessary.*
	Topsoil should also be stored in such a way that does not compromise its plant-support capacity.
	Protect topsoil in order to avoid erosion loss on steep slopes (notably on drainage crossings).
	Protect topsoil from contamination by aggregate, cement, concrete, fuels, litter, oils, domestic and industrial waste.
	Construct adequate erosion-control measures at stream crossings below dam wall (eg. gabions).
	If sand is needed for dam wall construction, then this must be acquired from within the dam basin, or if upstream or downstream of the proposed full-supply level then from transformed areas.
B.Vertebrate Fauna	
Transformation and fragmentation of habitat for animals	*A major trapping and relocation operation should be implemented within the dam basin, targeting the rescue and translocation of threatened, endemic and protected species where possible, particularly small mammals and reptiles; scientific institutions should be invited to collect live specimens.*
	All pipeline routes through untransformed vegetation should be regarded as least favourable options; routes should whenever possible traverse transformed habitats.

Increased poaching of animals	*Construction teams should not be allowed access to areas of untransformed vegetation where opportunities for poaching may be present; construction camps and work sites should be fenced off. Penalties should be levied on any construction teams that transgress and poachers should be prosecuted under relevant provincial legislation.*
Impoverishment of populations of important animals	*A major trapping and relocation operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species where possible, particularly small mammals and reptiles; scientific institutions should be invited to collect live specimens.*
	All pipeline routes through untransformed vegetation should be regarded as least favourable options; routes should whenever possible traverse transformed habitats.
	Dense vegetation should be allowed to re-grow along parts of the dam shoreline in order to regain habitat for certain Red Data bird species, viz. African Finfoot and White-backed Night Heron.
Dam acts as a barrier to terrestrial fauna movement along riparian corridor	*Dense vegetation should be allowed to re-grow along most of the dam shoreline in order to regain a functional riparian corridor.*
C.Invertebrate Fauna	
Transformation and fragmentation of habitat for protected invertebrates	*Consider an alternative design incorporating a lower dam wall; this would reduce area to be flooded, leaving more untransformed habitat and enhancing survival of remaining populations.*

Death of populations or individuals of protected invertebrate species	*Initial flooding of habitat to be done as slowly as possible and to be carried out during active season of adult stage of tiger beetes (Oct-Jan) to allow them to escape drowning; larvae will not be able to escape.*
	Consider an alternative design incorporating a lower dam wall; this would reduce area to be flooded, leaving more untransformed habitat and enhancing survival of remaining populations.
	Where pipeline routes and reservoir sites have alternative routes / sites over rocky outcrops, these alternatives should be avoided wherever possible.

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ANNEXURES

ABBREVIATIONS

DWAF	Department of Water Affairs and Forestry
GLeWaP	Groot Letaba River Water Development Project
LEMA	Limpopo Environmental Management Act (No.7 of 2003)
NEMBA	National Environmental Management: Biodiversity Act (No.10 of 2004)
NFA	National Forests Act (No.38 of 1998)
SACNASP	South African Council of Natural Scientific Professions

1. STUDY INTRODUCTION

1.1 BACKGROUND TO PROJECT

The Department of Water Affairs and Forestry (DWAF) is currently undertaking an Environmental Impact Assessment (EIA) to investigate the environmental feasibility of raising the Tzaneen Dam, the construction of a storage dam in the Groot Letaba River and associated bulk water infrastructure (water treatment, pipelines, pump stations, off-takes and reservoirs) in the Limpopo province. The EIA is being undertaken by ILISO Consulting with Zitholele Consulting providing the public participation support. The EIA is being undertaken according to the EIA Regulations under Section 24 (5) of the National Environmental Management Act (NEMA), (Act No 107 of 1998) as amended in Government Notice R385, 386, 387 – Government Gazette No. 28753 of 21 April 2006.

ILISO Consulting has appointed ECOREX Consulting Ecologists CC to undertake the Terrestrial Ecology Impact Assessment as part of the EIA.

1.2 STRUCTURE OF THIS REPORT

This specialist study will be undertaken in compliance with regulation 33(2) of GN 385. **Table 1.1** indicates how Regulation 33 of GN385 has been fulfilled in this report.

Table 1.1: Indication of compliance with Regulation 33 in this report

Regulatory Requirements	Section of Report
(a) The person who prepared the report; and the expertise of that person to carry out the specialist study or specialised process.	Chapter 2
(b) a declaration that the person is independent	Page i
(c) an indication of the scope of, and the purpose for which, the report was prepared	Chapter 3
(d) a description of the methodology adopted in preparing the report or carrying out the specialised process	Chapter 4
(e) a description of any assumptions made and any uncertainties or gaps in knowledge	Chapter 5

(f) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Chapters 6 & 7
(g) recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority	Chapter 8
(h) a description of any consultation process that was undertaken during the course of carrying out the study	Chapter 9
(i) a summary and copies of any comments that were received during any consultation process	Chapter 10
(j) any other information requested by the competent authority.	Chapter 11

2. PROJECT TEAM

Graham Deall of ECOREX Consulting Ecologists CC will undertake the Terrestrial Ecology Impact Assessment. He has a Masters degree in Botany, focussing on Vegetation Ecology. He specialises in Terrestrial Ecology Impact Assessments. He has completed Terrestrial Ecology Impact Assessments for developments such as dams, pipelines, townships, rail lines, and mines. He is a member of the South African Council of Natural Scientific Professions (SACNASP). Graham will be assisted by Warren McCleland, Peter Hawkes and Anthony Emery.

Warren McCleland has a diploma in Nature Conservation and is currently engaged in a BSc.Hons. (Biodiversity & Conservation Biology) through the University of the North-West (Potchefstroom Campus). He is a field ecologist specialising in flora and vertebrate fauna. Warren is co-author of "Field Guide to Trees of Mpumalanga & Kruger National Park". He was recently tasked by the Mpumalanga Parks Board to set the conservation targets for threatened bird species for the Mpumalanga Biodiversity Conservation Plan. Dr. Rob Palmer Pr.Sci.Nat. (Zoological Scientist) will review Warren's faunal input, and Graham Deall Pr.Sci.Nat (Botanical Scientist) will review his floral input.

Peter Hawkes is a professional entomologist with a B.Sc (Hons) degree. He is Director of his own company, AfriBugs CC. He specialises in Environmental Impact Assessment, Environmental Monitoring, and Insect Biodiversity Assessment. He is a member of the South African Council of Natural Scientific Professions (SACNASP), the SA Chapter of International Association for Impact Assessment (IAIA-sa), the Entomological Society of Southern Africa, and the Botanical Society of South Africa.

Anthony Emery is a professional conservation biologist with an M.Sc degree. He is a director of his own company, Emross Consulting (Pty) Ltd. He specialises in GIS mapping and wetland delineation. He a member of the South African Council of Natural Scientific Professions (SACNASP) and GISSA – Mpumalanga.

3. PURPOSE OF REPORT AND SCOPE OF WORK

The Terms of Reference are based on the terrestrial-ecology issues and potential impacts identified in the Scoping Phase of the EIA (ILISO, 2007).

3.1 BASELINE SURVEYS

Site-specific[1] ecological field surveys were undertaken from November 2007 to January 2008 before development commences. Thus all of the conservation-important plant and animal species potentially present in the project area were screened, making assessment of ecological sensitivity at farm scale more objective. Crucial aspects to be included in field surveys are outlined for each biotic group as follows:

Plants

The nine most significantly threatened Red Data plant species potentially present in the project area were carefully searched for during field surveys, viz. *Aloe monotropa, Borassus aethiopica, Encephalartos transvenosus, Ensete ventricosum, Melinis tenuissima, Mondia whitei, Oberonia disticha, Siphonochilus aethiopicus, Xylopia parviflora*. In addition, a checklist of confirmed species per vegetation type was compiled, with Threatened, Endemic, Utility[2], and Protected species highlighted. Threatened species were based on the South African Biodiversity Institute's (2007) interim Red Data list. Protected species were based on the schedules contained in the Limpopo Environmental Management Act (No. 7 of 2003) or the National Forests Act (Act 84 of 1998). Endemic species were defined as those whose distribution in South Africa is confined to Limpopo Province or to recognised centres of endemism that occur partially in Limpopo Province (e.g. the Wolkberg Centre). Utility species were those indicated by local herbalists.

Mammals

[1] Only untransformed designated development areas will be surveyed
[2] Those plant species utilised by local communities

Attempts to confirm the presence of Red Data mammals potentially present in untransformed areas of proposed development were made. The following strategy was adopted:

- Rocky outcrops were searched for bat roosts, elephant shrews.
- Nocturnal surveys were conducted to search for hedgehogs, rodents, shrews.
- Drift fence / pitfall traps used in the reptile surveys were checked for small mammals as well.
- Walk-in traps (e.g. Sherman traps) were laid in transects through representative habitats.

Birds

Attempts to confirm the presence of threatened Red Data birds potentially present in untransformed areas of proposed development were made. The following strategy was adopted:

- Early morning searches were conducted along the perennial rivers in order to search for numerous threatened water-associated species.
- As many large trees as possible were searched for bird of prey nests, particularly along the rivers and in mature woodland.
- Representative transects were walked through all relevant habitats and all bird species heard and seen will be recorded.

Reptiles and Amphibians

Attempts to confirm the presence of Red Data, endemic and protected reptiles and amphibians potentially present in untransformed areas of proposed development were made. The following strategy was adopted:

- A proportional number of drift fences combined with pit-fall traps were constructed in each major vegetation type.
- Nocturnal searches between November and January (calling season of *Pyxicephalus adspersus*) were conducted.
- Likely reptile habitat, such as large rock slabs, was surveyed during the day for resting reptiles.

Invertebrates

The invertebrate survey was designed to confirm the presence/absence of rare and/or protected invertebrate species within the untransformed areas of the proposed development. Field surveys for invertebrates included:

- night-time searches with ultraviolet light for the protected scorpions, especially the three predicted *Hadogenes* species, as presence/absence of *Hadogenes* can only be reliably ascertained by using this technique. Daytime searches for these and all other protected scorpion species were also carried out.
- A combination of pitfall trapping and day-time searches was used to confirm presence/absence of the protected beetle and spider species; surveys were carried out during the wet summer months (November-Jan).
- Baseline assessments of selected indicator taxa (e.g. *Dromica* spp.) were undertaken in case an invertebrate biodiversity-monitoring programme is required in the EMP.

3.2 IMPACT ASSESSMENT REPORTING AND MAPPING

All information collected during fieldwork was integrated with the desktop baseline information and collated in report format with updated ecological sensitivity maps and species checklists. Proposed infrastructure was overlaid on the maps to facilitate the identification and assessment of impacts. Mitigation measures for identified impacts were recommended.

4. METHODOLOGY

The key issues identified during the Scoping Phase informed the terms of references of the specialist studies. Each issue consists of components that on their own or in combination with each other give rise to potential impacts, either positive or negative and from the project onto the environment or from the environment onto the project.In the EIA the significance of the potential impacts were considered before and after identified mitigation is implemented.

A description of the nature of the impact, any specific legal requirements and the stage (construction/decommissioning or operation) is given. Impacts are considered to be the same during construction and decommissioning.

The following criteria are used to evaluate significance:

Nature
The nature of the impact is classified as positive or negative, and direct or indirect.

Extent and location
The magnitude of the impact in terms of its spatial influence is classified as:

- **Local**: the impacted area is only at the site – the actual extent of the activity
- **Regional**: the impacted area extends to the surrounding, the immediate and the neighbouring properties.
- **National**: the impact can be considered to be of national importance.

Duration
This measures the lifetime of the impact, and is classified as:

- **Short term**: the impact will be for 0 – 3 years, or only last for the period of construction.
- **Medium term**: three to ten years.

- **Long term**: longer than 10 years or the impact will continue for the entire operational lifetime of the project.
- **Permanent**: this applies to the impact that will remain after the operational lifetime of the project.

Intensity

This is the degree to which the project affects or changes the environment, and is classified as:

- **Low**: the change is slight and often not noticeable, and the natural functioning of the environment is not affected.
- **Medium**: The environment is remarkably altered, but still functions in a modified way.
- **High**: Functioning of the affected environment is disturbed and can cease.

Probability

This is the likelihood or the chances that the impact will occur, and is classified as:

- **Low**: during the normal operation of the project, no impacts are expected.
- **Medium**: the impact is likely to occur if extra care is not taken to mitigate them.
- **High**: the environment will be affected irrespectively; in some cases such impact can be reduced.

Confidence

This is based on the level of knowledge/information, the environmental impact practitioner or a specialist had in his/her judgement, and is rated as:

- **Low**: the judgement is based on intuition and not on knowledge or information.
- **Medium**: common sense and general knowledge informs the decision.

- **High**: Scientific and or proven information has been used to give such a judgement.

Significance

Based on the above criteria the significance of issues will be determined. This is the importance of the impact in terms of physical extent and time scale, and is rated as:

- **Low**: the impacts are less important, but may require some mitigation action.
- **Medium**: the impacts are important and require attention; mitigation is required to reduce the negative impacts
- **High**: the impacts are of great importance. Mitigation is therefore crucial.

Cumulative Impacts

The possible cumulative impacts will also be considered.

Mitigation

Mitigation for significant issues will be incorporated into the EMP for construction.

5. ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

5.1 FLORA

- Sampling was restricted to areas of untransformed vegetation where the likelihood of finding conservation-important plants was highest. However, the vast area covered by the bulk supply routes together with difficulties in accessing some of these areas within the given time frames meant that surveys were not exhaustive, but limited to sampling of selected areas. Nevertheless, since much of the vegetation is homogenous in species composition, the sampling is believed to have been representative. However, it is possible that certain inconspicuous conservation-important plant species may have been overlooked.
- Road re-alignments were not adequately surveyed due to late addition of these features to the project layout when fieldwork had already been planned. Nevertheless surveys of the Nwamitwa Dam basin area are considered to be adequately representative of the road re-alignment areas.
- No field surveys took place around the Tzaneen Dam shoreline. Impact assessment is therefore based on detailed study of high resolution aerial photographs supplied by Iliso. Such a study shows most of the shoreline to be transformed and/or degraded, and no habitat representative of Tzaneen Sour Bushveld appears to be present. Field surveys are not likely to add value to the assessment.

5.2 VERTEBRATE FAUNA

- No significant rainfall took place during mid-summer fieldwork, possibly affecting vocalisation of some frog species.
- Only three pitfall traps (with approximately 60 metres of drift fencing) and 25 Willan traps were set out Time restrictions did not allow for more extensive trapping, so most time was spent on active searches.

5.3 INVERTEBRATE FAUNA

- The huge and largely undocumented diversity of invertebrates means that any assessment of this group must be based on a small subset of the total community, determined largely by the current level of knowledge of taxonomy, abundance and distribution within the various taxa. Thus while an informed assessment of the

conservation-important impacts of the proposed development on the key taxa investigated may be achievable, it must be borne in mind that for other invertebrate taxa a different conclusion might have been reached if sufficient information for an assessment was available. The extrapolation of sensitivity assessments on a subgroup on invertebrate taxa to the invertebrate community as a whole may therefore not be entirely appropriate, but is the best that can currently be achieved given the constraints of time and available information.

- The very dispersed nature of the GLeWaP study area, difficulties in accessing some of the sites, exacerbated by the late addition of several road, pipeline and reservoir options after the survey had already been planned, resulted in our having to sub-sample some of the pipeline sections (surveying in detail e.g. only 1km of a 4km untransformed section). Assessment of some pipeline options and the road alignments which were not specifically surveyed in detail had to be done entirely on the basis of assuming that sensitivity will be similar to that of similar habitats that we did survey thoroughly survey. Thus while all 10 reservoir site options were visited and surveyed, some minor sections of untransformed pipeline routes as well as the road alignments were not covered.
- Time of day proved to be a significant factor influencing activity of most of the *Dromica* species (which are probably the most significant group in terms of sensitivity in the project area), and sampling was most effective during the late afternoon (4-6pm). To sample at this time of day in each reservoir and untransformed pipeline section and the road alignment routes, as well as several areas within the proposed impoundment, would have meant spending approximately 40-50 days in the field, which was not feasible in terms of available time & budget. So while we attempted to cover what we felt were the most important areas at this time of day, this was not always possible and many areas surveyed earlier in the day may end up being incorrectly assessed as of somewhat lower sensitivity than they should be. The design of any monitoring programme to be instituted must take this into account to ensure that successive active sampling events are carried out at the same time of day, as pitfall trapping (which is carried out over a long period and thus not influenced by daily activity patterns) did not prove very effective for sampling *Dromica* species.
- Despite these limitations, we feel that the samples and data obtained were sufficient to enable prediction of the significance of the potential impacts of the project with sufficient confidence for the purposes of this study.

6. EXISTING ENVIRONMENT

6.1 DESKTOP STUDY (SUMMARY OF SCOPING REPORT, ILISO 2007)

The project area covers two different vegetation types with a wide range in ecosystem status (**Table 6.1**).

Table 6.1: Vegetation Types of the Project Area

Vegetation Type	Ecosystem Status	Untransformed Vegetation to be Impacted	Transformed Areas to be Impacted	Proportion of National land cover of vegetation type
Granite Lowveld	Vulnerable	1 291 ha	2 118 ha	0.17%
Tsende Mopaneveld	Least Threatened	765 ha	1 166 ha	0.31%

The main factors of disturbance in the project area are human settlements, agriculture and forestry. Nearly 60 % of the project area is transformed or degraded by such developments. Table 6.1 indicates the significance of the proposed Nwamitwa Dam and associated infrastructure in terms of loss of untransformed areas of Granite Lowveld and Tsende Mopaneveld.

Applying the precautionary principle, a total of 91 species of Red Data flora and vertebrate fauna could potentially occur in the project area (18 plant, 36 mammal, 34 bird, 3 reptile & amphibian). Moreover, at least 21 species could be endemic or near-endemic (locally or regionally), and 115 are likely to be protected.

Vegetation types were ranked and assigned importance ratings ranging from Low to Very High. Areas designated of high conservation importance for a particular biotic group were considered 'sensitive' to development because of the potential impacts of such development on that particular group. **Table 6.2** summarizes the levels of conservation importance of each vegetation type in terms of the conservation-important biota potentially represented there. It also attempts to rank the vegetation types on the basis of their 'intrinsic biodiversity' reflected in the integration of all the component importance values. Thus some idea of intrinsic biodiversity value or 'ecological sensitivity' is realized.

Table 6.2: Conservation-importance values and Intrinsic Biodiversity values per vegetation type

Biota	Granite Lowveld	Tsende Mopaneveld
Plants	High	High
Mammals	High	High
Birds	High	High
Reptiles & Amphibians	Med	Med
Invertebrates	Very High	Very High
RANK	**1**	**1**
Intrinsic Biodiversity Value	High	High

Vegetation types with the highest percentage area intact, with the highest biodiversity values, and that are the most threatened are those that are likely to present the greatest constraints to development. Conversely, those with the lowest percentage area intact, with the lowest biodiversity values, and that are the least threatened are those that are likely to present the greatest opportunities for development.

On this basis, it is apparent from **Table 6.3** that both Granite Lowveld and Tsende Mopaneveld have High biodiversity values and are significantly threatened. Untransformed areas where these vegetation types are represented would therefore be potentially 'sensitive' to development.

Table 6.3: Vegetation Types most susceptible to development impacts

Vegetation Type	Ecosystem Status	Protection Status	Intrinsic Biodiversity Value
Granite Lowveld	Vulnerable	Moderately Protected	HIGH
Tsende Mopaneveld	Least Threatened	Well Protected	HIGH

Therefore, site-specific ecological field surveys and impact assessments were recommended before development commences. It was recommended that on site surveys of flora and fauna be undertaken in summer from October to February. Thus it would be possible to screen all of the conservation-important plant and animal species potentially present in the project area, making assessment of ecological sensitivity at farm scale more objective. In this way potential impacts of the proposed development would be more clearly identified, and mitigation measures to reduce impacts could be more accurately defined.

6.2 FIELD SURVEYS AND BASELINE ASSESSMENT

6.2.1 Flora

a) Methodology

Preliminary vegetation communities were mapped and potential Red Data species identified during the Scoping Phase of the GLeWAP project (Iliso, 2007). The boundary line between Granite Lowveld and Tsende Mopaneveld appeared to be very arbitrary and much of the area is transitional between the two vegetation types. Thus, all untransformed vegetation was ordered into three broad units or communities based on major physiographical zones and dominant species in each zone. Several meandering transects were placed within the proposed Nwamitwa Dam basin area and within proposed borrow pit areas and reservoir sites. Transects were also walked along proposed pipeline routes through untransformed areas. Plant species were listed per vegetation community and the following abundance classes were assigned to each plant species based on estimated canopy cover (after Kent & Coker, 1992):

Value	Braun-Blanquet cover
+	< 1%
1	1 – 5%
2	6 – 25%
3	26 – 50 %
4	51 – 75%
5	76 – 100%

Potential conservation-important plant species listed in Iliso (2007) were targeted in each transect. The floristic importance assessment of each vegetation community was based on an Associated Flora Index (AFI), after Deall (2003), modified to recognise higher values for the threat categories of Vulnerable, Endangered and Critically Endangered (**Table 6.4**). This index is derived from the summation of the species-status scores of constituent species. Such scores are assigned to plant species of conservation importance and are weighted in relation to local abundance and levels of importance. The latter are based on criteria such as protection status, endemic status, and Red Data status in terms of the Limpopo Environmental Management Act (No.7 of 2003), the National Forests Act (No. 84 of 1998) and the

latest update of the National Red Data plant list (www.sanbi.org/biodiversity/reddata.htm).

The higher the AF Index of a particular vegetation community, the higher the floristic importance of that community (**Table 6.5**). Thus an objective basis for assessing the significance of impacts on different vegetation communities at the local scale is derived.

Table 6.4: Species-status scores in relation to conservation importance and local abundance of flora

Conservation Importance	Local abundance[3]		
	Rare (+)	Frequent (1)	Abundant (2)
Red Data species (Critically Endangered)	6	7	8
Red Data species (Endangered)	5	6	7
Red Data species (Vulnerable)	4	5	6
Red Data species (DD, NT, LC)	3	4	5
Endemic species (En)	2	3	4
Protected species (Pr)	1	2	3

Table 6.5: AFI Scores in relation to Floristic Importance

AFI Score	Floristic Importance
>30	High
26-30	High-Medium
21-25	Medium-High
16-20	Medium
11-15	Medium-Low
6-10	Low-Medium
0-5	Low

In order to determine the perceived value and level of usage of traditional medicinal and / or useful plants within the project area, a local traditional healer was employed for a morning field visit to point out the most widely used plants. The proposed

[3] Based on the Braun-Blanquet cover-abundance scale

Nwamitwa Dam basin area was targeted as this is the area most likely to be negatively impacted.

b) Description of Vegetation Communities

Two vegetation types were represented in the area covered by the proposed Nwamitwa Dam basin and associated infrastructure, namely Granite Lowveld and Tsende Mopaneveld[4]. Both are characteristic of the undulating plains of the Lowveld and comprise medium-high to tall shrubby savannah.

At a finer scale, three vegetation communities were identified during fieldwork:

i. *Acacia – Combretum* Riparian Woodland (**Appendix 4l**)

This tall, closed-canopy woodland is confined to banks of perennial waterways in the project area, particularly the Groot Letaba and Nwanetsi Rivers (**Figure 6.1**). Vegetation height varies from 6 to 12 metres. *Acacia polyacantha* subsp. *campylacantha* and *Combretum erythrophyllum* are the dominant canopy tree species. Other common trees and woody shrubs include *Ficus sycomorus, Diospyros mespiliformis, Grewia flavescens* and *Trichilia emetica*. Invasive species dominate in certain areas, particularly *Lantana camara*, *Chromolaena trifida, Aristolochia elegans* and *Argemone ochraleuca*. *Panicum maximum* is very common on edges and in clearings, while *Phragmites australis* dominates open areas of the river line. A total of 109 species was recorded in this community during fieldwork, of which five have conservation importance (Appendix 4a, 4b). These species are protected, either under the National Forests Act (No.38 of 1998) or the Limpopo Environmental Management Act (No.7 of 2003). No Red Data species were recorded.

ii. *Colophospermum – Dichrostachys* Plains Woodland (**Appendix 4l**)

This medium-high to tall, mid-dense woodland is the most widespread of the untransformed vegetation communities, occurring throughout the GLeWaP project area (**Figure 6.1**). It is the dominant community within the proposed Nwamitwa Dam basin and, along with Riparian Woodland, is the community most likely to be impacted by the proposed dam. Canopy height varies from 5 – 10 metres. The most common trees in the canopy are *Colophospermum mopane, Acacia nigrescens,*

[4] Mucina & Rutherford, 2006

Combretum apiculatum and *Sclerocarya birrea* subsp. *cafra*, while a wide variety of less frequently encountered species included *Acacia exuvialis, Acacia gerrardii, Acacia grandicornuta, Albizia harveyi, Bridelia mollis, Dalbergia melanoxylon* and *Ozoroa paniculosa*. The undergrowth is dominated by woody shrubs, particularly *Dichrostachys cinerea* subsp. *nyassana*. Other common shrubs are *Gymnosporia glaucophylla, Grewia monticola, Grewia flavescens, Flueggea virosa, Euclea divinorum* and *Cordia sinensis*. The herb layer is also quite diverse and includes a variety of forbs and grasses, of which the most common are *Justicia flava, Kyphocarpha angustifolia*, *Tephrosia polystachya, Clerodendrum ternatum, Ocimum americanum, Abutilon sonneratium, Panicum maximum, Themeda triandra* and *Urochloa mossambica*. A total of 159 species was recorded in this community during fieldwork, of which nine species have conservation importance (**Appendix 4a, 4b**). One species has a National Red Data status of Least Concern (Declining), namely *Ansellia africana* and the rest are protected under the National Forests Act (No.38 of 1998) or the Limpopo Environmental Management Act (No.7 of 2003).

iii. *Combretum - Bridelia* Rocky Outcrop Woodland (**Appendix 4l**)

This shrubby savannah community is confined to low rocky ridges and isolated rock outcrops, mostly in the northern and western parts of the project area (**Figure 6.1**). Canopy height varies from 3 to 6 metres, with occasional emergent trees as tall as 10 metres. *Combretum apiculatum* is the dominant tree, with other co-dominants including *Kirkia acuminata, Bridelia mollis* and *Combretum zeyheri*. Other common trees and shrubs are *Vangueria infausta, Pappea capensis, Ficus glumosa, Pterocarpus angolensis* and *Combretum molle*. The vegetation on the hills around Hlohlokwe village, in the north-western part of the study area, was more closed and had a high proportion of succulent trees, particularly *Aloe marlothii, Euphorbia ingens* and *Euphorbia cooperi*. This is also the area in which one of the initial target Red Data species, *Xylopia parviflora*, was located. This species has subsequently been removed from the National Red Data list (October 2007 assessment on www.sanbi.org/biodiversity). A total of 176 species was recorded in this community during fieldwork, of which ten species have conservation importance (**Appendix 4a, 4b**). Two species that were found in this community have been evaluated as Least Concern (Declining) in the National Red Data list, namely *Ansellia africana* and *Elaeodendron transvaalense*. The rest are protected under the National Forests Act (No.38 of 1998) or the Limpopo Environmental Management Act (No.7 of 2003).

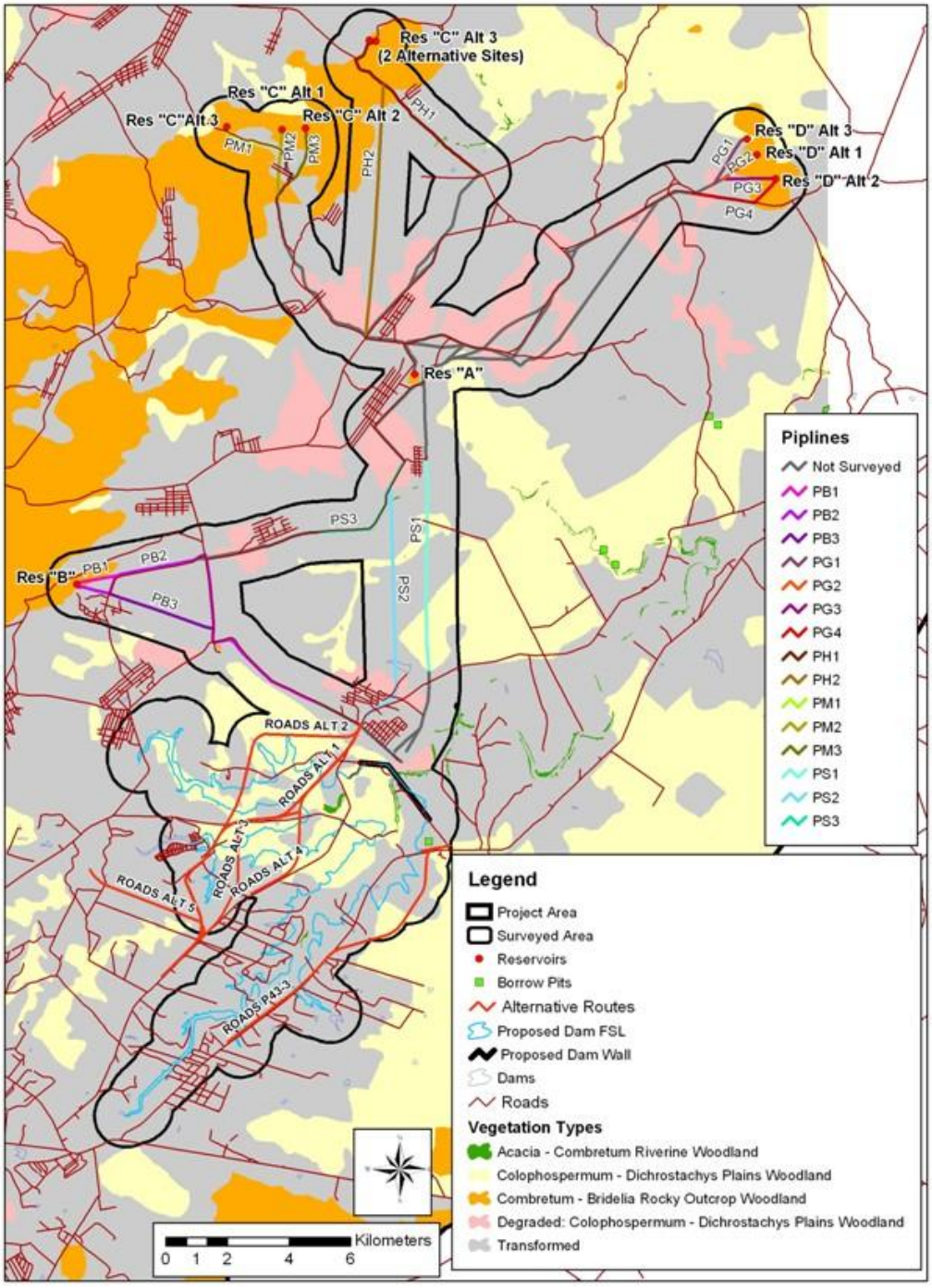

Figure 6.1: Vegetation Communities directly affected by proposed Nwamitwa Dam and associated infrastructure

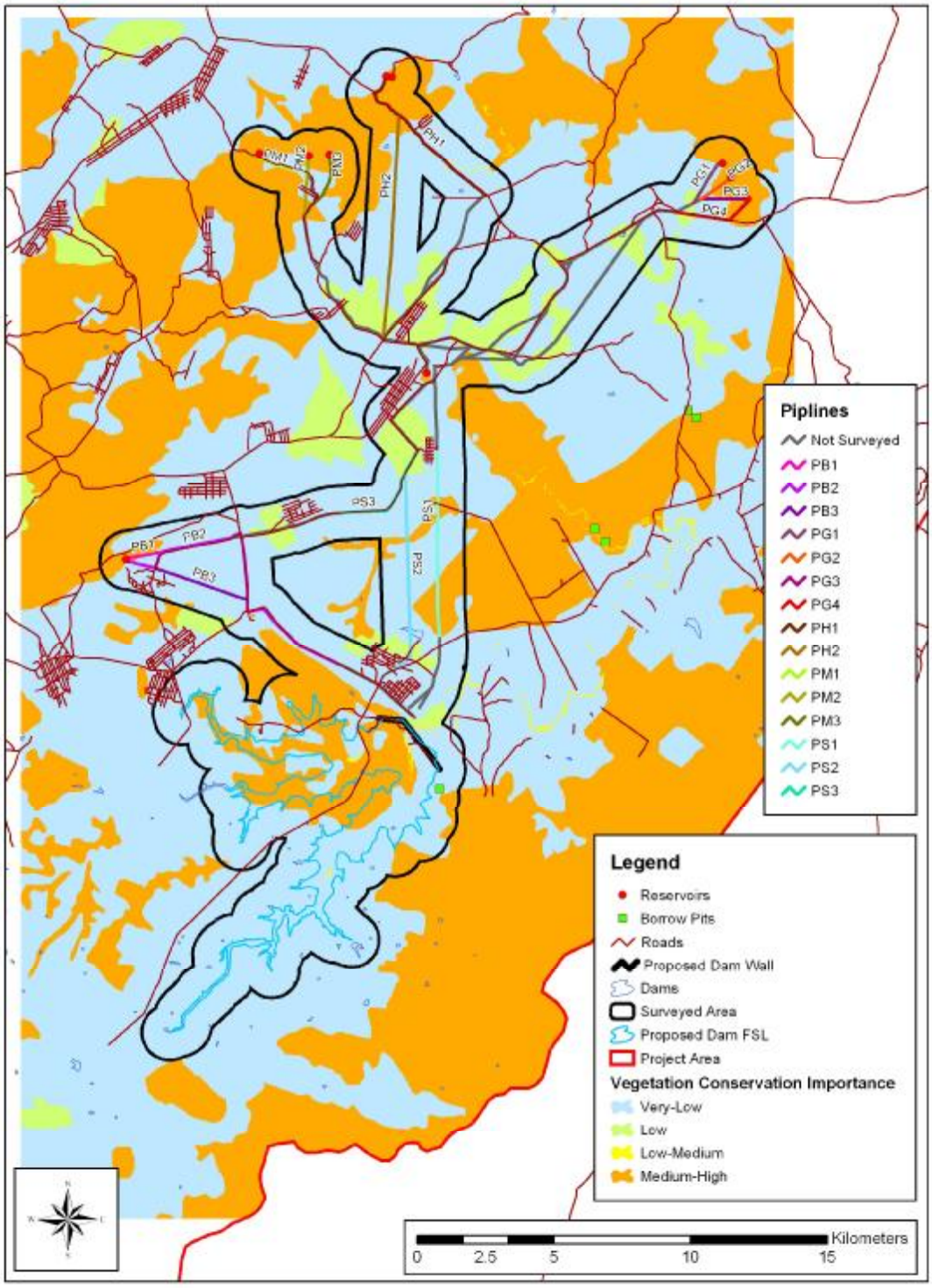

Figure 6.2: Conservation Importance of PLANTS in area to be directly affected by the Nwamitwa Dam and associated infrastructure

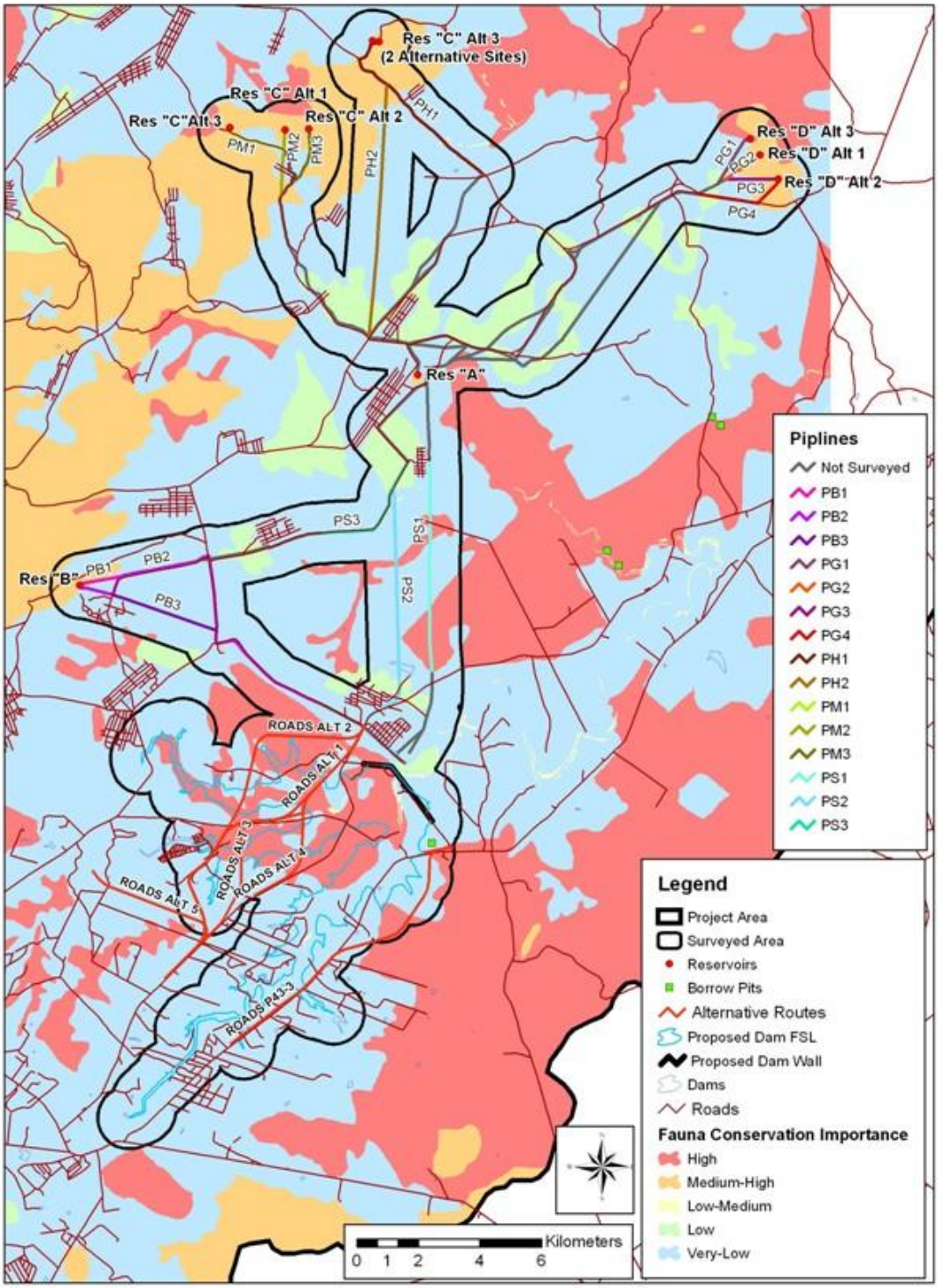

Figure 6.3: Conservation Importance of FAUNA in area to be directly affected by the Nwamitwa Dam and associated infrastructure.

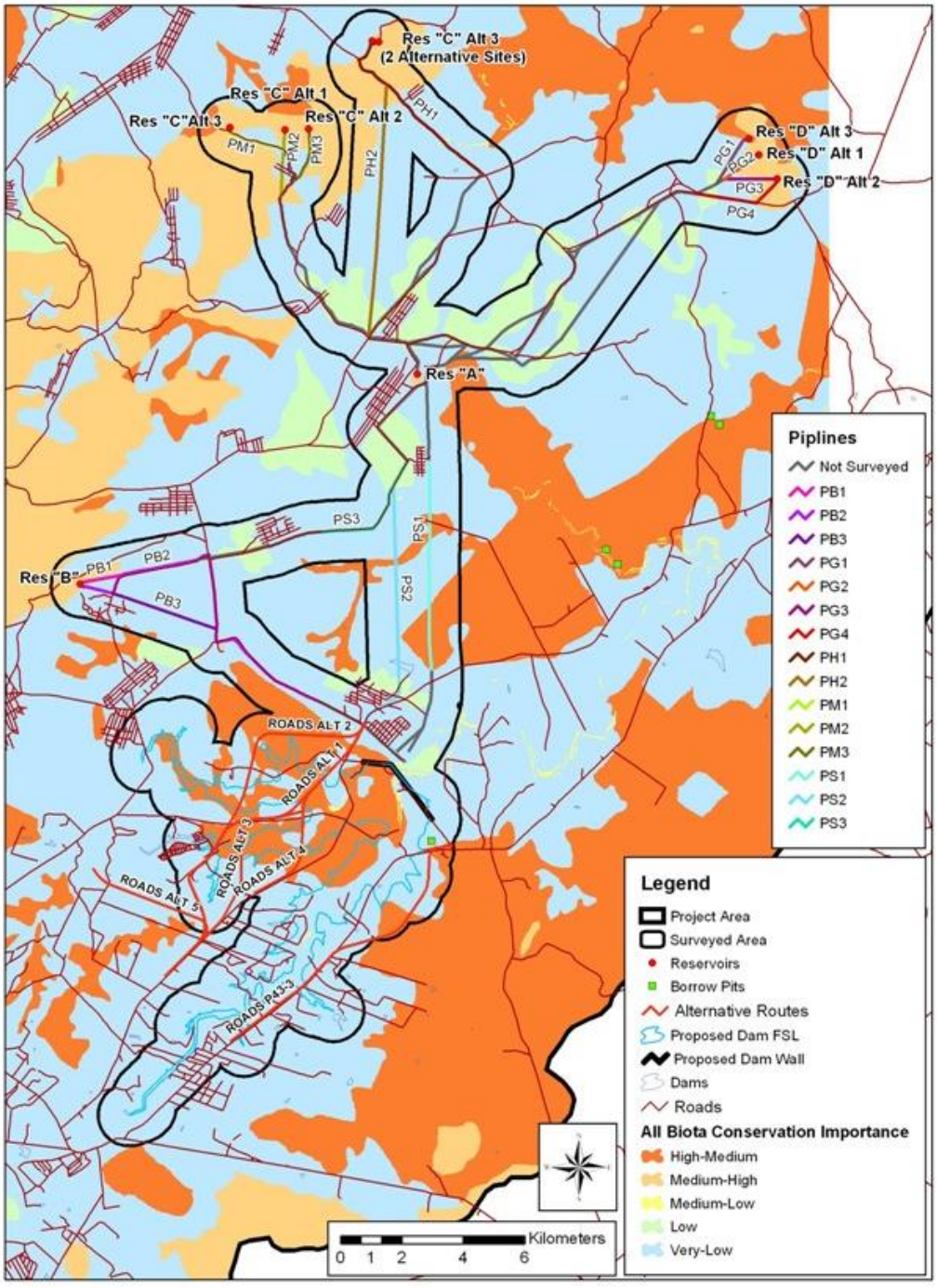

Figure 6.4: Conservation Importance of ALL BIOTA in area to be directly affected by the Nwamitwa Dam and associated infrastructure

c) Important Plant Taxa

Of the 271 conservation-important plant species potentially occurring within the entire GLeWaP study area (Iliso, 2007), a total of 30 species potentially occur within the area covered by the proposed Nwamitwa Dam and associated infrastructure (**Appendix 4c**). Fifteen of these (50%) were confirmed to occur during fieldwork (**Table 6.7**). Two have been assessed in the National Red Data list (October 2007 assessment, www.sanbi.org) and have been given a status of Least Concern (Declining):

- *Ansellia africana* (Leopard Orchid)
- *Elaeodendron transvaalense* (Bushveld Saffron)

This status indicates that the species do not qualify for any of the IUCN Red Data categories but have declining populations and are thus included in this study.

Nine Red Data species were highlighted by Iliso (2007) as being key species to search for during the EIA phase of this project. However, the most current evaluation (October 2007) of the National Red Data plant list includes only four of these species (**Table 6.6**), none of which were located during fieldwork. Three of these are considered to have a low likelihood of occurring in the GLeWAP project area, while *Mondia whitei* has a Moderate likelihood of occurring.

d) Traditional Useful and / or Medicinal Plants

Thirty-one plants were identified within the Nwamitwa dam basin area as being widely used by local residents (**Appendix 4d**). The majority of these species are widespread and common to abundant, and only three have any conservation importance (protected under the National Forest Act of 1998), although these are also widespread within the study area:

- *Combretum imberbe (Leadwood)*
- *Philenoptera violacea (Apple-leaf)*
- *Sclerocarya birrea subsp. cafra (Marula)*

Twenty-seven of the species pointed out are used medicinally, with 14 being exclusively used as such. Twelve species are used as a source of food, while five also have a utility value (e.g. building materials, sleeping mats). The relative abundance of most of the above species makes it unlikely that the GLeWaP development would have a significant impact on the availability of plant resources in

the study area, particularly if an opportunity is given for harvesting to take place within the dam basin area prior to flooding.

e) Floristic Importance Assessment

Associated Flora Indices (AFIs) were calculated for the three untransformed vegetation communities using weighted Species-Status Scores (**Table 6.4**). Results in **Table 6.7** indicate that *Combretum – Bridelia* Rocky Outcrop Woodland (AFI = 22) scores highest, followed by *Colophospermum – Dichrostachys* Plains Woodland (AFI = 21), both scores indicating **Medium-High** importance for flora (**Table 6.5**). *Acacia - Combretum* Riverine Woodland only scores 9, which indicates **Low-Medium** importance (**Table 6.5**).

Table 6.6: Red Data Plant Species potentially occurring in the GLeWaP Area

Species	Family	Growth Form	Previous RD Status	Current RD Status	Habitat	Likelihood of Occurrence in Project Area	Reason
Aloe monotropa	Asphodelaceae	Succulent	VU	VU	Forest fringe on steep, rocky slopes	Low	Confined to vicinity of Dublin Mine Kloof
Mondia whitei	Apocynaceae	Climber	LC	NT	Closed woodland, forest	Moderate	
Oberonia disticha	Orchidaceae	Epiphyte	NT	CR	Moist riverine forest	Low	Unsuitable habitat
Siphonichilus aethiopicus	Zingiberaceae	Geophyte	VU	CR	Undergrowth of closed woodland, forest	Low	Proximity to high human population; very rare; highly utilised

VU = Vulnerable

NT = Near Threatened

CR = Critically Endangered

LC = Least Concern

Table 6.7: AFI per Vegetation Community based on Species-Status scores of Conservation-Important plant species found

SCIENTIFIC NAME	FAMILY	Growth Form	Interim National Red Data Status	Endemic	Protected	*Acacia - Combretum* Riverine Woodland	*Colophospermum - Dichrostachys* Plains Woodland	*Combretum - Bridelia* Rocky Outcrop Woodland
Dicotyledons								
Sclerocarya birrea subsp.cafra	Anacardiaceae	tree			NFA	2	3	2
Xylopia parviflora	Annonaceae	tree			LEMA			1
Huernia sp.	Apocynaceae	succulent			LEMA		1	
Riocreuxia picta	Apocynaceae	climber			LEMA	2		
Balanites maughamii	Balanitaceae	tree			NFA		2	1
Eleaodendron transvaalense	Celastraceae	tree	LC(D)		NFA		4	6
Combretum imberbe	Combretaceae	tree			NFA		3	1
Spirostachys africana	Euphorbiaceae	tree			LEMA	2	2	
Philenoptera violacea	Fabaceae	tree			NFA	2	1	1
Pterocarpus angolensis	Fabaceae	tree			NFA			2
Breonadia salicina	Rubiaceae	tree			NFA	1		
Subtotal		11	1	0	11	9	16	14
Monocotyledons								
Boophane disticha	Amaryllidaceae	bulb			LEMA		1	2
Scadoxus sp.	Amaryllidaceae	bulb			LEMA			1
Aloe cryptopoda	Asphodelaceae	succulent			LEMA			1
Ansellia africana	Orchidaceae	epiphyte	LC(D)		LEMA		4	4
Subtotal		4	1	0	4	0	5	8
Total		15	2	0	15	9	21	22
					Floristic importance:	Low-Medium	Medium-High	Medium-High

LC (D) = Least Concern (Declining)
LEMA = Limpopo Environmental Management Act
NFA = National Forests Act

6.2.2 Vertebrate Fauna

a) Methodology

Lists of terrestrial mammals, birds, frogs and reptiles potentially occurring in the project area were derived from Iliso (2007), which included *inter alia* herpetological distribution data supplied by the Limpopo Department of Economic Development, Environment & Tourism (V.Egan *pers.comm*.). Potential occurrence of fauna in the various vegetation communities of the footprint was predicted based on knowledge of typical fauna of the area, and in some cases confirmed during fieldwork. All confirmed species were listed in Appendices 4e and 4f. Conservation-important fauna, i.e. South African endemics, protected species and/or Red Data species, were highlighted in the above lists and these were searched for during fieldwork. Survey methodology included:

- Pitfall traps with drift fences (**Appendix 4J**).
- Live walk-in traps (Willan traps) baited with a mixture of oats, peanut butter and sunflower oil (**Appendix 4J**).
- Active searching (transects, point counts) within 14 sample sites.

b) Mammals

Savannah / woodland habitats are recognised as supporting the highest mammal diversity in South Africa5. It is thus likely that mammal diversity would be high in untransformed areas within the GLeWaP project area, while transformed areas would support lower diversity. Iliso (2007) listed 64 conservation-important mammal species that potentially occur in the greater GLeWaP project area. Fifty of these species could occur within the proposed Nwamitwa Dam basin and associated pipeline routes (**Appendix 4g**). Only one of these has urgent threat status, namely Ground Pangolin (Manis temminckii) (Vulnerable). This has a moderate likelihood of occurring in untransformed areas, particularly on private farms within the dam basin, since the density of people is much lower on these properties.

Live walk-in traps (Willan traps) were placed in transects in Colophospermum – Dichrostachys Plains Woodland on the farm La Motte 464 LT, within the proposed Nwamitwa Dam basin. The only rodent species caught in these traps in 46 trap-nights was Aethomys ineptus. Active searches in vegetation transects revealed evidence of

5

ten other mammal species (**Appendix 4e, 4f**). Two of these, Steenbok (Raphicerus campestris) and Hippopotamus (Hippopotamus amphibius), are protected under LEMA. An additional mammal species was discovered on a rocky outcrop by the team of entomologists, namely Short-snouted Elephant Shrew (Elephantulus brachyrhynchus), which has a Red Data status of Data Deficient (**Appendix 4l**).

c) Birds

The area to be impacted by the Nwamitwa dam and associated infrastructure is in an area of high bird diversity. Over 340 bird species were recorded in this area during the first Southern African Bird Atlas Project[6]. While a high diversity of large birds of prey is included in this figure, most of these are only likely to be resident in large protected areas adjacent the project area. However, most of them are likely to forage over both transformed and untransformed areas. Iliso (2007) listed 62 conservation-important bird species that potentially occur in the greater GLeWaP project area. Thirty-three of these species could occur within the proposed Nwamitwa Dam basin and associated pipeline routes (**Appendix 4g**). Fifteen species have an urgent threat status, one of which, Saddle-billed Stork (*Ephippiorhynchus senegalensis*), is considered Endangered. The rest have been assessed as Vulnerable and include nine birds of prey, none of which are likely to be resident in the project area. Potential nesting sites for raptors and storks were searched for during fieldwork but none found. Two Vulnerable species are likely to occur in Riverine Woodland where dense vegetation overhangs the river, namely African Finfoot (*Podica senegalensis*) and White-backed Night Heron (*Gorsachius leuconotus*). No early morning surveys along the rivers revealed either species, but the likelihood of occurrence is still considered Moderate (night heron) to High (finfoot).

A total of 186 bird species was recorded during fieldwork, which represents over 50% of the species list for the area (**Appendix 4e, 4f**). The highest species richness was in *Colophospermum – Dichrostachys* Plains Woodland (128 species), followed by *Acacia* - *Combretum* Riverine Woodland (97 species). Eleven species were recorded at 50% or more of the sample sites and can be considered the most widespread species in the project area (**Table 6.8**).

[6] Harrison, et al. 1994

Table 6.8: Most widespread bird species in GLeWaP area during fieldwork (Jan 2008)

Yellow-fronted Canary	*Crithagra mozambicus*	Dark-capped Bulbul	*Pycnonotus tricolor*
Cape Turtle-Dove	*Streptopelia capicola*	Barn Swallow	*Hirundo rustica*
Rattling Cisticola	*Cisticola chiniana*	Black-crowned Tchagra	*Tchagra senegalus*
White-browed Scrub-Robin	*Cercotrichas leucophrys*	Stierling's Wren-Warbler	*Calamonastes stierlingi*
Blue Waxbill	*Uraeginthus angolensis*	White-bellied Sunbird	*Cinnyris talatala*
Tawny-flanked Prinia	*Prinia subflava*		

Two Red Data bird species were recorded during fieldwork:

- Black Stork (*Ciconia nigra*) – an immature was found in heavily grazed savannah along the pipeline route south-east of Hlohlokwe village (Gamela 679 LT). This is a species that breeds on cliffs and forages in wetlands. This bird was probably in transit to suitable foraging habitat.
- Lanner Falcon (*Falco biarmicus*) - two adults were seen flying with two immatures over the proposed reservoir site at Serolorolo village (Sirulurul 427 LT). The proximity of high human density and lack of breeding habitat make it highly unlikely that these birds bred at the site. They were seen making several attempts at hunting feral pigeons in the village and this is probably what is attracting them to the site.

d) Reptiles

ILISO (2007) listed 43 conservation-important reptile species that potentially occur in the greater GLeWaP project area, although most are confined to higher lying grasslands and montane forests. Fourteen species could occur within the proposed Nwamitwa Dam basin and associated pipeline routes (**Appendix 4g**). Five of these were confirmed to occur during fieldwork (**Table 6.9**). A total of 14 reptile species was confirmed in the field (**Appendix 4e**, **4f**). The most significant find was Common Flat Lizard (*Platysaurus intermedius intermedius*), which is endemic to Limpopo Province and confined to rocky outcrops. A small population of this species was located along the proposed alternative pipeline route just south of Hlohlokwe (**Appendix 4l**). Local residents confirmed the presence of one Red Data species, Nile Crocodile (*Crocodylus niloticus*), in the Groot Letaba River. Another Red Data species, Southern African Python (*Python natalensis*), has a High likelihood of occurring, especially in the dam basin area.

e) Frogs

The GLeWaP project area falls within an area of high species diversity but low importance for conservation-important species[7]. Only two conservation-important frog species of those listed in Iliso (2007) potentially occur within the area to be impacted by the proposed Nwamitwa Dam and associated infrastructure, namely Giant Bullfrog (*Pyxicephalus adspersus*) and Edible Bullfrog (*Pyxicephalus edulis*). Neither of these species was heard calling during fieldwork, although only Edible Bullfrog has a significant likelihood of occurring. The presence of this species was confirmed when numerous young Edible Bullfrogs were caught in traps placed for insects within the Nwamitwa Dam Basin and Borrow Pits 3 and 4. Fourteen frog species were recorded during fieldwork, mostly through active searches and checking of pitfall traps (**Appendix 4e, 4f**). The traps proved particularly effective for *Hemisus marmoratus*, a cryptic fossorial species that is often overlooked. A single Russet-backed Sand Frog (*Tomopterna marmorata*) collected on the farm Janetsi 463 LT proved to be the first record for this species in the grid 2330 CD, representing a small range increase[8].

f) Vertebrate Faunal Importance Assessment

Ninety-nine of the conservation-important fauna species listed in Iliso (2007) could occur within the area of the proposed Nwamitwa Dam and associated bulk supply route (**Appendix 4g**). Only twelve of these were confirmed to occur during fieldwork. Six were recorded in *Colophospermum - Dichrostachys* Plains Woodland and five each in *Acacia - Combretum* Riverine Woodland and *Combretum - Bridelia* Rocky Outcrop Woodland (**Table 6.9**).

Table 6.9. Conservation-important Fauna recorded during fieldwork.

Common Name	Scientific Name	Red Data	Endemic	Protected	*Acacia - Combretum* Riverine Woodland	*Colophospermum - Dichrostachys* Plains Woodland	*Combretum - Bridelia* Rocky Outcrop Woodland	Artificial Wetlands
Hippopotamus	*Hippopotamus amphibious*			LEMA	x			x
Steenbok	*Raphicerus campestris*			LEMA		x	x	
Short-snouted Elephant Shrew	*Elephantulus brachyrhynchus*	DD					x	

[7] Minter, et al. 2004
[8] Minter, et.al., 2007

Black Stork	*Ciconia nigra*	NT				x		
Cape White-eye	*Zosterops virens*		SA		x	x	x	
Lanner Falcon	*Falco biarmicus*	NT					x	
Common Flap-neck Chamaeleon	*Chamaeleo dilepis*			NEMBA	x			
Common Flat Lizard	*Platysaurus intermedius*		LP				x	
Distant's Ground Agama	*Agama aculeata distanti*		SA			x		
Rock Monitor	*Varanus albigularis*			NEMBA		x		
Water Monitor	*Varanus niloticus*			NEMBA	x			x
Edible Bullfrog	*Pyxicephalus edulis*			NEMBA	x	x		
Total	12	3	3	6	5	6	5	2

LP = Limpopo Province endemic
SA = South African Endemic
NEMBA = National Environmental Management: Biodiversity Act
LEMA = Limpopo Environmental Management Act

A summary of the importance values of the potentially occurring fauna within the three vegetation communities identified in the study area (as well as Artificial Wetlands) is presented in **Table 6.10**. This indicates that *Colophospermum - Dichrostachys* Plains Woodland and *Acacia - Combretum* Riverine Woodland are the most important communities, followed by *Combretum - Bridelia* Rocky Outcrop Woodland. Artificial Wetlands, while important for a few species, have a low overall score.

Table 6.10: Vertebrate faunal value of Vegetation Communities

Importance Value	**No.of conservation-important Fauna Species**			
	Acacia - Combretum Riverine Woodland	*Colophospermum - Dichrostachys* Plains Woodland	*Combretum - Bridelia* Rocky Outcrop Woodland	*Artificial Wetlands*
Very High	1	0	0	0
High	32	31	25	17
Medium	29	34	30	13
Low	8	10	13	1
RANK	**1**	**1**	**3**	**4**
Overall Importance	Medium	Medium	Medium	Low

6.2.3 Invertebrate Fauna

a) Methodology

Field surveys for invertebrates included pitfall trapping and day-time searches for beetles, spiders and scorpions, as well as night-time searches with ultraviolet light for protected scorpion species:

Surveys for ground beetles, scorpions, trapdoor and baboon spiders were carried out by pitfall trapping for four weeks in each of 4 habitat areas selected as being most likely to be permanently transformed by the project (the two proposed borrow pit areas and two areas, representing the two main habitat types, within the proposed dam impoundment), as well as by hand collecting by a team of 3 people during the first survey field visit (20-22 Dec 2007) and 4-5 people on different days during the second visit (17-24 January 2008). Each proposed reservoir site was searched for 1 - 1.5 hours depending on the number of personnel present, giving a total search effort of 5-6 person-hours per site. The borrow pit and dam impoundment areas received greater search effort, with each proposed borrow pit site being searched for at least 10-12 person-hours and the dam impoundment receiving a total of approximately 89 person-hours of daytime search effort. All except one of the ten main proposed pipeline sections identified as being within untransformed areas were also inspected, with a total of approximately 35 person-hours search effort being allocated to these areas. An additional 10 person-hours of night-time search with ultraviolet light was carried out during the initial site visit (November 2007) and the second survey visit (January 2008).

- Scorpions were searched for actively during the daytime searches in all surveyed areas, as well as by night with the aid of ultraviolet light in two areas within the proposed dam impoundment. Pitfall trapping also yielded some specimens.
- Trapdoor and baboon spiders were searched for actively during the daytime searches in all surveyed areas, and pitfall trapping also yielded some specimens.
- Visual searches and netting would be required to survey dragonfly and damselfly populations. However, since both of the predicted Red Data Odonata species (Samways 2006, Samways and Taylor 2004) would only be likely to occur in the catchment area well to the west and upstream of the proposed dam, and hence would be highly unlikely to be impacted in any way surveys were not carried out for these species.

- No rare or threatened cicada species were predicted for the project area so no specific searches for this group were carried out; a few incidental collections of cicada specimens were however made and these will be sent to Dr Martin Villet (Rhodes University) for identification.
- Ground beetles formed the primary focus of the field assessments, since the majority of the rare and protected invertebrate species predicted for the project area fell into this group; with the exclusion of butterflies, damselflies and dragonflies from the survey, all of the remaining invertebrates of "High" importance value were ground beetles. Representative of the species considered most likely to be of significance were processed and submitted to Peter Schüle immediately after the January field visit, while representative specimens of the remainder will be submitted later.
- Visual searches and netting would be required to survey for the predicted Red Data butterfly species. However, non-overlap of flight periods of the butterflies (September-November for Wolkberg Widow and Lotana Blue, November-December for Stevenson's Copper, December-January for Wolkberg Zulu and February-March for Swanepoel's Brown) would lead to a requirement for at least three intensive surveys. Thus, since all five of the predicted Red Data butterfly species (Woodhall 2005) would only be likely to occur in the catchment well to the west and upstream of the proposed dam, and hence would be highly unlikely to be impacted in any way, surveys were not carried out for these species.

b) Scorpions

At least six scorpion species were found in the project area and these included three protected species (*Hadogenes troglodytes*, *Opisophthalmus glabrifrons* and *Opistacanthus asper*). *H. troglodytes* were found in rocky outcrops along some of the proposed pipeline routes and at some proposed reservoir sites, *O. glabrifrons* were found along some of the pipeline routes and *O. asper* were found in trees within the proposed dam impoundment area, but it is probable that the latter two species are fairly widespread in all habitats in the region. *H. troglodytes* will however be restricted to areas of rocky outcrop with suitable cracks to provide refuge.

c) Trapdoor and Baboon Spiders

At least three baboon spider species were found in the project area, and these included the protected species *Augacephalus (Pterinochilus) junodi* and *Ceratogyrus*

bechuanicus; other specimens of baboon and trapdoor spiders have not yet been identified.

d) Dragonflies and Damselflies

No Odonata of conservation concern were noted during the field surveys.

e) Cicadas

No cicadas of conservation concern were noted during the field surveys; the few specimens that were captured will be sent to Prof Martin Villet at Rhodes University for identification and to confirm their status.

f) Ground Beetles

Large numbers of ground beetles, including representatives of three protected genera (*Mantichora*, *Megacephala* and *Dromica*) as well as several non-protected genera, were collected during the field surveys. Final identification of some of the specimens remains to be carried out, but preliminary results indicate that at least eight protected species occur in the project area. The most significant finds were two populations of *Dromica oberprieleri* (identification confirmed by Peter Schüle) on La Motte farm within the proposed dam impoundment area, where several specimens of this rare and localised species were collected.

g) Butterflies

No Lepidoptera of conservation concern were noted during the field surveys.

h) Identification of specimens

Specimens collected during the field surveys were identified mainly with the aid of the reference material lsted below and by consultation with relevant experts in the various taxonomic groups:

Scorpions - Leeming (2003), Prendini (2001, 2006), Ian Engebrecht (GDACE), pers comm.

Trapdoor & baboon spiders - Dippenaar-Schoeman (2002).

Dragonflies and damselflies - Tarboton & Tarboton (2002, 2005).

Beetles - Basilewsky (1977), Werner (2000), Peter Schüle, pers comm.

Butterflies - Woodhall (2005)

i) Invertebrate Faunal Importance Assessment

At least thirteen protected invertebrate species were located during the course of the field surveys (Appendix 4h), and this number may increase once the processing of specimens is completed. The protected beetle genus *Dromica* was particularly well represented in the project area and specimens were found in virtually every area surveyed. However, most of the *Dromica* specimens found were representatives of relatively widespread and common species; the main exception to this was *Dromica oberprieleri,* which was first discovered in the Hans Merensky Nature Reserve in 1981, and is known from only a few localised populations. The two areas of La Motte farm on which *D. oberprieleri* were located should thus be considered as very sensitive.

Another rare (although more widespread than *D. oberprieleri*) and protected ground beetle species, *Megacephala regalis vansoni*, was collected by pitfall trapping in the proposed dam impoundment area on La Motte. Both *D. oberprieleri* and *M. regalis vansoni* scored "high" importance ratings in the desktop study. *Mantichora scabra*, a protected giant tiger beetle, was found in both *Colophospermum – Dichrostachys* Plains Woodland and *Combretum – Bridelia* Rocky Outcrop Woodland in areas of suitable soft deep soil.

The protected baboon spider and scorpion species located within the project area are also all widespread (although the flat rock scorpion *Hadogenes troglodytes* has specific habitat requirements and would thus be more patchily distributed), and the two protected scorpion species with more limited distributions (combined also with specific habitat requirements) predicted for the greater project area would be most likely only to inhabit areas of higher altitude in the catchment area to the west. None of the protected baboon spider or scorpion species found appeared to be strongly linked to any habitat type and were apparently more dependant on substrate than vegetation type.

Although a final assessment cannot be made until specimen identifications are complete and all data analysed, it appeared that of the vegetation types surveyed, *Colophospermum – Dichrostachys* Plains Woodland has a higher density and variety of protected invertebrate species than *Combretum – Bridelia* Rocky Outcrop Woodland, both of which supported greater density and variety than *Acacia – Combretum* Riparian Woodland.

6.3 BIODIVERSITY AND CONSERVATION IMPORTANCE

Appendices 4a – 4h list the plant and animal species that were recorded or potentially occur within the area covered by the proposed Nwamitwa Dam and associated infrastructure. **Table 6.11** provides a summary of these. A total of 5 species of Red Data flora and fauna were recorded (2 plant, 1 mammal and 2 bird). Six endemic or near-endemic (locally or regionally) species were recorded (1 bird, 2 reptile, and 3 invertebrate). Thirty-two protected species were recorded (15 plant, 2 mammal, 3 reptile, 1 frog and 11 invertebrate).

This gives a total of 17 conservation-important plant species, 3 conservation-important mammal species, 3 conservation-important bird species, 5 conservation-important reptile species, 1 conservation-important frog species and 14 conservation-important invertebrate species. In all, 43 conservation important species of flora and fauna were recorded.

Table 6-11. Numbers of important biotic taxa recorded in the project area

Biotic group	Red Data	Endemic/Near-endemic[9]	Protected	Total
Plants	2	0	15	17
Mammals	1	0	2	3
Birds	2	1	0	3
Reptiles	0	2	3	5
Frogs	0	0	1	1
Invertebrates	0	3	11	14
Total:	**5**	**6**	**32**	**43**

The maps profiling conservation importance of the biota studied (**Figures 6.2 – 6.4**) are designed to inform the development planning process, and to provide a basis for impact assessment. Areas designated of high conservation importance for a particular biotic group would be considered 'sensitive' to development because of the potential impacts of such development on that particular group.

[9] Floristic endemism is determined at the scale of Limpopo Province, whilst faunal endemism is determined at a national (SA) or provincial (LIM) scale

Table 6-12 summarizes the levels of conservation importance of each vegetation type in terms of the conservation-important biota potentially represented there. It also attempts to rank the vegetation types on the basis of their 'intrinsic biodiversity' reflected in the integration of all the component importance values. Thus some idea of intrinsic biodiversity value or 'ecological sensitivity' is realized and mapped (**Figure 6.4**).

Table 6-12: Integration of importance values to derive Intrinsic Biodiversity values per vegetation type.

Biotic Group	**Importance value**		
	Acacia - Combretum Riverine Woodland	*Colophospermum - Dichrostachys* Plains Woodland	*Combretum - Bridelia* Rocky Outcrop Woodland
Plants	Low-Medium	Medium-High	Medium-High
Vertebrate Fauna	Medium	Medium	Medium
Invertebrate Fauna	Low-Medium	High	Medium-High
Intrinsic Biodiversity Value	Medium-Low	High-Medium	Medium - High
RANK	**3**	**1**	**2**

7. ASSESSMENT OF POTENTIAL IMPACTS

7.1 FLORA

7.1.1 Nwamitwa Dam

Description of potential impact	**Transformation and fragmentation of habitat for plants.**	
Nature of impact	Negative. Direct.	
Legal requirements	National Environmental Management Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Direct.	Negative. Direct.
Extent of impact	Local.	Local.
Duration of impact	Permanent	Permanent
Intensity	Medium (Bulk supply routes, reservoirs) High (Dam)	Low (Bulk supply routes, reservoirs) High (Dam)
Probability of occurrence	Medium (Bulk supply routes, reservoirs) High (Dam)	Low (Bulk supply routes, reservoirs) High (Dam)
Confidence of assessment	High	High
Level of significance before mitigation	Medium (untransformed habitats) Low (transformed habitats)	Medium (untransformed habitats) Low (transformed habitats)
Mitigation measures (EMP requirements)	1. A major plant rescue operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species where possible; scientific institutions should also be invited to collect live specimens. 2. Establish a holding nursery for local plants suitable for re-planting on rehabilitated surfaces after closure (construction camp, borrow pits).	1. Maintain holding nursery of local plants suitable for re-planting rehabilitated areas.

Level of significance after mitigation	Medium (untransformed habitats) Low (transformed habitats)	Medium (untransformed habitats) Low (transformed habitats)
Cumulative Impacts		Increased settlement around dam resulting in further fragmentation and loss of untransformed habitat
Comments or Discussion		

Description of potential impact	**Increased harvesting pressure on vegetation.**	
Nature of impact	Negative. Indirect.	
Legal requirements	Limpopo Environmental Management Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Indirect.	Negative. Indirect.
Extent of impact	Regional.	Regional.
Duration of impact	Long term	Long term
Intensity	Low (Bulk supply routes, reservoirs) Medium (Dam)	Low (Bulk supply routes, reservoirs) Medium (Dam)
Probability of occurrence	Low (Bulk supply routes, reservoirs) High (Dam)	Low (Bulk supply routes, reservoirs) High (Dam)
Confidence of assessment	Medium	Medium
Level of significance before mitigation	Medium (untransformed habitats) Low (transformed habitats)	Medium (untransformed habitats) Low (transformed habitats)
Mitigation measures (EMP requirements)	1. Construction teams should not be allowed access to areas of untransformed vegetation for collection of firewood, etc; construction camps and work sites should be fenced off. Penalties should be levied on any construction teams that transgress.	1. Not possible to mitigate for settlement of land adjacent dam, where harvesting impacts are likely to be highest.

	2. Allow local communities access to plant resources below full supply level, but not before plant rescue has been completed. 3. All pipeline routes through untransformed vegetation should be regarded as last resorts; routes should whenever possible traverse transformed habitats.	
Level of significance after mitigation	Medium (untransformed habitats) Low (transformed habitats)	Medium (untransformed habitats) Low (transformed habitats)
Cumulative Impacts		Increased settlement around dam resulting in further harvesting of vegetation.
Comments or Discussion		

Description of potential impact	**Increased invasion by alien plants.**	
Nature of impact	Negative. Indirect.	
Legal requirements	Conservation of Agricultural Resources Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Indirect.	Negative. Direct.
Extent of impact	Local.	Local.
Duration of impact	Long term	Long term
Intensity	Low (Bulk supply routes, reservoirs) Medium (Dam)	Low (Bulk supply routes, reservoirs) High (Dam)
Probability of occurrence	Medium (Bulk supply routes, reservoirs) High (Dam)	Medium
Confidence of assessment	Medium	Medium
Level of significance before mitigation	Medium (Dam)	High (Dam)

	Low (transformed habitats)	Low (transformed habitats)
Mitigation measures (EMP requirements)	1. Allow local communities access to plant resources below full supply level, but not before plant rescue has been completed.	1. Once dam construction is completed, control measures targeting alien plants within the construction areas and surrounding disturbed sites should be implemented, preferably using Working for Water teams. 2. Annual monitoring of levels of infestation of dam by alien plants; rapid response by teams removing plants.
Level of significance after mitigation	Medium (Dam) Low (transformed habitats)	Medium (Dam) Low (transformed habitats)
Cumulative Impacts		
Comments or Discussion :		

Description of potential impact	**Impoverishment of populations of important plants.**	
Nature of impact	Negative. Direct.	
Legal requirements	National Environmental Management: Biodiversity Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Direct.	Negative. Direct.
Extent of impact	Local.	Local.
Duration of impact	Permanent	Permanent
Intensity	Medium (Bulk supply routes, reservoirs) High (Dam)	Medium (Bulk supply routes, reservoirs) High (Dam)
Probability of occurrence	Medium (Bulk supply routes, reservoirs) High (Dam)	Medium (Bulk supply routes, reservoirs) High (Dam)

Confidence of assessment	High	High
Level of significance before mitigation	Medium (Dam) Low (transformed habitats)	Medium (Dam) Low (transformed habitats)
Mitigation measures (EMP requirements)	1. A major plant rescue operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species where possible; scientific institutions should also be invited to collect live specimens. 2. Establish a holding nursery for local plants suitable for re-planting on rehabilitated surfaces after closure (construction camp, borrow pits). 3. All pipeline routes through untransformed vegetation should be regarded as least favourable options; routes should whenever possible traverse transformed habitats.	1. Maintain holding nursery of local plants suitable for re-planting rehabilitated areas.
Level of significance after mitigation	Medium (Dam) Low (transformed habitats)	Medium (Dam) Low (transformed habitats)
Cumulative Impacts		Increased settlement around dam resulting in further impoverishment of populations of important species.
Comments or Discussion :		

Description of potential impact	**Dam acts as a barrier disrupting seed dispersal by water (along river) or animals (across river).**	
Nature of impact	Negative. Direct.	
Legal requirements	Not aware of any.	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Direct.	Negative. Direct.

Extent of impact	Regional.	Regional.
Duration of impact	Permanent	Permanent
Intensity	Medium	Medium
Probability of occurrence	Low	High
Confidence of assessment	Medium	Medium
Level of significance before mitigation	Low	Medium
Mitigation measures (EMP requirements)	None	None
Level of significance after mitigation	Low	Medium
Cumulative Impacts		
Comments or Discussion :		

Description of potential impact	**Disruption of natural fire regime across river, affecting species composition and structure of vegetation communities.**	
Nature of impact	Negative. Indirect.	
Legal requirements	National Veld and Forest Fires Act of 1998	
Stage	Pre-Construction and Construction	Operation
Nature of Impact		Negative. Indirect.
Extent of impact		Regional.
Duration of impact		Permanent
Intensity		Medium
Probability of occurrence		High
Confidence of assessment		Low
Level of significance before		Medium

mitigation		
Mitigation measures (EMP requirements)		1. Ensure that areas on all sides of dam are burnt with equal frequency and timing. Not sure whose responsibility this should be?
Level of significance after mitigation		Medium
Cumulative Impacts		
Comments or Discussion :.		

Description of potential impact	**Increased soil erosion.**	
Nature of impact	Negative. Indirect.	
Legal requirements	Conservation of Agricultural Resources Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Indirect.	Negative. Indirect.
Extent of impact	Regional.	Regional.
Duration of impact	Short term	Short term
Intensity	Medium	Medium
Probability of occurrence	Medium	Medium
Confidence of assessment	Medium	Medium
Level of significance before mitigation	Medium	Medium
Mitigation measures (EMP requirements)	1. Topsoil from the construction camp and borrow pits should be stored for post-construction rehabilitation work and should not be disturbed more than is absolutely necessary. 2. Topsoil should also be stored in such a way that does not compromise its plant-support capacity.	See Borrow Pit Rehabilitation notes and EMP (Appendix 4K)

	3. Protect topsoil in order to avoid erosion loss on steep slopes (notably on drainage crossings). 4. Protect topsoil from contamination by aggregate, cement, concrete, fuels, litter, oils, domestic and industrial waste. 5. Construct adequate erosion-control measures at stream crossings below dam wall (eg. gabions). 6. If sand is needed for dam wall construction, then this must be acquired from within the dam basin, or if upstream or downstream of the proposed full-supply level then from transformed areas.	
Level of significance after mitigation	Low	Low
Cumulative Impacts		
Comments or Discussion :		

7.1.2 Raising Tzaneen Dam

Description of potential impact	**Transformation and fragmentation of habitat for plants.**	
Nature of impact	Negative. Direct.	
Legal requirements	National Environmental Management Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Direct.	Negative. Direct.
Extent of impact	Local.	Local.
Duration of impact	Permanent	Permanent
Intensity	Medium	Medium
Probability of occurrence	High	High

Confidence of assessment	High	High
Level of significance before mitigation	Low	Low
Mitigation measures (EMP requirements)	1. A plant rescue operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species from any fragments of untransformed vegetation; scientific institutions should also be invited to collect live specimens.	
Level of significance after mitigation	Low	Low
Cumulative Impacts		
Comments or Discussion		

Description of potential impact	**Increased harvesting pressure on vegetation.**	
Nature of impact	Negative. Indirect.	
Legal requirements	Limpopo Environmental Management Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Indirect.	Negative. Indirect.
Extent of impact	Local	Local
Duration of impact	Long term	Long term
Intensity	Low	Low
Probability of occurrence	Medium	Medium
Confidence of assessment	Medium	Medium
Level of significance before mitigation	Low	Low
Mitigation measures (EMP requirements)	1. Construction teams should not be allowed access to areas of untransformed vegetation for collection of firewood, etc; construction camps and	

	work sites should be fenced off. Penalties should be levied on any construction teams that transgress.	
Level of significance after mitigation	Low	Low
Cumulative Impacts		
Comments or Discussion		

Description of potential impact	**Impoverishment of populations of important plants.**	
Nature of impact	Negative. Direct.	
Legal requirements	National Environmental Management: Biodiversity Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Direct.	Negative. Direct.
Extent of impact	Local.	Local.
Duration of impact	Permanent	Permanent
Intensity	Low	Low
Probability of occurrence	Low	Medium
Confidence of assessment	High	High
Level of significance before mitigation	Low	Low
Mitigation measures (EMP requirements)	1. A plant rescue operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species from any fragments of untransformed vegetation; scientific institutions should also be invited to collect live specimens.	

Level of significance after mitigation	Low	Low
Cumulative Impacts		
Comments or Discussion :		

7.2 VERTEBRATE FAUNA

7.2.1 Nwamitwa Dam

Description of potential impact	**Transformation and fragmentation of habitat for animals.**	
Nature of impact	Negative. Direct.	
Legal requirements	National Environmental Management Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Direct.	Negative. Direct.
Extent of impact	Local.	Local.
Duration of impact	Short term (Bulk supply routes) Permanent	Short term (Bulk supply routes) Permanent
Intensity	Medium (Bulk supply routes, reservoirs) High (Dam)	Low (Bulk supply routes, reservoirs) High (Dam)
Probability of occurrence	Medium (Bulk supply routes, reservoirs) High (Dam)	Medium (Bulk supply routes, reservoirs) High (Dam)
Confidence of assessment	High	High
Level of significance before mitigation	Medium (untransformed habitats) Low (transformed habitats)	Medium (untransformed habitats) Low (transformed habitats)
Mitigation measures (EMP requirements)	1. A major trapping and relocation operation should be implemented, targeting the rescue and translocation of	

	threatened, endemic and protected species where possible, particularly small mammals and reptiles; scientific institutions should be invited to collect live specimens.	
Level of significance after mitigation	Medium (untransformed habitats) Low (transformed habitats)	Medium (untransformed habitats) Low (transformed habitats)
Cumulative Impacts		Increased settlement around dam resulting in further fragmentation and loss of untransformed habitat
Comments or Discussion		

Description of potential impact	**Increased poaching of animals.**	
Nature of impact	Negative. Direct.	
Legal requirements	Limpopo Environmental Management Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Indirect.	Negative. Indirect.
Extent of impact	Local.	Local.
Duration of impact	Long term	Long term
Intensity	Medium (Bulk supply routes, reservoirs) High (Dam)	Low (Bulk supply routes, reservoirs) High (Dam)
Probability of occurrence	High	High
Confidence of assessment	Medium	Medium
Level of significance before mitigation	Medium (untransformed habitats) Low (transformed habitats)	Medium (untransformed habitats) Low (transformed habitats)
Mitigation measures (EMP requirements)	1. Construction teams should not be allowed access to areas of untransformed vegetation where	1. No suitable mitigation for increased poaching as a result of people settling around the shores of

	opportunities for poaching may be present; construction camps and work sites should be fenced off. Penalties should be levied on any construction teams that transgress and poachers should be prosecuted under relevant provincial legislation.	the dam.
Level of significance after mitigation	Low	Medium (untransformed habitats) Low (transformed habitats)
Cumulative Impacts		Increased settlement around dam resulting in more poaching opportunities arising, particularly regarding Hippo, Nile Crocodile and Python.
Comments or Discussion		

Description of potential impact	**Impoverishment of populations of important animals.**	
Nature of impact	Negative. Direct.	
Legal requirements	Limpopo Environmental Management Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Direct.	Negative. Direct.
Extent of impact	Local.	Local.
Duration of impact	Short term (Bulk supply routes) Permanent	Short term (Bulk supply routes) Permanent
Intensity	Medium (Bulk supply routes, reservoirs) High (Dam)	Low (Bulk supply routes, reservoirs) High (Dam)
Probability of occurrence	Medium (Bulk supply routes, reservoirs) High (Dam)	Medium (Bulk supply routes, reservoirs) High (Dam)

Confidence of assessment	High	High
Level of significance before mitigation	Medium (untransformed habitats) Low (transformed habitats)	Medium (untransformed habitats) Low (transformed habitats)
Mitigation measures (EMP requirements)	1. A major trapping and relocation operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species where possible, particularly small mammals and reptiles; scientific institutions should be invited to collect live specimens.	1. Dense vegetation should be allowed to re-grow along parts of the dam shoreline in order to regain habitat for certain Red Data bird species, viz. African Finfoot and White-backed Night Heron.
Level of significance after mitigation	Low	Low
Cumulative Impacts		Increased settlement around dam resulting in further fragmentation and loss of untransformed habitat for important animals.
Comments or Discussion		

Description of potential impact	**Dam acts as a barrier to terrestrial animal movement, particularly reduction of riparian zone as a migration corridor.**	
Nature of impact	Negative. Direct.	
Legal requirements	Not aware of any.	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Direct.	Negative. Direct.
Extent of impact	Regional.	Regional.
Duration of impact	Permanent (Dam)	Permanent (Dam)
Intensity	Medium (Dam)	High (Dam)
Probability of occurrence	High	High

Confidence of assessment	Medium	High
Level of significance before mitigation	Low	Medium
Mitigation measures (EMP requirements)		1. Dense vegetation should be allowed to re-grow along most of the dam shoreline in order to regain a functional riparian corridor.
Level of significance after mitigation	Low	Low
Cumulative Impacts		
Comments or Discussion		

7.2.2 Raising Tzaneen Dam

Description of potential impact	**Transformation and fragmentation of habitat for animals.**	
Nature of impact	Negative. Direct.	
Legal requirements	National Environmental Management Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Direct.	Negative. Direct.
Extent of impact	Local.	Local.
Duration of impact	Permanent	Permanent
Intensity	Low	Low
Probability of occurrence	High	High
Confidence of assessment	High	High
Level of significance before mitigation	Low	Low
Mitigation measures (EMP requirements)	None	None
Level of significance after mitigation	Low	Low

Cumulative Impacts		
Comments or Discussion		

Description of potential impact	**Increased poaching of animals.**	
Nature of impact	Negative. Direct.	
Legal requirements	Limpopo Environmental Management Act	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Negative. Indirect.	Negative. Indirect.
Extent of impact	Local.	Local.
Duration of impact	Long term	Long term
Intensity	Medium	Low
Probability of occurrence	Medium	Medium
Confidence of assessment	Medium	Medium
Level of significance before mitigation	Low	Low
Mitigation measures (EMP requirements)		
Level of significance after mitigation	Low	Low
Cumulative Impacts		
Comments or Discussion		

Description of potential impact	**Impoverishment of populations of important animals.**	
Nature of impact	Negative. Direct.	
Legal requirements	Limpopo Environmental Management Act	
Stage	Pre-Construction and Construction	Operation

Nature of Impact	Negative. Direct.	Negative. Direct.
Extent of impact	Local.	Local.
Duration of impact	Permanent	Permanent
Intensity	Low	Low
Probability of occurrence	Medium	Medium
Confidence of assessment	High	High
Level of significance before mitigation	Low	Low
Mitigation measures (EMP requirements)		
Level of significance after mitigation	Low	Low
Cumulative Impacts		
Comments or Discussion		

7.3 INVERTEBRATE FAUNA

7.3.1 Nwamitwa Dam

The proposed dam and associated processing plant, as well as both proposed borrow pit sites and the reservoir site alternatives except for Command Reservoir "C" alternatives 1-3, all fall within areas of Granite Lowveld or Tsende Mopaneveld. Both of these vegetation types received a "very high" conservation importance value in the desktop assessment of the GLeWaP, and both proved to contain significant populations of protected invertebrate species. The *Colophospermum – Dichrostachys* Plains Woodland component of Granite Lowveld appears of particular importance as populations of a rare and protected beetle species (*Dromica oberprieleri*) with a limited distribution and another rare but less restricted species (*Megacephala regalis vansoni*) were found in this habitat type. It is therefore inevitable that the proposed developments will have a negative impact on conservation-important invertebrate populations; the likely impacts and proposed mitigation options are described below, but these assessments must be considered as preliminary until all specimen identification has been completed.

Description of potential impact	Transformation of habitat for protected invertebrate species	
Nature of impact	Direct and negative	
Legal requirements	NEMBA, LEMA	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Direct and negative	Direct and negative
Extent of impact	Local	Local
Duration of impact	Long-term / Permanent	Long-term / Permanent
Intensity	High	High
Probability of occurrence	High	High
Confidence of assessment	High	High
Level of significance before mitigation	High	High
Mitigation measures (EMP requirements)	None (see comments)	None (see comments)
Level of significance after mitigation	N/A	N/A
Cumulative Impacts	Probable, due to surrounding transformation of land for agriculture	Probable, due to surrounding transformation of land for agriculture
Comments or Discussion: Loss of habitat is inevitable if construction of the Nwamitwa dam proceeds; the only mitigation possible is to build a lower dam resulting in less inundation.		

Description of potential impact	Death of populations or individuals of protected invertebrate species	
Nature of impact	Direct and negative	
Legal requirements	NEMBA, LEMA	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Direct and negative	Direct and negative
Extent of impact	Local	Local

Duration of impact	Permanent	Permanent
Intensity	High	High
Probability of occurrence	High	High
Confidence of assessment	High	High
Level of significance before mitigation	High	High
Mitigation measures (EMP requirements)	• Initial flooding of habitat areas to be carried out during the active season of the adult stage of the beetle species to allow them to avoid drowning; larvae will not be able to escape	
Level of significance after mitigation	Medium if sufficient untransformed habitat remains after filling of dam to maintain viable populations	Medium if sufficient untransformed habitat remains after filling of dam to maintain viable populations
Cumulative Impacts	Probable, due to surrounding transformation of land for agriculture and use of pesticides	Probable, due to surrounding transformation of land for agriculture and use of pesticides
Comments or Discussion:		

7.3.2 Pipeline installation, Reservoir Construction, Borrow Pits, Road Re-alignments

Final information on specimen identifications is needed before data can be analysed to properly assess the above. Some recommendations regarding preferred alternatives and can however be made on the basis of an initial assessment during the field surveys:

1. The site chosen for Command Reservoir A appears very disturbed and overgrazed, with the insect community almost completely dominated by *Anoplolepis custodiens* (an ant which thrives in disturbed areas); there seems little reason to oppose development of this site.
2. In strong contrast, the site chosen for Command Reservoir B appears to be a very undisturbed and sensitive site; as there appears to be no alternative, great

care should be taken to minimise damage to the area surrounding the reservoir itself.

3. Alternative 1 appears the most suitable option for Command Reservoir C as it is the most disturbed, but care will be needed to position it so that the pipeline alignment does not need to traverse the wetland area and drainage line just below it. Of the alternative sites, both areas marked as Alternative 3 are moderately disturbed through wood collecting and overgrazing, while Alternative 2 is situated in a wetland and its associated pipeline route follows a drainage line.
4. Alternative 3 would be the preferred option for Command Reservoir D as it is the most disturbed of the three alternatives and would require the shortest length of pipeline through untransformed areas. Alternative 2 would be the next most favoured option from an invertebrate perspective, with alternative 1 being the most sensitive and hence not recommended.
5. In general it is recommended that pipeline alternatives within road reserves be used as those not following roads traverse some diverse, undisturbed and sensitive areas (including drainage lines and wetlands). In particular it is recommended that the pipeline from the water treatment plant (WTP) to Command Reservoir A should follow the more western of the two alternatives indicated.
6. Road re-alignments in the proposed Nwamitwa Dam area are all within the same vegetation community within Granite Lowveld, namely *Colophospermum – Dichrostachys* Plains Woodland, which was identified as the most sensitive in the project area from an invertebrate perspective, so the only criterion to distinguish between alternatives is the amount of untransformed land they traverse. Considering land to be inundated as effectively transformed (including parts that are currently not transformed) this gives an ordering (from lowest to highest negative impact from an invertebrate perspective) of: **1)** Alternative 4, **2)** Alternative 1 / Alternative 3 (there is no significant difference between these), **3)** Alternative 2, with Alternative 5 marginally reducing the impact of any of alternatives 1, 2 and 3 (Alternative 5 is clearly not an applicable option if Alternative 4 is followed). There is little difference in predicted impacts from an invertebrate perspective between Alternatives 1, 3 and 4, so cost would probably be the driving factor here, with the practical aspects of long spans of causeways being a major concern. Unfortunately, the only option that effectively avoids the need for long causeways is Alternative 2, which is option with the highest negative impact from an invertebrate perspective. However, it should also be

borne in mind that the impacts of the road realignments will be of far lower significance than those resulting from the dam impoundment. If Alternative 2 is followed, careful attention should be paid to mitigating the barrier effect that this would have, as it bisects a fairly large area of untransformed land; this could most effectively be done by including substantial underpasses to allow movement of small flightless animals.

7.3.3 Raising Tzaneen Dam

No invertebrate surveys of the area surrounding the existing Tzaneen dam were undertaken, so probable impacts can be estimated only on the basis of an assessment of the conservation value of the vegetation type (Tzaneen Sour Bushveld) within which it lies. Both the desktop assessment and the results of the field surveys in the project area suggest that Tzaneen Sour Bushveld is of lower invertebrate biodiversity value than the Granite Lowveld within which the proposed Nwamitwa dam lies. In combination with the fact that the same additional capacity could probably be achieved with a lower additional area of inundated land by raising the Tzaneen dam, and that much of the area surrounding the Tzaneen dam is already transformed (under cultivation or forest plantations) it is to be expected that this option would result in substantially lower negative impacts on invertebrate biodiversity. The possibility that there might be additional impacts arising from the need for further pipeline infrastructure must however also be taken into account.

Description of potential impact	Transformation of habitat for protected invertebrate species	
Nature of impact	Direct and negative	
Legal requirements	NEMBA, LEMA	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Direct and negative	Direct and negative
Extent of impact	Local	Local
Duration of impact	Long-term / Permanent	Long-term / Permanent
Intensity	Low	Low

Probability of occurrence	Low	Low
Confidence of assessment	Medium	Medium
Level of significance before mitigation	Low	Low
Mitigation measures (EMP requirements)	None	None
Level of significance after mitigation	N/A	N/A
Cumulative Impacts		
Comments or Discussion:		

Description of potential impact	Death of populations or individuals of protected invertebrate species	
Nature of impact	Direct and negative	
Legal requirements	NEMBA, LEMA	
Stage	Pre-Construction and Construction	Operation
Nature of Impact	Direct and negative	Direct and negative
Extent of impact	Local	Local
Duration of impact	Permanent	Permanent
Intensity	Low	Low
Probability of occurrence	Medium	Medium
Confidence of assessment	Medium	Medium
Level of significance before mitigation	Low	Low
Mitigation measures (EMP requirements)	None	None
Level of significance after mitigation	Low	Low
Cumulative Impacts		
Comments or Discussion:		

8. RECOMMENDED MITIGATION MEASURES

The recommended mitigation measures apply to the Pre-Construction, Construction and Operation Phases.

8.1 FLORA

8.1.1 Nwamitwa Dam

Objective

To minimise transformation and fragmentation of habitat for plants.

Targets

- Maintenance of viable corridors of natural habitat in the project area.
- Minimise impact on natural vegetation

Method Statements

- All pipeline routes through untransformed vegetation should be regarded as least favourable options; routes should whenever possible traverse transformed habitats.
- Establish a holding nursery for local plants suitable for re-planting on rehabilitated surfaces after closure (construction camp, borrow pits).
- Rehabilitate borrow pits and construction camp according to DWAF's Integrated Environmental Management Series No.6: Environmental Best Practice Specifications (Construction), which is summarised in **Appendix 4K**.

Objective

To minimise harvesting pressure on vegetation

Targets

- Maintenance of vegetation in natural condition surrounding infrastructure.

Method Statements

- Construction teams should not be allowed access to areas of untransformed vegetation for collection of firewood, etc; construction camps and work sites should be fenced off. Penalties should be levied on any construction teams that transgress.
- Allow local communities access to plant resources below full supply level, but not before plant rescue has been completed.
- All pipeline routes through untransformed vegetation should be regarded as last resorts; routes should whenever possible traverse transformed habitats.

Objective

To minimise invasion by alien plants

Targets

- Maintenance of vegetation in natural condition surrounding infrastructure.

Method Statements

- Restrict development footprint to absolute minimum area necessary.
- Conduct annual monitoring of dam surface for invasion by exotic aquatic plants.
- Rehabilitate disturbed sites through ripping of soil surface and hydroseeding with a seed mix slurry of relevant indigenous grasses.

Objective

To minimise the loss of conservation-important plant species

Targets

- Maintenance of viable populations of conservation-important plant species.

Method Statements

- A major plant rescue operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species where possible; scientific institutions should also be invited to collect live specimens.
- Establish a holding nursery for local plants suitable for re-planting on rehabilitated surfaces after closure (construction camp, borrow pits)

- All pipeline routes through untransformed vegetation should be regarded as least favourable options; routes should whenever possible traverse transformed habitats.

Objective

To minimise the disruption of the natural fire regime on either side of proposed dam.

Targets

- Maintenance of equivalent fire regimes on both sides of the dam.

Method Statements

- Burns on both sides of dam should take place at similar frequency and at similar times.
- Not sure whose responsibility this would be.

Objective

To minimise the erosion and loss of topsoil from construction sites and borrow pits.

Targets

- Return soil surfaces to previous state after closure.

Method Statements

- Topsoil should be stockpiled separately from overburden; piles not to exceed 2 metres in height and not exceed a slope of 1:3.
- These stockpiles should not be stored for longer than 6 months and should be protected against erosion and weeds.
- See Appendix 4K.

8.1.2 Raising Tzaneen Dam

Objective

To minimise harvesting pressure on vegetation

Targets

- Maintenance of vegetation in natural condition surrounding infrastructure.

Method Statements

- Construction teams should not be allowed access to areas of untransformed vegetation for collection of firewood, etc; construction camps and work sites should be fenced off. Penalties should be levied on any construction teams that transgress.

Objective

To minimise invasion by alien plants

Targets

- Maintenance of vegetation in natural condition surrounding infrastructure.

Method Statements

- Restrict development footprint to absolute minimum area necessary
- Rip and hydroseed disturbed surfaces with indigenous grasses

Objective

To minimise the loss of conservation-important plant species

Targets

- Maintenance of viable populations of conservation-important plant species.

Method Statements

- A major plant rescue operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species where possible; scientific institutions should also be invited to collect live specimens.

8.2 VERTEBRATE FAUNA

8.2.1 Nwamitwa Dam

Objective

To minimise transformation and fragmentation of habitat for vertebrate fauna.

Targets

- Maintenance of viable corridors of natural habitat in the project area.
- Minimise impact on natural vegetation

Method Statements

- All pipeline routes through untransformed vegetation should be regarded as least favourable options; routes should whenever possible traverse transformed habitats.
- A major trapping and relocation operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species where possible, particularly small mammals and reptiles; scientific institutions should be invited to collect live specimens.
- Dense vegetation should be allowed to re-grow along most of the dam shoreline in order to regain a functional riparian corridor.

Objective

To minimise poaching of vertebrate fauna.

Targets

Maintenance of viable populations of vertebrate fauna

Method Statements

- Construction teams should not be allowed access to areas of untransformed vegetation where opportunities for poaching may be present; construction camps and work sites should be fenced off. Penalties should be levied on any construction teams that transgress and poachers should be prosecuted under relevant provincial legislation.

Objective

To minimise loss of conservation-important vertebrate fauna.

Targets

Maintenance of viable populations of conservation-important vertebrate fauna

Method Statements

- A major trapping and relocation operation should be implemented, targeting the rescue and translocation of threatened, endemic and protected species where possible, particularly small mammals and reptiles; scientific institutions should be invited to collect live specimens.
- All pipeline routes through untransformed vegetation should be regarded as least favourable options; routes should whenever possible traverse transformed habitats.
- Dense vegetation should be allowed to re-grow along parts of the dam shoreline in order to regain habitat for certain Red Data bird species, viz. African Finfoot and White-backed Night Heron.

8.2.2 Raising Tzaneen Dam

None

8.3 INVERTEBRATE FAUNA

8.3.1 Nwamitwa Dam

Objectives

- **To minimise loss of individuals of rare and protected beetle species.**
- **To minimise loss of protected scorpion and baboon spider species.**

Targets

Viable populations of *Dromica oberprieleri* and *Megacephala regalis vansoni,* as well as other protected beetle species, remain after completion of construction activities.

- No impacts on populations of Flat Rock Scorpions (*Hadogenes troglodytes*) and

minimal loss of individuals of protected baboon spiders and other protected scorpion species including *Opistophthalmus glabrifrons* and *Opistacanthus asper*.

Method Statements

- Filling of Nwamitwa Dam, if approved, should be done as slowly as feasible and as far as possible within the adult activity period of Dromica oberprieleri (October - January)
- Pipeline and reservoir construction should avoid areas with rocky outcrops suitable as habitat for H. troglodytes, area disturbed during construction should be minimised as far as is feasible so as to reduce impacts on baboon piders and other scorpion species.

8.3.2 Raising Tzaneen Dam

None

9. CONSULTATION PROCESS

Engagement with Interested and Affected Parties (I&APs) forms an integral component of the EIA process. I&APs have an opportunity at various stages throughout the EIA process to gain more knowledge about the proposed project, to provide input into the process and to verify that their issues and concerns have been addressed.

The proposed project was announced in July 2007 to elicit comment from and register I&Aps from as broad a spectrum of public as possible. The announcement was done by the following means:

- the distribution of Background Information Documents (BIDs) in four languages,
- placement of site notices in the project area,
- publishment of advertisements in regional and local newspapers,
- publishment of information on the DWAF web site,
- announcement on local and regional radio stations; and
- the hosting of five focus group meetings in the project area.

Comments received from stakeholders were captured in the Issues and Response Report (IRR) which formed part of the Draft Scoping Report (DSR). The DSR was made available for public comment in October 2007. A summary of the DSR (translated into four languages) was distributed to all stakeholders and copies of the full report at public places. Two stakeholder meetings were held in October to present and discuss the DSR. The Final Scoping Report was made available to stakeholders in December 2007.

The availability of the Draft Environmental Impact Assessment Report, its summary (translated in four languages), the various specialist studies, the Environmental Management Plans and Programmes will be announced by way of personalized letters to stakeholders and the placement of advertisements in regional and local newspapers. The draft documents will be made available to I&APs for the inputs and comments. Two stakeholder meetings are planned to present the contents of the documents and to discuss the findings of the study.

A public review period of thirty (30 days) will be available for stakeholders to comment on the Draft Environmental Impact Assessment Report, its summary (translated in four languages), the various specialist studies, the Environmental Management Plans and Programmes. Stakeholder comments will be taken into consideration with the preparation of the final documents. The availability of the final documents will be announced prior to submission to the decision-making authority.

10. COMMENTS RECEIVED

ISSUES REALTED TO THE ECOLOGY (VEGETATION) AND CONSERVATION		
ISSUE	**RAISED BY**	**SOURCE**
a. That the proposed project should improve the ecology along the river and the new proposed dam and should also focus on the protection of rare and sensitive fauna and flora in the proposed dam basin.	Daniel Mathye, Thomas Mathebula, Stanley Baloyi, Samson Ngobeni (headman Valoyi Tribal Authority), Oris Mgobeni, Macson Hlahleni – resident Nwamitwa village. MK (Mick) Angliss, Limpopo Dept Economic Dev, Env & Tourism Ms CA (Chantal) Matthys, DWAF: WA&IU (Environment & Recreation). Isaac Makatu, DEAT (Mopani)	Written submission (BID comment sheet) and attendance at meeting at Nwamitwa Tribal office, 1 August 2007. Written submission (BID comment sheet). Written submission (BID comment sheet). Written submission (BID comment sheet).
b. That the possible increase of invader plants species that might crowd out the indigenous riverine plants, congesting the water place be investigated.	Maria Hendricks, Blue Sands Trading, Tzaneen.	Written submission (BID comment sheet).
c. That the impact of the proposed new project be investigated on the ecosystem and biodiversity, aquatic habitat, functioning of species.	CA (Chantal) Matthys, DWAF: WA&IU (Environment & Recreation).	Written submission (BID comment sheet).
d. That botanical and zoological surveys are carried out with reference to the latest publication on fauna and flora distribution, particularly the latest VegMap. Attention must be paid to the possible occurrence of biodiversity hotspots in the area.	Luke Perkins, Wildlife and Environment Society of SA (WESSA).	Written submission (BID comment sheet).
e. That the riverine bush – recovery of wood should be considered.	JS (Johan) Barnard, Landowner.	Written submission (BID comment sheet).
f. That indigenous knowledge on natural trees around the proposed project area be undertaken for record purposes.	Andrew Tshivhase, DWAF – Forestry, Limpopo Region, Louis Trichardt.	Written submission (BID comment sheet).

ISSUES REALTED TO THE ECOLOGY (VEGETATION) AND CONSERVATION		
g. That information is needed on whether the precious trees on the river bed will be utilised effectively?	Willie Muller, Landowner.	Attended meeting at Letaba Junction on 1 August 2007 and the meeting held at the offices of the Groot Letaba Water User Association on 31 July 2007.
h. That mitigation should receive a high priority when protected species are removed.	Andrew Tshivhase, DWAF – Forestry, Limpopo Region, Louis Trichardt.	Written submission (BID comment sheet).
i. That a license should be applied for to remove protected species in the proposed dam basin area.	Andrew Tshivhase, DWAF – Forestry, Limpopo Region, Louis Trichardt.	Written submission (BID comment sheet).
j. The Biodiversity offset mitigation measures for the Red Data, endemic and near endemic species that will be lost to the dam construction should be investigated.	DEAT: Biodiversity on conservation division	Scoping Report
k. The Mean Annual Runoff that can support the downstream ecology should be investigated as the conservation of the dam will alter the stream flow and mean Annual Runoff	DEAT: Biodiversity on conservation division	Scoping Report
l. Construction of the dam will have impact on aquatic species migratory routes and some might lose the spawning areas and habitat that support the critical stages of their life cycle e.g. the larval stage. Therefore migratory aquatic species should be investigated.	DEAT: Biodiversity on conservation division	Scoping Report
m. There is a need to study the effects of this dam to the ecological functions and character of the downstream in the Kruger National Park, especially the impacts on the protected wild flora and fauna that are entirely dependent on the river system for survival.	DEAT: Biodiversity on conservation division	Scoping Report

11. OTHER INFORMATION REQUESTED BY THE AUTHORITY

No other information was requested by the authority.

12. CONCLUSION

The proposed Nwamitwa Dam and associated bulk storage scheme is partially situated within a Vulnerable vegetation type, namely Granite Lowveld, while the raising of the Tzaneen Dam wall would potentially impact an Endangered vegetation type, namely Tzaneen Sour Bushveld. However, several intact portions of Granite Lowveld exist within the proposed dam basin, while all vegetation around the shoreline of the Tzaneen Dam appears to be transformed or degraded, and not representative of Tzaneen Sour Bushveld.

Of the three vegetation communities identified during fieldwork, *Colophospermum – Dichrostachys* Plains Woodland and *Combretum – Bridelia* Rocky Outcrop Woodland are the most important for flora. All three vegetation communities are of Medium importance to Vertebrate Fauna, while *Colophospermum – Dichrostachys* Plains Woodland has a high importance for Invertebrate Fauna, followed by *Combretum – Bridelia* Rocky Outcrop Woodland (Medium-High). Integration of these results show that *Colophospermum – Dichrostachys* Plains Woodland has the highest importance for terrestrial biota (High-Medium), followed by *Combretum – Bridelia* Rocky Outcrop Woodland (Medium-Low) and *Acacia - Combretum* Riparian Woodland (Low-Medium). Plains Woodland is also the vegetation community most likely to be impacted by the proposed Nwamitwa Dam and the pipelines of the bulk storage scheme.

At least two rare and localised protected beetle species are likely to be significantly impacted by the Nwamitwa Dam, as well as populations of numerous other protected but widespread beetle, scorpion and spider species. As the most significant of these impacts will result from inundation of the dam impoundment area, and hence cannot be effectively mitigated, consideration should be given to the alternative option of raising the Tzaneen Dam wall.

If the Nwamitwa Dam were to go ahead, then strict adherence to proposed mitigations should be followed. This would include *inter alia* timing of flooding of the basin, rescue operations prior to inundation, and locating of pipeline routes in currently transformed or degraded habitats only. An additional recommendation, although not a mitigation, would be for the EMP to include an appropriate invertebrate

biodiversity-monitoring programme, for which baseline assessments of selected indicator taxa (e.g. Dromica spp.) must be undertaken prior to any development of the site.

13. ACKNOWLEDGEMENTS

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APPENDIX 4A. PLANT SPECIES RECORDED IN THREE VEGETATION COMMUNITIES OF THE PROJECT AREA

SCIENTIFIC NAME	FAMILY	Growth Form	Red Data	Endemic	Protected	*Acacia - Combretum* Riverine Woodland	*Colophospermum - Dichrostachys* Plains Woodland	*Combretum - Bridelia* Rocky Outcrop Woodland
Ferns								
Cheilanthes viridis	Pteridaceae	fern					+	+
Pellaea calomelanos	Pteridaceae	fern						1
Selaginella dregei	Selaginellaceae	fern					+	
Subtotal		3	0	0	0	0	2	2
Dicotyledons								
Barleria cf.ovata	Acanthaceae	dwarf shrub						+
Crabbea acaulis	Acanthaceae	herb					+	+
Dyschoriste sp. (no flowers)	Acanthaceae	herb					1	
Hypoestes sp.	Acanthaceae	herb				2		
Justicia flava	Acanthaceae	herb				1	1	
Ruellia cf.cordata	Acanthaceae	herb					+	
Ruellia cf.patula	Acanthaceae	herb					1	
Thunbergia sp. (climber)	Acanthaceae	climber					+	+
*Achyranthes aspera **	Amaranthaceae	herb				1		+
Cyathula cylindrica	Amaranthaceae	herb				1		+
Kyphocarpa angustifolia	Amaranthaceae	herb				+	1	1

Pupalia lappacea	Amaranthaceae	herb				+	1	1
Lannea discolor	Anacardiaceae	tree					+	1
Lannea stuhlmannii	Anacardiaceae	dwarf shrub				1	2	
Ozoroa paniculosa	Anacardiaceae	tree					1	1
Ozoroa spherocarpa	Anacardiaceae	tree						+
Rhus gueinzii	Anacardiaceae	shrub					1	+
Rhus leptodictya	Anacardiaceae	tree						1
Sclerocarya birrea subsp.cafra	Anacardiaceae	tree			NFA	1	2	1
Annona senegalensis	Annonaceae	tree						+
Hexalobus monopetalus	Annonaceae	tree						+
Xylopia cf.parviflora	Annonaceae	tree						+
Steganotaenia araliacea	Apiaceae	tree						+
Asclepias physocarpa	Apocynaceae	herb					1	+
Asclepias sp. (photo)	Apocynaceae	herb					+	
Huernia sp.	Apocynaceae	succulent			LEMA		+	
Riocreuxia picta	Apocynaceae	climber			LEMA	1		
Sarcostemma viminale	Apocynaceae	climber				+	+	1
Secamone sp.	Apocynaceae	herb				1		
*Aristolochia elegans**	Aristolochiaceae	herb				2		
*Ageratum houstonianum **	Asteraceae	herb				1		
*Bidens pilosa**	Asteraceae	herb				1		1
*Schkuhria pinnata**	Asteraceae	herb					1	1
Senecio sp.1	Asteraceae	herb						+
*Tagetes minuta **	Asteraceae	herb						1
Vernonia myriacantha	Asteraceae	shrub				1		
Vernonia sp.	Asteraceae	shrub				+		
Xanthium strumarium	Asteraceae	herb				1		
Balanites maughamii	Balanitaceae	tree			NFA		1	+
Cordia sinensis	Boraginaceae	shrub					1	1
Ehretia amoena	Boraginaceae	tree					1	+
Ehretia obtusifolia	Boraginaceae	tree					+	
Ehretia rigida	Boraginaceae	tree				1		+
Commiphora africana	Burseraceae	tree					1	
Commiphora glandulosa	Burseraceae	tree					+	+

Commiphora mollis	Burseraceae	tree					+	1
Wahlenbergia sp.	Camapanulaceae	herb						+
Capparis cf.sepiaria	Capparaceae	shrub				1		
Eleaodendron transvaalense	Celastraceae	tree	LC		NFA		+	1
Gymnosporia glaucophylla	Celastraceae	tree					2	+
Gymnosporia senegalensis	Celastraceae	tree				1	+	+
Gymnosporya maranguense	Celastraceae	tree					+	
Maytenus undata	Celastraceae	tree						+
Combretum apiculatum	Combretaceae	tree					2	3
Combretum collinum gazense	Combretaceae	tree					+	
Combretum collinum suluense	Combretaceae	tree					1	1
Combretum erythrophyllem	Combretaceae	tree				3		
Combretum hereroense	Combretaceae	tree				1	1	+
Combretum imberbe	Combretaceae	tree			NFA		2	+
Combretum molle	Combretaceae	tree					+	1
Combretum mossambicense	Combretaceae	tree						+
Combretum zeyheri	Combretaceae	tree					1	2
Terminalia brachystemma	Combretaceae	tree					+	+
Terminalia sericea	Combretaceae	tree				+	1	+
Ipomoea albivenia	Convolvulaceae	creeper					+	1
Ipomoea sp.	Convolvulaceae	creeper						+
Kalanchoe aff.brachyloba	Crassulaceae	succulent				+		
Cucurbitaceae sp.1	Cucurbitaceae	creeper				+		
Cucurbitaceae sp.2	Cucurbitaceae	creeper				+		
Diospyros mespiliformis	Ebenaceae	tree				2	1	+
Euclea crispa	Ebenaceae	shrub						+
Euclea divinorum	Ebenaceae	tree				+	1	1
Euclea natalensis	Ebenaceae	tree				+		+
Euclea schimperi	Ebenaceae	tree					+	+
Acalypha sp.	Euphorbiaceae	herb						+
Antidesma venosum	Euphorbiaceae	tree						+
Bridelia mollis	Euphorbiaceae	tree					1	2
Croton menyharti	Euphorbiaceae	tree						+
Delachampia capensis	Euphorbiaceae	herb						+

Euphorbia cooperi	Euphorbiaceae	succulent						+
Euphorbia ingens	Euphorbiaceae	succulent					+	1
Flueggea virosa	Euphorbiaceae	shrub				1	1	1
*Jatropha curcas**	Euphorbiaceae	shrub				+		
Phyllanthus reticulatus	Euphorbiaceae	shrub				1	1	+
Pseudolachnostylis maprouneifolia	Euphorbiaceae	shrub						1
*Ricinus communis**	Euphorbiaceae	herb				1		
Spirostachys africana	Euphorbiaceae	tree			LEMA	1	1	
Synadenium cupulare	Euphorbiaceae	tree						+
Tragia meyeriana	Euphorbiaceae	creeper					+	
Tragia sp.	Euphorbiaceae	herb					+	
Abrus laevigatus	Fabaceae	climber						+
Acacia caffra	Fabaceae	tree						+
Acacia erubescens	Fabaceae	tree					+	
Acacia exuvialis	Fabaceae	tree					1	1
Acacia gerrardii	Fabaceae	tree					1	
Acacia grandicornuta	Fabaceae	tree					1	+
Acacia karoo	Fabaceae	tree				+		
Acacia nigrescens	Fabaceae	tree				+	2	1
Acacia nilotica	Fabaceae	tree						1
Acacia polyacantha	Fabaceae	tree				3		
Acacia schweinfurthii	Fabaceae	climber/shrub				1		
Acacia tortilis	Fabaceae	tree					1	
Albizia harveyi	Fabaceae	tree					1	1
Albizia versicolor	Fabaceae	tree						+
Bauhinia galpinii	Fabaceae	climber/shrub				1	+	1
Bolusanthus speciosus	Fabaceae	tree				+	1	
Cassia abreviata	Fabaceae	shrub					+	
Chaemaecrista mimosoides	Fabaceae	herb					+	+
Colophospermum mopane	Fabaceae	tree				1	3	+
Crotalaria laburnifolia	Fabaceae	shrub					+	
Crotalaria sp.1	Fabaceae	dwarf shrub				1		
Dalbergia melanoxylon	Fabaceae	tree				+	1	+
Dichrostachys cinerea subsp.	Fabaceae	shrub				+	3	1

nyassana								
Indigofera hilaris	Fabaceae	herb						1
Indigofera sp.1	Fabaceae	shrub					+	
Mundulea sericea	Fabaceae	tree					+	1
Ormocarpum trichocarpum	Fabaceae	shrub					+	+
Peltophorum africanum	Fabaceae	tree				1	+	1
Philenoptera violacea	Fabaceae	tree			NFA	1	+	+
Piliostigma thonningii	Fabaceae	shrub						+
Pterocarpus angolensis	Fabaceae	tree			NFA			1
Pterocarpus rotundifolius	Fabaceae	tree				+		1
Rhynchosia caribea	Fabaceae	herb				+	+	
Rhynchosia totta	Fabaceae	herb				+	+	+
Schotia brachypetala	Fabaceae	tree				1	+	
*Senna bicapsularis**	Fabaceae	shrub				1		
Senna cf.pendulina	Fabaceae	shrub				1		
Senna italica	Fabaceae	shrub				+		
Senna petersiana	Fabaceae	tree				+	1	1
Sesbania sesban	Fabaceae	shrub				1		
Tephrosia cf.longipes	Fabaceae	herb						+
Tephrosia cf.rhodesiaca	Fabaceae	herb						+
Tephrosia polystachya	Fabaceae	shrub					1	1
Tephrosia sp.	Fabaceae	herb				+		+
Xanthocercis zambesiaca	Fabaceae	tree					+	
Zornia linearis	Fabaceae	herb						+
Scolopia zeyheri	Flacourtiaceae	tree					+	
Monsonia sp.	Geraniaceae	herb						+
Heteropyxis natalensis	Heteropyxidaceae	tree					+	+
Kirkia acuminata	Kirkiaceae	tree					+	2
Clerodendrum ternatum	Lamiaceae	dwarf shrub					1	1
Hemizygia cf.teucrifolia	Lamiaceae	herb						+
Hemizygia sp.1	Lamiaceae	herb					+	+
Leonotis intermedia	Lamiaceae	herb						+
Ocimum americanum	Lamiaceae	herb					1	+
Plectranthus spicatus	Lamiaceae	shrub					+	

Tinnea rhodesiana	Lamiaceae	shrub					+	
Cyphia stenopetala	Lobeliaceae	herb					+	
Tapinanthus rubromarginatus	Loranthaceae	parasite				+		
Tapinanthus sp.	Loranthaceae	parasite					+	
Galpinia transvaalica	Lythraceae	shrub				+		
Sphedamnocarpus pruriens	Malphigiaceae	climber						+
Abutilon sonneratianum	Malvaceae	shrub				1	1	
Dombeya rotundifolia	Malvaceae	tree						1
Gossypium herbaceum	Malvaceae	herb					+	+
Grewia bicolor	Malvaceae	tree				+	1	+
Grewia flavescens	Malvaceae	tree				1	1	1
Grewia hexamita	Malvaceae	tree					+	+
Grewia monticola	Malvaceae	tree				+	1	1
Hibiscus calyphyllus	Malvaceae	herb				1	1	
Hibiscus sp.	Malvaceae	herb				+		
Hibiscus sp.2 (red, photo)	Malvaceae	herb					+	+
Hibiscus vitifolius	Malvaceae	herb					+	+
Melhania didyma	Malvaceae	herb				1	1	
Melhania prostrata	Malvaceae	herb					+	
Melhania sp.	Malvaceae	shrub				+		
Sida cordifolia	Malvaceae	dwarf shrub					1	
Sida dregei	Malvaceae	dwarf shrub				1		
Waltheria indica	Malvaceae	herb				1	1	1
Trichilia emetica	Meliaceae	tree				1		
Ficus glumosa	Moraceae	tree						1
Ficus ingens	Moraceae	tree						+
Ficus salicifolia	Moraceae	tree						+
Ficus sycamorus	Moraceae	tree				2		
Olax dissitiflora	Olacaceae	tree					+	
Ximenia americana	Olacaceae	tree					+	
Ximenia caffra	Olacaceae	tree					1	
Jasmimum stenolobium	Oleaceae	climber					+	
Jasminum fluminense	Oleaceae	climber				1	1	
Oxalis obliquifolia	Oxalidaceae	herb				+	+	+

Argemone ochraleucha *	Papaveraceae	herb				1		
Adenia digitata	Passifloraceae	climber				1	1	
Ceratotheca triloba	Pedaliaceae	herb					+	+
Dicerocaryum senecioides	Pedaliaceae	creeper					+	+
Persicaria senegalensis	Polygalaceae	herb				1		
Berchemia discolor	Rhamnaceae	tree					+	
Berchemia zeyheri	Rhamnaceae	tree						1
Ziziphus mucronata	Rhamnaceae	tree				1	+	+
Breonadia salicina	Rubiaceae	tree			NFA	+		
Catunaregam spinosa	Rubiaceae	shrub						+
Gardenia volkensii	Rubiaceae	tree					+	+
Pavetta schumanniana	Rubiaceae	shrub					1	1
Psydrax livida	Rubiaceae	shrub					+	+
Kraussia floribunda	Rubiaceae	shrub						+
Vangueria infausta	Rubiaceae	tree					+	1
Dodonaea angustifolia	Sapindaceae	shrub						+
Pappea capensis	Sapindaceae	tree					+	1
Aptosimum procumbens	Scrophulariaceae	herb					+	
Manulea sp.	Scrophulariaceae	herb					+	+
Striga asiatica	Scrophulariaceae	herb						+
Solanum catombelense	Solanaceae	herb						+
*Solanum incanum**	Solanaceae	herb						+
Solanum mauritianum *	Solanaceae	shrub				1		
Solanum panduriforme	Solanaceae	shrub				+	+	+
Solanum seaforthianum *	Solanaceae	climber				1		
Sterculia rogersii	Sterculiaceae	tree						1
Strychnos spinosa	Strychnaceae	tree					1	1
Pouzolzia mixta	Urticaceae	shrub				+		+
Urera sp.	Urticaceae	herb				1		
Lantana camara *	Verbenaceae	shrub				2	1	
Lantana rugosa	Verbenaceae	shrub				+	1	
Leucas capensis	Verbenaceae	herb				+	+	
Lippia javanica	Verbenaceae	herb						+
Lippia wilmsii	Verbenaceae	herb						1

Priva cordifolia	Verbenaceae	herb					+	
Viscum combreticola	Viscaceae	parasite						+
Cissus cactiformis	Vitaceae	climber				+		+
Cissus carnifolia	Vitaceae	climber				+	1	
Cyphostemma sp.	Vitaceae	creeper				+		
Cyphostemma woodii	Vitaceae	creeper					+	1
Rhoicissus revoilii	Vitaceae	climber						+
Rhoicissus tridentata	Vitaceae	climber/shrub					1	+
Subtotal		222	1	0	10	88	125	138
Monocotyledons								
Albuca sp.	Alliaceae	bulb						+
Boophane disticha	Amaryllidaceae	bulb			LEMA		+	1
Scadoxus sp.	Amaryllidaceae	bulb			LEMA			+
Chlorophytum sp.	Anthericaceae	bulb						+
Stylochaeton natalense	Araceae	bulb					+	+
Asparagus angusticladus	Asparagaceae	shrub					+	
Asparagus cf.buchananii	Asparagaceae	shrub					+	
Asparagus cooperi	Asparagaceae	shrub				+	1	1
Asparagus suaveolens	Asparagaceae	climber					1	1
Aloe cf.chabaudii	Asphodelaceae	succulent					+	
Aloe cryptopoda	Asphodelaceae	succulent			LEMA			+
Aloe greatheadii var.davyana	Asphodelaceae	succulent				+	+	+
Aloe marlothii	Asphodelaceae	succulent					+	+
Commelina africana	Commelinaceae	herb						+
Commelina benghalensis	Commelinaceae	herb				+		
Commelina cf.erecta	Commelinaceae	herb						+
Cyperus cf.rupestris	Cyperaceae	sedge					+	+
Cyperus leptocladus	Cyperaceae	sedge					1	
Cyperus sp.	Cyperaceae	sedge				+		
Kyllinga alba	Cyperaceae	sedge				+		
Sanseviera hyacinthoides	Dracaenaceae	bulb						+
Ledebouria cf.floribunda	Hyacinthaceae	bulb					+	1
Ansellia africana	Orchidaceae	epiphyte	LC		LEMA		+	+
Aristida congesta	Poaceae	grass				1	1	1

Aristida sciurus	Poaceae	grass				+	1	
Brachiaria serrata	Poaceae	grass					+	
Brachiaria sp.	Poaceae	grass					+	
Cymbopogon cf.excavatus	Poaceae	grass					1	
Cynodon dactylon	Poaceae	grass				1	1	+
Digitaria eriantha	Poaceae	grass					1	+
Enneapogon conchroides	Poaceae	grass				+	1	1
Eragrostis curvula	Poaceae	grass				1		+
Eragrostis gummiflua	Poaceae	grass				+		
Eragrostis superba	Poaceae	grass						+
Heteropogon contortus	Poaceae	grass				1	1	1
Hyperthelia dissoluta	Poaceae	grass				+	1	1
Melinis nerviglumis	Poaceae	grass						+
Melinis repens	Poaceae	grass				1	1	1
Panicum maximum	Poaceae	grass				2	2	1
Perotis patens	Poaceae	grass					+	+
Phragmites australis	Poaceae	grass				2		
Pogonarthria squarrosa	Poaceae	grass				1	1	+
Setaria megaphylla	Poaceae	grass				1		
Setaria sp.	Poaceae	grass						+
Setaria sphacelata	Poaceae	grass						+
Sorghum bicolor	Poaceae	grass				1		
Themeda triandra	Poaceae	grass					2	1
Tragus berteronianus	Poaceae	grass				1	1	1
Trichoneura grandiglumis	Poaceae	grass					1	+
Urochloa mossambica	Poaceae	grass				1	2	1
Xerophyta retinervis	Vellociaceae	geophyte					+	+
Subtotal		51	1	0	4	21	32	36
Total		276	2	0	14	109	159	176

APPENDIX 4B. PLANT SPECIES RECORDED IN PROPOSED INFRASTRUCTURE FOOTPRINTS OF THE PROJECT AREA

SCIENTIFIC NAME	FAMILY	Growth Form	Red Data	Endemic	Protected	DAM BASIN	BORROW PITS			RESERVOIRS							PIPELINES		
							5 (Near dam wall)	1 & 2	3 & 4	1	2	3	4	5	6 & 7	10	Hlohlokwe	Jasi	Gakomkgwathi
Ferns																			
Cheilanthes viridis	Pteridaceae	fern									x				x			x	
Pellaea calomelanos	Pteridaceae	fern													x				
Selaginella dregei	Selaginellaceae	fern																x	
Subtotal		3	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	2	0
Dicotyledons																			
Barleria cf.ovata	Acanthaceae	dwarf shrub												x					
Crabbea acaulis	Acanthaceae	herb												x	x			x	
Dyschoriste sp. (no flowers)	Acanthaceae	herb				x	x		x									x	
Hypoestes sp.	Acanthaceae	herb				x													
Justicia flava	Acanthaceae	herb				x	x											x	
Ruellia cf.cordata	Acanthaceae	herb																x	
Ruellia cf.patula	Acanthaceae	herb							x				x	x					
Thunbergia sp. (climber)	Acanthaceae	climber													x			x	
*Achyranthes aspera **	Amaranthaceae	herb				x		x					x						
Cyathula cylindrica	Amaranthaceae	herb				x									x				
Kyphocarpa angustifolia	Amaranthaceae	herb				x	x	x	x		x		x		x		x	x	x
Pupalia lappacea	Amaranthaceae	herb					x		x				x		x			x	
Lannea discolor	Anacardiaceae	tree					x					x		x					
Lannea stuhlmannii	Anacardiaceae	dwarf shrub				x			x									x	
Ozoroa paniculosa	Anacardiaceae	tree					x		x	x		x			x	x	x	x	
Ozoroa spherocarpa	Anacardiaceae	tree								x									

Rhus gueinzii	Anacardiaceae	shrub													x			x	
Rhus leptodictya	Anacardiaceae	tree								x		x			x		x		
Sclerocarya birrea subsp.cafra	Anacardiaceae	tree			NFA		x	x	x	x	x	x	x		x	x	x	x	x
Annona senegalensis	Annonaceae	tree									x								
Hexalobus monopetalus	Annonaceae	tree													x				x
Xylopia cf.parviflora	Annonaceae	tree	LC								x								
Steganotaenia araliacea	Apiaceae	tree													x				
Asclepias physocarpa	Apocynaceae	herb						x			x		x						
Asclepias sp. (photo)	Apocynaceae	herb															x		
Huernia sp.	Apocynaceae	succulent			LEMA													x	
Riocreuxia picta	Apocynaceae	climber			LEMA			x											
Sarcostemma viminale	Apocynaceae	climber					x	x	x									x	
Secamone sp.	Apocynaceae	herb					x											x	
*Aristolochia elegans**	Aristolochiaceae	herb				x													
*Ageratum houstonianum **	Asteraceae	herb				x													
*Bidens pilosa**	Asteraceae	herb				x							x						
*Schkuhria pinnata**	Asteraceae	herb								x			x						
Senecio sp.1	Asteraceae	herb												x					
*Tagetes minuta **	Asteraceae	herb									x								
Vernonia myriacantha	Asteraceae	shrub				x													
Vernonia sp.	Asteraceae	shrub					x												
Xanthium strumarium	Asteraceae	herb				x		x											
Balanites maughamii	Balanitaceae	tree			NFA						x								x
Cordia sinensis	Boraginaceae	shrub								x			x		x		x	x	x
Ehretia amoena	Boraginaceae	tree							x	x			x		x	x		x	
Ehretia obtusifolia	Boraginaceae	tree															x	x	
Ehretia rigida	Boraginaceae	tree				x			x						x				
Commiphora africana	Burseraceae	tree				x	x	x	x									x	x
Commiphora mollis	Burseraceae	tree								x					x		x		x
Commiphora glandulosa	Burseraceae	tree							x						x				
Wahlenbergia sp.	Camapanulaceae	herb												x					
Capparis cf.sepiaria	Capparaceae	shrub						x											
Eleaodendron transvaalense	Celastraceae	tree	LC		NFA										x		x	x	
Gymnosporia glaucophylla	Celastraceae	tree				x	x			x							x	x	

Gymnosporia senegalensis	Celastraceae	tree					x	x				x				x		x	
Gymnosporya maranguense	Celastraceae	tree																x	
Maytenus undata	Celastraceae	tree															x		
Combretum apiculatum	Combretaceae	tree				x	x		x	x	x	x	x		x		x	x	x
Combretum collinum gazense	Combretaceae	tree					x				x	x				x			
Combretum collinum suluense	Combretaceae	tree								x					x		x	x	x
Combretum erythrophyllem	Combretaceae	tree				x													
Combretum hereroense	Combretaceae	tree				x	x	x	x								x	x	x
Combretum imberbe	Combretaceae	tree			NFA	x		x	x	x			x				x	x	x
Combretum molle	Combretaceae	tree												x	x				x
Combretum mossambicense	Combretaceae	tree													x				
Combretum zeyheri	Combretaceae	tree				x	x	x	x	x		x	x			x	x	x	
Terminalia brachystemma	Combretaceae	tree								x									
Terminalia sericea	Combretaceae	tree						x	x	x	x	x	x	x		x	x		
Ipomoea albivenia	Convolvulaceae	creeper					x												x
Ipomoea sp.	Convolvulaceae	creeper												x					
Kalanchoe aff.paniculata/ sexangularis	Crassulaceae	succulent	(LC)			x													
Cucurbitaceae sp.1	Cucurbitaceae	creeper				x	x												
Cucurbitaceae sp.2	Cucurbitaceae	creeper				x													
Diospyros mespiliformis	Ebenaceae	tree				x	x	x	x	x	x	x	x	x		x	x	x	
Euclea crispa	Ebenaceae	shrub									x					x			
Euclea divinorum	Ebenaceae	tree				x		x	x								x	x	x
Euclea natalensis	Ebenaceae	tree				x				x									
Euclea schimperi	Ebenaceae	tree											x				x		
Acalypha sp.	Euphorbiaceae	herb											x						
Antidesma venosum	Euphorbiaceae	tree										x							
Bridelia mollis	Euphorbiaceae	tree								x	x	x	x	x	x		x	x	x
Croton menyharti	Euphorbiaceae	tree										x							
Delachampia capensis	Euphorbiaceae	herb													x				
Euphorbia cooperi	Euphorbiaceae	succulent																	x
Euphorbia ingens	Euphorbiaceae	succulent									x						x		
Flueggea virosa	Euphorbiaceae	shrub				x	x		x	x	x		x		x		x	x	x
*Jatropha curcas**	Euphorbiaceae	shrub						x											

Phyllanthus reticulatus	Euphorbiaceae	shrub				x		x		x		x		x				x	
Pseudolachnostylis maprouneifolia	Euphorbiaceae	shrub								x			x				x		x
*Ricinus communis**	Euphorbiaceae	herb				x		x	x										
Spirostachys africana	Euphorbiaceae	tree			LEMA	x		x										x	x
Synadenium cupulare	Euphorbiaceae	tree													x				
Tragia meyeriana	Euphorbiaceae	creeper																x	
Tragia sp.	Euphorbiaceae	herb															x		
Abrus laevigatus	Fabaceae	climber												x					
Acacia caffra	Fabaceae	tree														x			
Acacia erubescens	Fabaceae	tree															x		
Acacia exuvialis	Fabaceae	tree											x		x	x		x	
Acacia gerrardii	Fabaceae	tree				x													x
Acacia grandicornuta	Fabaceae	tree														x	x		
Acacia karoo	Fabaceae	tree							x										
Acacia nigrescens	Fabaceae	tree				x	x	x	x	x		x	x		x			x	x
Acacia nilotica	Fabaceae	tree													x				x
Acacia polyacantha	Fabaceae	tree				x			x										
Acacia schweinfurthii	Fabaceae	climber/shrub				x		x											
Acacia tortilus	Fabaceae	tree					x												
Albizia harveyi	Fabaceae	tree							x	x					x			x	
Albizia versicolor	Fabaceae	tree														x	x		
Bauhinia galpinii	Fabaceae	climber/shrub							x					x			x		
Bolusanthus speciosus	Fabaceae	tree					x		x									x	
Cassia abreviata	Fabaceae	shrub															x		
Chaemaecrista mimosoides	Fabaceae	herb					x					x				x			
Colophospermum mopane	Fabaceae	tree				x	x	x	x								x	x	x
Crotalaria laburnifolia	Fabaceae	shrub															x		
Crotalaria sp.1	Fabaceae	dwarf shrub				x	x												
Dalbergia melanoxylon	Fabaceae	tree				x		x	x	x				x	x		x	x	
Dichrostachys cinerea subsp. nyassana	Fabaceae	shrub				x	x	x	x	x	x	x		x	x	x	x	x	x
Indigofera hilaris	Fabaceae	herb								x				x					
Indigofera sp.1	Fabaceae	shrub							x									x	

Mundulea sericea	Fabaceae	tree				x			x					x				x	
Ormocarpum trichocarpum	Fabaceae	shrub							x						x		x		
Peltophorum africanum	Fabaceae	tree				x	x	x							x		x	x	x
Philenoptera violacea	Fabaceae	tree			NFA	x		x	x	x			x					x	x
Piliostigma thonningii	Fabaceae	shrub								x		x							
Pterocarpus angolensis	Fabaceae	tree			NFA					x									
Pterocarpus rotundifolius	Fabaceae	tree					x			x		x		x					x
Rhynchosia caribea	Fabaceae	herb					x											x	
Rhynchosia totta	Fabaceae	herb							x		x			x		x		x	x
Schotia brachypetala	Fabaceae	tree						x		x							x	x	
*Senna bicapsularis**	Fabaceae	shrub						x											
Senna cf.pendulina	Fabaceae	shrub				x													
Senna italica	Fabaceae	shrub						x					x						
Senna petersiana	Fabaceae	tree							x	x	x	x	x	x		x	x		x
Sesbania sesben	Fabaceae	shrub				x													
Tephrosia cf.longipes	Fabaceae	herb														x			
Tephrosia cf.rhodesiaca	Fabaceae	herb												x					
Tephrosia polystachya	Fabaceae	shrub				x		x		x			x					x	
Tephrosia sp.	Fabaceae	herb					x				x								
Xanthocercis zambesiaca	Fabaceae	tree																x	
Zornia linearis	Fabaceae	herb								x									
Scolopia zeyheri	Flacourtiaceae	tree																	x
Monsonia sp.	Geraniaceae	herb								x									
Heteropyxis natalensis	Heteropyxidaceae	tree															x		x
Kirkia acuminata	Kirkiaceae	tree							x	x			x	x	x		x		x
Clerodendrum ternatum	Lamiaceae	dwarf shrub				x	x			x				x				x	x
Hemizygia cf.teucrifolia	Lamiaceae	herb									x								
Hemizygia sp.1	Lamiaceae	herb				x									x			x	
Leonotis intermedia	Lamiaceae	herb								x									
Ocimum americanum	Lamiaceae	herb				x	x	x	x	x	x		x		x		x	x	x
Plectranthus spicatus	Lamiaceae	shrub																x	
Tinnea rhodesiana	Lamiaceae	shrub															x		
Cyphia stenopetala	Lobeliaceae	herb															x		
Tapinanthus rubromarginatus	Loranthaceae	parasite					x												

Tapinanthus sp.	Loranthaceae	parasite																x	
Galpinia transvaalica	Lythraceae	shrub				x													
Sphedamnocarpus pruriens	Malphigiaceae	climber													x				
Abutilon sonneratianum	Malvaceae	shrub				x									x		x	x	
Dombeya rotundifolia	Malvaceae	tree									x	x	x	x		x	x		
Gossypium herbaceum	Malvaceae	herb	LC					x		x				x			x		
Grewia bicolor	Malvaceae	tree				x			x								x		x
Grewia flavescens	Malvaceae	tree				x	x		x				x		x		x	x	x
Grewia hexamita	Malvaceae	tree													x				
Grewia monticola	Malvaceae	tree				x	x	x	x	x		x		x			x	x	x
Hibiscus calyphyllus	Malvaceae	herb				x	x	x										x	
Hibiscus sp.	Malvaceae	herb					x											x	
Hibiscus sp.2 (red, photo)	Malvaceae	herb						x							x				
Hibiscus vitifolius	Malvaceae	herb								x								x	
Melhania didyma	Malvaceae	herb				x	x	x									x	x	
Melhania prostrata	Malvaceae	herb				x			x										
Melhania sp.	Malvaceae	shrub					x												
Sida cordifolia	Malvaceae	dwarf shrub																x	
Sida dregei	Malvaceae	dwarf shrub				x	x												
Waltheria indica	Malvaceae	herb				x	x	x	x	x		x			x	x	x	x	x
Trichilia emetica	Meliaceae	tree				x			x										
Ficus glumosa	Moraceae	tree									x	x							x
Ficus ingens	Moraceae	tree									x								
Ficus salicifolia	Moraceae	tree										x							
Ficus sycamorus	Moraceae	tree				x			x							x			
Olax dissitiflora	Olacaceae	tree															x		
Ximenia americana	Olacaceae	tree							x									x	
Ximenia caffra	Olacaceae	tree					x		x									x	
Jasmimum stenolobium	Oleaceae	climber																x	
Jasminum fluminense	Oleaceae	climber				x											x	x	x
Oxalis obliquifolia	Oxalidaceae	herb					x									x		x	
Argemone ochralencha	Papaveraceae	herb				x													
Adenia digitata	Passifloraceae	climber				x	x												
Ceratotheca triloba	Pedaliaceae	herb						x		x			x						x

Dicerocaryum senecioides	Pedaliaceae	herb					x									x			
Persicaria senegalensis	Polygalaceae	herb				x													
Berchemia discolor	Rhamnaceae	tree															x	x	
Berchemia zeyheri	Rhamnaceae	tree							x	x	x				x			x	x
Ziziphus mucronata	Rhamnaceae	tree				x		x									x	x	
Breonadia salicina	Rubiaceae	tree			NFA												x		
Catunaregum spinosa	Rubiaceae	shrub												x					x
Gardenia volkensii	Rubiaceae	tree				x					x	x						x	
Pavetta schumanniana	Rubiaceae	shrub									x		x	x	x			x	
Psydrax livida	Rubiaceae	shrub												x	x				
Kraussia floribunda	Rubiaceae	shrub													x				
Vangueria infausta	Rubiaceae	tree								x		x		x		x		x	x
Dodonaea angustifolia	Sapindaceae	shrub											x						
Pappea capensis	Sapindaceae	tree								x			x					x	
Aptosimum procumbens	Scrophulariaceae	herb																x	x
Manulea sp.	Scrophulariaceae	herb				x			x						x			x	
Striga asiatica	Scrophulariaceae	herb								x									
Solanum catombelense	Solanaceae	herb											x						
*Solanum incanum**	Solanaceae	herb											x						
*Solanum mauritianum **	Solanaceae	shrub				x													
Solanum panduriforme	Solanaceae	shrub						x			x					x	x	x	
*Solanum seaforthianum **	Solanaceae	climber				x													
Sterculia rogersii	Sterculiaceae	tree											x		x				
Strychnos spinosa	Strychnaceae	tree										x	x	x					x
Pouzolzia mixta	Urticaceae	shrub							x								x		
Urera sp.	Urticaceae	herb				x	x												
*Lantana camara **	Verbenaceae	shrub				x			x									x	
Lantana rugosa	Verbenaceae	shrub					x											x	
Leucas capensis	Verbenaceae	herb						x											
Lippia javanica	Verbenaceae	herb														x			
Lippia wilmsii	Verbenaceae	herb												x					
Priva cordifolia	Verbenaceae	herb																x	
Viscum combreticola	Viscaceae	parasite															x		
Cissus cactiformis	Vitaceae	climber				x									x				

Cissus carnifolia	Vitaceae	climber					x			x									x
Cyphostemma sp.	Vitaceae	creeper					x		x										
Cyphostemma woodii	Vitaceae	creeper								x	x			x					
Rhoicissus revoilii	Vitaceae	climber								x					x				
Rhoicissus tridentata	Vitaceae	climber/shrub													x	x	x	x	
Subtotal		222	4	0	10	71	51	42	52	51	29	28	38	34	51	27	60	83	47
Monocotyledons																			
Albuca sp.	Alliaceae	bulb																	
Boophane disticha	Amaryllidaceae	bulb			LEMA									x	x			x	
Scadoxus sp.	Amaryllidaceae	bulb			LEMA									x					
Chlorophytum sp.	Anthericaceae	bulb								x					x				
Stylochaeton natalense	Araceae	bulb													x			x	
Asparagus angusticladus	Asparagaceae	shrub															x		
Asparagus cf.buchananii	Asparagaceae	shrub																	x
Asparagus cooperi	Asparagaceae	shrub							x	x								x	
Asparagus suaveolens	Asparagaceae	climber					x	x			x							x	
Aloe cf.chabaudii	Asphodelaceae	succulent															x		
Aloe cryptopoda	Asphodelaceae	succulent			NEMA										x				
Aloe greatheadii var.davyana	Asphodelaceae	succulent	LC			x								x				x	
Aloe marlothii	Asphodelaceae	succulent									x						x		
Commelina africana	Commelinaceae	herb									x							x	
Commelina benghalensis	Commelinaceae	herb						x											
Commelina cf.erecta	Commelinaceae	herb																x	
Cyperus cf.rupestris	Cyperaceae	sedge				x													
Cyperus leptocladus	Cyperaceae	sedge				x													
Cyperus sp.	Cyperaceae	sedge					x				x								
Kyllinga alba	Cyperaceae	sedge				x												x	
Sanseviera hyacinthoides	Dracaenaceae	bulb													x				
Ledebouria cf.floribunda	Hyacinthaceae	bulb									x			x				x	
Ansellia (africana) gigantea	Orchidaceae	epiphyte	LC		LEMA						x						x		
Aristida congesta	Poaceae	grass				x	x	x	x	x	x	x		x	x	x	x	x	x
Aristida sciurus	Poaceae	grass					x				x		x	x			x	x	x
Brachiaria serrata	Poaceae	grass															x		
Brachiaria sp.	Poaceae	grass					x			x									

Cymbopogon cf.excavatus	Poaceae	grass					x												
Cynodon dactylon	Poaceae	grass						x			x								
Digitaria eriantha	Poaceae	grass					x			x	x	x		x		x		x	
Enneapogon conchroides	Poaceae	grass				x	x	x		x									
Eragrostis curvula	Poaceae	grass						x	x			x							
Eragrostis gummiflua	Poaceae	grass					x												
Eragrostis superba	Poaceae	grass													x				
Heteropogon contortus	Poaceae	grass				x	x		x	x	x	x	x	x	x		x		
Hyperthelia dissoluta	Poaceae	grass								x	x	x		x		x	x		
Melinis nerviglumis	Poaceae	grass												x					
Melinis repens	Poaceae	grass				x	x		x	x	x	x			x		x		
Panicum maximum	Poaceae	grass				x	x		x	x	x				x		x	x	x
Perotis patens	Poaceae	grass								x	x						x		
Phragmites australis	Poaceae	grass				x			x										
Pogonarthria squarrosa	Poaceae	grass				x	x	x	x	x	x	x		x		x	x	x	
Setaria megaphylla	Poaceae	grass				x													
Setaria sp.	Poaceae	grass									x								
Setaria sphacelata	Poaceae	grass								x									
Sorghum bicolor	Poaceae	grass				x													
Themeda triandra	Poaceae	grass				x	x		x						x			x	x
Tragus berteronianus	Poaceae	grass					x	x		x	x		x			x		x	
Trichoneura grandiglumis	Poaceae	grass								x				x		x			
Urochloa mossambica	Poaceae	grass				x	x	x	x	x		x	x		x	x		x	x
Xerophyta retinervis	Vellociaceae	geophyte							x	x				x	x			x	
Subtotal		51	2	0	4	15	16	9	11	17	18	8	4	13	13	7	13	18	6
Total		**276**	**6**	**0**	**14**	**86**	**67**	**51**	**63**	**68**	**48**	**36**	**42**	**47**	**66**	**34**	**73**	**103**	**53**

Protection Status

NFA = National Forests Act (Act 36 of 1998)

LEMA = Limpopo Environmental Management Act (No. 7 of 2003)

Endemic Status

LIM = Distribution in South Africa confined to Limpopo Province

Red Data Status

LC(D) = Least Concern (Declining); NT = Near Threatened

APPENDIX 4C. CONSERVATION-IMPORTANT PLANT SPECIES LIKELY TO OCCUR IN THE TWO VEGETATION TYPES ASSOCIATED WITH THE PROPOSED DEVELOPMENT FOOTPRINT

Plant Taxon	Interim National Red Data Status (SANBI, 2007)	Protection Status	Endemic Status	Granite Lowveld	Tsende Mopaneveld
Adansonia digitata		NFA		x	x
Afzelia quanzensis		NFA		x	x
Ansellia africana	LC (D)	LEMA		x	x
Balanites maughamii subsp. maughamii		NFA		x	x
Borassus aethiopum	NE	LEMA		x	x
Boscia albitrunca		NFA		x	x
Brachystelma brevipedicellatum		LEMA		x	
Breonadia salicina		NFA		x	x
Catha edulis		NFA		x	x
Ceropegia crassifolia var. crassifolia		LEMA		x	x
Combretum imberbe		NFA		x	x
Elaeodendron transvaalense	LC (D)	NFA		x	x
Eulophia hereroensis		LEMA		x	x
Harpagophytum zeyheri subsp. zeyheri	STBA			x	x
Melinis tenuissima		LEMA		x	x
Merwilla plumbea	LC (D)			x	x
Mondia whitei	NT	LEMA		x	
Nymphaea lotus		LEMA		x	
Orbea rogersii		LEMA			x
Orbeopsis lutea subsp. lutea		LEMA		x	
Philenoptera violacea		NFA		x	x

Pilotrichella pandurifolia			LEMA		x	x
Pittosporum viridiflorum			NFA		x	x
Pterocarpus angolensis			NFA		x	x
Sclerocarya birrea subsp. caffra			NFA		x	x
Sericanthe andongensis var. andongensis				LIM	x	x
Spirostachys africana			LEMA		x	x
Stapelia gettliffei			LEMA		x	x
Tavaresia meintjesii			LEMA		x	x
Xylopia parviflora			LEMA		x	x
TOTALS:	**27**	**6**	**27**	**1**	**29**	**26**

Protection Status
NFA = National Forests Act (Act 36 of 1998)
LEMA = Limpopo Environmental Management Act (No. 7 of 2003)
Endemic Status
LIM = Distribution in South Africa confined to Limpopo Province
Red Data Status
STBA = Status to be announced
LC(D) = Least Concern (Declining)
NE = Not Evaluated in Oct 2007
NT = Near Threatened

APPENDIX 4D. PLANT SPECIES USED BY LOCAL RESIDENTS OF THE PROJECT AREA

Scientific Name	Local Name	Use*	Plant Consumption	Plant Availability
Acacia nigrescens	Nkaya	Md, Ut	High	abundant
Acacia schweinfurthii	Renatlo	Md, Ut	Med	abundant
Berchemia discolor	Nyiri	Fd	High	moderate
Cassia abbreviata	Numanyama	Md	High	scarce
Colophospermum mopane	Xanatsi	Fd, Ut	High	abundant
Combretum hereroense	Xikhavi	Md	High	abundant
Combretum imberbe	Mondzo	Md	High	abundant
Cucumis sp.	Kaka	Md, Fd	High	abundant
Dalbergia melanoxylon	Nyatelo	Md	High	abundant
Dicrostachys cinerea	Ndzenga	Md, Ut	High	abundant
Diospyros mespiliformis	Ntoma	Md, Fd	High	abundant
Euphorbia tirucalli	Neta	Md	Med	abundant
Ficus sycamorus	Nkuwa	Md, Fd	High	abundant
Flueggea virosa	Sangasi	Md, Fd	High	abundant
Grewia flavescens	Nsihana	Md, Fd	High	abundant
Gymnosporya glaucophylla	Xihlangwa	Md	High	abundant
Juncus krausii	inHlanhla	Ut	High	abundant
Lantana camara	iTyabi abalungu	Md, Fd	High	abundant
Maytenus undata	eLum	Md	High	abundant
Philenoptera violacea	Mbhandzu	Md	High	abundant
Pupalea lapacea	erNawa	Md	High	abundant
Ricinus communis	Hlamfura	Md	Med	abundant
Schotia brachypetala	Chochelamandleni	Md, Fd	High	scarce
Sclerocarya birrea	Nkanyi	Fd	High	abundant

Spirostachys africana	Ndzopfori	Md	Med	abundant
Stephania abyssinica	Nyaka umThando	Md	High	moderate
Sterculia rogersii	Xpopa	Md	High	scarce
Strychnos spinosa	Nsala	Md, Fd	High	scarce
Trichilia emetica	Nkuhlu	Md	High	abundant
Ximenia americana	Ntsengele-lowu-ntsanana	Md, Fd	High	abundant
Ziziphus mucronata	Mphasamhala	Md, Fd	High	abundant

* Md = Medicinal, Fd = Food, Ut = Utility

APPENDIX 4E. VERTEBRATE FAUNA SPECIES RECORDED IN FOUR VEGETATION COMMUNITIES OF THE PROJECT AREA

Common Name	Scientific Name	Red Data	Endemic	Protected	*Acacia - Combretum* Riverine Woodland	*Colophospermum - Dichrostachys* Plains Woodl.	*Combretum - Bridelia* Rocky Outcrop Woodland	Artificial Wetlands
Mammals								
Cape Porcupine	*Hystrix africaeaustralis*					x		
Chacma Baboon	*Papio hamadryas*					x	x	
Common Warthog	*Phacochoerus africanus*				x			
Greater Kudu	*Tragelaphus strepsiceros*					x		
Grey Duiker	*Sylvicapra grimmia*				x	x		
Hippopotamus	*Hippopotamus amphibius*			LEMA	x			x
Red Veld Rat	*Aethomys ineptus*					x		
Scrub Hare	*Lepus saxatilis*					x		
Steenbok	*Raphicerus campestris*			LEMA		x	x	
Tree Squirrel	*Paraxerus cepapi*				x	x	x	
Vervet Monkey	*Cercopithecus pygerythrus*				x	x		
Subtotal	11	0	0	2	5	9	3	1
Birds								
Acacia Pied Barbet	*Tricholaema leucomelas*					x		
African Darter	*Anhinga rufa*							x
African Fish-Eagle	*Haliaeetus vocifer*				x			x
African Green-Pigeon	*Treron calvus*				x	x		
African Grey Hornbill	*Tockus nasutus*				x	x		
African Harrier-Hawk	*Polyboroides typus*				x			
African Hoopoe	*Upupa africana*					x		
African Jacana	*Actophilornis africanus*							x
African Paradise-Flycatcher	*Terpsiphone viridis*				x	x		
African Pied Wagtail	*Motacilla aguimp*							x
African Pygmy-Kingfisher	*Ispidina picta*				x	x		
Arrow-marked Babbler	*Turdoides jardineii*				x	x		
Ashy Flycatcher	*Muscicapa caerulescens*				x			
Barn Swallow	*Hirundo rustica*				x	x	x	x
Bearded Woodpecker	*Dendropicos namaquus*					x		
Black (Yellow-billed) Kite	*Milvus migrans*					x	x	x
Black Cuckoo	*Cuculus clamosus*					x		
Black Cuckooshrike	*Campephaga flava*				x	x		
Black Stork	*Ciconia nigra*	NT				x		

Common Name	Scientific Name	Red Data	Endemic	Protected	*Acacia - Combretum* Riverine Woodland	*Colophospermum - Dichrostachys* Plains Woodland	*Combretum - Bridelia* Rocky Outcrop Woodland	Artificial Wetlands
Mammals								
Cape Porcupine	*Hystrix africaeaustralis*					x		
Chacma Baboon	*Papio hamadryas*					x	x	
Common Warthog	*Phacochoerus africanus*				x			
Greater Kudu	*Tragelaphus strepsiceros*					x		
Grey Duiker	*Sylvicapra grimmia*				x	x		
Hippopotamus	*Hippopotamus amphibius*			LEMA	x			x
Red Veld Rat	*Aethomys ineptus*					x		
Scrub Hare	*Lepus saxatilis*					x		
Short-snouted Elephant Shrew	*Elephantulus brachyrhynchus*	DD					x	
Steenbok	*Raphicerus campestris*			LEMA		x	x	
Tree Squirrel	*Paraxerus cepapi*				x	x	x	
Vervet Monkey	*Cercopithecus pygerythrus*				x	x		
Subtotal	12	1	0	2	5	9	4	1
Birds								
Acacia Pied Barbet	*Tricholaema leucomelas*					x		
African Darter	*Anhinga rufa*							x
African Fish-Eagle	*Haliaeetus vocifer*				x			x
African Green-Pigeon	*Treron calvus*				x	x		
African Grey Hornbill	*Tockus nasutus*				x	x		
African Harrier-Hawk	*Polyboroides typus*				x			

African Hoopoe	*Upupa africana*					x		
African Jacana	*Actophilornis africanus*							x
African Paradise-Flycatcher	*Terpsiphone viridis*				x	x		
African Pied Wagtail	*Motacilla aguimp*							x
African Pygmy-Kingfisher	*Ispidina picta*				x	x		
Arrow-marked Babbler	*Turdoides jardineii*				x	x		
Ashy Flycatcher	*Muscicapa caerulescens*				x			
Barn Swallow	*Hirundo rustica*				x	x	x	x
Bearded Woodpecker	*Dendropicos namaquus*					x		
Black (Yellow-billed) Kite	*Milvus migrans*				x	x	x	x
Black Cuckoo	*Cuculus clamosus*					x		
Black Cuckooshrike	*Campephaga flava*				x	x		
Black Stork	*Ciconia nigra*	NT				x		
Black-backed Puffback	*Dryoscopus cubla*				x	x		
Black-collared Barbet	*Lybius torquatus*				x	x	x	
Black-crowned Tchagra	*Tchagra senegalus*				x	x	x	
Black-headed Heron	*Ardea melanocephala*					x		x
Black-headed Oriole	*Oriolus larvatus*				x	x	x	
Black-shouldered Kite	*Elanus caeruleus*					x		
Blacksmith Lapwing	*Vanellus armatus*							x
Blue Waxbill	*Uraeginthus angolensis*				x	x		
Blue-cheeked Bee-eater	*Merops persicus*				x			
Broad-billed Roller	*Eurystomus glaucurus*				x	x		
Bronze Mannikin	*Spermestes cucullatus*						x	
Brown Snake-Eagle	*Circaetus cinereus*				x	x		
Brown-backed Honeybird	*Prodotiscus regulus*					x	x	
Brown-crowned Tchagra	*Tchagra australis*					x	x	
Brown-headed Parrot	*Poicephalus cryptoxanthus*					x		
Brown-hooded Kingfisher	*Halcyon albiventris*				x	x	x	
Brubru	*Nilaus afer*					x	x	
Burchell's Coucal	*Centropus burchelli*					x		
Bushveld Pipit	*Anthus caffer*					x	x	

Cape Glossy Starling	*Lamprotornis nitens*				x	x	x	
Cape Turtle-Dove	*Streptopelia capicola*				x	x	x	
Cape White-eye	*Zosterops virens*		SA		x	x	x	
Cardinal Woodpecker	*Dendropicos fuscescens*					x	x	
Cattle Egret	*Bubulcus ibis*				x	x	x	x
Chestnut-backed Sparrowlark	*Eremopterix leucotis*					x		
Chinspot Batis	*Batis molitor*					x	x	
Cinnamon-breasted Bunting	*Emberiza tahapisi*					x	x	
Collared Sunbird	*Hedydipna collaris*				x			
Common Fiscal	*Lanius collaris*					x		
Common Sandpiper	*Actitis hypoleucos*							x
Common Scimitarbill	*Rhinopomastus cyanomelas*				x	x	x	
Common Waxbill	*Estrilda astrild*				x	x		
Crested Barbet	*Trachyphonus vaillantii*				x	x		
Crowned Lapwing	*Vanellus coronatus*				x			
Dark-capped Bulbul	*Pycnonotus tricolor*				x	x	x	
Diderick Cuckoo	*Chrysococcyx caprius*				x	x	x	x
Egyptian Goose	*Alopochen aegyptiaca*							x
Emerald-spotted Wood-Dove	*Turtur chalcospilos*				x	x	x	
Eurasian Golden Oriole	*Oriolus oriolus*					x		
European Bee-eater	*Merops apiaster*				x	x	x	x
European Roller	*Coracias garrulus*					x		
Fiery-necked Nightjar	*Caprimulgus pectoralis*					x		
Flappet Lark	*Mirafra rufocinnamomea*					x	x	
Fork-tailed Drongo	*Dicrurus adsimilis*				x	x		
Garden Warbler	*Sylvia borin*					x		
Giant Kingfisher	*Megaceryle maximus*				x			x
Golden-breasted Bunting	*Emberiza flaviventris*					x	x	
Golden-tailed Woodpecker	*Campethera abingoni*				x	x	x	
Great Egret	*Egretta alba*							x
Greater Honeyguide	*Indicator indicator*					x	x	
Green Wood-Hoopoe	*Phoeniculus purpureus*				x	x		

Green-backed Heron	*Butorides striata*							x
Green-winged Pytilia	*Pytilia melba*					x		
Grey Go-away-bird	*Corythaixoides concolor*					x		
Grey Heron	*Ardea cinerea*							x
Grey Penduline-Tit	*Anthoscopus caroli*					x		
Grey Tit-Flycatcher	*Myioparus plumbeus*				x			
Grey-backed Camaroptera	*Camaroptera brevicaudata*				x	x		
Grey-headed Bush-Shrike	*Malaconotus blanchoti*				x	x		
Hadeda Ibis	*Bostrychia hagedash*					x		
Hamerkop	*Scopus umbretta*							x
Helmeted Guineafowl	*Numida meleagris*				x	x		
House Sparrow	*Passer domesticus*					x		
Jacobin Cuckoo	*Clamator jacobinus*					x		
Jameson's Firefinch	*Lagonosticta rhodopareia*					x		
Klaas's Cuckoo	*Chrysococcyx klaas*				x	x	x	
Kurrichane Buttonquail	*Turnix sylvaticus*						x	
Kurrichane Thrush	*Turdus libonyanus*					x		
Lanner Falcon	*Falco biarmicus*	NT					x	
Laughing Dove	*Streptopelia senegalensis*				x	x	x	
Lesser Honeyguide	*Indicator minor*					x		
Lesser Masked-Weaver	*Ploceus intermedius*				x	x		x
Lesser Striped Swallow	*Hirundo abyssinica*				x	x	x	x
Lesser Swamp-Warbler	*Acrocephalus gracilirostris*							x
Levaillant's Cuckoo	*Clamator levaillantii*					x		
Lilac-breasted Roller	*Coracias caudatus*					x		
Little Bee-eater	*Merops pusillus*				x		x	
Little Egret	*Egretta garzetta*							x
Little Grebe	*Tachybaptus ruficollis*							x
Little Rush-Warbler	*Bradypterus baboecala*							x
Little Sparrowhawk	*Accipiter minullus*				x			
Little Swift	*Apus affinis*				x	x		x
Lizard Buzzard	*Kaupifalco monogrammicus*					x		

Long-billed Crombec	*Sylvietta rufescens*					x		
Long-tailed Paradise-Whydah	*Vidua paradisaea*					x	x	
Malachite Kingfisher	*Alcedo cristata*				x			x
Marsh Warbler	*Acrocephalus palustris*				x			
Namaqua Dove	*Oena capensis*					x		
Natal Francolin	*Pternistis natalensis*				x	x		
Neddicky	*Cisticola fulvicapilla*					x	x	
Orange-breasted Bush-Shrike	*Telophorus sulfureopectus*				x	x	x	
Orange-breasted Waxbill	*Sporaeginthus subflavus*							x
Osprey	*Pandion haliaetus*							x
Pale Flycatcher	*Bradornis pallidus*					x		
Pied Crow	*Corvus albus*					x	x	
Pied Kingfisher	*Ceryle rudis*				x			x
Pin-tailed Whydah	*Vidua macroura*				x	x		
Purple Heron	*Ardea purpurea*							x
Purple Indigobird	*Vidua purpurascens*					x		
Purple Roller	*Coracias naevius*					x		
Purple-crested Turaco	*Gallirex porphyreolophus*				x			
Rattling Cisticola	*Cisticola chiniana*				x	x	x	
Red-backed Shrike	*Lanius collurio*				x	x		
Red-billed Firefinch	*Lagonosticta senegala*				x	x		
Red-billed Hornbill	*Tockus erythrorhynchus*					x		
Red-billed Quelea	*Quelea quelea*				x			x
Red-breasted Swallow	*Hirundo semirufa*				x			
Red-capped Robin-Chat	*Cossypha natalensis*				x			
Red-chested Cuckoo	*Cuculus solitarius*				x	x		
Red-collared Widowbird	*Euplectes ardens*						x	
Red-eyed Dove	*Streptopelia semitorquata*				x	x	x	
Red-faced Cisticola	*Cisticola erythrops*				x			
Red-faced Mousebird	*Urocolius indicus*					x		
Red-headed Weaver	*Anaplectes melanotis*				x	x		
Reed Cormorant	*Phalacrocorax africanus*							x

Rufous-naped Lark	*Mirafra africana*					x		
Sabota Lark	*Calendulauda sabota*						x	
Scarlet-chested Sunbird	*Chalcomitra senegalensis*				x	x	x	
Shikra	*Accipiter badius*				x			
Sombre Greenbul	*Andropadus importunus*				x	x		
Southern Black Flycatcher	*Melaenornis pammelaina*					x		
Southern Black Tit	*Parus niger*					x		
Southern Boubou	*Laniarius ferrugineus*				x	x		
Southern Carmine Bee-eater	*Merops nubicoides*				x	x		
Southern Grey-headed Sparrow	*Passer diffusus*				x	x	x	
Southern Masked-Weaver	*Ploceus velatus*							x
Southern Red Bishop	*Euplectes orix*							x
Southern White-crowned Shrike	*Eurocephalus anguitimens*					x		
Southern Yellow-billed Hornbill	*Tockus leucomelas*					x		
Speckled Mousebird	*Colius striatus*				x	x		
Spectacled Weaver	*Ploceus ocularis*				x			
Spotted Flycatcher	*Muscicapa striata*					x		
Steppe Buzzard	*Buteo vulpinus*					x		
Stierling's Wren-Warbler	*Calamonastes stierlingi*				x	x	x	
Streaky-headed Seedeater	*Crithagra gularis*						x	
Striped Kingfisher	*Halcyon chelicuti*					x	x	
Swainson's Spurfowl	*Pternistis swainsonii*				x			
Tambourine Dove	*Turtur tympanistria*				x			
Tawny-flanked Prinia	*Prinia subflava*				x	x	x	
Terrestrial Brownbul	*Phyllastrephus terrestris*				x	x		
Thick-billed Weaver	*Amblyospiza albifrons*				x			x
Three-banded Plover	*Charadrius tricollaris*							x
Village Indigobird	*Vidua chalybeata*				x	x		
Violet-backed Starling	*Cinnyricinclus leucogaster*				x	x	x	
Violet-eared Waxbill	*Granatina granatina*					x		
Wahlberg's Eagle	*Aquila wahlbergi*				x			
White-bellied Sunbird	*Cinnyris talatala*				x	x	x	

White-breasted Cormorant	*Phalacrocorax lucidus*							x
White-browed Robin-Chat	*Cossypha heuglini*				x			
White-browed Scrub-Robin	*Cercotrichas leucophrys*				x	x	x	
White-crested Helmet-Shrike	*Prionops plumatus*				x	x	x	
White-faced Duck	*Dendrocygna viduata*							x
White-fronted Bee-eater	*Merops bullockoides*				x			
White-throated Robin-Chat	*Cossypha humeralis*				x	x		
White-winged Widowbird	*Euplectes albonotatus*							x
Willow Warbler	*Phylloscopus trochilus*				x	x		
Wire-tailed Swallow	*Hirundo smithii*				x			x
Wood Sandpiper	*Tringa glareola*							x
Woodland Kingfisher	*Halcyon senegalensis*				x	x		
Yellow-billed Kite	*Milvus aegyptius*				x	x		
Yellow-bellied Eremomela	*Eremomela icteropygialis*					x		
Yellow-bellied Greenbul	*Chlorocichla flaviventris*				x	x		
Yellow-breasted Apalis	*Apalis flavida*				x	x		
Yellow-fronted Canary	*Crithagra mozambicus*				x	x	x	
Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*					x	x	
Yellow-throated Longclaw	*Macronyx croceus*					x	x	
Yellow-throated Petronia	*Petronia superciliaris*					x		
Subtotal	186	2	1	0	97	128	54	41
Reptiles								
Common Flap-neck Chamaeleon	*Chamaeleo dilepis*			NEMBA	x			
Common Flat Lizard	*Platysaurus intermedius*		LP				x	
Common Rough-scaled Lizard	*Ichnotropus squamulosa*						x	
Distant's Ground Agama	*Agama aculeata distanti*		SA			x		
Five-lined Skink	*Trachylepis margaritifer*				x	x	x	
Giant Plated Lizard	*Gerrhosaurus validus*						x	
Leopard Tortoise	*Geochelone pardalis*					x		
Peters' Thread Snake	*Leptotyphlops scutifrons*				x	x		
Puff Adder	*Bitis arietans*				x			
Rock Monitor	*Varanus albigularis*			NEMBA		x		

Speke's Hinged Tortoise	*Kinixys spekei*					x		
Stripe-bellied Sand Snake	*Psammophis subtaeniatus*					x		
Variable Skink	*Trachylepis varia*				x	x	x	
Water Monitor	*Varanus niloticus*			NEMBA	x			x
Subtotal	14	0	2	3	6	8	5	1
Frogs								
Bubbling Kassina	*Kassina senegalensis*				x			x
Bushveld Rain Frog	*Breviceps adspersus*					x		
Common River Frog	*Afrana angolensis*				x			x
Dwarf Puddle Frog	*Phrynobatrachus mababiensis*				x	x		
Eastern Olive Toad	*Amietophrynus garmani*				x	x		
Edible Bullfrog	*Pyxicephalus edulis*			NEMBA	x	x		
Flat-backed Toad	*Amietophrynus maculatus*				x	x		
Guttural Toad	*Amietophrynus gutturalis*							x
Mottled Shovel-nosed Frog	*Hemisus marmoratus*				x			
Raucous Toad	*Amietophrynus rangeri*				x	x		
Red Toad	*Schismaderma carens*				x	x		
Russet-backed Sand Frog	*Tomopterna marmorata*				x			
Southern Foam Nest Frog	*Chiromantis xerampelina*				x	x		
Tremolo Sand Frog	*Tomopterna cryptotis*					x		
Subtotal	14	0	0	1	11	9	0	3
Total		**3**	**3**	**6**	**119**	**154**	**63**	**46**
LP = Limpopo Province endemic								
SA = South African Endemic								
NEMBA = National Environmental Management: Biodiversity Act								
LEMA = Limpopo Environmental Management Act								

APPENDIX 4F. VERTEBRATE FAUNA SPECIES RECORDED IN PROPOSED INFRASTRUCTURE FOOTPRINTS OF THE PROJECT AREA

						BORROW PITS			RESERVOIRS							PIPELINES		
Common Name	Scientific Name	Red Data	Endemic	Protected	DAM BASIN	5	1 & 2	3 & 4	1	2	3	4	5	6 & 7	10	Hlohlokwe	Jasi	Gakomkgwathi
Mammals																		
Cape Porcupine	*Hystrix africaeaustralis*				x												x	
Chacma Baboon	*Papio hamadryas*															x		
Common Warthog	*Phacochoerus africanus*				x													
Greater Kudu	*Tragelaphus strepsiceros*				x													
Grey Duiker	*Sylvicapra grimmia*				x			x								x	x	
Hippopotamus	*Hippopotamus amphibius*			LEMA	x			x										
Red Veld Rat	*Aethomys chrysophilus*				x													
Scrub Hare	*Lepus saxatilis*				x													
Steenbok	*Raphicerus campestris*			LEMA														x
Tree Squirrel	*Paraxerus cepapi*				x													x
Vervet Monkey	*Cercopithecus pygerythrus*				x												x	
Subtotal	11	0	0	2	9	0	0	2	0	0	0	0	0	0	0	2	3	2
Birds																		
Acacia Pied Barbet	*Tricholaema leucomelas*												x					x
African Darter	*Anhinga rufa*				x													
African Fish-Eagle	*Haliaeetus vocifer*				x													
African Green-Pigeon	*Treron calvus*				x												x	
African Grey Hornbill	*Tockus nasutus*						x		x									x
African Harrier-Hawk	*Polyboroides typus*				x													

African Hoopoe	*Upupa africana*				x													
African Jacana	*Actophilornis africanus*				x													
African Paradise-Flycatcher	*Terpsiphone viridis*				x											x	x	x
African Pied Wagtail	*Motacilla aguimp*				x													
African Pygmy-Kingfisher	*Ispidina picta*				x											x		
Arrow-marked Babbler	*Turdoides jardineii*				x													
Ashy Flycatcher	*Muscicapa caerulescens*				x													
Barn Swallow	*Hirundo rustica*				x			x	x	x					x		x	x
Bearded Woodpecker	*Dendropicos namaquus*				x											x		
Black (Yellow-billed) Kite	*Milvus migrans*				x										x			
Black Cuckoo	*Cuculus clamosus*															x		
Black Cuckooshrike	*Campephaga flava*				x											x		x
Black Stork	*Ciconia nigra*	NT														x		
Black-backed Puffback	*Dryoscopus cubla*						x	x	x							x	x	x
Black-collared Barbet	*Lybius torquatus*				x				x							x	x	
Black-crowned Tchagra	*Tchagra senegalus*				x		x		x	x					x	x	x	
Black-headed Heron	*Ardea melanocephala*															x		
Black-headed Oriole	*Oriolus larvatus*				x			x	x				x				x	x
Black-shouldered Kite	*Elanus caeruleus*				x													
Blacksmith Lapwing	*Vanellus armatus*				x												x	
Blue Waxbill	*Uraeginthus angolensis*				x			x	x	x		x			x	x	x	x
Blue-cheeked Bee-eater	*Merops persicus*				x													
Broad-billed Roller	*Eurystomus glaucurus*				x												x	
Bronze Mannikin	*Spermestes cucullatus*												x					
Brown Snake-Eagle	*Circaetus cinereus*				x													
Brown-backed Honeybird	*Prodotiscus regulus*															x		
Brown-crowned Tchagra	*Tchagra australis*				x			x									x	x
Brown-headed Parrot	*Poicephalus cryptoxanthus*																	x
Brown-hooded Kingfisher	*Halcyon albiventris*				x				x								x	x
Brubru	*Nilaus afer*								x							x		
Burchell's Coucal	*Centropus burchelli*																x	
Bushveld Pipit	*Anthus caffer*				x				x				x					

Cape Glossy Starling	*Lamprotornis nitens*				x		x									x	x	
Cape Turtle-Dove	*Streptopelia capicola*				x		x	x	x	x		x			x	x	x	x
Cape White-eye	*Zosterops virens*		E		x			x					x				x	
Cardinal Woodpecker	*Dendropicos fuscescens*				x											x	x	
Cattle Egret	*Bubulcus ibis*				x		x										x	
Chestnut-backed Sparrowlark	*Eremopterix leucotis*																	x
Chinspot Batis	*Batis molitor*							x								x	x	x
Cinnamon-breasted Bunting	*Emberiza tahapisi*								x			x	x			x		x
Collared Sunbird	*Hedydipna collaris*				x													
Common Fiscal	*Lanius collaris*																	x
Common Sandpiper	*Actitis hypoleucos*																x	
Common Scimitarbill	*Rhinopomastus cyanomelas*				x				x									x
Common Waxbill	*Estrilda astrild*				x											x		
Crested Barbet	*Trachyphonus vaillantii*				x		x											x
Crowned Lapwing	*Vanellus coronatus*				x													
Dark-capped Bulbul	*Pycnonotus tricolor*						x	x	x	x			x		x	x	x	
Diderick Cuckoo	*Chrysococcyx caprius*				x		x	x				x	x				x	
Egyptian Goose	*Alopochen aegyptiaca*																x	
Emerald-spotted Wood-Dove	*Turtur chalcospilos*				x			x	x							x	x	x
Eurasian Golden Oriole	*Oriolus oriolus*				x													
European Bee-eater	*Merops apiaster*				x			x		x					x		x	x
European Roller	*Coracias garrulus*							x										
Fiery-necked Nightjar	*Caprimulgus pectoralis*																	x
Flappet Lark	*Mirafra rufocinnamomea*								x	x					x			x
Fork-tailed Drongo	*Dicrurus adsimilis*				x			x	x							x	x	x
Garden Warbler	*Sylvia borin*																	x
Giant Kingfisher	*Megaceryle maximus*				x													
Golden-breasted Bunting	*Emberiza flaviventris*				x			x	x							x		x
Golden-tailed Woodpecker	*Campethera abingoni*				x		x		x							x		
Great Egret	*Egretta alba*				x													
Greater Honeyguide	*Indicator indicator*				x								x					
Green Wood-Hoopoe	*Phoeniculus purpureus*				x													

Green-backed Heron	*Butorides striata*				x													
Green-winged Pytilia	*Pytilia melba*																	x
Grey Go-away-bird	*Corythaixoides concolor*																	x
Grey Heron	*Ardea cinerea*				x													
Grey Penduline-Tit	*Anthoscopus caroli*				x												x	
Grey Tit-Flycatcher	*Myioparus plumbeus*				x													
Grey-backed Camaroptera	*Camaroptera brevicaudata*				x											x	x	
Grey-headed Bush-Shrike	*Malaconotus blanchoti*				x													x
Hadeda Ibis	*Bostrychia hagedash*							x										
Hamerkop	*Scopus umbretta*				x													
Helmeted Guineafowl	*Numida meleagris*				x			x										
House Sparrow	*Passer domesticus*									x		x			x			
Jacobin Cuckoo	*Clamator jacobinus*				x													x
Jameson's Firefinch	*Lagonosticta rhodopareia*				x			x									x	x
Klaas's Cuckoo	*Chrysococcyx klaas*				x								x					x
Kurrichane Buttonquail	*Turnix sylvaticus*								x									
Kurrichane Thrush	*Turdus libonyanus*															x		
Lanner Falcon	*Falco biarmicus*	NT										x						
Laughing Dove	*Streptopelia senegalensis*						x	x	x									x
Lesser Honeyguide	*Indicator minor*																x	
Lesser Masked-Weaver	*Ploceus intermedius*				x												x	
Lesser Striped Swallow	*Hirundo abyssinica*				x		x	x	x									
Lesser Swamp-Warbler	*Acrocephalus gracilirostris*				x													
Levaillant's Cuckoo	*Clamator levaillantii*								x									x
Lilac-breasted Roller	*Coracias caudatus*				x													
Little Bee-eater	*Merops pusillus*				x								x					
Little Egret	*Egretta garzetta*				x					x					x			
Little Grebe	*Tachybaptus ruficollis*				x													
Little Rush-Warbler	*Bradypterus baboecala*				x													
Little Sparrowhawk	*Accipiter minullus*				x													
Little Swift	*Apus affinis*				x													x
Lizard Buzzard	*Kaupifalco monogrammicus*																	x

Long-billed Crombec	*Sylvietta rufescens*				x				x			x					x	x
Long-tailed Paradise-Whydah	*Vidua paradisaea*									x					x	x		x
Malachite Kingfisher	*Alcedo cristata*				x													
Marsh Warbler	*Acrocephalus palustris*				x		x		x							x	x	x
Namaqua Dove	*Oena capensis*																	x
Natal Francolin	*Pternistis natalensis*				x													x
Neddicky	*Cisticola fulvicapilla*								x	x			x		x			x
Orange-breasted Bush-Shrike	*Telophorus sulfureopectus*				x								x			x	x	x
Orange-breasted Waxbill	*Sporaeginthus subflavus*				x													
Osprey	*Pandion haliaetus*				x													
Pale Flycatcher	*Bradornis pallidus*															x		x
Pied Crow	*Corvus albus*											x						
Pied Kingfisher	*Ceryle rudis*				x												x	
Pin-tailed Whydah	*Vidua macroura*				x		x										x	
Purple Heron	*Ardea purpurea*				x													
Purple Indigobird	*Vidua purpurascens*				x													
Purple Roller	*Coracias naevius*							x										
Purple-crested Turaco	*Gallirex porphyreolophus*				x													
Rattling Cisticola	*Cisticola chiniana*				x		x	x	x	x			x		x	x	x	x
Red-backed Shrike	*Lanius collurio*				x			x	x									
Red-billed Firefinch	*Lagonosticta senegala*				x											x		x
Red-billed Hornbill	*Tockus erythrorhynchus*				x													
Red-billed Quelea	*Quelea quelea*				x											x		
Red-breasted Swallow	*Hirundo semirufa*				x													
Red-capped Robin-Chat	*Cossypha natalensis*				x													
Red-chested Cuckoo	*Cuculus solitarius*				x											x		
Red-collared Widowbird	*Euplectes ardens*												x					
Red-eyed Dove	*Streptopelia semitorquata*				x		x						x			x	x	
Red-faced Cisticola	*Cisticola erythrops*				x		x										x	
Red-faced Mousebird	*Urocolius indicus*															x	x	x
Red-headed Weaver	*Anaplectes melanotis*				x													
Reed Cormorant	*Phalacrocorax africanus*				x												x	

Rufous-naped Lark	*Mirafra africana*				x		x		x	x					x		x	
Sabota Lark	*Calendulauda sabota*								x									
Scarlet-chested Sunbird	*Chalcomitra senegalensis*				x				x				x			x	x	
Shikra	*Accipiter badius*				x													
Sombre Greenbul	*Andropadus importunus*				x											x	x	
Southern Black Flycatcher	*Melaenornis pammelaina*																x	x
Southern Black Tit	*Parus niger*				x											x	x	
Southern Boubou	*Laniarius ferrugineus*																x	x
Southern Carmine Bee-eater	*Merops nubicoides*				x												x	
Southern Grey-headed Sparrow	*Passer diffusus*				x		x	x	x								x	
Southern Masked-Weaver	*Ploceus velatus*						x		x									x
Southern Red Bishop	*Euplectes orix*				x		x											
Southern White-crowned Shrike	*Eurocephalus anguitimens*				x													
Southern Yellow-billed Hornbill	*Tockus leucomelas*						x	x										
Speckled Mousebird	*Colius striatus*				x													x
Spectacled Weaver	*Ploceus ocularis*				x		x											
Spotted Flycatcher	*Muscicapa striata*											x						x
Steppe Buzzard	*Buteo vulpinus*				x													
Stierling's Wren-Warbler	*Calamonastes stierlingi*				x			x	x				x			x	x	x
Streaky-headed Seedeater	*Crithagra gularis*									x					x	x		
Striped Kingfisher	*Halcyon chelicuti*												x			x		
Swainson's Spurfowl	*Pternistis swainsonii*						x											
Tambourine Dove	*Turtur tympanistria*				x		x										x	
Tawny-flanked Prinia	*Prinia subflava*				x		x	x	x			x	x			x	x	x
Terrestrial Brownbul	*Phyllastrephus terrestris*																x	x
Thick-billed Weaver	*Amblyospiza albifrons*				x													
Three-banded Plover	*Charadrius tricollaris*				x													
Village Indigobird	*Vidua chalybeata*				x			x								x	x	x
Violet-backed Starling	*Cinnyricinclus leucogaster*				x		x		x				x				x	
Violet-eared Waxbill	*Granatina granatina*				x													
Wahlberg's Eagle	*Aquila wahlbergi*				x													
White-bellied Sunbird	*Cinnyris talatala*				x			x	x			x				x	x	x

White-breasted Cormorant	*Phalacrocorax lucidus*				x													
White-browed Robin-Chat	*Cossypha heuglini*				x													
White-browed Scrub-Robin	*Cercotrichas leucophrys*				x		x	x	x	x			x		x	x	x	x
White-crested Helmet-Shrike	*Prionops plumatus*				x				x							x		
White-faced Duck	*Dendrocygna viduata*				x			x									x	
White-fronted Bee-eater	*Merops bullockoides*				x													
White-throated Robin-Chat	*Cossypha humeralis*				x												x	
White-winged Widowbird	*Euplectes albonotatus*				x													
Willow Warbler	*Phylloscopus trochilus*				x			x								x	x	x
Wire-tailed Swallow	*Hirundo smithii*				x													
Wood Sandpiper	*Tringa glareola*				x													
Woodland Kingfisher	*Halcyon senegalensis*							x									x	
Yellow-billed Kite	*Milvus aegyptius*				x													x
Yellow-bellied Eremomela	*Eremomela icteropygialis*				x											x		x
Yellow-bellied Greenbul	*Chlorocichla flaviventris*				x											x	x	
Yellow-breasted Apalis	*Apalis flavida*				x			x								x	x	
Yellow-fronted Canary	*Crithagra mozambicus*				x		x	x	x	x		x	x		x	x	x	x
Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*				x				x							x		
Yellow-throated Longclaw	*Macronyx croceus*									x					x			
Yellow-throated Petronia	*Petronia superciliaris*							x										
Subtotal	186	2	1	0	132	0	29	36	41	17	0	12	23	0	18	53	64	61
Reptiles																		
Common Flap-neck Chamaeleon	*Chamaeleo dilepis*			NEMBA	x													
Common Flat Lizard	*Platysaurus intermedius*															x		
Common Rough-scaled Lizard	*Ichnotropus squamulosa*												x					
Distant's Ground Agama	*Agama aculeata distanti*				x													
Five-lined Skink	*Trachylepis margaritifer*				x							x				x		
Giant Plated Lizard	*Gerrhosaurus validus*															x		
Leopard Tortoise	*Geochelone pardalis*				x													
Peters' Thread Snake	*Leptotyphlops scutifrons*				x													
Puff Adder	*Bitis arietans*				x													
Rock Monitor	*Varanus albigularis*			NEMBA	x			x										

Stripe-bellied Sand Snake	*Psammophis subtaeniatus*					x												
Speke's Hinged Tortoise	*Kinixys spekei*				x													x
Variable Skink	*Trachylepis varia*				x								x			x		
Water Monitor	*Varanus niloticus*			NEMBA	x													
Subtotal	14	0	0	3	10	1	0	1	0	0	0	1	2	0	0	4	0	1
Frogs																		
Bubbling Kassina	*Kassina senegalensis*				x													
Bushveld Rain Frog	*Breviceps adspersus*					x												
Common River Frog	*Afrana angolensis*				x													
Dwarf Puddle Frog	*Phrynobatrachus mababiensis*				x													
Eastern Olive Toad	*Amietophrynus garmani*				x													
Edible Bullfrog	*Pyxicephalus edulis*			NEMBA	x			x										
Flat-backed Toad	*Amietophrynus maculatus*				x	x												
Guttural Toad	*Amietophrynus gutturalis*				x													
Mottled Shovel-nosed Frog	*Hemisus marmoratus*				x													
Raucous Toad	*Amietophrynus rangeri*				x			x										
Red Toad	*Schismaderma carens*				x			x										
Russet-backed Sand Frog	*Tomopterna marmorata*				x													
Southern Foam Nest Frog	*Chiromantis xerampelina*				x													
Tremolo Sand Frog	*Tomopterna cryptotis*					x												
Subtotal	14	0	0	1	12	3	0	3	0	0	0	0	0	0	0	0	0	0
Total		2	1	6	163	4	29	42	41	17	0	13	25	0	18	59	67	64

APPENDIX 4G: CONSERVATION-IMPORTANT VERTEBRATE FAUNA SPECIES LIKELY TO OCCUR IN THE FOUR VEGETATION COMMUNITIES ASSOCIATED WITH THE PROPOSED DEVELOPMENT FOOTPRINT

Common Name	Scientific Name	Red Data Status	Endemic Status	Protected	*Acacia - Combretum* Riverine Woodland	*Colophospermum - Dichrostachys* Plains Woodland	*Combretum - Bridelia* Rocky Outcrop Woodland	Artificial Wetlands
Mammals								
African Clawless Otter	*Aonyx capensis*			NEMBA	x			x
Southern African Hedgehog	*Atelerix frontalis*	NT		NEMBA		x	x	
African Civet	*Civettictis civetta*			LEMA	x	x	x	
Reddish-grey Musk Shrew	*Crocidura cyanea*	DD			x	x	x	
Tiny Musk Shrew	*Crocidura fuscomurina*	DD			x	x	x	
Lesser Red Musk Shrew	*Crocidura hirta*	DD			x	x	x	
Swamp Musk Shrew	*Crocidura mariquensis*	DD			x			x
Peters' Musk Shrew	*Crocidura silacea*	DD			x	x	x	
Spotted Hyaena	*Crocuta crocuta*	NT		NEMBA		x		
African Marsh Rat	*Dasymys incomtus*	NT			x			x
Nyika Climbing Mouse	*Dendromus nyikae*	NT			x	x	x	
Short-snouted Elephant-Shrew	*Elephantulus brachyrhynchus*	DD			x	x	x	
Gambian Epauletted Fruit Bat	*Epomophorus gambianus*	DD			x	x	x	
African Wild Cat	*Felis silvestris*			LEMA	x	x	x	
South African Galago	*Galago moholi*			LEMA	x	x		
Giraffe	*Giraffa camelopardalis*			LEMA		x		
Woodland Thicket Rat	*Grammomys dolichurus*	DD			x	x	x	
Rock Dormouse	*Graphiurus platyops*	DD					x	

Hippopotamus	*Hippopotamus amphibius*			LEMA	x			x
Sundevall's Leaf-nosed Bat	*Hipposideros caffer*	DD			x	x	x	x
Single-striped Grass-Mouse	*Lemniscomys rosalia*	DD				x		
Serval	*Leptailurus serval*	NT		NEMBA	x	x	x	
Spotted-necked Otter	*Lutra maculicollis*	NT		NEMBA	x			x
Ground Pangolin	*Manis temminckii*	VU		NEMBA	x	x	x	
Honey Badger	*Mellivora capensis*	NT		NEMBA	x	x	x	
Lesser Long-fingered Bat	*Miniopterus fraterculus*	NT			x	x	x	x
Schreibers' Long-fingered Bat	*Miniopterus schreibersii*	NT			x	x	x	x
Rufous Mouse-eared Bat	*Myotis bocagei*	DD			x	x	x	x
Temminck's Hairy Bat	*Myotis tricolor*	NT			x	x	x	x
Welwitsch's Hairy Bat	*Myotis welwitschii*	NT			x	x	x	x
Klipspringer	*Oreotragus oreotragus*			LEMA			x	
Aardvark	*Orycteropus afer*			LEMA	x	x	x	
Greater Galago	*Otolemur crassicaudatus*			LEMA	x	x		
Leopard	*Panthera pardus*			LEMA	x	x	x	
Selous's Mongoose	*Paracynictis selousi*	DD		LEMA	x	x		
Brown Hyaena	*Parahyaena brunnea*	NT		NEMBA		x	x	
Rusty Bat	*Pipistrellus rusticus*	NT			x	x	x	x
African Weasel	*Poecilogale albinucha*	DD			x	x	x	
Jameson's Rock Rabbit	*Pronolagus randensis*			LEMA			x	
Aardwolf	*Proteles cristatus*			LEMA	x	x	x	
Steenbok	*Raphicerus campestris*			LEMA	x	x	x	
Sharpe's Grysbok	*Raphicerus sharpei*			NEMBA	x	x		
Geoffroy's Horseshoe Bat	*Rhinolophus clivosus*	NT			x	x	x	x
Darling's Horseshoe Bat	*Rhinolophus darlingi*	NT			x	x	x	x
Hildebrandt's Horseshoe Bat	*Rhinolophus hildebrandtii*	NT			x	x	x	x
Meller's Mongoose	*Rhynchogale melleri*	DD		LEMA	x	x	x	
Least Dwarf Shrew	*Suncus infinitesimus*	DD			x	x	x	
Greater Dwarf Shrew	*Suncus lixus*	DD			x	x	x	
Lesser Dwarf Shrew	*Suncus varilla*	DD			x	x	x	
Bushveld Gerbil	*Tatera leucogaster*	DD				x	x	

Subtotal	**50**	**36**	**0**	**23**	**44**	**45**	**40**	**15**
Birds								
White-headed Vulture	*Aegypius occipitalis*	VU		NEMBA	x	x	x	
Lappet-faced Vulture	*Aegypius tracheliotus*	VU		NEMBA	x	x	x	
Half-collared Kingfisher	*Alcedo semitorquata*	NT			x			x
African Openbill	*Anastomus lamelligerus*	NT			x			
Ayres's Hawk-Eagle	*Aquila ayresii*	NT					x	
Tawny Eagle	*Aquila rapax*	VU		NEMBA	x	x	x	
Southern Ground-Hornbill	*Bucorvus leadbeateri*	VU		NEMBA	x	x	x	
Red-billed Oxpecker	*Buphagus erythrorhynchus*	NT			x	x	x	
Woolly-necked Stork	*Ciconia episcopus*	NT			x			x
Black Stork	*Ciconia nigra*	NT		NEMBA	x	x	x	x
Corn Crake	*Crex crex*	VU		LEMA		x		
Saddle-billed Stork	*Ephippiorhynchus senegalensis*	EN		NEMBA	x			x
Lanner Falcon	*Falco biarmicus*	NT				x	x	
Lesser Kestrel	*Falco naumanni*	VU		NEMBA		x	x	
African Barred Owlet	*Glaucidium capense*			LEMA	x	x		
White-backed Night-Heron	*Gorsachius leuconotus*	VU		LEMA	x			x
White-backed Vulture	*Gyps africanus*	VU		NEMBA	x	x	x	
Cape Vulture	*Gyps coprotheres*	VU		NEMBA		x	x	
Marabou Stork	*Leptoptilos crumeniferus*	NT			x	x	x	x
Black-bellied Bustard	*Lissotis melanogaster*	NT				x		
Bat Hawk	*Macheiramphus alcinus*	NT		LEMA	x	x	x	x
Yellow-billed Stork	*Mycteria ibis*	NT						x
Hooded Vulture	*Necrosyrtes monachus*	VU		NEMBA	x	x	x	
African Pygmy-Goose	*Nettapus auritus*	NT		LEMA				x
African Finfoot	*Podica senegalensis*	VU		LEMA	x			x
Grey-headed Parrot	*Poicephalus fuscicollis*			LEMA	x	x	x	
Martial Eagle	*Polemaetus bellicosus*	VU		NEMBA	x	x	x	
Greater Painted Snipe	*Rostratula benghalensis*	NT						x
Secretarybird	*Sagittarius serpentarius*	NT				x		
Bateleur	*Terathopius ecaudatus*	VU		NEMBA	x	x	x	

African Grass-Owl	*Tyto capensis*	VU		NEMBA		x		
White-crowned Lapwing	*Vanellus albiceps*	NT		LEMA	x			
Cape White-eye	*Zosterops virens*		E		x	x	x	
Subtotal	**33**	**30**	**1**	**21**	**22**	**22**	**18**	**11**
Reptiles								
Distant's Ground Agama	*Agama (aculeata) distanti*		SA			x	x	
Southern Rock Agama	*Agama atra*		SA				x	
Flap-neck Chamaeleon	*Chamaeleo dilepis*			NEMBA	x	x	x	
Van Dam's Girdled Lizard	*Cordylus vandami*		SA			x	x	
Nile Crocodile	*Crocodylus niloticus*	VU		NEMBA	x			x
Distant's Thread Snake	*Leptotyphlops distanti*		SA		x	x	x	
Cape File Snake	*Mehelya capensis*			LEMA	x	x	x	
Black File Snake	*Mehelya nyassae*			LEMA	x	x	x	
Van Son's Thick-toed Gecko	*Pachydactylus vansoni*		SA				x	
Common Flat Lizard	*Platysaurus intermedius*		LP				x	
Southern African Python	*Python natalensis*	VU		NEMBA	x	x	x	x
Lowveld Dwarf Burrowing Skink	*Scelotes bidigittatus*		LP			x	x	
Rock Monitor	*Varanus albigularis*			LEMA	x	x	x	
Water Monitor	*Varanus niloticus*			LEMA	x			x
Subtotal	**14**	**2**	**7**	**5**	**6**	**8**	**11**	**2**
Frogs								
Giant Bullfrog	*Pyxicephalus adspersus*	NT		NEMBA		x		x
African Bullfrog	*Pyxicephalus edulis*			NEMBA		x		x
Subtotal	**2**	**1**	**0**	**2**	**0**	**2**	**0**	**2**
TOTAL	**99**	**69**	**8**	**51**	**72**	**77**	**69**	**30**

VU = Vulnerable
NT = Near Threatened
SA = South African endemic
LP = Limpopo Province endemic
NEMBA = National Environmental Management: Biodiversity Act
LEMA = Limpopo Environmental Management Act

APPENDIX 4H. IMPORTANCE VALUES OF CONSERVATION-IMPORTANT INVERTEBRATE SPECIES CONFIRMED TO DATE IN PROJECT AREA

COMMON NAME	SPECIES	IUCN Red List status	SA Red Data Status	Endemic status	Protection status	Importance value	*Acacia - Combretum* Riverine Woodland	*Colophospermum - Dichrostachys* Plains Woodland	*Combretum - Bridelia* Rocky Outcrop Woodland
Scorpions									
Flat Rock Scorpion	*Hadogenes troglodytes*	-	-	Widespread	NEMBA	Medium			X
Burrowing Scorpion	*Opistophthalmus glabrifrons*	-	-	Widespread	NEMBA	Medium		X	X
Creeping Scorpion	*Opistacanthus asper*	-	-	Widespread	NEMBA	Medium	X	X	X
Trapdoor and baboon spiders									
Horned Baboon Spider	*Ceratogyrus bechuanicus*	-	-	Widespread	NEMBA	Medium		X	X
Golden Baboon Spider	*Pterinochilus junodi*	-	-	Regional	NEMBA	Medium		X	X
Ground beetles[10]									
Giant Tiger Beetle	*Mantichora latipennis* [NR]	-	-	Widespread	NEMBA	Medium		X	X
Tiger Beetle	*Megacephala regalis vansoni* [VR]	-	-	Local	NEMBA	High		X	
Tiger Beetle	*Dromica oberprieleri* [ER]	-	-	Local	NEMBA	High		X	
Tiger Beetle	*Dromica quadricostata (= costata)* [R]	-	-	Regional	NEMBA	Medium		X	X
Tiger Beetle	*Dromica lepidula* [R]	-	-	Regional	NEMBA	Medium	X	X	X

[10] Rarity ***in collections*** (according to Werner 2000) is indicated in brackets: NR = not rare, R = rare, VR = very rare, ER = extremely rare; since many of these beetle species are fast-moving and difficult to capture, this does not necessarily indicate rarity in the field.

Tiger Beetle	*Dromica tenella* [NR]	-	-	Widespread	NEMBA	Medium	X	X	X
Tiger Beetle	*Dromica concinna* [R]	-	-	Widespread	NEMBA	Medium		X	
Tiger Beetle	*Dromica kolbei* [R]	-	-	Widespread	NEMBA	Medium	X	X	
TOTAL	**13**	**0**	**0**	**2**	**13**		**4**	**12**	**9**

1. IUCN categories (brackets indicate meets criteria, but formal evaluation still in progress): EN = Endangered VU = Vulnerable DD = Data Deficient LC = Least Concern	**2**. SA Red data categories: RE = Regionally Extinct CR = Critically Endangered NT = Near-threatened VU = Vulnerable	**3**. Degree of endemism: note that some of the beetle species may be locally rather than regionally endemic, but insufficient data is available at present to substantiate this; their importance values may thus be slightly underestimated here.	**4**. Protection status: **NEMBA** = Included on current list of threatened and protected species in terms of National Environmental Management: Biodiversity Act. Restricted activities involving species on this list will be regulated from 1 June 2007.	Probability of occurrence: - = none/very low X = low XX = medium XXX = high

* All species of concern predicted for this vegetation type would be expected to inhabit only the periphery of the wetlands.

Note that

- **additional species may be included once identifications have been completed; only those definitely confirmed have been listed.**

APPENDIX 4I. VEGETATION COMMUNITIES WITHIN THE GLEWAP PROJECT AREA

Photo 1. *Acacia – Combretum* Riparian Woodland (Janetsi 463 LT).

Photo 2. *Colophospermum* – *Dichrostachys* Plains Woodland (La Motte 464 LT)

Photo 3. *Combretum – Bridelia* Rocky Outcrop Woodland (Sirulurul 427 LT)

APPENDIX 4J. MISCELLANEOUS PHOTOGRAPHS WITHIN THE GLEWAP PROJECT AREA

Photo 4. Willan Walk-in Live Trap

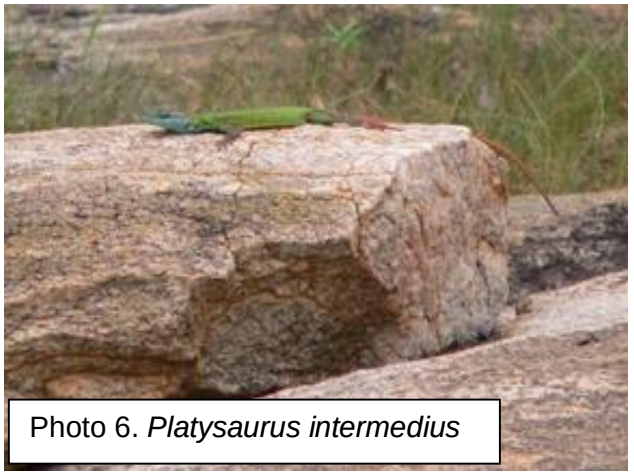

Photo 6. *Platysaurus intermedius*

Photo 5. Drift Fence and Pit-fall Trap

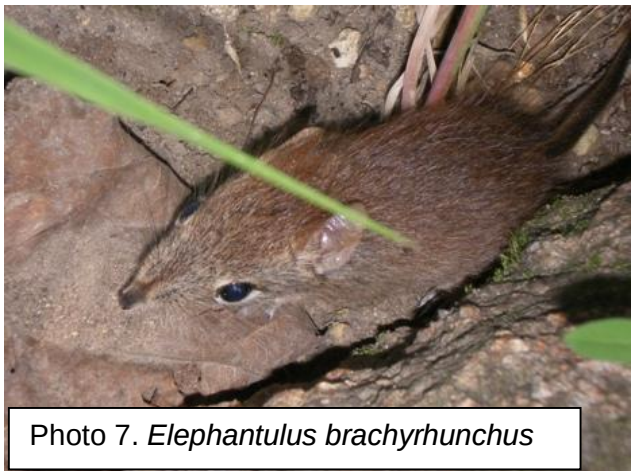

Photo 7. *Elephantulus brachyrhunchus*

APPENDIX 4K. REHABILITATION GUIDELINES FOR BORROW PITS AND CONSTRUCTION CAMPS

The following guidelines are based on the Department of Water Affairs & Forestry's *Integrated Environmental Management Series* 6: Environmental Best Practice Specifications for Construction Sites. However, it is not a comprehensive overview of the Department Guidelines. The Construction Contractor should have a copy of DWAF (2005) and should be assisted by an Environmental Control Officer in this regard.

Construction Phase

- Erect perimeter fence around borrow pits and construction camp, in order to prevent access into sensitive no-go areas.
- Any conservation-important species within the sites should be identified and removed to adjacent habitat.
- Plants should be placed in an on-site nursery where they can be tended until rehabilitation takes place. The nursery should be fenced and equipped with its own water supply. It should also be stocked with appropriate equipment, topsoil and compost. Trained staff should tend to plants delivered to nursery.
- Topsoil should be stockpiled separately from overburden; piles not to exceed 2 metres in height and not exceed a slope of 1:3. These stockpiles should not be stored for longer than 6 months and should be protected against erosion and weeds.
- Allow local communities to remove vegetation from affected areas prior to strip-clearing of vegetation.
- Minimise flow of surface water into borrow pits through use of earth berms or sandbags.

Closure Phase (Rehabilitation)

- Demolish and remove any infrastructure in construction camp.
- Backfill borrow pits with rubble and overburden. Shape all backfilled areas to appear similar to adjacent topography.
- Replace and redistribute stockpiled topsoil. Shape topsoil to blend in with surroundings.
- Rip and scarify topsoil within borrow pits as well disturbed surfaces within construction camp site.
- Suitably experienced contractor to transplant suitable plants from nursery, ensuring that plants are returned to applicable micro-habitats. Other areas to be planted through hydro-seeding with a seed mix slurry. Appropriate grasses and recommended application rates are:

GRASS SPECIES	COMMON NAME	APPLICATION RATE (KG/HA)
Anthephora pubescens	Wool grass	5
Cenchris ciliaris	Blue buffalo grass	4

Chloris gayana	Rhodes grass	4
Cynodon dactylon	Couch grass	5
Digitaria eriantha	Smutsfinger grass	8
Eragrostis curvula	Weeping lovegrass	4
Eragrostis tef	Teff	8
Panicum maximum	Guinea grass	6
Total		44

Rehabilitated areas should be maintained by experienced landscape contractors for up to a year after closure in order to ensure successful rehabilitation of vegetation